Enceliopsis nudicaulis var. *corrugata*
(Ash Meadows sunray)

5-Year Review:
Summary and Evaluation

Photo by Sarah Kulpa, U.S. Fish and Wildlife Service

U.S. Fish and Wildlife Service
Nevada Fish and Wildlife Office
Reno, Nevada

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5-YEAR REVIEW

Enceliopsis nudicaulis var. *corrugata* (Ash Meadows sunray)

I. GENERAL INFORMATION

Purpose of 5-Year Reviews:

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

Species Overview:

Enceliopsis nudicaulis var. *corrugata* was first collected in 1966 by Arthur Cronquist (Cronquist 1972, p. 246). *Enceliopsis nudicaulis* var. *corrugata* is a perennial plant in Asteraceae (sunflower family) that forms clumps 3.9 to 15.7 inches (in) (10 to 40 centimeters (cm)) high that rise from a stout, woody root-stock (Mozingo and Williams 1980, p. 21). The varietal name *corrugata* refers to leaf margins that are strongly ruffled-corrugate, especially towards the margins (Cronquist 1972, p. 246; Mozingo and Williams 1980, p. 21). The ray flowers are yellow and number 11 to 23. *Enceliopsis nudicaulis* var. *corrugata* occurs across a broad range of habitats including occasionally moist alkaline soils, spring and seep areas, and dry desert washes (Morefield 2001, p. 1; BIO-WEST 2011, p. 113). *Enceliopsis nudicaulis* var. *corrugata* is endemic to the Ash Meadows area of Nye County, Nevada. The range of *E. nudicaulis* var. *corrugata* encompasses the Ash Meadows National Wildlife Refuge (Refuge) and adjacent Bureau of Land Management's (BLM) Ash Meadows Area of Critical Environmental Concern (ACEC) and private lands.

Methodology Used to Complete This Review:

This review was prepared by the Nevada Fish and Wildlife Office (NFWO) following the Region 8 guidance issued in March 2008. We used information from the Recovery Plan for the Endangered and Threatened Species of Ash Meadows, Nevada (Recovery Plan) (Service 1990), survey information from experts who have been monitoring various localities of this subspecies, and the database maintained by the Nevada Natural Heritage Program. The Recovery Plan and personal communications with experts were our primary sources of information used to update the subspecies' status and threats. We received no information from the public in response to our Federal Notice initiating this 5-year review. This 5-year review contains updated

information on the subspecies' biology and threats and an assessment of new information compared to that known at the time of listing. We focus on current threats to the subspecies that are attributable to the Act's five listing factors. The review synthesizes all this information to evaluate the listing status of the subspecies and provides an indication of its progress towards recovery. Finally, based on this synthesis and the threats identified in the five-factor analysis, we recommend a prioritized list of conservation actions to be completed or initiated within the next five years.

Contact Information:

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Cooperating Field Office(s): Cristi Baldino, Biologist, Ash Meadows National Wildlife Refuge, Nevada; (775) 372-5435.

Federal Register (FR) Notice Citation Announcing Initiation of This Review:

On May 21, 2010, the Service announced initiation of the 5-year review for *Enceliopsis nudicaulis* var. *corrugata* and the opening of a 60-day comment period to receive information from the public regarding the subspecies status (75 FR 28636-28642). We did not receive any information from this announcement.

Listing History:

Original Listing
FR Notice: October 13, 1983; 48 FR 46590
Date of Final Listing Rule: May 20, 1985; 50 FR 20777
Entity Listed: *Enceliopsis nudicaulis* var. *corrugata*
Classification: Threatened

State Listing
The State of Nevada listed *Enceliopsis nudicaulis* var. *corrugata* as a fully protected plant species in 1987.

Associated Rulemakings:
Critical habitat was designated at the time of listing on May 20, 1985 (50 FR 20777-20794). 1,760 acres (ac) (712 hectares (ha)) of dry washes and whitish, saline soil associated with outcrops of pale whitish limestone on the Refuge are designated as critical habitat. These areas include:

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

Review History:
The status of *Enceliopsis nudicaulis* var. *corrugata* has not been reviewed since the subspecies was listed in 1985.

Species' Recovery Priority Number at Start of 5-Year Review:
The recovery priority number for *Enceliopsis nudicaulis* var. *corrugata* is 15 according to the Service's 2008 Recovery Data Call for the Nevada Fish and Wildlife Office, based on a 1-18 ranking system where 1 is the highest-ranked recovery priority and 18 is the lowest (Endangered and Threatened Species Listing and Recovery Priority Guidelines, 48 FR 43098, September 21, 1983). This number indicates that the taxon is a subspecies that faces a low degree of threat and has a high potential for recovery.

Recovery Plan or Outline

> **Name of Plan or Outline:** Recovery Plan for the Endangered and Threatened Species of Ash Meadows, Nevada.
> **Date Issued:** September 28, 1990.

II. REVIEW ANALYSIS

Application of the 1996 Distinct Population Segment (DPS) Policy

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

Information on the Species and its Status

<u>Species Biology and Life History</u>
Enceliopsis nudicaulis var. *corrugata* was first collected in 1966 by Arthur Cronquist (Cronquist 1972, p. 246). *Enceliopsis nudicaulis* var. *corrugata* is a perennial plant 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, p. 21). The leaves are densely tomentose with fine, grayish-white hairs and are relatively small, with a blade 0.4 to 0.8 in (1 to 2 cm) long, and ovate to subcircular (Mozingo and Williams 1980, p.21). Leaf margins are strongly ruffled-corrugate (wrinkled or folded), especially towards the margins, which refers to the varietal name *corrugata* and distinguishes it from *Enceliopsis nudicaulis* and *E. nudicaulis* var. *nudicaulis* (Cronquist 1972, p. 246; Mozingo and Williams 1980, p. 21). Flower stalks are leafless and bear individual heads with strongly compressed disks 0.8 to 1.4 in (2 to 3.5 cm) across. The ray flowers number 11 to 23, are yellow, and are 0.8 to 1 in (2 to 2.5 cm) long. Achenes are silky-pubescent and bear two, short, awl-shaped awns connected by a whorl of short, fused scales (Mozingo and Williams 1980, p. 21). Inflorescence buds begin developing in February and flowers open from late March to late May (Mozingo and Williams 1980, p.21; Pavlik and Moore 2010, p. 51).

In 2008 and 2009, Pavlik and Moore (2010, pp. 1-146) examined two subpopulations of *Enceliopsis nudicaulis* var. *corrugata* (60 plants total) and conducted studies on phenology, breeding system, and seed biology (seed output, germination). In both years, flowering peaked in late April, when 88.3 percent of all plants were in bloom (Pavlik and Moore 2010, p. 51). In 2008, the average *E. nudicaulis* var. *corrugata* plant output was 12.7 inflorescences and 11.5 infructescences; while in 2009, plant output averaged 18.5 inflorescences and 15.5 infructescences (Pavlik and Moore 2010, p. 52). Inflorescences that developed earlier in the season produced significantly more seeds than those developing later (Pavlik and Moore 2010, p. 52). Plants approximately produced 17.4 mature seeds per bud (Pavlik and Moore 2010, p. 88, Table 16). An examination of the seed to ovule ratio of mature fruits suggests that *E. nudicaulis* var. *corrugata*'s breeding system exemplifies facultative xenogamy (*e.g.*, predominantly outcrosses, but selfing is possible) (Pavlik and Moore 2010, pp. 52-53). *Enceliopsis nudicaulis* var. *corrugata* flowers attract at least 21 floral visitors, 19 which are bee taxa (BIO-WEST 2009, pp. 2-5). *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, p. 5).

There are no quantitative data on germination events or seedling observations for *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 breaking dormancy and then failing to survive when transferred to native soil (Pavlik and Moore 2010, p. 53). Transplanting and translocation studies have not been conducted.

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, p. 61; Service 1990, p. 25). 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" 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 winter months of normal years (Jensen, pers. comm. 2010; White Horse Associates 2010, pp.116, 509). In addition, recent surveys demonstrate that *E. nudicaulis* var. *corrugata* occurs in a broader range of Refuge habitats than was previously described, including occasionally moist alkaline soils, spring and seep areas, and dry desert washes (BIO-WEST 2011, p. 113).

Spatial Distribution

At the time of listing, *Enceliopsis nudicaulis* var. *corrugata* was described occurring only in the Ash Meadows area of Nevada and 1,760 ac (712 ha) was designated as critical habitat (Figure 1; Service 1985, p. 20777). In 1987, Knight and Clemmer (pp. 1-111) reviewed the available data on the rare plants of the Refuge and identified three general areas of *E. nudicaulis* var. *corrugata* habitat. In 1998, surveys were targeted on the three general areas identified by Knight and Clemmer (1987, p. 61); these areas were further defined, and *E. nudicaulis* var. *corrugata* was identified from six areas within the Refuge (Glenne and Alexander, unpubl. data 1998). In 2000, it was estimated that *E. nudicaulis* var. *corrugata* occurred on 5,274 ac (2134 ha); 1,950 ac (789 ha) of U.S. Fish and Wildlife (Service) land and 2,501 ac (1,012 ha) of Bureau of Land Management (BLM) land (BLM and Service 2000, pp. 3-5 and 3-6). In 2001, *E. nudicaulis* var. *corrugata* was estimated to occur on 26.9^{+} ac (10.9^{+} ha) with 15 minimum scale occurrences (0.1 mile (mi) (16 kilometer (km)) distance) or 11 maximum scale occurrences on the Refuge (0.6 mi (1 km) distance) (Morefield 2001, p. 1). Refuge-wide surveys of listed and rare plants, including *E. nudicaulis* var. *corrugata*, were initiated in 2008 and completed in 2010 (BIO-WEST 2011, pp. 1-207). As a result of these surveys, 9,000 ac (3,642 ha) were surveyed; the approximate Refuge area covered by *E. nudicaulis* var. *corrugata* is 216.1 ac (87 ha) (BIO-WEST 2011, p. 114). On these 216.1 ac (87.5 ha), 30 minimum scale occurrences (0.1 mi (0.16 km) distance) or 1 maximum scale occurrence (0.6 mi (1 km) distance) were reported (Figure 1; BIO-WEST 2011, p. 113).

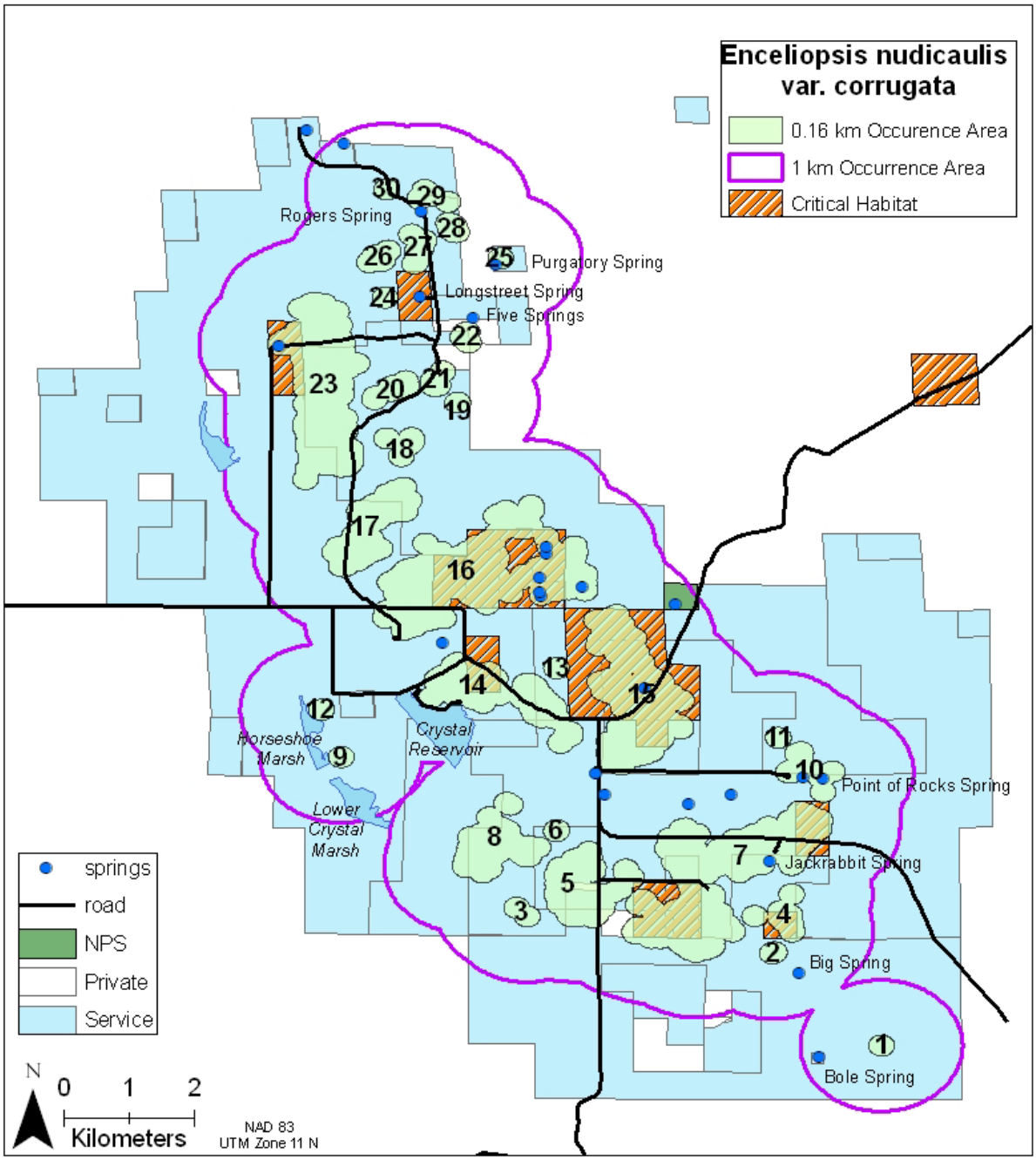

Figure 1. *Enceliopsis nudicaulis* var. *corrugata* distribution at Ash Meadows National Wildlife Refuge. *E. nudicaulis* var. *corrugata* distribution data is from BIO-WEST 2011. PLO No. 238 transferred the jurisdiction of BLM lands within the Refuge boundary to the Service for 20 years (until 2030) (BLM 2010a, p. 77658).

The California Native Plant Society (CNPS) reports that *Enceliopsis nudicaulis* var. *corrugata* may occur near Teakettle Junction in Inyo County, California (CNPS 2011, p.1). However, Personal communication documented from Bruce Pavlik (1996) notes that "identification of *E. nudicaulis* var. *corrugata* in California is doubtful because var. *nudicaulis* is scattered on limestone outcrops in the Last Chance Mountains near Teakettle junction, while the type locality of var. *corrugata* from Ash Meadows grows on spring deposits, not carbonate" (A. Sims, CNPS, pers. comm. 2011). There are no herbarium specimens of *E. nudicaulis* var. *corrugata* from California (A. Sims, pers. comm. 2011). In order to better assess the range of *E. nudicaulis* var. *corrugata*, potential locations in California would need to be surveyed, and specimens collected and compared to the Ash Meadows material. Based on the best available scientific information at this time, we determine that *E. nudicaulis* var. *corrugata* is endemic to the Ash Meadows area located in southeastern Nye County, Nevada. The range of the species is restricted to the Refuge and the BLM Ash Meadows ACEC. Private lands within the Refuge boundary likely have *E. nudicaulis* var. *corrugata*, but surveys have not been conducted in these areas.

Abundance

At the time of listing, a population estimate of *Enceliopsis nudicaulis* var. *corrugata* was not provided (Service 1985, 20777-20794). 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) distance) or 11 maximum scale occurrences (0.6 mi (1 km) distance) (Morefield 2001, p. 1). Results from the 2008-2010 Refuge wide survey (BIO-WEST 2011, p. 114) estimate that 79,508 individuals are present on the Refuge in 30 minimum scale occurrences (0.1 mi (0.16 km) distance) or 1 maximum scale occurrence (0.6 mi (1 km) distance) (Figure 1, Table 1). The largest occurrences of *E. nudicaulis* var. *corrugata* on the Refuge are at Jackrabbit Spring Road (occurrence 7), Collins Ranch (occurrence 15), Warm Springs (occurrence 16), and Cold Spring (occurrence 23) (Table 1). Abundance estimates of *E. nudicaulis* var. *corrugata* individuals on the BLM ACEC and private lands within the Refuge boundary do not exist.

Table 1. Known occurrences and estimates of individuals of *Enceliopsis nudicaulis* var. *corrugata* at the 0.16 km (0.1 mi) distance within the boundaries of Ash Meadows National Wildlife Refuge. Data from BIO-WEST 2011.

Occurrence ID	Site Name	Estimated number of individuals	% of total population
1	Bole Spring	14	0.018
2	Big Spring northwest	12	0.015
3	Spring Meadows Road south	16	0.020
4	Big Spring north	131	0.165
5	Spring Meadows Road	2697	3.392
6	Spring Meadows Road north	28	0.035
7	Jackrabbit Spring Road	13156	16.547
8	Spring Meadows Road northwest	2341	2.944
9	Lower Crystal Marsh	78	0.098
10	Point of Rocks Spring	1056	1.328
11	Point of Rocks Spring northwest	2	0.003
12	Horseshoe Marsh	7	0.009
13	Collins Ranch west	5	0.006
14	Crystal Reservoir	3994	5.023
15	Collins Ranch	14282	17.963
16	Warm Springs	12320	15.495
17	Longstreet Road south	2545	3.201
18	Longstreet Road east	70	0.088
19	Longstreet Road northeast	65	0.082
20	Cold Spring east	178	0.224
21	Longstreet Road north	55	0.069
22	Five Springs	68	0.086
23	Cold Spring	20054	25.223
24	Longstreet Spring west	12	0.015
25	Purgatory	5358	6.739
26	Longstreet Spring northwest	74	0.093
27	Rogers Spring southwest	311	0.391
28	Rogers Spring southeast	258	0.324
29	Rogers Spring northeast	276	0.347
30	Rogers Spring northwest	45	0.057

Habitat or Ecosystem

Enceliopsis nudicaulis var. *corrugata* occurs between 2,200 and 2,360 feet (ft) (671 and 719 meters (m)) above mean sea level and occurs across a broad range of Refuge habitats including occasionally moist alkaline soils, spring and seep areas, and dry desert washes (Morefield 2001, p. 1; BIO-WEST 2011, p. 113). *Enceliopsis nudicaulis* var. *corrugata* most often occupies intermittently flooded to upland mesic Alkali Shrub-Scrub habitat in alkali-clay soil and is occasionally a component of Salt Desert Scrub and Desert Pavement (embedded, tightly packed gravel) habitats (BIO-WEST 2011, p. 113). The specific hydrologic requirements for this species are being explored (see Species Biology and Life History) and surface and subsurface groundwater is probably an important habitat determinant for this species. Other plant species associated with *E. nudicaulis* var. *corrugata* include: *Arctomecon merriamii* Coville (desert bearpoppy), *Astragalus phoenix* Barneby (Ash Meadows milkvetch), *Atriplex confertifolia* (Torr. & Frém.) S. Watson (shadscale), *Cryptantha confertiflora* (Greene) Payson (basin yellow cryptantha), *Isocoma acradenia* (Greene) Greene var. *acradenia* (alkali goldenbush), and *Mentzelia leucophylla* Brandegee (Ash Meadows blazingstar) (Mozingo and Williams 1980, p. 21; Knight and Clemmer 1987, p. 56).

The primary elements of designated critical habitat consist of biological and physical attributes essential to the species' conservation within those areas. For *Enceliopsis nudicaulis* var. *corrugata*, primary elements described in the final listing rule include dry washes and whitish saline soil associated with outcrops of pale whitish limestone (Service 1985, p. 20788). The distribution and ecological requirements of *E. nudicaulis* var. *corrugata* were poorly understood (as described above under Species Biology and Life History) when the Service designated critical habitat; consequently some areas of designated critical habitat no longer provide suitable habitat for the species, while other areas not designated as critical habitat support large numbers of the species (Figure 1).

Changes in Taxonomic Classification or Nomenclature

The nomenclature or taxonomy of *Enceliopsis nudicaulis* var. *corrugata* has not changed since the species was first described in 1972 (Cronquist 1972, 246-247).

Genetics

Enceliopsis nudicaulis var. *corrugata* genetics remain unstudied.

Species-specific Research and Grant-supported Activities

The Service has implemented the below research and restoration projects for *Enceliopsis nudicaulis* var. *corrugata*.

Ash Meadows National Wildlife Refuge Invasive Species Control and Vegetation Management (SWEAT Inc.):

The Recovery Plan lists habitat alteration and exotic species as a major threat to the listed species. The Refuge began mapping and treating non-native plant invasions through a grant funded by the Southern Nevada Public Land Management Act (SNPLMA) in 2006. The amount, density, and locations of thirteen invasive plant species were mapped and treated with mechanical, chemical, or both prescriptions. Areas that were treated were re-vegetated with

native species (SWEAT Inc., presentation, Ash Meadows Symposium, 2008). Project status: Completed due to monies being exhausted, but additional treatments are needed.

Vegetation Community Mapping and Rare Plants Survey (BIO-WEST):
From 2007 to 2009, vegetation and rare plant studies were conducted to locate and map the distribution of rare and listed plants on the Refuge. In addition, vegetation communities were mapped and classified to the alliance and association scale (most specific levels of vegetation classification) throughout the entire Refuge. The information provided in the 2011 Vegetation Community Mapping and Rare Plants Survey Final Report, will assist with planning future habitat restoration activities (BIO-WEST 2011, pp. 1-207, plus appendices). Project Status: Completed.

Landtypes, Ash Meadows National Wildlife Refuge (White Horse Associates):
From 2007 to 2009, landtypes were mapped to better define the physical and hydrologic setting for biological studies of rare and endemic species, to help plan future restoration efforts, and to provide information on resources to better inform management decisions on the Refuge. The approach entailed two phases: (1) Stratify the Refuge into preliminary landtype classes distinguished by topographic, geomorphic, hydrologic, soil, and vegetative parameters and (2) Redefine and focus preliminary landtype classes towards the needs of other biological studies, restoration planning, and general management application (White Horse Associates 2010, pp. 1-541, plus appendices). Project Status: Completed.

Reproductive Biology of the Rare Plants Ash Meadows National Wildlife Refuge [Bruce Pavlik (BMP Ecosciences) and Kara Moore (U.C. Davis)]:
From 2008 to 2009, subpopulations of eleven rare plant taxa were mapped and marked on the Refuge. The three main goals for the project were: (1) Resolve demographically based patterns of phenology and reproductive output that will help to link rare plant biology to pollinator identification, activity, and habitat requirements; (2) Determine the breeding systems of rare plants from integrating parallel, demographically based studies of reproductive biology; and (3) Recommend general conservation and restoration prescriptions based on breeding systems and reproductive biology of rare plants on the Refuge (Pavlik and Moore 2010, pp. 1-146). Project Status: Complete.

Water and Soluble-Salts in Soils Relative to the Distribution of Endemic Plants at Ash Meadows National Wildlife Refuge, Nevada (USGS):
The objectives of this project are: (1) Describe the distribution and composition of soluble-salts and water in the unsaturated zone within areas with varied populations of endemic plants; (2) Interpret the plant distribution in context of geochemical and hydrologic processes known to be active in arid soils and sediments; and (3) Synthesize the findings to provide a generalized view of changes in the distribution of water and salt that might result from increasing aridity as a result of climate change, modification of hydrologic resources, and development of private in-holdings (Breit andMcKelvey 2010, pp. 1-7). Project Status: Data collection is complete; final report is in progress.

Inventory of Moisture and Salt Distribution in Soils and Sediments that Support Threatened and Endangered Plants in the Ash Meadows National Wildlife Refuge (USGS):

Auger holes and excavations will be used to inventory the vertical and lateral distribution of salts in soils and sediment at twenty sites known to contain protected plant species and at eight sites lacking those plants. Two sites will be instrumented with soil moisture sensors so that Refuge staff can monitor long-term change. Information from this project will help to identify suitable sites for expansion and restoration of threatened and endangered plants as well as provide baseline data on the full extent of impacts from water extraction within the Amargosa Desert Hydrographic Basin (Baldino 2011a, pp. 1-3). Project Status: On-going.

Five-Factor Analysis

The following five-factor analysis describes and evaluates the threats attributable to one or more of the five listing factors outlined in section 4(a)(1) of the Act. Due to threats to the entire Ash Meadows ecosystem, *Enceliopsis nudicaulis* var. *corrugata* was listed with six additional plants [*Astragalus phoenix; Centaurium namophilum* Reveal, Broome, & Beatley (spring-loving centaury); *Grindelia fraxino-pratensis* Reveal & Beatley (Ash Meadows gumplant); *Ivesia kingii* S. Watson var. *eremica* (Coville) Ertter (Ash Meadows ivesia); *Mentzelia leucophylla* and *Nitrophila mohavensis* Munz & Roos (Amargosa niterwort)] and one insect [Ash Meadows naucorid (*Ambrysus amargosus* La Rivers)]. The five factor analysis in the final rule applied to all of these species. As a result, it is difficult to separate specific threats to *E. nudicaulis* var. *corrugata* from threats to other Ash Meadows plants and the naucorid. We have broadened our analysis to include threats not specifically mentioned for *E. nudicaulis* var. *corrugata*, but which are also applicable to all of the Ash Meadows plants and one insect listed in 1985.

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

Enceliopsis nudicaulis var. *corrugata* faces four threats under listing Factor A (Service 1985, 50 FR 20777): groundwater withdrawal, road construction, off-highway vehicle (OHV) activity, and trampling by resident wild and free-roaming horses. Since listing, non-native plant species, wildfire, surface mining, and solar energy development have been identified as potential threats to *E. nudicaulis* var. *corrugata*.

<u>Groundwater withdrawal</u>
The Refuge encompasses over 23,000 ac (9,172 ha) of spring-fed wetlands and alkaline, desert uplands. More than 50 seeps and springs occur on the Refuge. The Refuge is a major discharge area within the Amargosa Desert (Hydrographic Basin 230) and the Death Valley Groundwater Flow System which stretches over more than 100 mi (160 km) from east to west and north to south. Most of the springs at the Refuge are created by discharge from the regional carbonate aquifer along the Ash Meadows fault system (Denny and Drewes 1965, pp. L1-L56). Other seeps and springs at the Refuge discharge from saturated valley-fill sediments which overlie and are supplied by the carbonate aquifer (Belcher 2004, pp. 1-408). The total annual discharge of Refuge seeps and springs is an estimated 17,000 acre-feet (ac-ft) (20,969,191 cubic meters (m^3)) a year (Walker and Eakin 1963, p. 21; Laczniak et al. 1999, pp. 1-70).

At the time of listing, groundwater withdrawal was a major threat to the entire Ash Meadows ecosystem. Local groundwater pumping at Ash Meadows (prior to the establishment of the

Refuge) was responsible for the destruction of many populations of plants and animals and their wetland habitats. *Enceliopsis nudicaulis* var. *corrugata* depends on near-surface water for its survival; therefore, it is reasonable to conclude that additional declines in groundwater levels in the Ash Meadows area (*e.g*., due to groundwater pumping) would negatively affect populations of this species. A number of measures have been implemented since the 1970's that, in part, have reduced the risk of groundwater level declines at the Refuge. The significance of the remaining threat posed by groundwater pumping will be evaluated below with respect to each of these measures.

Historical Groundwater Level Declines at Devils Hole and the Refuge

Devils Hole, a disjunct unit of Death Valley National Park, is an opening (collapsed depression) in the regional carbonate aquifer which supplies Refuge springs and is located within the boundaries of the Refuge. A gradual decline in water level occurred in Devils Hole from 1988 to 2004 (U.S. Geologic Survey (USGS) and U.S. Department of Energy (U.S. DOE) unpubl. data 2011). This decline followed an incomplete recovery from the effects of irrigation pumping in the Ash Meadows area in the late 1960's to 1970's (prior to the establishment of the Refuge). In 1973, a U.S. District Court granted a preliminary injunction on pumping that would lower the level of water in Devils Hole below a specified elevation. The injunction was made permanent in 1978 and ultimately lead to *Cappaert v. United States* [426 U.S. 128 1976] and the establishment of the U.S. Supreme Court mandated water level threshold in Devils Hole with the goal of protecting the endangered Devils Hole pupfish (*Cyprinodon diabolis*).

Bedinger and Harrill (2006, pp. 827-839) used multiple regression analyses to investigate water level changes in Devils Hole from 1963 to 2002 and concluded that the declines, including that observed from 1988 to 2002, were due to pumping rather than climatic factors. Specifically, Bedinger and Harrill (2006, pp. 827-839) suggest that historical declines in Devils Hole were primarily due to pumping that occurred in the Ash Meadows area from 1969 to 1977 (consistent with the findings of the U.S. District Court), secondarily due to pumping in the Amargosa Farms area (10 to 20 miles northwest of Devils Hole) beginning in the 1950's, and thirdly due to pumping at Army 1 WW (18 miles to the northeast of Devils Hole), a DOE water supply well on the southern end of the Nevada Test Site (USGS site 363530116021401) beginning in the 1960's. Both pumping areas are located in the same basin as the Refuge and Devils Hole (Hydrographic Basin 230).

A corresponding decline occurred at the Refuge from the late 1980's to 2004 (USGS and U.S. DOE unpubl. data 2011). While discharge records for springs at the Refuge (*e.g*., Fairbanks Spring and Big Spring) are noisy, (likely due to operational changes which include spring restoration activities) water level declines in monitoring wells at the Refuge are consistent with those observed in Devils Hole. In particular, water level declines in monitoring well AM-5 (Devils Hole Well), completely in valley-fill sediments overlying the carbonate aquifer, are analogous to that observed in Devils Hole from 1988 to 2004. Water levels in AM-3 (Five Springs Well), the only monitoring well at the Refuge completely in the carbonate aquifer (the source of the Refuge springs), exhibited similar declines.

Additionally, groundwater level declines have been recorded in wells located between the Refuge (and Devils Hole) and pumping centers at Amargosa Farms and Army 1 WW over the same period (the late 1980's to 2004), with the largest declines and rates of decline occurring in proximity to the pumping centers. Whereas no comprehensive analysis of these trends has been performed to date, the distribution of groundwater level declines within the Amargosa Desert is consistent with the conclusions of Bedinger and Harrill (2006, pp. 827-839): drawdown at Devils Hole (and by extension the Refuge), from 1988 to 2002, was due to pumping in the Amargosa Farms area and, to a lesser extent, pumping at Army 1 WW. As of 2005, a rise in water levels has occurred at Devils Hole and the Refuge, in response to a recharge pulse working its way through the Death Valley Regional Groundwater Flow System (a large and complex flow system) following anomalously wet conditions in late 2004/2005. However, the downward trend in groundwater levels which was suspended in 2004 could be expected to resume once this recharge pulse passes, although at a lesser rate due to the cessation of pumping at Army 1 WW in late 2005.

Implementation of Protection Measures to Listed Plant Species

Given the proximity of Devils Hole to the Refuge and their mutual source of water (the regional carbonate aquifer), the establishment of the U.S. Supreme Court mandated water level threshold in Devils Hole also created an important level of protection for groundwater levels and spring discharge at the Refuge which the listed plant species, including *Enceliopsis nudicaulis* var. *corrugata*, are dependent upon.

Additionally, the Nevada State Engineer, Nevada Department of Water Resources implemented several measures to protect water levels at Devils Hole and the Ash Meadows area. In 1979, the Nevada State Engineer 'designated' the Amargosa Desert Hydrographic Basin, declaring preferred uses for groundwater within the basin and effectively limiting the nature of any groundwater rights issued after that time. As of 2007, the State Engineer ruled that no water was available for appropriation in the basin (Ruling 5750), *i.e.*, the basin was fully appropriated (State of Nevada 2007, p. 22). In November 2008, the State Engineer issued Order 1197 which established a subarea that would limit the issuance of new groundwater rights in the basin and the movement of groundwater rights closer to Devils Hole through the change application process (State of Nevada 2008a, p. 1). Specifically, Order 1197 stipulated that any application for new groundwater rights in the Amargosa Desert Hydrographic Basin would be denied and that applications to change the point of diversion of an existing groundwater right closer to Devils Hole within the basin and a 25-mile radius of Devils Hole also would be denied, with several exceptions: 1) changes in points of diversion of less than 0.5 mi (0.8 km) would be allowed if the place of use is unchanged; 2) applications seeking 2.0 ac-ft (2,467 m^3) per year or less would be considered; and 3) applications requesting changes to multiple existing groundwater rights would be considered if the net impact of the proposed changes was the same or less than the existing rights and would not result in a point of diversion being moved within ten miles of Devils Hole. These exceptions could have a cumulative negative effect on groundwater levels at the Refuge and affect the groundwater and soil conditions (see Species Biology and Life History) needed for the persistence and establishment of listed plant species. Moreover, the method that the State Engineer would use to assess the net impact of multiple change applications has not been determined. Most important, Order 1197 was stayed in

December 2008, one month later, by the Fifth Judicial District Court of Nevada. The fate of Order 1197 remains uncertain today (State of Nevada 2008b, pp. 1-3 and Exhibit A; State of Nevada 2008c, pp.1-2).

Finally, the Service acquired surface water rights for approximately 17,000 ac-ft (20,969,191 m^3) of annual spring discharge at the Refuge (Mayer 2006, p.2). These rights serve as a basis for protesting junior applications in the Amargosa Desert Hydrographic Basin, including change applications, and therefore offer some level of protection to the listed plant species, including *Enceliopsis nudicaulis* var. *corrugata*.

Future Risk to Groundwater Levels

Since the lag time between pumping in the Amargosa Farms area and the Refuge (and Devils Hole) is likely in excess of 50 years (but otherwise unknown), the effects of more recent pumping in the Amargosa Farms area has not manifested at the Refuge. Specifically, groundwater rights in the Amargosa Farms area increased substantially beginning 50 to 60 years ago (in the 1950's, again in the late 1970's, and again from approximately 1989 to 1998) from less than 1,000 ac-ft (1,233,482 m^3) per year to more than 21,000 ac-ft (25,903,119 m^3) per year. As such, the full effects of historical increases in pumping in the Amargosa Farms area may not be evident at the Refuge today, but may become evident over the coming decades. Consequently, measures taken by the State Engineer to prohibit the issuance of additional groundwater rights in the Amargosa Desert Hydrographic Basin and limit the effects of change applications beginning in 2007 are important, but cannot mitigate the effects of groundwater rights which are already issued in the Basin, including the propagation of drawdown from the Amargosa Farms area to the Refuge (and Devils Hole) over a period of decades. Also, a lag time on the order of decades, described by Bredehoeft (2009) as the 'time to full capture problem', means that if (or when) the U.S. Supreme Court mandated water level threshold is reached in Devils Hole and pumping is restricted within the basin, any relief that occurs as a result of reduced pumping also will take decades to arrive at the Refuge and Devils Hole, while during that time additional declines in groundwater levels and spring discharge will continue to occur. Due to all of these considerations, we determine that a threat to groundwater levels and groundwater-dependent ecosystems, including the habitat of *Enceliopsis nudicaulis* var. *corrugata*, in the Ash Meadows area remains.

<u>Road Construction</u>

At the time of listing, *Enceliopsis nudicaulis* var. *corrugata* population numbers had been reduced by the loss of habitat from road construction. Since listing, the Service has ceased road construction and maintains only defined Refuge roads that allow for administrative, visitor, and private landowner access. Truckers often use Refuge roads to avoid the need to obtain permits required to transport loads through California (Service and DOT 2011, p. 27). A transportation study is being completed by the Refuge to identify transportation improvements and management strategies, improve safety, reduce operations and maintenance costs, ensure accessibility, and address traffic circulation needs (Service and Department of Transportation (DOT) 2011, pp. 1-98). Due to ceased road construction and initiation of a transportation study, road construction is no longer a threat to *Enceliopsis nudicaulis* var. *corrugata*.

Off-Highway Vehicle (OHV) Activity

Prior to listing, OHV activity was a threat to *Enceliopsis nudicaulis* var. *corrugata*. OHV races were permitted on BLM land in the Ash Meadows area. Since listing, OHV activity is prohibited on the Refuge and has been limited by the construction of fencing around the perimeter of the Refuge in 1995 (Service 2006, pp. 9, 103). Periodically, illegal OHV activity, likely due to downed sections of fencing and fence cutting, occurs on the Refuge (Baldino, pers. comm. 2010). Within the BLM ACEC, OHV activity is confined to existing roads, trails, and dry washes (BLM 1998a, Chapter 2 p. 2-32; Map 2-10). Signs and fences are not present to designate the BLM ACEC from the other bordering BLM land, making it unclear to the public that the BLM land surrounding the Refuge has a special ACEC designation (Baldino, pers. comm. 2010). Due to the periodic illegal OHV activity on the Refuge and undefined ACEC designation, OHV activity is still a threat to *Enceliopsis nudicaulis* var. *corrugata*.

Trampling by Resident Wild and Free-Roaming Horses

The final listing rule described trampling by wild and free-roaming horses as a threat to *Enceliopsis nudicaulis* var. *corrugata*. Since then, in 1995, a fence was constructed around the perimeter of the Refuge (Service 2006, pp. 9, 103). As a result, wild horse activity on the Refuge was stopped. In 1998, the BLM established the Ash Meadows ACEC that surrounds the Refuge and established the appropriate management level (AML) for wild horses as zero (BLM 1998b, p. 7 Table 2-5). Fences are not present to keep horses out of the designated ACEC and they have been seen infrequently near the area (Baldino, pers. comm., 2011). Thus, inspection and maintenance of the exclusionary fence on the Refuge is necessary to prevent re-invasion (Service 2006, p. 99). Due to these positive management practices, trampling by wild and free-roaming horses is no longer a threat to *E. nudicaulis* var. *corrugata* on the Refuge, but occasionally may be a threat to *E. nudicaulis* var. *corrugata* within the BLM ACEC.

Non-Native Plant Species

Since listing, non-native plants species have been identified as a threat to *Enceliopsis nudicaulis* var. *corrugata*. An estimated 42 percent of all species listed under the Act are considered to be at risk primarily due to non-native species (Pimental *et al*. 2005, p.1). Non-native plants directly compete with native plants for water, nutrients, and sunlight and indirectly by altering ecosystem processes such as hydrology, productivity, nutrient cycling, and fire regime (D'Antonio and Vitousek 1992, pp.63-87; Levine et al. 2003, pp. 775-781; Brooks et al. 2004, pp.677-688). Approximately 100 non-native species occur on the Refuge; 66 of them non-native plant species (Service, 2006, p. 7, pp. 52-53). Of these *Tamarix ramosissima* Ledeb. (saltcedar), *Acroptilon repens* (L.) DC. (Russian knapweed), *Bassia hyssopifolia* (Pall.) Kuntz (fivehorn smotherweed), *Centaurea melitensis* L. (Malta starthistle), and *Bromus rubens* L. (red brome) could potentially threaten *E. nudicaulis* var. *corrugata*.

The amount of *Enceliopsis nudicaulis* var. *corrugata* habitat threatened by non-native plant species was determined by overlaying Geographic Information System (GIS) weed mapping with occupied *E. nudicaulis* var. *corrugata* habitat. Non-native plant species threaten all mapped populations to differing degrees. Occurrences (1-12 and 24 to 30 on Figure 1) in the northern and southern part of the Refuge are most threatened by *Tamarix ramosissima* and *Bassia hyssopifolia*, whereas occurrences in the middle part of the Refuge (13-23 on Figure 1) are most threatened by *Bromus rubens*. Non-native plant species have not been mapped at Purgatory

Spring and within the BLM ACEC; therefore, the threat from non-native plant species to *E. nudicaulis* var. *corrugata* at these locations is unknown.

The Service is addressing the threat posed by non-native plant species through completion of two documents: the Integrated Pest Management Plan (IPM) (Service 2006, pp. 1-152) and the Geomorphic and Biological Assessment for the Refuge (Otis Bay 2006, pp. 1-247). The IPM is the Refuge's long-term approach for managing all invasive species on the Refuge and includes mapping, monitoring, and restoration planning. The Geomorphic and Biological Assessment describes targets for hydrologic and biologic functioning and provides a framework for restoring and managing the abandoned agricultural infrastructure that support weed populations. In addition, the Refuge began mapping and treating non-native plant invasions through a grant funded by the Southern Nevada Public Land Management Act (SNPLMA) in 2006. Invasive species were mapped and documented on 10,000 ac (4,047 ha) of the Refuge. In 2007, the Refuge was successful in removing *T. ramosissima*, *Elaeagnus angustifolia* L., (Russian olive), and *Tamarix aphylla* (L.) Karst. (athel) on 75 percent of the Refuge and treating 2,500 ac (1,012 ha) of broadleaf species (SWEAT Inc., presentation, Ash Meadows Symposium, 2008).

Substantial progress in combating non-native plant species has been achieved on the Refuge, but grant funding for these treatments has been exhausted. Successful control of non-native plant species is a continuous process, and without funding for treatment, they will likely re-invade. Even though *Enceliopsis nudicaulis* var. *corrugata* is not immediately threatened, non-native plant species have the opportunity to invade and re-establish. Thus, we conclude that non-native plant species are a threat to *E. nudicaulis* var. *corrugata*.

Wildfire

Since listing, nine wildfires have burned on the Refuge (Sunderman and Weisburg 2011, p. 3). The three largest wildfires (Fairbank fire in 2000 which was 744 ac (301 ha); Longstreet fire in 2004 which was 1,401 ac (567 ha); and Meadows fire in 2005 which was 267 ac (108 ha) were all partially in *Enceliopsis nudicaulis* var. *corrugata* habitat and burned prior to initiation of weed treatments in non-native plant species patches of *Tamarix ramosissima.* Treatment of the remaining *T. ramosissima* under SNPLMA funding (discussed above under Factor A, non-native plant species) may have suppressed the opportunity for large wildfires on the Refuge. Since treatments, the only wildfire on the Refuge was in 2008 and it only burned 37.3 ac (15.1 ha) (Big Spring fire) (Sunderman and Weisburg 2011, p. 3).

Under climate change scenarios (see Factor E), increased atmospheric carbon dioxide and altered precipitation events are predicted to increase invasion risk by non-native plant species (Hawkins et al. 2008, p. 37; Bradley *et al*. 2010, pp. 310-318). Non-native plant species alter ecosystem dynamics such as fire regimes. For example, on the Refuge, *Bromus rubens* is an annual, non-native grass, that could increase its dominance on the landscape under climate change predictions. In turn, this would increase the density of fine fuels and create an environment more susceptible to fire (Chambers and Pellant 2008, p. 31).

With the exhaustion of SNPLMA funding for non-native plant species treatments and opportunity for them to re-invade, wildfire frequency may increase through alteration of the fire regime. In addition, non-native plant species such as *Bromus rubens* could invade sparsely

vegetated *Enceliopsis nudicaulis* var. *corrugata* habitat, thus providing a vector to carry fire into a habitat that may have less tendency to burn. The threat of wildfire is not easily accessed and is dependent on many other factors, thus we conclude that it is a potential threat to *E. nudicaulis* var. *corrugata*.

Surface Mining

The Refuge is located in the Ash Meadows mining district (Tingley 1998, p. 20), which has the largest clay production of any district in Nevada (BLM 1998a, p. 3-75). At the time of listing, surface mining was identified as a threat to two other listed plant species, *Grindelia fraxino-pratensis* and *Astragalus phoenix*. Surface mining also poses a threat to *Enceliopsis nudicaulis* var. *corrugata* which co-occurs in many places with *A. phoenix*. Currently, only mining for clay minerals occurs in the Ash Meadows area. The playa sediments covering much of the Refuge contain clays and other minerals that could be classified as locatable minerals under the Mining Law of 1872, as amended (BLM and Service 2000, p. 3-1). Under the Mining Act of 1872, surface disturbance and impacts to rare species that do not have Federal protection are permissible as long as operations comply with all pertinent Federal and State laws. New mineral claims and mining could cause direct loss of *E. nudicaulis* var. *corrugata* habitat as well as indirect impacts due to diverting or draining water from occupied habitat.

Establishment of the BLM ACEC in 1998 diminished some of the potential threat posed by surface mining. On November 2, 2009, BLM issued PLO No. 7737 withdrawing the Ash Meadows ACEC from the mineral mining and entry for 20 years (BLM 2009, pp. 56657-56661). In addition, on December 13, 2010, the BLM issued PLO No. 238 withdrawing approximately 9,460 ac (3,828 ha) of BLM land within the Refuge boundary and about 5,570 ac (2,254 ha) of Service land from mineral mining and entry for 20 years, until 2030 (BLM 2010a, p. 77658). This PLO also transferred the jurisdiction of BLM lands within the Refuge boundary to the Service.

The mineral withdrawals do not supersede valid existing mineral rights and do not prevent road access and the means to mine existing claims. Existing mineral claims for specialty clay exist both within and outside of the Refuge and BLM ACEC (BLM and Service 2000, p. A-11). An existing claim in Section 26, T17S R50E, is north of the Warm Springs *Enceliopsis nudicaulis* var. *corrugata* occurrence (occurrence 16; Figure 1) within the Refuge boundary and there is high probability that mining will continue on private and lease lands near the Refuge (Wallace 1999, p.12).

We conclude that new mineral mining and entry is not a threat to *Enceliopsis nudicaulis* var. *corrugata* until 2029 on the BLM ACEC and 2030 within the Refuge due to the publishing of PLO No. 7737 and 238. The threat posed by existing mineral claims is difficult to assess because there is not available information on when or if these lands will be actively mined. Within Refuge boundaries, there could potentially be adverse effects for the Warm Springs occurrence of *Enceliopsis nudicaulis* var. *corrugata* (occurrence 16, Figure 1) that is south of an existing claim, due to alterations in the local groundwater table from mining activities at this location.

Solar Development

Since listing, solar development has been identified as a threat to *Enceliopsis nudicaulis* var. *corrugata*, specifically due to impacts from groundwater withdrawal. The Amargosa Valley has been selected as a Solar Energy Zone (SEZ) to be evaluated for its environmental and resource sustainability for larger-scale solar energy production (Department of Interior (DOI), 2009, p. 1). The Refuge is located about 20 mi (32 km) southeast of the SEZ (DOE/EIS 2010, pp. 11.1-21). The SEZ is a proposed area of 31,625 acres (12,798 ha) and maximum solar development of this area is assumed to be 80 percent over a period of 20 years on 25,300 ac (10,239 ha) (DOE/EIS 2010, pp. 11.1-1 to 11.1-3).

In November 2010, the BLM approved the construction of the first solar project in the SEZ: Solar Millennium, LCC on Amargosa Farm Road. This project is on 6,320 ac (2,558 ha) of land and will use dry-cooled technology. Total annual operational water usage is 400 ac-ft (493,393 m^3) per year, but will require 600 ac-ft (740,089 m^3) a year during construction (BLM 2010b, p.4; Service 2010a, p. 4). To accommodate their water needs, Solar Millennium is leasing water from the current water rights holder, GENEERCO Incorporated (Permit 15893, Certificate 5717), for the construction phase and power plant operations during the anticipated 30-year life of the project (BLM 2010c, Appendix A p. 5). Two water right applications, Applications 79699 and 79783, have been filed and approved by the Nevada Division of Water Resources (NDWR), Nevada State Engineers Office, for this purpose (State of Nevada 2010, pp. 1-10).

Application 79699 is an application for a change in the manner of use and place of use of 400 afy under existing Permit 15893 (Certificate 5717). Application 79783 is an application for a new point of diversion (new well), with a duty not to exceed 400 afy in combination with Application 79699, which will be located several hundred feet west-southwest of the well associated with Permit 15893. Application 79783 states that groundwater under Application 79783 will be used as the primary source of supply for the two solar power plants, while groundwater under Application 79699 will be used as a back-up (supplemental) source of water for project operations. These two applications change the point of diversion, manner of use and place of use of groundwater previously used for irrigation purposes to solar power generation (an industrial use).

Changing the use of 400 ac-ft (493,393 m^3) per year of water from irrigation to industrial use for this solar project and the solar projects that will follow is likely to have an impact on the groundwater supply. Agricultural water use allows some water to percolate back into the groundwater system (return flow). Water used for industrial utility-scale solar energy production likely will evaporate and not recharge to the aquifer. Additionally, no significant return flow is anticipated from solar mirror washing operations or other water uses given the average low humidity and high temperatures in the Mojave Desert.

As described above (under Factor A, groundwater withdrawal), the Amargosa Desert Hydrographic Basin has a complicated connectivity, but fluctuations in water level has been proven to be directly tied to groundwater pumping in the basin (Bedinger and Harrill 2006, pp. 827-839). Small declines in spring discharge, changes in water temperature, and adjustments in soil or water chemistry resulting from solar projects groundwater withdrawals in the basin would negatively affect *Enceliopsis nudicaulis* var. *corrugata.* Thus, we conclude that solar

development and its close ties to groundwater withdrawal is a threat to *Enceliopsis nudicaulis* var. *corrugata.*

Summary of Factor A

In summary, groundwater withdrawal continues to be the biggest threat to *Enceliopsis nudicaulis* var. *corrugata*, especially when coupled with solar development in the Amargosa Valley. The establishment of the U.S. Supreme Court water level threshold in Devils Hole (given its proximity to the Refuge and mutual water source) created an important level of protection for groundwater levels and spring discharge at the Refuge. Measures implemented by the Nevada State Engineer and water right acquisition by the Refuge have reduced the threat of groundwater pumping, but have not eliminated it. In addition, the Amargosa Valley has been selected as a SEZ which when developed, would change the use of water in the valley from irrigation to industrial use. Agricultural water use allows some water to percolate back into the groundwater system (return flow). Water used for industrial utility-scale solar energy production likely will evaporate and not recharge to the aquifer. Small declines in spring discharge, changes in water temperature, and adjustments in soil or water chemistry resulting from groundwater withdrawls would negatively affect *E. nudicaulis* var. *corrugata*.

OHV activity and non-native plant species also are threats to *E. nudicaulis* var. *corrugata*. Periodic illegal OHV activity still occurs on the Refuge. Signs and fences are not present to designate the BLM ACEC from the other bordering BLM land, making it unclear to the public that the BLM land surrounding the Refuge has a special ACEC designation. Substantial progress in combating non-native plant species has been achieved on the Refuge, but grant funding for these treatments has been exhausted. Successful control of non-native plant species is a continuous process, and without funding for treatment, they will likely re-invade. In turn, wildfire frequency may increase with the un-treated abundance of non-native plant species, thus making it a potential threat to *E. nudicaulis* var. *corrugata*.

New mining and entry is currently not a threat, but could potentially become one in the future. Publication of PLO No. 7737 and 238 removes this threat until 2029 in the BLM ACEC and 2030 within the Refuge boundaries. Road construction is no longer a threat to *E. nudicaulis* var. *corrugata* because road construction has ceased and a transportation study has been initiated by the Refuge. Wild and free-roaming horses are not a threat to *E. nudicaulis* var. *corrugata* within Refuge boundaries, but occasionally are a threat to *E. nudicaulis* var. *corrugata* within the BLM ACEC. A fence was constructed around the perimeter of the Refuge in 1995 to exclude horses. The AML for wild horses is zero within the BLM ACEC, but fencing does not exist so horses infrequently are present in the area.

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

Overutilization for commercial, recreational, scientific, or educational purposes was not considered a threat to *Enceliopsis nudicaulis* var. *corrugata* at the time of listing. Currently, it is not considered a threat.

FACTOR C: Disease or Predation

At the time of listing, disease and predation were not identified as threats to *Enceliopsis nudicaulis* var. *corrugata.* During the 2008 and 2009 phenology, breeding system, and seed biology studies, Pavlik and Moore (2010, pp. 38, 52) noted that both jackrabbit (*Lepus californicus*) and insect herbivory had a dramatic effect on *E. nudicaulis* var. *corrugata*. 6.7 percent of marked *E. nudicaulis* var. *corrugata* plants in 2008 and 51.7 percent of marked *E. nudicaulis* var. *corrugata* plants in 2009 had inflorescences removed by jackrabbits, as evidenced by droppings around affected plants (Pavlik and Moore 2010, p. 52). In addition, insect achene predators severely damaged 91.7 percent of infructescences in 2008 and 78.3 percent of infructescences in 2009 (Pavlik and Moore 2010, p. 52).

Though this is the first report of jackrabbit herbivory affecting *Enceliopsis nudicaulis* var. *corrugata*, negative impacts of jackrabbit herbiovory on *Astragalus phoenix*, another Refuge threatened plant species, have been observed and documented (Pavlik and Stanton 2008, pp. 1-38). Exclusion studies were conducted by Pavlik and Stanton (2008, pp. 4-5) using cages to remove jackrabbit herbivory pressure on individual *A. phoenix* plants. In the spring of 2008, one year after installation of the cages, the caged *A. phoenix* plants exhibited lateral canopy expansion two to ten times greater than that of the uncaged *A. phoenix* plants (Pavlik and Stanton 2008, p. 6). The total number of flowers on caged *A. phoenix* plants in 2008 was five times greater than that on uncaged plants; as the uncaged plants continued to produce flowers until early May, lagomorphs continuously removed them (Pavlik and Stanton 2008, p. 7). By May 2008, caged *A. phoenix* plants had produced nine times more fully-formed fruits than uncaged plants, which were almost completely devoid of fruits (Pavlik and Stanton 2008, p. 8). Overall, uncaged *A. phoenix* plants produced 95 to 99 percent fewer mature fruits than caged ones during 2007 and 2008 (Pavlik and Stanton 2008, p. 8).

Although jackrabbit population levels and cycles at Ash Meadows have not been documented, rabbit populations in arid environments tend to be cyclic and coupled to rainfall and abundance of forage (Wood 1980, pp. 72-77). In the western U.S., jackrabbit populations fluctuate sharply, oscillating from low to high densities in seven to ten year periods (Gross *et al.* 1974, pp. 57-64). Overgrazing because of high rabbit populations is common during high rainfall years, such as 2004/2005, and is a major reason for subsequent rabbit population crashes (Wood 1980, p 77). During periods of drought, overgrazing on concentrated areas can increase the carrying capacity of jackrabbits and cause a population increase (Bronson and Tiemeier 1959, pp. 197-198). During the 2008 and 2009 observations of herbivory on *Enceliopsis nudicaulis* var. *corrugata*, precipitation was below average for the Refuge (Western Regional Climate Center (WRCC) 2011). Previous studies on *Astragalus phoenix* have shown an 80 to 95 percent reduction in seed output in six of the last twelve years, thus suggesting that the impacts of jackrabbit herbivory on Ash Meadows' threatened plant species may be more chronic than cyclical (Pavlik and Stanton 2008, p. 11; Pavlik and Moore 2010, p. 68). In a habitat similar to the Refuge at Jackass Flat on the Nevada Test Site, jackrabbits have been documented congregating around water sources during the winter months, then dispersing in the spring and summer (Hayden 1966, pp. 835-838).

In addition to jackrabbit herbivory, insect predators were observed damaging achenes during the 2008 and 2009 study. This is the first documentation of insect achene predation on any of the Ash Meadows plant species; therefore the effect of predation on recruitment has not been

studied. Studies have suggested that pre-dispersal seed predation has a negative effect on plant seedling recruitment (Louda 1982, pp. 43-53; Anderson 1988, pp. 337-340; Louda 1990, pp. 105-113). For example, Louda (1990, p. 110) found that early feeding of insects reduced the release of viable seed of *Cirsium canescens* Nutt. (prairie thistle) by threefold, the establishment of seedling sixfold, and a six to thirty-seven fold reduction in the number of new adults.

As discussed under Species Biology and Life History above, population monitoring has not been conducted for *Enceliopsis nudicaulis* var. *corrugata*. 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. Herbivory and predation on *E. nudicaulis* var. *corrugata* should be considered a threat to this species. Exclusion experiments need to be conducted to determine the degree of the threat from herbivory and predation, which is dependent on how frequently it occurs during the growing season, the frequency and intensity in which it occurs among all *E. nudicaulis* var. *corrugata* occurrences, and how it interferes with seed bank recharge.

FACTOR D: Inadequacy of Existing Regulatory Mechanisms

The final listing rule (Service 1985, pp. 2077-20794) indicated that existing regulatory mechanisms were inadequate to protect *Enceliopsis nudicaulis* var. *corrugata.* Since listing, several State and Federal laws and regulations have been implemented that offer differing degrees of protection to *E. nudicaulis* var. *corrugata*. These laws and regulations are discussed below.

Federal Protections

Endangered Species Act of 1973, as amended (Act)

The Act is the primary Federal law providing protection for *Enceliopsis nudicaulis* var. *corrugata*. The Service's responsibilities include administering the Act, including sections 7, 9, and 10 that address take. Since listing, the Service has analyzed the potential effects of Federal projects under section 7(a)(2), which requires Federal agencies to consult with the Service prior to authorizing, funding, or carrying out activities that may affect listed species. A jeopardy determination is made for a project that is reasonably expected, either directly or indirectly, to appreciably reduce the likelihood of both the survival and recovery of a listed species in the wild by reducing its reproduction, numbers, or distribution (50 CFR 402.02). A non-jeopardy opinion may include reasonable and prudent measures that minimize the amount or extent of incidental take of listed species associated with a project.

With regard to federally listed plant species, section 7(a)(2) requires Federal agencies to consult with the Service to ensure any project they fund, authorize, or carry out does not jeopardize a listed plant species. Section 9 of the Act and Federal regulations pursuant to section 4(d) of the Act prohibit the "take" of federally endangered wildlife; however, the take prohibition does not apply to plants. Instead, plants are protected from harm in two particular circumstances. Section 9 prohibits (1) the removal and reduction to possession (i.e., collection) of endangered plants from lands under Federal jurisdiction, and (2) the removal, cutting, digging, damage, or destruction of endangered plants on any other area in knowing violation of a state law or

regulation or in the course of any violation of a state criminal trespass law. Federally listed plants may be incidentally protected if they co-occur with federally listed wildlife species.

National Environmental Policy Act (NEPA)

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

Federal Land Policy and Management Act of 1976 (FLPMA)

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

In 1998, the BLM established the 27,870 ac (11,279 ha) Ash Meadows Area of Critical Environmental Concern (ACEC), which encompasses the Refuge. It was designated as a special wildlife and riparian ACEC which is guided by the BLM Las Vegas District's Resource Management Plan (RMP) (BLM 1998b, pp. 1-52). Management directions for the BLM ACEC include closing the land to livestock grazing and establishing the appropriate management level for wild horses as zero; limiting vehicles and OHVs to existing roads, trails, and dry washes; closing the area to locatable, salable, and solid leasable minerals; and closing the area to geothermal prospecting and leasing (BLM 1998b, p. 7 Table 2-5). However, as mentioned under Factor A OHV activity, signs and fences are not present to designate the BLM ACEC from the other bordering BLM land, thus making it unclear to the public that the BLM land surrounding the Refuge has special designation (Baldino, pers. comm. 2010).

In addition, the Ash Meadows ACEC has been designated a rights-of-way avoidance area except within designated utility corridors. A utility corridor was designated in the ACEC on the western and southern borders of the Refuge in the 1998 RMP. Corridors range from 1,000 to 3,000 feet (ft) (305 to 914 meters (m)) in width (BLM 1998a, p. 4-26) and if built, would cross the Carson Slough, a major wetland and plant habitat of the Ash Meadows area (Service 2010b, pp. 1-3). The 1998 BLM Las Vegas District's RMP is in the process of being amended.

National Wildlife Refuge System Improvement Act of 1997

This act establishes the protection of biodiversity as the primary purpose of the National Wildlife Refuge system. This has lead to various management actions to benefit the federally listed species. According to the Service's 1984 Land Protection Plan: Proposed Acquisition to Establish Ash Meadows National Wildlife Refuge (pp. 1-39), the purpose of the Refuge is to "protect a unique desert oasis ecosystem that provides habitat for the greatest local concentration of endemic plants and animals found anywhere within the United States." Continued protection and management of *Enceliopsis nudicaulis* var. *corrugata* is central to the Refuge mission and will continue independent of protection under the Act.

Mining Law of 1872

Mineral entry is authorized by the Mining Law of 1872 (Mining Law), as amended (17 Stat. 91; 30 U.S.C. 22-54). The Mining Law and its amendments govern the exploration for and extraction of locatable minerals by claimants on public land. The Mining Law guides the Mining Law Administration program managed by the BLM which primarily involves the recordation of mining claims and sites, maintenance (annual work-surface management) of mining claims and sites, and mineral patents (43 CFR 3812). Federal mineral estate falls into one of three categories: locatable, leasable, and salable minerals. Preparing a list of locatable minerals is difficult because the history of the law has resulted in a definition of minerals that includes economics. Any mineral may become locatable if it meets the definition of "valuable mineral deposit" under the Mining Law and the definition of "locatable mineral" (43 CFR 3812.1).

Establishment of the BLM ACEC in 1998 diminished some of the potential threat posed by surface mining. The Clark County Public Land and Natural Resource Act of 2002 (Public Law 107-282, November 6, 2002) included a mineral withdrawal of all ACECs identified in the BLM Las Vegas Field Office 1998 RMP for a five-year period. A subsequent two-year extension of this temporary segregation was published on November 1, 2007, that included the Ash Meadows ACEC (BLM 2007, pp. 61898-61903). On November 2, 2009, BLM issued PLO No. 7737 withdrawing the Ash Meadows ACEC from the mineral mining and entry for 20 years (BLM 2009, pp. 56657-56661). In addition, on December 13, 2010, the BLM issued PLO No. 238 withdrawing approximately 9,460 ac (3,828 ha) of BLM land within the Refuge boundary and about 5,570 ac (2,254 ha) of Service land from mineral mining and entry for 20 years, until 2030 (BLM 2010a, p. 77658).

As mentioned above under Factor A surface mining, the mineral withdrawals do not supersede valid existing mineral rights and do not prevent road access and the means to mine existing claims. Existing mineral claims for specialty clay exist both within and outside of the Refuge and BLM ACEC (BLM and Service 2000, p. A-11). An existing claim in Section 26, T17S R50E, is north of the Warm Springs area (occurrence 16, Figure 1) within the Refuge boundary

and there is high probability that mining will continue on private and lease lands near the Refuge (Wallace 1999, p.12).

State Protections in Nevada

Nevada Division of Forestry (NDF)

Enceliopsis nudicaulis var. *corrugata* has been declared by the NDF to be threatened with extinction pursuant to Nevada Revised Statutes (N.R.S.) 527.260-.300, and was added to the state list of fully protected species of native flora (Nevada Administrative Code 527.010) in 1987. Removing or destroying plants on the State's fully protected list is prohibited except under special permit issued by NDF (N.R.S. 527.270). The adequacy of this law, however, depends on informed and cooperative land managers, or in some form of deterrent enforcement, for either of which the current law does not provide. It also depends on the State Forester Firewarden's discretion in issuing or withholding permits, and it placing protective conditions on permits that are issued. Nevada law does not mandate the continued survival of any plant species which it declares to be in danger of extinction.

Nevada Division of Water Resources

As mentioned above in Factor A groundwater withdrawal, in 2007 the Nevada State Engineer issued Ruling 5750 denying numerous water rights applications in the Amargosa Valley (located about 10 mi (16 km) northwest of the Refuge), based on the finding that the groundwater basin is over-appropriated (State of Nevada 2007, p. 22). In addition, in 2008, the Nevada State Engineer issued Order 1197 further stipulating that any new water rights in Amargosa Valley will be denied and that change applications that seek to move pumping closer to the 25 mi (40 km) radius of Devils Hole will be denied (State of Nevada 2008a, p. 1).

Though the Nevada State Engineer's Order 1197 precludes new water right applications in the Amargosa Valley, exceptions have been defined. Application exceptions include: 1) changes in points of diversion of less than 0.5 mi (0.8 km) would be allowed if the place of use is unchanged; 2) applications seeking 2.0 ac-ft (2,467 m^3) per year or less would be considered; and 3) applications requesting changes to multiple existing groundwater rights would be considered if the net impact of the proposed changes was the same or less than the existing rights and would not result in a point of diversion being moved within 10 mi (16 km) of Devils Hole. While seemingly minor, these exceptions could have a cumulative negative effect on groundwater levels at the Refuge. Moreover, the method that the State Engineer would use to assess the net impact of multiple change applications has not yet been determined. Most important, Order 1197 was stayed in December 2008, one month later, by the Fifth Judicial District Court of Nevada in response to a case filed by Nye County and others. The fate of Order 1197 remains uncertain today (State of Nevada 2008b, pp. 1-3 and Exhibit A and State of Nevada 2008c, pp.1-2).

Summary of Factor D

In summary, the Act is the primary Federal law that provides protection for this species since its listing as endangered in 1985. The National Wildlife Refuge System Improvement Act would provide adequate protections for *Enceliopsis nudicaulis* var. *corrugata* absent to its status under the Act, but only within Refuge boundaries. All other Federal and State regulatory mechanisms

provide discretionary protections for the species based on current management direction, but do not guarantee protection for the species absent its status under the Act. Therefore, other laws and regulations have limited ability to protect *E. nudicaulis* var. *corrugata* in absence of the Act.

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

At the time of listing, all plants, including *Enceliopsis nudicaulis* var. *corrugata*, were threatened from trampling by cattle and feral horses. Since listing, stochastic events and climate change have been identified as potential threats to *E. nudicaulis* var. *corrugata*.

Trampling by Cattle and Feral Horses

Cattle were removed from the Refuge when it was established in 1984. In 1998, the BLM established the Ash Meadows ACEC that closed the land to livestock grazing (BLM 1998b, Table 2-5 p. 7). Due to the removal of livestock grazing, we conclude that trampling by cattle and feral horses is no longer a threat to *Enceliopsis nudicaulis* var. *corrugata*.

Stochastic Events

Small, endemic populations with limited geographic distribution like *Enceliopsis nudicaulis* var. *corrugata* have a higher risk of extinction due to demographic and environmental uncertainty and natural catastrophes (Shaffer 1987, pp. 69-75; Lande 1993, pp. 911-927). *Enceliopsis nudicaulis* var. *corrugata* is known only from the Ash Meadows area. All mapped occurrences of *E. nudicaulis* var. *corrugata* are restricted to the Refuge. Drought and wildfire are the most likely stochastic events that could adversely affect *E. nudicaulis* var. *corrugata*, as this species is dependent on groundwater and moisture retained in the soil and susceptible to being destroyed by a single, large fire. We conclude that stochastic events are a threat to *E. nudicaulis* var. *corrugata*.

Climate Change

Enceliopsis nudicaulis var. *corrugata* is dependent on the springs and seeps of the Refuge. The potential effects of climate change on the regional aquifer system that supports *E.nudicaulis* var. *corrugata* are unclear. Current climatic models are predicting warmer air temperatures due to elevated levels of atmospheric carbon dioxide and increased drought and flood frequency (Intergovernmental Panel on Climate Change (IPCC) 2007, pp. 2-3). Other effects of climate change include, but are not limited to, changes in types of precipitation (Knowles *et al*. 2006, p. 4557), earlier spring run-off (Stewart *et al*. 2005, p. 1152), longer and more intense fire seasons (Chambers and Pellant 2008, pp. 31-32), increases in exotic species invasions (Hawkins *et al.* 2008, p. 37; Bradley *et al.* 2010, pp. 310-318), and more frequent extreme weather events (IPCC 2007, p. 13).

The springs and surface streams that support *Enceliopsis nudicaulis* var. *corrugata* are perennial and originate from a regional aquifer that includes runoff from the Spring Mountains approximately 100 mi (161 km) northeast (USGS 2003, pp. 7-9). As a result of warming, more winter precipitation is falling as rain, and has altered spring stream flow. Snowmelt driven stream flow in spring is about 10 to 15 days earlier than 50 years ago, which increases the frequency of drought by decreasing groundwater recharge and summer water reserves (IPCC 2007; Chambers and Pellant 2008, p. 30).

Increasing temperatures and drought frequency could adversely affect *Enceliopsis nudicaulis* var. *corrugata* by causing physiological stress, altering phenology, reducing recruitment events and seedling establishment, and altering fire frequencies. At this time, it is difficult to predict local climate change impacts to *E. nudicaulis* var. *corrugata*; thus, while the information indicates that climate change has the potential to affect and threaten its ecosystem in the long-term, there is much uncertainty regarding the attributes that could be affected and their timing, magnitude, and rate of change.

III. RECOVERY CRITERIA

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

The Service completed the Recovery Plan in 1990 (Service 1990, pp. 1-123). Three downlisting and four delisting recovery objectives in the Recovery Plan apply to *Enceliopsis nudicaulis* var. *corrugata* and are as follows:

<u>Downlisting Objectives from the Recovery Plan that apply to *Enceliopsis nudicaulis* var. *corrugata*</u>

1. *All non-native animals and plant species must be eradicated from essential habitat. These non-native species currently include sailfin mollies, mosquitofish, largemouth bass, black bullheads, bullfrogs, crayfish, turban snails, wild horses, salt cedar, and Russian olive.*

Several non-native plant species have been introduced or have moved onto the Refuge that were not identified in the recovery plan, including a multitude of terrestrial weeds, primarily *Acroptilon repens*, *Centaurea melitensis*, and *Bassia hyssopifolia*. The Refuge has made significant progress towards addressing this threat, including the removal of *Tamarix ramosissima* on 75 percent of the Refuge and treating 2,500 ac (1,012 ha) of broadleaf species (SWEAT Inc., presentation, Ash Meadows Symposium, 2008), developing and implementing an IPM plan, and developing a framework for restoring and managing abandoned agricultural

infrastructure that supports non-native plant populations. Grant funding for removal of non-native plant species has run out and these species will no longer be treated on the Refuge. Under climate change scenarios, wildfire frequency may increase through alteration of the fire regime if non-native species are given the opportunity for re-invasion. Non-native plant species that are left untreated could spread into un-invaded or sparsely vegetated areas and provide a vector to carry fire into rare plant habitats. Though *Enceliopsis nudicaulis* var. *corrugata* may not be immediately threatened, non-native plant species require continuous management and eradication to prevent future invasion that will not be provided.

Resident wild and free-roaming horses have been removed from within Refuge boundaries as a result of fence construction around the perimeter of the Refuge (Service 2006, pp. 9, 103). In 1998, the BLM established the Ash Meadows ACEC and established that the AML for wild horses was zero (BLM 1998b, p. 7 Table 2-5). However, fences are not present to keep horses out of the designated ACEC and horses are seen infrequently near this area (Baldino, pers. comm., 2011). Inspection and maintenance of the exclusionary fence on the Refuge is necessary to prevent re-invasion (Service 2006, p. 99).

This recovery criterion is influenced by two of the five listing factors: Factor A (the present or threatened destruction, modification, or curtailment of its habitat or range) and Factor E (other natural or manmade factors affecting its continued existence). This criterion is addressed in the Recovery Plan by Tasks 222 which requires removal of non-native plants and 223 which requires prevention of re-establishment of wild horse herds. This criterion has been partially achieved

2. *Secure and protect the Ash Meadows aquifer so that all spring flows return to historic discharge rates, and the water level in Devil's Hole is maintained at a minimum level of 1.4 feet below the copper washer.*

Loss of groundwater resources to pumping elsewhere in the basin could cause declines in spring discharge, change water temperature, adjust soil or water chemistry, or all of the above, which could negatively affect the distribution, habitat, and population size of *Enceliopsis nudicaulis* var. *corrugata*. The establishment of the U.S. Supreme Court mandated water level threshold in Devils Hole (given its proximity to the Refuge and mutual water source) created an important level of protection for groundwater levels and spring discharge at the Refuge. Measures implemented by the Nevada State Engineer and water right acquisition by the Refuge reduced the threat from groundwater pumping, but have not eliminated it. However, one of the measures, Nevada State Engineer Order 1197 was stayed in December 2008and the fate of Order 1197 remains uncertain today. In addition, the Amargosa Valley has been selected as a Solar Energy Zone which when developed, would change the use of water in the valley from irrigation to industrial use. Agricultural water use allows some water to percolate back into the groundwater system (return flow). Water used for industrial utility-scale solar energy production likely will evaporate and not recharge to the aquifer.

Two of the five listing factors are relevant to this criterion: Factor A (the present or threatened destruction, modification, or curtailment of its habitat or range) and Factor D (the inadequacy of existing regulatory mechanisms). Recovery Task 111 requires securing and protecting Devils Hole. Recovery Tasks 114 and 122 requires protecting subsurface waters and acquiring and

protecting surface waters. Recovery Task 211 requires determination of historic spring flow channels and discharge rates. Recovery Task 311 requires monitoring water levels, chemistry, and physical properties at Devils Hole. This criterion has been partially achieved.

4. *The essential habitat must be secure from detrimental human disturbances including mining, OHVs, and introduction of non-native species.*

Public land within the BLM ACEC and Refuge has been withdrawn temporarily from mineral entry and mining for 20 years due to publication of PLO No. 7737 and 238. The mineral withdrawals do not supersede valid existing mineral rights and do not prevent road access and the means to mine existing claims. Existing mineral claims for specialty clay exist both within and outside of the Refuge and BLM ACEC (BLM and Service 2000, p. A-11). The Refuge is closed to OHV recreation and OHV activity in the BLM ACEC is limited to existing roads, trails, and dry washes. Signs and fences are not present to designate the BLM ACEC from the other bordering BLM land, thus making it unclear to the public that the BLM land surrounding the Refuge has special designation (Baldino, pers. comm. 2010). Threats from non-native plant species is discussed above under downlisting objective 1. In addition, monitoring of *Enceliopsis nudicaulis* var. *corrugata* and other listed plants and their habitat on the Refuge has not been done; the first baseline survey of threatened and endangered plants was only just completed in 2010. If long-term monitoring is initiated, in addition to providing data on native species, it would allow for early detection of non-native plant species.

Three of the five listing factors are relevant to this criterion: Factor A (the present or threatened destruction, modification, or curtailment of its habitat or range), Factor D (the inadequacy of existing regulatory mechanisms), and Factor E (other natural or manmade factors affecting its continued existence). Recovery Task 113 requires securing private lands. Recovery Task 115 requires acquiring mineral rights. Recovery Task 222 requires removing introduced non-native plant species. Recovery Task 24 requires minimizing human disturbance. Recovery Task 252 requires monitoring of plant communities to determine successional changes and stability. This criterion has been partially achieved.

<u>Delisting Objectives from the Recovery Plan that apply to *Enceliopsis nudicaulis* var. *corrugata*</u>

1. *Criteria shown above for downlisting from endangered to threatened.*

Factors for criterion 1 are discussed above.

2. *Secure, protect, and maintain in natural vegetation corridors and adjacent buffer areas for gene flow and dispersal of listed plants within the essential habitat.*

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, road construction, 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 and should be purchased to facilitate Refuge management and benefit listed and endemic species. Grant funding for treatment of non-native species has been exhausted. Non-native plant species could spread again into *E. nudicaulis* var. *corrugata* habitat, increase fire frequency, or both which would threaten the natural vegetation corridors needed for gene flow and dispersal of listed plants. 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. Recently observed pressures on *E. nudicaulis* var. *corrugata* from herbivory and predation could negatively affect gene flow and dispersal by disrupting reproduction and seed bank recharge. 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 are unknown, but fluctuations in water levels in the Amargosa Desert Hydrographic Basin have been proven to be tied directly to groundwater pumping (Bedinger and Harrill 2006, pp. 827-839). Exploration into detailed habitat requirements of *E. nudicaulis* var. *corrugata* has just begun (Jensen, pers. comm. 2010; White Horse Associates 2010, pp.116, 509; BIO-WEST 2011, pp. 113-115). More information is needed on the affects of *E. nudicaulis* var. *corrugata* gene flow and dispersal from changes in spring discharge, groundwater levels, water temperature, and water and soil chemistry.

Two of the five listing factors are relevant to this criterion: Factor A (the present or threatened destruction, modification, or curtailment of its habitat or range) and Factor E (other natural or manmade factors affecting its continued existence). Recovery Task 1 requires securing and protecting land and water resources, which includes securing and protecting Devils Hole (Task 111), withdrawing Bureau lands (Task 112), securing private lands (Task 113), protecting subsurface waters, and acquiring and protecting surface waters (Task 114), acquiring mineral rights (Task 115), posting signs at the Refuge (Task 116), and securing and protecting critical habitats (Task 121). Recovery Task 64 requires determining the ecology of the seven listed plant species, including habitat requirements (Task 641), life history (Task 642), and community associations and interactions (Task 643). This criterion has been partially achieved.

3. Native plant communities and aquatic communities have been reestablished to historic structure and composition within all essential habitats.

Restoration on the Refuge is an on-going process. Jackrabbit Spring has been restored to historic structure. The first mile of Kings Spring outflow has been restored. Fairbanks and Soda spring outflows were returned to their historic channels in 2011. Restoration of Rogers and Longstreet outflows is an on-going project (Baldino 2011b, pp. 1-12). The Refuge has made significant progress towards addressing non-native plant species, including the removal of *Tamarix ramosissima* on 75 percent of the Refuge and treating 2,500 ac (1,012 ha) of broadleaf species (SWEAT Inc., presentation, Ash Meadows Symposium, 2008). Grant funding for removal of non-native plant species has run out and these species will no longer be treated on the Refuge. It is unknown if returning springs flow to their historic channels will re-create habitat for listed plant species such as *Enceliopsis nudicaulis* var. *corrugata*. The historic conversion of habitat to agricultural fields and sites for development and mineral exploration may have altered the soils and hydrology needed to support *E. nudicaulis* var. *corrugata*. In some areas, tilling and the addition of sand and organic matter, to make sites suitable for agriculture, likely destroyed the unique soils that the species requires.

Two of the five listing factors are relevant to this criterion: Factor A (the present or threatened destruction, modification, or curtailment of its habitat or range) and Factor E (other natural or manmade factors affecting its continued existence). Recovery Task 21 requires returning spring flows to historic channels. Recovery Tasks 22 and 23 requires enhancing and restoring terrestrial and aquatic ecosystems by returning native plants and animals to their historic distribution and removing non-native species. Recovery Task 25 requires monitoring enhanced and reestablished populations. This criterion has been partially achieved, but the feasibility is unknown until all restoration efforts have been completed. The Recovery Plan should emphasize ensuring and maintaining the viability of the known species occurrences, while secondarily attempting to return species to historic ranges.

6. *All of the listed plant species and the four candidate plants species are present in all the sites that they have historically occupied as identified in Appendix A, Table XV, and within each critical habitat unit, the listed plant has a frequency value equal to or greater than the frequency value determined by Task 644 needed as an indicator of a self-sustaining plant population.*

Refuge-wide surveys of listed and rare plants, including *Enceliopsis nudicaulis* var. *corrugata*, were initiated in 2008 and completed in 2010 (BIO-WEST 2011, pp. 1-207). Some historically occupied sites (critical habitat) identified in the Recovery Plan (1990, Appendix A, Table XV) did not contain plants in the 2008-2010 surveys, while one historically occupied site within the BLM ACEC was not surveyed (Figure 1). As mentioned above under criterion 4, the conversion of habitat to agricultural fields and sites for development and mineral exploration may have altered the soils and hydrology needed to support *E. nudicaulis* var. *corrugata*, creating unsuitable habitat. Recovery Task 644 calls for monitoring plots to be established to determine reference conditions and to track vegetation change on recovered sites. Recovery to date has been through natural succession. Since 21 years have elapsed since publication of the Recovery Plan, this type of data can no longer be collected to determine recovery.

One of the five listing factors is relevant to this criterion: Factor A (the present or threatened destruction, modification, or curtailment of its habitat or range). Recovery Task 221 requires determination of historic plant communities and their distribution, which includes preparing a current vegetation map (Task 2211) and historic plant community map (Task 2212). Recovery Task 225 requires reestablishing seven listed plant species throughout their historic habitat. Recovery Task 255 requires monitoring of the seven listed plant species. Recovery Task 644 requires determining frequency values for the seven listed plants from examples of vegetation that is unaltered. This criterion has been partially achieved, but Task 644 is no longer applicable.

IV. SYNTHESIS

The status of *Enceliopsis nudicaulis* var. *corrugata* has improved since it was listed in 1985. Recent 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. Studies of *E. nudicaulis* var. *corrugata* habitat requirements explored its association with groundwater and determined that superficial observations of adaptation to hard,

alkaline soils of upland topography are incorrect (Jensen, pers. comm. 2010; White Horse Associates 2010, pp.116, 509). Studies on phenology, breeding system, and seed biology also provided new information on *E. nudicaulis* var. *corrugata*.

Many threats to *Enceliopsis nudicaulis* var. *corrugata* as discussed in the original listing rule, including road construction, trampling by wild and free-roaming horse, and trampling by cattle and feral horses, have largely been addressed by the designation of the Refuge. OHV activity is periodically a threat to *E. nudicaulis* var. *corrugata* within the Refuge boundary. Designation of the BLM ACEC also has added additional protections, but lack of signs and fences threaten *E. nudicaulis* var. *corrugata* due to OHV activity and periodic trampling by wild horses. In addition, the threat from new mining and mineral entry on public lands has been removed within the BLM ACEC until 2029 and within the Refuge until 2030.

Groundwater withdrawal coupled with solar development is the greatest threat to *Enceliopsis nudicaulis* var. *corrugata*. Other threats, both immediate and potential, include non-native plant species, wildfire, and predation and herbivory. The Refuge has made substantial progress in combating non-native plant species, but with grant funding for this program running out, non-native plants species will not be receiving treatments needed to control invasion. Non-native plant species could spread into *E. nudicaulis* var. *corrugata* habitat, increase fire frequency, or both and threaten natural vegetation corridors. Recently observed pressures on *E. nudicaulis* var. *corrugata* from herbivory and predation could negatively affect gene flow and dispersal by disrupting reproduction and seed bank recharge.

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.

All of the recovery objectives described in the Recovery Plan have been partially achieved or are no longer relevant. In addition, trend data for demographic structure and recruitment events is nonexistent and nothing is known about the longevity of *Enceliopsis nudicaulis* var. *corrugata* seeds in the seed bank. Seed germination trials have been unsuccessful and transplanting and translocation studies have not been conducted. The number of individuals on the BLM ACEC and private lands is unknown. Based on the threats from groundwater withdrawal, solar development, non-native plant species to all occurrences of *E. nudicaulis* var. *corrugata* and OHV activity and wild horses to occurrences within the BLM ACEC, we determine that *E. nudicaulis* var. *corrugata* still meets the definition of threatened, and recommend no status change at this time.

V. RESULTS

Recommended Listing Action:

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

New Recovery Priority Number and Brief Rationale: 9
Based on the preceding analysis, *Enceliopsis nudicaulis* var. *corrugata* faces a moderate level of threat due to groundwater withdrawal and the indirect effects of solar development in the already over-appropriated Amargosa Desert Hydrographic Basin. More information is needed on the affects of *E. nudicaulis* var. *corrugata* gene flow and dispersal from changes in spring discharge, groundwater levels, water temperature, and water and soil chemistry. Grant funding for treatment of non-native species has been exhausted. Non-native plant species could spread again into *E. nudicaulis* var. *corrugata* habitat, increase fire frequency, or both which would threaten natural vegetation corridors. Recently observed herbivory and insect predation on *E. nudicaulis* var. *corrugata* may be negatively affecting gene flow and dispersal by disrupting reproduction and seed bank recharge. Exploration into detailed habitat requirements of *E. nudicaulis* var. *corrugata* has recently been initiated, but basic life history and biology of the plant are not understood. Information lacking on species biology could easily be addressed if recovery funds were available to conduct studies on population trend, demographic structure, and seed longevity. Despite the moderate level of threat, the establishment of the Refuge and BLM ACEC secured the majority of the habitat and removed threats from agriculture, livestock, ranching, road construction, and residential development, thus allowing for high recovery potential. We recommend, therefore, that the recovery priority number be changed from a 15 (low degree of threat, high recovery potential) to a 9 (moderate degree of threat, high recovery potential).

VI. RECOMMENDATIONS FOR ACTIONS OVER THE NEXT 5 YEARS

1. The Recovery Plan should be updated using the most recent and best scientific management information available.

2. Surveys for Ash Meadows threatened and endangered plant species, including *Enceliopsis nudicaulis* var. *corrugata*, should be performed in the BLM ACEC to determine species occurrences and habitat locations. In addition, habitat surveys around roads, trails, and dry washes will verify the impact OHV activity has on this species population.

3. Research on the life history strategies of *Enceliopsis nudicaulis* var. *corrugata* should be prioritized. Research should focus on demography, recruitment events, and seed longevity in the seed bank.

4. Seed from all listed plant species, including *Enceliopsis nudicaulis* var. *corrugata*, on the Refuge should be collected and stored for *ex situ* conservation. *Ex situ* studies of seed

and seedling biology should be conducted to enhance germination and propagation techniques.

5. Additional research is needed on the sensitivity and requirements of the species on groundwater and soil moisture throughout the growing season.

6. The Refuge is implementing many restoration projects that could benefit *Enceliopsis nudicaulis* var. *corrugata*; however minimal monitoring specific to listed plants is conducted. To document recovery of listed plants, these projects should include pre and post site sampling to verify and quantify the restoration actions as benefiting the species.

7. Environmental analyses on new solar projects in Amargosa Valley should include detailed assessments of the potential effects on the springs and groundwater table within the Refuge. The Service should participate in the review of these documents to ensure that they adequately disclose all potential impacts to *Enceliopsis nudicaulis* var. *corrugata* and the Ash Meadows ecosystem.

8. Long-term funding should be secured for long-term non-native plant species treatments on the Refuge

9. Mineral rights should be purchased or transferred for perpetuity to the Service or a program needs to be established to renew the mineral withdrawal every 20 years. In addition, existing mining claims should be acquired whenever possible.

10. Property and rights, such as conservation easements, should be acquired on private property that likely contains listed plant species.

11. Research and develop a jackrabbit exclusion study to determine the impacts jackrabbits are having on reproduction of *Enceliopsis nudicaulis* var. *corrugata*. If a significant affect to *E. nudicaulis* var. *corrugata* is found, a jackrabbit control plan should be established.

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

***Enceliopsis nudicaulis* var. *corrugata* (Ash Meadows sunray)**

Current Classification: Threatened

Recommendation Resulting from the 5-Year Review:

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

Appropriate Listing/Reclassification Priority Number: 9

Review Conducted By: Sarah Kulpa, Nevada Fish and Wildlife Office

Date Submitted to Region 8: _____

FIELD OFFICE APPROVAL:

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

Approve _____ Date 9/14/11