

Erigeron parishii
(Parish's daisy)

**5-Year Review:
Summary and Evaluation**



Photo by Scott Eliason

**U.S. Fish and Wildlife Service
Carlsbad Fish and Wildlife Office
Carlsbad, California**

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5-YEAR REVIEW

Erigeron parishii (Parish's daisy)

GENERAL INFORMATION

Species: *Erigeron parishii* (Parish's daisy), a plant species

Date listed under the Endangered Species Act: August 24, 1994

Federal Register citation: Service 1994 (59 FR 43652)

Classification: Threatened

Recovery Plan: Draft, September 1997, San Bernardino Mountains carbonate endemic plants Recovery Plan

Recovery Priority Number: 8C

Critical Habitat Designation: Service 2002 (67 FR 78569)

BACKGROUND

Under the Endangered Species Act of 1973, as amended (Act; 16 U.S.C. 1531 *et seq.*), the U.S. Fish and Wildlife Service (Service), referred to as “we” in this document, maintains lists of endangered and threatened wildlife and plant species (referred to as the List) in the Code of Federal Regulations (CFR) at 50 CFR 17.11 (for wildlife) and 17.12 (for plants). Section 4(c)(2)(A) of the Act requires us to review each listed species' status at least once every 5 years.

Most recent status review: Service 2009. *Erigeron parishii* (Parish's daisy) [5-year Review: Summary and Evaluation](#). Prepared by the Carlsbad Fish and Wildlife Office, Carlsbad, California. 20 pp.

We initiated a status review for *Erigeron parishii* on March 5, 2008. The review was finalized on August 13, 2009; it recommended no change in listing status.

Federal Register notice announcing this status review: On May 20, 2021, we published a Federal Register notice announcing initiation of the 5-year review of this species, and the opening of a 60-day comment period to receive information (Service 2021, pp. 27462–27464).

Species Overview and Habitat: *Erigeron parishii* is a small perennial herb in the *Asteraceae* (Aster) family. The species is endemic to the San Bernardino Mountains, Bighorn Mountains, and Little San Bernardino Mountains in San Bernardino County and northern Riverside County, California. The species primarily occurs on rocky slopes, active washes, and outwash plains on substrate derived from limestone or dolomite. Some occurrences are found on a granite/limestone interface characterized by a granitic parent material overlain with an outwash of limestone materials (Service 1994, p. 43653). In the eastern part of its range (vicinity of Pioneertown and Joshua Tree National Park), *E. parishii* often occurs on rocky north-facing slopes on gneiss, granodiorite, and monzogranite soils (Fraga *et al.* 2014, p. vii).

ASSESSMENT

Information acquired since the last status review

This 5-year review was conducted by the Service’s Carlsbad Fish and Wildlife Office. Information for this review was solicited from the public and interested parties through a Federal Register notice announcing this review on May 20, 2021. We reviewed data from the California Natural Diversity Database¹ (CNDDDB); the U.S. Forest Service’s (USFS) Threatened, Endangered, and Sensitive Plant database; the Consortium of California Herbaria; and CalFlora. We also contacted the California Department of Fish and Wildlife (CDFW), USFS, Bureau of Land Management (BLM), National Park Service, and species experts to request data or information that should be considered in this review. Additionally, we conducted a literature search and a review of information in our files.

SUMMARY OF NEW INFORMATION SINCE 2009

Distribution and Abundance

Since the most recent 5-year review (Service 2009, entire), our knowledge of *Erigeron parishii* distribution has grown. Previously, we described the range of *E. parishii* as spanning approximately 35 miles (mi) [56 kilometers (km)] (Service 1994, p. 43653; 2009, p. 3). However, the range of the species is now known to span approximately 50 mi [80 kilometers (km)], including into northern Riverside County, California ([Figure 1](#)). The 50-mi (80 km) range extends from the northern edge of the San Bernardino Mountains (north and east of Big Bear Lake), southeast to Quail Mountain in the Little San Bernardino Mountains, Joshua Tree National Park, California (Fraga *et al.* 2014, p. 17; CDFW 2022, dataset; [Figure 1](#)). For reference, we divided all known *E. parishii* locations into three geographic groups ([Figure 1](#)). The Western Group, primarily in San Bernardino National Forest, includes the majority of occupied habitat and designated critical habitat. The Eastern Group includes a cluster of locations at the eastern edge of San Bernardino National Forest and all locations in the Bighorns Mountains. The Southeastern Group contains all locations in the Little San Bernardino Mountains, including the locations near Pioneertown and in Joshua Tree National Park.

Nineteen new occurrences have been documented since the 2009 5-year review, all of which are Element Occurrences² (EO) in the CNDDDB. Of the 19 new occurrences, 4 are in the San Bernardino National Forest, 11 are on BLM land, and 4 are in Joshua Tree National Park. All of the new occurrences are in the Eastern and Southeastern geographic groups. Currently, we consider there to be 51 *Erigeron parishii* EOs in the CNDDDB (CDFW 2022, dataset; [Table 1](#)). While the CNDDDB dataset includes 52 EOs, the location of 1 of the occurrences (EO 64, directly north of Lake Arrowhead in the western San Bernardino Mountains) is likely erroneous. The actual location of the 2017 observation is likely in carbonate habitat west of the Mitsubishi plant

¹ The California Natural Diversity Database (CNDDDB) is an inventory of the status and locations of rare plants and animals in California.

² The CNDDDB assigns “Element Occurrence” (EO) numbers to unique locations of rare taxa. An EO is a specific location where a taxon has been known to occur, and that has practical conservation value. In this document, we use the term “occurrence” to refer to EOs delineated by the CNDDDB, or locations not in the CNDDDB that are greater than 0.25 mile (0.40 kilometer) apart.

in San Bernardino National Forest, where the observer recorded another plant on the same date (Crawford 2022, pers. comm.). Of the 51 occurrences, 26 are extant (i.e., the species was observed during the past 10 years), 24 are presumed extant (i.e., the species was not observed during the past 10 years, but suitable habitat is present), and 1 has an unknown status because the occurrence is unconfirmed (CDFW 2022, dataset; [Table 1](#)).

At the time of the listing rule in 1994, the total population of *Erigeron parishii* was estimated at 16,000 individuals among fewer than 25 occurrences (Service 1994, p. 43653). Twenty years later in 2014, the number of known occurrences had increased to 41 and the total population of *E. parishii* was estimated at just over 20,000 individuals (Fraga *et al.* 2014, p. 17). Fraga *et al.* (2014, p. 17) noted that the most abundant occurrences are in the San Bernardino Mountains and population size is thought to be decreasing in at least five occurrences, including in the largest population (EO 14).

We consider the current total population of *Erigeron parishii* in 2022 to be similar to the 2014 estimate of just over 20,000 individuals (Fraga *et al.* 2014, p. 17). Although 10 new occurrences have been documented since the 2014 estimate, none are reported to be abundant or extensive. Reports for these 10 occurrences range from an observation of a single vegetative individual to an observation of 50–100 plants (CDFW 2022, dataset). With the exception of the occurrence with 50–100 plants, all numerical observations were of 15 plants or fewer (CDFW 2022, dataset).

Since 2009, the National Park Service and the California Botanic Garden (formerly Rancho Santa Ana Botanic Garden) have been conducting studies on *Erigeron parishii* in Joshua Tree National Park (Fraga *et al.* 2014, entire; La Doux 2022, entire). There are approximately 208 acres (ac) [84 hectares (ha)] of occupied habitat in Joshua Tree National Park and total abundance is estimated at 1,200 individuals (Fraga *et al.* 2014, p. 17; La Doux 2022, p. 2). The Quail Mountain occurrence (EO 47) is the most extensive population in Joshua Tree National Park and is estimated at 1,000 individuals (Fraga *et al.* 2014, p. 17). However, density of individuals is low with plants growing sporadically across an approximate 250-ac (100-ha) area (La Doux 2022, pp. 1–2). Ten years of monitoring data suggest that the population in Joshua Tree National Park is experiencing a slow decline because of episodic high mortality coupled with low seedling recruitment (La Doux 2022, p. 3).

In summary, *Erigeron parishii* survey efforts have detected numerous additional locations, bringing the number of total occurrences to 51, more than twice as many occurrences as were known at the time of listing. Of the 51 known occurrences, 19 were discovered (or reported) for the first time since the 2009 5-year review. With the newly discovered occurrences, our understanding of *E. parishii* distribution has improved. We now consider the species' range to span approximately 50 mi (80 km), primarily in San Bernardino County but also extending into northern Riverside County. Considering the larger range and increased number of known occurrences, the rangewide abundance of *E. parishii* may be greater than previous estimates (i.e., 16,000 in the listing rule and just over 20,000 in a 2014 Conservation Assessment). However, an increase in the number of *E. parishii* occurrences does not suggest a commensurate increase in total population abundance. Population size in some occurrences may be decreasing (Fraga *et al.* 2014, p. 17) and most of the occurrences discovered since 1994 are small in comparison to the long-known occurrences in the western part of the range (CDFW 2022, dataset; [Figure 1](#)).

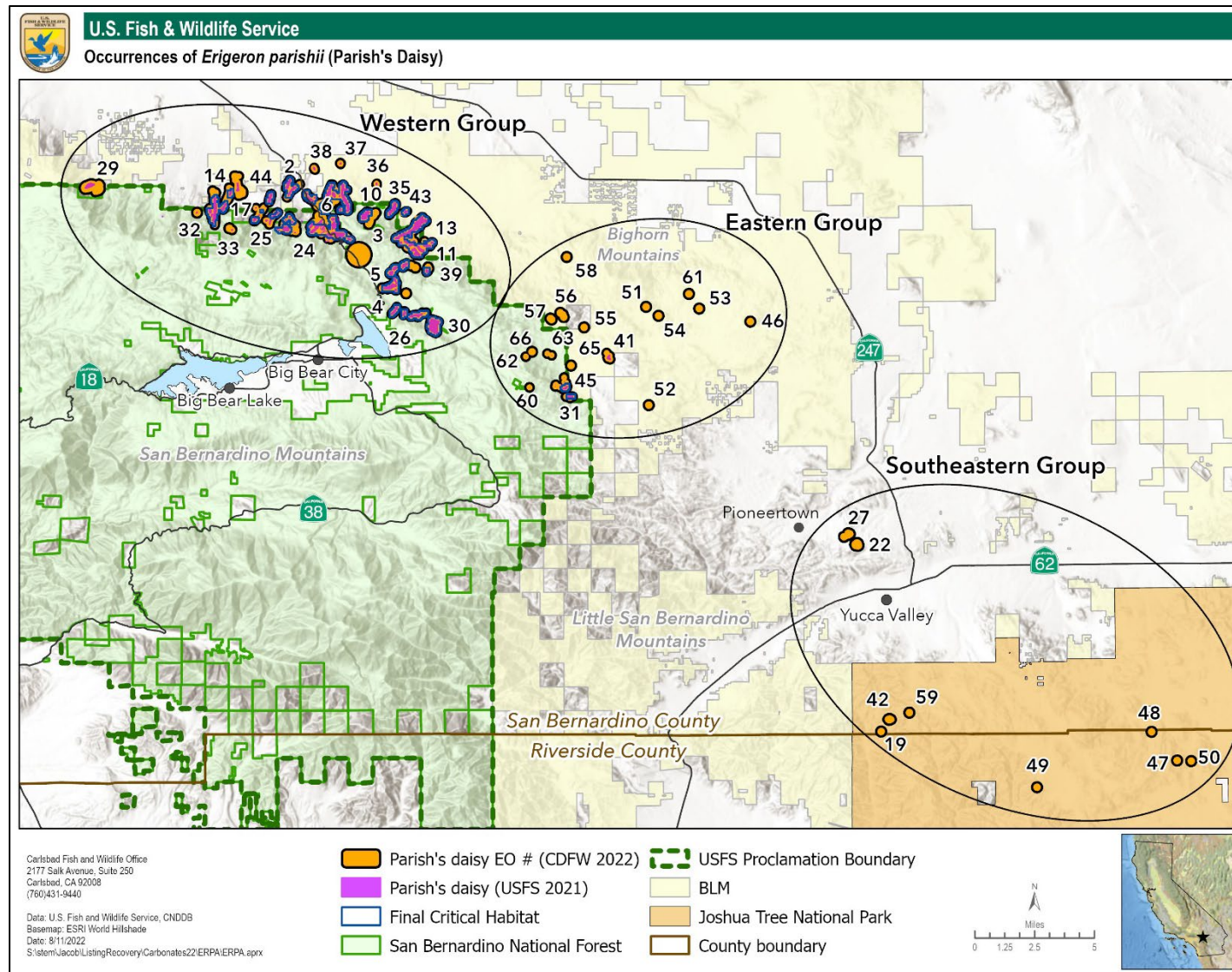


Figure 1. Map of *Erigeron parishii* occurrences and designated critical habitat. Occurrences are split into three geographic groups, Western, Eastern, and Southwestern. Occurrence data are sourced from the CNDDDB (CDFW 2022, dataset) and USFS Threatened, Endangered, and Sensitive Plant database (USFS 2021, dataset). BLM = Bureau of Land Management.

Table 1. Occurrence table for *Erigeron parishii* showing geographic group (corresponding to [Figure 1](#)), land ownership (BLM = Bureau of Land Management, NPS = National Park Service, and USFS = U.S. Forest Service), past and current occurrence status, and the first and last (most recent) year the species was reported (Fraga *et al.* 2014, p. 19; USFS 2021, dataset; CDFW 2022, dataset; La Doux 2022, p. 4). An occurrence is considered “extant” if the species was observed at the occurrence within the prior 10 years. An occurrence is considered “presumed extant” if the species was not observed within the prior 10 years but suitable habitat is present.

Geographic Group	CNDDDB Element Occurrence (EO) Number	Owner	Status in 1994	Status in 2009	Status in 2022	First Reported (Year)	Last Reported (Year)
Western	2	Private, BLM	Extant	Presumed extant	Presumed extant	1987	1998
Western	3	USFS	Presumed extant	Extant	Presumed extant	1926	2006
Western	4	USFS	Extant	Presumed extant	Presumed extant	1979	1988
Western	5	USFS	Extant	Presumed extant	Extant	1979	2014
Western	6	BLM, USFS, Private	Extant	Presumed extant	Extant	1979	2021
Western	10	USFS, Private	Extant	Presumed extant	Presumed extant	1988	1988
Western	11	USFS	Extant	Presumed extant	Extant	1979	2014
Western	13	USFS, BLM	Extant	Presumed extant	Presumed extant	1979	2012
Western	14	USFS, Private	Extant	Presumed extant	Extant	1988	2021
Western	17	Private	Extant	Presumed extant	Presumed extant	1979	1998
Western	24	USFS, Private	Extant	Extant	Presumed extant	1982	2010
Western	25	Private, USFS	Extant	Presumed extant	Presumed extant	1988	1988
Western	26	USFS	Extant	Presumed extant	Extant	1979	2014
Western	29	USFS, BLM, Private	Extant	Extant	Presumed extant	1988	2012
Western	30	USFS	Extant	Extant	Extant	1991	2014

Geographic Group	CNDDDB Element Occurrence (EO) Number	Owner	Status in 1994	Status in 2009	Status in 2022	First Reported (Year)	Last Reported (Year)
Western	32	USFS	Extant	Presumed extant	Presumed extant	1991	1991
Western	33	USFS	Extant	Presumed extant	Presumed extant	1992	1992
Western	35	USFS	No records	Presumed extant	Presumed extant	1995	1995
Western	36	USFS	No records	Presumed extant	Presumed extant	1995	1995
Western	37	BLM	No records	Presumed extant	Presumed extant	1995	1995
Western	38	BLM	No records	Presumed extant	Presumed extant	1995	1995
Western	39	USFS	Extant	Presumed extant	Presumed extant	1992	1992
Western	43	BLM	No records	Presumed extant	Extant	1998	2020
Western	44	Private or other land	Unknown	Unknown	Unknown	Unknown	Unknown
Eastern	31	USFS	Extant	Presumed extant	Extant	1992	2015
Eastern	41	BLM	No records	Extant	Presumed extant	2000	2011
Eastern	45	BLM, USFS	No records	Extant	Extant	2008	2015
Eastern	46	BLM	No records	No records	Presumed extant	2011	2011
Eastern	51	BLM	No records	No records	Extant	2013	2013
Eastern	52	BLM	No records	No records	Extant	2013	2013
Eastern	53	BLM	No records	No records	Extant	2013	2013
Eastern	54	BLM	No records	No records	Extant	2013	2013
Eastern	55	BLM	No records	No records	Extant	2014	2014

Geographic Group	CNDDDB Element Occurrence (EO) Number	Owner	Status in 1994	Status in 2009	Status in 2022	First Reported (Year)	Last Reported (Year)
Eastern	56	BLM	No records	No records	Extant	2013	2014
Eastern	57	BLM	No records	No records	Extant	2013	2013
Eastern	58	BLM	No records	No records	Extant	2013	2013
Eastern	60	USFS	No records	No records	Extant	2014	2014
Eastern	61	BLM	No records	No records	Extant	2014	2014
Eastern	62	USFS	No records	No records	Extant	2014	2014
Eastern	63	USFS	No records	No records	Extant	2014	2014
Eastern	65	BLM	No records	No records	Extant	2014	2014
Eastern	66	USFS	No records	No records	Extant	2017	2017
Southeastern	19	NPS	Presumed extant	Extant	Presumed extant	1975	2005
Southeastern	22	State (Burns Pinon Ridge Reserve)	Extant	Extant	Presumed extant	1973	2003
Southeastern	27	Private	Extant	Presumed extant	Presumed extant	1988	1988
Southeastern	42	NPS	Presumed extant	Extant	Presumed extant	1939	2006
Southeastern	47	NPS	No records	No records	Extant	2009	2022
Southeastern	48	NPS	No records	No records	Extant	2011	2011
Southeastern	49	NPS	No records	No records	Presumed extant	2009	2009
Southeastern	50	NPS	No records	Extant	Presumed extant	2008	2008
Southeastern	59	NPS	No records	No records	Extant	2013	2013

Genetics

During 2011, the California Botanic Garden completed a study of *Erigeron parishii* relative genetic diversity using an analysis of Inter-Simple Sequence Repeat (ISSR) genotype data (Fraga *et al.* 2014, p. 9; Prince and Fraga 2014, entire). Three populations of *E. parishii* were compared, two within Joshua Tree National Park [Quail Mountain (EO 47) and Long Canyon (EO 42)] and one on carbonate substrates in the San Bernardino National Forest (EO 6) (Fraga *et al.* 2014, p. 9).

Results of the study indicate that the San Bernardino National Forest population had the greatest genetic diversity with a total of 35 unique fragments, followed by the Joshua Tree National Park populations, Quail Mountain (12 unique fragments) and Long Canyon (8 unique fragments) (Prince and Fraga 2014, p. 30). Each population was genetically distinct, with the two Joshua Tree National Park populations more closely related to each other (Prince and Fraga 2014, p. 35). The populations in Joshua Tree National Park were each characterized by a number of unique ISSR bands not found in the San Bernardino National Forest population sampled (Prince and Fraga 2014, p. 36). Although distinct, the three populations were not reciprocally monophyletic, suggesting past or contemporary gene flow among all three populations (Prince and Fraga 2014, pp. 35–36). The statistical results of the population structure analyses are within the expected range for a rare plant with *Erigeron parishii*'s distribution and life history characteristics (Prince and Fraga 2014, p. 36).

Life History

Soils

Erigeron parishii occurs primarily on carbonate soils in the San Bernardino Mountains. At the time of the 2009 5-year review, we were only aware of two locations where *E. parishii* grew on soils that are not associated with limestone (Service 2009, p. 5). At the Burns Pinyon Ridge Reserve (EO 22) and an adjacent occurrence near Pioneertown (EO 27), the species occurs on quartz monzonite with no apparent limestone alluvium (Neel 2000, p. 84). Since 2009, *E. parishii* has been discovered at several new locations that are farther east and southeast of their range in carbonate soils of the San Bernardino National Forest and adjacent areas (CDFW 2022, dataset). Many of the newly discovered *E. parishii* occurrences are in soils derived from gneiss, granodiorite, or monzogranite (Fraga *et al.* 2014, pp. 13, 36).

A detailed soil analysis was conducted for the Quail Mountain occurrence (EO 47), the largest population of *Erigeron parishii* in Joshua Tree National Park (Rindfleisch 2009, entire). The analysis determined that preferred habitat for *E. parishii* includes areas with very shallow to shallow soils (Rindfleisch 2009, p. 72). In some cases, individual plants grew directly out of cracks in the bedrock or directly next to, or under, outcrops of granitic or gneissic bedrock (Rindfleisch 2009, p. 72). In most cases, soils were dominantly sandy loams with moderate amounts of coarse fragments (Rindfleisch 2009, p. 72).

Habitat

New information has become available about *Erigeron parishii* habitat in Joshua Tree National Park. In addition to the soil type information in the section above, *E. parishii* in the Quail

Mountain occurrence (EO 47) grow exclusively on rocky northern aspects, primarily on low hills with slopes up to 35 percent (Rindfleisch 2009, p. 72). This population of *E. parishii* grows in a variety of microhabitats that can be generally described as either (1) steep slopes with gneiss outcrops and loose loamy soil or (2) among granitic boulders along the canyons and washes, often growing from rock crevices (La Doux 2022, p. 1). For comparison, the typical description of occurrences in the western part of the species' range is that *E. parishii* often grow on alluvium in washes in canyon bottoms (Fraga *et al.* 2014, p. vii).

In 2012, a habitat model for *Erigeron parishii* was developed to map potential habitat in Joshua Tree National Park (Fraga *et al.* 2014, p. 13; Murphy *et al.* 2014, entire). Five environmental parameters (i.e., elevation, slope, aspect, soil type, and vegetation type) were used to assign probability values of potential habitat to the landscape (Murphy *et al.* 2014, p. 44). Modeled attributes associated with *E. parishii* occurrences in Joshua Tree National Park are described below.

1. The following three major vegetation types are associated with more than 90 percent of occupied *E. parishii* habitat in Joshua Tree National Park (Fraga *et al.* 2014, p. 13; Murphy *et al.* 2014, pp. 44–45):
 - a. *Pinus monophylla/Quercus cornelius-mulleri* (Single-leaf Pinyon Pine/Muller's Oak) Woodland Association.
 - b. *Juniperus californica/Coleogyne ramosissima* (California Juniper/Blackbush) Association.
 - c. *Quercus cornelius-mulleri—Eriogonum fasciculatum—Ericameria linearifolia* (Muller Oak—California buckwheat—Narrowleaf goldenbush) Association.
2. Two soil types (Pinecity gravelly loamy sand and Xeric Torriorthents-Bigbernie Association) were associated with more than 90 percent of occupied *E. parishii* habitat (Murphy *et al.* 2014, p. 45).
3. Seventy percent of occupied *E. parishii* habitat is between 4085 and 4740 feet in elevation (Murphy *et al.* 2014, p. 45).
4. Ninety-seven percent of occupied *E. parishii* habitat is on slopes between 6 and 34 degrees (Murphy *et al.* 2014, p. 45).
5. Eighty-three percent of occupied *E. parishii* habitat showed an aspect ranging between 310 and 90 degrees (north–northwest) (Fraga *et al.* 2014, p. 13; Murphy *et al.* 2014, p. 45).

The output from the habitat model was used to prioritize areas for surveys, which yielded discovery of a new occurrence in Joshua Tree National Park (EO 59) (Murphy *et al.* 2014, p. 45).

Climate

Compared to other rare, carbonate-soil plants in the San Bernardino Mountains, *Erigeron parishii* tends to occur in areas that are warmer and receive less precipitation; however,

conditions vary widely across the species' range. The annual average precipitation observed for 1975–2004 within the entire range of *E. parishii*, was 11.8 inches (in.) [30.0 centimeters (cm)] (CEC 2022, dataset). The western portion of the range (near Furnace Canyon) has the highest annual precipitation, and the southeastern part of the range has the lowest (Fraga *et al.* 2014, p. 14). Based on historical averages from three weather stations spanning the range of *E. parishii*, precipitation tends to decrease, and temperatures increase, from northwest to southeast across the species' range (Fraga *et al.* 2014, pp. 4, 14–15, Figure 2, Table 2), which is consistent with the Inlands Deserts region in this part of California (Hopkins 2018, p. 17). Mean annual precipitation ranged from 13.1 in. (33.3 cm) in the west to 5.8 in. (14.7 cm) in the southeast near Quail Mountain, while mean average temperature ranged from 49.9 to 60.9 degrees Fahrenheit (°F) [9.9 to 16.1 degrees Celsius (°C)] along the same gradient (Fraga *et al.* 2014, pp. 4, 15, Figure 2, Table 2). *Erigeron parishii* populations in the southeastern extent of the range (i.e., Joshua Tree National Park) appear to experience the driest and hottest conditions of anywhere else in their known range (Fraga *et al.* 2014, p. 14).

Reproduction and survival

A long-term demographic and reproductive biology study of the Quail Mountain population of *Erigeron parishii* is being conducted at Joshua Tree National Park (La Doux and Harding 2014, entire; La Doux 2022, entire). Preliminary findings of note are summarized below:

1. At the beginning of the study in 2009, five insects that were observed on *E. parishii* flowers were captured and identified to order. The five insects represent three taxa in two orders, *Diptera* and *Coleoptera* (La Doux and Harding 2014, p. 58).
2. All plants greater than 30.5 cubic in. (499.8 cubic cm) in size flowered during the 2009 season (La Doux and Harding 2014, p. 59). In contrast, only one of the six adult plants that were smaller than 30.5 cubic in. flowered in 2009 and the individual produced only two inflorescences (La Doux and Harding 2014, p. 59).
3. The mean number of flowering heads on an individual *E. parishii* ranged between 19 and 25 (maximum of 311) during a 4-week survey in May 2009 (La Doux and Harding 2014, p. 56). There is a strong positive relationship between the number of flowering heads and total plant volume (La Doux and Harding 2014, p. 59).
4. Low rainfall conditions (beyond a threshold) appear to negatively affect reproductive output. Based upon 10 years of monitoring data, La Doux (2022, p. 2) suggests that 2.0 in. (5.1 cm) of winter precipitation (October–March) may be a meaningful threshold for *E. parishii*. During 2013, an extremely dry year with a total annual precipitation of 2.9 in. (7.4 cm) and winter precipitation total of 1.2 in. (3.1 cm), 42 percent of plants observed did not produce any flowering heads, and 31 percent of them had fewer than 10 flowering heads (Fraga *et al.* 2014, p. 9; La Doux 2022, p. 2). In contrast, 89 percent of plants flowered and fruited during 2015 when total annual precipitation was 3.0 in. (7.5 cm) and total winter precipitation was 2.0 in. (5.1 cm) (La Doux 2022, p. 2).

5. Seedling establishment appears to be low (36 seedlings over a period of 10 years) (La Doux 2022, p. 2). Two-thirds of the 36 seedlings emerged from the monitoring plot (4 plots total) with the highest cover of granitic rock outcrops (La Doux 2022, p. 2).
6. Seedlings had lowest survival during their first year (67 percent), followed by their second year (79 percent) (La Doux 2022, p. 2).
7. Preliminary survivorship data supported that *E. parishii* has high survival and reproductive rates once an individual surpasses a certain size or age class (La Doux and Harding 2014, p. 59). Survivorship appears to increase after plants reach 30.5 cubic in. (499.8 cubic cm) (La Doux and Harding 2014, p. 59). None of the 10 seedlings [less than 3.0 cubic in. (49.2 cubic cm) in size] appeared to survive to the next monitoring visit 4 years later (La Doux and Harding 2014, p. 56).
8. *E. parishii* individuals can live for more than 10 years. Fifteen of the plants monitored during the study were already established at the beginning of monitoring in 2013 and they were still alive during 2022 (La Doux 2022, p. 2).

Germination

Germination trials conducted at the California Botanic Garden between 1990 and 2013 indicate that *Erigeron parishii* seeds have a high germination rate (75–100 percent) and do not require special treatment to break dormancy (Fraga *et al.* 2014, p. vii). The results of the trials also demonstrated that traditional means of seed storage (i.e., cold storage and low relative humidity) are effective as a long-term conservation strategy for securing germplasm of *E. parishii* (Fraga *et al.* 2014, p. 28).

Seed Collection

Since 2009, seeds of *Erigeron parishii* have been collected at seven sites in five EOs ([Table 2](#); California Botanic Garden 2022, unpublished data). The purpose of all collections made during 2010, 2011, and 2020 was seed banking for conservation (California Botanic Garden 2022, unpublished data). In 2021, the California Botanic Garden collected 6,883 seeds for an RNA (ribonucleic acid) integrity study being conducted by the Center for Plant Conservation (California Botanic Garden 2022, unpublished data).

Carbonate Habitat Management Strategy

As described in the 2009 5-year review, the Carbonate Habitat Management Strategy (Carbonate Strategy) (Olson 2003, entire) was developed through a collaboration among the Service, USFS, BLM, mining companies, major claim holders, San Bernardino County, and the California Native Plant Society. The goals of the Carbonate Strategy are to (1) protect the listed plants and the habitat components they require, (2) guide impact minimization and compensation for unavoidable impacts, (3) streamline reviews of mining activities in carbonate plant habitat, (4) guide habitat restoration, and (5) plan and provide for long-term needs of both the mining industry and listed species conservation.

Table 2. Total numbers of *Erigeron parishii* seeds collected at five EOs during 2010, 2011, 2020, and 2021 (California Botanic Garden 2022, unpublished data).

Element Occurrences	2010 seeds collected	2011 seeds collected	2020 seeds collected	2021 seeds collected
EO 5	746	3,221	0	0
EO 6	61,839	3,534	9,841	6,883
EO 13	0	0	4,129	0
EO 43	0	0	1,579	0
EO 47	0	14,300	0	0

Since the 2009 5-year review, implementation of the Carbonate Strategy has continued, including additions to the Habitat Reserve, which protects carbonate habitat from mining and other types of development. As outlined in the Carbonate Strategy, the USFS and partners establish and maintain a Habitat Reserve that provides conservation and protection of contiguous blocks of occupied, unoccupied, and designated critical habitat for *Erigeron parishii* and other carbonate plant species (Olson 2003, pp. 6–13; Service 2005, p. 30). For new mining projects, the Carbonate Strategy requires a 3:1 compensation ratio (in terms of Conservation Value added to the Habitat Reserve) for any loss of carbonate plant habitat (Olson 2003, p. 13).

Consultations

In 2015, we issued a biological opinion for three fuels reduction projects within the Big Bear Valley area on the San Bernardino National Forest (Service 2015, entire). We concluded the proposed action is not likely to jeopardize the continued existence of *Erigeron parishii* or adversely modify its designated critical habitat because (1) the project includes many measures to avoid and minimize impacts; (2) project-related impacts to the species and/or its designated critical habitat will be short in duration, with maintenance activities occurring on a 5 to 15 year cycle; (3) impacts to the species within the project area is less than 1 percent of total designated critical habitat; (4) suitable habitat for the species will not be treated unless San Bernardino National Forest has proposed regular monitoring to evaluate protective measures for *E. parishii*; and (5) any unauthorized roads used for the project will be rehabilitated and blocked after project completion (Service 2015, p. 32).

In 2016, the BLM requested our concurrence with their determination that two Omya California, Inc. projects meet the criteria outlined in the Carbonate Strategy (Olson 2003, entire) and our biological opinion on the Carbonate Strategy (Service 2005, entire). We concurred (conditionally for the direct sale property) that the proposed actions met the criteria of the Carbonate Strategy and biological opinion for calculating conservation credits (Service 2016, pp. 1–2). However, we did not concur with the BLM that the proposed reduction in conservation value of the direct sale property was consistent with the biological opinion (Service 2016, p. 4). The BLM resubmitted a biological assessment for the direct land sale to Omya California, Inc. in 2017. We concurred that the proposed action met the criteria of the Carbonate Strategy and our biological opinion (Service 2017b, p. 1).

In 2017, we issued a biological opinion for the Mitsubishi South Quarry Expansion on the San Bernardino National Forest and concluded that the proposed action is not likely to jeopardize the continued existence of *Erigeron parishii* or result in destruction or adverse modification of its designated critical habitat (Service 2017a, p. 26). While the proposed action deviates from the Carbonate Strategy by removing area from the Stage 1 Priority Reserve and modifying a boundary line between management areas, the proposed action allows for an increase in connective land by preserving large blocks of suitable and occupied habitat in contiguous patches (Service 2017a, p. 25).

In 2018, the BLM requested concurrence that the proposed Big Morongo Canyon Area of Critical Environmental Concern Programmatic Restoration Project is not likely to adversely affect *Erigeron parishii* (Service 2019c, p. 1). We concurred that the proposed project is not likely to adversely affect *E. parishii* based on the information provided and the agreed upon avoidance and minimization measures (Service 2019c, p. 8).

In 2019, we issued a biological opinion for the ongoing activities affecting 12 mountain plant species on the San Bernardino National Forest, including *Erigeron parishii* (Service 2019a, entire). The biological opinion discussed the general effects of the USFS 2006 Revised Land and Resource Management Plan (LRMP) on listed species (Service 2019a, pp. 18–26), and specific effects to *E. parishii* (Service 2019a, pp. 55–59). We concluded that the implementation of the revised LRMP is not likely to jeopardize the continued existence of *E. parishii* or result in destruction or adverse modification of its designated critical habitat because of (1) implementation of the Carbonate Strategy and (2) minimization and avoidance measures (Service 2019a, p. 59).

In 2019, we issued a biological opinion for the BLM’s proposed land use plan amendment under the West Mojave Route Network Plan, San Bernardino, Inyo, Kern, Riverside, and Los Angeles Counties, California (Service 2019b, entire). We concluded the proposed action is not likely to jeopardize the continued existence of *Erigeron parishii* or affect its designated critical habitat because the BLM (1) is not proposing to develop new routes through known occurrences and has decreased the area likely to be disturbed by designated routes; and (2) will allow stopping, parking, and camping only in previously disturbed areas, which are unlikely to support individuals of *E. parishii* (Service 2019b, p. 90).

In 2022, we issued a biological opinion for the USFS’s proposed special-use permit application to upgrade and rebuild the existing Doble 33-kilovolt overhead distribution line (Service 2022, entire). We concluded the proposed action is not likely to jeopardize the continued existence of *Erigeron parishii* or adversely modify its designated critical habitat because (1) the Applicant will implement conservation measures to avoid and minimize project impacts; (2) the proposed action is not likely to appreciably reduce the number, distribution, and reproduction because the loss of occupied habitat is considered negligible; and (3) the proposed action is not likely to cause impairment of recovery efforts (Service 2022, p. 43).

Other Research

Since the 2009 5-year review, two interrelated studies were published that involve three federally listed carbonate plants, *Erigeron parishii*, *Eriogonum ovalifolium* var. *vineum*, (Cushenbury

milk-vetch), and *Acanthoscyphus parishii* var. *goodmaniana* (Cushenbury oxytheca). The purposes of the studies were to demonstrate the application of graph theoretic metrics to evaluate habitat connectivity (Neel *et al.* 2014, entire) and to demonstrate an assessment approach for estimating persistence metrics for species based on habitat configuration (Che-Castaldo and Neel 2016, entire). In those demonstrations, the studies compared potential conservation implications of two land conservation scenarios, (1) the preservation of all Service-designated critical habitat and (2) an estimation of the Carbonate Strategy's Habitat Reserve. Species persistence in areas of critical habitat were reported to be similar to current levels, while species persistence was reported to be lower in the Carbonate Strategy Habitat Reserve; this was lower because habitat outside of the reserve area was excluded and was not considered in the modeling effort (Che-Castaldo and Neel 2016, p. 1303). However, the study provides a useful framework to evaluate species status and a tool to evaluate which recovery actions may be needed for recovery (Che-Castaldo and Neel 2016, p. 1304).

In addition to the habitat model developed by Joshua Tree National Park (discussed in the [Habitat](#) section above), several contractors have created habitat suitability models for *Erigeron parishii* and other rare plants in southern California. Reese *et al.* (2019, pp. 3, 5, Table 1) evaluated three of the contractors' habitat suitability models for *E. parishii* for an area of the California desert that is managed by the BLM and is prioritized for renewable energy development. The purpose of the study was to use the existing habitat models to map probable and potential suitable habitat for rare plant species (Reese *et al.* 2019, p. 1). The final map products are intended for use by land management agencies to review proposed projects and plan future surveys, and for use by developers to target sites that will likely minimize conflicts with rare plant conservation (Reese *et al.* 2019, p. 1). Based upon evaluation of the three models, Reese *et al.* (2019, S1 supporting information, p. 2) found 323,265 ac (130,821 ha) of probable suitable habitat for *E. parishii* within the project boundary, of which 3,031 ac (1,227 ha) occurred in areas prioritized for energy development. Complete electronic datasets for all Reese *et al.* (2019) study results are available from the [ScienceBase Catalog](#).

Threats

This section summarizes new information about threats to *Erigeron parishii* since 2009. The 2009 5-year review discussed Factor A threats (present or threatened destruction, modification, or curtailment of habitat or range) from mining, urban development, off-highway vehicle use, energy development projects, fire suppression activities, and other land use activities that could result in trampling or ground disturbance (Service 2009, pp. 6–8). The review also discussed Factor C threats (disease or predation) from burro grazing, Factor D threats (inadequacy of existing regulatory mechanisms) and Factor E threats (other natural or manmade factors affecting a species' continued existence) from stochastic extinction and climate change (Service 2009, pp. 9–12).

The description of threats in the 2009 5-year review is still accurate and mining is still the primary threat to *Erigeron parishii*. The following sections provide updated information on the threats of land use activities and climate change to *E. parishii*.

Land Use

The 2009 5-year review discussed threats from mining, urban development, off-highway vehicle use, energy development projects, fire suppression activities, and other land use activities that could result in trampling or ground disturbance (Service 2009, pp. 6–9). The following subsections provide updated information about the threat of grazing, descriptions of how land use threats are distributed across the range of *Erigeron parishii*, and a summary of land use designations (including active mining and Habitat Reserves) in the Carbonate Strategy area.

Grazing

The threat of grazing by burros was discussed in the 2009 5-year review but the potential effects to *Erigeron parishii* from burro grazing are considered minimal (Service 2009, p. 9). Cattle grazing was not described as a threat to *E. parishii* in the final listing rule (Service 1994, entire) or the previous 5-year review (Service 2009, entire). However, cattle grazing has been reported as a threat to 10 occurrences of *E. parishii* in the eastern San Bernardino Mountains and Bighorn Mountains (CDFW 2022, dataset). Effects to *E. parishii* from cattle could include predation (Factor C) or trampling and ground disturbance (Factor A).

Distribution of land use threats

The distribution of threats related to land use activities varies across the range of *Erigeron parishii*. Threat pressure and intensity differ by region, land ownership, and by management designation as a protected reserve or wilderness area. [Figure 2](#) shows landscape-level management areas that provide various levels of protection to *E. parishii* from land use threats. Most occurrences in the Eastern and Southeastern geographic groups are within the Bighorn Mountain or Joshua Tree wilderness areas ([Figure 2](#)). Wilderness area designation protects the land from mining, development, and authorized off-highway vehicle recreation. Primarily affecting Western Group occurrences, the Carbonate Strategy’s Habitat Reserve ([Figure 3](#)) protects blocks of carbonate habitat from mining and development for conservation of carbonate plant species. There will also be some protections for habitat in the proposed Blackhawk Research Natural Area (Western Group; [Figure 2](#)). Research Natural Areas are “managed in conditions minimally disturbed by human activities for nonmanipulative research, monitoring, education and to maintain natural diversity and ecological processes” (USFS 1993, p. 1). Once the designation is finalized, large portions of EO 6 and EO 10 will have this protection. The distributions of specific land use threats across the species’ range are summarized in [Table 3](#) below.

Table 3. Descriptions of the distribution of six land use threats across the range of *Erigeron parishii*.

Land Use Threat	Distribution of Threat
Mining	This threat is primarily limited to Western Group occurrences (Figure 3) but some <i>E. parishii</i> locations in the Eastern Group that are under mining claim (BLM 2022, dataset) or on private land are also threatened by mining.
Development (including energy development projects)	At least two occurrences are threatened by development (CDFW 2022, dataset). Near Pioneertown, EO 27 is threatened by development, while the neighboring occurrence (EO 22) is protected by its location on the Burns Piñon Ridge Reserve. EO 46 is reportedly threatened by a proposed powerline corridor even though the site is protected by its location in the Bighorn Mountains Wilderness. Generally, populations outside of protected areas (e.g., wilderness areas, reserves) may be affected by future development.
Off-highway vehicle use	This threat is present throughout most of the range of <i>E. parishii</i> , but the threat is lower in protected areas (e.g., wilderness areas, reserves). Off-highway vehicle use is not considered a potential threat to populations in Joshua Tree National Park (Fraga <i>et al.</i> 2014, p. 21).
Fire suppression activities	This threat could affect <i>E. parishii</i> in any part of the species' range.
Grazing	This threat is primarily a concern in the Eastern Group of occurrences in San Bernardino National Forest and on BLM land. Some occurrences in the eastern part of the Western Group (EOs 11, 26, and 30) are also threatened by cattle grazing.
Other land use activities that could result in trampling or ground disturbance (e.g., dispersed camping)	This threat could affect <i>E. parishii</i> in any part of the species' range.

Carbonate Strategy

Guided by the Carbonate Strategy (Olson 2003, entire) and consultations between the Service and San Bernardino National Forest (see sections titled [Carbonate Habitat Management Strategy](#) and [Consultations](#) above), the following changes have been made to land use status since 2009:

1. Portions of EO 6 and EO 10 have been protected by addition to the Habitat Reserve.
2. An additional portion of EO 24 has been approved for active mining.

At present, 31 *Erigeron parishii* occurrences and approximately 2,094 ac (847 ha) of mapped occupied habitat are within the geographic area covered by the Carbonate Strategy ([Figure 3](#)). [Table 4](#) shows the acreages of *E. parishii* occurrences in the various categories of land use described by the Carbonate Strategy (Olson 2003, pp. 15–17). Habitat in the Habitat Reserve category (15 percent; [Table 4](#)) is permanently protected from mining and is managed for the conservation of the rare carbonate plants.

Table 4. Acreages of occupied *Erigeron parishii* EOs (CDFW 2022, dataset) within the Carbonate Strategy area (USFS 2022, dataset).

Carbonate Strategy Land Use	Acres of Mapped Occupied Habitat
Total occupied habitat within the Carbonate Strategy area	2,094
Federal land not designated to another category	1,056
Private or state land not designated to another category	571
Habitat Reserve	320
Active mining	103
High commercial value federal lands that have been designated for transfer to private ownership	44

Climate Change

Climate change refers to a shift in the mean or variability in measures of climate (e.g., precipitation or temperature) that persists for an extended period, typically a decade or more, due to natural variability, human activity, or both (IPCC 2013, p. 1450). A recent climate change vulnerability assessment of Mojave Desert region plants classified *Erigeron parishii* as “moderately vulnerable” to climate change, meaning that the species’ abundance and/or range extent are likely to decrease by 2050 (Wilkening *et al.* 2021, pp. 7, 11, Table 2, Table 3). The key factors contributing to *E. parishii* vulnerability in the assessment were natural barriers that restrict movement in response to changing climatic conditions, dispersal ability, and physical habitat (dependence upon a particular uncommon landscape or geological feature) (Wilkening *et al.* 2021, pp. 11–12, Table 3).

The 2009 5-year review described climate change as a threat to *Erigeron parishii*, but region-specific projections of future climatic conditions were uncertain (Service 2009, p. 12). Since then, downscaled projections under multiple future climate scenarios have become available for California and its sub-regions, including the range of *E. parishii*. The following sub-sections describe projections for changes in temperature and precipitation within the range of *E. parishii* based on recent downscaled climate models.

Temperature changes

All of California has experienced a warming trend from 1896 to 2015 (He and Gautam 2016, p. 11). Cal-Adapt models project that annual average maximum and minimum temperatures in the range of *Erigeron parishii* will continue to increase in the 21st century (Table 5). Specifically, annual average maximum temperatures are projected to increase by 5.9 °F (3.3 °C) under the Representative Concentration Pathway (RCP) 4.5 emissions scenario, and by 8.7 °F (4.8 °C) under the RCP 8.5 emissions scenario by the end of the century (2070 and 2099) (CEC 2022, dataset). The frequency, duration, and intensity of heat waves is also expected to increase in southern California (Hall *et al.* 2018, p. 11–12; Hopkins 2018, p. 14; Kalansky *et al.* 2018, p. 21). How *E. parishii* will respond to these changes is uncertain.

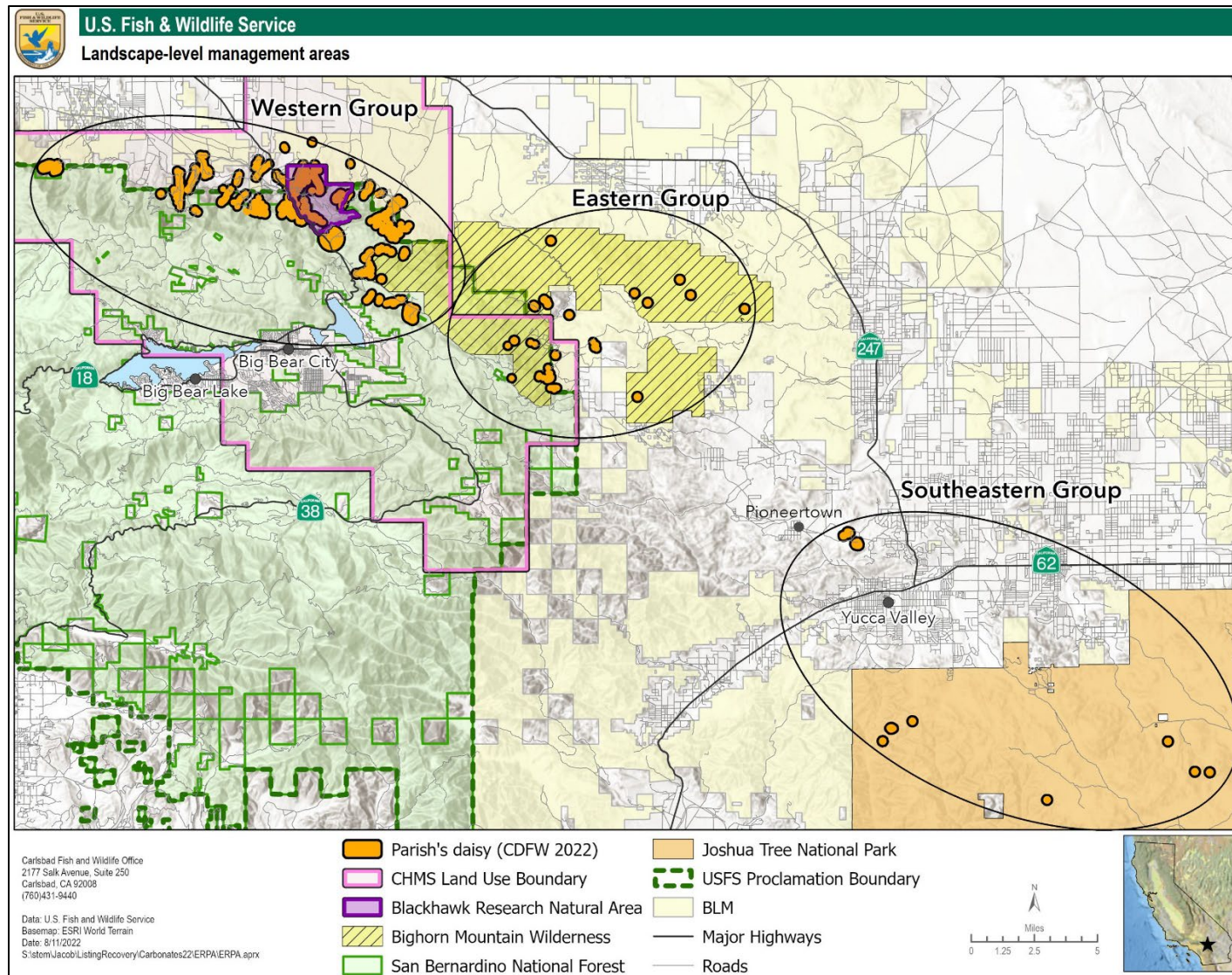


Figure 2. Map of *Erigeron parishii* occurrences (CDFW 2022, dataset) showing the Carbonate Habitat Management Strategy (CHMS) boundary, proposed Blackhawk Research Natural Area, Bighorn Mountain Wilderness Area, and Joshua Tree National Park. All occurrences in Joshua Tree National Park are also within the Joshua Tree Wilderness Area. BLM = Bureau of Land Management.

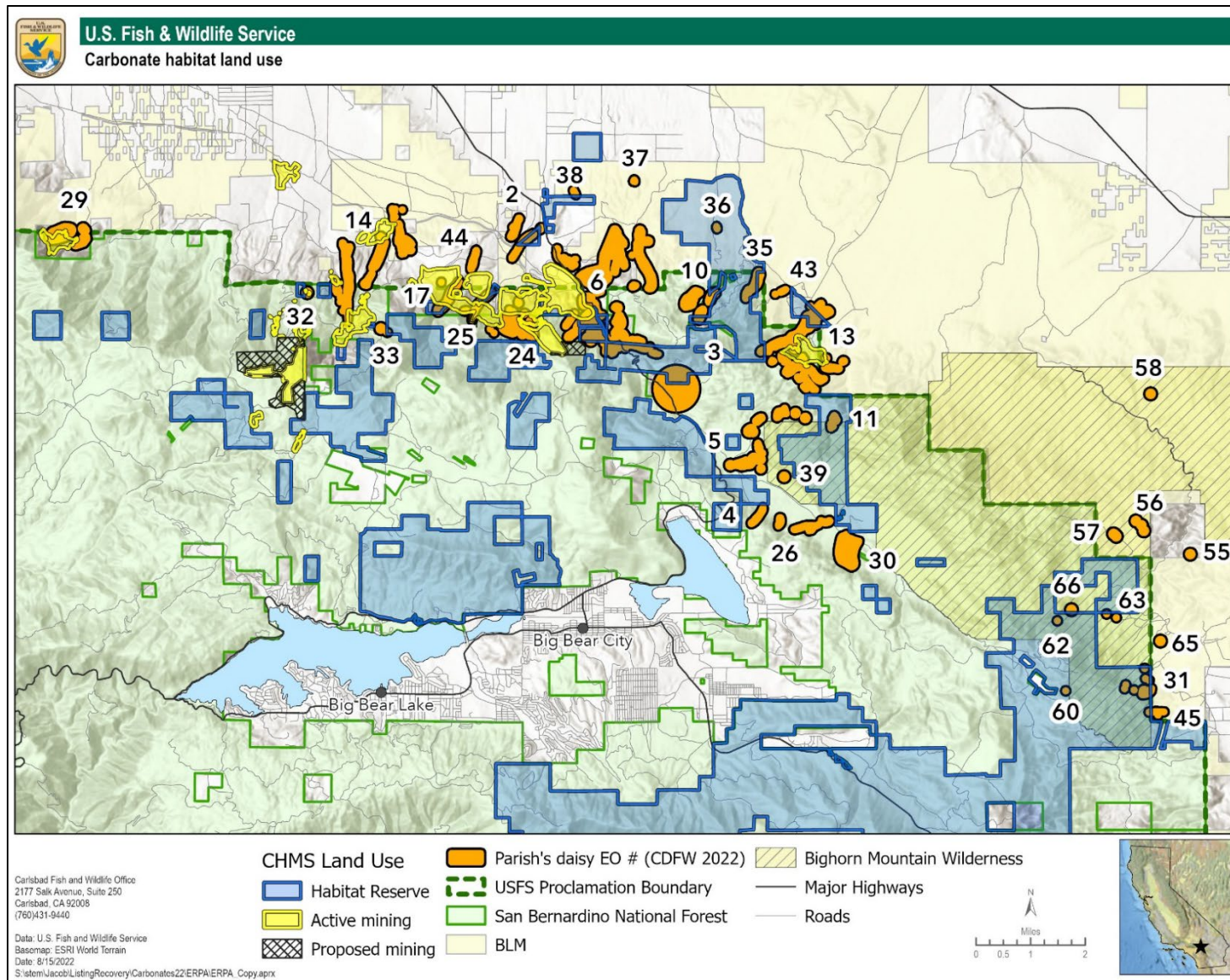


Figure 3. Map of the Carbonate Habitat Management Strategy's (CHMS) Habitat Reserve, active mining, and proposed mining land use types within the range of *Erigeron parishii* (USFS 2022, dataset). BLM = Bureau of Land Management.

Table 5. Projected annual average maximum and minimum temperatures for the range of *Erigeron parishii*. The values are the average of projections from four priority models (i.e., MIROC5, CanESM2, HadGEM2-ES, and CNRM-CM5) for the historical (1950–2004), mid-century (2040–2069), and end-of-century (2070–2099) time periods. Average projections are provided for two emissions scenarios, Representative Concentration Pathway (RCP) 4.5 and RCP 8.5. Units are in degrees Fahrenheit. Data are sourced from Cal-Adapt (CEC 2022, dataset).

Time Period	RCP 4.5 projected annual average maximum temperature	RCP 4.5 projected annual average minimum temperature	RCP 8.5 projected annual average maximum temperature	RCP 8.5 projected annual average minimum temperature
1950–2004 (modeled)	70.1 (range: 66.3–73.8)	39.7 (range: 36.9–42.5)	70.1 (range: 66.3–73.8)	39.7 (range: 36.9–42.5)
2040–2069	74.8 (range: 71.3–77.8)	44.2 (range: 41.9–47.8)	76.2 (range: 72.8–80.1)	45.5 (range: 42.2–51.1)
2070–2099	76.0 (range: 73.2–79.2)	45.2 (range: 42.8–47.8)	78.8 (range: 74.5–83.3)	48.9 (range: 45.1–53.9)

Precipitation changes

Climate change has already altered, and will continue to alter, the water cycle. Changes in the water cycle include (but are not limited to) changes in precipitation patterns and intensity, changes in the incidence of drought, widespread melting of snow and ice, increasing evaporation, and changes in soil moisture and runoff (U.S. Global Change Research Program 2009, p. 41).

Precipitation in southern California is highly variable from year to year (Hall *et al.* 2018, p. 12; Hopkins 2018, p. 5; Kalansky *et al.* 2018, p. 24). Models of future precipitation generally project small mean changes relative to historical variability, and the overall direction of future precipitation is unclear (Hall *et al.* 2018, p. 13; CEC 2022, dataset). While model predictions of future rainfall in the Inlands Desert region are highly variable, winter precipitation is generally projected to increase and summer precipitation decrease (Hopkins 2018, pp. 7, 18). Models also project increases in extreme precipitation frequency and intensity (Polade *et al.* 2017, p. 7; Swain *et al.* 2018, p. 428). With dryer soils because of higher temperatures and less summer precipitation, intense winter rainfall events are expected to increase runoff and probability of flash floods (Hopkins 2018, pp. 7, 18). In addition, droughts are projected to become more frequent and intense and will be exacerbated by higher temperatures (Hall *et al.* 2018, p. 19; Hopkins 2018, pp. 7–8; Kalansky *et al.* 2018, p. 25).

Climate change summary and synthesis

For this 5-year review, we discussed reports from California’s Fourth Climate Change Assessment (Hall *et al.* 2018, entire; Hopkins 2018, entire; Kalansky *et al.* 2018, entire) and climate change projections for the range of *Erigeron parishii* (CEC 2022, dataset). Climate

models provided projections of future maximum and minimum temperatures under two emissions scenarios (RCP 4.5 and RCP 8.5) and of future changes in patterns of precipitation.

In the 2009 review, we discussed potential effects of climate change but did not have enough information to make specific predictions about effects to *Erigeron parishii* (Service 2009, p. 12). Since then, new climate projections have become available, and long-term monitoring of a population in Joshua Tree National Park suggest that *E. parishii* is sensitive to climate conditions. The amount of winter precipitation appears to affect *E. parishii* survival, recruitment, and reproductive output (La Doux 2022, pp. 2, 6–7), likely because of its effect on soil moisture during the growing and reproductive season. While uncertain due to model variability, increases in winter precipitation may be beneficial for *E. parishii*. However, with the projections of increased incidence of drought and dryer soils, climate change could still negatively impact the species even if winter precipitation remains the same or increases.

While temperatures are cooler and precipitation is greater in the western part of the species' range, western *Erigeron parishii* populations could be similarly affected by shifts in temperature and soil moisture because these populations might be less adapted to hotter and drier conditions. Western populations are also mostly limited to isolated occurrences of specific carbonate soils. As discussed in the 2009 review (Service 2009, p. 12), these populations might have limited ability to shift their distribution in response to climate change (e.g., upward elevational shift in response to warmer conditions at lower elevations) because of the patchiness and limited availability of carbonate soil habitat. It remains uncertain whether *E. parishii* populations will be able to persist under projected climate conditions, but it is likely that increased temperatures, drought, and intensity of precipitation events in the future would negatively affect *E. parishii*.

Summary of Threats

Since the 2009 5-year review, we received new information about ongoing threats to *Erigeron parishii* relating to land use activities and climate change. This new information does not alter the conclusions of our 2009 5-year review.

CONCLUSION

The 2009 5-year review recommended no status change for *Erigeron parishii*. Since 2009, we reviewed new information on *E. parishii* distribution, abundance, genetics, life history, conservation activities, and threats. Nineteen new occurrences have been discovered since 2009. The status of land use has changed for three occurrences with some habitat being permanently protected for conservation of the species and other habitat being approved for active mining. Accounting for all new information, there are currently 51 occurrences of *E. parishii*. Of the 51 occurrences, 50 are extant or presumed extant and 1 has an unknown status (CDFW 2022, dataset). Cattle grazing has been identified as a new threat in this 5-year review, but mining and climate change are the primary threats to the species.

The change in status of occurrences and new information on threats do not substantially alter the species status or the results of the previous 5-factor analysis in the 2009 5-year review. Therefore, we conclude that *Erigeron parishii* remains a federally threatened species.

RECOMMENDATIONS FOR FUTURE ACTIONS

The recommended actions listed below are to be initiated over the next 5–10 years. Successful implementation of these actions will reduce threats to *Erigeron parishii* and provide information to better understand the biological and physical factors limiting population growth and distribution. We recognize that conservation of this taxon will require cooperation and coordination with partners to minimize impacts from current threats and aid future restoration efforts.

1. Continue implementation of the Carbonate Habitat Management Strategy, particularly additions of *E. parishii* habitat to the Habitat Reserve and withdrawal of mining claims on habitat with high conservation value.
2. Research *E. parishii* populations' susceptibility to climate change by determining climate tolerances (e.g., temperature, drought duration) for reproduction and survival of different age or size classes. Identify areas of climate refugia to protect in different populations across the range.
3. Determine appropriate monitoring frequency for *E. parishii* and implement a range-wide monitoring strategy that provides useful information about occupancy and population health.
4. Conduct a species status assessment to assess viability given climate change projections, conservation, and progress in threat reduction. The assessment may be used to revise recovery criteria or to inform a reclassification decision.
5. Continue managing the threat of roads, off-road vehicle activity, or other recreational activities to carbonate habitat. This may be achieved through road decommissioning, installation and maintenance of signs and barriers, or other management.
6. Research the efficacy of restoring *E. parishii* populations on reclaimed lands that have been restored after mining.
7. Finalize the establishment of the proposed Blackhawk Research Natural Area.
8. Collect additional *E. parishii* seeds, as needed, to maintain a viable and genetically diverse conservation seed bank.

REFERENCES CITED

- [BLM] Bureau of Land Management. 2022. Mineral & Land Records System. Bureau of Land Management National Land Status Database, U.S. Department of Interior. Accessed April 13, 2022. <https://mlrs.blm.gov/s/>.
- California Botanic Garden. 2022. *Erigeron parishii* seed collection data from the California Botanic Garden from EOs 5, 6, 13, 43, and 47 in 2010, 2011, and 2020 (unpublished data).
- [CDFW] California Department of Fish and Wildlife. 2022. California Natural Diversity Database. Accessed July 15, 2022. <https://apps.wildlife.ca.gov/>.
- [CEC] California Energy Commission. 2022. Cal-Adapt. Data: LOCA Downscaled CMIP5 Climate Projections (Scripps Institution of Oceanography), Gridded Observed Meteorological Data (University of Colorado Boulder), LOCA Derived Products (Geospatial Innovation Facility). Accessed August 8, 2022. <https://cal-adapt.org/>.
- Che-Castaldo, J.P. and M.C. Neel. 2016. Species-level persistence probabilities for recovery and conservation status assessment. *Conservation Biology* 30(6):1297–1306.
- Fraga, N., T. La Doux, L. Prince, M. Harding, and J. Hoines. 2014. Conservation assessment for Parish’s daisy (*Erigeron parishii*, Asteraceae) in Joshua Tree National Park. Natural Resource Report NPS/JOTR/NRR—2014/887. National Park Service, Fort Collins, Colorado.
- Hall, A., N. Berg, and K. Reich. 2018. Los Angeles region report. California's Fourth Climate Change Assessment. Publication number: SUM-CCCA4-2018-007, 97 pp.
- He, M., and M. Gautam. 2016. Variability and trends in precipitation, temperature and drought indices in the State of California. *Hydrology* 3(2), 14 pp.
- Hopkins, F. 2018. Inland Deserts Summary Report. California’s Fourth Climate Change Assessment. Publication number: SUM-CCCA4-2018-008, 67 pp.
- [IPCC] Intergovernmental Panel on Climate Change. 2013. Annex III: Glossary [Planton, S. (ed.)]. *In Climate Change 2013: The Physical Science Basis. Contribution of Working Group I to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change* [Stocker, T.F., D. Qin, G.-K. Plattner, M. Tignor, S.K. Allen, J. Boschung, A. Nauels, Y. Xia, V. Bex and P.M. Midgley (eds.)]. Cambridge University Press, Cambridge, United Kingdom and New York, New York, USA.
- Kalansky, J., D. Cayan, K. Barba, L. Walsh, K. Brouwer, and D. Boudreau. 2018. San Diego summary report. California's Fourth Climate Change Assessment. Publication number: SUM-CCCA4-2018-009, 114 pp.
- La Doux, T. 2022. Summary of *Erigeron parishii* monitoring at JOTR. Memorandum from the National Park Service sent to the U.S. Fish and Wildlife Service via email attachment on August 5, 2022. 7 pp.

- La Doux, T. and M. Harding. 2014. Appendix E: Pilot demographic and reproductive biology study for *Erigeron parishii* in Joshua Tree National Park, Pages 56–64 in Conservation assessment for Parish’s daisy (*Erigeron parishii*, Asteraceae) in Joshua Tree National Park. National Park Service. Pp. 56–64.
- Murphy, S., M. Harding, and T. La Doux. 2014. Appendix C: GIS habitat model for *Erigeron parishii*, Pages 44–51 in Conservation assessment for Parish’s daisy (*Erigeron parishii*, Asteraceae) in Joshua Tree National Park. National Park Service. Pp. 44–51.
- Neel, M.C. 2000. The structure of diversity: implications for reserve design. Ph.D. Thesis. University of California, Riverside. 218 pp.
- Neel, M., H.R. Tumas, and B.W. Marsden. 2014. Representing connectivity: quantifying effective habitat availability based on area and connectivity for conservation status assessment and recovery. PeerJ 2:e622.
- Olson, T.G. 2003. Carbonate habitat management strategy. Prepared for San Bernardino National Forest Association. 87 pp. + appendices.
- Polade, S.D., A. Gershunov, D.R. Cayan, M.D. Dettinger, and D.W. Pierce. 2017. Precipitation in a warming world: Assessing projected hydro-climate changes in California and other Mediterranean climate regions. Scientific Reports 7:10783.
- Prince, L. and N. Fraga. 2014. Appendix B: Genetic study (Rancho Santa Ana Botanic Garden), Pages 30–43 in Conservation assessment for Parish’s daisy (*Erigeron parishii*, Asteraceae) in Joshua Tree National Park. National Park Service. Pp. 30–43.
- Reese G.C., S.K. Carter, C. Lund, and S. Walterscheid. 2019. Evaluating and using existing models to map probable suitable habitat for rare plants to inform management of multiple-use public lands in the California desert. PLoS ONE 14(4): e0214099. <https://doi.org/10.1371/journal.pone.0214099>.
- Rindfleisch, P. 2009. Soil Analysis for Quail Mountain population, Report provided as Appendix G (Pages 72–77) in Conservation assessment for Parish’s daisy (*Erigeron parishii*, Asteraceae) in Joshua Tree National Park (2014). Natural Resource Conservation Survey and National Park Service. Pp. 72–77.
- Swain, D.L., B. Langenbrunner, J.D. Neelin, and A. Hall. 2018. Increasing precipitation volatility in twenty-first-century California. Nature Climate Change 8:427–433.
- [Service] U.S. Fish and Wildlife Service. 1994. Endangered and threatened wildlife and plants; five plants from the San Bernardino Mountains in southern California determined to be threatened or endangered; final rule. Federal Register 59:43652–43664.
- [Service] U.S. Fish and Wildlife Service. 2002. Endangered and threatened wildlife and plants; Designation of critical habitat for five carbonate plants from the San Bernardino Mountains in Southern California; final rule. Federal Register 67:78570–78610.

- [Service] U.S. Fish and Wildlife Service. 2005. Biological Opinion for the Carbonate Habitat Management Strategy, San Bernardino County, California. Carlsbad Fish and Wildlife Office, Department of the Interior. 38 pp.
- [Service] U.S. Fish and Wildlife Service. 2009. *Erigeron parishii* (Parish's daisy) 5-Year Review: Summary and Evaluation. Carlsbad Fish and Wildlife Field Office, Carlsbad, California. 20 pp.
- [Service] U.S. Fish and Wildlife Service. 2015. Biological Opinion for the North Big Bear, Baldwin Lake, and Bluff Mesa Fuels Reduction Projects, Mountaintop Ranger District, San Bernardino National Forest, California. Carlsbad Fish and Wildlife Office, Department of the Interior. 109 pp
- [Service] U.S. Fish and Wildlife Service. 2016. Memorandum: Bureau of Land Management submittal of reports on two projects to be covered under the programmatic biological opinion for the Carbonate Habitat Management Strategy. Palm Springs Fish and Wildlife Office, Palm Springs, California. 4 pp.
- [Service] U.S. Fish and Wildlife Service. 2017a. Biological Opinion for the Mitsubishi South Quarry Expansion, Mountaintop Ranger District, San Bernardino National Forest, San Bernardino County, California. Carlsbad Fish and Wildlife Field Office, Department of the Interior. 28 pp.
- [Service] U.S. Fish and Wildlife Service. 2017b. Memorandum: Bureau of Land Management Resubmission of Biological Assessment for a Direct Land Sale. Palm Springs Fish and Wildlife Field Office, Palm Springs, California. 2 pp.
- [Service] U.S. Fish and Wildlife Service. 2019a. Biological Opinion for the ongoing activities that affect twelve mountain plant species in the San Bernardino National Forest, California. Carlsbad Fish and Wildlife Office, Department of the Interior. 109 pp.
- [Service] U.S. Fish and Wildlife Service. 2019b. Biological Opinion for the West Mojave Route Network Project, San Bernardino, Inyo, Kern, Riverside, and Los Angeles Counties, California. Carlsbad Fish and Wildlife Office, Department of the Interior. 118 pp.
- [Service] U.S. Fish and Wildlife Service. 2019c. Memorandum: Informal Section 7 Consultation for the Proposed Big Morongo Canyon Area of Critical Environmental Concern Programmatic Restoration Project. Palm Springs Fish and Wildlife Field Office, Palm Springs, California. 9 pp.
- [Service] U.S. Fish and Wildlife Service. 2021. Initiation of 5-Year Status Reviews of 76 Species in California and Nevada. Federal Register 86:27462–27464.
- [Service] U.S. Fish and Wildlife Service. 2022. Biological Opinion for the Doble 33-kilovolt Distribution Line Rebuild, San Bernardino County, California. Carlsbad Fish and Wildlife Office, Department of the Interior. 68 pp.

[USFS] U.S. Forest Service. 1993. Research Natural Areas Program National Strategy: Opportunities for the Future. July 1993. 3 pp. Accessed August 5, 2022. <https://www.nrs.fs.fed.us/rna/local-resources/downloads/RNAstrategy93.pdf>.

[USFS] U.S. Forest Service. 2021. Threatened, Endangered, and Sensitive Plant database. Data current as of August 2, 2021.

[USFS] U.S. Forest Service. 2022. CHMS (Carbonate Habitat Management Strategy) Land Use spatial data. Data updated on March 7, 2022. Sent via email by Scott Eliason of the U.S. Forest Service to Stephanie Prevost of the U.S. Fish and Wildlife Service on March 7, 2022.

U.S. Global Change Research Program. 2009. Global climate change impacts in the United States, Karl, T.R., J.M. Melillo, and T.C. Peterson (eds.). Cambridge University Press, 196 pp.

Wilkening, J., L. Kobelt, and T. Pereira. 2021. Climate Change Vulnerability Assessment of Imperiled Plants in the Mojave Desert *In* S. Kumar (ed.), Endangered Plants. IntechOpen, London, United Kingdom. 10.5772/intechopen.95783.

Personal Communication

Crawford, M. 2022. Fish and Wildlife Biologist, U.S. Fish and Wildlife Service. Personal communication via email to Stephanie Prevost of the U.S. Fish and Wildlife Service dated August 4, 2022. Subject: erroneous ERPA record north of Lake Arrowhead.

FIELD OFFICE APPROVAL

Lead Field Supervisor, Fish and Wildlife Service

Approve

Scott A. Sobiech
Field Supervisor