Astragalus albens
(Cushenbury milk-vetch)

5-Year Review:
Summary and Evaluation

Photo by Scott Eliason

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

August, 2022

5-YEAR REVIEW

Astragalus albens
(Cushenbury milk-vetch)

GENERAL INFORMATION

Species: *Astragalus albens* (Cushenbury milk-vetch), a plant variety
Date listed under the Endangered Species Act: August 24, 1994
Federal Register citation: Service 1994 (59 FR 43652)
Classification: Endangered
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, maintain 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. *Astragalus albens* (Cushenbury milk-vetch) 5-year Review: Summary and Evaluation. Prepared by the Carlsbad Fish and Wildlife Office, Carlsbad, California. 20 pp.

We initiated a status review for *Astragalus albens* 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 (FR) 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, entire).

Species Overview and Habitat: *Astragalus albens* is a short-lived perennial herb in the *Fabaceae* (pea) family. The species is endemic to the northeastern San Bernardino Mountains, San Bernardino County, California. It occurs on discontinuous patches of carbonate soils derived from limestone, dolomite, or a mixture of limestone and dolomite (Tierra Madre Consultants, Inc. 1992, p. 33).

ASSESSMENT

Information acquired since the last status review

This 5-year review was conducted by the Service's Carlsbad Fish and Wildlife Office. Data for this review were 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 Database[1] (CNDDB); 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), 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 Occurrence Status

Astragalus albens is endemic to "bands" of carbonate soils found on desert-facing slopes at the northern edge of the San Bernardino Mountains (Service 1994, pp. 43652–43653). This species is limited to the carbonate soils just north and northeast of Big Bear Lake, San Bernardino County, California (Figure 1). There are 23 Element Occurrences[2] (EO) recognized by CDFW (2022, dataset) and there is one additional locality record approximately 0.5 mile east of EO 19 (USFS 2021, dataset) (Figure 1).

Since the most recent 5-year review (Service 2009, entire), our knowledge of *Astragalus albens* distribution and status of occurrences has changed slightly. These changes are described below and in Table 1.

1. Two new occurrences [EOs 28 and 30 (Table 1)] have been discovered since the 2009 5-year review.

2. Two occurrences that were discovered prior to 2009 [EO 29 and the unnumbered USFS locality east of EO 19 (Figure 1; Table 1)] are included in this assessment but were not included in the 2009 5-year review.

3. The status of land use has changed in portions of four occurrences (Table 1). Guided by the Carbonate Habitat Management Strategy (Carbonate Strategy; Olson 2003, entire) and consultations between the Service and San Bernardino National Forest (see sections

[1] The CNDDB is an inventory of the status and locations of rare plants and animals in California.
[2] The CNDDB 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 CNDDB, or locations not in the CNDDB that are greater than 0.25 mile (0.40 kilometer) apart.

titled Carbonate Habitat Management Strategy and Consultations below), the following changes have been made since 2009:

a. A large portion of EO 2 has been protected by addition to the Carbonate Strategy's Habitat Reserve.

b. A small portion of EO 4 has been protected by addition to the Habitat Reserve.

c. A small portion of EO 6 has been approved for active mining.

d. A large portion of EO 17 has been protected by addition to the Habitat Reserve.

In summary, we consider there to be 24 known occurrences of *Astragalus albens*. Of the 24 occurrences, 7 are extant (i.e., the species was observed during the past 10 years), 16 are presumed extant (i.e., the species was not observed during the past 10 years, but suitable habitat is present), and one is unknown because habitat suitability may have been impacted by mining (Table 1). One occurrence is fully protected and eight are partially protected as part of the Carbonate Strategy's Habitat Reserve (Figure 2; Table 1). Portions of four occurrences are known to be under active mining (i.e., are being actively mined or have approved plans to be mined) (Figure 2).

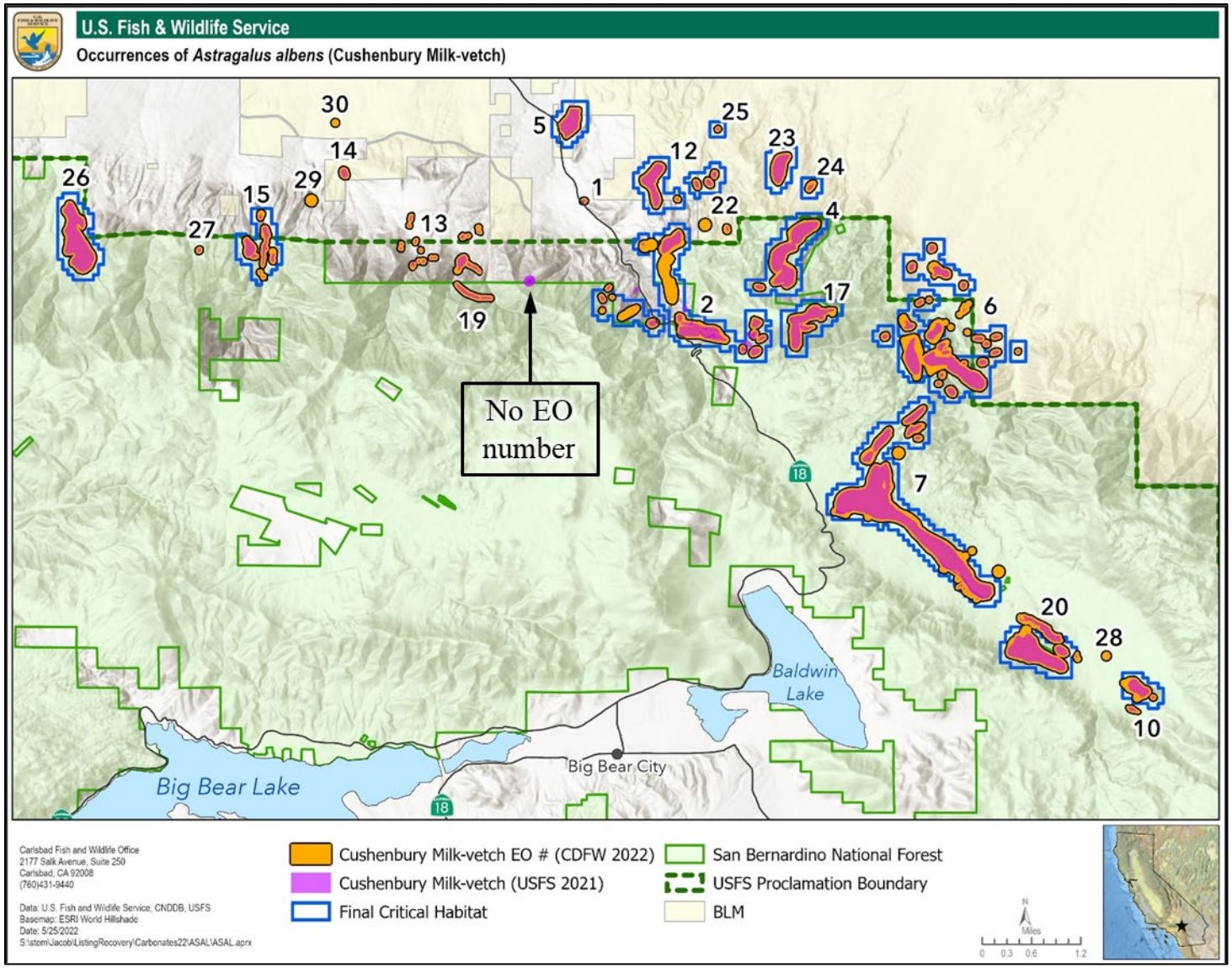

Figure 1. Map of *Astragalus albens* occurrences and critical habitat. Occurrence data are sourced from the California Natural Diversity Database (CDFW 2022) and USFS Threatened, Endangered, and Sensitive Plant database (USFS 2021). BLM = Bureau of Land Management.

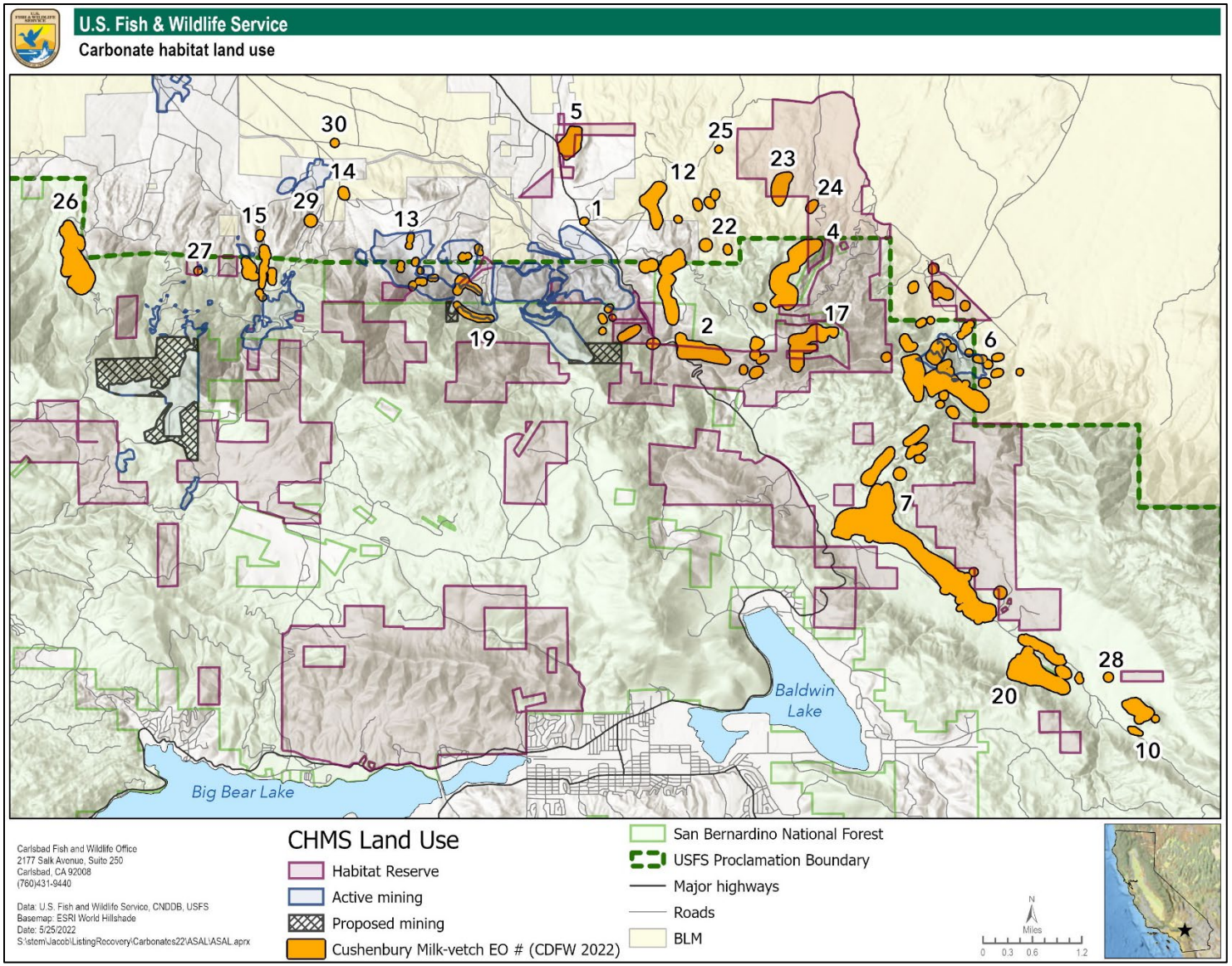

Figure 2. Map of the Carbonate Habitat Management Strategy's (CHMS) Habitat Reserve, active mining, and proposed mining land use types within the range of *Astragalus albens* (USFS 2022, dataset). BLM = Bureau of Land Management.

Table 1. Occurrence table for *Astragalus albens* showing 2022 occurrence status, changes since the 1994 final listing rule and 2009 5-year review, and threats (excluding climate change). 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.

CNDDB Element Occurrence (EO) Number	Owner	Status in 1994	Status in 2009	Status in 2022	Observations and counts[A]	Conservation status[B]	Threats[C]	Change since last review
1	Private	Presumed extant	Presumed extant	Presumed extant	1882: collected; 1942: collected; 1988: no plants found; Before 2000: recorded on unknown date	On private land near active mining; no critical habitat	Mining (including cement dust from adjacent mine activity)	No change
2	USFS, private	Extant	Presumed extant	Extant	FOR PORTIONS OF OCCURRENCE: 1986: fewer than 100 observed; 1987: 1 observed; 1988: 283+ observed; 1998: observed; 2011: 150 observed, seeds collected; 2014: 133 observed; 2017: "uncommon"	Partially protected by Habitat Reserve, partially on private land or under mining claim within proposed Blackhawk Research Natural Area, partially under mining claim on federal land near active mining, and partially on undesignated federal land	Mining; Off-road or off-highway vehicle activity	Partial change in conservation status (large portion became part of Habitat Reserve as a result of mining mitigation); observation update; seed collection
4	USFS	Extant	Presumed extant	Presumed extant	FOR PORTIONS OF OCCURRENCE: 1988: 60 observed, but 200 estimated; 1994: 8 observed; 1998: observed; 2011: 46 observed	Mostly under mining claim within proposed Blackhawk Research Natural Area and partially protected by Habitat Reserve	Mining; Off-road or off-highway vehicle activity	Partial change in conservation status (small area added to Habitat Reserve); observation update

CNDDB Element Occurrence (EO) Number	Owner	Status in 1994	Status in 2009	Status in 2022	Observations and counts[A]	Conservation status[B]	Threats[C]	Change since last review
5	BLM, private	No records	Presumed extant	Extant	1995: 50 observed in southwestern portion of occurrence; 1998: observed; 2020: seeds collected, "frequent/scattered, and at times locally common"	Mostly protected by Habitat Reserve and partially under mining claim on private land	Surrounded by development and disturbance; Mining; Off-road or off-highway vehicle activity; Road and trail construction and maintenance	Observation update; seed collection
6	USFS, BLM	Extant	Extant	Extant	FOR PORTIONS OF OCCURRENCE: 1987: between 100 and 1,000 observed; 1998: "locally common;" 2004: observed; 2010: 50 observed; 2014: 6 observed; 2020: "scattered on limestone slopes over a large area," seeds collected from 2 sites	Mostly on undesignated federal land, partially under active mining, partially protected by Habitat Reserve, and partially under mining claim on federal land	Mining (portions of occurrence have been used for limestone mining and possibly gold mining); Off-road or off-highway vehicle activity; Road and trail construction, use, and maintenance (mining roads pass through occurrence)	Partial change in conservation status (small area moved to active mining); observation update; seed collection

CNDDB Element Occurrence (EO) Number	Owner	Status in 1994	Status in 2009	Status in 2022	Observations and counts[A]	Conservation status[B]	Threats[C]	Change since last review
7	USFS	Extant	Extant	Extant	FOR PORTIONS OF OCCURRENCE: 1991 and 1992: 1,000's observed; 1998: observed; 2005: observed; 2006: observed; 2011: 150 observed, seeds collected; 2012: 100+ observed; 2013: 80–100 observed; 2014: 202 observed; 2015: 211 observed; 2021: 300+ observed, seeds collected	Mostly under mining claim on federal land and partially on undesignated federal land	Mining; Off-road or off-highway vehicle activity; Foot traffic/trampling; Grazing and trampling; Recreational use including target practice; Vandalism/dumping/ litter	Observation update; seed collection
10	USFS	Extant	Extant	Presumed extant	FOR PORTIONS OF OCCURRENCE: 1988: 100–200 plants estimated in northern polygon; 1998: observed; 2005: observed; 2012: collected; “Plants are small, scattered and less vigorous than elsewhere.”	Mostly under mining claim on federal land and partially on undesignated federal land	Mining	Observation update
12	BLM	Extant	Presumed extant	Presumed extant	1988: 3 plants found in small portion of the western polygon; 1998: observed	Mostly under mining claim within proposed Blackhawk Research Natural Area and partially on private land	Recreational use including target practice; Vandalism/dumping/ litter	No change

CNDDB Element Occurrence (EO) Number	Owner	Status in 1994	Status in 2009	Status in 2022	Observations and counts[A]	Conservation status[B]	Threats[C]	Change since last review
13	Private	Extant	Presumed extant	Presumed extant	1988: 4 plants observed in southernmost polygon; 1998: observed	Under active mining or alongside active mining on private land; no critical habitat	Mining; Road and trail construction and maintenance	No change
14	BLM	Extant	Presumed extant	Presumed extant	1988: 50+ estimated; 1992: "dozens" observed	On federal land that is high value for mining; no critical habitat	Mining; Off-road or off-highway vehicle activity; Road and trail construction, use, and maintenance (some plants found on roadway)	No change
15	USFS, private	Extant	Presumed extant	Presumed extant	1988: 20 observed but 50 estimated in population; 1996: 67 observed	Mostly under mining claim on federal land (some polygons alongside active mining) and partially on private land	Mining; Vandalism/dumping/ litter	No change
17	USFS	Extant	Presumed extant	Presumed extant	FOR PORTIONS OF OCCURRENCE: 1988: 13 observed, but 50 to 150 estimated nearby; 1998: observed; 1992: 25 observed in small portion of occurrence; 1998: collected and mentioned as "uncommon"; 2011: 1,203 observed at several sites in or near the occurrence	Mostly protected by Habitat Reserve and partially on undesignated federal land within proposed Blackhawk Research Natural Area	Mining; Off-road or off-highway vehicle activity; Road and trail construction and maintenance	Partial change in conservation status (large portion became part of Habitat Reserve as a result of mining mitigation); observation update

CNDDB Element Occurrence (EO) Number	Owner	Status in 1994	Status in 2009	Status in 2022	Observations and counts[A]	Conservation status[B]	Threats[C]	Change since last review
19	USFS, private	Extant	Presumed extant	Presumed extant	FOR PORTIONS OF OCCURRENCE: 1988: 3 observed; 1992: collected; 1993: 150 observed; 1998: observed	Mostly under active mining or alongside active mining on private land; part of one polygon is protected by Habitat Reserve; no critical habitat	Mining; Off-road or off-highway vehicle activity; Road and trail construction and maintenance	No change
20	USFS	Extant	Extant	Presumed extant	1991: 1,000 observed in southern polygon; 1998: observed; 2004: observed; 2005: observed	Mostly on undesignated federal land, partially on private land, and partially under mining claim on federal land	Mining; Off-road or off-highway vehicle activity (established trail crosses through site); Road and trail construction, use, and maintenance	No change
22	BLM	No records	Presumed extant	Extant	1995: 100 observed in eastern polygon; 2010: 50 individuals estimated in western polygon, seeds collected; 2020: seeds collected, “locally common”	Under mining claim within proposed Blackhawk Research Natural Area; no critical habitat	Mining	Observation update; seed collection
23	BLM	No records	Presumed extant	Presumed extant	1995: 20 observed in southern portion of occurrence; 1998: observed	Mostly protected by Habitat Reserve and partially under mining claim on federal land	Mining	No change

CNDDB Element Occurrence (EO) Number	Owner	Status in 1994	Status in 2009	Status in 2022	Observations and counts[A]	Conservation status[B]	Threats[C]	Change since last review
24	BLM	No records	Presumed extant	Extant	1995: 50 observed; 2020: "frequent/scattered," seeds collected	Fully protected by Habitat Reserve	Mining	Observation update; seed collection
25	BLM	Unknown	Presumed extant	Presumed extant	Before 2000: recorded on unknown date	Under mining claim on federal land	Mining	No change
26	USFS	No records	Presumed extant	Presumed extant	1994: 1,000 recorded	Under mining claim on federal land	Mining	No change
27	USFS	No records	Presumed extant	Presumed extant	1998: observed	Partially protected by Habitat Reserve and partially under mining claim on federal land near active mining; no critical habitat	Mining	No change
28	USFS	No records	No records	Presumed extant	2012: 30 observed in a localized population	On undesignated federal land; no critical habitat	Foot traffic/trampling; Grazing and trampling	New record
29	Private	No records	Extant but not included in 2009 review	Presumed extant	2008: collected and noted as "Most likely an escape from greenhouse attempts for reintroduction; however, growing freely"	On private land; no critical habitat	Unknown	No change

CNDDB Element Occurrence (EO) Number	Owner	Status in 1994	Status in 2009	Status in 2022	Observations and counts[A]	Conservation status[B]	Threats[C]	Change since last review
30	BLM	No records	No records	Extant	2021: 30 observed	Under mining claim on federal land that is high value for mining; no critical habitat	Mining; Off-road or off-highway vehicle activity; Road and trail construction, use, and maintenance (Powerline Road crosses through occurrence)	New record
No EO number (not in CNDDB)	USFS, private	Extant	Unknown (not included in 2009 review)	Unknown	1993: 100 observed	About half under active mining, partially on private land alongside active mining, and partially under mining claim on federal land; no critical habitat	Mining	No change

[A] Information for observations and counts is from the California Botanic Garden (2022, unpublished data), California Natural Diversity Database (CNDDB; CDFW 2022, dataset), Consortium of California Herbaria (2022, dataset), and USFS Threatened, Endangered, and Sensitive Plant database (USFS 2021, dataset).
[B] Conservation status is based on spatial data for the Carbonate Habitat Management Strategy (Olson 2003, entire; USFS 2022, dataset) and the Mineral and Land Records System database (BLM 2022, dataset).
[C] Threats information is from CNDDB (CDFW 2022, dataset).

Seed Collection

Since 2009, the California Botanic Garden has collected seeds of *Astragalus albens* at 9 sites in 6 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, 942 seeds were collected for an RNA (ribonucleic acid) integrity study being conducted by the Center for Plant Conservation (California Botanic Garden 2022, unpublished data).

Table 2. Total numbers of *Astragalus albens* seeds collected at six Element Occurrences (EO) during 2010, 2011, 2020, and 2021 (California Botanic Garden 2022, unpublished data).

Element Occurrences (EO)	2010	2011	2020	2021
EO 2	0	173	0	0
EO 5	0	0	509	0
EO 6	0	0	253	0
EO 7	0	146	0	942
EO 22	500	0	399	0
EO 24	0	0	266	0

Carbonate Habitat Management Strategy

As described in the 2009 5-year review, the 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.

Since the 2009 5-year review, implementation of the Carbonate Strategy has continued, including additions to the Habitat Reserve (Figure 2), 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 critical habitat for *Astragalus albens* 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 2016, 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 *Astragalus albens* or result in destruction or adverse modification of its 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 2019, we issued a biological opinion for the ongoing activities affecting 12 mountain plant species on the San Bernardino National Forest, including *Astragalus albens* (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 *A. albens* (Service 2019a, pp. 40–45). We concluded that the implementation of the revised LRMP is not likely to jeopardize the continued existence of *A. albens* or result in destruction or adverse modification of its critical habitat because of (1) implementation of the Carbonate Strategy and (2) minimization and avoidance measures (Service 2019a, pp. 44–45).

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 *Astragalus albens* or affect its critical habitat because the BLM (1) is not proposing to develop new routes through known occurrences and (2) will allow stopping, parking, and camping only in previously disturbed areas, which are unlikely to support individuals of *A. albens* (Service 2019b, p. 92).

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 would not affect critical habitat and is not likely to jeopardize the continued existence of *Astragalus albens* because (1) the Applicant will implement conservation measures; (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, pp. 40–41).

Threats

This section summarizes new information about threats to *Astragalus albens* since 2009. The 2009 5-year review discussed Factor A threats (present or threatened destruction, modification, or curtailment of habitat or range) from mining, off-highway vehicle use, and energy

development projects (Service 2009, pp. 7–9). The review discussed 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. 10–13). The description of threats in the 2009 5-year review is still accurate and mining (Figure 2) is still the primary threat to *A. albens*.

The following sections provide updated information on the threat of climate change to *Astragalus albens*. A list of threats other than climate change for each occurrence is provided in Table 1.

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 *Astragalus albens* 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, 10, Table 2, Table 3). The key factors contributing to *A. albens* vulnerability in the assessment were exposure to climate change mitigation actions (i.e., placement of solar arrays in habitat), dispersal ability, and physical habitat (dependence upon a particular uncommon landscape or geological feature) (Wilkening *et al.* 2021, pp. 10, 12, Table 3).

The 2009 5-year review described climate change as a threat to *Astragalus albens*, 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 *A. albens* in the San Bernardino Mountains. The following sub-sections describe projections for changes in temperature and precipitation within the range of *A. albens* 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 *Astragalus albens* will continue to increase in the 21st century (Table 3). Specifically, annual average maximum temperatures are projected to increase by 5.9 degrees Fahrenheit (F) under Representative Concentration Pathway (RCP) 4.5 emissions scenario, and by 8.7 degrees F 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 *A. albens* will respond to these changes is uncertain.

Table 3. Projected annual average maximum and minimum temperatures for the range of *Astragalus albens*. 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)	65.3 (range: 61.5–69.1)	35.8 (range: 33.2–38.4)	65.3 (range: 61.5–69.1)	35.8 (range: 33.2–38.4)
2040–2069	69.9 (range: 66.3–73.1)	40.1 (range: 37.9–43.6)	71.4 (range: 68.0–75.4)	41.5 (range: 38.2–47.1)
2070–2099	71.2 (range: 68.3–74.6)	41.2 (range: 38.7–44.1)	74.0 (range: 69.5–78.6)	44.9 (range: 40.9–49.8)

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). Models do project increases in extreme precipitation frequency and intensity (Polade *et al.* 2017, p. 7; Swain *et al.* 2018, p. 428). However, droughts are also 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).

In Big Bear Valley (San Bernardino Mountains), average annual precipitation ranges from about 18 to 35 inches (USGS 2012, p. 4). Due to a rain shadow effect, precipitation generally decreases from west to east across Big Bear Valley (USGS 2012, p. 4). Therefore, the effects of changing precipitation amount and timing will also likely differ at a relatively fine scale in the San Bernardino Mountains.

Climate change summary and conclusion

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 *Astragalus albens* (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 on montane species but did not have enough information to make specific predictions about effects to *Astragalus albens* (Service 2009, p. 12). Since then, new climate projections have become available for the range of *A. albens*, but we do not have specific information about how those changes will affect the species. However, the projected abiotic pressures resulting from climate change (i.e., increased temperature and changes in precipitation) could alter *A. albens* habitat, particularly through altered soil moisture. Changes in precipitation amount and timing could impact individual *A. albens* at all life stages by reducing the amount of water available for germination, growth, and reproduction. Increasing temperatures combined with greater precipitation extremes could cause drier conditions, potentially decreasing *A. albens* population resiliency. As discussed in the 2009 review (Service 2009, p. 13), climate change is particularly problematic for *A. albens* because this soil endemic is limited to isolated occurrences of specific carbonate soils. Therefore, the species will likely have limited ability to shift its distribution in response to climate change (e.g., upward elevational shift in response to warmer conditions at lower elevations) because of limited carbonate soil habitat.

Summary of threats

Since the 2009 5-year review, we have received new information about ongoing threats to *Astragalus albens* relating to 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 *Astragalus albens*. We reviewed new information on *A. albens* occurrences, conservation, and threats since 2009. Two new occurrences have been discovered since 2009 and two additional occurrences that were discovered prior to 2009 (but not included in the 2009 5-year review) have been included in this review. The status of land use has changed for portions of four occurrences with habitat being permanently protected for conservation of the species in three occurrences and a small part of one occurrence being approved for active mining. Accounting for all new information, there are currently 23 known occurrences of *A. albens* that are extant or presumed extant and one occurrence with an unknown status. While portions of some of these occurrences are affected by active mining operations, no known occurrences have been extirpated since listing and the amount of permanently conserved habitat has increased. Seed collection and banking for conservation has also occurred at six occurrences since 2009.

The change in status of occurrences and new information on the threat of climate change 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 *Astragalus albens* remains a federally endangered 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 *Astragalus albens* 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 *A. albens* habitat to the Habitat Reserve and withdrawal of mining claims on habitat with high conservation value.

2. Research the species' susceptibility to climate change by determining climate tolerances (e.g., temperature, drought duration) and identify climate refugia to protect within carbonate habitat.

3. Determine appropriate monitoring frequency and implement a range-wide monitoring strategy that provides useful information about population health.

4. 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.

5. Research the efficacy of restoring populations on reclaimed lands that have been restored after mining.

6. Finalize the establishment of the proposed Blackhawk Research Natural Area.

7. Collect additional 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. Unpublished data. Spreadsheet with seed collection information (2010–2021) for three species of plants sent via email attachment to Stephanie Prevost of the U.S. Fish and Wildlife Service. Email sent on June 14, 2022 by Cheryl Birker, California Botanic Garden, subject: CalBG Seed Collection Info.

[CDFW] California Department of Fish and Wildlife. 2022. California Natural Diversity Database. Accessed May 23, 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 July 12, 2022. *https://cal-adapt.org/*

Consortium of California Herbaria. 2022. Data provided by the participants of the Consortium of California Herbaria. Accessed January 6, 2022. *https://www.cch2.org/portal/*

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.

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.

[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. 2005. Biological Opinion for the Carbonate Habitat Management Strategy, San Bernardino County, California. Carlsbad Fish and Wildlife Office, Department of Interior. 38 pp.

[Service] U.S. Fish and Wildlife Service. 2009. *Astragalus albens* (Cushenbury milk-vetch) 5-Year Review: Summary and Evaluation. Carlsbad Fish and Wildlife Field Office, Carlsbad, California. 20 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 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 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 Interior. 118 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 Interior. 68 pp.

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.

Tierra Madre Consultants, Inc. 1992. Evaluation of carbonate substrates and distributions for five plants reported from the San Bernardino Mountains, San Bernardino County, California. Report prepared for: Pfizer Inc., Pleuss-Staufer (OMTA) Inc., Mitsubishi Cement Corporation, and Riverside Cement Company.

[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, Thomas R. Karl, Jerry M. Melillo, and Thomas C. Peterson (eds.). Cambridge University Press, 196 pp.

[USGS] U.S. Geological Survey. 2012. Geohydrology of Big Bear Valley, California: *Phase 1*—geologic framework, recharge, and preliminary assessment of the source and age of groundwater. Flint, L.E., and P. Martin, eds., with contributions by Brandt, J., A.H. Christensen, A.L. Flint, L.E. Flint, J.A. Hevesi, R. Jachens, J.T. Kulongoski, P. Martin, and M. Sneed. U.S. Department of Interior. 130 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.

FIELD OFFICE APPROVAL

Lead Field Supervisor, Fish and Wildlife Service

☒ Approved

SCOTT SOBIECH
Digitally signed by SCOTT SOBIECH
Date: 2022.08.19 15:15:22 -07'00'

Scott A. Sobiech
Field Supervisor