Biological Opinion and Conservation Review

Consultation History

Discussions concerning consultation on the Solar Energy Program commenced in August, 2009. The Fish and Wildlife Service (FWS) and BLM met repeatedly in the following months to consider a strategy to complete programmatic consultation. On February 2, 2012, BLM requested initiation of consultation and later that month BLM and FWS signed a consultation agreement expressing expected outcomes and a schedule for completing consultation. Since then staff of the two agencies have convened teleconferences approximately once a week to discuss details of the consultation and progress toward completion. Our review and biological opinion rely upon those discussions, the programmatic Environmental Impact Statement prepared in connection with the program, and a Biological Assessment and Conservation Assessment provided by BLM. This document was prepared in the FWS Division of Consultation, Habitat Conservation Plans, Recovery, and State Grants based on materials provided by FWS Regions 2, 6, and 8.

Programmatic Biological Opinion

Description of the Proposed Action

The Bureau of Land Management (BLM) proposes establishing a Solar Energy Program by amending land use plans in 6 southwestern States (Arizona, California, Colorado, Nevada, New Mexico, and Utah). The amendments would exclude certain areas from availability for utility-scale solar energy development, identify Solar Energy Zones (SEZs) within which utility-scale solar energy development would be a priority use, and establish design features that would be applicable to all future utility-scale solar energy development on BLM-administered lands. Seventeen SEZs are currently proposed comprising 285,000 acres (1,153 km^2).

Scope

As part of this consultation, the agencies have agreed to conduct a conservation review of the program pursuant to section 7(a)(1) of the Endangered Species Act and a formal consultation under section 7(a)(2) of the Act regarding the effects of designating the SEZs. It is understood that subsequent solar development projects within SEZs or elsewhere will be examined for effects to listed species and critical habitat and where appropriate will be subject to the consultation requirements of section 7. This programmatic biological opinion was prepared in accordance with the July 16, 2003, guidance for programmatic-level consultations (FWS 2003) as described below.

Programmatic consultations can provide the benefit of streamlining the consultation process while leading to a more landscape-based approach to consultations that can minimize the potential “piecemeal” effects that can occur when evaluating individual projects out of the context of a complete agency program. Due to the number of potential solar energy projects and lack of project-level information, a tiered-programmatic approach has been taken by the FWS in an attempt to analyze the effects to listed species at the level of the SEZ and streamline future consultations. This programmatic biological opinion does not exempt incidental take of any existing or future action.

The tiered approach is a two-stage consultation process. The first stage evaluates the landscape-level effects. The second stage results in the completion of project-specific documentation that addresses the specific effects of each individual project. Under the tiered approach, two complete biological opinions are required for each proposed action, with the second-stage documents "tiering" to the first-stage document by incorporating portions of it by reference. Thus each action has its own individual consultation document that is supported by the programmatic document.

As individual projects are proposed under the tiered programmatic consultation approach, project-specific information will be provided that: (1) describes each proposed action and the specific areas to be affected; (2) identifies the species and critical habitat that may be affected; (3) describes the manner in which the proposed action may affect listed species; (4) describes the anticipated effects; (5) specifies whether the anticipated effects from the proposed project are consistent with those analyzed in the programmatic biological opinion; (6) describes proposed measures to minimize potential effects of the action; and (7) describes any additional effects, if any, not considered in the programmatic consultation. The FWS reviews this information and then completes a tiered biological opinion with a project-specific incidental take statement. This document, while meeting the basic requirements of biological opinions as specified at 50 CFR 402.14(h), generally requires less effort to complete because it references back, or tiers, to the program-level biological opinion.

Description of the Action Area

The action area includes all areas within the boundaries of the SEZs; access roads and power transmission lines; and desert tortoise translocation areas including recipient and control sites (if determined to be necessary during project-specific analyses). We chose to include a 0.5-mile area adjacent to and surrounding each SEZ to fully capture direct and indirect effects to tortoises with home ranges that overlap the SEZs. The action area for the access roads and transmission lines is not fully known but will be determined during planning for future projects and evaluated in project-level consultation. This inclusion of areas adjacent to the SEZs is consistent with similar actions and consultations. No projects or other disturbance beyond power transmission and access are anticipated to occur outside the SEZ boundaries. Because we do not know the location of all future project-related areas outside the SEZs, our analysis of the environmental baseline and effects in this programmatic consultation is limited to general information provided by BLM. A thorough, project-level analysis will be performed when a given project is proposed and a request for consultation has been submitted to the Service, at which time incidental take may be exempted, as appropriate.

The programmatic action area also encompasses the hydrographic basins that support habitat for the entire range of the Moapa dace, Devils Hole pupfish, Amargosa niterwort, Ash Meadows blazing-star, Ash Meadows gumplant, Ash Meadows ivesia, Ash Meadows milkvetch, Ash Meadows sunray, spring-loving centaury, Ash Meadows naucorid, Ash Meadows amargosa pupfish, Ash Meadows speckled dace, and Warm Springs pupfish. The action area also includes the hydrographic basins that support habitat within a portion of the range for the Hiko White River springfish, White River springfish, and Pahranagat roundtail chub. All these would potentially be affected by project-related groundwater withdrawals.

Assumptions

The following assumptions regarding future consultation (second stage) are incorporated into this programmatic biological opinion:

1. Analysis for site-specific actions proposed in SEZs that are likely to result in adverse effects to listed species will be submitted to FWS pursuant to section 7 or section 10 of the Act, as appropriate.

2. Specific actions that the Federal permitting agency or FWS determines may affect listed species will undergo consultation according to section 7(a)(2). These actions will be assessed on their own merits and be evaluated relative to the jeopardy and adverse modification criteria of the Act, as appropriate.

3. Specific actions that do not have a Federal nexus but may result in adverse effects to listed species may require a section 10 incidental take permit. These actions will be assessed on their own merits and be evaluated relative to the jeopardy and adverse modification criteria and section 10 issuance criteria of the Act, as appropriate.

4. FWS will provide guidance on future site-specific actions in order to ensure that the project description is consistent with our biological opinion, so that our determination remains valid.

Results of the Biological Assessment

The Biological Assessment identified 17 species as likely to be adversely affected by solar development within the SEZs: desert tortoise (*Gopherus agassizii*), Amargosa niterwort (*Nitrophila mohavensis*), Ash Meadows blazing-star (*Mentzelia leucophylla*), Ash Meadows gumplant (*Grindelia fraxino-pratensis*), Ash Meadows ivesia (*Ivesia eremica*), Ash Meadows milkvetch (*Astragalus phoenix*), Ash Meadows sunray (*Enceliopsis nudicaulis* var. *corrugata*), spring-loving centaury (*Centaurium namophilum*), Ash Meadows naucorid (*Ambrysus amargosus*), Ash Meadows amargosa pupfish (*Cyprinodon nevadensis mionectes*), Ash Meadows speckled dace (*Rhinichthys osculus nevadensis*), Devils Hole pupfish (*Cyprinodon diabolis*), Moapa dace (*Moapa coriacea*), Warm Springs pupfish (*Cyprinodon nevadensis pectoralis*), White River springfish (*Crenichthys baileyi baileyi*), Hiko White River springfish (*Crenichthys baileyi* *grandis*), and Pahranagat roundtail chub (*Gila robusta jordani*). The Biological Assessment also found that the proposed action may affect but is not likely to adversely affect the following species: northern aplomado falcon (*Falco femoralis septentrionalis*), Utah prairie dog (*Cynomys parvidens*), Pahrump poolfish (*Empetrichthys latos*), southwestern willow flycatcher (*Empidonax trailllii extimus*), Mexican spotted owl (*Strix occidentalis lucida*), and Yuma clapper rail (*Rallus longirostris yumanensis*). Effects to all these species are addressed in this Biological Opinion.

Concurrences and other Determinations

We concur with BLM determinations that the proposed action may affect, but is not likely to adversely affect the southwestern willow flycatcher and its critical habitat, Yuma clapper rail, Mexican spotted owl and critical habitat, Utah prairie dog, and Pahrump poolfish for the following reasons:

Southwestern willow flycatcher with currently designated and proposed critical habitat

- Implementation of conservation measures will ensure the effects of development of solar energy facilities within the designated Solar Energy Zones (SEZs) and associated transmission lines and access roads to Southwestern willow flycatcher are insignificant because: pre-disturbance surveys for the southwestern willow flycatcher would be conducted by qualified biologists within the SEZ, and within access road corridors if necessary, to determine the presence of the southwestern willow flycatcher and its breeding habitat; if the species is found within any potential development areas, those locations would be avoided and adequate setback distances would be established; pre-disturbance coordination with the Service would be conducted to determine the potential for breeding southwestern willow flycatcher to occur outside of the proposed project area, but within the area of potential indirect effects; if the Service determines that the species may be indirectly affected by development, solar facilities and access roads should be constructed at appropriate setback distances or other actions, established through coordination with the Service, would be taken that are necessary to reduce the potential for indirect effects; design criteria will minimize effects to groundwater elevations supporting habitat; development upslope of any nearby inhabited locations would be prohibited to prevent site runoff from affecting inhabited areas; noise and lighting restrictions, established through coordination with the Service, would also be implemented in efforts to avoid disturbing nearby individuals; projects would be sited and designed to avoid direct and indirect impacts on habitats that may be utilized by the southwestern willow flycatcher, including waters of the United States, streams (ephemeral, intermittent, and perennial), springs, seeps, ponds and other aquatic habitats, riparian habitat, marshes, and playas.

- Effects to critical habitat are insignificant because the likelihood of direct or indirect interaction between the proposed action and primary constituent elements is low. Design criteria will minimize effects to groundwater elevations supporting habitat. Any effects from transmission line crossings of riparian habitat would be localized and minimized through spanning of the habitat.

Yuma clapper rail

- Implementation of conservation measures will ensure the effects of development of solar energy facilities within the designated Solar Energy Zones (SEZs) and associated transmission lines and access roads to Yuma clapper rail are insignificant because: pre-disturbance surveys for the Yuma clapper rail would be conducted by qualified biologists within the SEZ, and within access road corridors if necessary, to determine the presence of the species and its habitat; if the species is found within any potential development areas, those locations would be avoided and adequate setback distances would be established; projects would be sited and designed to avoid direct and indirect impacts on habitats that may be utilized by the Yuma clapper rail, including waters of the United States, streams (ephemeral, intermittent, and perennial), springs, seeps, ponds and other aquatic habitats, riparian habitat, marshes, and playas.

Mexican spotted owl and critical habitat

- Effects to Mexican spotted owl are insignificant because the likelihood of direct or indirect interaction between the proposed action and owls is low as there is no suitable habitat on the SEZs and the nearest breeding habitat is at least 35 miles away.

- There will be no effects to critical habitat as there is no critical habitat within the project area.

Utah prairie dog

We conclude that the program may affect, but is not likely to adversely affect this species. We base our determination on required measures agreed upon during the consultation process, namely the following:

- Surface occupancy or other surface disturbing activities will be avoided within 0.5 mile of active prairie dog colonies.

- Permanent surface disturbances or facilities will be avoided within 0.5 mile of potentially suitable, unoccupied prairie dog habitat, identified and mapped by the Utah Division of Wildlife Resources.

  The Conservation Measures (section 1.1) will be followed during all solar energy development activities within the Solar Energy Zones (SEZ's), along with all of the measures described in Section 2.2 (2.2.1-2.2.7) "Required Programmatic Design Features." If site specific operational plans can not adhere to all applicant committed conservation measures, consultation under section 7 of the Endangered Species Act will be initiated.

Pahrump poolfish

We concur with BLM's determination that the remoteness of its habitat from the nearest SEZ renders any adverse effect unlikely.

Northern aplomado falcon

We agree that no adverse effects are likely. As an experimental population, the falcon is treated as a species proposed to be listed for purposes of section 7, and no concurrence from FWS is required.

ANALYTICAL FRAMEWORK FOR THE JEOPARDY AND ADVERSE MODIFICATION DETERMINATIONS

Section 7(a)(2) of the Endangered Species Act (Act) requires that Federal agencies ensure that any action they authorize, fund, or carry out is not likely to jeopardize the continued existence of listed species. "Jeopardize the continued existence of" means to engage in an action that reasonably would be expected, directly or indirectly, to reduce appreciably the likelihood of both the survival and recovery of a listed species in the wild by reducing the reproduction, numbers, or distribution of that species (50 CFR §402.02).

The jeopardy analysis in this biological opinion relies on four components:

1. The status of the species, which describes the rangewide condition of the desert tortoise and groundwater dependent species, the factors responsible for that condition, and their survival and recovery needs;
2. The environmental baseline, which analyzes the condition of the desert tortoise and groundwater dependent species in the action area, the factors responsible for that condition, and the relationship of the action area to the survival and recovery of those species;
3. The effects of the action, which determine the direct and indirect impacts of the proposed Federal action and the effects of any interrelated or interdependent activities on the desert tortoise and groundwater dependent species and designated critical habitat; and
4. The cumulative effects, which evaluates the effects of future, non-Federal activities in the action area on the desert tortoise and groundwater dependent species.

In accordance with policy and regulation, the jeopardy determination is made by evaluating the effects of the proposed Federal action in the context of the rangewide status of the desert tortoise and groundwater dependent species, taking into account any cumulative effects in the action area, to determine if implementation of the proposed action is likely to cause an appreciable reduction in the likelihood of both the survival and recovery of the desert tortoise and groundwater dependent species in the wild. For the purposes of making the jeopardy determination, the analysis in this biological opinion places an emphasis on consideration of the rangewide survival and recovery needs of the desert tortoise and groundwater dependent species and the role of the action area in the survival and recovery of the desert tortoise and groundwater dependent species as the context for evaluating the significance of the effects of the proposed Federal action, together with cumulative effects.

Section 7(a)(2) of the Act also requires that Federal agencies ensure that any action they authorize, fund, or carry out does not result in the destruction or adverse modification of designated critical habitat. This biological opinion does not rely on the regulatory definition of “destruction or adverse modification” of critical habitat at 50 CFR 402.02. Instead, we have relied upon the statutory provisions of the ESA to complete the following analysis with respect to critical habitat.

In accordance with policy and regulation, the adverse modification analysis in this biological opinion relies on four components:

1. The Status of Critical Habitat, which evaluates the range-wide condition of designated critical habitat for the groundwater dependent species (those species that have critical habitat designated) in terms of primary constituent elements (PCEs), the factors responsible for that condition, and the intended recovery function of the critical habitat overall;

2. The Environmental Baseline, which evaluates the condition of the critical habitat in the action area, the factors responsible for that condition, and the recovery role of the critical habitat in the action area;

3. The Effects of the Action, which determines the direct and indirect impacts of the proposed Federal action and the effects of any interrelated or interdependent activities on the PCEs and how that will influence the recovery role of affected critical habitat units; and

4. Cumulative effects, which evaluates the effects of future, non-Federal activities in the action area on the PCEs and how that will influence the recovery role of affected critical habitat units.

For purposes of the adverse modification determination, effects of the proposed Federal action critical habitats of groundwater dependent species are evaluated in the context of the range-wide condition of the critical habitat, taking into account any cumulative effects, to determine if the critical habitat range-wide would remain functional (or would retain the current ability for the PCEs to be functionally established in areas of currently unsuitable but capable habitat) to serve its intended recovery role for the groundwater dependent species.

The analysis in this biological opinion places an emphasis on using the intended range-wide recovery function of groundwater dependent species critical habitat and the role of the action area relative to that intended function as the context for evaluating the significance of the effects of the proposed Federal action, taken together with cumulative effects, for purposes of making the adverse modification determination.

Status of the Species/Critical Habitat Rangewide

1. Status of the Desert Tortoise

On August 20, 1980, the Service published a final rule listing the Beaver Dam Slope population of the desert tortoise in Utah as threatened and designated 16,640 acres of BLM-administered land as critical habitat (45 *Federal Register* 55654). Major threats to the species identified in the rule included habitat destruction through development, overgrazing, and geothermal development, collection for pets, malicious killing, road kills, and competition with grazing or feral animals. In 1984, Defenders of Wildlife, Natural Resources Defense Council, and Environmental Defense Fund petitioned the Service to list the species as endangered. The following year, we determined that listing the desert tortoise as endangered was warranted, but higher priorities precluded any action.

In 1989, more information regarding threats to desert tortoises became available prompting the Service to publish an emergency rule listing the Mojave population (all desert tortoises north and west of the Colorado River) as endangered (54 *Federal Register* 32326). On April 2, 1990, the Service determined the Mojave population of the desert tortoise to be threatened (55 *Federal Register* 12178). Reasons for the determination included significant population declines, loss of habitat from construction projects such as roads, housing and energy developments, and conversion of native habitat to agriculture. Livestock grazing and off-highway vehicle (OHV) use were identified as factors causing degradation of additional habitat. Also cited as threatening the desert tortoise's continuing existence were: illegal collection by humans for pets or consumption; upper respiratory tract disease; predation on juvenile desert tortoises by common ravens, coyotes, and kit foxes; fire; and collisions with vehicles on paved and unpaved roads.

The species was listed as threatened under the California Endangered Species Act in 1989 and is considered a species at risk under California's Wildlife Action Plan (Bunn *et al.* 2006). California Department of Fish and Game manages over 48,000 acres of land for the conservation of the desert tortoise, and additional lands acquired as mitigation for projects that result in impacts to the species. The Mojave desert tortoise is protected by state regulations in Nevada, Arizona, and Utah.

On February 8, 1994, the Service designated approximately 6.4 million acres of critical habitat for the Mojave population of the desert tortoise in portions of California, Nevada, Arizona, and Utah (59 *Federal Register* 5820), which became effective on March 10, 1994.

Section 4(c)(2) of the Endangered Species Act requires the Service 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); these reviews, at the time of their completion, provide the most up-to-date information on the rangewide status of the species. For this reason, we are incorporating the 5-year review by reference to provide most of the information needed for this section of the biological opinion (Service 2010a). The following paragraphs provide a summary of the relevant information in the 5-year review.

The 5-year review discusses the status of the desert tortoise as a single distinct population segment and provides information on the *Federal Register* notices that resulted in its listing and the designation of critical habitat. The 5-year review also describes its ecology, life history, spatial distribution, abundance, habitats, and the threats that led to its listing (*i.e.*, the 5-factor analysis required by section 4(a)(1) of the Endangered Species Act). The 5-year review concludes by recommending that the status of the desert tortoise as a threatened species be maintained.

With regard to the status of the desert tortoise as a distinct population segment, the Service concluded in the 5-year review that the recovery units recognized in the original and revised recovery plans (Service 1994 and 2011, respectively) do not qualify as distinct population segments under the Service's distinct population segment policy (61 *Federal Register* 4722; February 7, 1996). We reached this conclusion because individuals of the listed taxon occupy habitat that is relatively continuously distributed, exhibit genetic differentiation that is consistent with isolation-by-distance in a continuous-distribution model of gene flow, and likely vary in behavioral and physiological characteristics across the area they occupy as a result of the transitional nature of, or environmental gradations between, the described subdivisions of the Mojave and Colorado deserts.

The 5-year review summarizes information with regard to the desert tortoise's ecology and life history. Of key importance to assessing threats to the species and to developing and implementing a strategy for recovery is that desert tortoises are long-lived, require up to 20 years to reach sexual maturity, and have low reproductive rates during a long period of reproductive potential. The number of eggs that a female desert tortoise can produce in a season is dependent on a variety of factors including environment, habitat, availability of forage and drinking water, and physiological condition. Predation seems to play an important role in clutch failure. Predation and environmental factors also affect the survival of hatchlings.

The 5-year review discusses various means by which researchers have attempted to determine the abundance of desert tortoises and the strengths and weaknesses of those methods. The 5-year review provides a summary table of the results of range-wide monitoring that the Service initiated in 2001. This ongoing sampling effort is the first comprehensive attempt to determine the densities of desert tortoises across their range. Table 1 of the 5-year review provides a summary of data collected from 2001 through 2007; we summarize data from the 2008 through 2010 sampling efforts in subsequent reports (Service 2010b, 2010c). As the 5-year review notes, much of the difference in densities between years is due to variability in sampling; determining actual changes in densities will require many years of monitoring. Additionally, due to differences in area covered and especially to the non-representative nature of earlier sample sites, data gathered by the range-wide monitoring program cannot be reliably compared to information gathered through other means at this time.

The 5-year review provides a brief summary of habitat use by desert tortoises; more detailed information is available in the revised recovery plan (Service 2011). In the absence of specific and recent information on the location of habitable areas of the Mojave Desert, especially at the outer edges of this area, the 5-year review also describes and relies heavily on a quantitative, spatial habitat model for the desert tortoise north and west of the Colorado River that incorporates environmental variables such as precipitation, geology, vegetation, and slope and is based on occurrence data of desert tortoises from sources spanning more than 80 years, including data from the 2001 to 2005 range-wide monitoring surveys (Nussear *et al.* 2009). The model predicts the probability that desert tortoises will be present in any given location; calculations of the amount of desert tortoise habitat in the 5-year review and in this biological opinion use a threshold of 0.5 or greater predicted value for potential desert tortoise habitat. The model does not account for anthropogenic effects to habitat and represents the potential for occupancy by desert tortoises absent these effects.

To begin integrating anthropogenic activities and the variable risk levels they bring to different parts of the Mojave and Colorado deserts, the 5-year review contains an extensive review of the threats that were known to affect desert tortoises at the time of their listing and updates that information with more current findings. The review follows the format of the five-factor analysis required by section 4(a)(1) of the Endangered Species Act. The Service described these threats as part of the process of its listing (55 *Federal Register* 12178; April 2, 1990), further discussed them in the original recovery plan (Service 1994), and reviewed them again in the revised recovery plan (Service 2011).

To better understand the relationship of threats to populations of desert tortoises and how to implement recovery actions most effectively, the Desert Tortoise Recovery Office is developing a spatial decision support system that models the interrelationships of threats to desert tortoises and how those threats affect population change. The spatial decision support system describes the numerous threats that desert tortoises face, explains how these threats interact to affect individual animals and habitat, and how these effects in turn bring about changes in populations. For example, we have long known that the construction of a transmission line can result in the death of desert tortoises and loss of habitat. We have also known that common ravens (*Corvus corax*), known predators of desert tortoises, use the transmission line's pylons for nesting, roosting, and perching and that the access routes associated with transmission lines provide a vector for the introduction and spread of invasive weeds and increase human access into an area. Increases in human access can accelerate illegal collection and release of desert tortoises and their deliberate maiming and killing, as well as facilitate the spread of other threats associated with human presence, such as vehicle use, garbage and dumping, and invasive plants (Service 2011). Changes in the abundance of native plants as a result of invasive weeds can compromise the physiological health of desert tortoises, making them more vulnerable to drought, disease, and predation. The spatial decision support system allows us to map threats across the range of the desert tortoise and model the intensity of stresses that these multiple and combined threats place on desert tortoise populations.

The Service described these threats as part of the process of its listing (55 *Federal Register* 12178; April 2, 1990), further discussed them in the original recovery plan (Service 1994), and reviewed them again in the revised recovery plan (Service 2011). The threats described in these documents continue to affect the species. Some of the most apparent threats are those that result in mortality and permanent habitat loss across large areas, such as military operations and base expansion, urbanization, and large-scale renewable energy projects, and those that fragment and degrade habitats, such as proliferation of roads and highways, off-highway vehicle activity, poor grazing management, and habitat invasion by non-native invasive species. Indirect impacts to desert tortoise populations and habitat are also known to occur in accessible areas that interface with human activity. Most threats to the desert tortoise or its habitat are associated with human land uses; research since 1994 has clarified many mechanisms by which these threats act on desert tortoises. Increases in human access can accelerate illegal collection and release of desert tortoises and deliberate maiming and killing, as well as facilitate the spread of other threats associated with human presence, such as vehicle use, garbage and dumping, and invasive weeds. However, we remain unable to adequately quantify how threats affect desert tortoise populations. The assessment of the original recovery plan emphasized the need for a better understanding of the implications of multiple, simultaneous threats facing desert tortoise populations and of the relative contribution of multiple threats on demographic factors (*i.e.*, birth rate, survivorship, fecundity, and death rate; Tracy *et al.* 2004).

Since the completion of the 5-year review, the Service has issued several biological opinions that affect large areas of desert tortoise habitat as a result of numerous proposals to develop renewable energy within its range. These biological opinions concluded that the proposed solar plants were not likely to jeopardize the continued existence of the desert tortoise primarily because they were located outside of critical habitat and desert wildlife management areas that contain most of the land base required for the recovery of species. The proposed actions also included numerous measures intended to protect desert tortoises during the construction of the projects, such as translocation of affected individuals. Additionally, the BLM and California Energy Commission, the agencies permitting these facilities, have required the project proponents to fund numerous measures, such as land acquisition and the implementation of recovery actions that are intended to offset the adverse effects of the proposed actions. In aggregate, these projects resulted in an overall loss of approximately 26,111 acres of habitat of the desert tortoise; three of the projects (BrightSource Ivanpah, Stateline Nevada, and Desert Sunlight) constricted linkages between conservation areas that are important for the recovery of the desert tortoise. We also predicted that up to 1,444 desert tortoises would be translocated, injured, or killed as a result of these projects; we estimate that most of the individuals in these totals are juveniles. The mitigation required by the BLM and California Energy Commission will result in the acquisition of private land within critical habitat and desert wildlife management areas and funding for the implementation of various actions that are intended to promote the recovery of the desert tortoise. Many of these conservations measures are yet to be implemented or have been only recently implemented so that we cannot assess the success of these measures.

The following table summarizes information regarding the proposed solar projects that have undergone formal consultation.

Approved solar projects in desert tortoise habitat on public and private land.

Project	**Acres of Desert Tortoise Habitat**	**Recovery Unit**
Ivanpah Solar Electric Generating System- CA	3,582	Eastern Mojave
Abengoa Mojave- CA	1,765	Western Mojave
Nevada Solar One- NV	400	Northeastern Mojave
Copper Mountain North, NV	1,400	Northeastern Mojave
Copper Mountain - NV	380	Northeastern Mojave
Silver State North- NV	2,966	Eastern Mojave
Genesis- CA	4,640	Colorado
Blythe- CA	7,025	Colorado
Blythe Energy II- CA	9,400	Colorado
Palen- CA	4,195	Colorado

Desert Sunlight- CA	4,165	Colorado
Amargosa Farm Road - NV	4,350	Eastern Mojave
Calico- CA	4,604	Western Mojave
Moapa KRoad Solar- NV	2,152	Northeastern Mojave

Population and habitat connectivity came to the fore as an important threat to the desert tortoise conservation as the Service analyzed the multitude of renewable energy projects proposed throughout the species' range. Quantifying the degree to which a landscape promotes or hinders movements among patches of habitat for a given species, hereafter referred to as "habitat connectivity" (Fischer and Lindenmayer 2007), has become increasingly important relative to desert tortoise recovery. As we evaluate utility-scale solar development and other land uses within the range of the species, it is essential that habitat linkages between and among populations are conserved. For gene flow to occur across the range, populations of desert tortoises need to be connected by areas of occupied habitat that support sustainable numbers of reproductive individuals. Recent research provides evidence that genetic differentiation within the Mojave population is consistent with isolation by distance in a continuous-distribution model of gene flow. Populations at the farthest extremes of the distribution are therefore the most differentiated and a gradient of genetic differentiation occurs between those populations, across the range of the species (Britten *et al*. 1997, Edwards *et al.* 2004a, Murphy *et al*. 2007, Hagerty and Tracy 2010). Genetic analyses also suggest that levels of gene flow among subpopulations of desert tortoises were likely high, corresponding to high levels of habitat connectivity (Murphy *et al.* 2007, Hagerty 2008). In essence, the Mojave population historically represents a series of continuous, overlapping home ranges within suitable habitats whose boundaries between divergent units may be marked by ecological or major topographic features, such as steep mountainous terrain or, even more significantly, the Colorado River (Germano *et al.* 1994, Service 2008, Nussear *et al*. 2009).

Individual desert tortoises can make long-distance movements through restricted habitats, which may contribute to gene flow (Berry 1986, Edwards *et al*. 2004b), though we do not know the extent to which individuals utilize narrow corridors of relatively intact habitat. The underpinning of the continuous-distribution model of gene flow described above, and the evidence from desert tortoise population genetic studies and distribution, is that individual desert tortoises breed with their neighbors, those desert tortoises breed with other neighbors, and so on. The movements that maintain the genetic diversity across populations occur over generations and not necessarily during the life span of a single desert tortoise. Therefore, for gene flow to happen reliably, populations need to be connected across the range by occupied areas of habitat linkages that support sustainable numbers of desert tortoises.

To define the area required to maintain resident populations within the linkages, we consider desert tortoise home range size and the magnitude of edge effects. The size of desert tortoise home ranges varies with respect to location and year (Berry 1986) and may serve as an indicator of resource availability and opportunity for reproduction and social interactions (O'Connor *et al.* 1994). Females have long-term home ranges that may be as little as or less than half that of the average male, which can range to 200 acres or more (Burge 1977, Berry 1986, Duda *et al*. 1999, Harless *et al*. 2009). Core areas used within the lifetime home range of desert tortoises depend on the number of burrows used within those areas (Harless *et al*. 2009). Over its lifetime, a desert tortoise may use more than 1.5 mi^2 of habitat and may make periodic forays of more than 7 miles at a time (Berry 1986). We therefore assess the viability of the linkages based on the ability of those linkages to maintain the lifetime home range of a desert tortoise or the ability of home ranges of this size to connect to one another absent any barriers. Because we expect lifetime home ranges to expand and contract over time, we can consider whether the linkage could remain viable in a year where decreased resource availability results in a smaller population of individuals that respond by expanding their home ranges.

In assessing lifetime home ranges, the Service (1994a) assumed a circular configuration of this area when using it in the population viability assessment. We based this assumption on the fidelity that desert tortoises exhibit towards an overwintering burrow year after year. Consequently, the overwintering burrow serves as an anchor point from which the lifetime utilization area radiates out. Using a circular lifetime home range of 1.5 mi^2 for a desert tortoise, we estimate that a linkage would need to be at least 1.4 miles wide to accommodate the width of a single home range. While the minimum width of a linkage should accommodate several home ranges (Service 1994a; Beier *et al.* 2008), we do not know the exact area or land configuration required to support sustainable numbers of resident desert tortoises within any particular linkage, which would be dependent upon several factors.

Based on the best available information, occupancy likely depends on many site-specific factors, including: 1) desert tortoise densities in the vicinity (i.e., lower density sites require larger areas to reliably support sustainable numbers of desert tortoises); 2) length-to-width ratio of the linkage (i.e., longer linkages may need to be wider to preserve the dynamic home ranges and interactions required for gene flow); and 3) potential edge effects and integrity of the ecosystem within and adjacent to the linkage. Another consideration is the extent to which slope and ruggedness of the terrain allows desert tortoise occupancy or passage. In addition, maintaining connectivity of desert tortoise habitats and populations should reflect results from the landscape genetic analyses of Hagerty (2008) and Hagerty *et al*. (2010). These analyses showed that desert tortoise gene flow generally occurred historically in a diffuse pattern across the landscape unless otherwise constrained to more narrow, concentrated pathways created by topographic barriers (e.g., around the Spring Mountains in western Nevada). As a result, it is evolutionarily imperative that conservation is focused on maintaining a series of redundant linkages between core populations and critical habitats.

As a cooperating agency for the BLM/DOE's Solar PEIS planning process, the Service performed a landscape-scale modeling exercise to identify habitat linkages between and among CHUs and other conserved lands using data from the USGS desert tortoise habitat model (Nussear *et al*. 2009), desert tortoise landscape genetics analysis (Hagerty 2008, Hagerty and Tracy 2010, Hagerty *et al*. 2010), The Nature Conservancy's Mojave Desert Ecoregional Assessment (Randall *et al*. 2010), and lands designated as Wildlife Habitat Management Areas (WHMAs) that are important for desert tortoise connectivity and wildlife movement under the BLM's NECO Plan (BLM 2002). The intersection of these data sets established an initial range-wide linkage design for desert tortoise connectivity that the Service has recommended be maintained outside of designated desert tortoise conservation areas (e.g., CHUs, DWMAs, wilderness areas, national parks and monuments, and conserved private lands). This linkage design, however, requires refinement on a local and regional scale to account for on-the-ground limitations to desert tortoise occupancy and movement opportunities.

As the 5-year review (Service 2010a) notes, "(t)he threats identified in the original listing rule continue to affect the (desert tortoise) today, with invasive species, wildfire, and renewable energy development coming to the forefront as important factors in habitat loss and conversion. The vast majority of threats to the desert tortoise or its habitat are associated with human land uses." Oftedal's work (2002 in Service 2010a) demonstrates that invasive weeds may adversely affect the physiological health of desert tortoises. Modeling with the spatial decision support system indicates that invasive species likely affect a large portion of the desert tortoise's range. Furthermore, high densities of weedy species increase the likelihood of wildfires; wildfires, in turn, destroy native species and further the spread of invasive weeds.

Global climate change is also likely to affect the species' ability to recover. For example, estimates for the range of the Mojave desert tortoise suggest more frequent and/or prolonged droughts with an increase of the annual mean temperature by 3.5 to 4.0 degrees Celsius. The greatest increases will likely occur in summer (June-July-August mean increase of as much as 5 degrees Celsius [Christensen *et al.* 2007 in Service 2010a]). Precipitation will likely decrease by 5 to 15 percent annually in the region, with winter precipitation decreasing by up to 20 percent and summer precipitation increasing by 5 percent. Because germination of the desert tortoise's food plants is highly dependent on cool-season rains, the forage base could be reduced due to increasing temperatures and decreasing precipitation in winter. Although drought occurs fairly routinely in the Mojave Desert, extended periods of drought have the potential to affect desert tortoises and their habitats through physiological effects to individuals (*i.e.*, stress) and limited forage availability. To place the consequences of long-term drought in perspective, Longshore *et al.* (2003) demonstrated that even short-term drought can result in elevated levels of mortality of desert tortoises; therefore, long-term drought is likely to have even further reaching effects, particularly given that the current fragmented nature of desert tortoise habitat (*e.g.*, urban and agricultural development, highways, freeways, military training areas, etc.) will make recolonization of extirpated areas difficult, if not impossible.

The 5-year review notes that the combination of a long period of time until it reaches breeding age and a low reproductive rate challenges our ability to achieve recovery. When determining whether a proposed action is likely to jeopardize the continued existence of a species, we are required to consider whether the action would "reasonably be expected, directly or indirectly, to reduce appreciably the likelihood of both the survival and recovery of a listed species in the wild by reducing the reproduction, numbers, or distribution of that species (50 *Code of Federal Regulations* 402.02). Although the 5-year review does not explicitly address these metrics, we have used the information in that document to summarize the status of the desert tortoise with respect to its reproduction, numbers, and distribution.

The 5-year review notes that desert tortoises increase their reproduction in high rainfall years; more rain provides desert tortoises with more high quality food (*i.e.*, plants that are higher in water and protein), which, in turn, allows them to lay more eggs. Conversely, the physiological stress associated with foraging on food plants with insufficient water and nitrogen may leave desert tortoises vulnerable to disease (Oftedal 2002); the reproductive rate of diseased desert tortoises is likely lower than that of healthy animals. Young desert tortoises also rely upon high-quality, low-fiber nutrients (*e.g.*, in native forbs) not present in the invasive weeds that have increased in abundance across its range (Oftedal *et al.* 2002; Tracy *et al.* 2004). Compromised nutrition of young desert tortoises likely represents an effective reduction in reproduction by reducing the number that reaches adulthood. Consequently, although we do not have quantitative data that show a direct relationship, the abundance of disturbance-dependent species within the range of the desert tortoise has the potential to negatively affect the reproduction of desert tortoises and recruitment into the adult population.

Data from long-term study plots, which were first established in 1976, cannot be extrapolated to provide an estimate of the number of desert tortoises on a range-wide basis; however, these data indicate "appreciable declines at the local level in many areas, which coupled with other survey results, suggest that declines may have occurred more broadly" (Service 2010a). Other sources indicate that local declines are continuing to occur. For example, surveyors observed "lots of dead [desert tortoises]" in the western expansion area of Fort Irwin (Western Mojave Recovery Unit) in 2008 (Fort Irwin Research Coordination Meeting 2008). After the onset of translocation, coyotes (*Canis latrans*) killed 105 desert tortoises in Fort Irwin's southern translocation area (Western Mojave Recovery Unit); other canids may have been responsible for some of these deaths. Other incidences of predation were recorded throughout the range of the desert tortoise during this time (Esque *et al.* 2010). Esque *et al.* (2010) hypothesized that this high rate of predation on desert tortoises was influenced by low population levels of typical prey for coyotes due to drought conditions in previous years. Recent surveys in the Ivanpah Valley (Eastern Mojave Recovery Unit) for a proposed solar facility detected 31 live desert tortoises and the carcasses of 25 individuals that had been dead less than 4 years (First Solar 2011); this ratio of carcasses to live individuals over such a short period of time may indicate an abnormally high rate of mortality for a long-lived animal. In summary, the number of desert tortoises range-wide likely decreased substantially from 1976 through 1990 (*i.e.*, when long-term study plots were initiated through the time the desert tortoise was listed as threatened), although we cannot quantify the amount of this decrease. Additionally, more recent data collected from various sources throughout the range of the desert tortoise suggest that local declines continue to occur.

The distribution of the desert tortoise has not changed substantially since the publication of the original recovery plan in 1994 (Service 2010a) in terms of the overall extent of its range. Prior to 1994, desert tortoises were extirpated from large areas within their distributional limits by urban and agricultural development (*e.g.*, the cities of Barstow, Lancaster, Las Vegas, St. George, etc.; agricultural areas south of Edwards Air Force Base and east of Barstow), military training (*e.g.*, Fort Irwin, Leach Lake Gunnery Range), and off-road vehicle use (*e.g.*, portions of off-road management areas managed by the BLM and unauthorized use in areas such as east of California City). Since 1994, urban development around Las Vegas has likely been the largest contributor to habitat loss throughout the range. Desert tortoises have been essentially removed from the southern expansion area at Fort Irwin; a relatively small number of animals remain in this area at this time.

The following table depicts acreages of habitat (as modeled by Nussear *et al.* 2009) within various regions of the Mojave desert tortoise's range and of impervious surfaces as of 2006. Impervious surfaces include paved and developed areas and other disturbed areas that have zero probability of supporting desert tortoises.

Regions[1]	Modeled Habitat (acres)	Impervious Surfaces within Modeled Habitat	Percent of Modeled Habitat that is now Impervious
Western Mojave	7,582,092	1,864,214	25
Colorado Desert	4,948,900	494,981	10
Northeast Mojave	7,776,934	1,173,025	15
Upper Virgin River	232,320	80,853	35
Total	20,540,246	3,613,052	18

[1]The regions do not correspond to recovery unit boundaries; we used a more general separation of the range for this illustration.

On an annual basis, the Service produces a report that provides an up-to-date summary of the factors that were responsible for the listing of the species, describes other threats of which we are aware, describes the current population trend of the species, and includes comments of the year's findings. The Service's (2011) recovery data call report describes the desert tortoise's status as 'declining,' and notes that "(a)nnual range-wide monitoring continues, but the life history of the desert tortoise makes it impossible to detect annual population increases (continued monitoring will provide estimates of moderate- to long-term population trends). Data from the monitoring program do not indicate that numbers of desert tortoises have increased since 2001. The fact that most threats continue at generally the same levels suggests that populations are still in decline. Information remains unavailable on whether mitigation of particular threats has been successful."

In conclusion, we have used the 5-year review (Service 2010a), revised recovery plan (Service 2011), and additional information that has become available since these publications to review the reproduction, numbers, and distribution of the Mojave desert tortoise. The reproductive capacity of the desert tortoise may be compromised to some degree by the abundance and distribution of invasive weeds across its range; the continued increase in human access across the desert likely continues to facilitate the spread of weeds and further affect the reproductive capacity of the species. Prior to its listing, the number of desert tortoises likely declined range-wide, although we cannot quantify the extent of the decline; since the time of listing, data suggest that declines have occurred in local areas throughout the range. The continued increase in human access across the desert continues to expose more desert tortoises to the potential of being killed by human activities. The distributional limits of the desert tortoise's range have not changed substantially since the issuance of the original recovery plan in 1994; however, desert tortoises have been extirpated from large areas within their range (*e.g.*, Las Vegas, other desert cities). The species' low reproductive rate, the extended time required for young animals to reach breeding age, and the multitude of threats that continue to confront desert tortoises combine to render its recovery a substantial challenge.

2. a. Status of *Astragalus phoenix* (Ash Meadows milkvetch)

Species Description

Astragalus phoenix (Ash Meadows milkvetch) was listed as threatened with critical habitat on May 20, 1985 (50 *Federal Register* 20777). The critical habitat designation includes 1,200 acres (ac) (485.6 hectares (ha)) of dry, hard, white, barren, saline, clay flats, knolls, and slope at Ash Meadows National Wildlife Refuge (Refuge), BLM Area of Critical Environmental Concern (ACEC), and private inholdings. *Astragalus phoenix* also was listed as critically endangered by the State of Nevada in 1979 and is protected under Nevada Revised Statute (NRS) 527.260-300.

Rupert Barneby formally described *Astragalus phoenix* in 1970, although partial specimens were collected as early as 1898 by Carl Anton Purpus (Barneby 1970). *Astragalus phoenix* is a long-lived, perennial forb in Fabaceae (pea family) that develops into low, spreading mounds that can reach 5.5 inches (in) (15 centimeters (cm)) high and 19.5 in (50 cm) in diameter (Reveal 1978a). The specific name, *phoenix*, refers to being born of ashes and is descriptive of the plant's dense, ashen mound of leaves partly covered over with fine, white soil (Mozingo and Williams 1980). One to three, 0.5 to 1.0 in pink-purple, pea-like flowers are borne on tiny erect stems from February to early May (Reveal 1978a; Pavlik and Moore 2010). Dense, grayish white hairs cover the finely divided (pinnately compound), 0.5 to 1.5 in (1.5 to 3.5 cm) long leaves and 0.25 in (2 cm) pea-pod-like fruits (Reveal 1978a). *Astragalus phoenix* is endemic to the Ash Meadows area of Nye County, Nevada. The range of the species encompasses the Refuge, adjacent areas within the BLM ACEC, and private lands.

Studies on phenology, breeding system, and seed biology (seed output, germination) of 60 *Astragalus phoenix* plants have been conducted (Pavlik and Moore 2010). *Astragalus phoenix* is the first rare taxon at the Refuge to develop floral buds, which can develop as early as February (Pavlik and Moore 2010). Severe herbivory by lagomorphs has been previously documented and can cause an 80 to 90 percent reduction in *A. phoenix* reproductive output (Pavlik et al. 2006; Pavlik and Stanton 2008). In this study, *A. phoenix* plants were caged so that study objectives could be met. Caged plants bore 50 to several 100 flowers each whereas un-caged plants averaged 13 flowers. An examination of the seed-to-ovule ratio of mature fruits suggests that this taxon has a nearly obligate xenogamous breeding system (*i.e.*, requires cross-pollination) (Pavlik and Moore 2010). *Astragalus phoenix* attracts 1 floral visitor, *Anthophora porterae*, which is a known milkvetch specialist (BIO-WEST 2009). It appears that *A. porterae* more than compensates for the lack of other floral visitors due to tenacious and aggressive pollen and nectar collection behaviors. It is likely that *A. porterae* is a vital pollinator of *A. phoenix* (BIO-WEST 2009).

Germination events and seedling observations of *Astragalus phoenix* are rare (Reveal 1978a, Pavlik et. al 2006). Pavlik et al. (2006) did not observe germination or seedlings in five subpopulations during a year with 162 percent above average precipitation. Pavlik *et al.* (2006) hypothesized that either the soil seed bank was depleted or that the species was dependent on the most extreme and infrequent precipitation events. In a demographic analysis, Pavlik *et al.* (2006) determined only two out of five subpopulations studied had "recent" germination and establishment events, perhaps during the 1997-1998 growing season which had 211 percent of average precipitation. They determined that small plants, *i.e.*, those less than 7.7 in^2 in diameter, were completely absent from one subpopulation and comprised less than 5 percent of the sampled plants at all populations (Pavlik *et al.* 2006). In addition, attempts to germinate 170 *A. phoenix* seeds with and without scarification were successful, with scarification doubling the germination response, but no seedlings survived when transplanted into any medium (Pavlik and Moore 2010).

Transplanting and translocation studies have not been conducted. This strongly suggests that establishment of *A. phoenix* is sporadic and unlikely in most years, and that population persistence depends heavily on the longevity of individual plants which must, therefore, tolerate unpredictable environmental variations through time (Pavlik *et al.* 2006).

The lifespan of individual *Astragalus phoenix* plants is not known, but we believe that they are relatively long-lived, with the largest plants, which can form mounds up to 20 in (50.8 cm) across, likely exceeding 10 years or more in age. Studies using caged and uncaged plants have shown that some plants can grow in diameter by as much as 1.6 in (4 cm) and 0.8 in (2 cm) per year, respectively (Pavlik and Stanton 2008). Although the relationship between growth rate and diameter is unlikely to be linear, this suggests that a plant could reach 20 in (50.8 cm) in as little as 12.5 years if growth is not hindered by herbivory. The actual growth rate, especially in the presence of herbivory, is likely to be much slower and individual plants could take decades to reach their maximum size.

Astragalus phoenix occurs between 2,200 and 2,350 feet (ft) (671 and 716 meters (m)) above mean sea level and occurs in areas with sparse herbaceous cover within alkali shrub-scrub and alkali meadow habitats that often have depressional areas with mesic conditions where water might collect following rain (Morefield 2001a; BIO-WEST 2011). Based on superficial observation of its habitat, it was assumed initially that *A. phoenix* was a xerophyte, adapted to hard, dry, alkaline soils of upland topography (Knight and Clemmer 1987; Service 1990). However, Pavlik (2006) suggests that this characterization may be misleading and based on observations made during low rainfall years. During a high precipitation year, Pavlik (2006) observed the species growing directly in channels with running and slow moving water. Further, about 16 percent of *A. phoenix* populations occur on a landtype with a hydric character (hydric marl/sandstone) that is saturated to the surface by groundwater during the winter months of average precipitation years (White Horse Associates 2010). Other plant species associated with the *A. phoenix* include: *Atriplex confertifolia* (Torr. & Frém.) S. Watson (shadscale), *Distichlis spicata* (L.) Greene (saltgrass), *Enceliopsis nudicaulis* (A. Gray) A. Nelson var. *corrugata* Cronquist (Ash Meadows sunray), *Isocoma acradenia* (Greene) Greene (alkali goldenbush), and *Mentzelia leucophylla* Brandegee (Ash Meadows blazingstar), Knight and Clemmer 1987).

At the time of listing, *Astragalus phoenix* was known only from four sites on the Refuge and was estimated to be made up of 1,000 individuals (Reveal 1978a). Knight and Clemmer (1987) reviewed the available data on the rare plants of the Ash Meadows area and identified six general areas (Rogers Spring, Cold Spring, South of Longstreet Spring, Collins Ranch, Jackrabbit Spring, and Spring Meadows Road South) from which *A. phoenix* had been reported. In 2001, the *A. phoenix* population was estimated to be about 1,943 individuals in 13 minimum scale occurrences (0.1 mi (0.16 km) separation distance) or 10 maximum scale occurrences (0.6 mi (1 km) separation distance) on 9.1 acres (3.7 ha) (Morefield 2001a). Results from the 2008-2010 Refuge-wide rare plant survey (BIO-WEST 2011) estimate that 15,606 individuals are present on the Refuge in 12 minimum scale occurrences (0.1 mi (0.16 km) separation distance) or 2 maximum scale occurrence (0.6 mi (1 km) distance) on a total of 73 ac (29.5 ha). The largest occurrences of *A. phoenix* on the Refuge are at Spring Meadows road south, Jackrabbit Spring road, Cold Spring, and Collins Ranch south. Estimates of *A. phoenix* individuals on the BLM ACEC and private lands within the Refuge boundary do not exist.

Status and Distribution

The primary threats to *Astragalus phoenix* included in the final listing rule were groundwater withdrawal, road construction, surface mining, trampling by wild and free-roaming horses, inadequate regulatory mechanisms, and trampling by cattle and feral horses. Threats identified since listing include non-native plant species, wildfire, off-highway vehicle (OHV) activity, and predation and herbivory. Endemism and limited geographic distribution will continue to threaten *A. phoenix* due to the vulnerability of small populations to a range of environmental, demographic, and stochastic factors. At this time, it is difficult to predict local climate change impacts to *A. phoenix*. Information indicates that climate change has the potential to affect and threaten the Ash Meadows ecosystem in the long-term, but there is much uncertainty regarding the attributes that could be affected and their timing, magnitude, and rate of change.

Establishment of the Refuge in 1984 secured the land for federally-listed plant species by removing threats from agriculture, wild and free-roaming horses, livestock and ranching, and residential development. The creation of the BLM ACEC in 1998 added additional protections to species whose range extended past the Refuge boundary. Habitat for *Astragalus phoenix* is almost entirely protected from development (except on private inholdings) and new mineral entry (for 20 years) within the Refuge and BLM ACEC. Private inholdings still exist within the Refuge boundaries. OHV activity is periodically a threat to *A. phoenix* within the Refuge boundary, due to downed sections of fencing and lack of law enforcement presence (C.Baldino, Ash Meadows National Wildlife Refuge, pers. comm. 2012). In addition, though OHV activity is confined to existing trails, roads and dry washes within the BLM ACEC, there are no signs and fences that would inform the OHV community of its special designation. Non-native plant species could spread into *A. phoenix* habitat, increase fire frequency, or both, any or all of which would threaten the natural vegetation corridors needed for gene flow and dispersal in this taxon. Recent, comprehensive, baseline surveys on public land have added new known populations; there are now 12 occurrences (0.1 mi (0.16 km) minimum scale) made up of 15,606 individuals on 73 ac (29.5 ha) within Refuge boundaries. The little trend data that is available suggests that establishment of *A. phoenix* is sporadic and unlikely in most years, and that population persistence depends heavily on the longevity of individual plants which must, therefore, tolerate unpredictable environmental variations through time. Nothing is known about the longevity of *A. phoenix* seeds in the seed bank. Recent observations of herbivory and predation suggest that the intensity of herbivory on *A. phoenix* is unacceptably high and is disrupting reproduction and seed bank recharge (Pavlik and Moore 2010). The Amargosa Valley has been selected as a Solar Energy Zone (SEZ) even though the Amargosa Desert Hydrographic Basin is already over-appropriated. The hydrologic impacts to Ash Meadows from solar development are unknown, but fluctuations in water levels in the Amargosa Desert Hydrographic Basin have been tied directly to groundwater pumping (Bedinger and Harrill 2006). Exploration into detailed hydrologic habitat requirements of *A. phoenix* has begun (White Horse Associates 2010). More information is needed on the potential effects of changes in spring discharge, groundwater levels, water temperature, and water and soil chemistry upon patterns of gene flow and dispersal in *A. phoenix*.

2.b. Status of *Astragalus phoenix* (Ash Meadows milkvetch) Critical Habitat

Critical habitat for *Astragalus phoenix* was designated on Federal and private land on May 20, 1985, in three township and range units (Township 17 south , Range 50 east; Township 18 south, Range 50 east; and Township 18 south, Range 51 east) totaling 1,200 ac (485.6 ha). The primary constituent elements for these areas are dry, hard, white, barren, saline, clay flats, knolls, and slopes (50 *Federal Register* 20777). Critical habitat areas are as follows:

- Township 17 South, Range 50 East
  - W ½ NW ¼ and SW ¼ SW ¼, Section 14
  - SW ¼ NE ¼ and W ½ SE ¼, Section 21
  - NE ¼ SE ¼, Section 22
  - NW ¼, Section 26
- Township 18 South, Range 50 East
  - SW ¼ and W ½ SE ¼, Section 1
  - NW ¼ NE ¼ and N ½ NW ¼, Section 12
  - SW ¼ SW ¼, Section 13
  - W ½ NW ¼, Section 24
- Township 18 South, Range 51 East
  - SE ¼ SW ¼ and SW ¼ SE ¼, Section 7
  - N ½ NW ¼ and E ½ SW ¼, Section 18
  - NE ¼ NW ¼, Section 19

The portion of critical habitat located in Township 17 south, Range 50 east, NW ¼, Section 26 occurs outside of the Refuge on the BLM ACEC and private land and has not been surveyed. It is unknown if this habitat is occupied. The portion of critical habitat in Township 17 south, Range 50 east, NE ¼ SE ¼, Section 22 occurs on a private inholding within the Refuge and has not been surveyed. It is unknown if this habitat is occupied. The portion of critical habitat located in Township 17 south, Range 50 east, SW ¼ SW ¼, Section 14 is not occupied. All other portions of critical habitat are occupied.

3. a. Status of *Enceliopsis nudicaulis* var. *corrugata* (Ash Meadows sunray)

Species Description

Enceliopsis nudicaulis var. *corrugata* (Ash Meadows sunray) was listed as threatened with critical habitat on May 20, 1985 (50 *Federal Register* 20777). The critical habitat designation includes 1,760 ac (712 ha) of dry washes and whitish, saline soil associated with outcrops of pale whitish limestone on the Refuge and BLM ACEC. *Enceliopsis nudicaulis* var. *corrugata* also was listed as critically endangered by the State of Nevada in 1987 and is protected under NRS 527.260-300.

Enceliopsis nudicaulis var. *corrugata* was first collected in 1966 by Arthur Cronquist (1972). It is a perennial forb in Asteraceae (sunflower family) that forms clumps 3.9 to 15.7 in (10 to 40 cm) high that rise from a stout, woody root-stock (Mozingo and Williams 1980). The varietal name *corrugata* refers to leaf margins that are strongly ruffled-corrugate, especially towards the margins (Cronquist 1972; Mozingo and Williams 1980). The ray flowers are yellow and number 11 to 23 per inflorescence. Inflorescence buds begin developing in February and flowers open from late March to late May (Mozingo and Williams 1980; Pavlik and Moore 2010). *Enceliopsis nudicaulis* var. *corrugata* is endemic to the Ash Meadows area of Nye County, Nevada. The range of *E. nudicaulis* var. *corrugata* encompasses the Refuge, adjacent areas within the Bureau BLM ACEC, and private lands.

Studies on phenology, breeding system, and seed biology (seed output, germination) of 60 *Enceliopsis nudicaulis* var. *corrugata* plants have been conducted (Pavlik and Moore 2010). In this study, inflorescences that developed earlier in the season produced significantly more seeds than those developing later (Pavlik and Moore 2010). Plants produced 17.4 mature seeds per bud (Pavlik and Moore 2010, Table 16). An examination of the seed-to-ovule ratio of mature fruits suggests that this taxon's breeding system exemplifies facultative xenogamy (*i.e.*, predominantly outcrosses, but selfing is possible) (Pavlik and Moore 2010). *Enceliopsis nudicaulis* var. *corrugata* flowers can attract at least 21 floral visitors, 19 which are bee taxa (BIO-WEST 2009). *Enceliopsis nudicaulis* var. *corrugata* is important to the nectiferous insect community at the Refuge because it provides pollen and nectar early in the growing season (BIO-WEST 2009).

There are no data on germination events nor have seedlings been observed in *Enceliopsis nudicaulis* var. *corrugata*. Monitoring that could provide insight into population trend and demographic structure has not been conducted. The seed bank buffers against environmental stochasticity and extinction in desert plants; nothing is known about the longevity of *E. nudicaulis* var. *corrugata* seeds in the seed bank. Attempts to germinate 120 *E. nudicaulis* var. *corrugata* seeds with and without scarification were unsuccessful, with only two seeds breaking dormancy and then failing to survive when transferred to native soil (Pavlik and Moore 2010). Transplanting and translocation studies have not been conducted.

Enceliopsis nudicaulis var. *corrugata* occurs between 2,200 and 2,360 ft (671 and 719 m) above mean sea level and occurs across a broad range of habitats including open, hard, whitish alkaline soils often on or near calcareous outcrops, occasionally moist alkaline soils, spring and seep areas, and dry desert washes (Morefield 2001b; BIO-WEST 2011). Based on superficial observation of its habitat, it was assumed initially that *Enceliopsis nudicaulis* var. *corrugata* was a xerophyte, adapted to hard, alkaline soils of upland topography (Knight and Clemmer 1987; Service 1990). However, this characterization may be misleading because it is based on observations made during summer months (S. Jensen, White Horse Associates, pers. comm. 2010). During winter months, landtypes considered "upland" (*i.e.* hard, whitish, and alkaline soil areas not directly affiliated with a spring system) are saturated at or near the surface (Jensen, pers. comm. 2010). Further, about 14 percent of *E. nudicaulis* var. *corrugata* populations occur on a landtype with a hydric character (hydric marl/sandstone and moderately-deep (hydric) alluvium from marl/clay) that is saturated to the surface by groundwater during the winter months of average precipitation years (Jensen, pers. comm. 2010; White Horse Associates 2010). Other plant species associated with *E. nudicaulis* var. *corrugata* include: *Arctomecon merriamii* Coville (desert bearpoppy), *Astragalus phoenix*, *Atriplex confertifolia*, *Cryptantha confertifolia* (Greene) Payson (basin yellow cryptantha), *Isocoma acradenia*, and *Mentzelia leucophylla* (Mozingo and Williams 1980; Knight and Clemmer 1987).

At the time of listing, a population estimate of *Enceliopsis nudicaulis* var. *corrugata* was unknown (50 *Federal Register* 20777). In 2001, the *E. nudicaulis* var. *corrugata* population on the Refuge was estimated at 1,849 individuals in 15 minimum scale occurrences (0.1 mi (0.16 km) separation distance) or 11 maximum scale occurrences (0.6 mi (1 km) separation distance) (Morefield 2001b). Results from the 2008-2010 Refuge-wide rare plant survey (BIO-WEST 2011) estimate that 79,508 individuals are present on the Refuge in 30 minimum scale occurrences (0.1 mi (0.16 km) separation distance) (Table 1) or 1 maximum scale occurrence (0.6 mi (1 km) distance) on a total of 216.1 ac (87 ha). The largest occurrences of *E. nudicaulis* var. *corrugata* on the Refuge are at Jackrabbit Spring Road, Collins Ranch, Warm Springs, and Cold Spring. Estimates of *E. nudicaulis* var. *corrugata* individuals on the BLM ACEC and private lands within the Refuge boundary do not exist.

Status and Distribution

The primary threats to *Enceliopsis nudicaulis* var. *corrugata* included in the final listing rule were groundwater withdrawal, road construction, OHV activity, trampling by wild and free-roaming horses, inadequate regulatory mechanisms, and trampling by cattle and feral horses. Threats identified since listing include non-native plant species, wildfire, surface mining, and predation and herbivory. Endemism and limited geographic distribution will continue to threaten *E. nudicaulis* var. *corrugata* due to the vulnerability of small populations to a range of environmental, demographic, and stochastic factors. At this time, it is difficult to predict local climate change impacts to *E. nudicaulis* var. *corrugata*. Information indicates that climate change has the potential to affect and threaten the Ash Meadows ecosystem in the long-term, but there is much uncertainty regarding the attributes that could be affected and their timing, magnitude, and rate of change.

Establishment of the Refuge in 1984 secured the land for federally-listed plant species by removing threats from agriculture, wild and free-roaming horses, livestock and ranching, and residential development. The creation of the BLM ACEC in 1998 added additional protections to species whose range extended past the Refuge boundary. Habitat for *Enceliopsis nudicaulis* var. *corrugata* is almost entirely protected from development (except on private inholdings) and new mineral entry (for 20 years) within the Refuge and BLM ACEC. Private inholdings still exist within the Refuge boundaries. OHV activity is periodically a threat to *E. nudicaulis* var. *corrugata* within the Refuge boundary, due to downed sections of fencing and lack of law enforcement presence (Baldino, pers. comm. 2012). In addition, though OHV activity is confined to existing trails, roads and dry washes within the BLM ACEC, there are no signs and fences that would inform the OHV community of its special designation. Non-native plant species could spread into *E. nudicaulis* var. *corrugata* habitat, increase fire frequency, or both, any or all of which would threaten the natural vegetation corridors needed for gene flow and dispersal in this taxon. Recent, comprehensive, baseline surveys on public land have added new known populations; there are now 30 occurrences (0.1 mi (0.16 km) minimum scale) made up of 79,508 individuals on 216.1 ac (87 ha) within Refuge boundaries. Trend data for demographic structure and recruitment events is nonexistent and nothing is known about the longevity of *E. nudicaulis* var. *corrugata* seeds in the seed bank. Recent observations of herbivory and predation upon *E. nudicaulis* var. *corrugata* could negatively affect gene flow and dispersal by disrupting reproduction and seed bank recharge. The Amargosa Valley has been selected as a Solar Energy Zone (SEZ) even though the Amargosa Desert Hydrographic Basin is already over-appropriated. The hydrologic impacts to Ash Meadows from solar development are unknown, but fluctuations in water levels in the Amargosa Desert Hydrographic Basin have been tied directly to groundwater pumping (Bedinger and Harrill 2006).

Exploration into detailed hydrologic habitat requirements of *E. nudicaulis* var. *corrugata* has begun (Jensen, pers. comm. 2010; White Horse Associates 2010; BIO-WEST 2011). More information is needed on the potential effects of changes in spring discharge, groundwater levels, water temperature, and water and soil chemistry upon patterns of gene flow and dispersal in *E. nudicaulis* var. *corrugata*.

3. b. Status of *Enceliopsis nudicaulis* var. *corrugata* (Ash Meadows sunray) Critical Habitat

Critical habitat for *Enceliopsis nudicaulis* was designated on Federal and private land on May 20, 1985, in four township and range units (Township 17 south, Range 50 east; Township 17 south, Range 51 east; Township 18 south, Range 50 east; and Township 18 south, Range 51 east) totaling 1,760 ac (712 ha). The primary constituent elements for these areas are dry washes or whitish saline soil associated with outcrops of pale whitish limestone (50 *Federal Register* 20777). Critical habitat areas are as follows:

- Township 17 South, Range 50 East
    - SW ¼ SE ¼, Section 15
    - SW ¼ NE ¼ and W ½ SE ¼, Section 21
    - SW ¼ NE ¼, Section 22
    - E ½ SE ¼, Section 34
    - SW ¼ NE ¼, S ½ NW ¼, SW ¼, and W ½ SE ¼, Section 35
- Township 17 South, Range 51 East
    - SE ¼, Section 20
- Township 18 South, Range 50 East
    - NW ¼, SW ¼ and W ½ SE ¼, Section 1
    - E ½ SE ¼, Section 2
    - NE ¼ NW ¼, Section 12
    - E ½ SW ¼ and W ½ SE ¼, Section 13
- Township 18 South, Range 51 East
    - SW ¼ SE ¼, Section 7
    - NW ¼ NE ¼ and SE ¼ SW ¼, Section 18

The portion of critical habitat located in Township 18 south, Range 51 east, SE ¼ Section 20 occurs outside of the Refuge, within the BLM ACEC and has not been surveyed. It is unknown if this habitat is occupied. The portions of critical habitat located in Township 17 south, Range 50 east, SW ¼ SE ¼, Section 15 and SW ¼ NE ¼, Section 22 are not occupied. All other portions of critical habitat are occupied.

4. a. Status of *Grindelia fraxino-pratensis* (Ash Meadows gumplant)

Species Description

Grindelia fraxino-pratensis (Ash Meadows gumplant) was listed as threatened with critical habitat on May 20, 1985 (50 *Federal Register* 20777). The critical habitat designation includes 1,968 ac (796.4 ha) of saltgrass meadows along streams and pools or drier areas with alkali clay soils on the Refuge and in Inyo County, California. *Grindelia fraxino-pratensis* was listed as critically endangered by the State of Nevada in 1982 and is protected under NRS 527.260-300. The species is not listed by the State of California. However, it is on the California Native Plant Society's "List 1B"; this designation indicates the species qualifies for state listing, and must be considered during review of proposed projects under the California Environmental Quality Act (CEQA).

Reveal and Beatley described *Grindelia fraxino-pratensis* in 1971, although Beatley had collected it as early as 1965 (Reveal and Beatley 1971). *Grindelia fraxino-pratensis* is an erect biennial or more commonly a perennial forb in Asteraceae (sunflower family) reaching 25 to 40 in (63.5 to 101.6 cm) in height with 1 to 3 stems arising from a woody root stock (Mozingo and Williams 1980). The stems are glaboruous and contain leathery, dark green leaves that are dotted with resinous glands. The inflorescence is open with individual, resinous heads measuring 0.31 to 0.39 in (8 to 10 mm) across. Ray flowers number 13 per head, are golden to lemon yellow, and are 0.12 to 0.16 in (3 to 4 mm) long; the disk flowers are golden yellow and 0.16 to 0.2 in (4 to 5 mm) long (Mozingo and Williams 1980). *Grindelia fraxino-pratensis* flowers from June to October (Mozingo and Williams 1980; Pavlik and Moore 2010). *Grindelia fraxino-pratensis* is endemic to Nye County, Nevada and Inyo County, California. The range of *G. fraxino-pratensis* in Nevada is the Refuge, adjacent areas within the BLM ACEC, and on private lands, and in California it is found approximately 1 mile (mi) (1.6 kilometer (km)) past the California/Nevada state line on BLM land.

Studies on phenology, breeding system, and seed biology (seed output, germination) of 60 *Grindelia fraxino-pratensis* plants have been conducted (Pavlik and Moore 2010). In this study, plants averaged 57.8 inflorescences on 2.9 main stems. Seeds that were produced in the early to mid-growing season were significantly heavier than those produced later in the season. In addition, pollinator exclusion significantly reduced seed count, but did not affect seed weight (Pavlik and Moore 2010). An examination of the seed-to-ovule ratio of mature fruits suggests that this taxon's breeding system exemplifies facultative xenogamy (*i.e.*, predominantly outcrosses, but selfing is possible) (Pavlik and Moore 2010). *Grindelia fraxino-pratensis* flowers attract at least 5 floral visitors, but visits are made so rapidly, making insect collections and observations is difficult (BIO-WEST 2009).

There are no data on germination events nor have seedlings been observed in *Grindelia fraxino-pratensis*. Monitoring that could provide insight into population trend and demographic structure has not been conducted in Nevada. In 2003, transects were used to develop a population estimate for the California population(see below). The seed bank buffers against environmental stochasticity and extinction in desert plants; nothing is known about the longevity of *G. fraxinopratensis* seeds in the seed bank. Attempts to germinate 160 *G. fraxino-pratensis* seeds collected in 2008 under three different germination trials were low, with only 13 to 20 percent germinating. Stratification of seeds improved the germination response, but not significantly. No seedlings survived more than 2 weeks after transplantation to any medium (Pavlik and Moore 2010). Transplanting and translocation studies have not been conducted.

Grindelia fraxino-pratensis occurs between 2,070 and 2,320 ft (631 to 707 m) above mean sea level and occurs in seasonally flooded to mesic alkali meadows and wet meadows with moist clay soils that are sometimes dark in color (Morefield 2001c; BIO-WEST 2011). *Grindelia fraxino-pratensis* populations are also located in additional habitats such as the edges of Ash communities, in alkali shrub-scrub, and in some alkali seeps (BIO-WEST 2011). On the basis of isotopic analysis, Hasselquiest and Allen (2009) found that *G. fraxino-pratensis* uses surface water or soil moisture near the soil surface in early spring, but switches to utilizing groundwater during the drier summer months likely due to its dimorphic root system. Other plant species associated with *G. fraxino-pratensis* in its wet meadow habitat include: *Anemopsis californica* (Nutt.) Hook. & Arn. (yerba mansa), *Atriplex confertifolia*, *Baccharis emoryi* A. Gray (Emory's Baccharis), *Distichlis spicata*, *Isocoma acradenia*, *Sporobolus airoides* (Torr.) Torr. (alkali sacaton), *Tamarix ramosissima* Ledeb. (saltcedar), and *Zeltnera namophila* (Reveal et al.) G. Mans (spring-loving centaury) (Mozingo and Williams 1980; Morefield 2001c).

At the time of listing, *Grindelia fraxino-pratensis* was known from thirteen occurrences and was estimated to be made up of 10,000 to 13,000 individuals (Cochrane 1981). Knight and Clemmer (1987) reviewed the available data on the rare plants of the Ash Meadows area and identified nine general areas that contained *G. fraxino-pratensis*. In 2001, *G. fraxino-pratensis* population was estimated to be about 13,000 individuals in 16 minimum scale occurrences (0.1 mi (0.16 km) separation distance) or 14 maximum scale occurrences (0.6 mi (1 km) separation distance) 15.1 ac (6.1 ha) (Morefield 2001c). Results from the 2008-2010 Refuge-wide rare plant survey estimate that 656,890 individuals are present on the Refuge in 23 minimum scale occurrences (0.1 mi (0.16 km) separation distance) or 1 maximum scale occurrence (0.6 mi (1 km) distance) on a total of 136.3 ac (55.2 ha) (BIO-WEST 2011). The largest occurrences of *G. fraxino-pratensis* on the Refuge are at Spring Meadows road, Ash Meadows road, northeast of Crystal Reservoir and in between Crystal Reservoir and Lower Crystal Marsh (BIO-WEST 2011). Estimates of *G. fraxino-pratensis* individuals on the BLM ACEC and private lands within the Refuge boundary do not exist.

Based on a 2003 survey on the California population, which used transects to develop a population estimate, there are 241,514 ± 69,660 *Grindelia fraxino-pratensis* plants within 88.3 ac (35.75 ha) (Johnston and Zink 2004). Although sampling occurred in an area of fairly uniform distribution, large portions of the area were still devoid of plants. The highly dependent nature of the plant to water made for dense occurrence along slough channels followed by gaps between channels that were essentially devoid or sparsely populated. The gradient distribution of plant numbers in relation to the waterways of the slough may account for the high standard deviation (Johnston and Zink 2004).

Status and Distribution

The primary threats to *Grindelia fraxino-pratensis* included in the final listing rule were groundwater withdrawal, surface mining, road construction, trampling and grazing by wild and free-roaming horses, agricultural development, inadequate regulatory mechanisms, and trampling by cattle and feral horses. Threats identified since listing include non-native plant species, wildfire, OHV activity, and herbivory. Endemism and limited geographic distribution will continue to threaten *G. fraxino-pratensis* due to the vulnerability of small populations to a range of environmental, demographic, and stochastic factors. At this time, it is difficult to predict local climate change impacts to *G. fraxino-pratensis*. Information indicates that climate change has the potential to affect and threaten the Ash Meadows ecosystem in the long-term, but there is much uncertainty regarding the attributes that could be affected and their timing, magnitude, and rate of change.

Establishment of the Refuge in 1984 secured the land for federally-listed plant species by removing threats from agriculture, wild and feral horses, livestock and ranching, and residential development. The creation of the BLM ACEC in 1998 added additional protections to species whose range extended past the Refuge boundary. Habitat for *G. fraxino-pratensis* is almost entirely protected from development (except on private inholdings) and new mineral entry (for 20 years) within the Refuge and BLM ACEC. Private inholdings still exist within the Refuge boundaries. OHV activity is periodically a threat to *G. fraxino-pratensis* within the Refuge boundary, due to downed sections of fencing and lack of law enforcement presence. In addition, increased OHV activity has been reported in the Carson Slough (Baldino, pers. comm. 2012). Non-native plant species could spread into *G. fraxino-pratensis* habitat, increase fire frequency, or both, any or all of which would threaten the natural vegetation corridors needed for gene flow and dispersal in this taxon. Recent, comprehensive, baseline surveys on public land have added new known populations; there are now 23 occurrences (0.1 mi (0.16 km) minimum scale) made up of 656,890 individuals on 136.3 ac (55.2 ha) within Refuge boundaries. In addition, there is an estimated 241,514 ± 69,660 plants on 88.3 ac (35.75 ha) in California. Nothing is known about the longevity of *G. fraxino-pratensis* seeds in the seed bank. Predation pressure from cattle and feral horses has been removed, but recent observation of herbivory (*i.e.*, lagomorphs – likely black-tailed jackrabbits) and insect seed predation upon *G. fraxino-pratensis* could negatively affect gene flow and dispersal by disrupting reproduction and seed bank recharge (Pavlik and Moore 2010).

The Amargosa SEZ occurs within the Amargosa Desert Hydrographic Basin which is already over-appropriated. The hydrologic impacts to Ash Meadows from solar development are unknown, but fluctuations in water levels in the Amargosa Desert Hydrographic Basin have been tied directly to groundwater pumping (Bedinger and Harrill 2006). Increasing the demand for already limited water resources can have severe direct and indirect consequences on the persistence of *G. fraxino-pratensis*. Increasing groundwater pumping will lower the water table and directly prevent *G. fraxino-pratensis* from accessing a reliable water source during dry months. More information is needed on the potential effects of changes in spring discharge, groundwater levels, water temperature, and water and soil chemistry upon patterns of gene flow and dispersal in *G. fraxino-pratensis*.

4. b. Status of *Grindelia fraxino-pratensis* (Ash Meadows gumplant) Critical Habitat

Critical habitat for *Grindelia fraxino-pratensis* was designated on Federal and private land on May 20, 1985, in four township range units (Township 26 north, Range 6 east; Township 17 south, Range 50 east; Township 18 south, Range 50 east; and Township 18 south, Range 51 east) totaling 1,986 ac (803.7 ha). The primary constituent elements for these areas are saltgrass meadows along streams and pools or drier areas with alkali clay soils *(50 Federal Register 20777)*. Critical habitat areas are as follows:

<u>Inyo County, California</u>

- Township 26 North, Range 6 East
  - NE ¼, E ½ NW ¼, SW ¼ NW ¼, N ½ SW ¼, and NW ¼ SE ¼, Section 30

Nye County, Nevada

- Township 17 South, Range 50 East
    - SE ¼ NW ¼, Section 26
    - W ½ SW ¼ NE ¼ and W ½ NW ¼ SE ¼, Section 33
    - W ½ NW ¼, SW ¼ SW ¼, E ½ SE ¼, and W ½ SE ¼, Section 35
- Township 18 South, Range 50 East
    - N ½ SW ¼, Section 1
    - N ½ NW ¼, Section 2
    - NE ¼ NE ¼ and NW ¼ NW ¼, Section 3
    - SW ¼ NE ¼, SE ¼ NW ¼, NE ¼ SW ¼, and NW ¼ SE ¼, Section 4
    - W ½ NE ¼ and NW ¼ SE ¼, Section 5
    - N ½ NE ¼, Section 7
    - NE ¼ SE ¼, Section 10
    - W ½ NW ¼ and NW ¼ SW ¼, Section 11
    - SW ¼ NE ¼ and E ½ SE ¼, Section 14
    - SW ¼ NW ¼, SW ¼ SE ¼, W ½ SW ¼, and SE ¼ SW ¼, Section 20 northeast of the Nevada-California boundary
    - E ½ NE ¼ and E ½ SE ¼, Section 23
    - W ½ SW ¼, Section 24
    - NW ¼ NE ¼, Section 29 northeast of the Nevada-California boundary
- Township 18 South, Range 51 East
    - SW ¼ NW ¼ and NW ¼ SW ¼, Section 18

The portion of critical habitat located in Township 18 south, Range 50 east, W ½ NE ¼ and NW ¼ SE ¼, Section 5; SW ¼ NW ¼, SW ¼ SE ¼, W ½ SW ¼, and SE ¼ SW ¼, Section 20; and NW ¼ NE ¼, Section 29 occur outside of the Refuge, within the BLM ACEC and have not been surveyed. The portion of critical habitat located in Township 18 south, Range 50 east, N ½ NE ¼, Section 7 occurs outside of the Refuge on private land and has not been surveyed. It is unknown if these habitats are occupied. The portions of critical habitat located in Township 17 south, Range 50 east, SE ¼ NW ¼, Section 26; W ½ SW ¼ NE ¼ and W ½ NW ¼ SE ¼, Section 33; and W ½ NW ¼, Section 35 are not occupied. In addition, the portions of critical habitat located in Township 18 south, Range 50 east, NE ¼ NE ¼ and NW ¼ NW ¼, Section3; SW ¼ NE ¼, SE ¼ NW ¼, NE ¼ SW ¼, and NW ¼ SE ¼, Section 4; and SW ¼ NE ¼, Section 14 are not occupied. All other portions of critical habitat are occupied.

5. a. Status of *Ivesia kingii* var. *eremica* (Ash Meadows ivesia)

Species Description

Ivesia kingii var. *eremica* (Ash Meadows ivesia) was listed as threatened with critical habitat on May 20, 1985 *(50 Federal Register 20777).* The critical habitat designation includes 880 ac (3556.1 ha) of saline seep areas of light colored clay uplands on the Refuge. *Ivesia kingii* var. *eremica* also was listed as critically endangered by the State of Nevada in 1987 and is protected under NRS 527.260-300.

Ivesia kingii var. *eremica* was first described by Coville and Funston in 1891 (Knight and Clemmer 1987). It is a prostrate perennial forb in Rosaceae (rose family) that grows between 7.5 to 15 in (19 to 38.1 cm) tall from an erect, thick, woody root that bears a basal tuft of grayish, pubescent leaves that can reach a length of 5.2 in (13 cm) (Mozingo and Williams 1980; Knight and Clemmer 1987). Each pinnately (*i.e.*, leaflets arranged on opposite sides of an elongated axis) compound leaf bear up to 60 pairs of 0.08 to 0.1 in (2 to 2.5 mm) wide leaflets (Mozingo and Williams 1980). The inflorescence is a cyme that bears a few, small, five petaled white flowers (Mozingo and Williams 1980; Knight and Clemmer 1987). Plants bud, flower, and fruit continuously from June to October (Pavlik and Moore 2010). *Ivesia kingii* var. *eremica* is endemic to the Ash Meadows area of Nye County, Nevada. The range of *I. kingii* var. *eremica* encompasses the Refuge, adjacent areas within the BLM ACEC, and private lands.

Studies on phenology, breeding system, and seed biology (seed output, germination) of 60 *Ivesia kingii* var. *eremica* plants have been conducted (Pavlik and Moore 2010). The average individual bears 6.3 inflorescences, but since flowering and seed dispersal is so rapid, it is impossible to estimate the number of successful f lowers produced by each inflorescence (Pavlik and Moore 2010). Due to rapid development and dispersal, the seed-to-ovule ratio of mature fruits was not calculated for *I. kingii* var. *eremica*. However, inflorescences that were excluded from pollinators still produced fully formed seeds with weights equal to those from non-excluded inflorescences, which strongly suggests that *I. kingii* var. *eremica* has an autogamous (*i.e.*, self-fertilizing) breeding system (Pavlik and Moore 2010). Further supporting its autogamous breeding system, *I. kingii* var. *eremica* infrequently attracts floral visitors (BIO-WEST 2009).

There are no data on germination events nor have seedlings been observed in *Ivesia kingii* var. *eremica*. Monitoring that could provide insight into population trend and demographic structure has not been conducted. The seed bank buffers against environmental stochasticity and extinction in desert plants; nothing is known about the longevity of *I. kingii* var. *eremica* seeds in the seed bank. Germination trials of 60 *I. kingii* var. *eremica* seeds that developed with and without pollinator exclusion showed similar results with only 30 percent germinating. Seeds that germinated were readily grown in native soil under greenhouse conditions (Pavlik and Moore 2010). Transplanting and translocation studies have not been conducted.

Ivesia kingii var. *eremica* occurs between 2,150 and 2,350 ft (655 to 716 m) above mean sea level and occurs on mesic, intermittently flooded to saturated alkali seeps, wet meadows, alkali meadows, and the edges of alkali shrub-scrub. Soils are saturated to moist clay with an alkali crust (Morefield 2001d, BIO-WEST 2011). *Ivesia kingii* var. *eremica* populations are often located in areas with shallow groundwater or saturated soils such as topographic contour breaks and depressional areas where groundwater seeps to the surface. These habitats are sparsely vegetated due to the high level of soil alkalinity (BIO-WEST 2011). Other plant species associated with *I. kingii* var. *eremica* include: *Atriplex confertifolia*, *Distichlis spicata*, *Isocoma acradenia*, *Juncus balticus* Willd. (Baltic rush), *Spartina gracilis* Trin. (alkali cordgrass), and *Zeltnera namophila* (Mozingo and Williams 1980; Morefield 2001d).

At the time of listing, a population estimate of *Ivesia kingii* var. *eremica* was unknown (50 *Federal Register* 20777). Knight and Clemmer (1987) reviewed the available data on the rare plants of

Ash Meadows and identified general areas from which *I. kingii* var. *eremica* had been reported. In 2001, the *I. kingii* var. *eremica* population on the Refuge was estimated at 3,862 individuals in 9 minimum scale occurrences (0.1 mi (0.16 km) separation distance) or 8 maximum scale occurrences (0.6 mi (1 km) separation distance) (Morefield 2001d). Results from the 2008-2010 Refuge-wide rare plant survey (BIO-WEST 2011) estimate that 510,744 individuals are present on the Refuge in 19 minimum scale occurrences (0.1 mi (0.16 km) separation distance) or 2 maximum scale occurrence (0.6 mi (1 km) distance) on a total of 116.14 ac (47 ha). The largest occurrences of *I. kingii* var. *eremica* on the Refuge are at Spring Meadows road, Collins Ranch south, Marsh Spring, Crystal Reservoir east, and Lower Crystal marsh. Estimates of *I. kingii* var. *eremica* individuals on the BLM ACEC and private lands within the Refuge boundary do not exist.

Status and Distribution

The primary threats to *Ivesia kingii* var. *eremica* included in the final listing rule were groundwater withdrawal, agricultural development, road construction, grazing by cattle and feral horses (predation), inadequate regulatory mechanisms, and trampling by cattle and feral horses. Threats identified since listing include non-native plant species, wildfire, surface mining, and OHV activity. Endemism and limited geographic distribution will continue to threaten *I. kingii* var. *eremica* due to the vulnerability of small populations to a range of environmental, demographic, and stochastic factors. At this time, it is difficult to predict local climate change impacts to *I. kingii* var. *eremica.* Information indicates that climate change has the potential to affect and threaten the Ash Meadows ecosystem in the long-term, but there is much uncertainty regarding the attributes that could be affected and their timing, magnitude, and rate of change.

Establishment of the Refuge in 1984 secured the land for federally-listed plant species by removing threats from agriculture, wild and feral horses, livestock and ranching, and residential development. The creation of the BLM ACEC in 1998 added additional protections to species whose range extended past the Refuge boundary. Habitat for *I. kingii* var. *eremica* is almost entirely protected from development (except on private inholdings) and new mineral entry (for 20 years) within the Refuge and BLM ACEC. Private inholdings still exist within the Refuge boundaries. OHV activity is periodically a threat to *I. kingii* var. *eremica* within the Refuge boundary, due to downed sections of fencing and lack of law enforcement presence. In addition, though OHV activity is confined to existing trails, roads and dry washes within the BLM ACEC, there are no signs and fences that would inform the OHV community of its special designation (Baldino, pers. comm. 2012). Non-native plant species could spread into *I. kingii* var. *eremica* habitat, increase fire frequency, or both, any or all of which would threaten the natural vegetation corridors needed for gene flow and dispersal in this taxon. Recent, comprehensive, baseline surveys on public land have added new known populations; there are now 19 occurrences (0.1 mi (0.16 km) minimum scale) made up of 510,744 individuals on 116.14 ac (47 ha) within Refuge boundaries. Nothing is known about the longevity of *I. kingii* var. *eremica* seeds in the seed bank. Predation pressure from cattle and feral horses has been removed, but insect seed predation has recently been observed on *I. kingii* var. *eremica*, which could negatively affect gene flow and dispersal by disrupting reproduction and seed bank recharge (Pavlik and Moore 2010). The Amargosa Valley has been selected as a Solar Energy Zone (SEZ) even though the Amargosa Desert Hydrographic Basin is already over-appropriated. The hydrologic impacts to Ash Meadows from solar development are unknown, but fluctuations in water levels in the Amargosa Desert

Hydrographic Basin have been tied directly to groundwater pumping (Bedinger and Harrill 2006). Increasing the demand for already limited water resources can have severe direct and indirect consequences on the persistence of *I. kingii* var. *eremica*. More information is needed on the potential effects of changes in spring discharge, groundwater levels, water temperature, and water and soil chemistry upon patterns of gene flow and dispersal in *I. kingii* var. *eremica*.

5. b. Status of *Ivesia kingii* var. *eremica* (Ash Meadows ivesia) Critical Habitat

Critical habitat for *Ivesia kingii* var. *eremica* was designated on Federal and private lands on May 20, 1985, in two township and range units (Township 17 south, Range 50 east and Township 18 south, Range 50 east) totaling 880 ac (356.1 ha). The primary constituent elements for these areas are saline seep areas of light colored clay uplands (50 *Federal Register* 20777). Critical habitat areas are as follows:

- Township 17 South, Range 50 East
    - SW ¼ NE ¼ and W ½ SE ¼, Section 21
    - S ½ SW ¼ and SW ¼ SE ¼, Section 35
- Township 18 South, Range 50 East
    - SW ¼, Section 1
    - N ½ NW ¼ and SW ¼ SW ¼, Section 2
    - NE ¼ NE ¼, Section 3
    - NW ¼ NE ¼, Section 12
    - N ½ NE ¼ and SE ¼ NE ¼, Section 23
    - N ½ NW ¼, SW ¼ NW ¼, and NW ¼ SW ¼, Section 24

The portions of critical habitat located Township 17 south, Range 50 east, SW ¼ NE ¼ and W ½ SE ¼, Section 21 and Township 18 south, Range 50 east, NW ¼ NE ¼, Section 12 are not occupied. All other portions of critical habitat are occupied.

6. a. Status of Mentzelia leucophylla (Ash Meadows blazingstar)

Species distribution
Mentzelia leucophylla (Ash Meadows blazingstar) was listed as threatened with critical habitat on May 20, 1985 (50 *Federal Register* 20777). The critical habitat designation includes 1,240 ac (501.8 ha) of sandy or saline clay soils along canyon washes and near springs and seeps on the Refuge and private inholdings. *Mentzelia leucophylla* was also listed as critically endangered by the state of Nevada in 1979 and is protected under NRS 527.260-300.

Mentzelia leucophylla was first collected in 1898 by Carl Purpus, but not re-collected (recognized) until the 1970's (Reveal 1978b; Knight and Clemmer 1987). Purpus' collection was described as *M. leucophylla* by T.S. Brandegee in 1899 (Brandegee 1899), and was known only by the type specimen for several years. Darlington (1934) modified the species description of *M. leucophylla* and included in her concept plants now treated as *Mentzelia oreophila* J. Darl. (Argus blazingstar). Jepson (1936) placed specimens of *M. oreophila* collected in Inyo County, California, into his concept of *M. leucophylla.* True *M. leucophylla* from Ash Meadows was not collected again until

1968 by Reveal. Consultation with the authority of the genus *Mentzelia*, Dr. Henry J. Thompson of the University of California at Los Angeles, differentiated between California *M. oreophila* and Nevada *M. leucophylla* at the species level (Reveal 1977; Reveal 1978b). Further examination of the genetic and physical characteristics of *M. leucophylla* and *M. oreophila* by John J. Schenk (Florida State University, pers. comm. 2010) again differentiated these plants at the species level. *M. leucophylla* belongs to the section *Bartonia*, which consists of about forty species that differ from all other *Mentzelia* species due to having lenticular, usually winged seeds that are horizontally aligned in the capsule (Holmgren and Holmgren 2002).

Mentzelia leucophylla has been described as both an erect biennial forb (Reveal 1978b; Knight and Clemmer 1987; Service 1990) and a short-lived perennial forb (Beatley 1971; Caicco 2006) in the Loasaceae (stick-leaf or blazingstar) family. Plants are 11.8-19.7 in (30-50 cm); with one to several (mostly 3 or less) white stems arising from a thick, woody taproot (Reveal 1978b). Leaves are densely white tomentose with short, stiff hairs on both surfaces (Reveal 1978b). The specific name, *leucophylla*, refers to the short, white hairs on the leaves (Mozingo and Williams 1980). The flowers are borne on branched panicles and are small, bright yellow in color, and made up of five petals that are about 0.4 in (1 cm) long (Reveal 1978b). Flowers open in the late afternoon (Reveal 1978b) and bloom between late April to October (Pavlik and Moore 2010). The cup-shaped capsule produces 0.1 in (3 mm) long, flat, narrowly winged, white seeds (Reveal 1978b). Seed dispersal is primarily by wind and secondarily by water vectors (Reveal 1978b). Dead stalks with dehisced fruit remain erect during the fall and winter, allowing seeds that are still in the capsules to be blown and shaken from the fruit and dispersed. *Mentzelia leucophylla* is endemic to the Ash Meadows area of Nye County, Nevada. The range of *M. leucophylla* encompasses the Refuge, adjacent areas of the BLM ACEC, and private lands.

Studies on phenology, breeding system, and seed biology (seed output, germination) of 64 *Mentzelia leucophylla* plants have been conducted (Pavlik and Moore 2010). Of all the rare plants on the Refuge, *Mentzelia leucophylla* had the longest period of anthesis, extending from late April to October (Pavlik and Moore 2010). In this study, seeds of fruit that originated in May or June were more abundant (averaging six or seven per capsule) and heavier than those from buds that originated early or later in the reproductive season (Pavlik and Moore 2010). Plants produced 6.03 mature seeds per fruit, which is very low (Pavlik and Moore 2010). An examination of the seed-to-ovule ratio of mature fruits suggests that this taxon has a xenogamous, nearly obligate breeding system (*i.e.*, requires cross-pollination) (Pavlik and Moore 2010). *Mentzelia leucophylla* flowers attract at least 11 non-specialist floral visitors, 10 of which are bee taxa (BIO-WEST 2009). *Mentzelia leucophylla* is important to the nectiferous insect community at the Refuge because its blooms for 6 months and its blooms open late in the day, offering the last available nectar resources before nightfall (BIO-WEST 2009).

During the 2-year study period for Pavlik and Moore (2010), no *in situ* germination or seedling recruitment was observed within any of the three study populations of *Mentzelia leucophylla*. In addition, monitoring that could provide insight into population trend and demographic structure has not been conducted. The seed bank buffers against environmental stochasticity and extinction in desert plants; nothing is known about the longevity of *M. leucophylla* seeds in the seed bank. Attempts to germinate 220 *M. leucophylla* seeds collected in 2008 and 2009 under three different germination trials were low, with only 13 to 20% germinating. Treatment with gibberellic acid significantly enhanced germination of 2009 seeds relative to the control, but not the 2008 seeds.

Fungal attack was a major cause of seed mortality in the germination dishes. After seedlings were transplanted into native soil, seedlings appeared robust, but were infected, and soon died under greenhouse conditions (Pavlik and Moore 2010). Transplanting and translocation studies have not been conducted.

Mentzelia leucophylla occurs between 2,220 and 2,350 ft (676.7 and 716.3 m) above mean sea level and occurs in xeric-to-intermittently flooded alkali shrub-scrub and salt desert shrub where plants populate small outcroppings, hills, or slopes with spares vegetation cover and gravel-to-sandy clay soil (Morefield 2001e; BIO-WEST 2011). Based on superficial observations of its habitat, it was initially assumed that *M. leucophylla* was a xerophyte, adapted to arid upland conditions characterized by dry soils uninfluenced by seepage from springs or seeps (Reveal 1978b; Service 1990). However, this characterization may be misleading because it is based on observations made during summer months (S. Jensen, White Horse Associates, pers. comm. 2010). During winter months, landtypes considered "upland" (*i.e.* hard, whitish, and alkaline soil areas not directly affiliated with a spring system) are saturated at or near the surface (Jensen, pers. comm. 2010). Further, about 77 percent of *M. leucophylla* populations occur on a landtype with a hydric character (hydricmarl/sandstone) that is saturated to the surface during winter months of a normal year (White Horse Associates 2010). Additionally, through the use of lysimeters, (Breit, U.S. Geological Survey, pers. comm. 2010) demonstrated that this species is located where the soil is saturated at 30 to 40 cm (11.8 to 15.7 in) or less, even though there is no indication of moisture on the soil surface (Breit, pers. comm. 2010). Other plant species associated with *M. leucophylla* include: *Astragalus phoenix*, *Atriplex confertifolia*, *Cryptantha confertiflora*, *Enceliopsis nudicaulis* var. *corrugata*, and *Isocoma acradenia* (Mozingo and Williams 1980).

At the time of listing, *Mentzelia leucophylla* was known only from two sites on the Refuge and was estimated to be made up of less than 100 individuals (Reveal 1978b). Knight and Clemmer (1987) reviewed the available data on the rare plants of the Ash Meadows area and identified four general areas (Purgatory Spring, Cold Spring, Longstreet road, and Warm Springs) from which *M. leucophylla* had been reported. Knight and Clemmer (1987) did not find the plant at two (Longstreet road and Warm Springs) of the general areas during their survey. In 2001, the *M. leucophylla* population was estimated to be about 358 individuals in 8 minimum scale occurrences (0.1 mi (0.16 km) separation distance) or 6 maximum scale occurrences (0.6 mi (1 km) separation distance) on 3.0 acres (1.2 ha) (Morefield 2001e). Results from the 2008-2010 Refuge-wide rare plant survey (BIO-WEST 2011) estimate that 1,513 individuals are present on the Refuge in 12 minimum scale occurrences (0.1 mi (0.16 km) separation distance) or 2 maximum scale occurrence (0.6 mi (1 km) distance) on a total of 13.5 ac (5.5 ha). The largest occurrences of *M. leucophylla* on the Refuge are at Cold Spring, Crystal Reservoir, Point of Rocks road, Purgatory Spring, and Warm Springs North. Estimates of *M. leucophylla* individuals on the BLM ACEC and private lands within the Refuge boundary do not exist.

Status and Distribution

The primary threats to *Mentzelia leucophylla* included in the final listing rule were groundwater withdrawal, road construction, trampling by wild and free-roaming horses, inadequate regulatory mechanisms, and trampling by cattle and feral horses. Threats identified since listing include non-native plant species, wildfire, surface mining, OHVs, and predation and herbivory. Endemism and limited geographic distribution will continue to threaten *M. leucophylla* due to the vulnerability of small populations to a range of environmental, demographic, and stochastic factors. At this time, it is difficult to predict local climate change impacts to *M. leucophylla.* Information indicates that climate change has the potential to affect and threaten the Ash Meadows ecosystem in the long-term, but there is much uncertainty regarding the attributes that could be affected and their timing, magnitude, and rate of change.

Establishment of the Refuge in 1984 secured the land for federally-listed plant species by removing threats from agriculture, wild and free-roaming horses, livestock and ranching, and residential development. The creation of the BLM ACEC in 1998 added additional protections to species whose range extended past the Refuge boundary. Habitat for *Mentzelia leucophylla* is almost entirely protected from development (except on private inholdings) and new mineral entry (for 20 years) within the Refuge and BLM ACEC. Private inholdings still exist within the Refuge boundaries. OHV activity is periodically a threat to *M. leucophylla* within the Refuge boundary, due to downed sections of fencing and lack of law enforcement presence. In addition, though OHV activity is confined to existing trails, roads and dry washes within the BLM ACEC, there are no signs and fences that would inform the OHV community of its special designation (Baldino, pers. comm. 2012). Non-native plant species could spread into *M. leucophylla* habitat, increase fire frequency, or both, any or all of which would threaten the natural vegetation corridors needed for gene flow and dispersal in this taxon. Recent, comprehensive, baseline surveys on public land have added new known populations; there are now 12 occurrences (0.1 mi (0.16 km) minimum scale) made up of 1,513 individuals on 13.5 ac (5.5 ha) within Refuge boundaries. Trend data for demographic structure and recruitment events is nonexistent and nothing is known about the longevity of *M. leucophylla* seeds in the seed bank. Recent observations of herbivory and predation upon *M. leucophylla* could negatively affect gene flow and dispersal by disrupting reproduction and seed bank recharge (Pavlik and Moore 2010). The Amargosa Valley has been selected as a Solar Energy Zone (SEZ) even though the Amargosa Desert Hydrographic Basin is already over-appropriated. The hydrologic impacts to Ash Meadows from solar development are unknown, but fluctuations in water levels in the Amargosa Desert Hydrographic Basin have been tied directly to groundwater pumping (Bedinger and Harrill 2006). Exploration into detailed hydrologic habitat requirements of *M. leucophylla* has begun though preliminary studies have shown that this species occurs in areas where water is available below ground, which is not obvious from surface soil features (Breit, pers. comm. 2010; Jensen, pers. comm. 2010; White Horse Associates 2010; BIO-WEST 2011). More information is needed on the potential effects of changes in spring discharge, groundwater levels, water temperature, and water and soil chemistry upon patterns of gene flow and dispersal in *Mentzelia leucophylla.*

6. b. Status of Mentzelia leucophylla (Ash Meadows blazingstar) Critical Habitat

Critical habitat for the *Mentzelia leucophylla* was designated on Federal and private land on May 20, 1985, in two township and range units (Township 17 south, Range 50 east and Township 18 south, Range 50 east) totaling 1,240 ac (501.8 ha). The primary constituent elements for these areas are sandy or saline soils along canyon washes and near springs and seeps *(50 Federal Register 20777).* Critical habitat areas are as follows:

- Township 17 South, Range 50 East
    - SW ¼ SW ¼, Section 15

  - S ½ NE ¼, N ½ SE ¼, and SW ¼ SE ¼, Section 21
  - NW ¼ NW ¼, S ½ NW ¼, and NE ¼ SE ¼, Section 22
  - NW ¼ SW ¼, Section 23
  - NW ¼ NE ¼, Section 28
  - SE ¼ SW ¼ and SE ¼, Section 35
  - SW ¼ SW ¼, Section 36
- Township 15 South, Range 50 East
  - NW ¼ NW ¼, SW ¼ SW ¼, and E ½ SW ¼, Section 1
  - NE ¼ NE ¼ and S ½ SE ¼, Section 2
  - N ½ NE ¼, Section 11
  - NW ¼, Section 12

The portion of critical habitat located in Township 17 south, Range 50 east, NW ¼ SW ¼ Section 23 occurs outside of the Refuge on private land and has not been surveyed. It is unknown if this habitat is occupied. The portions of critical habitat located in Township 17 south, Range 50 east, NW ¼ NW ¼, S ½ NW ¼, and NE ¼ SE ¼, Section 22; NW ¼ NE ¼, Section 28; and SW ¼ SW ¼, Section 36 and Township 18 south, Range 50 east, N ½ NE ¼, Section 11 are not occupied. *Mentzelia leucophylla* occur just outside the critical habitat border in Township 17 south, Range 50 east, NE ¼ SE ¼, Section 22 and NW ¼ NE ¼, Section 28. All other portions of critical habitat are occupied.

7. a. Status of *Nitrophila mohavensis* (Amargosa niterwort)

Species Description

Nitrophila mohavensis (Amargosa niterwort) was listed as endangered with critical habitat on May 20, 1985 *(50 Federal Register 20777)*. The critical habitat designation includes 1,200 ac (485.6 ha) of salt encrusted alkaline flats on the Refuge and in Inyo County, California. *Nitrophila mohavensis* was listed as critically endangered by the State of Nevada in 1986 and is protected under NRS 527.260-300. In 1979 the species was also listed as endangered under the California Endangered Species Act and is protected by CEQA.

Nitrophila mohavensis was first collected in 1954 by Philip Munz and John Roos in open flats of the Amargosa Desert in Inyo County, California and wasn't found until 1984 on the Refuge in Nevada (Knight and Clemmer 1987). *Nitrophila mohavensis* is an erect, perennial forb in Amaranthaceae (amaranth family); formerly in the Chenopodiaceae (goosefoot family)) that grows up to 4 in (10.2 cm) tall (Knight and Clemmer 1987; Wetherwax et al. 2012). Vegetative growth of shoots from ramets (rhizomes) is probably the principle mean of colonization and persistence. Flowers are small, less than 0.2 in (4 mm) in diameter, perfect, and cluster in groups of 1 to 3 in the upper leaf axils. The sepals are rose-colored when fresh, but turn tan or whitish and somewhat papery when dry. There is one, round, shiny black seed per fruit (Knight and Clemmer 1987; Pavlik and Moore 2010). *Nitrophila mohavensis* flowers from late April to July, with fruiting starting in June and lasting into September (Pavlik and Moore 2010). *Nitrophila mohavensis* is endemic to the Carson Slough area in Nevada and adjacent Inyo County, California. The range of *N. mohavensis* encompasses in Nevada is the Refuge, adjacent areas within the BLM ACEC, and on private lands, and on adjacent BLM and private lands in Inyo County, California near Death Valley Junction and Tecopa Hot Springs.

Studies on phenology, breeding system, and seed biology (seed output, germination) of 90 *Nitrophila mohavensis* plants have been conducted (Pavlik and Moore 2010). *Nitrophila mohavensis* was studied on the Refuge at Crystal Reservoir and Soda Springs. Ramets at Fairbanks were, on average, half as tall as those at Crystal Reservoir (20.6 mm versus 46.7 mm) and produced fewer sexual reproductive structures (1.9 sexual reproductive structures/mm verses 2.5 sexual reproductive structures/mm) (Pavlik and Moore 2010). The seed-to-ovule ratio of mature fruits was not calculated for *N. mohavensis* because treatments were conducted on whole ramets and it was not possible to assess the number of seeds produced per ramet due to rapid seed dispersal (Pavlik and Moore 2010). Pollinator exclusion studies were conducted, though ants were occasionally seen entering cages and climbing ramets, and *N. mohavensis* was still able to produce seeds suggesting an autogamous (*i.e.*, self-fertilization) breeding system, though this does not rule out the possibility that this species is cleistogamous (*i.e.*, a flower that doesn't open and is self-fertilized in the bud) (BIO-WEST 2009; Pavlik and Moore 2010).

There are no data on germination events in *Nitrophila mohavensis*. Monitoring that could provide insight into population trend and demographic structure has not been conducted in Nevada. In 2003, 2010, and 2011 at the Death Valley Junction populations in California, transects were used to develop a population estimate (see below). The seed bank buffers against environmental stochasticity and extinction in desert plants; nothing is known about the longevity of *N. mohavensis* seeds in the seed bank. Attempts to germinate 60 *N. mohavensis* seeds were unsuccessful and no seeds germinated; after 4 weeks exposure to dark, moist, and warm conditions; the seed coat remained largely intact (Pavlik and Moore 2010). Transplanting and translocation studies have not been conducted.

Nitrophila mohavensis occurs between 2,100 and 2,160 ft (640 and 658 m) above mean sea level and occurs most commonly in alkali seep and alkali meadow habitat in open areas with saturated or moist to clay to gravelly/sandy soils and a prominent alkali crust (Morefield 2001f; BIO-WEST 2011). In a few instances, *N. mohavensis* individuals were observed occupying intermittent drainages with remnant alkali crust between upland mesic to mesic alkali shrub-scrub habitat (BIO-WEST 2011). On the basis of isotopic analysis, Hasselquiest and Allen (2009) found that *N. mohavensis* uses surface water and soil moisture near the soil surface (depths 1 ft (30 cm) from the ground surface). Soil moisture below *N. mohavensis* was two times greater than below *Grindelia fraxino-pratensis*, which is also affiliated with wetter environments, especially near the soil surface. Higher soil moisture below *N. mohavensis* may in part be explained by groundwater upwelling or the movement of deep groundwater upward in the soil profile (Hasselquiest and Allen 2009). But at the Crystal Reservoir population of *N. mohavensis*, ramets were found about 0.3 to 0.5 ft (8 to 15 cm) below ground and roots were developed and growing to depths greater than 0.3 to 1 ft (10 to 30 cm), suggesting that this species may also be able to utilize groundwater (Willoughby 2011). Other plant species associated with *N. mohavensis* in its alkali seep and meadow habitat include: *Atriplex confertifolia*, *Cleomella brevipes* S. Watson (shortstalk stinkweed), and *Distichlis spicata* (Knight and Clemmer 1987; Morefield 2001f).

At the time of listing, *Nitrophila mohavensis* was only known from one location, the south end of the Carson Slough on both sides of the Nevada/California border *(50 Federal Register 20777)*. Knight and Clemmer (1987) reviewed the available data on the rare plants of the Ash Meadows area and identified two general areas that contained *N. mohavensis*: Central Carson Slough in Nevada and South Carson Slough in California. In 2001, three occurrences of *N. mohavensis* were mapped and the population was estimated to be 13,000 individuals on approximately 229 ac (92.7 ha) (Morefield 2001f). Results from the 2008-2010 Refuge-wide rare plant survey estimate that 58,292 above ground ramets are present on the Refuge in 11 minimum scale occurrences (0.1 mi (0.16 km) separation distance) or 2 maximum scale occurrence (0.6 mi (1 km) distance) on a total of 21.4 ac (8.7 ha) (BIO-WEST 2011). The largest occurrences of *N. mohavensis* on the Refuge are concentrated around Crystal Reservoir, Horseshoe Marsh, and Soda Spring (BIO-WEST 2011). Estimates of NIMO ramets on the BLM ACEC and private lands do not exist.

There are three occurrences of *Nitrophila mohavensis* in California: two occurrences in critical habitat near Death Valley junction that occur on BLM land and one occurrence at Tecopa Hot Springs that occurs on BLM and private land. In 2003, the two occurrences near Death Valley junction were surveyed using transects and macroplots to develop a population estimate. It was estimated that Occurrence 1 contains 243,478 ± 69.337 ramets (± 95% confidence interval) within 10 ac (4.08 ha) and Occurrence 2 contains 28,951 ± 20,372 ramets (± 95% confidence interval) within 418.5 ac (169.37 ha) (Johnston and Zink 2004). In 2010-2011, Occurrence 1 in California was re-surveyed using transects and five macroplots in an effort to establish a permanent monitoring protocol for *N. mohavensis*. The estimates for the number of rooted stems in the combined area of the macroplots in Occurrence 1 were 59,540 ± 24,782 in 2010 and 58,431 ± 21,541 in 2011 (± 95% confidence interval) (Willoughby 2011). The slightly lower estimate for 2011 was not statistically significant. Because of problems inherent in accurately counting rooted stems (*i.e.*, where stems were solitary or few there was no problem counting rooted stems but, where stems were very clumped it was impossible to accurately count rooted stems without damaging plants), these numbers are not considered to accurately track *N. mohavensis* abundance between years. Rooted stems will be dropped as a measured attribute in future years and clump estimates will be used instead. Both the estimated number of clumps (*i.e.*, single plants or groups of plants separated by at least 2 cm from each other from the place they are rooted) and frequency were greater in 2011 than in 2010. Clump numbers were estimated to be 33,309 ± 12,895 in 2011, about twice as many as 16,712 ± 5,938 estimated for 2010, a difference that was statistically significant. The 2011 frequency of 0.088 (± 0.027) was significantly greater than the 2010 frequency of 0.061 (± 0.015) (Willoughby 2011). Total growing season precipitation was about the same for the 2 years, the higher *N. mohavensis* abundance observed in 2011 appears to have resulted from a better distribution of precipitation during the hotter months, which is supported by groundwater levels measured in a piezometer immediately adjacent to the niterwort population at Lower Carson Slough (Willoughby 2011). Occurrence 3, on BLM lands near Tecopa Hot Springs, was surveyed in 2005 and was estimated to contain 1,000s of individuals (Caicco 2005). An estimate of N. mohavensis ramets on the private land near Tecopa Hot Springs does not exist.

Status and Distribution

The primary threats to *Nitrophila mohavensis* included in the final listing rule were groundwater withdrawal, OHV activity, surface mining, inadequate regulatory mechanism, and trampling by cattle and feral horses. Threats identified since listing include non-native plant species and wildfire. Endemism and limited geographic distribution will continue to threaten *N. mohavensis* due to the vulnerability of small populations to a range of environmental, demographic, and stochastic factors. At this time, it is difficult to predict local climate change impacts to *N. mohavensis.* Information indicates that climate change has the potential to affect and threaten the Ash Meadows ecosystem in the long-term, but there is much uncertainty regarding the attributes that could be affected and their timing, magnitude, and rate of change.

Establishment of the Refuge in 1984 secured the land for federally-listed plant species by removing threats from agriculture, wild and feral horses, livestock and ranching, and residential development. The creation of the BLM ACEC in 1998 added additional protections to species whose range extended past the Refuge boundary. Habitat for *N. mohavensis* is almost entirely protected from development (except on private inholdings) and new mineral entry (for 20 years) within the Refuge and BLM ACEC. Private inholdings still exist within the Refuge boundaries. OHV activity is periodically a threat to *N. mohavensis* within the Refuge boundary, due to downed sections of fencing and lack of law enforcement presence. In addition, increased OHV activity has been reported in the Carson Slough (Baldino, pers. comm. 2012). Non-native plant species could spread into *N. mohavensis* habitat, increase fire frequency, or both, any or all of which would threaten the natural vegetation corridors needed for gene flow and dispersal in this taxon. Recent, comprehensive, baseline surveys on public land have added new known populations; there are now 11 occurrences (0.1 mi (0.16 km) minimum scale) made up of 58,292 above ground ramets on 21.4 ac (8.7 ha) within Refuge boundaries. In addition, there is an estimated 33,309 ± 12,895 clumps in Occurrence 1 in California as of 2011(Willoughby 2011) and 28,951 ± 20,372 ramets in Occurrence 2 in California as of 2003 (Johnston and Zink 2004). Occurrence 3, on BLM lands near Tecopa Hot Springs was estimated to contain 1,000s of individuals (Caicco 2005). An estimate of N. mohavensis ramets on the private land near Tecopa Hot Springs does not exist. Nothing is known about the longevity of *N. mohavensis* seeds in the seed bank. The Amargosa Valley has been selected as a Solar Energy Zone (SEZ) even though the Amargosa Desert Hydrographic Basin is already over-appropriated. The hydrologic impacts to Ash Meadows from solar development are unknown, but fluctuations in water levels in the Amargosa Desert Hydrographic Basin have been tied directly to groundwater pumping (Bedinger and Harrill 2006). Increasing the demand for already limited water resources can have severe direct and indirect consequences on the persistence of *N. mohavensis*. Increasing groundwater pumping will lower the water table and indirectly affect the amount of groundwater being forced to the surface, which may affect the growing conditions of *N. mohavensis*. More information is needed on the potential effects of changes in spring discharge, groundwater levels, water temperature, and water and soil chemistry upon patterns of gene flow and dispersal in *N. mohavensis*.

7. b. Status of *Nitrophila mohavensis* (Amargosa niterwort) Critical Habitat

Critical habitat for *Nitrophila mohavensis* was designated on Federal land on May 20, 1985 in one township and range unit (Township 25 north, Range 6 east) totaling 1,200 ac (485.6 ha) in Inyo County, California. The primary constituent element for this area is salt encrusted alkaline flats *(50 Federal Register 20777).* Critical habitat areas are as follows:

- Township 25 North, Range 6 East

- W ½, Section 5
- E ½, Section 6
- NE ¼ and E ½ NW ¼, Section 7
- NW ¼, Section 8

All portions of NIMO critical habitat are occupied.

8. a. Status of *Zeltnera namophila* (spring-loving centaury)

Species description

Zeltnera namophila (syn. *Centaurium namophilum*) (spring-loving centaury) was listed as threatened with critical habitat on May 20, 1985 (Service 1985). The critical habitat designation encompasses 1,840 ac (745 ha) of moist to wet clay soils along banks of streams or in seeping areas on the Refuge, BLM ACEC, and private inholdings. *Zeltnera namophila* also was listed as critically endangered by the State of Nevada in 1982 and is protected under NRS 527.260-300.

Reveal, Broome, and Beatley described *Zeltnera namophila* in 1973, although Coville and Funston had collected it as early as 1891 (Reveal *et al.* 1973). A member of Gentianaceae (gentian family), *Z. namophila* is an upright, glabrous, annual forb that measures 17.5 in (45 cm) tall with many branches that bear flowers measuring approximately 0.3 to 0.5 in (7 to 12 mm) in diameter (Reveal *et al.* 1973; Mozingo and Williams 1980). The flower is tubular with 0.2 to 0.3 in (7 to 8 mm) long petals (Reveal *et al.* 1973; Mozingo and Williams 1980). Petals are deep rose-pink with a yellowish throat and five dark purple spots below the point at which the adjacent petals attach to the body of the flower (Reveal *et al.* 1973). The stamens are conspicuously exerted, and after pollen release, the yellow anthers become twisted (Reveal *et al.* 1973). *Zeltnera namophila* flowers from June to September with flowers developing into narrow, linear seed capsules (Reveal *et al.* 1973; Pavlik and Moore 2010). The range of *Z. namophila* encompasses the Refuge, the adjacent BLM ACEC, and private lands.

Studies have been conducted on phenology, breeding system, and seed biology (seed output, germination) of 71 *Zeltnera namophila* plants (Pavlik and Moore 2010). Inflorescences that developed earlier in the season produced significantly heavier seed than those that originated later in the season (Pavlik and Moore 2010). Plants produced approximately 27.2 floral buds that each yielded approximately 23 seeds (Pavlik and Moore 2010). *Zeltnera namophila* has a facultative autogamous breeding system: it is capable of self-fertilization, but probably benefits from outcross pollen and increased pollen loads provided by insect pollinators (Pavlik and Moore 2010).

There are no data on germination events for *Zeltnera namophila*. Monitoring capable of providing insight into population trend and demographic structure has not been conducted. The seed bank buffers against environmental stochasticity and extinction in desert plants; nothing is known about the longevity of spring-loving centaury seeds in the seed bank. Germination trials of *Z. namophila* seeds have not been conducted due to the robust nature of this species reproduction (*i.e.* large number of seeds per bud, buds per plant) and the extremely small size of the seeds (Pavlik and Moore 2010). Transplanting and translocation studies have not been conducted.

Zeltnera namophila grows between 2,070 and 2,320 ft (630 to 707 m) above mean sea level and is widespread across the Refuge in seeps, wet meadows, and spring channel banks (Morefield 2001b; BIO-WEST 2011). The species is adapted to alkaline clay soils of the Ash Meadows area and it appears that any location on the Refuge that contains surface or near-surface water at any time during the year would produce a *Z. namophila* community (BIO-WEST 2011). The wet meadow ecosystem occupied by *Z. namophila* is typically dominated by *Distichlis spicata* with scattered *Fraxinus velutina* Torr. (velvet ash) and *Prosopis pubescens* Benth. (screwbean mesquite). Other associates of the species in *D. spicata* meadows include *Anemopsis californica* and *Grindelia fraxino-pratensis*. On drier sites, common associates include *Cordylanthus tecopensis* Munz & Roos (Tecopa bird's beak) and *Ivesia kingii* var. *eremica* (Reveal *et al*. 1973; Morefield 2001b).

At the time of listing, a population estimate of *Zeltnera namophila* was unknown *(50 Federal Register 20777)*. Knight and Clemmer (1987) reviewed the available data on the rare plants of Ash Meadows and identified general areas from which *Z. namophila* had been reported. In 1998, surveys were targeted on the seven general areas identified by Knight and Clemmer (1987) and the total population was estimated to be about 175,000 plants on 522 ac (211 ha) (BLM and Service 2000). Results from the 2008-2009 Refuge-wide rare plant surveys (BIO-WEST 2011) estimate that 4,593,971 individuals are present on the Refuge in 33 minimum scale occurrences (0.1 mi (0.16 km) separation distance) (Table 2) or 2 maximum scale occurrences (0.6 mi (1 km) separation distance) on a total of 527.2 ac (231.6 ha). Estimates of *Z. namophila* individuals on the BLM ACEC and private lands within the Refuge boundary do not exist.

Status and Distribution

The primary threats to *Zeltnera namophila* included in the final listing rule were groundwater withdrawal; road construction; trampling and overgrazing by cattle and wild and free-roaming horses; and inadequate regulatory mechanisms. Threats identified since listing include non-native plant species, wildfire, and surface mining. Endemism and limited geographic distribution will continue to threaten *Z. namophila* due to the vulnerability of small populations to a range of environmental, demographic, and stochastic factors. At this time, it is difficult to predict local climate change impacts to *Z. namophila*. Information indicates that climate change has the potential to affect and threaten the Ash Meadows ecosystem in the long-term, but there is much uncertainty regarding the attributes that could be affected and their timing, magnitude, and rate of change.

Establishment of the Refuge in 1984 secured the land for listed plant species by removing threats from agriculture, wild and free-roaming horses, livestock and ranching, and residential development. The creation of the BLM ACEC in 1998 added additional protections to species whose range extends past the Refuge boundary. Habitat for *Zeltnera namophila* is almost entirely protected from development (except on private inholdings) and new mineral entry (for 20 years) within the Refuge and BLM ACEC. Private inholdings still exist within the Refuge boundaries. OHV activity is periodically a threat to *Z. namophila* within the Refuge boundary, due to downed sections of fencing and lack of law enforcement presence (Baldino, pers. comm. 2012). In addition, though OHV activity is confined to existing trails, roads and dry washes within the BLM ACEC, there are no signs and fences that would inform the OHV community of its special designation. Non-native plant species could spread in *Z. namophila* habitat, increase fire frequency, or both and threaten natural vegetation corridors needed for gene flow and dispersal in this species. Recent, comprehensive baseline surveys on public land have added new known populations; there are now 33 occurrences (0.1 mi (0.16 km) minimum scales) made up of 4,593,971 individuals on 527.2 ac (231.6 ha) within Refuge boundaries. Trend data for demographic structure and recruitment events is nonexistent and nothing is known about the longevity of *Z. namophila* seeds in the seed bank. The Amargosa Valley has been selected as a SEZ even though the Amargosa Desert Hydrographic Basin is already over-appropriated. The hydrologic impacts to Ash Meadows from solar development are unknown, but fluctuations in water levels in the Amargosa Desert Hydrographic Basin have been tied directly to groundwater pumping (Bedinger and Harrill 2006). Since *C. namophilum* is adapted to the wetter environments of the Refuge, more information is needed on the effects of changes in spring discharge, groundwater levels, water temperature, and water and soil chemistry to gene flow and dispersal in *Z. namophila*.

8. b. Status of *Zeltnera namophila* (spring-loving centaury) Critical Habitat

Critical habitat

Critical habitat for *Zeltnera namophila* was designated on Federal and private land on May 20, 1985, in three township and range units (Township 17 south, Range 50 east; Township 18 south, Range 50 east; and Township 18 south, Range 51 east) totaling 1,840 ac (744.6 ha). The primary constituent elements for these areas are moist to wet clay soils along banks of streams or seepage areas *(50 Federal Register 20777)*. Critical habitat areas are as follows:

- Township 17 South, Range 50 East
  - SW ¼ NE ¼, SE ¼ NW ¼, E ½ SW ¼, and W ½ SE ¼, Section 21
  - W ½ NW ¼, Section 23
  - NW ¼ NE ¼ and NE ¼ NW ¼, Section 28
  - SE ¼ SE ¼, Section 34
  - SW ¼ SW ¼ and E ½ SW ¼, Section 35
- Township 18 South, Range 50 East
  - SW ½, Section 1
  - NE ¼ NW ¼ and W ½ NW ¼, Section 2
  - E ½ NE ¼, Section 3
  - NE ¼, Section 7
  - SE ¼ SE ¼, Section 23
  - SE ¼ SW ¼, Section 24
- Township 18 South, Range 51 East
  - NW ¼ SE ¼, Section 7
  - S ½ NW ¼ and SW ¼, Section 18
  - NW ¼ and NE ¼ SE ¼, Section 19
  - E ½ SW ¼, Section 20
  - N ½ NW ¼, Section 29
  - NE ¼ NW ¼, Section 30

The portion of critical habitat located in Township 18 south, Range 50 east, NE ¼ Section 7 occurs outside of the Refuge within the BLM ACEC and private inholdings and has not been surveyed. It is unknown if this habitat is occupied. The portions of critical habitat located in Township 17 south, Range 50 east, W ½ NW ¼, Section 23 and NW ¼ NE ¼ and NE ¼ NW ¼, Section 28 and Township 18 south, Range 51 east, E ½ SW ¼, Section 20 and N ½ NW ¼, Section 29 are not occupied. All other portions of critical habitat are occupied.

9.a. Status of the Ash Meadows Naucorid

Species Description

On May 20, 1985, the Service determined the Ash Meadows naucorid (naucorid) to be threatened and concurrently designated critical habitat (50 *Federal Register* 20786). The naucorid is an Ash Meadows-endemic aquatic insect (Hemiptera:Naucoridae) that occurs within thermal springs of the Point of Rocks area of the Ash Meadows NWR. This species was listed in part due to severe habitat destruction within its historic range. The naucorid is a small, flattened, ovate aquatic insect which ranges in size from a mode of 0.07 inches (nymphal instar I) to 0.19 inch (nymphal instar V), with adults averaging 0.24 inch. It is univoltine (one generation per year), and produces a few (probably seven) large eggs per year. Eggs are stalked and laid on a variety of substrates, with the exception of fines and substrate larger than small cobble (Parker *et al.* 2000). Eggs hatch within approximately one month and juveniles mature to adulthood in approximately 2 months (Polhemus 1994). Naucorids are active ambush predators with main prey being amphipods (*Hyalella azteca*).

Status and Distribution

The populations of naucorids in the Point of Rocks area were surveyed by Southern Oregon University and USGS-BRD during 1997 and 1998, and were determined to fluctuate in abundance depending on the season; however, they were at relatively low abundance due to restricted and poor habitat. A total of 39 individuals were transferred to the restored King's Spring outflow during the late summer and fall of 1997, where they increased in numbers (10,000+). Incidental surveys during 2003 and 2004 of the King's outflow suggested that this large population was subsequently lost due to an unknown reason, potentially the increase of cattails within the system and crayfish predation.

Numbers of naucorids were significantly greater in suitable substrate and flows, preferring pebbles and fast current velocity (Parker *et al.* 2000). From previous investigations regarding the naucorid, it has been suggested that habitat for this species has gradually degraded due to habitat disturbance and water diversion. Generally, the lack of natural maintenance flows through the habitat has prevented proper substrate from occurring. Habitat where the naucorid was most numerous was determined to be gravel-pebble substrate as well as submerged roots of vegetation. They also occur on larger substrate, but this does not provide as much surface area for prey species. During habitat restoration activities at Point of Rocks, habitat where the naucorid was historically present was observed to be overgrown by grasses and other vegetation. In addition, the spring that contained the known bulk of the species was impacted by public use and water diversions. This resulted in reduced water flow since the Refugia's inception as well as vegetation encroachment and a continual source of disturbance to the substrates. This problem was described by Polhemus in 1994 correspondence (Polhemus 1994), who stated that the species was in a period of decline due to altered habitat, an issue which potentially dates back to the early 1980s.

9.b. Status of the Ash Meadows Naucorid Critical Habitat

Critical habitat for the Ash Meadows naucorid was designated on May 20, 1985, *(50 Federal Register 20777)* in Section 7, T18S, R51E. All naucorid critical habitat occurs within critical habitat designated for the Ash Meadows Amargosa pupfish. Critical habitat for the Ash Meadows naucorid consists of about 10 acres in Ash Meadows NWR including Point of Rocks Springs and their immediate outflows. Primary constituent elements for the Ash Meadows naucorid are flowing warm water over rock and gravel substrate. The critical habitat of this species is currently being manipulated for restoration purposes, and existing habitat is high quality throughout its range.

10. Status of the Devils Hole Pupfish

Species Description

The Devils Hole pupfish (*Cyprinodon diabolis*) was listed under the Endangered Species Preservation Act of 1966 and became one of the original species listed under the Endangered Species Act of 1973.

Devils Hole pupfish are opportunistic feeders on algae (such as *Spirogyra*), various diatoms, amphipods (*Hyalella*), ostracods, protozoans, beetles, flatworms, and snails (Minckley and Deacon 1975). Due to the orientation of Devils Hole and the aquifer's emergence 50 feet below the top of the surrounding landscape, direct sunlight reaches the water for only a limited time during spring, summer, and fall and does not reach the water at all in winter (Riggs and Deacon 2002). Water temperature in Devils Hole is nearly constant at about 93ºF except on the shallow shelf, where temperatures vary greatly (Riggs and Deacon 2002).

Spawning occurs throughout the year, but reaches a peak in May (Minckley and Deacon 1973). Devils Hole pupfish are egg-layers. The water in Devils Hole is near the limits of egg production for closely related pupfish (Shrode and Gerking 1977).

Status and Distribution

Recovery plans for Devils Hole pupfish establish recovery actions for the maintenance of self-reproducing populations of pupfish in two locations away from Devils Hole (Service 1980, Service 1990). Several attempts to establish refuge populations have failed (Barrett *et al.* 2008). Invasive *Melanoides* snails preyed upon pupfish at one refuge (Hoover Dam). Closely related Ash Meadows Amargosa pupfish bred with a genetically pure population of Devils Hole pupfish at another refuge (Point of Rocks), resulting in hybrid progeny.

A new refuge facility is being constructed at Ash Meadows NWR. The new facility has a 30-foot deep chamber and shallow shelf to emulate the Devils Hole environment. In preparation for the new facility, research on the reproduction and growth of Devils Hole pupfish has been underway since 2008 at the University of Arizona's Cooperative Fish and Wildlife Research Unit. Due to the limited number of genetically pure Devils Hole pupfish that exist, all of which live only in Devils Hole, the work in Arizona has been done with hybrid pupfish originating from the Point of Rocks refuge.

Currently, NPS monitoring activities implement a comprehensive site plan at Devils Hole, which includes minimization measures to reduce disturbance to the Devils Hole pupfish and its habitat (File Nos. 1-5-99-F-455 and 84320-2009-I-0285).

In the 1960s and early 1970s, groundwater pumping caused the water level in Devils Hole to drop, threatening habitat on the shallow shelf. Litigation over this impact rose to the U.S. Supreme Court (*Cappaert v. United States* 1976) and ultimately resulted in less groundwater pumping to ensure a court-mandated minimum water depth above the shelf.

Because the Devils Hole pupfish occurs in a single location in the wild at relatively low numbers, many factors threaten its existence (Service 1990). Loss of evolutionary potential (genetic diversity) due to inbreeding depression and genetic drift are serious concerns (Spielman *et al.* 2004, USGS 2007).

Major causes of mortality in captive Devils Hole pupfish include bacterial infections throughout the gut, nephrocalcinosis, and lymphosarcoma (Barrett *et al.* 2008). These maladies also have been documented in wild pupfish from Devils Hole (Barrett *et al.* 2008), although data for wild fish are limited. Given Devils Hole's small size, even one natural or anthropogenic event, such as pollution, invasion by a harmful species, or a seismic event could potentially extirpate the entire species (Service 2010).

Other threats to Devils Hole pupfish include declines in water level due to regional groundwater extraction (Deacon *et al.* 2007) and impacts from climate change such as decreased groundwater inputs (precipitation) and increased ambient temperatures (Glick *et al.* 2011). Impacts that raise water temperature on the shallow shelf even slightly could hamper survival because the pupfish currently survives near or at its upper thermal limit for successful egg production and incubation (Riggs and Deacon 2002). Water temperature on the shallow shelf varies because the shallow water has less thermal inertia compared to the deep chasm, which combined with variable ambient conditions leads to localized heating and cooling on the shelf (Riggs and Deacon 2002). Cooler temperatures, albeit temporary, may be critical to successful spawning of Devils Hole pupfish (Barrett and Deacon 2008). Earthquakes occasionally slosh the water in Devils Hole.

From the late 1970s through 1995, the population is relatively stable with an average observed population count of 324 individuals. Beginning in 1996, the count declined for unknown reasons to a low of 38 fish in spring 2006 and 2007. Spring counts represent the low point in the annual population cycle (Riggs and Deacon 2002). Spring counts have increased slowly to over 100 fish in 2010 for the first time in 5 years. These counts remain below the recovery goal of 300 pupfish during winter and 700 pupfish during late summer and early autumn (Service 1990).

The fall 2011 Devils Hole pupfish survey for adult pupfish in Devils Hole was conducted in September with 119 adult pupfish. The number of pupfish observed in fall 2011 is essentially the same as the previous 2 years. Recent counts indicate a sustained improvement from 2006 when the Devils Hole pupfish count dropped to less than 50 adults in spring and less than 100 adults in fall. In prior decades, however, the pupfish count was typically above 300 adults and at times above 400 or 500 adults.

11.a. Status of the Ash Meadows Amargosa Pupfish

Species Description

The Ash Meadows Amargosa pupfish was listed as endangered with critical habitat on September 2, 1983 (48 *Federal Register* 40178). The Ash Meadows Amargosa pupfish (Eigenmann and Eigenmann) was first described in 1889 and belongs to the Family Cyprinodontidae. The Ash Meadows Amargosa pupfish is the most morphologically variable species of pupfish, but can be defined by the following combination of characters: scale surface deeply reticulate, circuli without obvious spine-like projections; scales large, usually 25 to 26 in lateral series; central cusp of tricuspid teeth narrower than outer cusps; and breeding color of males deep blue and without yellow color (Miller 1948; Moyle 1976). The Ash Meadows Amargosa pupfish subspecies differs by scale and finray counts lower than average for the species; a reduced body size; a short, deep, and slab-sided body with a greatly arched and compressed predorsal profile; and a very long head and opercle. Generally, the pupfish is less than 2 inches in length.

The Ash Meadows Amargosa pupfish is endemic to the Ash Meadows area in Nye County, Nevada. The range of the Ash Meadows Amargosa pupfish is entirely within the Ash Meadows NWR and adjacent BLM lands, occupying seven major spring systems, their outflows, and their tributaries. The Ash Meadows Amargosa pupfish was listed as endangered on September 2, 1983 (48 *Federal Register* 40178). The species is considered threatened by the State of Nevada and is protected under Nevada Administrative Code 503.065.

Status and Distribution

The Ash Meadows Amargosa pupfish is fairly widespread occurring in suitable springs and their outflows and marsh areas at Ash Meadows NWR (Scoppettone *et al.* 1995). Population estimates have been problematic and only springheads have been effectively measured, which contain an unknown but likely small proportion of the population. A substantial portion of the population occurs within marsh or shallow water habitats, and has never been effectively sampled. Given these issues, population size cannot be determined using historic survey methods and existing data. These data can only be interpreted as an index to population change.

Soltz and Naiman (1978) indicate that most pupfish occur downstream in outflow and marsh habitats; sites that have not been surveyed. Observations throughout the Ash Meadows NWR suggest that in fact *C. nevadensis* ssp. are frequently very abundant in outflows and flooded sites (Scoppettone *et al.* 1995), which cannot be effectively censused using conventional methods. For example, Crystal Spring harbored the highest population estimate (11,971; p=0.95) for the endangered Ash Meadows Amargosa pupfish based on a 2007 native fish survey. However, trapping in Crystal Spring during the native fish survey only occurred from the spring orifice down to the start of the concrete channel behind headquarters; therefore, the actual population size is likely larger than estimated. This does not account for the abundant fish that occur in marsh habitats or seasonal overflow of channels, which likely would substantially increase the population estimate, nor does it account for juvenile fish that are not surveyed due to limitations in methodology, which would also add to the estimate. It is likely that these existing data of populations in spring habitats are useful as indices of population trend since mark-recapture census methods have remained the same, especially relevant to isolated populations separated by barriers, or when sampled from contiguous outflows such as at Crystal Spring. Due to the variable nature of populations in outflows, attempts to characterize data should be used with caution. Additional information regarding refuge-wide abundance is being collected by the USGS.

Several other factors affect abundance and variability. Pupfish in lotic habitats, as opposed to lentic (predominantly spring pool) fish, are highly variable in population size, changing 10 to 20 times magnitude over the course of a year. Population abundance may also be affected by behavior and habitat use (Soltz and Naiman 1978). Pupfish change habitat use depending on time-of-day, and may migrate to cooler waters during the hotter portions of the day. This behavior may be localized at extreme conditions at sites such as with other subspecies, such as *C. nevadensis* at Tecopa.

Spawning peaks in the spring, but occurs from April to October, and the size of each population fluctuates throughout the course of a year (Soltz and Naiman 1978), which also adds a variable to population estimates. Although significantly regulated by diel light cycles and partially by water temperature, spawning likely occurs year-round, especially in warmer habitat. Pupfish reproduce in waters of 77-88˚ F (Gerkin and Lee 1983). The individuals in the springs and stable habitats likely have a different reproductive strategy than at the spring outflows with harsher, variable conditions or in ephemeral habitats, where population numbers likely fluctuate greatly depending on conditions. Population stability is also relative to predation, and presence of non-native predatory fish has been demonstrated to nearly extirpate populations.

The primary threats to the Ash Meadows Amargosa pupfish included in the 1983 proposed rule and 1985 final rule are: agricultural and municipal development of habitat; the introduction of exotic fish and other aquatic prey species that compete with or prey upon native fishes; inadequacy of existing regulatory mechanisms; and the extremely small range and habitat requirements which makes the species vulnerable to stochastic (demographic and environmental) threats. Of these threats, non-native fishes and prey species is the most serious remaining threat to the Ash Meadows Amargosa pupfish as it is likely the non-natives suppress the overall population size of the pupfish.

Recently, fire within riparian habitat has been identified as a threat to the species when riparian habitat is dominated by non-native species. Native plants may be adapted to frequent, low-intensity fire. In 2005, the Jackrabbit Fire burned within occupied habitat. The fire was high-intensity with high fuel loads of saltcedar. The heat of the fire raised the water temperature above the thermal tolerance of the species. As a result, in some stretches of the Jackrabbit Spring outflow there was 100 percent mortality of all native fishes.

Establishment of the Ash Meadows NWR and the subsequent purchase of water rights and private lands containing habitat, removed many of the threats facing the Ash Meadows Amargosa pupfish. However, groundwater pumping in the adjacent hydrologic sub-basin is now being pumped at roughly two times the rate predicted to be sustainable. Disruptions to the surface and subsurface hydrology are particularly important threats to the species, and all known populations of the pupfish face this threat. Habitat restoration and invasive species management also have improved overall population numbers, however many local populations are at risk of extirpation due to the introduction of game fish such as largemouth bass. The current rangewide trend for the species is generally thought to be stable.

11.b. Status of the Ash Meadows Amargosa Pupfish Critical Habitat

Designated critical habitat for the Ash Meadows Amargosa pupfish is each of the following springs and outflows plus surrounding land areas for a distance of 164 feet from these springs and outflows: (1) Fairbanks Spring and its outflow to the boundary between Sections 9 and 10, T17S, R50E; (2) Rogers Spring and its outflows to the boundary between Sections 15 and 16, T17S, R50E; (3) Longstreet Spring and its outflow to the boundary between Sections 15 and 22, T17S, R50E; (4) three unnamed springs (currently named “Five Springs”) in the northwest corner of Section 23, T17S, R50E and each of their outflows for a distance of 246 feet from the spring; (5) Crystal Pool and its outflow for a distance of 1,312 feet from the pool; (6) Bradford Springs in Section 11, T18S, R50E, and their outflows for a distance of 984 feet from the springs; (7) Jackrabbit Spring and its outflow flowing southwest to the boundary between Section 24 in T18S, R50E and Section 19, T18S, R51E; (8) Big Spring and its outflow to the boundary between Section 19 T18S, R51E and Section 24, T18S, R50E; and (9) Point of Rocks Springs and their entire outflows within Section 7, T18S, R51E.

The designation of critical habitat for the Ash Meadows Amargosa pupfish occurred prior to the requirement for identification of primary constituent elements that are essential for the conservation of the listed species; therefore, the best available scientific and commercial data is utilized to determine these habitat qualities. These habitat qualities of critical habitat determined necessary for conservation of the pupfish are water, physical habitat, and biological environment. The desired conditions for each of these elements are summarized below.

- Water – a sufficient quantity and quality of water (*i.e.,* temperature, dissolved oxygen, contaminants, nutrients, turbidity, etc.) that is delivered to a specific location in accordance with a hydrologic regime that is identified for the particular life stage for the pupfish. This includes the following:

- Physical habitat – areas of the springs and their outflows that are inhabited or are potentially habitable by a particular life stage of the pupfish, for use in spawning, feeding, and rearing, or corridors between such areas:

- Biological environment – food supply, predation, and competition are important elements of the biological environment and are considered components of this constituent element. Food supply is a function of nutrient supply, productivity, and availability to each life stage of the pupfish. Predation and competition, although considered normal components of this environment, are out of balance due to non-native fish species in many areas.

12.a. Status of the Ash Meadows Speckled Dace

Species Description

The Ash Meadows speckled dace was listed as endangered with critical habitat on September 2, 1983, (48 *Federal Register* 40178). Speckled dace are members of the minnow family of fishes (Cyprinidae); various forms of speckled dace occur in river basins throughout western North America (Minckley 1973, Moyle 1976, Lee *et al.* 1980). The original description and diagnosis of this subspecies of speckled dace is described by Gilbert (1893) (summarized by La Rivers 1962). Typically the body is fusiform, albeit more robust than other dace and with a broad, large head. Head and body depth are approximately four times into body length. Scales are irregular and difficult to enumerate. Body coloration varies widely within a population. Generally, the dorsum is olive-gray blending ventrally to golden. Black spots frequently cover the body and there may be one or two distinct, black lateral stripes. It reaches a maximum length of approximately 3.9 inches and may live as long as 4 years (John 1964). Speckled dace generally prefer flowing streams where they feed on drifting insects (Moyle 1976). Intestines are short, approximately half the body length (La Rivers 1994), suggesting a carnivorous diet. Spawning occurs primarily during the spring and summer over stream riffles where eggs are broadcast by females and fertilized as they drift to the substrate (Mueller 1984).

Speckled dace generally prefer flowing streams where they feed on drifting insects (Moyle 1976). Spawning occurs primarily during the spring and summer over stream riffles (Mueller 1984). Body coloration is olive-gray dorsally blending to golden ventrally often with black spots throughout and there may be one or two distinct, black, lateral stripes (Hubbs *et al.* 1974). Speckled dace reach a maximum length of approximately 4 inches and may live as long as 4 years (John 1964).

Status and Distribution

Hydrographically isolated basins that speckled dace occupy in southern Nevada include the Amargosa River, White River, Meadow Valley Wash, Moapa River, and Colorado River (Miller 1984).

Population estimates of Ash Meadows speckled dace in Bradford Spring from field surveys were 175 in 2008, 407 in 2007, and 493 in 2005 (NDOW 2005, 2007, 2008). At Jackrabbit Spring, population estimates for the spring pool and about 325 feet downstream were 118 in 2007 and 117 in 2005 (NDOW 2005, 2007). Several hundred young of year speckled dace were introduced into the combined outflow of the Point of Rocks springs in 2004 and 2005, and into Forest Spring in 2006. Current status of these populations is not known, but recent surveys by the USGS have captured few fish indicating that the populations in these systems are minimal (USGS 2008). Loss of faster-flowing, cool water due to habitat alteration, and introduced aquatic species, has prevented the reintroduction of the Ash Meadows speckled dace into most of its historical habitat.

Threats to Ash Meadows speckled dace include its limited distribution and the presence of introduced predatory and competing species (La Rivers 1962, Williams and Sada 1985, Service 1990). Collection records show that the speckled dace once shared many of the same springs and outflows that the Ash Meadows pupfish inhabits, but they now only occur in three springs (Bradford, Jackrabbit, and Fairbanks) in stable populations.

12.b. Status of the Ash Meadows Speckled Dace Critical Habitat

Designated critical habitat for the Ash Meadows speckled dace includes the following springs and outflows plus surrounding land areas for a distance of 164 feet from these springs and outflows: (1) Bradford Springs in Section 11, T18S, R50E, and their outflows for a distance of 984 feet from the springs; (2) Jackrabbit Spring and its outflow flowing southwest to the boundary between Section 24 in T18S, R50E and Section 19, T18S, R51E; (3) Big Spring and its outflow to the boundary between Section 19 T18S, R51E and Section 24, T18S, R50E.

The designation of critical habitat for the Ash Meadows speckled dace occurred prior to the requirement for identification of primary constituent elements that are essential for the conservation of the listed species; therefore, the best available scientific and commercial data is utilized to determine these habitat qualities. These habitat qualities of critical habitat determined necessary for conservation of speckled dace are water, physical habitat, and biological environment. The desired conditions for each of these elements are summarized below.

- Water – a sufficient quantity and quality of water (*i.e.,* temperature, dissolved oxygen, contaminants, nutrients, turbidity, etc.) that is delivered to a specific location in accordance with a hydrologic regime that is identified for the particular life stage for the speckled dace. This includes the following:

- Physical habitat – areas of the springs and their outflows that are inhabited or are potentially habitable by a particular life stage of the speckled dace, for use in spawning, feeding, and rearing, or corridors between such areas:

- Biological environment – food supply, predation, and competition are important elements of the biological environment and are considered components of this constituent element. Food supply is a function of nutrient supply, productivity, and availability to each life stage of the speckled dace. Predation and competition, although considered normal components of this environment, are out of balance due to the presence of non-native fish species in many areas.

13. Status of the Warm Springs Pupfish

Species Description

The Warm Springs pupfish was listed as endangered on October 13, 1970 (35 *Federal Register* 16047). No critical habitat has been designated for the species; however, essential habitat was identified during the listing. The species is considered endangered by the State of Nevada and is protected under Nevada Administrative Code 503.065.

The Warm Springs pupfish is the most morphologically variable species of pupfish, but can be defined by several morphological features of the scales and teeth (Miller 1943; Moyle 1976). The Warm Springs pupfish is the smallest of the *Cyprinodon nevadensis* subspecies and can be distinguished from the other forms by its shorter, deeper body and more numerous pectoral fin rays (La Rivers 1962). Albeit variable based on habitat conditions, breeding males are similar to the

Ash Meadows Amargosa pupfish, but with a pronounced yellow tint on the nape (Soltz and Naiman 1978).

Minimal life history information has been gathered for the Warm Springs pupfish; however, a significant body of literature exists on *Cyprinodon* physical tolerances in general due to the harshness of the habitats in which they live. Genetic work has been completed on this genus in part to understand intraspecific relationships, habitat tolerance, principles of speciation due to biogeography, and to ascertain pathways of aquatic species movement over geologic time. Given the nature of the existing body of literature, generalizations must be used by comparing the Warm Springs pupfish to other subspecies or closely related species of pupfish.

Cyprinodon nevadensis is highly eurythermal (McCauley and Thomson 1988; Brown and Feldmuth 1971; Otto and Gerking 1973), i.e. the species can tolerate a wide variety of temperatures ranging from 35.6 to 111.2˚ F (Feldmeth 1981). In the laboratory, Hirshfield *et al.* (1980) determined *C. n. mionectes* taken from the Big Springs pool and acclimatized to standard temperature and oxygen levels to have a thermal minimum of approximately 36.8˚ F and a maximum of approximately 107.0˚ F which was significantly less variable than *C. n. amargosae*, which is adapted to a more variable habitat. These thermal limits are the extremes for survival that were developed in a closed tank, and tolerances for oogenesis and egg development are much narrower (Shrode and Gerking 1977). Also, activities such as feeding or breeding would likely not occur at the extreme temperatures. Hirshfield *et al.* (1980) report critical oxygen minima to be 1.66 parts per million; however these fish were also acclimatized, originated from the stable Big Spring pool, and the minima is likely higher relevant to development and other activities such as sustained feeding or breeding.

Most of the spring systems within the Mojave Desert are alkaline, and pupfish are susceptible to low pHs. Lee and Gerking (1980) determined critical minima and effects of low pH on *C. n. nevadensis*. Lee and Gerking also found that larvae were less tolerant to pH stress than were adults. Pupfish in general have a very wide tolerance to salinity, and pupfish from within the Colorado River/Death Valley system have been maintained and reproduced in water ranging from distilled water to a salinity 2.5 times saltier than seawater (with some fish surviving in water up to 3.7 times saltier) (Soltz and Naiman 1978). This is due to their unique ability to rapidly adjust serum osmotic concentration of ions, preventing water loss.

Pupfish are relatively short-lived species, with a life span of Ash Meadows Amargosa pupfish being 2 to 4 years (Scoppettone *et al.* 1995). Soltz and Naiman (1978) provide a summary of life history and growth traits of pupfish, including *C. nevadensis*. Longevity is relative to water temperature, and is a function of metabolism. Typically pupfish living in the warm waters reach maturity at 2 to 4 months, and then live 6 to 9 months as an adult. In colder waters, such as spring outflow tailwaters or marshes, pupfish may go dormant during winter, ultimately extending their lives to approximately 3 years. As with most species, pupfish in harsher environments have more drastic survivorship curves for juveniles than fish in stable environments. The highest death rate occurs during juvenile and early adolescent life stages in unstable, harsh environments, and for juvenile and adults in a stable environment. Pupfish mature very quickly, and grow about 9 percent of their body mass per day as opposed to 1 percent for adults, depending upon available resources and physical habitat. Growth is highly dependent on environmental temperature, and fish in constant warm water grow year-round whereas fish in variable cooler waters grow at lower rates.

All pupfish have similar diets, essentially being omnivores and detritivores (Soltz and Naiman 1978). The primary food for the pupfish is periphyton and algae, but they also consume invertebrates, detritus, and diatoms (Moyle 1976; Naiman 1979; Scoppettone *et al.* 1995).

Status and Distribution

The Warm Springs pupfish is an endemic species restricted to six springs and their outflows in a 0.77-square mile area within the Ash Meadows NWR. All of these springs are small (discharge less than 1.7 gallons per second (Dudley and Larson 1976)), and some have no source pool. Physiology of the fish allows for a wide range of suitable habitats, and fish may occur in nearly all habitats present within the Warm Springs; however, some fish may be limited by upper thermal constraints, especially during spawning. This discourages use of extreme upper portions of the springs, especially during times with high air temperatures and increased solar inputs. Gravel substrate is critical for establishment of endemic invertebrates, which form an important forage resource for the pupfish.

All of the springs have been altered by diversion into earthen channels, impoundment, livestock trampling, drying due to pumping of local groundwater, and/or elimination of desirable native riparian vegetation. School Springs and North and South Indian springs have been restored and crayfish and non-native fish have been eradicated. Crayfish are absent from Marsh Spring and North Indian Spring.

Warm Springs pupfish occur in areas of limited water volume; consequently their numbers are relatively few (Scoppettone *et al.* 1995). Population estimates have been problematic, and only springheads have been effectively measured. A substantial portion of the population occurred within marsh habitats, and was not effectively sampled. For example, a portion of the marsh below Marsh Spring was cleared of vegetation to allow for trapping in 2006. A majority of the fish seen was small and able to go through the trap mesh, but catch rate was still high at 9.9 catch per unit effort. This suggests there were likely several thousand individuals in the population, whereas previous estimates for Marsh Spring were consistently below 100. Notes on reports also indicated a large population of fish, possibly in the thousands, occurred in the North Scruggs stream which was not included in population estimates. In addition, population estimates previous to 1994 were likely estimates from observation and not directly comparable to the later mark-recapture methodologies.

Like other members of *Cyprinodon nevadensis*, the Warm Springs pupfish spawn throughout the year with a peak in the spring. Local environmental conditions also influence fecundity, life history, and mortality, subsequently the population fluctuates throughout the course of a year. The number of individuals in the population likely peaks in fall, but dies back in the winter. Recent efforts to develop a standardized survey protocol would allow for use of historic data as indices of stability.

The 1990 recovery plan describes the primary threats to the species as its small population vulnerability to alteration and the presence of predatory and/or competing species such as mosquito fish (*Gambusia affinis*), crayfish (*Procambarus clarkii*), and bullfrogs (*Lithobates catesbeiana*).

Crayfish appear to currently occur only in the South Scruggs system, but due to the proximity of all of the springs in the Warm Springs Complex, the chance of the other systems being invaded or re-invaded is extremely high. Aquifer depletion and global warming have recently been suggested as causes for declining amount of habitat. Genetic bottlenecks and recent isolation of populations due to shrinking habitat are also threats that are currently being investigated.

Since the species was listed, populations have improved. In 1984 the Ash Meadows NWR was established to protect threatened and endangered species in the area. Establishment of the Ash Meadows NWR and the subsequent purchase of water rights, reduced some of the threats facing the Warm Springs pupfish. Several populations are at risk of extirpation due to the presence of mosquitofish and crayfish, and habitat degradation from unstable hydrology. Habitat restoration activities have been completed at School, North Indian, and South Indian springs. Overall trends for this species indicate the population to be slightly declining as discussed above (Service 2000).

14.a. Status of the Hiko White River Springfish

Species Description

The Hiko White River springfish (*Crenichthys baileyi grandis*) was listed as endangered with critical habitat on September 27, 1985 (50 *Federal Register* 39123). The Hiko White River springfish recovery plan was completed on May 26, 1998 (Service 1998).

Hiko White River springfish is a member of the Family Goodeidae. Although springfish and poolfish (*Empetrichthys*) were moved by biologists among several families in the order Cyprinodontiformes (reviewed by Grant and Riddle 1995), biologists now agree that these genera form a well defined subfamily (Empetrichthyinae), within the family Goodeidae, within the order Cyprinodontiformes (Parenti 1981; Doadrio and Domínguez 2004; Webb *et al.* 2004). Springfish and poolfish are distinct from other Goodeids, however, because springfish and poolfish lay eggs, are limited in diversity to only four species in two genera (one species now extinct), and are limited ecologically to spring systems in southern Nevada. Other Goodeids bear live young, have about 36 species in 16 genera, and occupy a wide variety of habitats in central Mexico (Doadrio and Domínguez 2004). Springfish and poolfish therefore represent biodiversity at the subfamily (or nearly family) level of differentiation that is unique and restricted to Nevada.

Hiko White River springfish is one of two subspecies of White River springfish that naturally occurred in Pahranagat Valley in Lincoln County, Nevada. The other subspecies in Pahranagat Valley is the nominate form, White River springfish (*C. b. baileyi*). Both of these subspecies are listed as federally endangered. Three other subspecies of White River springfish occur outside Pahranagat Valley to the south in the Muddy River (Moapa White River springfish; *C. b. moapae*) and north in White River Valley itself near Preston/Lund (Preston White River springfish; *C. b. albivallis*) and Moorman Spring/Hot Creek (Moorman White River springfish; *C. b. thermophilus*). These latter three subspecies of springfish are not federally listed.

Hiko White River springfish is a relatively large subspecies of springfish, averaging more than 1.6 inches in length. Hiko White River springfish require waters with stable environmental parameters; especially stable vegetative cover and freedom from nonnative fishes. Hiko spring maintains a temperature of 81ºF.

Very little information is available on the life history and habitat requirements of Hiko White River springfish. However, research has been conducted on other springfish subspecies. Based on their close relatedness, the various subspecies of White River springfish presumably have similar life histories and habitat needs.

Deacon and Minckley (1974) defined springfish spawning as asynchronous, *i.e,*. individual females will spawn at different times of the year. Most females average two spawning periods a year, while the spawning season of the entire population extends over a long period of time each year. White River springfish spawn year-round with peak spawning activity from April through August (Scoppettone *et al.* 1987). The period of spawning activity may be regulated by primary productivity (production of food) in the fish's habitat (Schoenherr 1981).

Status and Distribution

Hiko Spring is used for agricultural and municipal purposes. The entire outflow stream is usually captured by underground pipes and transported to nearby agricultural lands. The only surface water remaining is an impoundment at the spring source and a small marsh created by seepage from the spring pool.

Crystal Spring has been modified for agricultural purposes since before European settlement. It consists of at least two individual springs; one flows from an orifice in limestone bedrock and the other from a contact between alluvium and bedrock (Garside and Shilling 1979). The water level is controlled by a gate that directs flow into either outflow. Dense vegetation, consisting mostly of the nonnative aquatic weed watercress *(Nasturtium officinale),* lines the sand and silt bottom of the spring pools. The main outflow has a maximum depth of 5 feet, width between 33 and 100 feet, and extends approximately 0.6-mile before discharging into a concrete irrigation ditch (Tuttle *et al.* 1990). This reach is also characterized by dense aquatic vegetation and silty substrate. The southern ditch off of the spring pool is much shallower and narrower, has little vegetation, and has a silty substrate.

The original population of Hiko White River springfish was extirpated from Hiko Spring and its outflow stream due to habitat modification for irrigation in 1963, and by the later introduction of mosquitofish, shortfin mollies, largemouth bass, and crayfish to the Hiko system. Invasive species impact the Hiko White River springfish population negatively and severely.

The Crystal Spring population has declined from historic levels due to habitat modification for irrigation and also by predation, competition, and disturbance by convict cichlids, shortfin mollies, common carp, and exotic crayfish. The nonnative species may have invaded Crystal Spring from Ash Springs, which is downstream in the same watershed.

The species continues to be threatened by direct habitat modification, indirect loss of spring flows due to groundwater pumping and possibly climate change, and competition, predation, and parasitism from exotic species.

Hiko White River springfish is native to and still present in Hiko Spring and Crystal Spring and its outflow. The fish has also been introduced into Blue Link Spring in Mineral County, Nevada. The original Hiko Spring population was extirpated by 1967 (Tuttle *et al.* 1990). In 1984, Hiko White River springfish were reintroduced to Hiko Springs using fish from Crystal Springs (Service 1998). The population that now exists at Hiko Spring descends from individuals taken from Crystal Spring.

The estimated springfish population at Hiko Spring varied between 2,500 and 8,000 fish over the 14 years prior to invasion by exotic crayfish, which were first detected in 2000. After crayfish appeared, the estimated springfish population dropped dramatically to between about 1,000 and 2,000 springfish for the next 5 years, until 2005. The estimated springfish population at Hiko Spring then dropped again to between about 300 and 1,000 fish from 2006 to 2011. In 2011, the estimated springfish population at Hiko Spring was 247 fish with a 95 percent confidence interval of 147 to 448 fish (NDOW 2011a).

The estimated springfish population at Crystal Spring from 2004 to 2011 varied between 200 and 800 fish. Crayfish and other aquatic invasive species also threaten springfish at Crystal Spring. In 2011, the estimated springfish population was 831 fish with a 95 percent confidence interval of 349 to 2,064 fish (NDOW 2011b).

The Blue Link Spring refuge population was established by NDOW in 1985 with 274 springfish, and in 1990 with 150 additional springfish. Two years after establishment in 1987, Blue Link Spring supported about 11,000 springfish. The Blue Link Spring population declined in 1990 when water flow into the reservoir decreased, and the water cooled to unfavorable temperatures. The population rebounded after the spring box water supply valves were repaired and 150 additional fish from Hiko Spring were introduced to aid in repopulating the spring. This refuge population occurs in a relatively secure setting, due to Blue Link Spring's remoteness. Blue Link Spring exists on land administered by BLM. Over the years the average estimated population size is 5,000 fish. In 2005, the estimated springfish population was 4,818 fish with a 95 percent confidence interval of 3,507 to 6,832 fish (NDOW 2005).

14.b. Status of the Hiko White River Springfish Critical Habitat

Critical habitat for the Hiko White River springfish was designated at the time of listing on September 27, 1985 (50 *Federal Register* 39123) as two springs and their outflows in Lincoln County, Nevada plus surrounding land areas for a distance of 50 feet from these springs and outflows: (1) Hiko Spring and associated outflows within Section 14, T4S, R60E; and (2) Crystal Springs and associated outflows within Sections 10 and 11, T5S, R60E.

Primary constituent elements of the critical habitat for White River springfish include warm-water springs and their outflows and surrounding land areas that provide vegetation for cover and habitat for insects and other invertebrates on which the springfish feeds. The most critical elements to survival of the springfish are the consistent quality and quantity of springflows. Approximately 7 acres of privately owned lands are designated as critical habitat for the Hiko White River springfish.

Hiko and Crystal Springs are the northernmost, smallest, and coolest of three major spring systems in Pahranagat Valley. Flow in these spring systems is about 6 cubic feet per second (cfs) for Hiko and from 6 to 11 cfs for Crystal (Service 1998). Both spring systems have been extensively modified for agricultural use, and currently support many aquatic invasive species, including crayfish and exotic fishes, such as western mosquitofish, shortfin mollies, and convict cichlids. Due to diversion and piping, Hiko Spring now consists primarily of an impounded spring pool and small marsh created by seepage from the spring pool. Crystal Springs consists of several impounded spring pools with outflows that are also diverted for agriculture.

15.a. Status of the White River Springfish

Species Description

On September 27, 1985, the White River springfish (*Crenichthys baileyi baileyi*) was listed as endangered with critical habitat (50 *Federal Register* 39123).

Adult White River springfish primarily uses areas with little or no velocity and areas near the bottom (Deacon *et al.* 1980 and Tuttle *et al.* 1990). Tuttle *et al.* (1990) observed that juveniles and larvae tended to be more vertically dispersed and occurred in shallower water. They are omnivorous and opportunistic feeders though may be primarily herbivorous (Williams and Williams 1982, Hobbs 1998). White River springfish are uniquely egg layers within the Goodeidae family which primarily bear live young (Grant and Riddle 1995).

Status and Distribution

The White River springfish is endemic to thermal pools and outflows created by Ash Springs (Williams and Wilde 1981). Ash Springs water temperatures have been recorded between 88 and 97˚ F (Garside and Schilling 1979, Tuttle *et al.* 1990). The White River springfish can tolerate low dissolved oxygen levels (Sumner and Sargent 1940, Hubbs and Hettler 1964).

Historically, the distribution of White River springfish in the outflow of Ash Springs was as far down as 5 to 7 miles north of Alamo (Miller and Hubbs 1960). The outflow stream west of U.S. Highway 95 is commonly referred to as the Pahranagat River or Pahranagat Ditch. Approximately 95 percent of the fish’s distribution is on private property and the remaining 5 percent is within lands administered by the BLM, respectively (C. Kallstrom, Service biologist, personal observation).

At Ash Springs there are six main spring heads and flow rates are 6,353 to 8,579 gallons/minute (Eakin, 1963 and Mifflin 1968 as cited in Garside and Schilling 1979). Ash Springs had streams with continuous flow emanating from springheads before it was modified (Service 1998). Construction of U.S. Highway 93 resulted in the large pools that now exist where water depths range from 1.6 to 6.6 feet through the total length of 0.2 mile that it occurs (Tuttle *et al.* 1990).

Depths are controlled by a control gate located adjacent to Highway 93 which is used to manage outflows used for irrigation.

Population counts of White River springfish have been inconsistent in methods and frequency throughout its monitoring history because of access issues related to land ownership. Methods used to estimate population abundance have included ocular estimates, snorkel surveys, and mark-recapture using a Petersen estimator with methods described by Ricker (1975). An evaluation of population demographics is not possible because this data is not collected. The population is stable, but remains low based on observations reported earlier during its history of monitoring. Studies by Tuttle *et al.* (1990) did not document any apparent pattern of seasonal abundance.

In February 2007, a snorkel survey of Ash Springs reported about 470 White River springfish throughout the Ash Springs system (NDOW 2007a). In March 2010, two snorkelers surveyed Ash Springs in a coordinated fashion and counted 730 springfish, of which 605 fish (83 percent) were greater than 1.4 inches total length (NDOW 2010). The habitats at Ash Springs are extensive, deep, complicated, and well vegetated and it is certain that many springfish were not counted during the 2010 survey, as some areas of the outflow observed from shore to support springfish were not visited by the snorkelers (Lee H. Simons, Service biologist, personal observation). The numbers reported by snorkelers are best interpreted as a minimum number observed, rather than a reliable population estimate.

Golden *et al.* (2007) performed biological surveys of the BLM managed portion of Ash Springs. Aquatic vegetation documented included: creeping primrose-willow (*Ludwigia repens*), duckweed (*Spirodela* sp.), and horsehair algae (*Chlorophyceae* sp.). Emergent vegetation included: Olney's three square bulrush (*Schoenoplectus americanus*), saltgrass, spikerush (*Eleocharis* sp.), and Yerba mansa. Shrubs or trees around Ash Springs include tamarix (BLM 1989 and C. Kallstrom, Service biologist, personal observation 2008), cottonwood (*Populus* sp.) and green ash (*Fraxinus pennsylvanica*). Surveys that included the private portion of Ash Springs described the most abundant aquatic plants to include spiny naiad (*Najas marina*), filamentous alga, muskweed, and red ludwigia (*Ludwigia repens*) which was lower in abundance than the previous two (NDOW 2007a).

Primary threats affecting the White River springfish include: (1) introductions of exotic species through competition and predation throughout its range (Deacon *et al.* 1964, Deacon and Minckley 1974, Courtenay et al 1985, Tuttle *et al.* 1990, Scoppettone 1993, NDOW 2007b);
(2) habitat for White River springfish has been altered by irrigation practices and recreational activities; (3) management of water levels may benefit red ludwigia (*Ludwigia repens*), an exotic aquatic plant species, which is a new and indirect threat; and (4) habitat for the White River springfish may be impacted by groundwater development in the surrounding hydrographic basins.

15.b. Status of the White River Springfish Critical Habitat

Critical habitat for the White River springfish was designated at the time of listing on September 27, 1985 (50 *Federal Register* 39123) at Ash Springs and associated outflows in Lincoln County, Nevada, plus surrounding land areas for a distance of 50 feet from the springs and outflows within the following areas: T6S, R60E, E½ of E½ Section 1 and T6S, R61E, NW¼ of NW¼ Section 6.

Ash Springs is the southernmost, largest, and warmest of the three major spring systems in Pahranagat Valley. Ash Springs consists of at least seven springs which originate from a contact between alluvium and bedrock (Garside and Shilling 1979). The springs have a common outflow stream, which has been impounded by construction of U.S. Highway 93, and now forms a large pool. The spring pool provides good stream flow when the gate controlling the water level is open. Ash Springs was historically a stream with continuous flow before it was modified into the existing deep convoluted pool. Below the highway, the outflow stream flows southwest to join the outflow stream from Crystal Spring. From this point on, the stream is referred to as the Pahranagat River (also known as the ditch).

The Ash Springs pool occupies a surface area less than 2 acres in size, and is approximately 0.2 mile long and 1.6 to 6.6 feet deep (Tuttle *et al*. 1990). The bottom consists of sand and silt with locally dense submergent vegetation and algal mats. A thick canopy of willow (*Salix* sp.) and ash trees (*Fraxinus* sp.) border the eastern bank while the west side is more sparsely vegetated with willow, ash, and grasses. Flow from Ash Springs averages 19.8 cfs and is relatively stable in temperature at from 88 to 97˚ F.

Critical habitat at Ash Springs encompasses approximately 12 acres, of which 11.9 acres are located on private land and 0.1 acre is located on land administered by BLM. Primary constituent elements of critical habitat include warm-water springs and their outflows and surrounding land areas that provide vegetation for cover and habitat for insects and other invertebrates on which the springfish feeds.

16. Status of the Pahranagat Roundtail Chub

Species Description

The Pahranagat roundtail chub was listed as endangered on October 13, 1970 (35 *Federal Register* 16047). No critical habitat has been designated for the species. The Pahranagat roundtail chub is a member of the minnow family Cyprinidae. Roundtail chub are streamlined, similar to trout in appearance, and characterized by a robust body and tail, are olive gray in color, with silvery sides and a white belly. The roundtail chub matures at about 2 to 3 years of age and likely lives about 7 years or more. Breeding males develop red or orange coloration on the lower half of the cheek and at the bases of paired fins. Individuals may reach 19.3 in but usually average 9.8 to 11.8 in. Spawning occurs in the late spring; females broadcast about 2,000 tiny sticky eggs over a gravel and cobble bottom. Transparent larvae 0.3 inch in length hatch in 5 days and grow to about 3 inches in one year. They are omnivores, feeding mostly on aquatic insects, and to a lesser extent on fishes and other vertebrates.

Status and Distribution

The historic range of the Pahranagat roundtail chub is poorly documented, but probably included about 18.6 miles of streams in Pahranagat Valley, including outflows from Hiko, Crystal, and Ash springs, Pahranagat Creek (aka “Ditch” and/or “Drain”), Pahranagat Lake, and Maynard Lake (Service 1998). By the 1980s, chubs were located in only 3.8 miles of the system, including primarily Ash Spring outflow, Pahranagat Creek, and intermittently in Ash Spring proper (Tuttle *et al.* 1990). Subsequently, wild chubs have not been observed beyond this 3.8-mile reach.

Biologists count fish as they snorkel upstream, which is a low-impact means of estimating Pahranagat roundtail chub numbers, although survey error is unknown. Between 1986 and 1996, snorkel-based counts of the adult chub population varied seasonally from a low of 94 in winter to 306 in summer. During this period the juvenile chub count varied from 18 in winter to 505 in summer (Service 1998). Since the late 1990s, the wild chub count (adults and juveniles combined) has declined with almost every survey. The most recent surveys (and counts) were in December 2006 (84 fish), October 2009 (4 fish), June 2010 (2 fish), and December 2011 (8 fish).
Most wild Pahranagat roundtail chubs observed over the past 2 decades were seen in Pahranagat Creek well above where the creek bifurcates into 1) a cement-lined canal known locally as the Ditch, and 2) a continuation of the creek that is often dewatered known locally as the Drain. The Drain is suboptimal habitat that is rarely occupied by Pahranagat roundtail chubs except when the population was robust (Tuttle *et al.* 1990; Service 1998).

Wild Pahranagat roundtail chub were collected in 1985 (n=46), 1986 (n=49), and 1987 (n=36) to establish a captive population at the Service's Dexter National Fish Hatchery (NFH) in New Mexico. In January 2010, the Dexter NFH population was healthy with 366 breeders. In 2004 (n=1,000) and 2005 (n= 1,400), 2,400 Dexter NFH fish were used to establish a refuge population at Key Pittman Wildlife Management Area (WMA) in Lincoln County, Nevada (Knight 2010). The Key Pittman WMA population is managed by NDOW and has increased to a population estimated in the 1,000s (Hobbs *et al.* 2007; Hobbs 2009a).

On May 6, 2011, 8 chubs from 3.1 to 6.7 inches in total length were moved from the Key Pittman WMA to Cottonwood Spring on the Pahranagat National Wildlife Refuge. On June 30, 2011, 1,000 Pahranagat roundtail chubs were stocked into Cottonwood Spring and another 1,000 chubs were stocked into the Key Pittman WMA pond by staff from Dexter National Fish Hatchery. The chubs from Dexter were age-1 fish from the 2010 year class and averaged 4.7 inches in total length.

Factors that negatively impact the Pahranagat roundtail chub include: (1) interactions with invasive species (mollies, mosquitofish, cichlids, carp, crayfish, etc.); (2) management of the Pahranagat Valley's water primarily for agriculture, which alters temperature regimes and exacerbates impacts of invasive species; and (3) potential direct effects of agriculture, such as grazing effects on invertebrate communities that represent food for the chubs and physical impacts by cattle within waterways (Service 1998).

17. Moapa Dace

Species Description

The Moapa dace was federally listed as endangered under the Endangered Species Preservation Act of 1966 on March 11, 1967 (32 *Federal Register* 4001), and has been protected under the Act since its inception in 1973. Critical habitat has not been designated for the Moapa dace.

The Moapa dace was first collected in 1938 and was described by Hubbs and Miller (1948). Key identification characteristics are a black spot at the base of the tail and small, embedded scales, which create a smooth leathery appearance. Coloration is olive-yellow above with indistinct blotches on the sides, with a white belly. A diffuse, golden-brown stripe also is present. Maximum size is approximately 4.7 inches fork length. The oldest known specimen on record is over 4 years old (Scoppettone *et al.* 1992).

The Moapa dace is a member of the North American minnow family, *Cyprinidae*. The genus *Moapa* is regarded as being most closely related to the dace genera *Rhinichthys* (speckled dace) and *Agosia* (longfin dace) (Coburn and Cavender 1992). These three dace genera, along with the genera *Gila* (chub), *Lepidomeda* (spinedace), *Meda* (spikedace), and *Plagopterus* (woundfin), developed from a single ancestral type (monophyletic) and are only associated with the Colorado River Basin (Service 1996).

The Moapa dace is thermophilic and endemic to the headwaters of the Warm Springs area. The Moapa dace typically occur in waters ranging from 78.8 to 89.6° F (Hubbs and Miller 1948); however, one individual was collected in water temperatures of 67.1°F (Ono *et al.* 1983). Although Rinne and Minckley (1991) rarely observed the species below 86º F, Deacon and Bradley (1972) indicated that the species reaches its greatest abundance at warmer temperatures between 82.4 and 86.0º F.

Juveniles occur almost exclusively in the spring-fed tributaries, whereas adults occur in the mainstem of the Muddy River (Scoppettone *et al.* 1992). Adults show the greatest tolerance to cooler water temperatures, which is 78.8° F (Scoppettone 1993). Given the species temperature tolerances and cooling pattern of the river (in a downstream direction), its range is restricted to the warmer waters of the upper springs and tributaries of the Warm Springs area (Deacon and Bradley 1972, Cross 1976, Scoppettone *et al.* 1992).

Reproduction occurs year-round and is confined to the upper, spring-fed tributaries where the water temperatures vary from 84.2 to 89.9° F and dissolved oxygen concentrations vary between 4.1 and 6.2 parts per million (Scoppettone *et al.* 1992).

Status and Distribution

The Service assigned the Moapa dace the highest recovery priority because: it is the only species within the genus *Moapa*; the high degree of threat to its continued existence; and the high potential for its recovery (Service 1996). A final recovery plan was approved by the Service in 1996 (Service 1996).

Threats to Moapa dace habitat include non-native fishes (e.g. tilapia and mollies) and parasites; habitat loss from water diversions and impoundments; increased threat of fire due to encroachment of non-native plant species such as palm trees; and reductions to surface spring-flows resulting from groundwater development, which reduces spawning, nursery habitats, and the food base for the species. The Moapa dace is more vulnerable to catastrophic events due to its limited distribution in conjunction with these threats.

The Warm Springs Natural Area and the Moapa Valley NWR encompass about 20 springs that form the headwaters of the Muddy River. The springs and their outflows onto the Warm Springs

Natural Area are home to the majority of the Moapa dace population. In September 2007, the Southern Nevada Water Authority purchased 1,179 acres of private property that encompasses several springs in the Muddy River headwaters area, including the former Warm Springs Ranch. The property includes 3.8 miles of the mainstream Muddy River. The Warms Springs Natural Area is managed as a nature preserve for protection of Moapa dace; and restoration and management of the areas as an ecological reserve.

Moapa dace surveys have been conducted throughout the upper Muddy River system. The 2007 survey data indicate that there were approximately 1,172 fish in the population that occurred throughout 5.6 miles of habitat in the upper Muddy River system. Approximately 97 percent of the total population occurred within one major tributary that included 1.78 miles of spring complexes that emanate from the Pedersen, Plummer, and Apcar spring complexes on the Moapa Valley NWR and their tributaries (upstream of the gabion barrier). Approximately 48 percent of the population was located on the Moapa Valley NWR and Refuge Stream supplied by the Pederson-Plummer springs. The highest densities of Moapa dace occurred on the Plummer and Pedersen units within the Moapa Valley NWR.

In 2008, the number of Moapa dace declined approximately 60 percent, from 1,172 fish in 2007 to 459 in 2008. Most of this decline is due to large changes in the numbers of dace in the Pederson, Plummer, and Refuge Stream areas which supported more than 92 percent of the population in 2007. The cause of the population decline is currently unknown, although beavers have recently changed stream characteristics in the Refuge Stream and vegetation management occurred along the Pederson Unit. In addition, habitat restoration projects have been implemented over the past few years in the Pederson and Plummer units of the Moapa Valley NWR, restoring the streams to a more natural state. Survey data since 2008 indicate an increasing population trend (Figure 4).

The August 2011 Moapa dace count resulted in an increase of ~2.3 percent (+ 16 fish) over the past year and 24 percent over the past 6 months (+139 fish). The overall trend suggests continued growth in the Moapa dace population since the lowest count which occurred in 2008. In the past 3 years, the estimated population has increased by approximately 54 percent (+251 fish). Restored areas continued to show increasing or stable numbers of Moapa dace (upper Apcar, lower Pederson, Goodchild [Little] spring). The largest concentration of Moapa dace continued to be on the upper Plummer springbrooks on the Moapa Valley NWR which supported about 29 percent of all Moapa dace observed in August 2011. An unusual concentration of Moapa dace observed in the upper Plummer springbrook about a month after the July 2010 wildfire was not observed in 2011. The number of Moapa dace observed in 2011 is similar to all other estimates observed in the area over the past decade.

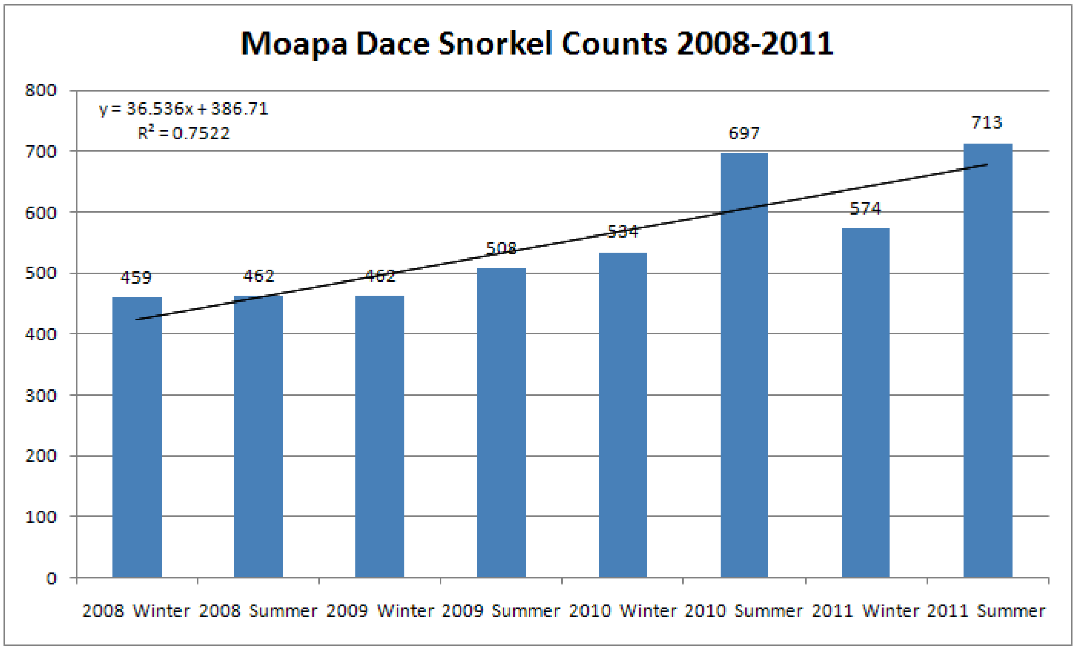

Figure 4.

Moapa Valley NWR continued to support about 53 percent of the Moapa dace observed in August 2011. Recent small-scale habitat improvements in the lower Apcar area may have begun a resurgence of Moapa dace in the area. Moapa dace continued to be absent from most of the tilapia-infested area (reaches 11-16) with the exception of a single Moapa dace that was observed in Muddy Creek (reach 14). Tilapia is presumed to be absent from most of the tilapia-infested area (reaches 10-15) due to chemical eradication efforts in late 2010 and early 2011. Seventeen tilapia of different sizes have been observed in reach 16 (South Fork) both above (n=15) and below (n=2) the gabion barrier. Efforts to control and monitor tilapia are currently underway.

Environmental Baseline

1. Status of the Species/Critical Habitat and Factors Affecting the Species/Critical Habitat in the Action Area for the Amargosa SEZ

a. Desert tortoise

The Amargosa SEZ is located in the Amargosa Desert with elevations from 2,358 to 2,500 feet. Soils are generally characterized as well-drained secondary soils with low to very low available water holding capacity (Tierra Data 2009). These soils are weathered from bedrock on the mountains, medium to coarse textured soils on alluvial fans and terraces and fine-grained, alluvial soils on the valley floors.

The vegetation present is Mojave desert scrub with *Larrea tridentata-Ambrosia dumosa*, *Larrea tridentata-Atriplex polycarpa*, *Larrea tridentata-Lepidium fremontii*, and *Larrea tridentata-Ambrosia dumosa-Atriplex polycarpa* as the co-dominant associations. The *Larrea tridentata-*

Ambrosia dumosa association occurs on mostly flat, gravelly desert pavement with herbaceous growth limited to beneath the shrub canopies or in close proximity.

In addition to the upland plant communities noted above, two wetland biomes occupy narrow strips along margins and bottoms of many washes that traverse the uplands. These are the riparian scrublands along the periphery of washes and the interior strand along the sandy/gravelly wash bottoms. Within riparian corridors, the vegetation is similar to adjacent upland vegetation but occurs more abundantly and denser. Riparian trees include desert willow (*Chilopsis linearis*) and catclaw (*Acacia greggii*), the shrubs are generally the same as those in the uplands, but cheesebush, also called white burrobrush (*Hymenoclea salsola*), occurs on rare occasions along the wash banks. Along the well-defined banks of Fortymile Wash, *Atriplex polycarpa* occurs more abundantly than in the uplands (Tierra Data 2009).

Desert tortoise surveys in the Amargosa SEZ were not conducted for this consultation but will be considered for the project-level consultations. Though outside the action area, previous desert tortoise surveys have been conducted in the Amargosa Desert which provides information on desert tortoise numbers and distribution. Desert tortoise surveys were conducted in 2009 for the Amargosa Farm Road Solar Project resulted in observation of four deteriorated burrows on the 7,670 acres surveyed during a time when tortoises would have been most active. No dead or live tortoises were observed nor were any shells, scutes, or bone segments of dead tortoises detected. Desert tortoise surveys conducted in 2006 (Knight and Leavitt 2006) and in 2007 (Converse Consultants 2008) approximately 25 miles northwest of the project area near Beatty, Nevada indicate population densities of 0-10 tortoises per square mile. Extensive surveys for desert tortoise on the Nevada National Security Site (Department of Energy), located northeast of the project, have indicated low to very low densities of desert tortoise (Rautenstrauch and O'Farrell 1994). Various surveys in Pahrump Valley also indicated low densities of desert tortoise (Tierra Data 2009). Surveys were conducted in Pahrump Valley as part of the range-wide monitoring program in 2008 (USFWS 2010c). Those survey results yielded an estimated density of adult tortoises of 6.7/square mile in Pahrump Valley, which was about 40% of the density level of areas sampled elsewhere that year in the Eastern Mojave Recovery Unit.

The Amargosa SEZ and action area includes a variety of land use types such as secondary and unimproved roads, trails, pipelines, electrical transmission lines, utility corridors, and other facilities developed around the Amargosa Farms community. The northeastern boundary of the SEZ parallels U.S. Highway 95. The Amargosa River occurs at the western boundary of the SEZ. Development on adjacent lands has resulted in habitat loss, degradation, and fragmentation for the local desert tortoise population, as well as increased harm and harassment of desert tortoises. Illegal dumping and off-road recreation continue to contribute to the cumulative degradation of biological resources in the area. Additional threats include illegal collection of tortoises as pets, vandalism (shooting, crushing or mutilation), and roadkill mortality (Service 1994).

On November 25, 1997, the Service issued a Programmatic Biological Opinion (Service File No. 1-5-97-F-251) to BLM for implementation of various land management programs within the Las Vegas District planning area excluding desert tortoise critical habitat and ACECs, and outside the Las Vegas Valley. The action areas for the Amargosa Valley and Dry Lake SEZs occur within the programmatic area. Activities proposed that may affect the desert tortoise in the action area include issuance of ROW, Recreation and Public Purposes Act leases, mineral material sales and leases, and mining plans of operation. The programmatic consultation is limited to activities which may affect up to 240 acres per project, and a cumulative total of 10,000 acres excluding land exchanges and sales. Only land disposals by sale or exchange in Clark County (but outside the Las Vegas Valley) are covered under the consultation up to a cumulative total of 14,637 acres. Thus, a maximum total of 24,637 acres of desert tortoise habitat may be affected by the proposed programmatic activities.

On June 18, 1998, the Service issued a Programmatic Biological Opinion (Service File No. 1-5-98-F-053) to BLM for implementation of various land management programs within desert tortoise habitat and the Las Vegas planning area, including desert tortoise critical habitat and ACECs. Activities that were proposed that may affect the desert tortoise in the action area include recreation; designation of utility corridors and mineral material extraction areas and designation of the desert tortoise ACECs. The action areas for the Amargosa Valley and Dry Lake SEZs occur in the programmatic area.

b. Ash Meadows Species/Critical Habitat

The action area for the Amargosa SEZ includes the entire range of the Spring-loving centaury, Ash Meadows sunray, Ash Meadows milkvetch, Ash Meadows ivesia, Ash Meadows gumplant, Ash Meadows blazing star, Amargosa niterwort, Ash Meadows Amargosa pupfish and Ash Meadows naucorid, and their critical habitat. The action area for this SEZ also includes the entire range of the Devils Hole pupfish, Ash Meadows speckled dace, and Warm Springs pupfish (no critical habitat has been designated for these species). Therefore, the rangewide status of the species and their critical habitat (if designated) is the same as their status in the action area.

The Ash Meadows Refuge encompasses over 23,000 acres of spring-fed wetlands and alkaline desert uplands. The refuge is a major discharge point for a vast underground carbonate aquifer system stretching 100 miles. The carbonate aquifer system is hydrologically connected to the Amargosa Desert Hydrographic Basin, covering an area of 2,593 square miles, which is part of the Death Valley Hydrographic Region.

Most of the springs are created by groundwater discharge from the carbonate aquifer system along the Ash Meadows fault system (Denny and Drewes 1965). Other seeps and springs discharge from saturated valley-fill sediments which overlie and are supplied by the carbonate aquifer system (Belcher 2004). The total annual discharge of Ash Meadows seeps and springs is an estimated 17,000 acre feet per year (afy) (Walker and Eakin 1963, Laczniak *et al.* 1999).

Devils Hole is a collapsed depression (opening) to the same carbonate aquifer system which supplies springs on Ash Meadows NWR within a 40-acre detached unit of Death Valley National Park located within Ash Meadows NWR. Devils Hole was established in 1952 and added to the then Death Valley National Monument (DVNM) by presidential proclamation, in which it was recognized for its uniqueness, scientific value, and for the endemic pupfish living within it (66 Stat. c.18, 17 Federal Register 691).

Since the early 1950s, extensive investigations have been conducted to evaluate the water resources potential of the Death Valley Hydrographic Region, which include the impacts of groundwater pumping, information on groundwater recharge from wash infiltration, evaluation and characterization of regional groundwater flow and other water resources in the area. A series of extensive hydrological monitoring infrastructure has resulted in the accumulation of over 40 years of water level monitoring and water chemistry analysis in the region.

From 1969 to 1977, water pumping in the vicinity of Ash Meadows NWR reduced water levels in Devils Hole (Bedinger and Harrill 2006). In 1973, groundwater pumping in the vicinity of Ash Meadows NWR and Devils Hole was limited by an injunction issued by the U.S. District Court in Nevada to restore the water level of the pool in Devils Hole to 3 feet below a reference point on the rock wall to protect the Devils Hole pupfish living in the pool. This decision eventually lead to the U.S. Supreme Court's decision in *Cappaert v. United States* (426 U.S. 128 1976), which held that the 1952 proclamation establishing Devils Hole as part of DVNM reserved that amount of water necessary to preserve the scientific interests associated with the pool. The consequence of this decision is that groundwater pumping is now limited, and a minimum water level of 32.4 inches below the reference point was established with the goal of protecting the endangered Devils Hole pupfish. The water level rebounded from a historic low in 1972, with the maximum level in 1988 (USGS 2010). However, from 1988 to 2004 at Devils Hole, water level measurements declined approximately 1.2 inches (NPS 2010, USGS 2010).

From 1983 to 1988, at Ash Meadows NWR, spring discharge declined 0.3 cubic feet per second at Fairbank Spring (USGS 2010). However, discharge records for Ash Meadows NWR springs are inconsistent due to operational changes related to restoration activities. For instance, Five Springs well, the only monitoring well at the refuge completely in the carbonate aquifer (the source of the refuge springs), declined 2.4 inches from 1992 to 2004 (USGS 2010); however, the record is incomplete prior to 1992. From late 1980's to 2004, water levels also declined in two carbonate monitoring wells located between the Refuge and Army 1 WW. Army 1 WW is located 18 miles to the northeast of Devils Hole within Hydrographic Basin 230. Bedinger and Harrill (2006) used multiple regression analyses to examine these changes in water level in Devils Hole between 1963 and 2002 and concluded that the declines were due to pumping, not climatic factors (reductions in precipitation and groundwater recharge). They suggested that the water level declines in Devils Hole were primarily due to pumping that occurred between 1969 to 1977 at Ash Meadows and Amargosa Farms area. Secondarily, declines were a result of pumping that began in the 1950s and 1960s at a Department of Energy water supply well (Army1 WW) located at the south end of the Nevada National Security Site (USGS site 363530116021401).

Since 2005, the water level in Devils Hole has increased approximately 4.32 inches. It is unclear if this upward trend is due to reduced pumping in the basin or increased recharge from rain events. It is also unclear if this upward trend will be maintained or revert to a decline. As of May 2010, the water level in Devils Hole is 10.95 inches above the minimum mandated water level (NPS 2010).

The large concentration of endemic species in the Ash Meadows area, many of which are restricted to extremely local habitats, makes recovery for listed species in Ash Meadows unique and more complicated than is usual for the recovery of individual species. The single most important requirement for recovery of these species is the protection of their habitats. This can be accomplished by preventing activities that reduce populations by disturbing land and that adversely affect springs and reduce their outflows. The ecosystems supporting these listed species are extremely local and subject to deleterious alteration. The close association of these environments is strongly confirmed by the substantial overlap in areas designated as critical habitat for terrestrial and aquatic species (Service 1990).

On November 1, 2010, the Service issued a biological opinion and concluded informal consultation with the BLM for the proposed Amargosa Farm Road Solar Project. The project proponent, Solar Millennium, proposes to lease water from GENEERCO (Permit 15893; Certificate 5717) in the amount of 603 afy during construction and 400 afy during operation. The full duty of GENEERCO's Permit 15893 is 603 afy; groundwater rights under this permit have not historically been fully utilized. Based on annual pumping estimates, historical groundwater pumping under Permit 15893 has averaged 398 afy. Construction of the project has not begun.

2. Status of the Species/Critical Habitat and Factors Affecting the Species/Critical Habitat in the Action Area for the Dry Lake Valley SEZ

Desert tortoise

The desert tortoise occurs within the Dry Lake SEZ and surrounding area. Designated desert tortoise critical habitat occurs in the Mormon Mesa critical habitat unit west of the SEZ. The USGS desert tortoise model (Nussear *et al*. 2009) identifies the entire SEZ as having overall high habitat suitability for desert tortoise (suitability score greater than or equal to 0.5 out of 1.0).

No desert tortoise surveys were performed in support of the proposed action but will be deferred to individual projects. On the basis of surveys conducted in the Mormon Mesa critical habitat unit, adjacent to the western border of the SEZ, the SEZ may support up to 213 desert tortoises (Stout 2009). Designated critical habitat does not occur within the action area for the Dry Lake SEZ.

The western and southern boundaries of the Dry Lake Valley SEZ are approximately defined by U.S. Highway 93 and Interstate 15 which occur along the eastern boundary. The Union Pacific railroad occurs within the action area for the SEZ along the eastern boundary. The Harry Allen electrical power generating plant occurs north of the SEZ and will likely be part of power transmission for future solar projects. Electrical power transmission lines traverse the SEZ as well as the Kern River and UNEV gas transmission lines. A commercial mineral operation occurs in the extreme southern portion of the SEZ.

Two parallel natural gas pipelines operated by Kern River traverse the northern portion of the Dry Lake SEZ. Features of the pipeline ROWs that co-occur in the action area for the solar project include the utility (main) access road were the road crosses over the ROWs in two locations. The pipeline projects required a license from the Federal Energy Regulatory Commission (FERC), ROWs from BLM, and permit from the Army Corps of Engineers. The biological opinion for the first KRGT pipeline was issued to FERC on December 21, 1990 (Service File No. 1-1-87-F-36R). The Service concluded that 45 desert tortoises may be killed or injured; 424 desert tortoises harassed; and 93 desert tortoise nests destroyed. As of June 24, 1991, approximately 23 deaths and 253 captures/movements of desert tortoise were recorded by Kern River along the pipeline ROW. Problems associated with vehicular traffic on the ROW and access roads may have contributed to the mortalities in combination with high desert tortoise activity levels that were not anticipated.

Consequently, on June 24, 1991, FERC requested reinitiation of formal consultation for the project based on a high incidence of desert tortoise mortality and captures/movements on the pipeline project, which exceeded those limits established in the incidental take statement. The Service responded by letter dated June 28, 1991, and under reinitiation of consultation, imposed additional minimization measures, increased the capture/movement limits for desert tortoise from 294 to an unlimited number, and injury/mortality limits from 25 to 35.

On July 9, 2002, the Service issued a biological opinion (Service File No. 1-5-02-F-476) to FERC for construction, operation, and maintenance of the second KRGT pipeline, adjacent to the first pipeline. The second pipeline project approximates the previous pipelines constructed under the 1990/1991 biological opinions. The pipeline ROW crosses approximately 318.8 miles of potential desert tortoise habitat, of which about 102.9 miles traverse desert tortoise critical habitat. Pipeline construction resulted in disturbance of 4,182 acres of desert tortoise habitat including 1,333 acres of desert tortoise critical habitat. Approximately 50 feet of the construction ROW overlapped the previously-disturbed land that was affected by construction of first KRGT pipeline. During construction of the second KRGT pipeline project, over 840 desert tortoises were encountered and one was killed as a direct result of project activities which includes one desert tortoise in Utah; and approximately 380 tortoises in Nevada. One tortoise was killed on June 8, 2011, as a result of maintenance operations. Consequently, BLM and the Service agreed that the requirement for reinitiation of consultation had been triggered and on September 28, 2011, the Service issued a biological opinion to the BLM for O&M of the KRGT pipelines (Service File No. 84320-2011-F-0337).

3. Status of the Species/Critical Habitat and Factors Affecting the Species/Critical Habitat in the Action Area for the Dry Lake Valley North SEZ

a. Desert Tortoise

The SEZ lacks suitable habitat for the desert tortoise. Tortoises may occur in the action area outside the SEZ. Desert tortoises occurs as near as 30 miles southwest of the Dry Lake Valley North SEZ. Based on the USGS desert tortoise habitat model (Nussear *et al*. 2009), habitat for the desert tortoise is not expected to occur in the area of direct effects within the SEZ or the 0.5-mile surrounding area; however, potentially suitable habitat may occur in the portion of the action area associated with power transmission and access road corridors. Desert tortoise surveys in support of future projects in the SEZ will provide data on the potential occurrence in the area.

Although outside the action area, an existing 69-kV capacity transmission line traverses the SEZ which could provide access from the SEZ to the transmission grid.

b. Hiko White River Springfish

The SEZ lacks suitable habitat for the Hiko White River springfish. These springfish may occur in the affected area outside the SEZ. The Hiko White River springfish occurs about 25 miles west of the Dry Lake Valley North SEZ at Hiko and Crystal Springs in Pahranagat Valley. Hiko and Crystal Springs are federally designated critical habitat for the Hiko White River springfish. Depending upon the effects of groundwater withdrawals and climate change or trends, which remain poorly understood at this time, Hiko White River springfish could be adversely affected by future projects in the SEZ. Studies of groundwater dynamics in support of future projects in the SEZ will provide data on the potential effects of groundwater withdrawals and climate change

c. White River Springfish

The SEZ lacks suitable habitat for the White River springfish. These springfish may occur in the affected area outside the SEZ. The White River springfish occurs about 26 miles west by southwest of the Dry Lake Valley North SEZ at Ash Springs in Pahranagat Valley. Ash Springs is federally designated critical habitat for the White River springfish. Depending upon the effects of groundwater withdrawals and climate change or trends, which remain poorly understood at this time, Ash Springs with their White River springfish could be adversely affected by future projects in the SEZ. Studies of groundwater dynamics in support of future projects in the SEZ will provide data on the potential effects of groundwater withdrawals and climate change.

d. Pahranagat Roundtail Chub

The SEZ lacks suitable habitat for the Pahranagat roundtail chub. The Pahranagat roundtail chub occurs about 26 miles west by southwest of the Dry Lake Valley North SEZ at the Pahranagat Creek in Pahranagat Valley. Depending upon the effects of groundwater withdrawals and climate change or trends, which remain poorly understood at this time, Pahranagat roundtail chub could be adversely affected by future projects in the SEZ. Studies of groundwater dynamics in support of future projects in the SEZ will provide data on the potential effects of groundwater withdrawals and climate change.

4. Status of the Desert Tortoise and Factors Affecting the Species in the Action Area for the Riverside East SEZ

The proposed Riverside East SEZ is the largest of the proposed SEZs in the six-state action area**,** with a total developable area of 147,910 acres. The SEZ spans a distance of about 45 miles between the points farthest west and east, but it has an irregular shape with a large excluded central area. The Riverside East SEZ occurs in the Colorado Desert Recovery Unit for the desert tortoise and is immediately adjacent to Joshua Tree National Park/Desert Wildlife Management Area (DWMA) and the Chuckwalla DWMA. Desert tortoise density estimates for these two DWMAs from 2007 surveys were 7.3 and 9.6 desert tortoises per square mile, respectively (Service 2010b). The proposed SEZ shares borders with the two DWMAs and from previous project-specific surveys within the SEZ boundaries, is known to support occupied and suitable desert tortoise habitats.

Northern and Eastern Colorado Desert Coordinated Management Plan

The proposed Riverside East SEZ occurs within the plan area for the BLM's Northern and Eastern Colorado Desert Coordinated Management Plan (NECO; BLM 2002), which is one of six regional amendments to the California Desert Conservation Area (CDCA) Plan. The NECO plan focused on several aspects of BLM's multiple use mandate including biological considerations.

Stated biological purposes of the NECO plan include preventing the need for new listings as special status species (BLM 2002), protecting connectivity between protected communities (BLM 2002), and considering the fragmenting effects of new projects.

Under NECO, the term "Multi-species Conservation Zone" was defined to include existing restricted lands (BLM Wilderness Areas, Joshua Tree National Park, and Chocolate Mountain Aerial Gunnery Range lands), DWMAs, and Wildlife Habitat Management Areas (WHMAs). WHMAs identified some of the areas that support special status species and their habitats including dune, playa, and desert dry wash communities that would likely require special consideration, protection, and/or management (BLM 2002). Some regulatory elements were applied to WHMAs, such as closure of some routes of travel and closure of some dune and playa areas (Palen and Ford Dry Lake and associated dune systems) and requiring mitigation in some WHMAs as a disincentive to development in these locations (e.g., 3: 1 habitat compensation ratio for disturbance to desert dry wash woodland communities) (BLM 2002). A large portion of the proposed Riverside East SEZ overlaps with several WHMAs (BLM 2002; Map 2-21).

A WHMA occurs along 1-10 between the Chuckwalla DWMA and the Chuckwalla Valley, and the Chemehuevi DWMA to the north is a WHMA with the specific role of providing connectivity for the desert tortoise between these areas (BLM 2002; Map 2-21). The Riverside East SEZ overlaps this WHMA on the north side of 1-10. In addition to the Desert Tortoise Connectivity WHMA, this area supports the Palen-Ford WHMA where management is focused on the extensive dune and playa system, and several other conservation units such as the Alligator Rock, Desert Lily Preserve, and Palen Dry Lake ACECs, and the Palen-McCoy Wilderness.

Prior to surveys conducted in support of the several proposed and approved renewable energy projects, few surveys had been done in the northern part of the Chuckwalla Valley or outside of the Chuckwalla CHU and DWMA and little biological data were available. Range-wide surveys for desert tortoise provide limited information at the recovery unit level, but no site-specific information was available with the exception of the limited portion of the action area south of I-10.

Renewable Energy Projects in the California Desert District of BLM

In an effort to meet the California Renewable Portfolio Standards (33 percent renewable energy by 2020) and national energy priorities, a large number of renewable energy projects have been proposed on BLM-managed land, State-owned land, and private land in California and throughout the West. As of May 2012, there were approximately 170 proposed renewable energy projects in California in various stages of the environmental review process or under construction (J. Gilbreath, CEC, pers. comm. 2012). Solar, wind, and geothermal developers have requested ROW grants on approximately 1 million acres of BLM-managed lands within the California deserts. State and private lands have also been targeted for renewable solar and wind projects (BLM 2011).

The Palm Springs-South Coast Field Office of the BLM is processing 17 solar projects on 123,592 acres for 11,873 MW and 4 wind projects on 5,851 acres (BLM 2011). Because of intense competition for utility Power Purchase Agreements and Federal funding incentives, not all of the projects will be completed. In addition to the projects for which biological opinions have already been issued, several projects are nearing completion of the environmental review process or have submitted their Plans of Development to the BLM; the majority of the solar projects are sited within or immediately adjacent (within 0.5 mile of the SEZ boundary) to the proposed Riverside East SEZ. . Collectively, the proposed projects within and around the proposed SEZ constitute about 45,000 acres.

The project-by-project and cumulative effects of the renewable energy program within the range of the Mojave population of the desert tortoise have the potential to reduce the amount of available, occupied and/or suitable habitat by hundreds of thousands of acres. The effects from utility-scale projects and impacts to habitat and population (i.e., genetic) connectivity have recently come to the forefront as a significant threat to the desert tortoise. The magnitude and duration of habitat loss that would result from construction and operation of the approved and proposed renewable energy projects along the I-10 corridor within the SEZ and up to 0.5 mile outside the SEZ boundary have the potential to constrict the remaining habitat linkages and limit gene flow between the Mojave and Colorado deserts (see Effects section).

Desert Tortoise Population and Habitat Connectivity

Understanding desert tortoise densities and abundance within the proposed Riverside East SEZ is integral to the effects analysis, and it is equally as important to consider the linkages between desert tortoise populations at the landscape-level and throughout the species' range and the potential impacts to these linkages from the project and other land uses. The USGS model depicts higher predicted desert tortoise habitats in the western portion of the SEZ, which generally correspond with higher elevations along the upper bajadas. Therefore, these areas become more important for conservation relative to population and genetic connectivity between the Chuckwalla CHU and DWMA, Joshua Tree National Park/Pinto Mountains CHU and DWMA to the north, and the Chemehuevi CHU and DWMA to the northeast. This putative habitat linkage along the western edge of the SEZ is encumbered by numerous obstacles to potential gene flow, including the Colorado River Aqueduct, the nonoperational Kaiser Railroad, Eagle Mountain Road, Kaiser Road, numerous utility lines and access roads, flood control levees, and mining spoil piles. Though the individual and collective effects of these obstacles to desert tortoise occupancy have not been studied, they likely result in unquantified levels of mortality to the resident population, and depress population densities to levels below the natural carrying capacity. However, despite these linkage constraints, moderate to high densities of desert tortoises were documented on and around the Desert Sunlight project in this area. This suggests that the local population is persisting and some level of occupancy and gene flow continues within the area.

As discussed in the "Status of the Species" section, it is essential that habitat linkages between and among desert tortoise populations are conserved, particularly in this portion of the species' range, given that there are limited suitable contiguous habitats and several significant barriers to movement. Based on recent genetics studies (Hagerty *et al*. 2010) and the USGS habitat model (Nussear *et al*. 2009), desert tortoise populations within conservation areas (e.g., DWMAs) in the Mojave and Colorado portions of the range may only be connected by a few tenuous linkages supporting suitable habitat. Within the action area, these include a narrow corridor along Cottonwood Wash at the southern entrance to Joshua Tree National Park (with resident desert tortoises occupying areas along narrow sections of the canyon) and through the Pinto Wash between the Eagle and Coxcomb mountains. The viability of these linkages, however, is not clearly understood.

Farther east in this SEZ, the habitat is generally lower in elevation with hotter, drier climes, and substrates are dominated by less friable soils associated with the Palen-Ford Dry Lake sand transport system that dominates the I-10 corridor east of Desert Center. Patches of habitat in these harsh environments likely support low densities of desert tortoises, and connections between suitable habitats become increasingly rare across the landscape. In these low density areas, home ranges can become distant from one another, and reproduction rates decline as the probability of individuals of reproductive age encountering one another is diminished. This phenomenon, known as the Allee effect (Allee 1931, Stephens *et al*. 1999, Dennis 2002), poses a natural obstruction to gene flow between breeding populations, which may be the case across some portions of the SEZ, which is mostly modeled as low predicted habitat by USGS (Nussear *et* al. 2009). The designation of the Riverside East SEZ would commit these lands to a single industrial use and conflict with any attempts to maintain desert tortoise connectivity across these hot, dry lowlands.

Despite the patchy distribution of desert tortoise sign documented within previously surveyed project areas and areas of low predicted habitat, any portion of the proposed SEZ may be important for connectivity between and dispersal from surrounding habitats. Desert tortoises are known to use lower-quality intermountain habitat as dispersal routes, providing passage between high-quality habitat areas in the surrounding areas (Averill-Murray and Averill-Murray 2005). Historically, desert tortoise populations in the Sonoran Desert have exchanged individuals at a rate of one migrant per generation (Averill-Murray and Averill-Murray 2005).

Past Consultations in the Action Area for the Riverside East SEZ

Eagle Mountain Landfill (1-6-92-F-39)

On September 10, 1992, the Service issued a biological opinion for the Eagle Mountain Landfill Project; however, litigation relative to an integral land exchange has continued to delay project implementation. The proposed action involves the conversion of an existing, inactive iron ore mine to a Class III, non-hazardous, solid waste landfill.. The site consists of private (2,409 ac) and public (2,280 ac) lands north of I-10, adjacent to Joshua Tree National Park. The biological opinion exempted take, in the form of mortality or injury, for one desert pupfish (*Cyprinodon macularia*), a federally endangered species, due to direct and indirect effects of the action and one desert tortoise per year over the life of the project. In addition, take, in the form of harassment, of up to 160 desert tortoises was anticipated for the purposes of moving those individuals out of harm's way during project activities.

Estimates of desert tortoise abundance were based on other project-specific surveys conducted in the vicinity of the proposed landfill site and may be high given the previously disturbed nature of the site. Consistent with other projects in the action area, measures to avoid, minimize, and offset adverse effects to the species were included and analyzed as part of the proposed landfill project. These measures included repair and maintenance of culverts under the Eagle Mountain railroad to maintain tortoise connectivity, and placement of ballast to provide escape ramps for tortoises caught between the rails. Neither of these measures has been accomplished to date and, as a result, blocked and hanging culverts and other mortality sinks along the railroad within the habitat linkage at issue remain an obstacle to desert tortoise occupancy and movement and need to be rectified if habitat potential for natural population density and gene flow are to be realized and maintained.

NECO Coordinated Management Plan Amendment (1-8-01-F-16), June 17, 2002, as amended on March 31, 2005, and November 30, 2007 (1-8-04-F-43R)

To provide for management of recreational use, and to resolve other resource and public land use conflicts, section 602(d) of Federal Land Policy and Management Act of 1976 (FLPMA) directed the Secretary of the Interior to "prepare and implement a comprehensive, long-range plan for management use, development, and protection of the public lands within the California Desert Conservation Area." The CDCA Plan is an over-arching or programmatic plan from which activity-level or more site-specific plans are tiered. The NECO Plan is an amendment to the 1980 CDCA Plan.

The Service issued a programmatic biological opinion evaluating the effects of BLM's CDCA Plan Amendment for the BLM's NECO Plan (BLM 2002) on desert tortoises in 2002 and as amended in 2005 and 2007. The programmatic biological opinion exempted take of desert tortoise for casual uses (e.g., recreation, mining, OHV use), livestock grazing, and burro removal that BLM authorizes through approval of the CDCA Plan. Projects outside of these activity categories require separate consultation. Ongoing land uses covered under these previously issued biological opinions have allowed for additional habitat degradation within the proposed SEZ from factors such as introduction and spread of nonnative plant species and predators associated with disturbed habitats.

Transmission Lines Approved within the Riverside East SEZ

While issuance of biological opinions for the Blythe, Desert Southwest, and Devers-Palo Verde 2 (DPV2) transmission line projects allowed for additional take of desert tortoises and degradation of habitat within the proposed Riverside East SEZ, these biological opinions included avoidance, minimization, and compensation measures that were intended to ensure the environmental baseline of the species was maintained. However, effectiveness monitoring has not been conducted for any of these projects to determine the extent to which this intent has been realized. Only the DPV2 transmission line includes a monitoring requirement to address subsidies provided by the project for common raven or other avian predators. The numerous electrical towers and lines allowable with this utility corridor afford hunting perches and nesting substrate for several species of avian predators of desert tortoises (primarily raptors and common ravens), which have the potential to reduce desert tortoise population densities within hunting range of these structures. The contribution and impact of this mortality mechanism, along with that of highway-related impacts along I-10, to declines in desert tortoise densities or changes in population demographics remain unknown.

Minor Construction Activities within the CDCA

The Service issued a biological opinion for effects to desert tortoises from minor construction activities within the BLM's California Desert District in 1997. For the purposes of the biological opinion, minor construction activities constitute land disturbance of less than 2 acres per activity, cannot exceed 10 acres of impacts to designated critical habitat in any one year, and cannot exceed 40 acres within the Colorado Desert Recovery Unit (formerly referred to as the Eastern Colorado Recovery Unit) over the life of the opinion. These thresholds have been met and the Service is working with the BLM on reinitiation.

A variety of activities were addressed under this biological opinion, including construction of communications facilities, location of temporary helicopter staging sites, construction of guzzlers or spring development for wildlife, or location of apiary sites. Disturbance from these actions and other minor construction activities could require cross-country travel by vehicles, construction of access roads or fencing, and staging areas for construction equipment. The biological opinion exempts take, in the form of direct mortality or injury, of up to 2 desert tortoises per year from construction activities, and take, in the form or harassment, of up to 10 desert tortoises per year for the purposes of moving individuals out of harm's way. Conservation measures are required as part of the proposed action to avoid, minimize, and offset adverse effects to the species.

Blythe Solar Power Plant Project (FWS-ERIV-09B0186-10F0880)

On October 8, 2010, the Service issued a biological opinion to the BLM for a proposed right-of-way to construct, operate, and maintain the proposed Blythe Solar Power Plant project. The solar project would occur on approximately 9,400 acres of BLM-managed lands. The proposed project is located in Riverside County, California, approximately 8 miles northwest of Blythe and approximately 2 miles north of the Interstate 10 (I-10) corridor. Project components generally include construction, operation, and maintenance of the solar power plant site and support facilities, an access road/utility corridor, and a generation-tie (gen-tie) transmission line. The project includes construction of a 1,000-megawatt (MW) commercial solar thermal power-generating facility that will use solar parabolic trough technology to generate electricity. The proposed project will disturb an estimated total of 7,025 acres of which approximately 6,958 acres is desert tortoise habitat.

Access to the plant site will be on a new, 5-mile paved road heading north from the existing Black Rock Road. The new access road will also be used as a utility corridor that will include buried lines (telecommunications and natural gas) and a portion of the proposed power transmission line. The new gas pipeline will connect to an existing Southern California Gas Company main pipeline south of I-10. Voice and data communications would be provided by a new telecommunications cable.

A new approximately 11-mile 230-kV double-circuit, monopole transmission line will also be constructed as part of the project. A new unpaved access road will be constructed for the portion of the line that lies west of the access road/utility corridor. The transmission line will extend south from the plant site primarily along the access road/utility corridor to a point south of I-10, and then turn west to connect to the Colorado River Switchyard substation.

The Service estimated that up to 20 subadult and adult tortoises, up to 10 juveniles, and an unquantifiable number of eggs could occur in the project footprint. Using our best professional judgment in light of best available information, we anticipate that construction of the proposed project will result in the incidental take of two individuals and that operations and maintenance activities will result in incidental take of two individuals per year. We also exempted take in the form of trapping, capture, or collection of up to 60 subadult and adult tortoises for the purposes of blood draw to assess disease prevalence.

Genesis Solar Energy Project (FWS-ERIV-08B0060-10F0878)

On November 2, 2010, the Service issued a biological opinion to the BLM for their proposed issuance of a right-of-way grant that would authorize the construction, operation, and maintenance of the proposed Genesis Solar Energy project. The project is located in Riverside County on 2,000 acres of BLM-managed lands just south of the Palen/McCoy Wilderness Area and 25 miles west of Blythe, California, and is currently under construction. The project occurs in marginal desert tortoise habitat.

The solar power plant site will consist of two independent 125-MW nominal power units, and support facilities will include the power blocks, solar arrays, two 5-acre evaporation ponds, water storage tanks, leach fields, auxiliary systems, administration buildings, parking, and other ancillary facilities. The plant site will be cleared of all vegetation, graded and fenced.

The plant site will be accessed via a new paved road extending approximately 6.5 miles from Wiley's Well Rest Area at the I-10 interchange to the project site. Crossings for all major washes will be Arizona-type crossings.

Linear facilities, including distribution and communication lines, natural gas and water pipelines, and a generation tie line will be constructed within a utility corridor extending approximately 6.5 miles adjacent to the access road from Wiley's Well Rest Area to the plant site. The gen-tie line will extend an additional 1.5 miles from the Wiley's Well Rest Area, cross I-10, and tie into the Blythe Energy Project transmission line (BEPTL). The gen-tie line will use the existing pole structures of the BEPTL to interconnect with SCE's future Colorado River Switchyard (CRS)

Substation to the east. However, six new transmission line poles will be constructed from the BEPTL to tie into the CRS as part of the proposed project.

The Service estimated that up to five subadult and adult tortoises, up to three juveniles, and an unquantifiable number of eggs could occur in the project footprint. Using our best professional judgment in light of best available information, we anticipate that construction of the proposed project will result in the incidental take of two individuals and that O&M activities will result in incidental take of two individuals per year. We also exempted take in the form of capture or collection of up to 20 subadult and adult tortoises (up to five from the project footprint, up to ten from the Genesis recipient site, and up to five from the Upper McCoy Wash recipient site) for the purposes of blood draw to assess disease prevalence.

Palen Solar Project (FWS-ERIV-09B0187-11F0244)

On June 2, 2011, the Service issued a biological opinion to the BLM for their proposed issuance of a right-of-way grant that would authorize the construction, operation, and maintenance of the proposed Palen Solar Power Project. The proposed project in the western section of the Riverside East SEZ approximately 10 miles east of Desert Center and 0.5 mile north of the I–10 corridor. Project components generally include construction and operations and maintenance of the solar power plant site and support facilities, an access road/utility corridor, and a gen-tie transmission line.

The biological opinion for the Palen project anticipates the permanent loss of 4,195 acres of desert tortoise habitat. Take is anticipated, in the form of capture or collection, of up to 97 subadult and adult and 6 juvenile desert tortoises for the purposes of moving individuals out of harm's way, translocation to a recipient site, and disease screening of all translocated, resident, and control animals. Take is anticipated, in the form of mortality or injury, of up to one desert tortoise per year during construction and one desert tortoise per year for operations and maintenance-related activities is anticipated.

The Palen project would obstruct desert tortoise linkages under three of the larger bridges along the I-10 corridor within the Desert Tortoise Connectivity WHMA approved under the BLM's NECO Plan (BLM 2002). Though the project narrows the opportunities for desert tortoise connectivity along this highway barrier, the impact would be offset by land acquisitions designed to consolidate BLM management responsibility further west of the proposed project site between Cactus City and Desert Center, where we expect the higher elevation habitats in that area to support higher desert tortoise densities. However, the effectiveness of the habitat acquisition will depend on 1) additional future acquisitions across the extensive landownership checkerboard north and south of I-10; 2) the capability to remove impediments to desert tortoise occupancy/linkages within this larger area that may require the cooperation of other private/ public sector entities; and

3) the ability to maintain an effective linkage across the ROW of the proposed project and adjoining lands between Pinto Wash and the Eagle Mountains.

The portion of the Chuckwalla CHU and DWMA where the Red Bluff Substation components and portions of the gen-tie line are sited contains several proposed, existing, or authorized transmission lines and associated access roads.

Desert Sunlight Solar Farm and Red Bluff Substation Project (FWS-ERIV-08B0789-11F0041)

On July 6, 2011, the Service issued a biological opinion to the BLM for their proposed issuance of a right-of-way grant that would authorize the construction, operation, and maintenance of the proposed Desert Sunlight Solar Farm project; the BLM also proposes to issue a right-of-way grant for the construction, operation, and maintenance of the Southern California Edison (SCE) Red Bluff Substation and associated components. The two projects are sited on approximately 4,000 acres and 172 acres of BLM-managed lands, respectively. The solar farm component is located in Riverside County approximately 6 miles north of the rural community of Desert Center and approximately 6.5 miles north of the I-10 corridor.

The proposed project will disturb up to 4,176 acres, all of which is desert tortoise habitat on lands administered by the BLM, with the exception of approximately 1.1 miles along Kaiser Road. The Red Bluff Substation component of the project occurs within the Chuckwalla designated critical habitat unit for desert tortoise. Access would be provided from the Corn Springs exit off I-10 via Chuckwalla Valley Road, heading east along the paved southern frontage of the freeway. From this point the access would head south along a 300-foot long section of Corn Springs Road, then would turn west through roadway improvements to approximately 4.5 miles of the existing dirt pipeline patrol road to the substation site. Approximately 33 acres would be adversely affected with these road improvements.

The Service estimated that up to 35 subadult and adult tortoises, up to 25 juveniles, and 129 eggs could occur in the solar facility and substation project footprints. Using our best professional judgment in light of best available information, we anticipate that construction of the proposed project will result in the incidental take of three individuals and that O&M activities will result in incidental take of three individuals per year. We also exempted take in the form of trapping, capture, or collection of up to 114 subadult and adult tortoises for the purposes of blood draw to assess disease prevalence within the translocated and resident populations. In addition, take in the form of capture or collection was exempted for up to 31 subadult and adult and 25 juveniles at a control site, should one be required, for post-translocation monitoring.

Eagle Mountain Pumped Storage Hydroelectric Project (FWS-ERIV-08B0101-11F0266)

The Service issued a biological opinion on the Federal Energy Regulatory Commission's (FERC) proposed issuance of a license to Eagle Crest Energy Company authorizing the construction, operation, and maintenance of the proposed 1,300 MW Eagle Mountain Pumped Storage Hydroelectric Project in Riverside County, California. The proposed project includes a central project area and linear components (e.g., access roads and generation tie line) and totals 2,527 acres. The site is immediately adjacent to Joshua Tree National Park approximately 11 miles north of the rural community of Desert Center and 11.5 mi north of I-10. Because the majority of the site is disturbed from past mining practices, little intact desert tortoise habitat remains; an estimated 90 acres of occupied and suitable habitats will be impacted by the proposed project. The project is designed to generate electricity during periods of peak demand, primarily during the day on weekdays, and then use available nighttime and weekend energy to pump water back to an upper reservoir for reuse. The project also would provide ancillary services to the grid such as voltage regulation, load following, spinning reserves, and black start capacity. Like all hydroelectric pumped storage projects, Eagle Mountain would be a net consumer of energy.

As described in the biological opinion for this project, the developer did not have site control of the central project area and therefore could not conduct any on-site surveys. Data from previously proposed projects, such as the Eagle Mountain Landfill, and aerial photography were used to characterize the site. Because the available information did not allow an accurate estimation of the number of desert tortoises in the central project area, the Service did not exempt the incidental take of any individuals for project activities in the central project area.

Construction of the transmission line and water pipeline is contingent upon a separate Federal action by the BLM. Surveys conducted along the linear components estimated up to 3 subadult and adult desert tortoises, up to 13 juveniles, and up to 17 eggs may be affected by the proposed project. Because of the linear nature of these components, however, take in the form of capture or collection for the purposes of moving individuals out of harm's way was exempted for all desert tortoises located along these project features; no take in the form of injury or mortality was exempted. While FERC and Eagle Crest would be exempt from such taking in compliance with the terms and conditions of the incidental take statement, the BLM would not be exempt until it initiates consultation with the Service on their issuance of a ROW for the linear components and a joint amended/revised biological opinion is issued to BLM and FERC.

Effects of the Proposed Action

Desert Tortoise

Construction and operation and maintenance (O&M) of solar projects in the Amargosa Valley SEZ, Dry Lake SEZ, and Riverside East SEZ would likely kill and injure desert tortoises during activities such as clearing and grubbing of vegetation; trenching activities and entrapment in open trenches and pipes; and collisions with or crushing by vehicles or heavy equipment, including individuals that take shelter under parked vehicles and are killed or injured when vehicles are moved. Desert tortoises that enter or attempt to cross project access roads or work areas may be struck resulting in death or injury. Mortality mechanisms also include individual desert tortoises or their eggs being crushed or buried in burrows during construction and O&M-related activities. Because of increased human presence in the area, desert tortoises may be killed or injured due to collection or vandalism associated with increased encounters with workers, visitors, and unauthorized pets. Desert tortoises also may be attracted to the construction area by application of water to control dust, placing them at higher risk of death or injury.

We expect all life stages of desert tortoise to occur on the SEZs. Our estimate of the numbers of desert tortoises and eggs that are likely to occur within the action area for future projects will be derived from pre-project survey data. We acknowledge, however, that not all individuals killed or injured during construction and O&M activities will be detected. The inability to detect all tortoises is largely due to the cryptic nature of desert tortoises and their fossorial habits, and limited abundance; and in the case of juveniles and eggs, their small size and location underground that reduce detection probabilities of these life stages. Another confounding factor is that scavengers may locate, consume, or remove carcasses before monitors can locate them.

Overall, we expect that most subadult and adult tortoises will avoid death and injury during construction and O&M activities through implementation and compliance of minimization measures (design features) in the BA and summarized in this biological opinion. Measures intended to minimize injury and mortality of desert tortoises include, but are not limited to, avoidance of occupied desert tortoise habitats, use of fencing to exclude desert tortoises from project areas; assignment of an authorized desert tortoise biologist to monitor and oversee project activities and compliance with protective measures; timing of activities to minimize effects to desert tortoises (e.g., conduct activities during the inactive season and when temperatures are above desert tortoise activity thresholds); move or translocate tortoises from harm's way in coordination with the BLM and Service when avoidance is infeasible; worker awareness training; conduct pre-activity surveys to locate desert tortoises on-site; restrict vehicles to access roads with enforceable speed limits; and minimize the risk of entrapment by capping pipes and constructing escape ramps in open excavations.

Project Access Effects on the Desert Tortoise

Access to solar project sites, utility infrastructure, and other ancillary facilities would be identified by the BLM and included in the project-level consultation. Access to project work areas outside of the fenced facilities may kill or injure desert tortoises due to construction of new routes or increased use and improvement of existing routes. The primary effect of project access on desert tortoises is the risk of injury or mortality from vehicle strikes. The risk to desert tortoises on access roads is influenced by variables such as speed limits, weather conditions, the nature and condition of the roads, and activity patterns of desert tortoises at the time the roads are in use. Further complicating this risk is use of project roads by the public.

Existing access roads, utility corridors, and other infrastructure will be used to the maximum extent feasible. Because all workers will participate in the proposed worker awareness training, and appropriate signage and speed limits will be posted, workers may be less likely to strike desert tortoises than a casual user. Low speed limits for project vehicles and equipment would allow operators more time to see a desert tortoise in their path or harm's way. Temporary or project-created roads will be closed where appropriate. In addition, clearance surveys and the use of authorized desert tortoise biologists and monitors during construction of the access roads will minimize potential effects to the desert tortoise. Speed limits would minimize the risk to desert tortoises during construction and O&M activities.

Effects of Loss of Desert Tortoise Habitat

The Amargosa Valley SEZ occurs within the Eastern Mojave Recovery Unit. Based on the work by Nussear *et al.* (2009), we calculated that approximately 4,331,402 acres of the 10,714,309 acres within the Eastern Mojave Recovery Unit is considered habitat modeled at the 0.5 or greater "predicted habitat potential level" for desert tortoise (Matt Ball, 2012, pers. comm.). The habitat that would be disturbed in the Amargosa Valley SEZ on a long-term basis (i.e., up to 8,479 acres) constitutes approximately 0.2 percent of the modeled habitat at the 0.5 level in the Eastern Mojave Recovery Unit.

The Dry Lake SEZ occurs within the 5,106,939-acre Northeast Mojave Recovery Unit of which 2,814,646 acres is modeled desert tortoise habitat. The habitat that would be disturbed in the Dry Lake Valley SEZ on a long-term basis (i.e., up to 5,717 acres) constitutes approximately 0.2 percent of the modeled habitat at the 0.5 level in the Northeastern Mojave Recovery Unit.

The Riverside East SEZ occurs in the 7,636,463-acre Colorado Desert Recovery Unit of which 4,414,537 acres is modeled desert tortoise habitat. The habitat that would be disturbed in the Riverside East SEZ on a long-term basis (i.e., up to 147,910 acres) constitutes approximately 3.35 percent of the modeled habitat at the 0.5 level in the Colorado Desert Recovery Unit.

Because recovery of vegetation in the desert can take decades or longer, we consider all ground-disturbing impacts associated with future solar projects to be long-term. Vasek *et al*. (1975) found that in the Mojave Desert transmission line construction and O&M activities resulted in a unvegetated maintenance road, enhanced vegetation along the road edge and between tower sites (often dominated by nonnative species), and reduced vegetation cover under the towers, which recovered significantly but not completely in about 33 years. Webb (2002) determined that absent active restoration following extensive disturbance and compaction in the Mojave Desert, soils in this environment could take between 92 and 124 years to recover. Other studies have shown that recovery of plant cover and biomass in the Mojave Desert could require 50 to 300 years in the absence of restoration efforts (Lovich and Bainbridge 1999). Based on a quantitative review of studies evaluating post-disturbance plant recovery and success in the Mojave and Sonoran deserts, Abella (2010) found that reestablishment of perennial shrub cover (to amounts found on undisturbed areas) generally occurs within 100 years but no fewer than 40 years in some situations. He also found that a number of variables likely affect vegetation recovery times, including but not limited to climate (e.g., precipitation and temperatures), invasion by nonnative plant species, and the magnitude and extent of ongoing disturbance. If project proponents mow vegetation and leave the root structure of shrubs intact, recovery time would be substantially reduced.

The percentage of desert tortoise habitat (i.e., 0.2 to 3.35 percent) affected by the proposed action does not constitute a numerically significant portion of the affected recovery units; however, we do not have the ability to place a numerical value on edge effects, habitat degradation, and overall fragmentation that the proposed action may cause or that occurs in the recovery unit as a whole. As a result, the low percentage of habitat within the recovery unit that would be lost underestimates impact of the proposed project on the desert tortoise, especially in light of existing land uses, changes in species composition and fire regimes due to establishment of nonnative plant species, existing and increasing disease and predation rates, and the expansion of human occupancy in what were once remote desert landscapes. The revised recovery plan (Service 2011) and 5-year review (Service 2010a) provide detailed discussions of these and other past, present, and future threats facing the desert tortoise.

To the extent possible, staging and parking areas will be located within the site of the solar energy facility to minimize habitat disturbance in areas adjacent to the site. Facilities would be consolidated to maximize use of existing disturbed areas. No projects will be sited in critical habitat designated for the desert tortoise (Service 1994), ACECs, or similar conservation areas. Although we analyzed full build-out of the SEZs, if less development occurs, the undisturbed habitat would remain undeveloped. Because BLM will not propose solar projects in desert tortoise critical habitat, direct adverse effects to critical habitat would likely be avoided from this type of use; however, impacts to critical habitat from transmission infrastructure (e.g., generation tie lines, substations, and access roads) is likely to occur.

Additional measures proposed by BLM to minimize habitat effects include the following: maintain native vegetation cover and soils to the extent possible; retain native vegetation to the maximum extent possible, which may include mowing instead of blading; minimize blading;

procure and develop locally and regionally appropriate native plant materials; require project developers to contribute funding to support the BLM Native Plant Materials Development Program; develop an Ecological Resources Mitigation and Monitoring Plan to revegetate disturbances, stabilize soils, and control erosion; investigate the possibility of revegetating parts of the solar array area; re-establish vegetation within temporarily disturbed areas immediately following the completion of construction activities; transplant salvaged plants; establish native plant communities similar to those present in the vicinity of the project site; use helicopters where appropriate; and monitor and continue habitat rehabilitation efforts until all success criteria have been met. Baseline data will be collected in each project area prior to its development as a benchmark for measuring the success of reclamation efforts.

Retention of native root structure and seeds within the project area would help retain soil stability, minimize soil erosion, and minimize fugitive dust pollution. Retention of native seed and roots within the project site will also facilitate recovery of vegetative cover. Use of native plant species will minimize the need to water the vegetation, because native species are already adapted to the local climate and moisture regime of the area.

Effects of Desert Tortoise Handling and Translocation

Desert tortoises on solar project sites and associated areas will be captured and likely translocated prior to any ground disturbance. Capture and translocation of desert tortoises may result in accidental death and injury from stress or disease transmission associated with handling desert tortoises; stress associated with moving individuals outside of their established home range; stress associated with artificially increasing the density of tortoises in an area and thereby increasing competition for resources; and disease transmission between and among translocated and resident desert tortoises. Capture and handling of desert tortoises for the purposes of conducting health assessments, which include visual inspection relative to body condition, clinical signs of disease, and collection of biological samples for disease screening (i.e., blood samples to test for antibodies to pathogens), could result in accidental death or injury.

Capturing, handling, and moving tortoises for the purposes of translocating them out of the project areas or out of harm’s way may result in accidental death or injury if these methods are performed improperly, such as during extreme temperatures, or if individuals void their bladders and are not rehydrated. Averill-Murray (2002) determined desert tortoises that voided their bladders during handling had lower overall survival rates (0.81 to 0.88) than those that did not void (0.96). If multiple desert tortoises are handled by biologists without the use of appropriate protective measures and procedures, pathogens may be spread among individuals.

Because of the difficulty in locating juvenile desert tortoises and eggs, some but not all are likely to be translocated from the project areas. Effects to juvenile desert tortoises and eggs that are undetected on the project sites are discussed later in this section. Translocation has the potential to increase the prevalence of diseases, such as upper respiratory tract disease, in translocated and resident desert tortoises. Physiological stresses associated with handling and movement or from density-dependent effects could exacerbate this risk if translocated individuals with subclinical upper respiratory tract disease or other diseases present symptoms subsequent to translocation. This potential conversion of translocated desert tortoises from a non-contagious to contagious state may increase the potential for infection in the resident population above pre-translocation levels. To minimize this risk, health assessments would be required on all desert tortoises to be translocated prior to being released in accordance with the most recent Service guidance.

If desert tortoises displaced from project areas are held in quarantine pens, their exposure and vulnerability to stress, dehydration, and inadequate food resources may increase. The potential exists, however, for predators or poachers to target quarantined desert tortoises. Desert tortoises monitored *in-situ* may be subject to similar effects as those in quarantine pens. When a project is proposed that requires translocation of desert tortoises, the Service will work with the BLM and the project proponent to develop and implement a translocation plan to address these potential effects.

Because we cannot reasonably predict if an increase in disease prevalence within a resident desert tortoise population may occur due to translocation, the BLM and project proponent should implement the most recent Service translocation guidance, which includes, but is not limited to, the following measures:

- Use experienced biologists and approved handling techniques;
- do not translocate any animal that has clinical signs of disease; and
- institute long-term monitoring of translocated, resident, and control individuals to help determine the prevalence of disease transmission.

Apart from disease, translocation also affects resident desert tortoises within the area due to local increases in population densities. Desert tortoises from project sites would likely be moved to areas now supporting a resident population, which may result in increased inter-specific encounters and, thereby, an increased potential for spread of disease, potentially reducing the health of the overall population; increased competition for shelter sites and other limited resources; increased competition for forage, especially during drought years; and increased incidence of aggressive interactions between individuals (Saethre *et al*. 2003). To minimize potential density-dependent effects, recipient areas must be sufficiently large to accommodate and maintain the resident and translocated desert tortoises.

Effects of Power Transmission and Predation on the Desert Tortoise

Facility infrastructure, such as power transmission towers and poles, fences, buildings, and other structures on the project site, may provide perching, roosting, and nesting opportunities for ravens and other avian predators. Natural predation rates may be altered or increased when natural habitats are disturbed or modified and human presence in otherwise remote desert areas increases. Common raven populations in some areas of the Mojave Desert have increased 1,500 percent from 1968 to 1988 in response to expanding human use of the desert (Boarman 2002). Since ravens were scarce in the Mojave Desert prior to 1940, the current level of raven predation on juvenile desert tortoises is considered to be an unnatural occurrence (BLM 1990). Human activities may provide food in the form of trash and litter or water that attracts desert tortoise predators such as the common raven, desert kit fox, feral dogs, and coyote (Berry 1986; BLM 1990).

Common ravens and coyotes are attracted to human activities in the desert because of food and water subsidies, and roosting and nesting substrates that would otherwise be unavailable. Human activities also facilitate expansion of raven and coyote populations into areas where they were previously absent or in low abundance. Ravens likely will frequent project areas because of the potential availability of such subsidies. Road-kill of wildlife provides additional attractants and subsidies for opportunistic predators and scavengers.

To avoid and minimize the availability of project sources of predator subsidies, BLM has proposed measures to remove raven nests from transmission towers. Transmission line support structures and other facility structures shall be designed to discourage their use by raptors for perching or nesting (e.g., by use of anti-perching devices) in accordance with the most current Avian Power Line Interaction Committee (APLIC) guidelines. A trash abatement plan will be developed to contain trash and food in closed and secured containers and remove them periodically to reduce their attractiveness to common ravens and other desert tortoise predators. A Nuisance Animal and Pest Control Plan will be prepared to include monitoring ravens and their use of tall structures and other species that are attracted to developed areas. Evaporation ponds and open water sources will be fenced and netted to prevent use by ravens and other predators. Washing of solar panels may result in ponding of water, providing a subsidized resource for ravens. These water sources may have elevated levels of harmful contaminants (e.g., total dissolved solids and selenium) and could harm tortoises and other wildlife. The lower 18 inches of the fencing will be a solid barrier to tortoise and other terrestrial wildlife.

The Riverside East, Amargosa Valley, Dry Lake, and Dry Lake Valley North SEZs occur adjacent to or within 1 mile of an existing BLM utility corridor. The Dry Lake Valley North and Millers SEZs in Nevada and the Brenda SEZ in Arizona are not within the range of the Mojave desert tortoise but generated power may be transmitted to Las Vegas, Nevada (Dry Lake Valley North and Millers SEZs) and San Bernardino-Riverside County, California (Brenda SEZ) through Mojave desert tortoise habitat resulting in similar effects from transmission infrastructure. The location of the tie-in to the transmission grid could be the nearest existing transmission line, if that line had a high enough capacity and sufficient uncommitted capacity to accept the power from the SEZ. If capacity is insufficient, the line may be upgraded or a new line would be constructed. Any construction of transmission lines to tie solar energy facilities in these SEZs into the main power grid would be required, resulting in habitat disturbance. If a new transmission line is required outside an existing transmission corridor or ROW, the potential effects to the desert tortoise would be greater than constructing the line adjacent to existing transmission lines. New transmission poles and towers may provide nesting and perching opportunities for avian tortoise predators.

The BLM performed an analysis to estimate an upper-bound land disturbance that could be associated with transmission line construction for each of the SEZs. This analysis is based on the assumption that no capacity for SEZ-generated power will be available on existing transmission lines. The analyses identify the most likely load center or load centers for generation sources in SEZs, and provide an estimate of land disturbance that would be caused by construction of all new transmission lines from the SEZs to the load centers. Specific locations for the new transmission lines are not known at this time; however, the BLM expects that the lines would follow the routes of existing lines in order to minimize land disturbance and make use of existing corridors.

The desert tortoise effects analyses are based on the following assumptions:

- New lines would be 230-kV and constructed to the nearest existing transmission line;
- the corridor right-of-way (ROW) width would be up to 250 feet including areas disturbed during construction;.
- the 250-foot ROW would result in approximately 30 acres of land disturbance per mile of transmission line construction;
- the ROWs occur within a 1-mile wide corridor and no specific location within the corridor was identified for construction;
- if more than one project would be built within an SEZ, transmission lines will be shared between projects; and
- no capacity for SEZ-generated power will be available on existing transmission lines in the future and an upper-bound estimate of land disturbance that would be caused by construction of all new transmission lines from the SEZs to the load centers.

Based on the assumptions provided above, BLM estimates land disturbance for construction of new transmission lines to load centers is 8,284 acres for the Amargosa Valley SEZ; 669 acres for the Dry Lake SEZ; and 144,973 acres for the Riverside East SEZ. The total disturbance for the Miller SEZ is 8,709 acres and the Brenda SEZ is 2,242 acres. The Service determined that an unknown amount of this anticipated upper-bound disturbance is desert tortoise habitat. The locations of these lines were only generally indicated for these analyses. Project-level analyses would be done in preparation for actual transmission line construction when specific plans and routing information are available.

Effects of Nonnative Plant Species on the Desert Tortoise

Another indirect effect from the solar projects is the potential introduction and spread of nonnative, potentially invasive plant species into habitats adjacent to the project sites. Construction and O&M activities of these projects may increase distribution and abundance of nonnative species within the action area due to ground-disturbing activities that favor these species. Project equipment may transport nonnative propagules into the project area where they may become established and proliferate. In addition, the introduction of nonnative plant species may lead to increased wildfire risk, which ultimately may result in future habitat losses (Brooks *et al*. 2003) and changes in forage opportunities for desert tortoises. If herbicides are used, tortoises may be directly or indirectly affected. BLM proposes to limit the type of herbicides used to those with low toxicity to wildlife and nontarget native plant species, and herbicide use will be analyzed in future project-level consultation with the Service.

BLM proposed the following conservation measures as part of the proposed action to address the potential effects from nonnative plant species which include those described previously for habitat effects: Develop a Weed Management Plan with monitoring and control components; implement actions to avoid introduction of weed by vehicles and equipment; use low-toxicity herbicides applied in accordance with the plan; use certified weed-free seed mixes of native shrubs, grasses, and forbs of local origin; provide worker awareness training; limit ground disturbance; and expedite reestablishment of native vegetation in disturbed areas to prevent weeds from colonizing newly disturbed areas.

We expect an increase in nonnative plant species abundance within the action area but cannot predict the magnitude of this effect to the desert tortoise.

Edge Effects on the Desert Tortoise

Desert tortoises also may be adversely affected by construction noise, ground vibrations, and artificial lighting. Increased noise levels and the presence of full-time facility lighting may affect desert tortoise behavior during construction and operations of the facility over a 30-year period. While limited data exists on the effect of noise on desert tortoises, Bowles *et al.* (1999) demonstrated that the species has relatively sensitive hearing (i.e., mean = 34 dB SPL), but few physiological effects were observed with short-term exposures to jet air craft noise and sonic booms. These results cannot be extrapolated to chronic exposures over the lifetime of an individual or a population. Based on the ability of other species to adapt to noise disturbance, noise attenuation as distance from the project increases, and the fact that desert tortoises do not rely on auditory cues for their survival, we do not expect any desert tortoises to be injured or killed as a result of project-related noise impacts.

We also do not have sufficient data documenting the effects of artificial lighting on desert tortoise behavior and therefore cannot reasonably predict the magnitude of effect light will have on adjacent desert tortoise populations. Lighting will be designed to provide the minimum illumination needed to achieve safety and security objectives. Lighting shall be shielded and orientated to focus illumination on the desired areas and to minimize or eliminate lighting of off-site areas.

Because few data exist relative to edge effects from noise, light, vibration, and increased dust from project activities, we cannot determine how these potential impacts may affect desert tortoise populations within and adjacent to the SEZs. Thus, the magnitude and extent of these edge effects cannot be articulated at this time, but conceivably could disturb individual desert tortoises to the extent that they abandon all or a portion of their established home ranges and move elsewhere.

Effects on Desert Tortoise Population Connectivity

Landscape genetic analysis performed by Latch *et al.* (2011) identified both natural (slope) and anthropogenic (roads) landscape variables that significantly influenced desert tortoise gene flow of a local population. Although they found a higher correlation of genetic distance with slope compared to roads, desert tortoise pairs from the same side of a road exhibited significantly less genetic differentiation than tortoise pairs from opposite sides of a road. Project access roads are not anticipated to decrease population connectivity substantially beyond the existing conditions.

As discussed in the revised recovery plan (Service 2011) and elsewhere, habitat linkages are essential to maintaining range-wide genetic variation (Edwards *et al.* 2004, Segelbacher *et al.* 2010) and the ability to shift distribution in response to environmental stochasticity, such as climate change (Ricketts 2000, Fischer and Lindenmayer 2007, EPA 2009). Natural and anthropomorphic constrictions (e.g., I-10 and I-15) can limit gene flow and the ability of desert tortoises to move between larger blocks of suitable habitat and populations. In the action area, existing anthropomorphic constrictions compound effects of natural barriers on desert tortoise population connectivity.

The predicted pathway of desert tortoise movement in the Amargosa Valley is east of the SEZ along U.S. Highway 95 and southwest to Death Valley National Monument. The Amargosa SEZ does not occur within an important movement corridor or area with contiguous high habitat value for the desert tortoise. The Dry Lake SEZ occurs within the northern portion of the pathway providing contiguous habitat between the southern Mormon Mesa Critical Habitat Unit and the Gold Butte Pakoon Critical Habitat Unit through Lake Mead National Recreation Area.

As discussed in the “Status of the Species” and “Environmental Baseline” sections, portions of the proposed Riverside East SEZ lie within a naturally constricted linkage in the Upper Chuckwalla

Valley and Upper Pinto Wash that connects the desert tortoise population in the Chuckwalla CHU and DWMA with populations in Joshua Tree National Park, Pinto Mountain CHU, Chemehuevi CHU and DWMA, and thence the Mojave Desert portion of the species' range. This linkage is defined by topography, elevation, and geomorphology, with steep, rocky mountains limiting desert tortoise distribution to the west, and low elevations and sand dunes and playas limiting the distribution to the east. The linkage boundaries are based on the BLM's NECO Plan landform data (i.e., dunes, playas, mountains, and hills), the 500-foot elevation contour, our knowledge of habitat conditions in the action area, and desert tortoise survey data from other lowland areas in the Colorado/Sonoran Desert with comparable habitat conditions. This linkage corresponds well with the USGS desert tortoise habitat model (Nussear *et al.* 2009). The Riverside East SEZ also overlaps the Desert Tortoise Connectivity WHMA on the north side of I-10, potentially disrupting desert tortoise connectivity in this area.

Linkages in the western portion of the Riverside East SEZ are already influenced by existing anthropogenic constrictions that compound effects of natural barriers on desert tortoise population connectivity. These barriers include the Colorado River Aqueduct, a nonoperational railroad, Eagle Mountain Road, Kaiser Road, numerous utility lines and associated access roads, flood control structures, and mining spoil piles and levees. Some of these facilities function as sources of mortality, thus the combined impacts from the edge effects (e.g., impacts from construction-related noise, light, dust, increased vehicular traffic, and ground vibration), existing obstacles to occupancy and movement, and potential increases in mortality have the potential to exert a significant adverse effect on the connectivity function of this and other areas where occupied and suitable habitats occur in narrow bands surrounded by lower predicted habitats within the SEZ.

Within this SEZ, higher predicted desert tortoise habitats generally occur within the upper bajadas of the mountain ranges (Nussear *et al*. 2009); however, even areas modeled as low predicted habitat have been documented to support relatively low desert tortoise densities during pre-project surveys in the region and the intact nature of the SEZ (i.e., the lack of barriers to dispersal), its adjacency to habitats currently occupied by desert tortoises, and the availability of suitable habitat establishes the importance of this area for population connectivity, even if at a presumed lower level of functionality. Because individuals are known to move across extensive tracts of marginal habitats (Averill-Murray and Averill-Murray 2005; Edwards *et al.* 2004), we anticipate that low numbers of desert tortoises occasionally use much of the SEZ in such a manner. Build-out of the proposed Riverside East SEZ may further constrict the already constrained linkage within the Upper Chuckwalla Valley and Upper Pinto Wash area.

Using the USGS desert tortoise habitat model (Nussear *et al*. 2009), the Service evaluated the potential for all linkages in this region. Based on our analyses, the Upper Chuckwalla Valley and Upper Pinto Wash, especially along the upper bajadas of the Eagle and Coxcomb mountains, represent the most viable remaining linkage in this area. However, the steep and rocky Eagle and

Cottonwood mountains limit the distribution of desert tortoises to the west and the viability of Cottonwood Canyon is limited because of a busy paved road that likely functions as a mortality sink, which further constrains desert tortoise occupancy and movement potential in this narrow canyon (M. Vamstad, Joshua Tree National Park, pers. comm. 2010).

Beyond these few linkage opportunities through otherwise steep rugged topography, the only other potential connection in the western portion of the Riverside East SEZ with 0.5 or higher predicted desert tortoise habitat (Nussear *et al*. 2009) lies on the eastern side of the Desert Sunlight project ROW, in the narrow band of alluvium along Pinto Wash and the base of the Coxcomb Mountains. SR 177 truncates this area at its southernmost extent, and the matrix of largely unsuitable disturbed private lands and extensive sand dune and playa system here would not function effectively as a reliable alternative north-south linkage between the Chuckwalla CHU and DWMA populations and populations to the north connecting with the Mojave Desert. Unknown future changes in land uses and the extent of interest in renewable energy development across this BLM/private lands matrix add further uncertainty to reliance upon these lesser value habitats for connectivity.

Climate change may exacerbate this circumstance, given that future temperatures generally are expected to rise; the effects of climate change on rainfall are less predictable at this time (International Panel on Climate Change 2007). A future rise in temperature would increase environmental variability and desert tortoise mortality within the few hypothetical and putative linkages described above. Because of its habitat requirements and life history traits, the desert tortoise is considered to be highly vulnerable to the effects of climate change (U.S. EPA 2009, National Wildlife Federation 2011). The combination of increased environmental variability and decreased genetic variation in desert tortoise populations would lead to a higher likelihood of extirpation in linkage areas due to stochastic factors and human-related activities. Thus, landscape-scale redundancy in core habitat-linkage reserve design is an important principle in conservation strategies for widely distributed species like the desert tortoise (Service 1994a, 2011).

Based on the above discussion of the effects of the proposed project on habitat connectivity, our assessment of the range-wide status of the species indicates that the potential loss of functionality of the habitat linkage within the Upper Chuckwalla Valley and Upper Pinto Wash adjacent to the Riverside East SEZ could eliminate gene flow between the Chuckwalla CHU and DWMA populations and those to the north in the Mojave portion of the species' range. Since redundancy in the linkage network between core populations in this portion of the species' range are extremely limited, maintenance of connectivity along the I-10 corridor through Pinto Wash is imperative. Therefore, conserving the smaller-scale, internal redundancy within remaining portions of the habitat linkage is essential; these include 1) habitat connections to as many culverts and bridges under I-10 as possible; and 2) minimizing the loss of desert tortoise habitat within the BLM/private landownership checkerboard that would preclude habitat connections to these crossings along the section of I-10 that borders the SEZ.

Private lands along this section of I-10 and within the Riverside East SEZ are at risk of or are currently being developed, as evidenced by the high asking prices for parcels located within the DWMA exclusion areas in BLM's NECO Plan associated with each of the freeway on-and off-ramp intersections along I-10 (R. Lopez, Wildlands Inc., pers. comm. 2010), and the Paradise Valley project proposed near Cactus City in Shavers Valley. In addition, BLM is pursuing a land exchange on a parcel near Chiriaco Summit that would transfer a BLM parcel to private ownership that would be subject to development (M. Massar, BLM, pers. comm. 2011). The disjunct landownership pattern introduces a high level of risk to maintenance of desert tortoise connectivity unless development pressure can be eliminated through acquisition of private lands, which would help to offset cumulative impacts of solar development along the I-10 corridor and impacts to habitat connectivity from individual developments within the proposed SEZ.

Groundwater-dependent Species and their Critical Habitat in the Action Areas for the Nevada SEZs

The groundwater-dependent species will not be directly affected by the physical construction of solar projects or their O&M activities; however, groundwater pumping associated with the action is an interrelated activity that is likely to affect these species. Withdrawals from groundwater or surface water sources may alter hydrological regimes and reduce the amount of surface water available to the species, resulting in adverse effects on the groundwater-dependent species identified in this biological opinion. Hydrological dynamics within wetland and riparian areas may also be affected, thereby potentially affecting the aquatic and terrestrial plant and animal species that utilize these resources. Individual organisms may die and local populations may become extirpated if water resources are reduced.

The 12 listed Ash Meadows species, three fish species in the Dry Lake North SEZ action area, and Moapa dace are dependent on groundwater, including the Devils Hole pupfish which needs water above the shelf (Service 2010a) and the listed plants which need water within 20 inches of their root system (BioWest 2010). Critical habitat may be lost or degraded, potentially resulting in loss of primary constituent elements of critical habitat. The primary constituent elements potentially affected include saltgrass meadows alongside streams and pools, saline seeps, moist to wet clay soils along streams or in seeps, and spring outflows. The primary threat to the critical habitat and primary constituent elements is lowered groundwater elevation due to groundwater pumping in support of solar projects.

The groundwater declines that have occurred due to groundwater pumping in the past have adversely affected these species and are likely to continue to affect these species. The Ash Meadows plant species are adapted to the wetter environments of the Ash Meadows National Wildlife Refuge.

Small declines in spring discharge, changes in water temperature, drying of soils, and adjustments in soil or water chemistry resulting from the project's groundwater withdrawals in the basin may affect all groundwater-dependent species and their critical habitat. A thorough project-level analysis would be required to provide more information on the effects of changes in spring discharge, groundwater levels, water temperature, and water and soil chemistry to Ash Meadows listed species.

The Amargosa Desert Hydrographic Basin is currently over-appropriated. The hydrologic impacts to Devils Hole and Ash Meadows aquatic resources from future solar development in the Amargosa SEZ are uncertain, but fluctuations in water levels in the Amargosa Desert Hydrographic Basin have been tied directly to groundwater pumping (Bedinger and Harrill 2006).

The effects of the proposed groundwater pumping in the adjacent hydrographic basin on the Moapa dace were previously analyzed in a 2006 Intra-Service Programmatic Biological Opinion (Service File No. 1-5-05-F-536), which evaluated the effects of the multiple parties withdrawing 16,100 afy of groundwater from the carbonate aquifer in Coyote Spring Valley and California Wash on the endangered Moapa dace in accordance with a memorandum of agreement which includes the Service. Because the interconnections among adjacent basins are not fully understood in combination with uncertainty regarding future water use for solar projects, adverse effects may occur to the Moapa dace as a result of groundwater use for solar projects in the Dry Lake SEZ.

Analysis of Effects to Groundwater-dependent Species with Implementation of BLM-committed Design Features or Conservation Measures

The following proposed measures in the Solar PEIS BA are intended to reduce potential effects to groundwater-dependent species:

- Projects shall be sited and designed to avoid direct and indirect impacts on important, sensitive, or unique resources, including aquatic habitat and habitats supporting listed species. For cases in which impacts cannot be avoided, they shall be minimized and mitigated appropriately, in coordination with federal and state agencies.

- Projects shall avoid surface water or groundwater withdrawals that affect sensitive habitats (e.g., aquatic, wetland, and riparian habitats) and any habitats occupied by listed species. Applicants shall demonstrate, through hydrologic modeling, that the withdrawals required for their project are not going to affect groundwater discharges that support listed species or their habitats.

- The capability of local surface water or groundwater supplies to provide adequate water for the operation of proposed solar facilities shall be considered early in the project siting and design. Technologies that would result in large withdrawals that would affect water bodies that support listed species shall not be considered.

- A Water Resources Mitigation and Monitoring Plan shall be developed for each project. Changes in surface water or groundwater quality or flow that result in the alteration of terrestrial plant communities or communities in wetlands, springs, seeps, intermittent streams, perennial streams, and riparian areas (including the alteration of cover and community structure, species composition, and diversity) off the project site shall be avoided to the extent practicable. A monitoring plan shall be developed that determines the effects of groundwater withdrawals on plant communities.

In addition, the BLM agreed to include the following measures to minimize potential effects to groundwater-dependent species.

- Developers should purchase and relinquish existing groundwater rights to support their projects in an amount that offsets any loss of irrigation return flows due to the change in use (e.g., agricultural to industrial), and any probable increase in actual groundwater pumping due to less than full utilization of the rights converted for the project. BLM and the developer should ensure that annual consumptive groundwater use within basins supporting the groundwater-dependent species (and those providing significant underflow to those basins) does not increase over current levels as a result of future solar projects, e.g., due to a loss of irrigation return flows and (or) the full utilization of groundwater rights that have not been historically fully utilized.

- BLM should ensure that future solar projects do not result in points of groundwater withdrawal being moved closer to locations supporting the groundwater-dependent species and (or) increased pumping in the regional carbonate aquifer in areas with a significant potential to affect habitat for those species (albeit the total consumptive groundwater use may remain the same).

The Service anticipates that implementation of the six measures above would reduce potential effects to groundwater-dependent species by permitting only those projects that would not withdraw groundwater to the extent that adverse effects would occur in habitat for listed species. In the absence of data and information to further evaluate the potential effects of groundwater withdrawal, the Service anticipates that adverse effects may occur as a result of solar projects in the Nevada SEZs. The BLM and Service will evaluate the project-level effects when projects are proposed, determine if adverse effects to listed species and their critical habitat are likely to occur, and follow the appropriate consultation procedures.

Cumulative Effects

Cumulative effects include the effects of future State, local, tribal, or private actions that are reasonably certain to occur in the action area considered in this biological opinion. Future

Federal actions that are unrelated to the proposed action are not considered in this section because they require separate consultation pursuant to section 7 of the Act.

Currently, there are 11 solar energy projects proposed on private lands within 0.5 miles of the proposed Riverside East SEZ boundary. In total, these projects will impact approximately 13,600 acres and generate approximately 2,130 MW of energy. Most of the private lands upon which these projects are sited are generally intermixed with the BLM lands that comprise the SEZ, effectively forming a continuous solar energy development area within the Riverside East action area. Cumulatively, build-out of the projects on private lands together with those proposed and approved BLM projects within the SEZ would exacerbate impacts to ecosystem function, particularly from habitat fragmentation and loss of population connectivity, increased establishment and spread of invasive, nonnative plant species, increased predator populations often associated with human development, and the loss of entire home ranges of individual desert tortoises within, and possibly adjacent to, project footprints on private lands. An unknown number of desert tortoises will be impacted by these projects, but roughly two-thirds (8,000 ac) of the 13,600 acres is categorized as low predicted desert tortoise habitat based on the USGS habitat model (Nussear et al. 2009).

Also, the Riverside East SEZ may ultimately be part of the development focus area being considered under the alternatives for the California Desert Renewable Conservation Plan (DRECP). The DRECP is a multi-agency (Federal, State, and local entities) and stakeholder driven planning process to guide renewable energy development in the desert. Upon completion of the plan, many of the projects on private lands considered here would likely be addressed under the DRECP or other habitat conservation plan.

The SEZs in Nevada are entirely made up of federal land, and any activities within these SEZs would involve federal oversight. Therefore, no cumulative effects are expected to occur in the Nevada SEZs.

CONCLUSION

After reviewing the status, the environmental baseline for the action area, the effects of the proposed action, and the cumulative effects, it is our biological opinion that the proposed action is not likely to jeopardize the continued existence of the desert tortoise, Amargosa niterwort, Ash Meadows blazing-star, Ash Meadows gumplant, Ash Meadows ivesia, Ash Meadows milkvetch, Ash Meadows sunray, spring-loving centaury, Ash Meadows naucorid, Ash Meadows amargosa pupfish, Ash Meadows speckled dace, Devils Hole pupfish, Moapa dace, Warm Springs pupfish, White River springfish, Hiko White River springfish, and Pahranagat roundtail chub. We have determined that the proposed action is not likely to destroy or adversely modify designated critical habitat for the spring-loving centaury, Amargosa niterwort, Ash Meadows blazing-star, Ash Meadows gumplant, Ash Meadows ivesia, Ash Meadows milkvetch, Ash Meadows sunray, Ash Meadows naucorid, Ash Meadows amargosa pupfish, Hiko White River springfish, and White River springfish, We have reached this conclusion for the following reasons:

1. Impacts to desert tortoises and groundwater dependent species will be minimized or avoided during construction and O&M activities through implementation of design features intended to minimize the chances of encountering those species.

2. BLM will require development and implementation of tortoise translocation plans at the project level to attempt to minimize the numbers of tortoises being directly killed or injured by project activities.

3. To minimize impacts to groundwater dependent species, BLM will require applicants to implement conservation measures, including purchase and relinquishment of groundwater rights to offset the effects of groundwater withdrawal and avoidance of siting points of groundwater withdrawal closer to species occurrences and (or) increased pumping in areas with a significant potential to affect habitat for those species.

INCIDENTAL TAKE STATEMENT

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

The FWS is not exempting take of endangered or threatened species incidental to the BLM Solar Program from the prohibitions of section 9 of the Act in this opinion. Establishment of the program, by itself, would not result in the take of endangered or threatened species because, in the absence of solar development projects, the establishment of the program will not cause incidental take of any listed species. Instead, the elements of the program control the development of projects. Take of endangered or threatened species could occur only when a site-specific action or project is undertaken in compliance with requirements of the program. Each approval document for site-specific actions goes through further review, including as appropriate consultation pursuant to section 7 of the Act, and that review creates an opportunity to cancel, delay, or modify an action before that action might result in the take of endangered or threatened species. In consultation on the program as a whole, it is impossible to identify the specific actions that might result in the take of endangered or threatened species or the number of individuals that might be taken by those actions, the proportion of populations of endangered or threatened species these might represent, or any surrogate measure.

In addition, approval documents for site-specific actions that might result in the take of endangered or threatened species would undergo separate formal consultation before any take would occur. Any biological opinion that resulted from one of those subsequent consultations would include an incidental take statement that exempted any incidental take likely to be caused by the action under consultation. Based on our interpretation of section 7(b)(4) and section 7(o)(2) of the Act, deferring incidental take exemptions until subsequent consultations fulfills the letter and spirit of the obligations the ESA places on FWS. It is also appropriate in the context of a consultation that evaluates a broad program.

CONSERVATION RECOMMENDATIONS

Section 7(a)(1) of the Act directs Federal agencies to use their authorities to further the purposes of the Act by carrying out conservation programs for the benefit of endangered and threatened species. Conservation recommendations are discretionary agency activities to minimize or avoid adverse effects of a proposed action on listed species or critical habitat, to help implement recovery plans, or to develop information.

The Service recommends the following conservation measures which should be considered for future solar energy projects. These measures may provide additional information or detail beyond those proposed in the BA.

Desert Tortoise

1. BLM should continue working with the Service to refine tortoise translocation plans to try to minimize the number of tortoises that would be killed or injured by solar development and infrastructure projects.

2. BLM should incorporate measures to exclude tortoises from entering solar development sites to reduce the number of tortoises impacted. Examples include tortoise-proof fencing (fence specifications should be consistent with those approved by the Service in the Desert Tortoise Field Manual [Service 2009]), and tortoise guards at all road access points, where desert tortoise-proof fencing is interrupted, to exclude desert tortoises from road and solar facilities.

3. BLM should develop programs to reduce the attractiveness of solar development and infrastructure areas to opportunistic predators such as desert kit fox, coyotes, and common ravens. Examples include litter control programs, measures to discourage the presence of ravens onsite including elimination of available water sources as proposed, designing structures to discourage potential nest sites, use of hazing to discourage raven presence, and active monitoring of the site for presence of ravens. Another opportunity is contributing to

the account held by the National Fish and Wildlife Foundation (NFWF) to implement a regional management plan for common ravens for the reduction of predation by the common raven on the desert tortoise in the California Desert. The account was established by the REAT agencies in coordination with NFWF to manage the funds that will be used to implement the regional management plan.

4. For projects that affect desert tortoise linkages, the BLM should develop Desert Tortoise Habitat Linkage Management and Monitoring Plans and a Desert Tortoise Population Connectivity Effectiveness-Monitoring Plan. In general, the emphasis of the plans are twofold: to minimize the effects of proposed projects by improving habitat conditions and maintaining desert tortoise habitat and population connectivity within linkage habitats through identification of natural and anthropogenic obstacles to connectivity and implementation of management actions to eliminate those obstacles; and to monitor the effectiveness of the habitat linkage in maintaining gene flow using adaptive management principles. Under this component, the baseline genetic composition of resident desert tortoises within the study area will be determined and monitored over time to evaluate gene flow and differentiation across the geographic extent of the study area over the life of the project; data on mortality mechanisms and the fate of individuals and spatial habitat use within the study area will also be monitored. These data are necessary to adaptively manage the linkage to optimize the opportunity for maintaining connectivity and better understand the implications of habitat loss within linkages and the factors limiting gene flow within these areas.

5. BLM should exercise its authorities pursuant to existing ROW grants within the action area to ensure that crossings along existing facilities (e.g., Kaiser Railroad, Kaiser and Eagle Mountain roads, and aqueduct within the Riverside East SEZ) are either upgraded or maintained such that desert tortoise occupancy and connectivity are not compromised. This action would include strategic placement of desert tortoise fences and culverts along these roads, and repair of existing culverts under the railroad.

6. BLM should consider habitat acquisition to offset impacts to desert tortoise population and habitat linkages in the Riverside East SEZ, targeting land within the BLM/private landownership checkerboard along the I-10 corridor between Cactus City and Desert Center and other areas identified as high priorities. This acquisition would facilitate 1) the consolidation of landownership and management; 2) minimize the risk of these lands being developed; and 3) strengthen the internal redundancy of connectivity opportunities throughout the action area to help ensure habitat continuity and access by desert tortoises and other wildlife species to a network of conserved lands or otherwise contiguous habitats.

REINITIATION

This concludes formal consultation on the proposed action outlined in the request. Reinitiation of formal consultation is ordinarily required where discretionary Federal agency involvement or control over the action has been retained (or is authorized by law) and if (1) the authorized amount or extent of incidental take is exceeded; (2) new information reveals effects of the proposed action on listed species or critical habitat in a manner or to an extent not considered in an opinion, (3) the agency action is subsequently modified in a manner that causes an effect to listed species or critical habitat that was not considered in the opinion or, (4) a new species is listed or critical habitat is designated that may be affected by the proposed action. However, exemption of incidental take has been deferred to subsequent stages of the BLM Solar Energy Program. Consequently, we believe only reinitiation triggers (2), (3), and (4) to be applicable in this instance.

CONSERVATION REVIEW

Section 7(a)(1) of the Act requires Federal agencies "in consultation with and with the assistance of the Secretary" to "utilize their authorities in furtherance of the purposes of this Act by carrying out programs for the conservation of endangered species and threatened species…." The Secretary referred to is the Secretary of the Interior or the Secretary of Commerce; within the Department of the Interior, responsibilities under section 7 are delegated to the Fish and Wildlife Service. We evaluate the BLM solar program to determine whether it effectively enlists the authorities available to the agency to further the purposes of the Act.

We have reviewed the Conservation Assessment provided by BLM, which describes the conservation measures incorporated into the agency's solar program for the benefit of endangered and threatened species. Within the six affected States, BLM proposes to designate 285,417 acres as Solar Energy Zones (SEZ), exclude 97,921,069 acres from solar development for a variety of reasons, and make the remaining 20,324,863 acres available for solar development under a variance process subject to environmental and other review conducted at the expense of the applicant. A set of design features would apply to all solar development projects covered by the program.

We note several elements of the solar program that will contribute to the conservation of endangered, threatened, proposed, and candidate species:

Several land classes have been excluded from eligibility for utility-scale solar development. These include proposed and designated critical habitat, areas within which BLM has committed to take actions with respect to habitat of sensitive species, such as greater sage-grouse and Gunnison sage-grouse habitat and flat-tailed horned lizard and fringe-toed lizard habitat, desert tortoise translocation sites, old growth forest, and all or portions of several previously proposed SEZs that were determined to be inappropriate for development.

Within variance areas, BLM will require thorough environmental review, and proposed variances that pose unacceptable adverse effects to listed, proposed, or candidate species will be denied.

Several categories of design features will apply to all projects within the program (Table 4 of the Conservation Assessment). These include siting and design requirements, general multiphase measures, site characterization requirements, construction requirements, operations requirements, decommissioning/reclamation requirements, and requirements applied to transmission lines and roads. These design features are intended generally to ensure effective coordination with FWS and State counterpart agencies, limit land disturbance, limit adverse effects to wildlife and native vegetation, and apply stringent requirements with respect to special status species. The design features specify the need for site-specific plans of various types, many of which would benefit conservation of special-status species. Importantly, the design features represent an explicit set of standards against which performance of BLM and project developers may be evaluated

We conclude that the features of the solar program described above can be considered elements of a program for the conservation of endangered species and threatened species, as described in section 7(a)(1) of the Act.

Conservation Recommendations Relative to the Conservation Review

1. BLM should periodically consider the need to exclude additional areas currently within SEZs or variance areas from solar development if potential adverse effects to listed species are identified.

2. BLM should consider extending the avoidance requirement of element 9 of its "siting and design" and element 12 of its "general multiphase measures" design features to special status plant species.

3. BLM should involve FWS in formulating any mitigation required by design features for special status species.

4. BLM should describe in greater detail what it would consider to be "unacceptable adverse effects" in evaluating proposed variances.

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<u>Desert Tortoise</u>

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