Acanthoscyphus parishii var. *goodmaniana* (*Oxytheca p.* var. *g.*) (Cushenbury oxytheca)

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

Acanthoscyphus parishii var. *goodmaniana* (*Oxytheca p*. var. *g*.) (Cushenbury oxytheca)

GENERAL INFORMATION

Species: *Acanthoscyphus parishii* var. *goodmaniana* (*Oxytheca p*. var. *g*.) (Cushenbury oxytheca), 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: 9C.
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. *Acanthoscyphus parishii* var. *goodmaniana* (Cushenbury oxytheca) 5-year Review: Summary and Evaluation. Prepared by the Carlsbad Fish and Wildlife Office, Carlsbad, California. 21 pp.

We initiated a status review for *Acanthoscyphus parishii* var. *goodmaniana* 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).

Species Overview and Habitat: *Acanthoscyphus parishii* var. *goodmaniana* is an annual herb and a member of the *Polygonaceae* (buckwheat) family. The plant variety 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

Genetics

There is ongoing research of the *Oxytheca* clade in the subfamily *Eriogonoideae* being conducted by J. Travis Columbus with the California Botanic Garden (formerly Rancho Santa Ana Botanic Garden). The research includes phylogenetic study of the four varieties of *Acanthoscyphus parishii*. Preliminary results suggest that *A. p.* var. *goodmaniana* and *A. p.* var. *cienegensis* (*Cienega Seca oxytheca*) may warrant a different species designation separate from *A. p.* var. *parishii* and *A. p.* var. *abramsii* based on morphological and phylogenic divergence (Columbus and Fraga 2022, *in litt*.). The ongoing phylogenetic research has also provided information on the taxonomic identity of plants described as morphological intermediates between *Acanthoscyphus parishii* var. *goodmaniana* and *A. p.* var. *cienegensis* (Fraga and Bell 2015, p. 16). Preliminary analysis of genetic data grouped individuals that have been described as intermediate between the two varieties in a single clade with *A. p.* var. *cienegensis*, not a mix of the two varieties (Columbus and Fraga 2022, *in litt*.). These results suggest that the *A. p.* var. *goodmaniana* occurrences directly east and southeast of Big Bear Lake are *A. p.* var. *cienegensis* (Figure 1; Columbus 2022, *in litt*.). Upon peer-review and publication of this genetic research, revisions of *A. p.* var. *goodmaniana*'s range may occur.

[1] The California Natural Diversity Database is an inventory of the status and locations of rare plants and animals in California.

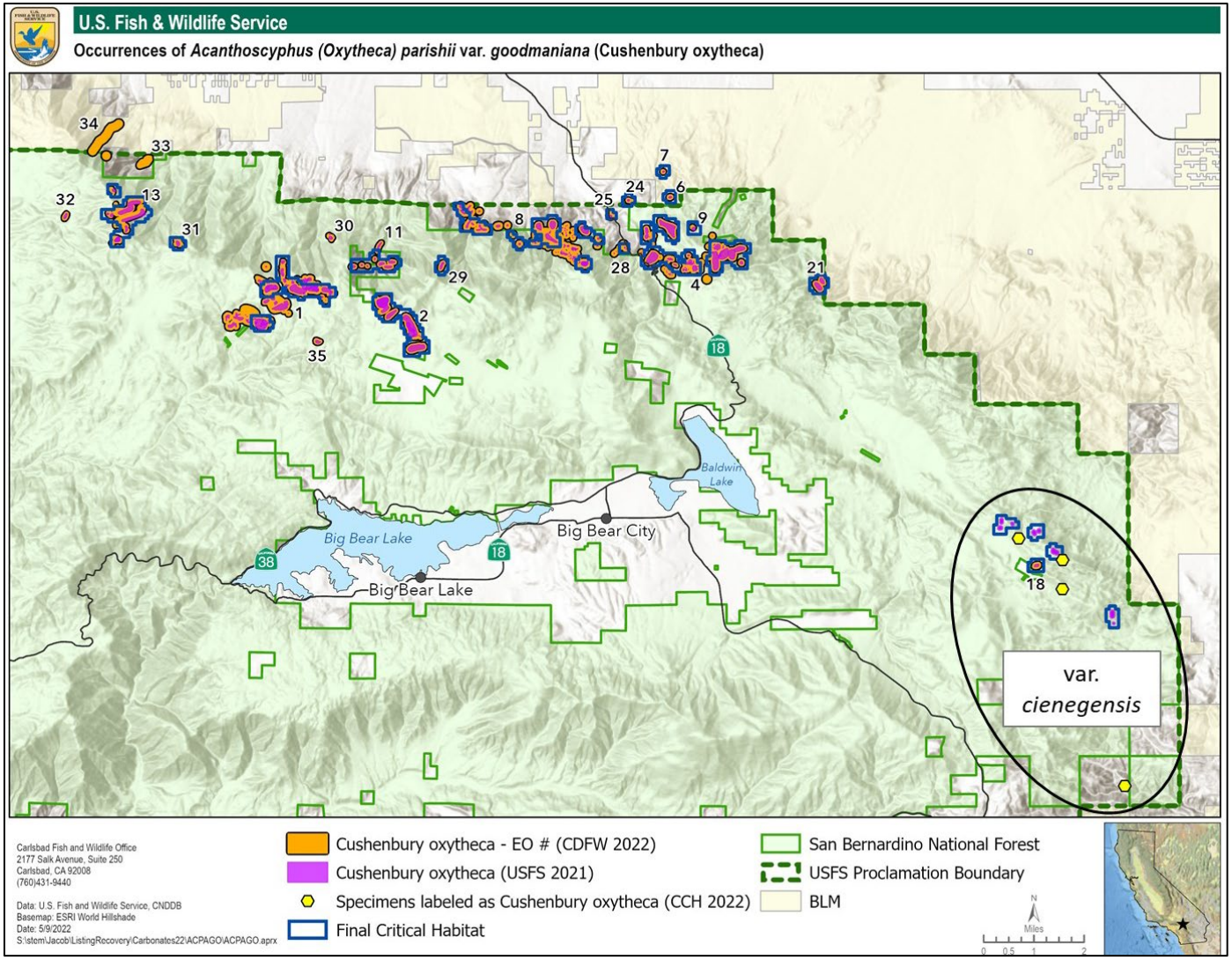

Figure 1. Map of *Acanthoscyphus parishii* var. *goodmaniana* occurrences and designated critical habitat. Occurrence data are sourced from the CNDDB (CDFW 2022), Consortium of California Herbaria (CCH 2022), and USFS Threatened, Endangered, and Sensitive Plant database (USFS 2021). The oval at the southeastern extent of the map contains those occurrences, previously considered *A. p.* var. *goodmaniana*, that are now considered *A. p.* var. *cienegensis* (Columbus 2022, *in litt*.). BLM = Bureau of Land Management.

Distribution and Occurrence Status

Acanthoscyphus parishii var. *goodmaniana* 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 variety is limited to the carbonate soils just north of Big Bear Lake, San Bernardino County, California (Figure 1). There are 21 Element Occurrences[2] (EO) recognized by CDFW (2022, dataset) and there are several additional locality records within the vicinity of EO 18 (USFS 2021, dataset) and south of EO 18 along Pipes Canyon Road (CCH 2022, dataset) (Figure 1).

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

1. Based on recent research (see Genetics section above), experts consider EO 18, and the additional locality records [not recognized by CDFW (2022, dataset)] at the southeastern extent of the species' range, to be *Acanthoscyphus parishii* var. *cienegensis* (Figure 1). This change in current knowledge suggests that the overall distribution of *A. p.* var. *goodmaniana* is narrower than previously described. Publication of this genetic research may help inform revision of *A. p.* var. *goodmaniana*'s range.

2. Three new occurrences [EOs 33, 34, and 35 (Figure 1)] have been included that were discovered prior to 2009 but were not included in the 2009 5-year review.

3. The status of land use has changed for 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 titled Carbonate Habitat Management Strategy and Consultations below), the following changes have been made since 2009:

    a. A portion of EO 1 has been protected by addition to the Carbonate Strategy's Habitat Reserve and another portion of the occurrence has been approved for active mining.

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

    c. A portion of EO 8 has been approved for active mining.

    d. All of EO 28 has been protected by addition to the Habitat Reserve.

In summary, we consider there to be 20 known occurrences of *Acanthoscyphus parishii* var. *goodmaniana*. Of the 20 occurrences, 6 are extant (i.e., the species was observed during the past 10 years) and 14 are presumed extant (i.e., the species was not observed during the past 10 years,

[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.

but suitable habitat is present) (Table 1). Two occurrences are fully protected and seven 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).

Seed Collection

In 2010, 2,293 seeds of *Acanthoscyphus parishii* var. *goodmaniana* were collected opportunistically during a post-fire survey in an area burned by the Butler Fire (Fraga 2022, *in litt*.). The seeds were collected for conservation purposes and are being stored by the California Botanic Garden (Fraga 2022, *in litt*.).

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 designated critical habitat for *Acanthoscyphus parishii* var. *goodmaniana* 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).

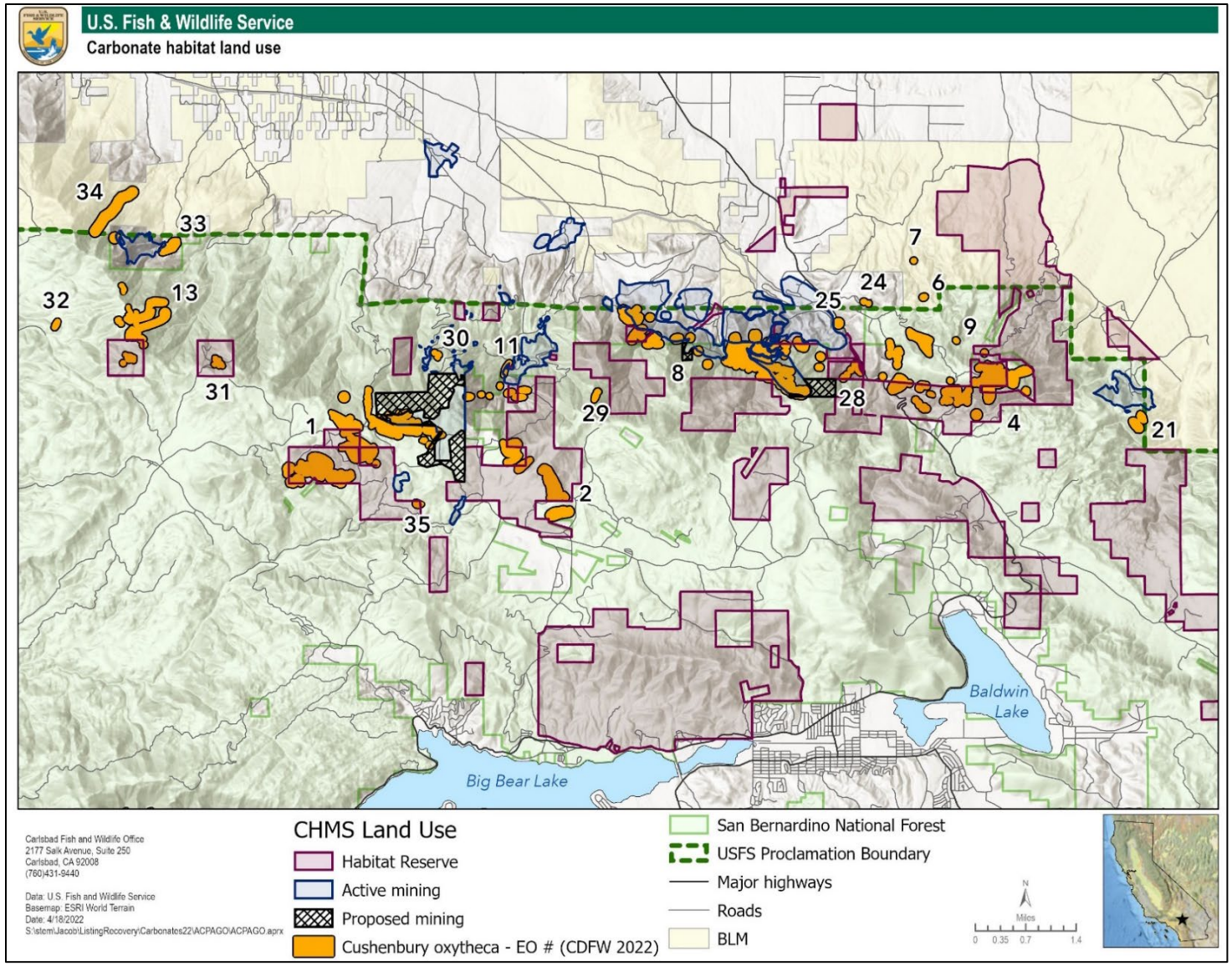

Figure 2. Map of the Carbonate Strategy's (CHMS) Habitat Reserve, active mining, and proposed mining land use types within the range of *Acanthoscyphus parishii* var. *goodmaniana* (USFS 2022, dataset). BLM = Bureau of Land Management.

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 *Acanthoscyphus parishii* var. *goodmaniana* 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 2019, we issued a biological opinion for the ongoing activities affecting 12 mountain plant species on the San Bernardino National Forest, including *Acanthoscyphus parishii* var. *goodmaniana* (Service 2019b, entire). The biological opinion discussed the general effects of the USFS 2006 Revised Land and Resource Management Plan (LRMP) on listed species (Service 2019b, pp. 18–26), and specific effects to *A. p.* var. *goodmaniana* (Service 2019b, pp. 33–40). We concluded that the implementation of the revised LRMP is not likely to jeopardize the continued existence of *A. p.* var. *goodmaniana* 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 2019b, p. 40).

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 2019c, entire). We concluded the proposed action is not likely to jeopardize the continued existence of *Acanthoscyphus parishii* var. *goodmaniana* or affect its designated critical habitat because there are no known occurrences or designated critical habitat that overlap with routes identified in the action area (Service 2019c, pp. 89, 95).

In 2019, we issued a biological opinion for the Omya California Butterfield and Sentinel quarries ongoing operations and expansion on the San Bernardino National Forest and concluded that the proposed action is not likely to jeopardize the continued existence of *Acanthoscyphus parishii* var. *goodmaniana* or result in destruction or adverse modification of its designated critical habitat (Service 2019a, p. 36). The proposed action met the criteria of the Carbonate Strategy by including mitigation (additions to the Habitat Reserve) to offset effects on federally listed plant species and designated critical habitat (Service 2019a, pp. 20, 27).

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 *Acanthoscyphus parishii* var. *goodmaniana* 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, pp. 38–39).

Table 1. Occurrence table for *Acanthoscyphus parishii* var. *goodmaniana* 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	USFS	Extant	Extant	Extant	FOR PORTIONS OF OCCURRENCE: 1932: collected at 2 sites, 1990: 2,000+, 1994: 1,700, 1995: 5,000, 1997: collected at 1 site, 1998: "locally common," 2001: 92,400+ throughout much of site, 2008: 17,000, 2009: 100, 2010: 14,500, 2011: 4,800+, 2012: not found at 2 sites, 2017: 33, 2019: "occasional"	Partially protected by Habitat Reserve, partially under active mining, and partially under mining claim	Mining and mining haul roads, Weeds and nonnative plants, Improper burning regime, Off-road or off-highway vehicle activity, Road and trail construction and maintenance	Partial change in conservation status (some land moved to active mining and some to 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
2	USFS	Extant	Presumed extant	Extant	FOR PORTIONS OF OCCURRENCE: 1990: several 100, 1993: 50, 1995: 10,000+, 1998: "locally abundant," 2010: 12,000, 2011: 9,000, 2012: 18,000, 2014: 3 in small portion of occurrence	Partially protected by Habitat Reserve and partially under mining claim	Mining, Off-road or off-highway vehicle activity (jeep road through eastern edge of population), Road and trail construction and maintenance, Proposed wind energy development (Eliason 2022, pers. comm.)	Observation update
4	USFS, private	Extant	Presumed extant	Presumed extant	FOR PORTIONS OF OCCURRENCE: 1980: collected, 1982: collected, 1990: locally common near Whiskey Springs, 1993: 111, 1995: 350, 1998: "occasional" below Peak #6624 and "abundant" north of Peak #6309, 2010: "uncommon" at north edge of Cactus Flat, 2011: 18,550	Mostly within proposed Blackhawk Research Natural Area and protected by Habitat Reserve, partially under mining claim on federal land, partially on undesignated federal land, and partially on private 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
6	BLM	No records	Extant	Presumed extant	1995: 3,000, 2011: fewer than 30	Under mining claim within proposed Blackhawk Research Natural Area	Mining	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
7	BLM	No records	Extant	Presumed extant	1995: 200, 2010: 14 ("plants scarce on steep slope") at location within 0.25 mi of EO in 2010 (CDFW (2022) attributes this CCH (2022) record to EO#6, but the location is closer to EO#7)	Under mining claim within proposed Blackhawk Research Natural Area	Mining	Observation update
8	USFS, private	Extant	Extant	Extant	FOR PORTIONS OF OCCURRENCE: 1982: collected 1993: 200, 1994: 500, 1995: 250 (approximate), 1996: 1,000, 1997: collected at 2 sites, 1998: "occasional; patchy throughout area often abundant in patches" and "abundant on slope and generally distributed throughout," 2008: 1,959,000 estimated, 2009: 320+, 2010: 62,270, 2011: 39, 2012: recorded at several sites, 2017: 1,600 (approximate)	Partially under active mining, partially under mining claim on private and federal land, partially protected by Habitat Reserve, and partially on undesignated federal land	Mining	Partial change in conservation status (portion moved to active mining); 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
9	USFS	Extant	Presumed extant	Presumed extant	1994: 19	Under mining claim within proposed Blackhawk Research Natural Area	Mining, Road and trail construction and maintenance (spoil from nearby road threatens plants)	No change
11	Private, USFS	Extant	Presumed extant	Presumed extant	FOR PORTIONS OF OCCURRENCE: 1993: 250, 1994: 1,125, 1996: 1,000's, 1998: 250	Mostly on private land (some under mining claim), partially protected by Habitat Reserve, and partially under active mining	Mining (tailings from adjacent mining operation threaten to bury a portion of the site)	No change
13	USFS	Extant	Extant	Extant	1994: 5,600 throughout most of population, 1995: 1,500 plants near South Peak, 1998: "locally frequent," 2001: 6,000+ throughout most of population, 2014: 9 near South Peak	Mostly on undesignated federal land and partially protected by Habitat Reserve; former mining claims have been closed	Mining, Road and trail construction and maintenance (a road and spurs pass through population), Off-road or off-highway vehicle activity	Observation update
18	USFS	No records	Presumed extant	Unknown	Before 2000: recorded on unknown date	Fully protected by Habitat Reserve	Not applicable	New genetics information suggests plants here are *A. p.* var. *cienegensis*
21	USFS	No records	Presumed extant	Presumed extant	1998: "fairly common" in scattered patches	On undesignated federal land (unknown if under mining claim)	Mining (former site of Partin Limestone Mine)	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	Private	No records	Presumed extant	Extant	Before 2000: recorded on unknown date, 2017: fewer than 10 seen in eastern polygon	On private land within proposed Blackhawk Research Natural Area	Unknown	Observation update
25	Private	Presumed extant	Presumed extant	Extant	1978: collected, 1980: collected, 2010: collected, 2019: “common”	On private land within proposed Blackhawk Research Natural Area	Unknown	Observation update
28	Private	Extant	Presumed extant	Presumed extant	1993: “occasional,” 2010: “uncommon,” 2011: 25	Fully protected by Habitat Reserve	Unknown	Received protection as part of Habitat Reserve as a result of mining mitigation; observation update
29	USFS	Extant	Presumed extant	Presumed extant	1993: 1,500, 1998: “common” on scattered small patches near ridgetop	Under mining claim	Mining	No change
30	USFS	No records	Extant	Presumed extant	2001: 560	Under mining claim; no designated critical habitat	Mining (major mining haul road surrounds population; "aggressive" limestone extraction in area), Road and trail construction and maintenance	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
31	USFS	No records	Extant	Presumed extant	1998: "locally frequent," 2001: 10,000	Fully protected by Habitat Reserve	Road and trail construction and maintenance (a dirt road passes through population)	No change
32	USFS	No records	Extant	Presumed extant	2001: occupancy mapped to a polygon of 2.9 acres	On undesignated federal land; no designated critical habitat	Unknown	No change
33	Private	No records	Extant but not included in 2009 review	Presumed extant	2002: "patchy, scattered plants"	On private land alongside active mining; no designated critical habitat	Mining	No change
34	Private, BLM	No records	Extant but not included in 2009 review	Presumed extant	2002: "patchy and scattered" in small southern polygon, 2005: fewer than 10 in long northern polygon, Noted as possibly an ephemeral occurrence washed down from higher in watershed)	Partially under active mining, partially under mining claim on private and federal land, and partially on undesignated federal land; no designated critical habitat	Mining, Altered hydrologic regime, Long northern polygon is probably an ephemeral occurrence likely to be eliminated by future flooding	No change
35	USFS	No records	Extant but not known during 2009 review	Presumed extant	2008: photographed, 2011: 500	Mostly protected by Habitat Reserve, partially under mining claim on federal land; no designated critical habitat	Mining, Improper burning regime	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
Additional locality records near EO 18	USFS and non-profit	No records	Extant	Unknown	Before 2000: recorded on unknown date, 2000: four polygons mapped, 2003: "patchy," collected from one site, 2014: several dozen; collected from three sites	Mostly protected by Habitat Reserve	Not applicable	New genetics information suggests plants here are *A. p.* var. *cienegensis*

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

Other Research

Since the 2009 5-year review, two interrelated studies were published that involve three federally listed carbonate plant species, *Acanthoscyphus parishii* var. *goodmaniana*, *Erigeron parishii* (Parish's daisy), and *Eriogonum ovalifolium* var. *vineum* (Cushenbury buckwheat). 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).

Since 2009, several contractors created habitat suitability models for rare plants in southern California. Reese *et al.* (2019, pp. 3, 5, Table 1) evaluated two of the contractors' habitat suitability models for *Acanthoscyphus parishii* var. *goodmaniana* 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 two models, Reese *et al.* (2019, S1 supporting information, p. 1) found 47,863 acres of probable suitable habitat for *A. p.* var. *goodmaniana* within the project boundary and 222 of those acres were in areas prioritized for energy development. Complete electronic datasets for all Reese *et al.* (2019, entire) study results are available from the ScienceBase Catalog.

Threats

This section summarizes new information about threats to *Acanthoscyphus parishii* var. *goodmaniana* 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 also 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. 9–13). The description of threats in the 2009 5-year review is still accurate and mining (Figure 2) is still the primary threat to *A. p.* var. *goodmaniana*.

The following sections provide updated information on the threats of energy development and climate change to *Acanthoscyphus parishii* var. *goodmaniana*. A list of threats other than climate change for each EO is provided in Table 1 (CDFW 2022, dataset).

Energy Development

The final listing rule described two proposed energy development projects, a hydroelectric project and a 115-kilovolt powerline, as threats to *Acanthoscyphus parishii* var. *goodmaniana* (Service 1994, p. 43659). At the time of the 2009 5-year review, no known energy development projects posed a threat to *A. p.* var. *goodmaniana* (Service 2009, p. 8). At present, there is a proposed wind energy development being reviewed that may affect *A. p.* var. *goodmaniana* at EO 2 (Eliason 2022, pers. comm.).

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 *Acanthoscyphus parishii* var. *goodmaniana* 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 *A. p.* var. *goodmaniana* 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 *Acanthoscyphus parishii* var. *goodmaniana*, 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. p.* var. *goodmaniana* in the San Bernardino Mountains. The following sub-sections describe projections for changes in temperature and precipitation within the range of *A. p.* var. *goodmaniana* 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 *Acanthoscyphus parishii* var. *goodmaniana* will continue to increase in the 21st century (Table 2). Specifically, annual average maximum temperatures are projected to increase by 5.9 degrees Fahrenheit (F) under the 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. p.* var. *goodmaniana* will respond to these changes is uncertain.

Table 2. Projected annual average maximum and minimum temperatures for the range of *Acanthoscyphus parishii* var. *goodmaniana*. 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)	64.5 (range: 60.6–68.3)	35.4 (range: 33.0–37.9)	64.5 (range: 60.6–68.3)	35.4 (range: 33.0–37.9)
2040–2069	69.1 (range: 65.5–72.3)	39.7 (range: 37.5–43.1)	70.6 (range: 67.2–74.5)	41.1 (range: 37.8–46.6)
2070–2099	70.4 (range: 67.5–73.8)	40.8 (range: 38.4–43.6)	73.2 (range: 68.7–77.8)	44.4 (range: 40.5–49.2)

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 *Acanthoscyphus parishii* var. *goodmaniana*

(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 *Acanthoscyphus parishii* var. *goodmaniana* (Service 2009, p. 12). Since then, new climate projections have become available for the range of *A. p.* var. *goodmaniana*, 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. p.* var. *goodmaniana* habitat, particularly through altered soil moisture. Changes in precipitation amount and timing could impact individual *A. p.* var. *goodmaniana* 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. p.* var. *goodmaniana* population resiliency. As discussed in the 2009 review (Service 2009, p. 13), climate change is particularly problematic for *A. p.* var. *goodmaniana* because the 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 received new information about ongoing threats to *Acanthoscyphus parishii* var. *goodmaniana* relating to (1) energy development and (2) 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 *Acanthoscyphus parishii* var. *goodmaniana*. Since 2009, we reviewed new information on *A. p.* var. *goodmaniana* genetics, occurrences, and threats. New genetic information suggests that *A. p.* var. *goodmaniana* occurrences directly east and southeast of Big Bear City (EO 18 and its neighboring localities at the southeastern extent of the species' range) are *A. p.* var. *cienegensis* (Columbus 2022, *in litt*.). This change in taxonomic status indicates that the overall distribution of *A. p.* var. *goodmaniana* may be narrower than previously described. However, three new occurrences (EOs 33, 34, and 35) have also been mapped at the northwestern extent of the species' range since 2009. The status of land use has changed for four 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 20 known occurrences of *A. p.* var. *goodmaniana* that are extant or presumed extant. 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.

The change in status of occurrences and new information on the threats of energy developments and 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 *A. p.* var. *goodmaniana* 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 *Acanthoscyphus parishii* var. *goodmaniana* 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 Strategy, particularly additions of *A. p.* var. *goodmaniana* habitat to the Habitat Reserve and withdrawal of mining claims on habitat with high conservation value.

2. Research the variety's 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 occupancy and population health.

4. Conduct a species status assessment to evaluate viability given climate change projections, conservation, and progress in threat reduction. The assessment may be used to revise recovery criteria, or to inform a downlisting or delisting 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 populations on reclaimed lands that have been restored after mining.

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

8. Collect additional seeds from different occurrences to expand the conservation seed bank.

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FIELD OFFICE APPROVAL

Lead Field Supervisor, Fish and Wildlife Service

☒ Approve

SCOTT SOBIECH

Digitally signed by SCOTT SOBIECH
Date: 2022.08.31 16:30:25 -07'00'

Scott A. Sobiech
Field Supervisor