Status Review for Inyo Rock Daisy (*Laphamia inyoensis*, synonym *Perityle inyoensis*)

Report to the Fish and Game Commission

August 2023

Suggested citation:

California Department of Fish and Wildlife (CDFW). 2023. Report to the Fish and Game Commission, status review for Inyo rock daisy (*Laphamia inyoensis*, synonym *Perityle inyoensis*). California Department of Fish and Wildlife, P.O. Box 944209, Sacramento CA 94244-2090. 77 pp., with appendices.

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

LIST OF APPENDICES

LIST OF ABBREVIATIONS, ACRONYMS, AND TERMS

ACEC – Area of Critical Environmental Concern
BLM – Bureau of Land Management
CCVI – Climate Change Vulnerability Index
CDCA – California Desert Conservation Area
CEQA – California Environmental Quality Act
CESA – California Endangered Species Act
CMA – Conservation and Management Actions
CNDDB – California Natural Diversity Database
Commission – California Fish and Game Commission
CRPR – California Rare Plant Rank
Department – California Department of Fish and Wildlife
EO – CNDDB Element Occurrence
ESA – Federal Endangered Species Act
Evaluation – Evaluation of the Petition from Maria Jesus, the Center for Biological Diversity, and California Native Plant Society to List Inyo Rock Daisy (*Perityle inyoensis*) as Threatened or Endangered under the California Endangered Species Act
MPM – Mojave Precious Metals, Inc.
NCL – California Desert National Conservation Lands
NEPA – National Environmental Policy Act
NPPA – Native Plant Protection Act
Petition – A Petition to List the Inyo Rock Daisy (*Perityle inyoensis*, synonym *Laphamia inyoensis*) as Threatened or Endangered under the California Endangered Species Act (CESA)
PRISM – Parameter-elevation Regressions on Independent Slopes Model
SMARA – California Surface Management and Reclamation Act
Status Review – Status Review for Inyo rock daisy (*Laphamia inyoensis*, synonym *Perityle inyoensis*)
USFWS – United States Fish and Wildlife Service
VegCAMP- Vegetation Classification and Mapping Program

et al. – "and others"
id. – "the same"
spp. – more than one species
subsp. – subspecies
var. – variety

EXECUTIVE SUMMARY

This status review for Inyo rock daisy (*Laphamia inyoensis*, synonym *Perityle inyoensis*) (Status Review) has been prepared by the California Department of Fish and Wildlife (Department) for the California Fish and Game Commission (Commission) pursuant to the requirements of the California Endangered Species Act (CESA) (Fish & G. Code, § 2050 et seq.). This Status Review is based on the best scientific information currently available to the Department regarding each of the components listed under section 2072.3 of the Fish and Game Code, and section 670.1 of title 14 of the California Code of Regulations. In addition, this Status Review includes a preliminary identification of habitat that may be essential to the continued existence of the species, and the Department's recommendations for management activities and other recommendations for recovery of the species (Fish & G. Code, § 2074.6). This Status Review has been independently reviewed by scientific peers (Fish & G. Code, § 2074.6).

Inyo rock daisy is a subshrub that is known from 28 occurrences and is restricted to the southern Inyo Mountains of Inyo County, California. Inyo rock daisy grows on calcareous (calcium carbonate) rock outcrops with all mapped occurrences growing between 1,834 and 2,957 m (6,018-9,700 ft) in elevation. Inyo rock daisy plants have been found in a geographic area that covers about 72 km^2 (28 mi^2) and the total population size is estimated in the low thousands.

Inyo rock daisy is primarily threatened by habitat modification and destruction from proposed exploratory mining activities and potential mining operations in the future. Inyo rock daisy occurs in low numbers across a small geographic area making it especially vulnerable to chance events. Inyo rock daisy is likely self-incompatible which can lead to reduced seed set if few compatible mates are nearby. Inyo rock daisy relies on pollinators to reproduce but pollinators may not be able to easily find and visit flowers since the species occurs in small and isolated populations across the landscape. This can cause breeding among genetically similar individuals, resulting in lower seed production, or offspring with reduced ability to survive and reproduce. Climate change threatens Inyo rock daisy because the species has a restricted range, grows in a specialized habitat, grows at mid to high elevations within its range, has poor long-distance dispersal ability, and has long generation times. In addition, invasive grasses may outcompete Inyo rock daisy seedlings for establishment and alter the fire regime in the future.

The Department recommends that the Commission find the petitioned action to list Inyo rock daisy to be warranted. Furthermore, the Department recommends that the Commission list Inyo rock daisy as a threatened species under CESA. The Department also recommends implementation of the management recommendations and recovery measures described in this Status Review.

INTRODUCTION

Petition History

On February 2, 2022, the Commission received a petition (Petition) from Maria Jesus, the Center for Biological Diversity, and California Native Plant Society to list Inyo rock daisy (*Perityle inyoensis*, synonym *Laphamia inyoensis*) as threatened or endangered pursuant to CESA (Fish & G. Code, § 2050 et seq.).

On February 14, 2022, pursuant to Fish and Game Code section 2073, the Commission referred the Petition to the Department for evaluation.

On February 25, 2022, pursuant to Fish and Game Code section 2073.3, the Commission published notice of receipt of the Petition in the California Regulatory Notice Register (Cal. Reg. Notice Register 2022, No. 8-Z, p. 207-208).

On April 21, 2022, pursuant to Fish and Game Code section 2073.5, the Commission approved the Department's request for a 30-day extension to complete its petition evaluation report.

On May 2, 2022, the Department provided the Commission with a report, "Evaluation of the Petition from Maria Jesus, the Center for Biological Diversity, and California Native Plant Society to List Inyo Rock Daisy (*Perityle inyoensis*) as Threatened or Endangered under the California Endangered Species Act" (Evaluation). Based upon the information contained in the Petition, the Department concluded, pursuant to Fish and Game Code section 2073.5, that sufficient information exists to indicate that the petitioned action may be warranted and recommended to the Commission that the Petition be accepted and considered.

On August 17, 2022, at its public meeting pursuant to Fish and Game Code sections 2074 and 2074.2, the Commission considered the Petition, the Department's Evaluation and recommendation, comments received, and oral testimony. The Commission found that sufficient information exists to indicate the petitioned action may be warranted and accepted the Petition for consideration.

On September 2, 2022, pursuant to Fish and Game Code section 2074.2, the Commission published its Notice of Findings for Inyo rock daisy in the California Regulatory Notice Register, designating Inyo rock daisy a candidate species (Cal. Reg. Notice Register 2022, No. 35-Z, p. 1018), and pursuant to Fish and Game Code section 2074.6, the Department subsequently initiated this Status Review for Inyo rock daisy.

Status Review Overview

Pursuant to Fish and Game Code section 2074.6 and the California Code of Regulations, title 14, section 670.1, the Department has prepared this Status Review to indicate whether the petitioned action to list Inyo rock daisy as threatened or endangered under CESA is warranted. An endangered species under CESA is one "which is in serious danger of becoming extinct throughout all, or a significant portion, of its range due to one or more causes, including loss of habitat, change in habitat, overexploitation, predation, competition, or disease" (Fish & G. Code, § 2062). A threatened species under CESA is one that "although not presently threatened with extinction, is likely to become an endangered species in the foreseeable future in the absence of the special protection and management efforts required by [CESA]" (*id.*, § 2067). A species' range for CESA purposes is the species' California range (Cal. Forestry Assn. v. Cal. Fish and Game Com. (2007) 156 Cal.App.4th 1535, 1551).

Using the best scientific information available to the Department, this Status Review includes information on each of the following components pursuant to Fish and Game Code section 2072.3 and title 14 of the California Code of Regulations section 670.1: population trend(s), range, distribution, abundance, life history, factors affecting the species' ability to survive and reproduce, the degree and immediacy of threats, the impact of existing management efforts, the availability and sources of information, habitat that may be essential to the continued existence of the species, and the Department's recommendations for future management activities and other recovery measures to conserve, protect, and enhance the species.

Specifically, this Status Review analyzes whether there is sufficient scientific information to indicate that the continued existence of Inyo rock daisy throughout all or a significant portion of its range is in serious danger, or is threatened, by one or a combination of the following factors: present or threatened modification or destruction of its habitat, overexploitation, predation, competition, disease, or other natural occurrences or human-related activities (Cal. Code Regs., tit. 14, § 670.1, subd. (i)(1)(A)).

Notification, Information Received, and Peer Review

Following the Commission's action to designate Inyo rock daisy as a candidate species for threatened or endangered status, the Department notified affected and interested parties and solicited data and comments on the petitioned action pursuant to Fish and Game Code section 2074.4 (see also Cal. Code Regs., tit. 14, § 670.1, subd. (f)(2)). Comments on the petitioned action were invited via a Tribal notification and general notification, both dated September 20, 2022. These notifications were distributed to Tribes, owners and managers of lands supporting Inyo rock daisy populations, people familiar with Inyo rock daisy, and other interested individuals and organizations. The Department received 16 comments in response to the general notification and no comments in response to the Tribal notification; see Appendix B of this report for additional information.

Pursuant to Fish and Game Code section 2074.6, the status review process included independent peer review of the draft status review by persons in the scientific and academic community acknowledged to be experts on Inyo rock daisy and related topics and possessing the knowledge and expertise to evaluate the assessments and conclusions in this status review report. Appendix C contains a table outlining the specific input provided to the Department by the individual peer reviewers and the Department's response to the input (Fish & G. Code, § 2074.6; Cal. Code Regs., tit. 14, § 670.1, subd. (f)(2)). Independent experts that reviewed the draft version of this Status Review are listed in Table 1, below.

Table 1. Status Review peer reviewers.

Name	Title and Affiliation
Duncan Bell	Senior Conservation Botanist, California Botanic Garden
Isaac Lichter-Marck	National Science Foundation Post-Doctoral Research Fellow, University of California Los Angeles
Emma Lynch	Natural Resource Specialist, Bureau of Land Management, Ridgecrest Field Office
James Morefield	Retired Lead Botanist, Nevada Division of Natural Heritage

BIOLOGY

Species Description

Inyo rock daisy is a member of the sunflower family (Asteraceae). It is a subshrub with a woody stem at the base of the plant and many herbaceous (i.e., non-woody) stems that die back seasonally (Ferris 1958, Yarborough and Powell 2006, Baldwin et al. 2012, Keil 2012). Inyo rock daisy is typically 10-30 cm (3.9-11.8 in) tall and has opposite or alternate leaves that are ovate (egg-shaped) to triangular or round, with serrate to serrate-lobed edges (Figure 1) (Keil 2012). Leaves are about 5-20 mm (0.2-0.8 in) long and as broad as, or somewhat broader, than long (Ferris 1958, Keil 2012). Leaves are attached to the stem by a petiole that is 0.5-2 mm (0.02-0.08 in) long according to Keil (2012) and up to 5 mm (0.2 in) long according to Ferris (1958). A longer petiole length of 5-20 mm (0.2-0.8 in) long is given by Yarborough and Powell (2006) but this is likely an error. The stems and leaves have many long, soft, spreading hairs that are generally less than 1.5 mm (0.06 in) long, intermixed with short, glandular hairs (Ferris 1958, Yarborough and Powell 2006, Keil 2012). Inyo rock daisy is aromatic, with plants having a lemony, turpentine aroma that is especially notable when the leaves are crushed (Department observation 2022).

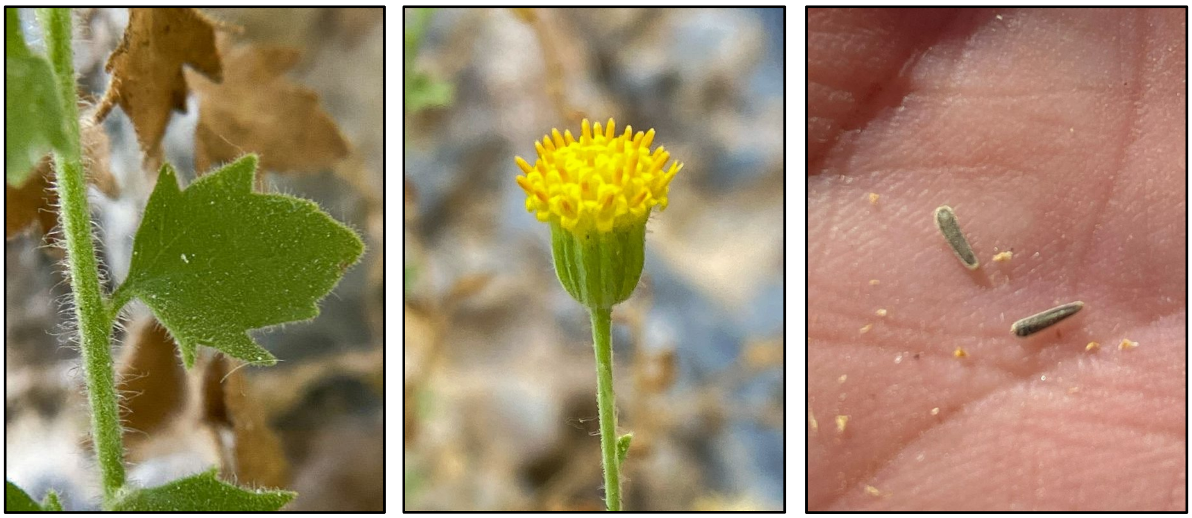

Figure 1. Photographs of Inyo rock daisy including the stem and leaf (left), inflorescence/capitulum (middle), and seeds (right). Photo credit: Kristi Lazar.

Inyo rock daisy, like most members of the sunflower family, has numerous small flowers (florets) clustered together into an inflorescence (a grouping of florets) to give the appearance of a single flower. Inflorescences contain 35 to 60 yellow florets clustered together into a dense head called a capitulum (Figure 1) (Yarborough and Powell 2006). Each stem typically has a single capitulum at the tip but can sometimes have 2 to 3 capitula (Ferris 1958, Yarborough and Powell 2006, Keil 2012). Each individual floret consists of a yellow, radially symmetric, tubular corolla (all of the petals fused together) with four symmetrical lobes (Yarborough and Powell 2006, Keil 2012). Total corolla length measures 4-5 mm (0.16-0.2 in) long, with the tube of the floret 1.4-1.6 mm (0.06 in) long, the throat 2-2.4 mm (0.08-0.09 in) long, and the lobes 0.6-0.7 mm (0.02-0.03 in) long (Yarborough and Powell 2006, Keil 2012)

Inyo rock daisy produces dry, single-seeded fruits called cypsela or achenes that are 3-3.5 mm (0.12-0.14 in) long (Figure 1) (Keil 2012). The faces of the fruits are covered with a fine down of hairs while the edges are short hairy (Yarborough and Powell 2006, Keil 2012). The fruits are either lacking a pappus or have a much-reduced pappus (Yarborough and Powell 2006, Keil 2012). A pappus is a group of structures such as awns, bristles, or scales that are attached to single-seeded fruits in plants of the sunflower family and often aid in seed dispersal, especially by wind (Sheldon and Burrows 1973, Baldwin et al. 2012). Given the absence of a well-developed pappus, Inyo rock daisy seeds likely do not use wind dispersal to travel long distances.

Taxonomy

Inyo rock daisy was first described as *Laphamia inyoensis* by Roxanna Ferris in 1958 (Ferris 1958). The original description was based on a collection made by Annie Alexander and Louise Kellogg in 1942 from Cerro Gordo Peak, above Cerro Gordo mines, at 2,500 m (8,200 ft) in elevation (Ferris 1958, CCH 2022). *L. inyoensis* was subsequently transferred to the genus *Perityle* by A. Michael Powell in 1968, based mainly on differences in pappus structure and the type of hairs present on the edges of the fruits (Powell 1968).

Inyo rock daisy was petitioned for CESA listing as *P. inyoensis* with a note that the scientific name for Inyo rock daisy was expected to change back to *L. inyoensis* once a study by Isaac Lichter-Marck and Bruce Baldwin reclassifying the rock daisies was published (Jesus et al. 2022b). This study became published in September 2022 (Lichter-Marck and Baldwin 2022). This phylogenetic study of the rock daisies shows that the genus *Perityle*, in its former broad circumscription, was not monophyletic; in other words, it did not contain all descendants of a common ancestor. As a result of this study, certain species previously placed in the genus *Perityle* were reclassified into the genus *Laphamia*. This has resulted in Inyo rock daisy's scientific name changing from *P. inyoensis* back to *L. inyoensis*. *L. inyoensis* is considered the correct scientific name for Inyo rock daisy at this time. This scientific name change does not affect anything else about the species, including the rarity or distribution of Inyo rock daisy as proposed by the Petition or as described in this Status Review.

Similar Taxa

Inyo rock daisy is not known to co-occur with any other species of rock daisy (*Laphamia* sp.); however, it is morphologically similar to Hanaupah rock daisy (*L. villosa*) (Ferris 1958, Powell 1973). Inyo rock daisy can be distinguished from Hanaupah rock daisy by examining the leaves (Ferris 1958). Inyo rock daisy has leaves that are arranged in an opposite or alternate manner with leaf edges that are serrate to serrate-lobed, while Hanaupah rock daisy has leaves that are only arranged alternately with leaf edges that are smooth or with 1 to 3 short, pointed lobes (Yarborough and Powell 2006, Keil 2012). In addition, Inyo rock daisy has a shorter petiole that is 0.5-2 mm (0.02-0.08 in) long compared to Hanaupah rock daisy which has a petiole that is 3-6 mm (0.1-0.2 in) long (Keil 2012). While Yarborough and Powell (2006) and Keil (2012) indicate that Hanaupah rock daisy occurs in the Inyo Mountains, no collections or observations of Hanaupah rock daisy from the Inyo Mountains are known to the Department. The closest documented occurrence of Hanaupah rock daisy to Inyo rock daisy is on the east side of the Panamint Range of Inyo County, about 80 km (50 mi) southeast of the southern-most occurrence of Inyo rock daisy (CCH 2022, CNDDB 2023). Rock daisy plants at Tin Mountain, at the northern end of the Cottonwood Mountains in Death Valley National Park, have been collected and identified as Inyo rock daisy and Hanaupah rock daisy at different herbaria but are now believed to be an undescribed rock daisy species (Lichter-Marck pers. comm. 2022, Lichter-Marck and Baldwin 2022). This undescribed rock daisy species at Tin Mountain is thought to be most closely related to Hanaupah rock daisy; for this reason, Tin Mountain is not included in the distribution of Inyo rock daisy in this Status Review (Lichter-Marck pers. comm. 2022, Lichter-Marck and Baldwin 2022).

Nevada rock daisy (*L. megalocephala*) also occurs in the mountains near Inyo rock daisy and is more widely distributed to the north and east (Powell 1973, Calflora 2022). Nevada rock daisy can be distinguished from Inyo rock daisy by its generally larger size and by looking at the hairs on the plant (Powell 1973, Keil 2012). Nevada rock daisy has short, rough hairs while Inyo rock daisy generally has long hairs (Keil 2012). The closest documented occurrence of Nevada rock daisy is at Lost Burro Gap on the west side of the Cottonwood Mountains of Inyo County, about 40 km (25 mi) northeast of the northeastern-most occurrence of Inyo rock daisy (Calflora 2022).

Rock daisy plants to the south of the known Inyo rock daisy range, at Talc City Hills and on carbonate rocks along Highway 190, bear a strong resemblance to Nevada rock daisy but show some characteristics that are similar to Inyo rock daisy (e.g., occasional serrate edges, triangular leaves, or soft, straight hairs) (Lichter-Marck pers. comm. 2022). In 2019, a rock daisy plant was collected from the south end of the Malpais Mesa Wilderness that was tentatively identified as Inyo rock daisy (Jesus 786, RSA0385950) (CCH 2022). However, these plants exhibited some intermediate characters and differences in habitat, so this collection was determined to be an unknown species of rock daisy (Jesus et al. 2022a, b, Lichter-Marck pers. comm. 2022). Further study would be needed to better understand the relatedness of these plants to Inyo rock daisy.

Range and Distribution

Range is the general geographical area in which an organism occurs. For purposes of CESA and this Status Review, the range of a species is strictly its California range (Cal. Forestry Assn. v. Cal. Fish and Game Com. (2007) 156 Cal.App.4th 1535, 1551). Distribution describes the actual sites where individuals and populations of the species occur within the species' range.

The total range of Inyo rock daisy is approximately 72 km^2 (28 mi^2). Inyo rock daisy has only been documented to occur at the southern end of the Inyo Mountains in Inyo County, California. The Inyo Mountains are the southern continuation of the White Mountains, lying east of the Sierra Nevada between Owens Valley to the west and Saline Valley to the east. The Inyo Mountains are about 95 km (59 mi) long and 20 to 25 km (12 to 16 mi) wide with the highest elevation occurring on Waucoba Mountain at 3,390 m (11,125 ft) (Lee et al. 2009). Within the southern Inyo Mountains, Inyo rock daisy reaches its northern limit in the vicinity of Cerro Gordo Spring and extends south and southeast to the Conglomerate Mesa area, with its southern limit being an isolated occurrence near Santa Rosa Mine on the eastern side of the Malpais Mesa Wilderness (CNDDB 2023). The highest elevation within Inyo rock daisy's range at the southern end of the Inyo Mountains is Point Pleasant at about 2,957 m (9,700 ft) in elevation. Based on herbarium collections, Inyo rock daisy can grow between 1,800 and 2,957 m (5,900 and 9,700 ft) in elevation; however, all recently documented locations are from between 1,834 and 2,957 m (6,018 and 9,700 ft) in elevation (CCH 2022, CNDDB 2023). The low elevation of 1,800 m (5,900 ft) is based on a 1939 Edmund Jaeger collection and may be the result of imprecise elevational information on the collection label, but additional surveys are needed to conclusively determine the lower elevational limit for Inyo rock daisy (CCH 2022). Inyo rock daisy occurrences are found within the Owens Lake, Salt Lake, and Santa Rosa Wash watersheds (USGS 2018).

The distribution of Inyo rock daisy is based on data documented in the California Natural Diversity Database (CNDDB). Plant taxa, animal taxa, and natural communities that are documented within the CNDDB are of conservation concern within California and are referred to as "elements." An "element occurrence" (occurrence or EO) is a location record for a site which contains an individual, population, nest site, den, or stand of a special status element, and each occurrence for an element is assigned a number in the CNNDB for tracking purposes (CNDDB 2020). Populations, individuals, or colonies that are located within 0.40 km (0.25 mi) of each other generally constitute a single occurrence, sometimes with multiple polygons (CNDDB 2020). CNDDB occurrences for Inyo rock daisy were updated in December 2021 prior to the Petition being submitted to the Commission, and again in December 2022 and March 2023 after Inyo rock daisy advanced to candidacy. A distribution map showing CNDDB occurrences for Inyo rock daisy is included as Figure 2. Specific occurrence locations for Inyo rock daisy are available at the CNDDB; the figures in this status review show occurrences as more generalized features to adhere to the CNDDB license agreement and protect the species from harm (CNDDB 2018).

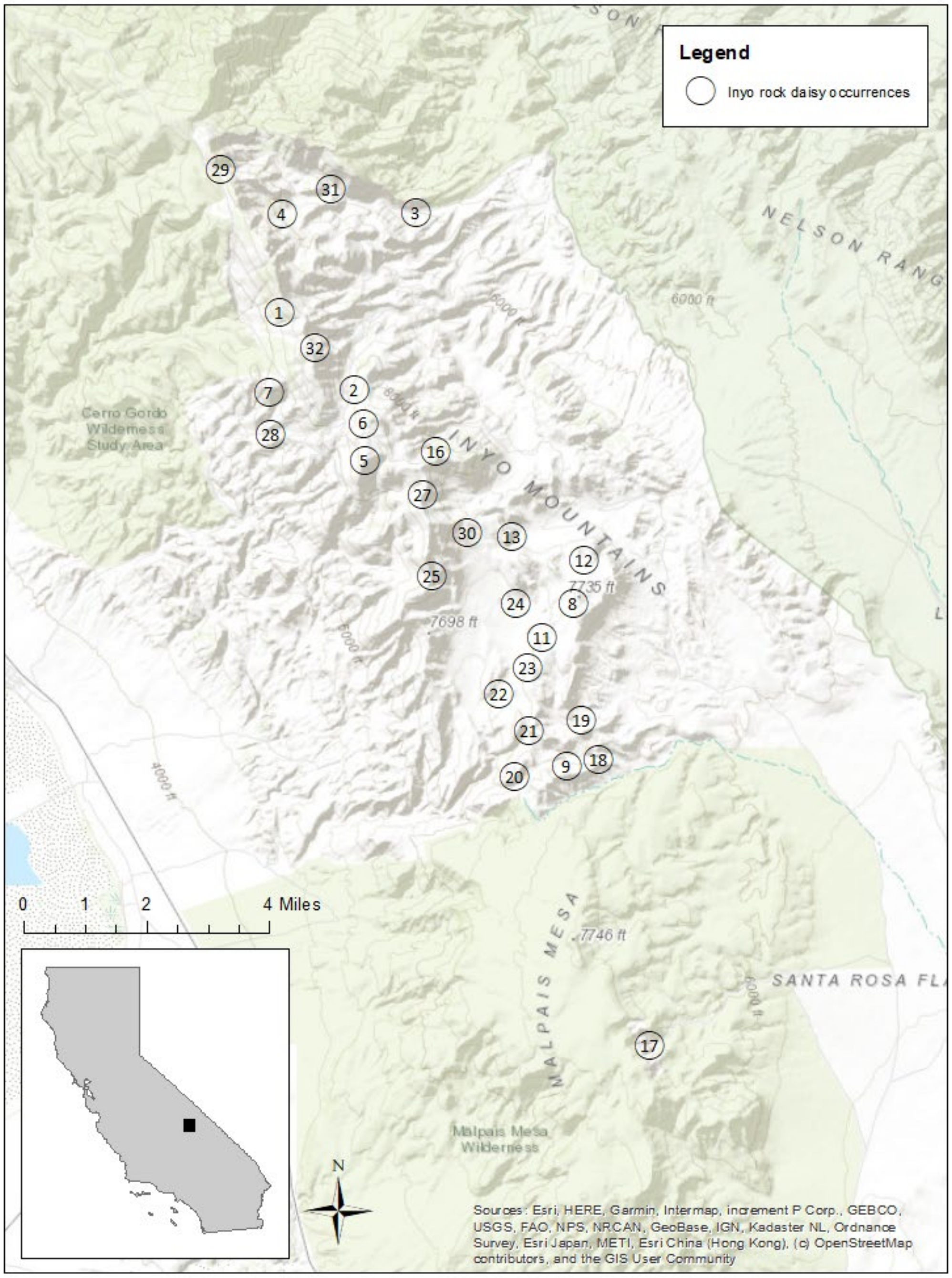

Figure 2. Inyo rock daisy distribution map (CNDDB 2023). Circles represent the center of CNDDB Inyo rock daisy occurrences as of March 2023 and are labeled with the CNDDB occurrence number. CNDDB disclaimer: There may be additional occurrences within this area which have not yet been surveyed. Lack of information in the CNDDB about a species or area can never be used as proof that no special status species occur in the area.

There are 28 occurrences of Inyo rock daisy documented in the CNDDB as of March 2023 (Figure 2, Appendix A) (CNDDB 2023). Prior to 2018, Inyo rock daisy was only documented from eight occurrences based on historical collections, maps from the 1970s and 1980s, survey data from the mid-1990s, and observations from 2011 and 2013. From 2018 to 2022, a concerted effort was made to document range extensions and new occurrences of Inyo rock daisy, which resulted in the discovery of 20 new occurrences, expanding the range to both the north and south. Most of these surveys were conducted as part of a study to document the vascular flora of the southern Inyo Mountains, a study on the taxonomy of rock daisies, and seed banking efforts by the California Botanic Garden and Santa Barbara Botanic Garden (Jesus 2021, Carson pers. comm. 2022a, Jesus et al. 2022b, Lichter-Marck pers. comm. 2022).

Inyo rock daisy occurrences are patchily distributed in the southern Inyo Mountains on calcareous (calcium carbonate) rock outcrops. The Inyo rock daisy occurrence at Cerro Gordo Spring represents the northern-most documented occurrence of the species. Further north of Cerro Gordo Spring, carbonate rock outcrops along the Swansea Road and near New York Butte were surveyed in 2018, but no Inyo rock daisy plants were found (Lichter-Marck pers. comm. 2022). This suggests that the Cerro Gordo Spring area may be the northern limit for Inyo rock daisy. From Cerro Gordo Spring, Inyo rock daisy occurrences extend in a patchy manner southeast and south to the south end of Conglomerate Mesa, with the highest concentration of Inyo rock daisy populations growing on calcareous rock outcrops within the Conglomerate Mesa area. Approximately 7.4 km (4.6 mi) south of the Conglomerate Mesa is a single disjunct Inyo rock daisy occurrence at Santa Rosa Mine on the eastern side of the Malpais Mesa. Extensive surveys have occurred in the intervening area between the Conglomerate Mesa and Santa Rosa Mine with no Inyo rock daisy plants or habitat found (Jesus et al. 2022b). The lack of Inyo rock daisy plants is likely due to the large expanse of volcanic rock substrate without a calcareous component (Hall and MacKevett Jr 1962, Stone et al. 2009). The Santa Rosa Mine occurrence may represent the southern-most limit for Inyo rock daisy. Plants to the south of the Malpais Mesa, at Talc City Hills and on carbonate rocks along Highway 190, exhibit characteristics of both Nevada rock daisy and Inyo rock daisy (see the Similar Taxa section of this Status Review for further discussion).

Based on observations made by Department staff during a site visit at Conglomerate Mesa in July 2022 and notes from CNDDB occurrence records, it is likely that extensions to known Inyo rock daisy occurrences and undiscovered occurrences may exist. Federal lands managed by the Bureau of Land Management (BLM) in the Conglomerate Mesa area should be methodically surveyed for additional plants. In addition, private land in the Cerro Gordo Peak area has not been systematically surveyed for Inyo rock daisy, and there may be additional occurrences yet to be found in this area. Despite the likelihood that additional occurrences will be found, there is limited habitat for Inyo rock daisy within its known range and the discovery of new occurrences is not anticipated to significantly increase the range of the species.

Life History

Inyo rock daisy flowers June through September with peak flowering in July and August (Keil 2012, Jesus et al. 2022b). Many insects, including bees (families Apidae, Halictidae, and Megachilidae), flies (families Bombyliidae, Culicidae, and Tachinidae), and wasps (family Vespidae), have been observed visiting Inyo rock daisy flowers and likely serve as pollinators (Lichter-Marck 2018). The main insect visitors to Inyo rock daisy flowers observed by Department staff in July 2022 were bee flies, likely belonging to the genus *Geron* in the Bombyliidae (Figure 3).

Figure 3. Photographs of bee flies visiting Inyo rock daisy flowers in July 2022 at Conglomerate Mesa, Inyo County. Photo credit: Kristi Lazar.

Based on studies of closely related species, Inyo rock daisy is thought to be self-incompatible which means that an individual plant cannot pollinate itself, and the species is therefore dependent on pollinators to deliver pollen from nearby plants to reproduce. A study initiated in 1965 examined hybridization in several closely related genera, including species of the broad circumscription of *Perityle* described by Powell (1968) (see the Taxonomy section of this Status Review for further discussion), and found that all 33 *Perityle* species that were tested (many now considered *Laphamia* species) were self-incompatible (Powell 1968, 1972). While Inyo rock daisy was not included in the study, the closely related Hanaupah rock daisy and Nevada rock daisy were included and determined to be self-incompatible (Powell 1972). Inyo rock daisy likely shares this self-incompatibility trait with its close relatives. There is no evidence of asexual reproduction (clonal reproduction) in Inyo rock daisy (Jesus et al. 2022b).

Fruiting has been observed to occur as early as July for lower elevation populations and can continue into September for plants at higher elevation (Jesus et al. 2022b). Given the absence of a well-developed pappus in Inyo rock daisy, seeds likely do not rely on wind to disperse long distances. Since Inyo rock daisy occurs on rock outcrops, which appear as islands of habitat surrounded by unsuitable conditions, it is thought that long distance wind dispersal offers more risks than benefits to the species (Carlquist 1966, Cody and Overton 1996, Cheptou et al. 2008, Riba et al. 2009, Schenk 2013, Lichter-Marck et al. 2020). If seeds are dispersed too far, they will likely encounter unsuitable conditions and not germinate, whereas if long-distance dispersal potential is diminished (i.e., the pappus is reduced or lost altogether), seeds are more likely to disperse short distances and remain within the area with suitable conditions. It is presumed that Inyo rock daisy seed dispersal occurs mainly through gravity moving the seeds to crevices where nutrients accumulate, or through animal movement (Larson et al. 2000b, Jesus et al. 2022b). Wind may play a role in moving seeds short distances if the seeds are light enough to travel without a pappus to aid dispersal (Davis 1951).

Not much is known about the longevity and viability of Inyo rock daisy seeds in the wild. The California Botanic Garden performed germination trials on Inyo rock daisy seeds collected in 2018 from two sites, and found that after one year, the germination rates with no pre-treatment were 52.6% and 73.8% (Birker pers. comm. 2022). The length of time that seeds are viable is unknown but California Botanic Garden plans to do follow-up germination tests on the same two collections after five years of storage in 2023 (Birker pers. comm. 2022). The Department is not aware of any studies that have been done on Inyo rock daisy seed germination in the field.

Seedling establishment in arid environments, such as the desert habitats where Inyo rock daisy occurs, is generally low. One study of perennial plant species in the Mojave Desert found only 1 of 201 seedlings survived to four years (a 0.5% survival rate), while a similar study in the Sonoran Desert found only 2 of 2,008 seedlings survived to four years (a 0.1% survival rate) (Ackerman 1979, Bowers et al. 2004). Inyo rock daisy is restricted to crevices in rock outcrops. Often those crevices are already occupied by other plant taxa thereby limiting the ability of Inyo rock daisy seedlings to establish (Davis 1951). In the field, few Inyo rock daisy seedlings have been seen; fewer than five seedlings were observed in 2018 and 2019, and fewer than 20 seedlings in 2020 (Jesus et al. 2022b). Department staff did not observe any seedlings during field surveys in 2022. This scarcity of seedlings has been reported as a common feature in plant taxa adapted to growing on or among rocks, and it is not unusual for individuals in these habitats to go years without establishing any offspring since there are few suitable crevices for seedling establishment (Davis 1951).

Inyo rock daisy has a short, woody stem at the base of the plant that helps anchor the plant into crevices in its rocky habitat (Poot et al. 2012, Lichter-Marck and Baldwin 2023). Inyo rock daisy is likely moderate to long-lived and slow growing based on studies of plants that grow on or among rocks, as well as studies of other desert shrub species. Plants that grow in rock and cliff habitats are generally long-lived perennials to compensate for the difficulty and time needed to become established (Davis 1951). Studies on survivorship of desert shrubs have confirmed that many desert shrub species are long-lived with lifespans greater than 100 years (Bowers et al. 1995, Cody 2000). Since Inyo rock daisy is a subshrub, its lifespan may be less than many of the larger desert shrubs. Goldberg and Turner (1986) found that small subshrubs (similar in growth form to Inyo rock daisy) in their permanent plot study in the Sonoran Desert, had a maximum observed lifespan of 3 to 32 years, but these were not species that grow on rock outcrops or cliffs, which are thought to have an older maximum age than plants in surrounding habitats (Davis 1951, Goldberg and Turner 1986, Larson et al. 1999). This longer lifespan may be at least partly because these habitats provide a refuge from conditions in the surrounding landscape that could affect survivorship, including competition with plants, fire, and human disturbances (Davis 1951, Larson et al. 1999, 2000a).

In addition to having longer lifespans, many plants in the desert are slow growing. Small shrub species in the Mojave Desert were found to expand in area at an average rate of about 0.02-0.05 m^2 (0.07-0.16 ft^2) per year (Cody 2000). Plants that grow in crevices or cracks in the rock, such as Inyo rock daisy, often do not have enough nutrients or space for a fast growth rate (Larson et al. 2000b). Given Inyo rock daisy's habitat preferences for growing on rock outcrops in the desert, Inyo rock daisy plants likely have a slow growth rate.

HABITAT THAT MAY BE ESSENTIAL TO THE CONTINUED EXISTENCE OF THE SPECIES

Inyo rock daisy grows in sparsely vegetated calcareous rock outcrops within pinyon woodlands, Joshua tree woodlands, or sagebrush shrublands (Jesus et al. 2022b). The Department's preliminary identification of the habitat that may be essential to the continued existence of Inyo rock daisy includes habitats that fit the general habitat descriptions provided below in this section, habitat that supports a healthy population of Inyo rock daisy plants, habitat that represents elevational and distributional limits of the species, and/or habitat that is predicted to remain suitable for Inyo rock daisy in the future despite the effects of climate change.

Geology and Soils

Inyo rock daisy is restricted to the southern portion of the Inyo Mountains in Inyo County, California. The Inyo Mountains were initially formed about 14 million years ago when the rock was uplifted due to normal faulting along the East Inyo Fault Zone (Conrad 1993). The southern Inyo Mountains contain a mixture of igneous and sedimentary rock. The igneous rock includes plutonic and volcanic rocks, and the sedimentary rock includes limestone, dolomite, quartzite, and shale, with nearly all Inyo rock daisy occurrences on sedimentary rock (Merriam 1963, Stone et al. 2004, 2009, Jennings et al. 2010). Inyo rock daisy is restricted to rock outcrops which are areas where a portion of bedrock is protruding through the soil level (Figure 4) (Larson et al. 2000b). Inyo rock daisy can often be found growing on steep slopes and cliffs that are associated with the rock outcrops. The species appears to be limited to calcareous substrates.

Figure 4. Inyo rock daisy habitat photos showing rock outcrops at Conglomerate Mesa (upper left and upper right), rock outcrop in Bonham Canyon (lower left), and close-up of rock outcrop in Bonham Canyon with Inyo rock daisy plants (lower right). Photo credit: Kristi Lazar.

Geologic formations that Inyo rock daisy has been documented to occur on all have a limestone or dolomite component and include Keeler Canyon Formation, Sedimentary Rocks of Santa Rosa Flat, Conglomerate Mesa Formation, Tin Mountain Limestone, Mexican Spring Formation, Lost Burro Formation, Union Wash Formation, Hidden Valley Dolomite, and Fanglomerate of Bonham Canyon (Stone et al. 2004, 2009). A portion of a single occurrence (CNDDB EO #29) is found on Rest Spring Shale (also called Chainman Shale) which is mostly comprised of clay shale and silty shale but can also contain limestone (Merriam 1963, Conrad 1993). A single isolated Inyo rock daisy occurrence (CNDDB EO #17) at Santa Rosa Mine is in an area with a limestone vein deposit surrounded by volcanic rocks (MacKevett 1953, Hall and MacKevett Jr 1962).

Inyo rock daisy grows on rock outcrops with minimal soil formation. Soil survey data for the area where Inyo rock daisy occurs is incomplete. The Natural Resources Conservation Service only has soil survey data available for the vicinity of CNDDB EO #1 and #7 in the northern portion of the range of Inyo rock daisy (Soil Survey Staff 2022). CNDDB EO #1 and #7 occur in soil series noted as having well-drained loam soils weathered from metasedimentary rock, metavolcanics, and/or granite.

Ecoregions

Ecoregions (also called ecological regions or ecosystem regions) are large areas that have commonality in the type, quality, and quantity of environmental features (Omernik 1987, Bailey 2014, Griffith et al. 2016). They are identified through the analysis of spatial patterns and composition of biotic and abiotic factors (such as climate, geology, geography, natural vegetation, soils, land use, wildlife, hydrology, etc.) (Omernik 1987, Bailey 2005, Griffith et al. 2016). Ecoregions serve as a spatial framework for research, assessment, management, and monitoring of ecosystems and are useful for planning at regional scales (McNab et al. 2007, Griffith et al. 2016). Knowing the ecoregions where Inyo rock daisy occurs can help with understanding of the type of ecosystems Inyo rock daisy inhabits, how those ecosystems relate to surrounding areas, and for developing ecosystem-level management strategies.

In 1997, the U.S. Forest Service published a report on the ecological regions of California based on the National Hierarchical Framework of Ecological Units (CEC 1997). The report presented a hierarchy of ecological regions at multiple geographic scales concentrating on the two smallest units of scale: sections and subsections. Each of the sections and subsections represents an area with relatively homogenous ecological characteristics that interact to create environments with similar responses to disturbance and similar resource management needs (McNab et al. 2007). The southern Inyo Mountains, where Inyo rock daisy occurs, are described as being part of the Southeastern Great Basin section and Inyo Mountains subsection (Miles and Goudey 1997). The Inyo Mountains subsection includes the Inyo Mountains, Malpais Mesa, and Deep

Springs Valley. It is characterized as a temperate to cold, arid climate with a mean annual precipitation of about 20 to 41 cm (8 to 16 in) and a mean annual temperature of 2 to 12°C (35 to 54°F). The Inyo Mountains subsection is predominantly comprised of natural communities dominated by big sagebrush (*Artemisia tridentata*) at lower elevations and natural communities dominated by single-leaf pinyon (*Pinus monophylla*) at higher elevations.

Building on previous ecoregion classifications, Griffiths et al. developed an ecoregion map and hierarchical framework for California in 2016 (Griffith et al. 2016). The 2016 ecoregion classification uses Roman numerals to represent different levels in the ecological hierarchy, with Level I as the coarsest level and Level IV as the most detailed level. The southern Inyo Mountains consist of several Level IV ecoregions: Sierra Nevada-Influenced Ranges, Tonopah Sagebrush Foothills, and Western Mojave Low Ranges and Arid Footslopes (Figure 5) (Griffith et al. 2016). The majority of Inyo rock daisy occurrences are in the Sierra Nevada-Influenced Ranges ecoregion, which is described as being in the Sierra Nevada rain shadow, receiving minimal summer rainfall, and containing pinyon-juniper woodlands. Several additional Inyo rock daisy occurrences are in the Tonopah Sagebrush Foothills ecoregion characterized as being in the rain shadow of the Sierra Nevada and adjacent to the Mojave Desert. Where summer moisture is more prevalent, Mojave Desert species such as blackbrush (*Coleogyne ramosissima*), western Joshua tree (*Yucca brevifolia*), and cholla cactus (*Cylindropuntia* sp.) become more common in the Tonopah Sagebrush Foothills ecoregion. Just a single occurrence of Inyo rock daisy occurs in the Western Mojave Low Ranges and Arid Footslopes ecoregion which receives little summer rainfall and consists of erosional highlands of exposed bedrock that rise above the alluvium of the basin floors. Griffith et al. (2016) notes that some areas in this ecoregion appear to be more similar to the Western Mojave Basins ecoregion which receives little summer rainfall and has basins dominated by creosotebush (*Larrea tridentata*) and white bursage (*Ambrosia dumosa*), as well as areas of shadscale (*Atriplex confertifolia*), fourwing saltbush (*Atriplex canescens*), and scattered western Joshua trees.

Vegetation

Vegetation describes the assemblage and arrangement of plants in an area (CNPS 2022a). Vegetation is often considered the single best surrogate for habitat and ecosystems and is a useful classification unit for assessing and monitoring habitat conditions, changes, and management strategies (CSUN and CDFW 2014). Vegetation can be classified into vegetation types based on species composition, percent cover of species, structure (e.g., as tree height), and/or environmental information (e.g., slope, aspect, and soil texture) (CSUN and CDFW 2014). Vegetation alliances and associations are vegetation classification categories that describe repeating patterns of plants across a landscape, with an alliance classifying vegetation at a broader scale than an association (CNPS 2022a).

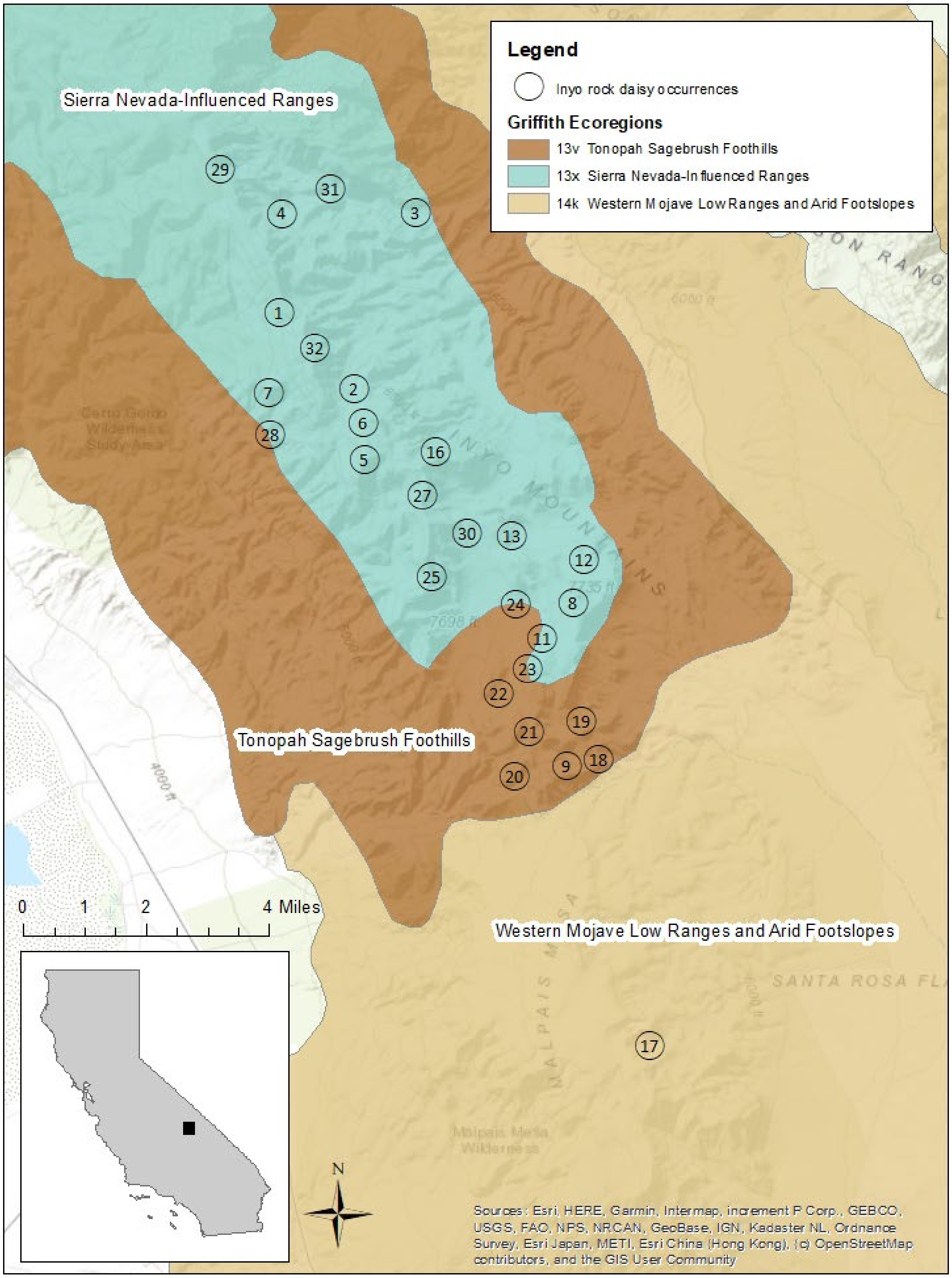

Figure 5. Ecoregions in the vicinity of Inyo rock daisy occurrences (Griffith et al. 2016, CNDDB 2023). Circles represent the center of CNDDB Inyo rock daisy occurrences as of March 2023 and are labeled with the CNDDB occurrence number.

The Department's Vegetation Classification and Mapping Program (VegCAMP) has vegetation data for the central Mojave Desert region. This vegetation data was used to produce a map and classification of vegetation community types for this area in 2004 based on the U.S. National Vegetation Classification Standard (Thomas 2002, Thomas et al. 2004). The minimum mapping unit for this central Mojave Desert vegetation map was 5 ha (12 ac), meaning any vegetation feature smaller than 5 ha (12 ac) could not be mapped as a discrete vegetation type. Since the Mojave Desert vegetation map was produced in 2004, additional updates and refinements have been made to vegetation classification as a whole and are reflected in the online version of A Manual of California Vegetation (CNPS 2022a).

Based on the central Mojave Desert vegetation map (Thomas 2002, Thomas et al. 2004), Inyo rock daisy occurrences are within vegetation types classified as: Big Sagebrush Shrubland (*Artemisia tridentata* Shrubland Alliance and/or *Ephedra viridis-Artemisia tridentata* Shrubland Alliance), Pinyon Woodlands and Shrublands (*Pinus monophylla* Sparsely Wooded Shrubland Alliance and/or *Pinus monophylla*-(*Juniperus osteosperma*) Woodland Alliance), Joshua Tree Wooded Shrubland (*Yucca brevifolia* Wooded Shrubland Alliance), and Shadscale Shrubland (*Atriplex confertifolia* Shrubland Alliance). As of 2022, the online version of A Manual of California Vegetation recognizes slightly different names for several of these alliances (Table 2) (CNPS 2022b). The *Ephedra viridis-Artemisia tridentata* Shrubland Alliance and the *Pinus monophylla* Sparsely Wooded Shrubland Alliance are no longer recognized by A Manual of California Vegetation, with the former likely representing an association within the *Artemisia tridentata* subsp. *vaseyana* Shrubland Alliance and the latter reflecting one of several associations within the *Pinus monophylla*-(*Juniperus osteosperma*) Woodland Alliance. In addition, the *Yucca brevifolia* Wooded Shrubland Alliance is now called the *Yucca brevifolia* Woodland Alliance.

Nearly all Inyo rock daisy occurrences are mapped within Big Sagebrush Shrubland, Pinyon Woodlands and Shrublands, and Joshua Tree Wooded Shrubland vegetation types, which is consistent with information presented in the CNDDB occurrence level descriptions of Inyo rock daisy habitat (Table 2, Figure 6) (Thomas 2002, CNDDB 2023). The central Mojave Desert vegetation map indicates that one Inyo rock daisy occurrence is likely in Shadscale Shrubland (CNDDB EO #17 at Santa Rosa Mine); however, based on direct field observations in the CNDDB, the occurrence is actually in a Joshua Tree Wooded Shrubland and not Shadscale Shrubland. This discrepancy between the vegetation map and reported associates in the CNDDB is likely due to the coarse scale of the vegetation map and due to occurrences being scattered along a transition area between Big Sagebrush Shrubland, Pinyon Woodlands and Shrublands, and Joshua Tree Wooded Shrubland vegetation types.

Table 2. Vegetation alliances and descriptions at Inyo rock daisy occurrences (Thomas 2002, Thomas et al. 2004, CNPS 2022a, CNDDB 2023).

Alliance Name (Thomas 2002, Thomas et al. 2004)	Currently Recognized Alliance Name (CNPS 2022a)	Alliance Description	CNDDB Inyo Rock Daisy EO Numbers
Artemisia tridentata Shrubland (Big Sagebrush Shrubland) and/or *Ephedra viridis-Artemisia tridentata* Shrubland	*Artemisia tridentata* Shrubland (Big Sagebrush Shrubland) and/or *Artemisia tridentata* subsp. *vaseyana* Shrubland (Mountain Big Sagebrush)	*Artemisia tridentata* ≥2% absolute cover in the shrub canopy; no other single species with greater cover; *Ephedra viridis* <1% absolute cover. *Artemisia tridentata* subsp. *vaseyana* >50% relative cover in the shrub canopy.	1, 4*, 7, 19*, 25*, 28, 29, 32
Pinus monophylla Sparsely Wooded Shrubland and/or *Pinus monophylla*-(*Juniperus osterosperma*) Woodland (Pinyon Woodlands and Shrublands)	*Pinus monophylla*-(*Juniperus osteosperma*) Woodland (Singleleaf Pinyon-Utah Juniper Woodlands)	*Pinus monophylla* >25% absolute cover in the tree canopy or ≥1% but <25% cover with *Juniperus* spp. present. *P. monophylla* occurs over a sparse to relatively dense cover of shrubs.	2, 3, 4*, 5, 6, 8, 11, 12, 13, 16, 23*, 25*, 26, 27, 30, 31
Yucca brevifolia Wooded Shrubland (Joshua Tree Wooded Shrubland)	*Yucca brevifolia* Woodland (Joshua Tree Woodland)	*Yucca brevifolia* evenly distributed at ≥1% cover, *Juniperus* and/or *Pinus* spp. <1% absolute cover in the tree canopy.	9, 17**, 18, 19*, 20, 21, 22, 23*, 24

*CNDDB EO numbers with an asterisk next to them are partially within the given vegetation alliance.

**CNDDB EO #17 is mapped in Shadscale Scrubland in the central Mojave Desert vegetation map but based on direct observation, it is in a Joshua Tree Wooded Shrubland.

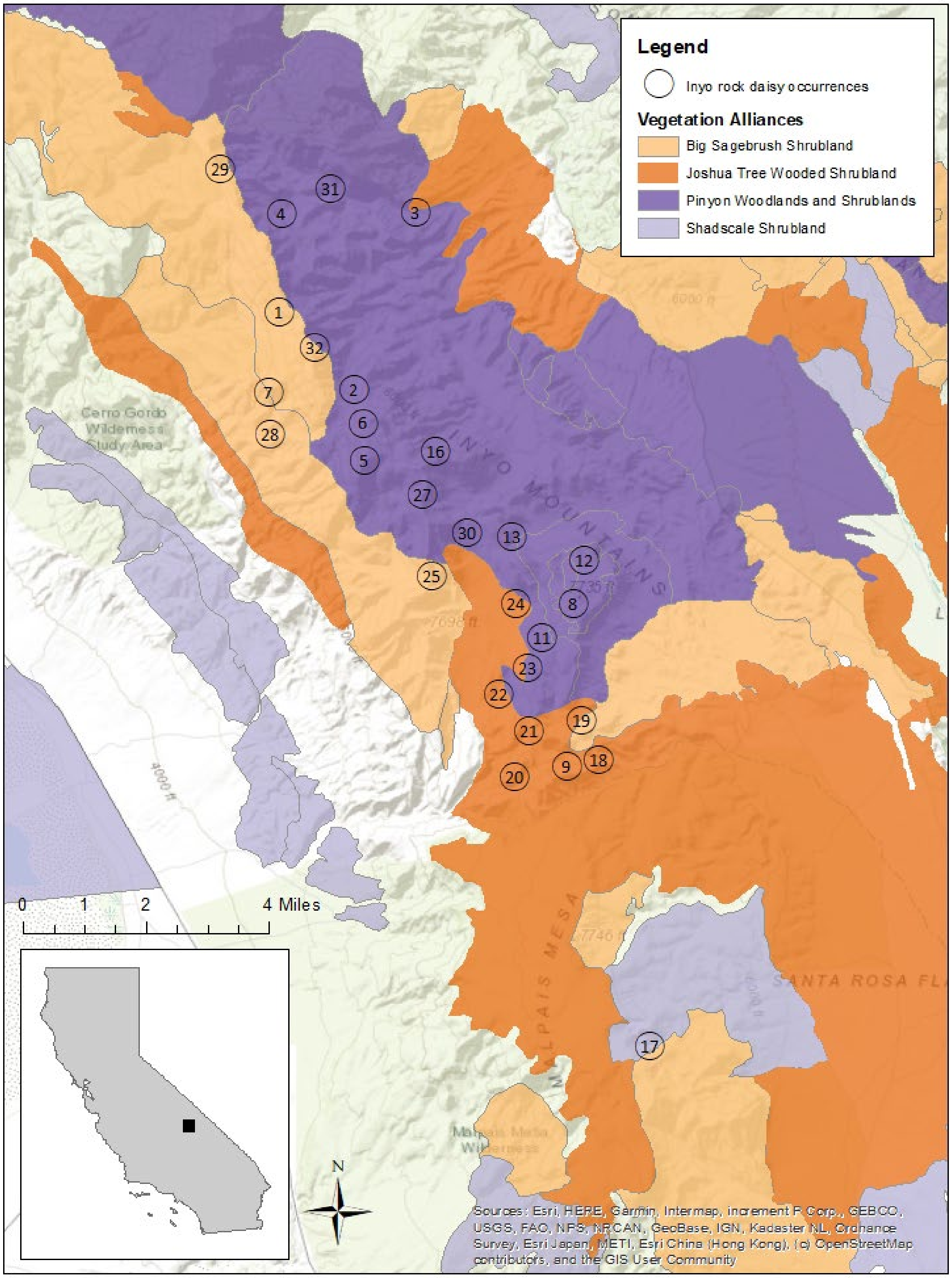

Figure 6. Vegetation alliances in the vicinity of Inyo rock daisy occurrences (Thomas 2002, CNDDB 2023). Circles represent the center of CNDDB Inyo rock daisy occurrences as of March 2023 and are labeled with the CNDDB occurrence number.

Common associates of Inyo rock daisy include single-leaf pinyon pine and western Joshua tree, which are situated in the vegetation surrounding the rock outcrops where Inyo rock daisy grows. Other common associates include black sagebrush (*Artemisia nova*), big sagebrush (*Artemisia tridentata*), Utah juniper (*Juniperus osteosperma*), Mormon tea (*Ephedra viridis*), rabbitbrush (*Ericameria* spp.), Antelope bitterbrush (*Purshia tridentata*), granite prickly phlox (*Linanthus pungens*), thickstem wild cabbage (*Caulanthus crassicaulis*), shadscale (*Atriplex confertifolia*), and Heermann's buckwheat (*Eriogonum heermannii* var. *argense*) (Jesus et al. 2022b, CNDDB 2023).

Other tree and shrub associates can include mountain maple (*Acer glabrum* var. *diffusum*), fernbush (*Chamaebatiaria millefolium*), yellow rabbitbrush (*Chrysothamnus viscidiflorus* subsp. *puberulus*), Nevada ephedra (*Ephedra nevadensis*), spiny greasebush (*Glossopetalon spinescens*), broom snakeweed (*Gutierrezia sarothrae*), oceanspray (*Holodiscus discolor* var. *microphyllus*), winterfat (*Krascheninnikovia lanata*), beavertail cactus (*Opuntia basilaris*), plains pricklypear (*Opuntia polyacantha*), rock spirea (*Petrophytum caespitosum*), limber pine (*Pinus flexilis*), Stansbury's cliffrose (*Purshia stansburyana*), desert gooseberry (*Ribes velutinum*), and desert snowberry (*Symphoricarpos longiflorus*) (Jesus et al. 2022b).

Other herbaceous plant associates can include Fremont's milkvetch (*Astragalus lentiginosus* var. *fremontii*), Newberry's milkvetch (*Astragalus newberryi* var. *newberryi*), red brome (*Bromus rubens*), cheatgrass (*Bromus tectorum*), pinyon mariposa (*Calochortus brunueanis*), Douglas' sedge (*Carex douglasii*), desert paintbrush (*Castilleja chromosa*), Douglas' dustymaiden (*Chaenactis douglasii* var. *douglasii*), Sacramento waxy dogbane (*Cycladenia humilis* var. *jonesii*), Bigelow mimulus (*Diplacus bigelovii*), squirreltail (*Elymus elymoides*), rayless daisy (*Erigeron aphanactis* var. *aphanactis*), birdnest buckwheat (*Eriogonum nidularium*), pagoda buckwheat (*Eriogonum rixfordii*), showy gilia (*Gilia cana*), Jaeger's halimolobos (*Halimolobos jaegeri*), pink alumroot (*Heuchera rubescens*), galleta (*Hilaria jamesii*), desert pepperweed (*Lepidium fremontii*), Great Basin wild rye (*Leymus cinereus*), Nevada biscuitroot (*Lomatium nevadense*), silvery lupine (*Lupinus argenteus*), roughseed cryptantha (*Oreocarya flavoculata*), notch-leaved phacelia (*Phacelia crenulata*), James' galleta (*Pleuraphis jamesii*), Sandberg bluegrass (*Poa secunda*), Russian thistle (*Salsola* sp.), San Francisco champion (*Silene verecunda*), desert prince's plume (*Stanleya pinnata* var. *pinnata*), Indian ricegrass (*Stipa hymenoides*), desert needlegrass (*Stipa speciosa*), and sixweeks fescue (*Vulpia octoflora*) (Jesus et al. 2022b).

California Rare Plant Rank (CRPR) taxa are those plants that the California Native Plant Society considers to be of conservation concern in California. Several CRPR plants are known to grow near Inyo rock daisy including Inyo onion (*Allium atrorubens* var. *cristatum*), Shockley's rockcress (*Boechera shockleyi*), Parry's monkeyflower (*Diplacus parryi*), dwarf goldenbush

(*Ericameria nana*), limestone daisy (*Erigeron uncialis* var. *uncialis*), Wildrose Canyon buckwheat (*Eriogonum eremicola*), Pinyon Mesa buckwheat (*Eriogonum mensicola*), prickle-leaf (*Hecastocleis shockleyi*), Jaeger's hesperidanthus (*Hesperidanthus jaegeri*), rosy-petalled cliffbush (*Jamesia americana* var. *rosea*), Badger Flat threadplant (*Nemacladus inyoensis*), caespitose evening-primrose (*Oenothera cespitosa* subsp. *crinita*), bristlecone pine (*Pinus longaeva*), and Mojave fish-hook cactus (*Sclerocactus polyancistrus*) (Jesus et al. 2022b, CNDDB 2023).

Climate, Hydrology, and Other Factors

Inyo rock daisy occurs in the California desert bioregion with climate characterized by high solar radiation, low soil moisture, irregular and unpredictable precipitation, and relatively high fluctuations in temperatures (Solbrig 1982). Within the desert bioregion, Inyo rock daisy occurs in a transition area between the Mojave Desert and Great Basin Desert, with the Mojave Desert being hotter and drier on average than the Great Basin Desert (Pavlik 2008). Inyo rock daisy populations at higher elevations occur in habitats with a strong Great Basin Desert influence, while lower elevation populations may see more of a Mojave Desert influence (Pavlik 2008).

The Parameter-elevation Regressions on Independent Slopes Model (PRISM) provides a localized estimate of climate using point measurements of climate data, a digital elevation model, and other spatial datasets to generate 4 km cell gridded estimates of climatic variables (primarily precipitation and temperature) (Daly et al. 1994, 2008). According to PRISM output from 1991 through 2020 across Inyo rock daisy's range, daily maximum temperature averaged over all days in each month was highest for the month of July with an average high of 27.9°C (82.3°F) (PRISM Climate Group 2022). Daily minimum temperature averaged over all days in each month was coldest for the months of December and February with an average low of −3.5°C (25.7°F) (PRISM Climate Group 2022). Precipitation across Inyo rock daisy's range averaged 26.9 cm (10.6 in) per year (PRISM Climate Group 2022). The PRISM data also showed that the northern portion of the range of Inyo rock daisy in the Cerro Gordo Peak area is cooler and wetter, while the southern end of the range in the Malpais Mesa area is warmer and drier (Table 3) (PRISM Climate Group 2022).

Table 3. Modeled average temperature and precipitation for areas within the range of Inyo rock daisy from 1991 through 2020 (PRISM Climate Group 2022).

Location	Average daily maximum temperature for the hottest month (July) (°C/°F)	Average daily minimum temperature for the coldest month (December or February) (°C/°F)	Average mean temperature across all months (°C/°F)	Average yearly precipitation (cm/in)
Cerro Gordo Peak area (northern part of Inyo rock daisy range)	25.9/78.6	−4.1/24.5	8.8/47.8	29.5/11.6
Conglomerate Mesa area (middle part of Inyo rock daisy range)	28.1/82.6	−3.9/24.9	9.8/49.6	26.7/10.5
Malpais Mesa area (southern part of Inyo rock daisy range)	29.9/85.8	−2.4/27.7	11.4/52.6	24.3/9.6
Entire Inyo rock daisy range	27.9/82.3	−3.5/25.7	10/50	26.9/10.6

In addition to the climate estimates available in PRISM for the southern Inyo Mountains, direct measurements of temperature and precipitation are available from a weather station at the north end of Owens Lake (117° 55’ W, 36° 29’ N; 1,123 m [3,684 ft] in elevation), located approximately 16 km (10 mi) west of the southern Inyo Mountains (UCIPM 2023). The Owens Lake weather station is the closest station to Inyo rock daisy populations; however, the elevation at Owens Lake is 1,123 m (3,684 ft), while Inyo rock daisy is restricted to elevations 711-1,834 m (2,333-6,017 ft) higher than Owens Lake in the adjacent Inyo Mountains. Using climate data from Owens Lake from 2003 through 2022, the hottest months in the area are consistently July and August, with an average high temperature of approximately 37.3°C (99.2°F); and the coldest months are January and December, with an average low temperature of approximately −2.3°C (27.8°F). Most precipitation generally falls during January and December, coinciding with the coldest months, but in some years, summer monsoons will provide most of the year’s rainfall in July or August (Powell and Klieforth 1991). Precipitation at Owens Lake from 2003 through 2022 never exceeded 15 cm (6 in) per year, with some years experiencing less than 2.5 cm (1 in) of precipitation; average precipitation at Owens Lake was 6 cm (2.4 in) per year. While annual precipitation at Owens Lake can be quite variable, there has been an overall downward trend in annual precipitation between 2003 and 2022.

As elevation increases, temperature generally decreases and precipitation generally increases, so the climate in the Inyo Mountains is likely quite different from that reported at Owens Lake. Studies have found that elevation plays a key role in average maximum temperatures with a rough approximation of temperature dropping about 6.5°C per 1,000 m (3.6°F per 1,000 ft) (Green and Harding 1980, Dodson and Marks 1997, Rolland 2003, Iacobellis et al. 2016). Based on this, and extrapolating from weather data at Owens Lake, a rough approximation of the average daily maximum temperature for the hottest month in Inyo rock daisy’s range is about 25.3-32.9°C (77.6-91.3°F) depending on elevation.

There is almost no surface water (e.g., creeks, streams, rivers, or lakes) in the range of Inyo rock daisy, although the northern-most occurrence of Inyo rock daisy is at Cerro Gordo Spring, which has been observed to discharge a small amount of water (Jesus 2021). Less than a mile north of Cerro Gordo Spring is Mexican Spring, which currently appears to lack surface water but there is evidence of historical mining equipment at the spring suggesting that the spring may have once been used as a source of water (Jesus 2021). In 1963, Merriam noted that the Cerro Gordo Springs (including Mexican Spring) were little more than seeps and likely completely dried up by late summer each year (Merriam 1963). Based on this, Inyo rock daisy is presumably dependent on moisture from precipitation and winter snowpack to survive and reproduce across its range and does not rely on a steady supply of surface water or ground water. In addition, rock crevices where Inyo rock daisy plants are rooted may be able to retain precipitation runoff better than the surrounding rocky habitat.

At present, Inyo rock daisy occurs in habitats that do not appear to be subject to much wildfire. Several lightning-caused wildfires have been documented in mountain ranges to the east of the Inyo Mountains (in the Nelson Range and Cottonwood Mountains), but the California Department of Forestry and Fire Protection database, which includes documented fires from 1878 through 2021, does not have any records of fire burning in the Inyo Mountains (CAL FIRE 2023).

POPULATION TRENDS AND ABUNDANCE

There are a total of 28 documented occurrences of Inyo rock daisy in the CNDDB, with the smallest occurrence consisting of a single population of three plants and the largest occurrence consisting of multiple subpopulations totaling over 680 plants (Appendix A) (CNDDB 2023). A complete census of Inyo rock daisy occurrences has not yet been performed and most reported population sizes are for portions of occurrences. However, based on the population data that is available in the CNDDB, the current abundance of Inyo rock daisy plants is likely in the low thousands (CNDDB 2023). Area of occupancy is not available for most populations of Inyo rock daisy but based on the small population sizes documented for most occurrences, the area of occupancy is presumed to be similarly small.

Population monitoring has not been conducted for Inyo rock daisy, making it difficult to infer population trends for the species. Inyo rock daisy occurs in areas that have been mined in the past, and while it is unknown what impact mining activity has had on Inyo rock daisy populations, it is likely that disturbances from historical mining have negatively impacted the species (see the Present or Threatened Modification or Destruction of Habitat section of this Status Review for further discussion). This mining activity has occurred in two main areas of Inyo rock daisy's range: the Cerro Gordo Peak area and at Santa Rosa Mine in the eastern Malpais Mesa.

In the Cerro Gordo Peak area, mining began on a small scale at the foot of Cerro Gordo Peak in 1865 but by the end of the 1860s, there were over 900 mining claims in the area as word got out about the high-quality silver-lead ore (Shumway et al. 1980, Rosan 2019). While the largest concentration of mines was located within a 1.6 km (1 mi) radius of Cerro Gordo Peak, the Cerro Gordo Mining District covered an area of approximately 21 km^2 (8 mi^2), with mines scattered throughout this area (Figure 7) (Downey et al. 2007). Blast furnaces were used to extract silver and lead from the ore which required large amounts of charcoal to fuel the furnaces (Merriam 1963). The charcoal came from the burning of single-leaf pinyon pine, juniper (*Juniperus* sp.), and mountain mahogany (*Cercocarpus ledifolius*) harvested from the upper elevations of the Inyo Mountains (Merriam 1963, Lueders 2019). As these trees became scarce, limber pine and bristlecone pine were also harvested for fuel and the building of mining structures (DeDecker 1966). Remains of charcoal pits or flats, large wood piles, and cut trees are evident throughout the Cerro Gordo Mining District and surrounding areas (Merriam 1963, Jesus 2021). Mining activity around Cerro Gordo Peak was largely abandoned by 1950 and the historical mining town of Cerro Gordo is now a privately owned mining “ghost town” (Downey et al. 2007).

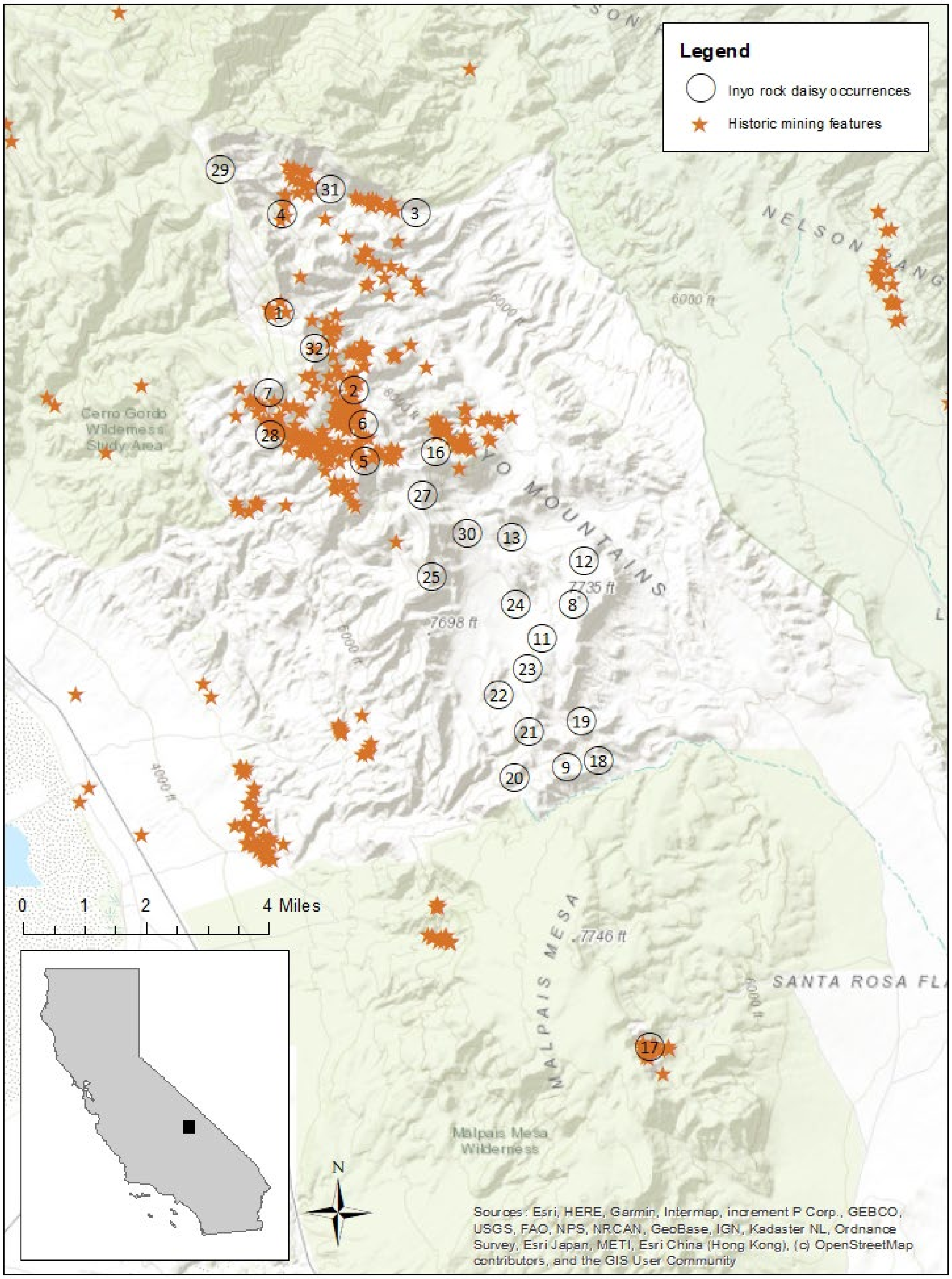

Figure 7. Map showing historical mining features (orange stars) in the vicinity of Inyo rock daisy occurrences (circles) (Horton and San Juan 2022, CNDDB 2023). Inyo rock daisy occurrences are generalized and labeled with the corresponding CNDDB occurrence number. Mining features can include mines, prospect pits, audits, tunnels and shafts, etc.

CNDDB Inyo rock daisy EO #1, #2, #3, #4, #5, #6, #7, #16, #28, #31, and #32 are in the vicinity of the historical mining activities in the Cerro Gordo Mining District (Figure 7) (CNDDB 2023). Since no population level plant surveys have been performed in this area prior to the mid-1990s, it is unknown if there were undocumented populations of Inyo rock daisy that were extirpated by historical mining activity. It is possible that this is the case based on the proximity of known Inyo rock daisy occurrences to historical mines, mining structures, and roads. In 2018, at the historical Silver Spear Mine in the Cerro Gordo Mining District, Inyo rock daisy plants were found growing among old mining structures and equipment indicating a high likelihood that Inyo rock daisy plants experienced some negative impacts from historical mining at this occurrence (CNDDB EO #32) (Figure 8).

Figure 8. Photos of Inyo rock daisy plants at the historical Silver Spear Mine in the Cerro Gordo Mining District (CNDDB EO #32). Photo credit: Duncan Bell.

In addition to the Cerro Gordo Peak area, the Santa Rosa Mine in the eastern Malpais Mesa has been prospected intermittently from 1870 until 1949 (MacKevett 1953). CNDDB Inyo rock daisy EO #17 was discovered at Santa Rosa Mine in 2018 (Figure 7) (CNDDB 2023). Since there is no historical population data available for Inyo rock daisy at this site, it is unknown if historical mining activity at Santa Rosa Mine negatively impacted this occurrence in the past or if other occurrences once grew at the site that is now the Santa Rosa Mine.

In summary, the abundance of Inyo rock daisy is low. Lack of complete survey data limits the ability of the Department to make an accurate estimate of global population size. In addition, lack of historical survey data (pre-1990s) makes assessing trends in population size difficult. Several Inyo rock daisy occurrences have been documented in recent years in areas that have experienced historical mining impacts: the Cerro Gordo Peak area and at Santa Rosa Mine. Given the proximity of some occurrences to historical mining activity, it is likely that some occurrences were negatively impacted by historical mining or that there were additional undocumented Inyo rock daisy populations in these areas that have since been extirpated.

FACTORS AFFECTING THE ABILITY TO SURVIVE AND REPRODUCE

Present or Threatened Modification or Destruction of Habitat

The threat of habitat modification and/or destruction for Inyo rock daisy primarily comes from mineral exploration and mining-related activities. As a BLM-designated wilderness area, the Malpais Mesa Wilderness provides a single Inyo rock daisy occurrence (CNDDB EO #17) with protection from certain habitat-modifying activities. However, the remaining Inyo rock daisy occurrences are outside of BLM-designated wilderness areas, meaning they are more susceptible to impacts from a variety of activities, including the operation of a commercial enterprise, road building, installation or building of structures, etc. Drilling and road construction for mineral exploration has occurred at Conglomerate Mesa, which contains the majority of Inyo rock daisy occurrences. As of January 2023, there is an exploratory drilling proposal under review by the BLM for additional drill sites on public land at Conglomerate Mesa.

Modification or destruction of habitat from mineral exploration and mining

Conglomerate Mesa is on federally owned land administered by the BLM. Part of the BLM's multiple-use mission involves managing mineral development on public lands (BLM 2019). The BLM's responsibility includes recording mining claims, managing annual maintenance fees and mineral patents, and ensuring surface management requirements are met to protect the surface resources during exploration and mining activities (BLM 2019).

In the Conglomerate Mesa area, the BLM permitted exploratory drilling and road development by mining companies in the late 1980s and the creation of additional drilling access routes and 85 additional drill sites in the late 1990s (MPM and Benchmark Resources 2021). Those drilling access routes were subsequently reclaimed (i.e., decommissioned, recontoured, revegetated, and blocked from further use) in 2000 (MPM and Benchmark Resources 2021). In 2013-2015, there was some trenching and sampling of ore, but no further drilling occurred (K2 Gold 2022). In 2015, Silver Standard mining company proposed the construction of seven new drill pads on top of previously mined and reclaimed drill pad sites in addition to drilling seven new exploration holes on previously unmined sites (BLM 2017). Following an environmental assessment and finding of no significant impact, the BLM approved the proposal in May 2018 (Symons 2022). The proposal that was approved contained a BLM-preferred alternative for accessing drill sites that prioritized access by helicopter over access by road to minimize overland travel and surface disturbance to an area of 0.08 ha (0.2 ac) (BLM 2017, Symons 2018). While Silver Standard did not proceed with this project, the approved plan of operations was resubmitted with additional drill sites when Mojave Precious Metals, Inc. (MPM) became the new operator in June 2020 (MPM and Benchmark Resources 2021).

MPM is a subsidiary of the K2 Gold Corporation which is a gold exploration company based in Canada (K2 Gold 2021). MPM is the current operator of an area called the Mojave Property which encompasses over 9,000 ha (22,240 ac) (5,830 ha [14,406 ac] of mining concession areas) at Conglomerate Mesa (Stitt 2020). MPM's current exploratory efforts are focused in a smaller area of 121 mining claims encompassing 981 ha (2,424 ac) at the eastern end of the Mojave Property (Figure 9) (MPM and Benchmark Resources 2021). MPM completed exploratory drilling at four drill sites in this area in October and November of 2020 (MPM and Benchmark Resources 2021).

In February of 2021, MPM proposed drilling at up to 30 additional locations, with about 120 exploratory drill holes, to determine if sufficient mineral resources are present to continue exploratory work (MPM and Benchmark Resources 2021). The new exploratory drilling proposal would include overland access, reconstruction of previously reclaimed roads, construction of exploration drill pads, and construction of areas to hold water and drill waste materials within the prior disturbance footprints. Due to the increase in areas that could potentially be disturbed, as well as concerns by Tribes, the public, and other agencies about disturbance to natural resources, the BLM determined in March 2022 that an environmental impact statement is warranted in accordance with the National Environmental Policy Act (NEPA) (Symons 2022). The BLM indicates it will publish a notice of intent to prepare an environmental impact statement as part of the process for determining if MPM can proceed with their exploratory drilling operations at Conglomerate Mesa (DAC 2022, Wiegmann pers. comm. 2022). Natural resource surveys as part of the MPM environmental impact statement are anticipated to occur in Spring 2023 (Wiegmann pers. comm. 2022).

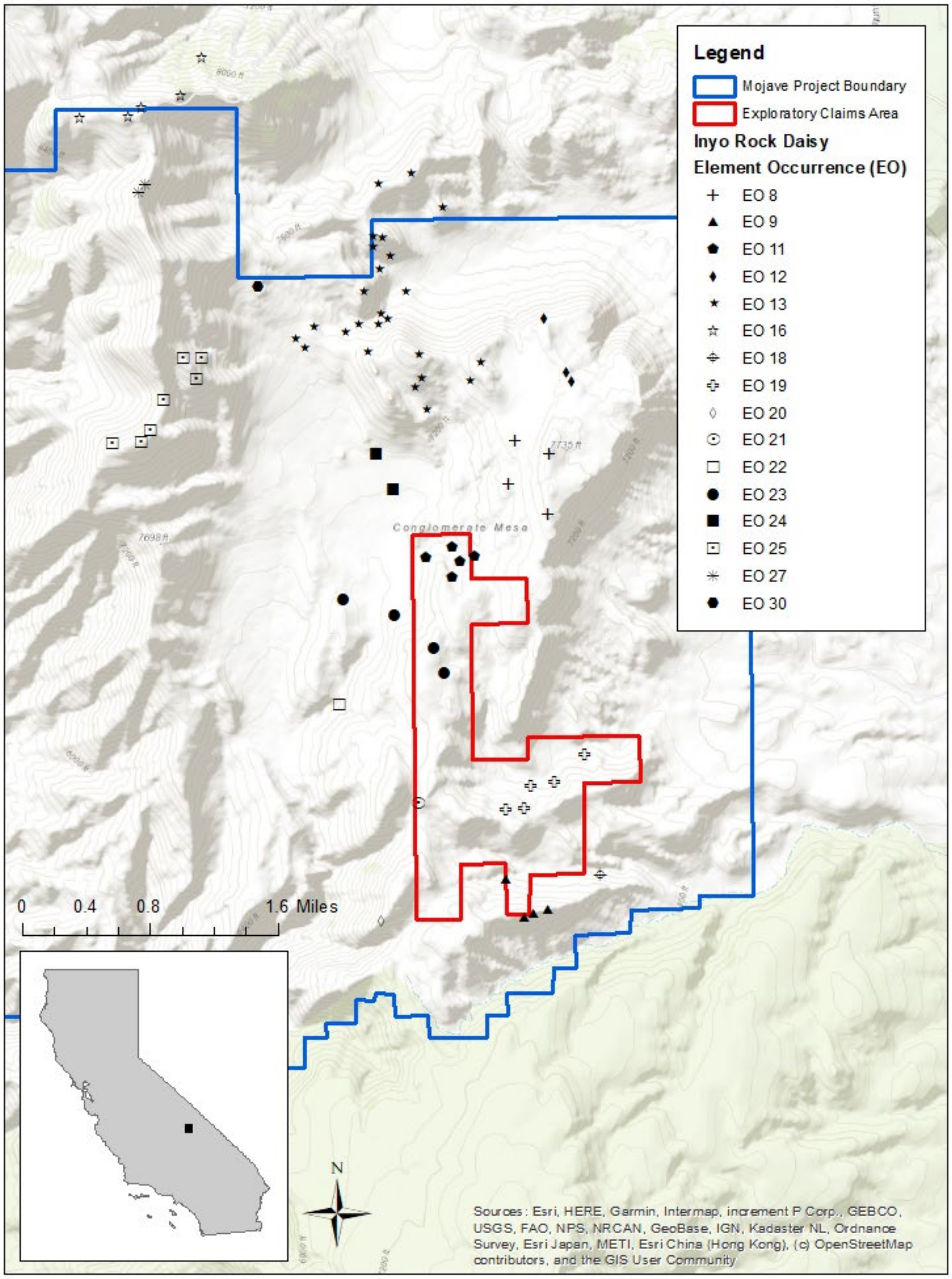

Figure 9. Map showing Inyo rock daisy occurrences in the vicinity of proposed exploratory drilling activities by MPM (MPM and Benchmark Resources 2021, CNDDB 2023). Map outlines the approximate eastern boundaries of the larger Mojave Project in blue and the proposed exploratory claims area in red. All other symbols represent the centers of mapped Inyo rock daisy polygons in the CNDDB, with different symbols representing different CNDDB Inyo rock daisy occurrences (some occurrences have multiple polygons).

At Conglomerate Mesa, MPM is specifically searching for gold and has reported finding high grade sediment-hosted oxide gold (micron-sized gold in sedimentary rock), as well as zones of copper and silver-lead-zinc (Berger et al. 2014, K2 Gold 2020, 2021, Stitt 2020). If exploratory drillings find Conglomerate Mesa to be a valuable mineral reserve, a large-scale mining operation could be proposed. The nature of ore deposits found would determine the size and scope of mining operations and techniques to be used. A large amount of material would likely need to be excavated and processed due to the gold being micron-sized. MPM mentions that the gold mineralization found so far in the Conglomerate Mesa area is similar to that of deposits in the Carlin Trend, an area in Nevada (Berger et al. 2014, K2 Gold 2020). Carlin Trend mines have used open pit mining methods and cyanide heap leaching (application of sodium cyanide to dissolve metals) to extract gold from oxidized ore (Berger et al. 2014, Manning and Kappes 2016). If a mining operation proceeds at Conglomerate Mesa, it is likely that large areas of the mesa will be disturbed for mining operations and Inyo rock daisy plants, habitat, and pollinators would be negatively impacted.

There are currently two Inyo rock daisy occurrences (CNDDB EO #19 and #21) and portions of an additional three occurrences (CNDDB EO #9, #11, and #23) that could be impacted by future exploratory drilling projects within the MPM exploration area at the eastern end of the Mojave Project (Figure 9). Impacts from exploratory drilling could include direct impacts from trampling, removal of plants, and habitat destruction, and indirect effects from dust and noise due to increased use of the area. Dust can affect a plant's ability to photosynthesize, while dust and noise can disrupt pollinator activities. Inyo rock daisy is especially vulnerable to disruption of pollinators because the species is likely self-incompatible and relies on pollinators to reproduce. No studies have been done to determine how resilient Inyo rock daisy may be to these types of disturbances; however, it can be inferred that Inyo rock daisy will have difficulty recovering from certain disturbances due to its long generation time and slow growth rate. While MPM plans to focus exploratory drilling efforts at the eastern end of the Mojave Project, there are an additional nine Inyo rock daisy occurrences (CNDDB EO #8, #12, #18, #20, #22, #24, #25, #27, and #30) and a portion of two occurrences (CNDDB EO #13 and #16) within the larger Mojave Project area that may be affected if exploratory drilling activities expand or a mining operation proceeds in the future (Figure 9). The proposed mineral exploration and future mining activities discussed above could impact as much as 57% of the known Inyo rock daisy occurrences.

Modification or destruction of habitat from development and recreation

Most Inyo rock daisy occurrences are on land owned by the BLM, so are not subject to residential development, and are in remote areas not subject to much recreational use. Several Inyo rock daisy occurrences (CNDDB EO #6, and portions of CNDDB EO #2 and #16) are on private land in the Cerro Gordo Peak area. This area has experienced historical mining impacts and is the location of the historical mining town of Cerro Gordo. Inyo rock daisy CNDDB EO #6 and a portion of CNDDB EO #2 are on private land proposed for development into a ghost town tourist attraction. Redevelopment of Cerro Gordo and increased use of the area by visitors could result in destruction and/or trampling of individual plants in this area and loss of habitat. Based on 2022 aerial imagery, it appears that most structures associated with the historical mining town are not directly adjacent to any known Inyo rock daisy occurrences, but increased use of the roads and surrounding area could negatively impact the species.

Vulnerability of Small Populations

Inyo rock daisy has a restricted range, as well as a small number of occurrences and a total population size estimated in the low thousands, making it particularly vulnerable to extinction. Species with few populations and/or small population sizes are highly vulnerable to extinction due to human activities, natural catastrophes, as well as demographic, environmental, and genetic chance events (Shaffer 1981, 1987, Menges 1991, Matthies et al. 2004). When a species has a restricted distribution and/or small population sizes, like Inyo rock daisy, human activities and natural catastrophes (such as floods, fires, landslides, and droughts) are more likely to negatively impact a large portion of the species range (Shaffer 1981). In 2021 and 2022, Inyo rock daisy was observed to be experiencing negative impacts from California's current drought, which is classified as a natural catastrophe (see the Climate Change section of this Status Review for further discussion). Inyo rock daisy also occurs in areas that periodically experience flash flooding, which could result in mudslides extirpating portions of a population.

Demographic chance events are those random events that affect the survival and reproductive success of the species (Shaffer 1981, 1987). In larger populations, fluctuations in survival and reproductive success may be distributed over the entire population, but this is often not the case in species such as Inyo rock daisy which occur over a small geographic area with small population sizes (Lande 1993). Environmental chance events are random or unpredictable events related to year-to-year variation in temperature, rainfall, habitat, predators, parasites, etc., which then drive population-level fluctuations in survival and reproduction (Shaffer 1981, 1987, Melbourne and Hastings 2008). Environmental chance events that negatively affect the pollinators that Inyo rock daisy relies upon for cross-pollination could indirectly affect Inyo rock daisy populations. Due to the patchy distribution of Inyo rock daisy occurrences, pollinators may have difficulty finding and visiting Inyo rock daisy flowers from more distant plants. If pollinators deliver pollen from Inyo rock daisy plants that are further away, the plants (and pollen) are more likely to differ genetically which can help prevent inbreeding depression (reduction in the ability of offspring to survive and reproduce due to closely related parents mating) (Hedrick and Kalinowski 2000). Activities that further fragment Inyo rock daisy populations or that impact pollinator behavior may negatively impact the species reproductive success (Rathcke and Jules 1993).

Genetically, plants with small population sizes are at increased risk from random changes in genetic diversity and reproductive success (mainly due to genetic drift, inbreeding depression, and gene flow) (Shaffer 1987, Ellstrand and Elam 1993). The genetics of Inyo rock daisy populations have not been studied so it is unclear how much genetic variation there is, how it is distributed within and among populations, and if the species is experiencing a reduction in genetic variation or any other genetic effects due to its self-incompatibility trait and small population size. While self-incompatibility reduces the chances that a plant will breed with itself or a close genetic relative, it can also lead to a reduction in seed set if the number of genetically compatible mates available is low. Since Inyo rock daisy is self-incompatible and insect-pollinated, it is reliant on pollinators for gene flow. Small and/or isolated populations are less likely to be visited by pollinators who would normally be delivering pollen from distant, more genetically diverse relatives. This could result in a restriction in gene flow between populations and fertilization failing more often. The reduction in seed set or offspring with reduced ability to survive and reproduce that may result from restricted gene flow could negatively affect the long-term health and viability of Inyo rock daisy (Levin 1984, Byers and Meagher 1992, Allphin et al. 2002). Inyo rock daisy occurs patchily in the southern Inyo Mountains so activities that cause populations to become even more isolated from adjacent populations could influence the genetics of the entire species.

The Inyo rock daisy occurrence at Santa Rosa Mine (CNDDB EO #17) is especially vulnerable to impacts associated with small population size since it consists of only about 50 individuals and is isolated from other Inyo rock daisy occurrences by about 8 km (5 mi). While some pollinators that live in social groups (e.g., honeybees) have been shown to have maximum foraging distances of 14.4 km (8.9 mi), this is uncommon and pollinators generally do not go further than 2 km (1.2 mi) to search for food (Beekman and Ratnieks 2000, Zurbuchen et al. 2010). If pollinators are unable to cross a large expanse of terrain, this may increase the likelihood that the Inyo rock daisy plants at Santa Rosa Mine are experiencing genetic consequences from isolation (Lynch et al. 1995, Allphin et al. 2002). In addition to its isolation, the occurrence at Santa Rosa Mine is closer than other Inyo rock daisy occurrences to presumed hybrid populations in the Talc City Hills and other locations in the Malpais Mesa Wilderness. If the hybrid populations are close enough for pollinators to visit both Inyo rock daisy and hybrid plants, the Santa Rosa Mine occurrence may be at higher risk of extirpation due to hybridization with other rock daisy species.

Climate Change

The Earth's surface has become successively warmer each of the last three decades which has resulted in atmospheric warming, reduction in the amount of snow and ice, rising sea levels, and other global impacts (IPCC 2014). Much of this global warming and subsequent change in climate is a result of increased anthropogenic greenhouse gas emissions directly caused by human activities (Hawkins et al. 2008, IPCC 2021). Climate change is likely to result in higher average land and sea temperatures, increased evaporation resulting in more rainfall globally, more variability in rainfall and temperature, increased frequency and severity of extreme weather events, vegetation shifts, and more (Hawkins et al. 2008). Climate change has been shown to be negatively impacting wildlife and plant taxa and ecosystems across the globe, with local extinctions related to climate change becoming widespread (Parmesan and Yohe 2003, Parmesan 2006, Warren et al. 2011, Scheffers et al. 2016, Wiens 2016, IPCC 2022).

California is already experiencing the effects of climate change (e.g., warming temperatures, extreme precipitation events, reduced snowpack, etc.) and those effects are anticipated to increase over the coming decades (Bedsworth et al. 2018). Climate change projections for California can be challenging given the state's complex topography and broad latitudinal range which create different climatic regions (Snyder and Sloan 2005, Pierce et al. 2018). Consensus is that temperatures in California will rise during the 21st century although the magnitude of the increase varies from model to model. Between 2006 and 2100, California's temperatures are expected to rise by between 2°C (3.6°F) in the low range to 7°C (12.6°F) in the high range (Pierce et al. 2018). Across California, relatively small changes in total precipitation are anticipated, although projections suggest there may be a decrease in the frequency of daily precipitation but an increase in the amount of precipitation delivered during heavy precipitation events (Cayan et al. 2008). Overall, researchers anticipate a greater year-to-year variability in total precipitation (Berg and Hall 2015, Polade et al. 2017, Pierce et al. 2018).

While snowpack projections are not available specifically for the southern Inyo Mountains, projections made for the Sierra Nevada are likely similar to what can be expected in the adjacent Inyo Mountains. Snowpack in the eastern Sierra Nevada up to 3,000 m (9,843 ft) is projected to melt earlier and accumulate less as the mean temperature rises (Bales et al. 2015). With warmer temperatures, more precipitation will fall as rain instead of snow, the snowpack will melt earlier in the year, and the volume of snowmelt will be less (Costa-Cabral et al. 2013, Dettinger et al. 2018). Dettinger et al. (2018) projects that by the end of the century, snowpacks in the Sierra Nevada will be reduced by 90%. A reduction in snowpack and earlier snowmelt may result in greater winter and spring runoff thereby causing a decrease in the amount of water available during the summer for use by flora and fauna (Harpold and Molotch 2015, Dettinger et al. 2018).

In the deserts of the southwestern United States, including the Mojave Desert, droughts have become more frequent and intense in recent years compared to historical periods (Khatri-Chhetri et al. 2021). Khatri-Chhetri et al. (2021) showed that plant communities in these desert regions were experiencing more intense dry periods for longer periods of time between 2000 and 2015 than the plant communities experienced in the more distant past (1950-1999).

Inyo rock daisy appears to be experiencing negative effects from California's prolonged drought. Observations at Conglomerate Mesa in 2021 and 2022 showed many plants that appeared to be dormant or possibly dead, and those that flowered had a noticeable decrease in the number of flowers from previous years (Figure 10) (Department observation 2022, Jesus et al. 2022a). Observations north of the road to Cerro Gordo (CNDDB EO #7), found Inyo rock daisy plants to be extremely drought stressed in 2022 with just 1% of the plants flowering (Carson pers. comm. 2022b). Inyo rock daisy plants observed further north in Bonham Canyon in 2022 appeared to have more flowering stalks, which may be due to increased precipitation in the area and surrounding topography that facilitates prolonged snowpack (Department observation 2022, Jesus et al. 2022a). The drought in 2021 was severe (Figure 11) and drought conditions are anticipated to continue for at least several more years based on climate model simulations published in January 2022 (NDMC 2022, Williams et al. 2022). In late December 2022 and January 2023, a series of atmospheric rivers led to heavy rain across California (Tinker and Riganti 2023). While these intense precipitation events may reduce the drought intensity in California, the long-term California drought is expected to continue into 2023 (Tinker and Riganti 2023). This prolonged drought may reduce population sizes, affecting the ability of Inyo rock daisy to persist into the future.

Figure 10. Photographs of drought-stressed Inyo rock daisy plants in July 2022 at Conglomerate Mesa, Inyo County. Note the abundance of dried flowering stalks (remains from flowering in previous years) and few green stalks with flowers indicating a reduction in flowering that is likely due to California's drought. Photo credit: Kristi Lazar.

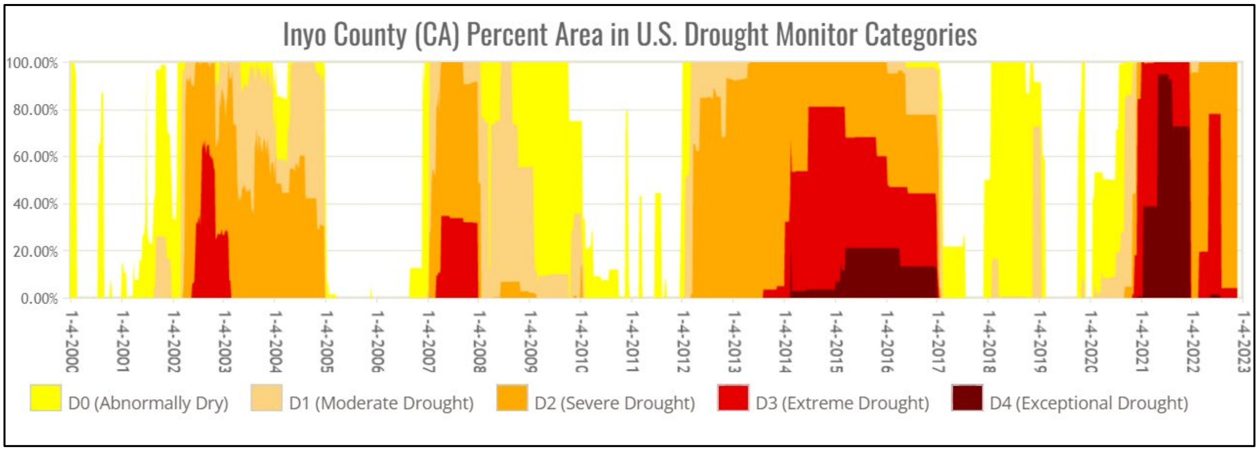

Figure 11. Time series graph of drought conditions in Inyo County taken directly from the U.S. Drought Monitor website (NDMC 2022). Graph shows year on the X axis (January 2000 through January 2023) and percent area of Inyo County experiencing drought on the Y axis.

Plant taxa will respond to climate change in different ways. Some species may be resilient to changes, some may adapt as climate conditions change, some may be able to migrate to more favorable conditions, and some species may go extinct (Hawkins et al. 2008, Kelly and Goulden 2008, Corlett and Tomlinson 2020). Inyo rock daisy is at a high risk of being negatively affected by climate change due to its restricted range, specialized habitat requirements, mid to high elevational range, poor dispersal ability, and long generation times.

A restricted range has been repeatedly shown to be the most important predictor of how vulnerable a species is to climate change and overall extinction risk (Thuiller et al. 2005, Payne and Finnegan 2007, Harnik et al. 2012, Pearson et al. 2014, Chichorro et al. 2019, Staude et al. 2020, Rose et al. 2022). Inyo rock daisy's restricted range means that biotic and abiotic factors or events (such as drought) have a greater likelihood of affecting the species across its entire range given that it only occurs in a 72 km^2 (28 mi^2) area, whereas similar stressors would be less likely to affect the total range of a more widespread species.

Habitat specialists tend to also be more susceptible to climate change (Damschen et al. 2012, Harnik et al. 2012, Rose et al. 2022). Inyo rock daisy is restricted to slopes and cliffs on calcareous rock outcrops. Slopes and cliffs are often considered refuges from climate change as they have properties that can buffer against climatic fluctuations. Slopes and cliffs can offer different microclimates, which provide the opportunity for a plant to migrate to an area with a more suitable microclimate, if needed (such as movement from a crevice with a sunny exposure to a crevice with a more shaded exposure) (Davis 1951, Ackerly et al. 2010, Suggitt et al. 2018). However, climate change may outpace the ability of a species to migrate to more favorable areas, which could result in species extinction (Davis 1951, Ackerly et al. 2010, Wiens 2016).

Inyo rock daisy is also restricted to the mid to high elevation areas within its small range so there is limited habitat in the southern Inyo Mountains for it to easily disperse to in the face of a warming climate. The highest elevation area within Inyo rock daisy's range is at Pleasant Point (about 2,957 m/9,700 ft) and Inyo rock daisy already occupies this area. Potentially suitable areas at appropriate latitudes and elevations in adjacent mountain ranges are currently occupied by Nevada rock daisy, which is a more common rock daisy species that can also inhabit calcareous rock outcrops and that may outcompete Inyo rock daisy if Inyo rock daisy was able to migrate to those areas (Powell 1973, Yarborough and Powell 2006, Jesus et al. 2022b).

Another key trait that makes Inyo rock daisy more vulnerable to climate change is its poor dispersal capability. Inyo rock daisy lacks a well-developed pappus (a structure that helps seeds to disperse by wind), so seeds are unlikely to disperse long distances by wind (Sheldon and Burrows 1973, Yarborough and Powell 2006, Keil 2012). This means that it will be difficult for Inyo rock daisy to migrate to other suitable calcareous rock outcrops that are farther away. In addition, as a subshrub, Inyo rock daisy likely takes longer to reach reproductive age. This longer lifecycle can make it slower for the species to migrate and adapt to changing climate conditions (Jump and Peñuelas 2005, Bisbing et al. 2021).

Department staff assessed the vulnerability of Inyo rock daisy to climate change using the NatureServe Climate Change Vulnerability Index Version 3.02 (CCVI) (CDFW 2022, NatureServe 2022). The CCVI assesses a species vulnerability to climate change by evaluating three main components: the exposure to climate change (predicted temperature and moisture changes), the sensitivity of the species to climate change, and the ability of the species to adapt to climate change. The CCVI uses these components to separate species into one of four categories based on their vulnerability to climate change: Less Vulnerable, Moderately Vulnerable, Highly Vulnerable, and Extremely Vulnerable. Based on the Department's assessment using climate data inputs from NatureServe, Inyo rock daisy has a climate change vulnerability index value of Highly Vulnerable, indicating that the abundance and/or range extent of Inyo rock daisy is likely to decrease significantly by 2050 due to climate change. Factors that contributed to this vulnerability assessment include Inyo rock daisy's limited dispersal ability, mid to high elevation habitat, calcareous substrate requirement, potential negative impacts from invasive grasses, and self-incompatibility.

Invasive Species

Invasive, non-native species are one of the greatest threats to biodiversity next to habitat loss (Wilcove et al. 1998). They are often associated with a significant decline in native species richness, especially in Mediterranean-type ecosystems like California (Wilcove et al. 1998, Gaertner et al. 2009). Invasive plant species may alter community structure and ecosystem-level processes through direct competition with native plants for space, competition for resources (such as water, light, and nutrients), alteration of hydrologic regimes, changes in the chemical composition of the soil (such as pH and salinity), alteration of the nutrient cycle (especially nitrogen cycling), disruption of pollinator activity, alteration of disturbance regimes (such as fire frequency and intensity), buildup of thatch which may inhibit seed germination and seedling recruitment, or other mechanisms (Vitousek 1990, D'Antonio and Vitousek 1992, Levine et al. 2003). While the invasion of non-native plant species into an ecosystem may not result in the extinction of native plant species in the short term (since the process of extinction generally takes longer than the process of invasion), invasive, non-native plant species can still cause the decline and eventual extirpation of native populations (Davis 2009, Gaertner et al. 2009).

Competition from Invasive Species

Invasive annual grasses have been documented throughout the range of Inyo rock daisy. Invasive annual grasses are widespread and effective competitors with native plants by altering ecosystem functions, environmental conditions, and resource availability (Young and Evans 1973, D'Antonio and Vitousek 1992, Rimer and Evans 2006). The invasive annual grasses that are of greatest concern for Inyo rock daisy are cheatgrass and red brome (Jesus et al. 2022b). Cheatgrass, in particular, has been shown to be specifically adapted to growing in Mediterranean-like climates and has become the dominant species in many habitats in the western United States (Young and Evans 1973, Mack 1981, Rimer and Evans 2006). In higher elevation areas with pinyon-juniper woodlands (such as the habitat of Inyo rock daisy), cheatgrass was not considered a serious invader until about the 1950s (Billings 1994).

Inyo rock daisy occurs on rock outcrops, which are difficult habitats for most species to occupy. Cheatgrass and red brome have been observed to occupy rock crevices on the same outcrops as Inyo rock daisy (Department observation 2022, Jesus pers. comm. 2022). While no studies have been done to ascertain the effect that cheatgrass or red brome could be having on Inyo rock daisy, it is likely that these invasive annual grasses are occupying habitat that would normally be ideal habitat for Inyo rock daisy seedlings. In addition, invasive annual grasses may create more plant litter making the local environment less suitable for seedling establishment (Facelli and Pickett 1991).

Cheatgrass has a higher nutrient uptake rate and growth rate compared to other native grasses (Kerns and Day 2017). Researchers hypothesize that cheatgrass has spread so successfully because it is easily established with a shallow dense root system and rapid growth (Morrow and Stahlman 1984). This shallow root system allows cheatgrass to deplete soil moisture and nutrients in the upper layers of the soil profile (Morrow and Stahlman 1984), which enhances its ability to outcompete native plants for water and nutrients. Cheatgrass has been shown to change the nitrogen cycle by altering the amount of inorganic nitrogen available in the soil. In arid ecosystems like the Mojave Desert, the soil is already low in organic matter and nitrogen so invasion by cheatgrass reduces the availability of an already limited resource (Evans et al. 2001). A decrease in the amount of fertile soil and nitrogen available can result in the loss of native plant diversity and an increase in non-native plant species causing irreversible changes to the ecosystem (Rimer and Evans 2006).

Cheatgrass has been shown to be so competitive that newly emerging seedlings of native species are often unable to become established (Monsen 1994). In years with higher precipitation, invasive annual grasses in the southern Inyo Mountains have been observed to have high germination rates (Jesus pers. comm. 2022), which could result in annual grass seedlings outcompeting Inyo rock daisy seedlings for suitable environments. Little is known about the timing of Inyo rock daisy germination so it is possible that invasive annual grasses germinate at a different time of year than Inyo rock daisy resulting in minimal direct competition for establishment. While invasive annual grasses have been documented to co-occur with Inyo rock daisy, further study is needed to determine the effect these invasive annual grasses may be having on Inyo rock daisy seedling establishment. If invasive annual grasses, like cheatgrass and red brome, are outcompeting Inyo rock daisy seedlings for establishment, this could be a significant threat to the continued existence of Inyo rock daisy.

Invasive Species and Fire

Invasive annual grasses, especially cheatgrass and red brome, have been documented throughout Inyo rock daisy's range, but were not serious invaders until the middle of the 20th century (Billings 1994, Jesus et al. 2022b). In arid ecosystems, dominance of invasive annual grasses is often correlated with an increase in fire frequency and severity due to the fuel load (i.e., thatch) that annual grasses provide each year when they die (Mack 1981, Morrow and Stahlman 1984, Whisenant 1990, D'Antonio and Vitousek 1992, Brooks 1999). As fire becomes more frequent in ecosystems where fire was previously uncommon (or at least less frequent), such as the California deserts, the habitat is being replaced by large expanses of cheatgrass (Billings 1994, Peters and Bunting 1994). Invasive annual grasses are highly flammable since they support a microclimate with hotter surface temperatures (causing plants to dry out more quickly), they create more standing dead material, and they increase the amount of litter biomass present (Brooks 1999, Evans et al. 2001). These conditions create a feedback loop where invasive grasses colonize an area and provide the fuel needed for a fire; after fire, invasive grasses recover more quickly than native plants, creating a landscape dominated by grasses, which then further contributes to an increase in the frequency and intensity of fires

(D'Antonio and Vitousek 1992, Billings 1994, Brooks et al. 2018). This more frequent fire interval results in a loss of species diversity, as native desert species are often poorly adapted to survive frequent fire, and perennial plants can struggle to recover from short fire return intervals, leaving invasive annual plants to dominate the landscape (Whisenant 1990, D'Antonio and Vitousek 1992, Knapp 1996, Brooks 1999).

The effect of fire on Inyo rock daisy is not well known. There are no records of fire burning in the Inyo Mountains which suggests that plant taxa restricted to the Inyo Mountains are likely not well adapted to survive fire, especially high severity, frequent fires which may happen as invasive, annual grasses further invade the landscape (CAL FIRE 2023). Rock outcrops are thought to experience low fire frequency because these areas generally have low fuel load and the exposed rock presents a barrier to the spread of fire (Hopper 2000, Benwell 2007). However, if a high intensity fire were to burn through Inyo rock daisy habitat, it could kill the vegetation in the area, including Inyo rock daisy plants, and make the habitat more suitable for annual grass invasion during post-fire recovery. As invasive annual grasses occupy more rock outcrop habitat, this natural firebreak may become less effective. If a low intensity fire were to burn through Inyo rock daisy habitat, Inyo rock daisy plants might be able to survive if the fire is unable to burn through the rock outcrops due to lack of fuel load.

REGULATORY SETTING

Some state and federal environmental laws apply to activities undertaken in California that may provide protection for Inyo rock daisy and its habitat. In addition, non-regulatory rare plant rankings may provide some protection through public awareness and impact disclosure and avoidance during project planning. The following is not an exhaustive list of all laws that may provide protection to Inyo rock daisy.

Federal Endangered Species Act

On February 2, 2022, a petition to list Inyo rock daisy as threatened or endangered under the federal Endangered Species Act (ESA), and to concurrently designate critical habitat, was received by the United States Fish and Wildlife Service (USFWS) (USFWS 2023). On March 21, 2023, the USFWS announced its 90-day finding for Inyo rock daisy and found that the petition to list Inyo rock daisy presents substantial scientific or commercial information to indicate that the petitioned action may be warranted (USFWS 2023). The USFWS has initiated a status review of Inyo rock daisy, and based on the status review, will issue a 12-month petition finding to address whether or not the petitioned action is warranted (USFWS 2023).

Inyo rock daisy has been considered for ESA listing in the past. In 1973, the ESA directed the Smithsonian Institution to review "species of plants which are now or may become endangered or threatened" and to report their findings to Congress (16 U.S.C. § 1541). In its 1975 report titled "Report on Endangered and Threatened Plant Species of the United States", the Smithsonian Institution recommended that more than 3000 plant taxa be added to the list of endangered and threatened species (USFWS 1975). Inyo rock daisy was included in this report, with the Smithsonian Institution recommending it be added to the list of endangered and threatened species, with threatened status (USFWS 1975). The USFWS considered this report from the Smithsonian Institution to constitute a petition for listing under the ESA and that "ample justification has been presented to warrant a review to determine whether plants identified in the report should be added to the lists of Threatened or Endangered species" (USFWS 1975). In 1980, 1985, and 1990, the USFWS considered Inyo rock daisy a "category 2" species which was defined as: "Taxa for which information now in possession of the Service indicates the probable appropriateness of listing as endangered or threatened, but for which sufficient information is not presently available to biologically support a proposed rule. Further biological research and field study will usually be necessary to determine the status of the taxa included in this category" (USFWS 1980, 1985, 1990). In practice, category 2 species sometimes referred to candidate species where ESA listing was determined to be "warranted but precluded" until sufficient information became available, and sometimes referred to species where listing was determined to be not warranted (USFWS 1993a). In 1993, the USFWS announced that category 2 species will, for the first time, correspond to a petition determination of "not warranted" and all candidate species from category 2 that were "warranted but precluded" were moved to category 1 (species with sufficient information to support ESA listing but for which listing is precluded by other listing activities) (USFWS 1993a). Inyo rock daisy remained as a category 2 species in 1993, indicating that the USFWS considered ESA listing to not be warranted for the species (USFWS 1993b). In 1996, the USFWS discontinued the category 2 species designation to reduce confusion as to the conservation status of the taxa, since USFWS did not regard category 2 species as candidates for ESA listing (USFWS 1996). Category 2 species, including Inyo rock daisy, were not included in any subsequent USFWS listing notices after 1993.

California Endangered Species Act

Inyo rock daisy was designated a candidate species under CESA on September 2, 2022. During candidacy, CESA prohibits the import, export, take, possession, purchase, or sale of Inyo rock daisy, or any part or product of Inyo rock daisy, except as otherwise provided by the Fish and Game Code, such as through a permit or agreement issued by the Department under the authority of the Fish and Game Code (Fish & G. Code, § 2080 et seq.). For example, the Department may issue permits that allow the incidental take of listed and candidate species if the take is minimized and fully mitigated, the activity will not jeopardize the continued existence of the species, and other conditions are met (*id*. at § 2081, subd. (b)). The Department may also authorize the take and possession of listed and candidate species for scientific, educational, or management purposes (*id*. at § 2081, subd. (a)). Furthermore, the Department may issue a Safe Harbor Agreement to authorize incidental take of listed or candidate species if a landowner provides a net conservation benefit to the species, implements practices to avoid or minimize incidental take, establishes a monitoring program, and meets other program conditions (*id*. at § 2089.2 et seq.). Finally, the Department may authorize take associated with routine and ongoing agricultural activities through Voluntary Local Programs if management practices avoid and minimize take to the maximum extent practicable, as supported by the best scientific information for both agricultural and conservation practices, among other conditions (*id*. at § 2086).

California Environmental Quality Act

State and local agencies must conduct environmental review under the California Environmental Quality Act (CEQA) for discretionary projects proposed to be carried out or approved by the public agency unless the agency properly determines the project is exempt from CEQA (Pub. Resources Code, § 21080). If a project has the potential to substantially reduce the habitat, decrease the number, or restrict the range of any rare, threatened, or endangered species, the lead agency must make a finding that the project will have a significant effect on the environment and prepare an environmental impact report or mitigated negative declaration as appropriate before proceeding with or approving the project (Cal. Code Regs., tit. 14, §§ 15065(a)(1), 15070, & 15380.). An agency cannot approve or carry out any project for which the environmental impact report identifies one or more significant effects on the environment unless it makes one or more of the following findings: (1) changes have been required in or incorporated into the project that avoid the significant environmental effects or mitigate them to a less than significant level; (2) those changes are in the responsibility and jurisdiction of another agency and have been, or can and should be, adopted by that other agency; or (3) specific economic, legal, social, technological, or other considerations make infeasible the mitigation measures or alternatives identified in the environmental impact report (Pub. Resources Code, § 21081; Cal. Code Regs., tit. 14, §§ 15091 & 15093). For (3), the agency must make a statement of overriding considerations finding that the overriding benefits of the project outweigh the significant effects on the environment. CEQA establishes a duty for public agencies to avoid or minimize such significant effects where feasible (Cal. Code Regs., tit. 14, § 15021).

CEQA applies to all species listed as rare, threatened, or endangered under the ESA, CESA, and the Native Plant Protection Act (NPPA), as well as species that meet the criteria of rare, threatened, or endangered but that are not officially listed as such under the ESA, CESA, or

NPPA (Cal. Code Regs., tit. 14, § 150380). Inyo rock daisy is a California Rare Plant Rank 1B.2 species (plants the California Native Plant Society considers rare, threatened, or endangered in California and elsewhere) (CNDDB and CNPS 2020, CNDDB 2023) and these species are generally thought to meet the definition of a "rare, threatened, or endangered" species under CEQA. As such, impacts to Inyo rock daisy should be identified, evaluated, disclosed, and avoided or mitigated under the biological resources section of an environmental document prepared pursuant to CEQA. The majority of Inyo rock daisy occurrences are on federal land, so CEQA is only applicable if there is a state or local discretionary action for the project, such as a permit requirement or other approval.

Natural Heritage Program Ranking

Natural heritage programs provide location, natural history, and rarity status information on special status plants, animals, and natural communities to the public, government agencies, and conservation organizations (CNDDB 2020). There is a nationwide network of natural heritage programs, with more than 80 programs throughout the western hemisphere, overseen by an organization called NatureServe (CNDDB 2020). The CNDDB is California's natural heritage program.

All natural heritage programs use the same ranking methodology originally developed by The Nature Conservancy and subsequently revised and maintained by NatureServe (Master et al. 2012). This ranking methodology consists of a global conservation status rank (global rank), describing the status of a given taxon over its entire distribution, and a subnational conservation status rank (subnational rank), describing the status of a given taxon over its state distribution (Master et al. 2012). Both global ranks and subnational ranks are calculated using NatureServe's rank calculator which uses a combination of rarity, threats, and trends to assign a conservation status rank for the species (Master et al. 2012). The CNDDB has assigned Inyo rock daisy a global rank of G2 and a subnational rank of S2, indicating that the species is imperiled both within California and globally, with a high risk of extirpation due to a restricted range, few populations or occurrences, steep declines, severe threats, or other factors (CNDDB 2020, 2023).

California Rare Plant Rank

The California Native Plant Society works in collaboration with botanical experts throughout the state, including Department biologists, to assign rare plants a CRPR reflective of their rarity status (CNDDB and CNPS 2020). Inyo rock daisy has been assigned a CRPR of 1B.2 (CNPS 2022b). Plants with a CRPR of 1B are considered rare, threatened, or endangered throughout their range with the majority endemic to California (CNDDB and CNPS 2020). The threat code extension of ".2" indicates that the species is moderately threatened in California, with 20 to 80 percent of occurrences threatened and a moderate degree and immediacy of threat (CNDDB and CNPS 2020).

EXISTING MANAGEMENT

Of the 28 known Inyo rock daisy occurrences, the majority (24 occurrences, 86%) are entirely on land owned by the BLM. An additional three occurrences are partially on BLM land and partially on private land, and another occurrence is entirely on private land. The BLM has a multi-use mission to sustain the health, diversity, and productivity of the public lands for the use and enjoyment of present and future generations (BLM 2022). Several important management designations and protections relevant for Inyo rock daisy occurrences growing on BLM lands are discussed below. In addition, seeds have been collected for long-term storage from three Inyo rock daisy occurrences on BLM land.

BLM Special Status Species

Inyo rock daisy is currently designated a BLM special status species (CNDDB 2023). The BLM maintains a list of special status species which are species found on BLM administered lands that are:

- Listed or proposed for listing under the ESA, and
- Requiring special management consideration to promote their conservation and reduce the likelihood and need for future listing under the ESA (BLM 2008).

The BLM state director decides which species within the state are designated as special status species (Lynch pers. comm. 2023). The objectives for having BLM special status species are to conserve and/or recover ESA listed species so that ESA protections are no longer needed, and to initiate proactive conservation measures for species that are currently unlisted to reduce or eliminate threats and ensure the species does not need to be listed under the ESA in the future (BLM 2008).

BLM special status species are managed on BLM-administered land to minimize or eliminate threats affecting the species or the condition of their habitat (BLM 2008). According to the 2008 BLM Special Status Species Management Manual, whenever the BLM engages in the planning process, BLM special status species and their habitats will be addressed in land use plans and associated NEPA documents when appropriate, and significant land use conflicts with BLM special status species should be identified and resolved (BLM 2008).

BLM Wilderness Areas

BLM-designated wilderness areas are open to uses consistent with the preservation of their wilderness character and future use and enjoyment as wilderness (43 C.F.R. § 6302.11). Certain activities (e.g., operating a commercial enterprise, building roads and structures, and using motorized equipment) are prohibited in wilderness areas since they are considered inconsistent with the preservation of the lands as wilderness (43 C.F.R. § 6302.20).

A single Inyo rock daisy occurrence at Santa Rosa Mine (CNDDB EO #17) is within the Malpais Mesa Wilderness, a BLM-designated wilderness area. The Santa Rosa Mine claim block was donated by the heir of the claim holder back to the BLM for inclusion in the Malpais Mesa Wilderness in 1999 (BLM 2015). The claim block has been withdrawn from new mineral entry, but it still needs to be officially reclassified as part of the Malpais Mesa Wilderness (BLM 2015). Since this occurrence is within the Malpais Mesa Wilderness, it will likely be protected from future mining impacts (Porter pers. comm. 2022).

California Desert National Conservation Lands

Inyo rock daisy grows on BLM lands that are classified as California Desert National Conservation Lands (NCL) within the California Desert Conservation Area (CDCA) (BLM 2016a). NCLs are managed for conservation purposes and are subject to Conservation and Management Actions (CMAs), which are management actions and allowable uses that govern activities on NCL lands (BLM 2016a). CMAs that are relevant for Inyo rock daisy include conducting properly timed surveys in accordance with survey protocols for BLM special status species, implementing an avoidance setback of 0.25 mi for all BLM special status species occurrences, and avoiding (to the extent feasible) impacts to BLM special status species habitat (BLM 2016a).

CMAs also include ground disturbance limits that range from 0.1% to 1% of an area, depending on land designation (BLM 2016a). The majority of Inyo rock daisy occurrences are on BLM lands designated as being part of the Cerro Gordo-Conglomerate Mesa Area of Critical Environmental Concern (ACEC). ACEC's are areas that require "special management attention….to protect and prevent irreparable damage to important historical, cultural, or scenic values, fish and wildlife resources or other natural systems or processes, or to protect life and safety from natural hazards" (43 U.S.C. § 1702(a)). The CMA ground disturbance limit for the Conglomerate Mesa portion of the ACEC is 0.1%, which accounts for six partial or entire CNDDB Inyo rock daisy occurrences (BLM 2016a). Inyo rock daisy occurrences within the Cerro Gordo portion of the ACEC, and all other Inyo rock daisy occurrences on non-wilderness BLM lands, are subject to a CMA ground disturbance limit of 1%, which accounts for 23 partial or entire CNDDB Inyo rock daisy occurrences (some occurrences overlap onto the Conglomerate Mesa ACEC). These ground disturbance limits can be implemented as either a limitation or can be used as an objective, where going over the limit will trigger disturbance mitigation (BLM 2016a).

In practice, CMAs are addressed in project review but exceptions to following CMAs can be made. A 2017 environmental assessment was prepared by the BLM as part of Silver Standard US Holdings Inc.'s (Silver Standard) application to the BLM for authorization to drill and sample mining claims at Conglomerate Mesa (BLM 2017). This environmental assessment indicated that the CMA implementing an avoidance set-back of 0.25 mi from Inyo rock daisy populations was not needed since the impacts to individual plants were acceptable and the project would not move the species toward the need for ESA protection. The environmental assessment further noted that CMAs are not laws and since Inyo rock daisy is not a threatened or endangered species (only a BLM special status species), then performance standards laid out in the Code of Federal Regulations for Surface Management (43 C.F.R. § 3809.420) which say that "the operator shall take such action as may be needed to prevent adverse impacts to threatened or endangered species, and their habitat which may be affected by operations" are not applicable. The BLM approved an alternative which only allowed helicopter access to transport drill rigs, supplies, and equipment in order to avoid road construction and reduce impacts to the area (Symons 2018).

CMAs can be changed through the land use amendment process (BLM 2016b). A draft amendment to the CDCA was announced by the BLM in 2021, which would modify certain CMAs and ACEC designations in order to provide flexibility and streamlining for renewable energy development projects (BLM 2021, Sierra Club 2021). This amendment purportedly removed the ground disturbance limit at Conglomerate Mesa to make it easier and cheaper for exploratory drilling to occur in the area (Sierra Club 2021). The 2021 draft amendment to the CDCA was subsequently withdrawn (de la Vega 2021) but illustrates that protections afforded by CMAs can be changed depending on land management priorities.

BLM Surface Management Regulations

Surface management regulations (43 C.F.R. § 3809 et seq.) establish procedures and standards for mineral operations on public land. All locatable mineral operations above casual use on public land that are associated with "prospecting, exploration, discovery and assessment work, development, extraction, and processing of mineral deposits" must submit either a notice or a plan of operations to BLM to proceed. The purpose of the surface management regulations is to establish procedures and standards to prevent the unnecessary and undue degradation of public lands by operations authorized by mining laws, and to make sure disturbed areas are reclaimed. Surface management regulations would apply to any operation located on public lands that cause surface disturbance greater than casual use. These surface management regulations may provide some protection for Inyo rock daisy occurrences that are on mining claims located on BLM lands.

California Surface Mining and Reclamation Act

Surface mining activities on BLM land are subject to the California Surface Mining and Reclamation Act (SMARA), which is administered by the California Department of Conservation's Division of Mine Reclamation and the State Mining and Geology Board (Pub. Resources Code, § 2710 et seq.; Cal. Code Regs., tit. 14, § 3500 et seq.). SMARA provisions ensure that adverse environmental effects from surface mining are prevented or minimized, and mined lands are reclaimed to a useable condition. In Inyo County, where Inyo rock daisy grows, the Inyo County Planning Department serves as lead agency in administering SMARA (MPM and Benchmark Resources 2021). If any future surface mining operations in the vicinity of Inyo rock daisy occur on BLM land and disturb an area greater than one acre or move more than 1,000 cubic yards of mining product or surface material (i.e., the layer of soil, rock, and vegetation that is removed to access the ore being mined), then an approved SMARA reclamation plan (which includes an environmental review pursuant to CEQA) is required before the start of mining activity.

Conservation Seed Banking

Seeds have been collected from a total of three Inyo rock daisy occurrences for long-term storage and conservation purposes. In 2018, the California Botanic Garden collected 5,741 seeds (from 55 maternal lines) from one occurrence on BLM land at Conglomerate Mesa (CNDDB EO #13) and 2,427 seeds (from 26 maternal lines) from another occurrence on BLM land near Belmont Mine, just north of Conglomerate Mesa (CNDDB EO #16) (Birker pers. comm. 2022). In 2021, the Santa Barbara Botanic Garden collected 3,357 seeds (from 36 maternal lines) from an occurrence in the northern part of the species range on BLM land between Cerro Gordo Peak and Cerro Gordo Spring (CNDDB EO #1) (Carson pers. comm. 2022a). These seed collections are currently in long-term seed storage at these two botanic gardens with back-up seed stored at the National Laboratory for Genetic Resources Preservation in Fort Collins, Colorado (Birker pers. comm. 2022).

SCIENTIFIC DETERMINATIONS REGARDING THE STATUS OF INYO ROCK DAISY IN CALIFORNIA

CESA directs the Department to prepare a status review to assess the status of Inyo rock daisy based upon the best scientific information available to the Department (Fish & G. Code, § 2074.6). The preceding sections of this Status Review describe the best scientific information available on Inyo rock daisy's biology, habitat, population trends and abundance, and factors affecting the ability of the species to survive and reproduce.

CESA's implementing regulations identify key factors that are relevant to the Department's assessment. Specifically, a "species shall be listed as endangered or threatened ... if the Commission determines that its continued existence is in serious danger or is threatened by any one or any combination of the following factors: 1. Present or threatened modification or destruction of its habitat; 2. Overexploitation; 3. Predation; 4. Competition; 5. Disease; or 6. Other natural occurrences or human-related activities" (Cal. Code Regs., tit. 14, § 670.1, subd. (i)(1)(A)). This section specifically addresses these factors as laid out in the California Code of Regulations and, for each factor, considers the significance of the threats to the continued existence of Inyo rock daisy.

Present or Threatened Modification or Destruction of Habitat

The threat of habitat modification and/or destruction for Inyo rock daisy primarily comes from mineral exploration and mining-related activities. Exploratory drilling and road construction activities have occurred in the Conglomerate Mesa area periodically since the late 1980s. As of January 2023, the BLM is reviewing a proposal to drill additional sites at Conglomerate Mesa. The BLM has required an environmental impact statement be prepared before further exploratory drilling activities can proceed.

There are two Inyo rock daisy occurrences (CNDDB EO #19 and #21) and portions of an additional three occurrences (CNDDB EO #9, #11, and #23) within the area currently proposed by MPM for mineral exploration at Conglomerate Mesa. These occurrences are threatened with modification or destruction of habitat from mineral exploration activities. If results from exploratory drilling show Conglomerate Mesa to be a valuable mineral reserve, the large-scale mining operation that could follow would likely have a much larger impact on Inyo rock daisy, threatening 57% of the known Inyo rock daisy occurrences with modification or destruction of habitat.

Two Inyo rock daisy occurrences are on private land that may be subject to recreational development or impacts. Inyo rock daisy CNDDB EO #6 and a portion of CNDDB EO #2 are on private land that was sold in 2018 to investors with plans to develop the area into a ghost town tourist attraction. Construction activities associated with restoring and rebuilding portions of the historical mining town of Cerro Gordo, as well as increased use of the area by visitors, may result in destruction and/or trampling of individual plants in this area.

Based on this assessment, the Department considers present or threatened modification or destruction of habitat due to mineral exploration and mining-related activities to be a significant threat to the continued existence of Inyo rock daisy in a significant portion of its range. Recreational development and activities may pose an additional threat to portions of Inyo rock daisy's range.

Overexploitation

There have been no documented instances of overexploitation of Inyo rock daisy. The species is not known to be in the nursery trade, nor is the Department aware of any other use of the species by humans. The Department does not currently consider overexploitation to be a significant threat to the continued existence of Inyo rock daisy.

Herbivory and Predation

There has been no documented herbivory or predation on Inyo rock daisy plants or seeds. Neither herbivory nor predation were reported as threats in any CNDDB occurrence records, and evidence of herbivory or predation on Inyo rock daisy was not observed during site visits conducted from 2018 through 2022. The Department does not currently consider herbivory or predation to be a significant threat to the continued existence of Inyo rock daisy.

Competition

Invasive plant species, particularly cheatgrass and red brome, are present throughout Inyo rock daisy's range and may threaten the species through competition for space and resources. In addition, invasive annual grasses may create more plant litter that makes habitat less suitable for Inyo rock daisy seedling establishment. Cheatgrass has been shown to be so competitive that newly emerging seedlings of native taxa are often unable to become established. Further study is needed to determine if invasive annual grasses are affecting Inyo rock daisy seedling establishment; however, if this is the case then invasive annual grasses could severely affect the ability of Inyo rock daisy to successfully reproduce.

The Department considers competition with annual invasive grasses, especially cheatgrass and red brome, to be a significant threat to the continued existence of Inyo rock daisy.

Disease

The Department does not have any information on diseases or parasites affecting Inyo rock daisy. The Department does not currently consider disease or parasites to be a significant threat to the continued existence of Inyo rock daisy.

Other Natural Occurrences or Human-related Activities

Small population size

Inyo rock daisy is known from only 28 occurrences with a global population size estimated in the low thousands. The inherent vulnerability of small populations is a significant and ongoing threat to all Inyo rock daisy populations. Inyo rock daisy occurs in such low numbers and over such a small geographic area that even localized accidents and chance events could lead to the extirpation of a population or could have severe and long-lasting negative effects on the ability of the species to survive and reproduce. Human activity, natural catastrophes (e.g., drought), environmental chance events that negatively affect pollinators and their ability to visit plants, and genetic chance events resulting in genetic drift, inbreeding depression, and/or gene flow effects, are the factors that the Department anticipates having the most significant negative impact on Inyo rock daisy due to its small population size.

Climate change

California is already experiencing the effects of global climate change and those effects are expected to increase in the future. The climate of California is expected to get warmer and have greater year to year variability in precipitation due to climate change. Inyo rock daisy is at a high risk of being negatively affected by climate change due to its restricted range, specialized habitat requirements, mid to high elevational range, poor dispersal ability, and long generation times. Given Inyo rock daisy's biology and habitat, Inyo rock daisy will likely have difficulty adapting to climate change in the future.

Alteration of fire regime

An increase in the frequency and intensity of fire due to the presence of invasive plants may negatively affect Inyo rock daisy. Plants that grow on rock outcrops (such as Inyo rock daisy) are generally not adapted to survive fire, since historically fire in these habitats was rare due to lack of fuel load. There are no records of fire burning in the Inyo Mountains which suggests that plants restricted to the Inyo Mountains are likely not well adapted to survive fire, especially high severity, frequent fires which may happen as invasive, annual grasses further invade the landscape.

The Department considers small population size, climate change, and alteration of the fire regime due to invasive plants to be significant threats to the continued existence of Inyo rock daisy.

SUMMARY OF KEY FINDINGS

Inyo rock daisy is a subshrub that is known from 28 occurrences and is restricted to the southern Inyo Mountains of Inyo County. Inyo rock daisy grows on calcareous rock outcrops with all mapped occurrences growing between 1,834 and 2,957 m (6,018 and 9,700 ft) in elevation. The total range of Inyo rock daisy covers about 72 km^2 (28 mi^2) and total population size is estimated in the low thousands.

Inyo rock daisy is primarily threatened by habitat modification and destruction from proposed exploratory mining activities and potential mining operations in the future. Inyo rock daisy occurs in low numbers across a small geographic area making it especially vulnerable to chance events. Inyo rock daisy is likely self-incompatible which can lead to reduced seed set if no compatible mates are nearby. Inyo rock daisy relies on pollinators to reproduce and pollinators may not be able to easily find and visit flowers since the species occurs in small and isolated populations across the landscape. This can cause breeding among genetically similar individuals, resulting in lower seed production, or offspring with reduced ability to survive and reproduce. Climate change threatens Inyo rock daisy because the species has a restricted range, grows in a specialized habitat, grows at mid to high elevations within its range, has poor long-distance dispersal ability, and has long generation times. In addition, invasive grasses may outcompete Inyo rock daisy seedlings for establishment and alter the fire regime in the future.

An endangered species is one that is in serious danger of becoming extinct throughout all or a significant portion of its range (Fish & G. Code, § 2062), and a threatened species is one that, although not currently faced with extinction, is likely to become an endangered species in the foreseeable future in the absence of protection by CESA (Fish & G. Code, § 2067). Although Inyo rock daisy is not currently faced with extinction, it is threatened by mineral exploration and mining activities, invasive annual grasses potentially outcompeting Inyo rock daisy seedlings for establishment, genetic consequences due to a small population size, chance events due to a restricted range, altered fire regime due to an increase in invasive annual grasses, and climate change (along with associated prolonged periods of drought). The information available to the Department regarding the status of Inyo rock daisy indicates that these are significant threats to the continued existence of the species.

RECOMMENDATION FOR THE COMMISSION

CESA requires the Department to prepare this report assessing the status of Inyo rock daisy in California based upon the best scientific information available to the Department (Fish & G. Code, § 2074.6). CESA also requires the Department to indicate in this Status Review whether the petitioned action is warranted (Fish & G. Code, § 2074.6; Cal. Code Regs., tit. 14, § 670.1, subd. (f)). Based on the criteria described above, the best scientific information available to the Department indicates that Inyo rock daisy, although not presently threatened with extinction, is likely to become an endangered species in the foreseeable future in the absence of the special protection and management efforts required by CESA.

The Department recommends that the Commission find the petitioned action to list Inyo rock daisy to be warranted. Furthermore, the Department recommends that the Commission list Inyo rock daisy as a threatened species under CESA.

PROTECTION AFFORDED BY LISTING

It is the policy of the state to conserve, protect, restore and enhance any endangered or any threatened species and its habitat (Fish & G. Code, § 2052). If listed as an endangered or threatened species, unauthorized "take" of Inyo rock daisy will be prohibited, making the conservation, protection, and enhancement of the species and its habitat an issue of state-wide concern. As noted earlier "take" is defined under CESA as hunt, pursue, catch, capture, or kill, or attempt to hunt, pursue, catch, capture, or kill (*id.*, § 86). Any person violating the take prohibition would be punishable under state law. The Fish and Game Code provides the Department with related authority to authorize "take" under certain circumstances (*id.*, §§ 2081, 2081.1, 2086, 2087, 2089.6, 2089.10, & 2835). As authorized through an incidental take permit, however, impacts of the taking of Inyo rock daisy caused by the activity must be minimized and fully mitigated according to state standards.

Additional protection of Inyo rock daisy following listing would also occur during required state and local agency environmental review under CEQA. CEQA requires affected public agencies to analyze and disclose project-related environmental effects, including potentially significant impacts on endangered, threatened, and rare special status species. Under CEQA's "substantive mandate," state and local agencies in California must avoid or substantially lessen significant environmental effects to the extent feasible. With that mandate, and the Department's regulatory jurisdiction generally, the Department expects related CEQA review will likely result in increased information regarding the status of Inyo rock daisy in California as a result of pre-project biological surveys. Where significant impacts are identified under CEQA, the Department expects project-specific required avoidance, minimization, and mitigation measures will also benefit the species. While CEQA may require analysis of potential impacts to Inyo rock daisy regardless of its listing status under CESA, the statue contains specific requirements for analyzing and mitigating impacts to listed species. In common practice, potential impacts to listed species are scrutinized more in CEQA documents than are potential impacts to unlisted species. CESA listing, in this respect, and required consultation with the Department during state and local agency environmental review under CEQA, is expected to benefit the species by reducing impacts from individual projects to a greater degree than may occur absent listing.

If Inyo rock daisy is listed under CESA, it may increase the likelihood that state and federal land and resource management agencies will allocate funds towards protection and recovery actions. However, funding for species recovery and management is limited, and there is a growing list of threatened and endangered species.

MANAGEMENT RECOMMENDATIONS AND RECOVERY MEASURES

CESA directs the Department to include in its Status Review recommended management activities and other recommendations for recovery of Inyo rock daisy (Fish & G. Code, § 2074.6; Cal. Code Regs., tit. 14, § 670.1, subd. (f)). Recovery of Inyo rock daisy is dependent on the cooperation of all stakeholders in the area to protect existing populations and to better understand the species and habitat preferences to determine the best management strategies and ensure Inyo rock daisy persists in the future. Department staff generated the following list of recommended management actions and recovery measures to achieve conservation of Inyo rock daisy.

1. Preserve a significant proportion of Inyo rock daisy occurrences and habitat in perpetuity.

   1a. Conduct a complete census of the southern Inyo Mountains for Inyo rock daisy. Particular attention should be given to Mexican Springs at the north end of Inyo rock daisy's range, and any calcareous rock outcrops within the Malpais Mesa Wilderness. Extensive surveys at Conglomerate Mesa should also be done to determine the full extent of the species in this area.

   1b. Identify areas that could be proposed for a change in land designation (e.g., to BLM's Wilderness Area designation) and propose this change to the proper agency.

   1c. Identify private properties that contain Inyo rock daisy and could be preserved in perpetuity through purchase by the Department or other partners, or preserved through conservation agreements (e.g., conservation easements or Safe Harbor Agreements).

   1d. Identify and preserve habitat that could serve as potential refuges for Inyo rock daisy in the face of climate change.

2. Remove or minimize the threat of habitat elimination and degradation due to mineral exploration, mining, recreational development, and associated activities.

2a. Protect Inyo rock daisy populations from mineral exploration and mining activities at Conglomerate Mesa. This includes protection from direct disturbances such as trampling or plant removal, as well as indirect disturbances, such as dust from increased road use which could negatively affect the ability of the plant to photosynthesize and disrupt pollinator activity.

2b. Protect Inyo rock daisy populations from construction activities at the historical mining town of Cerro Gordo as restoration of the town progresses. Inyo rock daisy populations should also be protected from any recreational activities (such as hiking and rock climbing) that may occur as the historical mining town of Cerro Gordo becomes a tourist attraction. Any disturbances to Inyo rock daisy populations associated with the restoration and revitalization of the historical mining town of Cerro Gordo should be eliminated or minimized.

3. Remove or minimize the threat of habitat degradation due to increased fire risk and competition from invasive species.

3a. Study the effects of invasive annual grasses on the establishment of Inyo rock daisy seedlings, focusing on the effects of competition. Determine the degree to which invasive annual grasses may contribute to build-up of litter and competition for resources in Inyo rock daisy habitat. Strategize ways to ameliorate any negative effects that invasive annual grasses are having on Inyo rock daisy.

3b. If fire becomes more prevalent in the Inyo Mountains, studies on the effect of fire intensity and fire frequency on survival of Inyo rock daisy plants and seeds would be needed.

4. Maintain redundant collections of seed in long-term conservation storage that represents the genetic diversity of the species.

4a. Assess genetic variability in Inyo rock daisy populations across its range to determine if inbreeding depression, genetic drift, or hybridization is occurring and inform related management.

4b. Collect seed from Inyo rock daisy populations for long-term conservation storage, targeting the entire species' range to ensure the genetic diversity of Inyo rock daisy is captured. Make sure that Inyo rock daisy seed is stored at accredited seed banking institutions.

5. Use the best available science to build a habitat profile of the needs and tolerances of Inyo rock daisy across its range that can inform conservation decisions (e.g., establishing new populations and assisted migration).

5a. Population size estimates for all Inyo rock daisy occurrences should be determined to ascertain the total number of plants in existence. Implement a population monitoring program to track population trends over time.

5b. Conduct a habitat assessment to determine the environmental parameters that appear to be associated with Inyo rock daisy presence. Use these environmental parameters to develop a species distribution model for Inyo rock daisy to identify possible habitat in and around the current Inyo rock daisy range, as well as to identify suitable areas to serve as potential refuges for Inyo rock daisy in the face of climate change. Survey areas that the model identifies as habitat to find new occurrences and validate the model.

5c. Conduct studies on aspects of Inyo rock daisy life history such as longevity, timing of seed germination, seedling establishment and survival, and reproductive age. Design studies to provide useful information on how to manage the species as climate change progresses and to determine how habitat disturbance affects the species ability to recover and persist.

5d. Conduct studies of Inyo rock daisy pollination and seed dispersal. Conduct entomological surveys to determine what kinds of pollinators visit Inyo rock daisy flowers and whether the types of pollinators vary across the range. Design and implement studies to determine how seed is dispersed and if animals play a role in seed dispersal.

5e. Study habitat characteristics and elevation limits for Inyo rock daisy. Inyo rock daisy is thought to be restricted to calcareous substrates and elevations between 1,834 and 2,957 m (6,018 and 9,700 ft) but studies to better understand the species' substrate preferences and elevational limits would be beneficial.

5f. Study the effects of drought on Inyo rock daisy and whether individuals can remain dormant until favorable conditions return.

ACKNOWLEDGMENTS

This Status Review was prepared by Kristi Lazar in the Department's Habitat Conservation Planning Branch, Native Plant Program. Cover photo of Inyo rock daisy by Kristi Lazar.

The Department would like to thank Duncan Bell, Isaac Lichter-Marck, Emma Lynch, and Jim Morefield for providing scientific peer review for this Status Review.

LITERATURE CITED

The following sources were used during the preparation of this Status Review:

Literature

Ackerly, D., S. Loarie, W. Cornwell, S. Weiss, H. Hamilton, R. Branciforte, and N. Kraft. 2010. The geography of climate change: implications for conservation biogeography. Diversity and Distributions 16:476–487.

Ackerman, T. 1979. Germination and survival of perennial plant species in the Mojave Desert. The Southwestern Naturalist 24:399–408.

Allphin, L., D. Wiens, and K. Harpert. 2002. The relative effects of resources and genetics on reproductive success in the rare Kachina daisy, *Erigeron kachinensis* (Asteraceae). International Journal of Plant Sciences 163:599–612.

Bailey, R. 2005. Identifying ecoregion boundaries. Environmental Management 34:S14–S26.

Bailey, R. 2014. Ecoregions: the ecosystem geography of the oceans and continents. 2nd edition. Springer, New York, NY, USA.

Baldwin, B., D. Goldman, D. Keil, R. Patterson, T. Rosatti, and D. Wilken. 2012. The Jepson Manual, vascular plants of California. 2nd edition. University of California Press, Berkeley, CA, USA.

Bales, R., R. Rice, and S. Roy. 2015. Estimated loss of snowpack storage in the Eastern Sierra Nevada with climate warming. Journal of Water Resources Planning and Management 141:04014055.

Bedsworth, L., D. Cayan, G. Franco, L. Fisher, and S. Ziaja. 2018. Statewide summary report. California's fourth climate change assessment. Publication number: SUM-CCCA4-2018-013.

Beekman, M., and F. L. W. Ratnieks. 2000. Long-range foraging by the honey-bee, *Apis mellifera* L. Functional Ecology 14:490–496.

Benwell, A. 2007. Response of rock-outcrop and fringing vegetation to disturbance by fire and drought. Australian Journal of Botany 55:736–748.

Berg, N., and A. Hall. 2015. Increased interannual precipitation extremes over California under climate change. Journal of Climate 28:6324–6334.

Berger, V., D. Mosier, J. Bliss, and B. Moring. 2014. Sediment-hosted gold deposits of the world- database and grade and tonnage models (ver. 1.1, June 2014): U.S. Geological Survey Open-File Report 2014-1074. 46 p.

Billings, W. 1994. Ecological impacts of cheatgrass and resultant fire on ecosystems in the Western Great Basin. Pages 22–30 *in* S. Monsen and S. Ketchum, editors. Proceedings- ecology and management of annual rangelands. General technical report INT-GTR-313. United States Department of Agriculture, Forest Service, Intermountain Research Station.

Bisbing, S., A. Urza, B. Buma, D. Cooper, M. Matocq, and A. Angert. 2021. Can long-lived species keep pace with climate change? Evidence of local persistence potential in a widespread conifer. Diversity and Distributions 27:296–312.

BLM, (Bureau of Land Management). 2008. Manual 6840 - special status species management. U.S. Department of the Interior.

BLM, (Bureau of Land Management). 2015. Documentation of BLM Wilderness Findings on Record, WIU #CDCA 124. U.S. Department of the Interior.

BLM, (Bureau of Land Management). 2016a. Desert Renewable Energy Conservation Plan Land Use Plan Amendment to the California Desert Conservation Area Plan, Bishop Resource Management Plan, and Bakersfield Resource Management Plan. U.S. Department of the Interior.

BLM, (Bureau of Land Management). 2016b. Desert Renewable Energy Conservation Plan Record of Decision for the Land Use Plan Amendment to the California Desert Conservation Plan, Bishop Resource Management Plan, and Bakersfield Resource Management Plan. U.S. Department of the Interior.

BLM, (Bureau of Land Management). 2017. Perdito exploration project environmental assessment. DOI-BLM-CA-D050-0037-EA. U.S. Department of the Interior.

BLM, (Bureau of Land Management). 2019. Mining claims and sites on federal lands brochure. U.S. Department of the Interior. Available from: https://www.blm.gov/sites/default/files/PublicRoom_Mining_Claims_Brochure-2019.pdf (Accessed: 15 September 2022).

BLM, (Bureau of Land Management). 2021. Press release: Bureau of Land Management announces draft environmental impact statement for Desert Plan Amendment. U.S. Department of the Interior.

BLM, (Bureau of Land Management). 2022. Bureau of Land Management: our mission webpage. Available from: https://www.blm.gov/about/our-mission (Accessed: 29 November 2022).

Bowers, J., R. Turner, and T. Burgess. 2004. Temporal and spatial patterns in emergence and early survival of perennial plants in the Sonoran Desert. Plant Ecology 172:107–119.

Bowers, J., R. Webb, and R. Rondeau. 1995. Longevity, recruitment and mortality of desert plants in Grand Canyon, Arizona, USA. Journal of Vegetation Science 6:551–564.

Brooks, M. 1999. Alien annual grasses and fire in the Mojave Desert. Madroño 46:13–19.

Brooks, M., R. Minnich, and J. Matchett. 2018. Southeastern deserts bioregion, chapter 18. Pages 353–378 *in* Fire in California's ecosystems. 2nd edition. University of California Press, Berkeley, CA, USA.

Byers, D., and T. Meagher. 1992. Mate availability in small populations of plant species with homomorphic sporophytic self-incompatibility. Heredity 68:353–359.

CAL FIRE (California Department of Forestry and Fire Protection). 2023. Fire perimeters dataset (GIS). Available from: https://frap.fire.ca.gov/mapping/gis-data/ (Accessed 4 January 2023).

Calflora. 2022. Taxon report: *Perityle megacephala*. Available from: https://www.calflora.org/app/taxon?crn=6260 (Accessed: 28 December 2022).

Carlquist, S. 1966. The biota of long-distance dispersal. II. Loss of dispersibility in Pacific Compositae. Evolution 20:30–48.

Cayan, D., E. Maurer, M. Dettinger, M. Tyree, and K. Hayhoe. 2008. Climate change scenarios for the California region. Climatic Change 87:21–42.

CCH, (Consortium of California Herbaria). 2022. Consortium of California Herbaria portal 2. Available from: https://cch2.org/portal/ (Accessed: 20 July 2022).

CDFW, (California Department of Fish and Wildlife). 2022. Climate change vulnerability assessment for Inyo rock daisy (*Laphamia inyoensis*). The NatureServe Climate Change Vulnerability Index, release 3.02.

CEC, (Commission for Environmental Cooperation). 1997. Ecological regions of North America: toward a common perspective. Montreal (Quebec), Canada.

Cheptou, P., O. Carrue, S. Rouifed, and A. Cantarel. 2008. Rapid evolution of seed dispersal in an urban environment in the weed *Crepis sancta*. Proceedings of the National Academy of Sciences of the United States of America 105:3796–3799.

Chichorro, F., A. Juslén, and P. Cardoso. 2019. A review of the relation between species traits and extinction risk. Biological Conservation 237:220–229.

CNDDB, (California Natural Diversity Database). 2018. License agreement for the California Natural Diversity Database. California Department of Fish and Wildlife. Sacramento, CA, USA. Available from: https://nrm.dfg.ca.gov/FileHandler.ashx?DocumentID=75516&inline (Accessed: 13 December 2022).

CNDDB, (California Natural Diversity Database). 2020. California Natural Diversity Database (CNDDB) Management Framework. California Department of Fish and Wildlife. Sacramento, CA, USA. Available from: https://nrm.dfg.ca.gov/FileHandler.ashx?DocumentID=181808&inline (Accessed: 13 December 2022).

CNDDB, (California Natural Diversity Database). 2023. RareFind 5 [internet]. Government version - dated March 2023. California Department of Fish and Wildlife.

CNDDB, (The California Natural Diversity Database), and CNPS (California Native Plant Society). 2020. The CNDDB and CNPS cooperative relationship and rare plant status review process. Sacramento, CA, USA. Available from: https://nrm.dfg.ca.gov/FileHandler.ashx?DocumentID=175695&inline (Accessed: 13 December 2022).

CNPS, (California Native Plant Society). 2022a. A manual of California vegetation, online edition. Available from: http://www.cnps.org/cnps/vegetation (Accessed: 2 November 2022).

CNPS, (California Native Plant Society). 2022b. CNPS inventory of rare and endangered plants of California: *Perityle inyoensis*. Available from: https://rareplants.cnps.org/Plants/Details/1320 (Accessed: 29 July 2022).

Cody, M. 2000. Slow-motion population dynamics in Mojave Desert perennial plants. Journal of Vegetation Science 11:351–358.

Cody, M., and J. Overton. 1996. Short-term evolution of reduced dispersal in island plant populations. Journal of Ecology 84:53–61.

Conrad, J. 1993. Late Cenozoic tectonics of the southern Inyo Mountains, Eastern California. Thesis, San Jose State University, San Jose, CA, USA.

Corlett, R. T., and K. Tomlinson. 2020. Climate change and edaphic specialists: irresistible force meets immovable object? Trends in Ecology and Evolution 35:367–376.

Costa-Cabral, M., S. Roy, E. Maurer, W. Mills, and L. Chen. 2013. Snowpack and runoff response to climate change in Owens Valley and Mono Lake watersheds. Climatic Change 116:97–109.

CSUN, (California State University Northridge), and CDFW (California Department of Fish and Wildlife). 2014. A shared vision for the survey of California vegetation. Available from: https://nrm.dfg.ca.gov/FileHandler.ashx?DocumentID=114778&inline (Accessed: 5 October 2022).

DAC, (Desert Advisory Council). 2022. Field office, fire and fuel reports, Desert Advisory Council, May 2022. Available from: https://www.blm.gov/get-involved/rac/california/california-desert-district (Accessed: 24 August 2022).

Daly, C., M. Halbleib, J. Smith, W. Gibson, M. Doggett, G. Taylor, J. Curtis, and P. Pasteris. 2008. Physiographically sensitive mapping of climatological temperature and precipitation across the conterminous United States. International Journal of Climatology 28:2031–2064.

Daly, C., R. Neilson, and D. Phillips. 1994. A statistical-topographic model for mapping climatological precipitation over mountainous terrain. Journal of Applied Meteorology 33:140–158.

Damschen, E., S. Harrison, D. Ackerly, B. Fernandez-Going, and B. Anacker. 2012. Endemic plant communities on special soils: early victims or hardy survivors of climate change? Journal of Ecology 100:1122–1130.

D'Antonio, C., and P. Vitousek. 1992. Biological invasions by exotic grasses, the grass/fire cycle, and global change. Annual Review of Ecology and Systematics 23:63–87.

Davis, M. 2009. Invasion Biology. 1st edition. Oxford University Press, Oxford, UK.

Davis, P. 1951. Cliff vegetation in the Eastern Mediterranean. Journal of Ecology 39:63–93.

De la Vega, S. 2021. Temporary suspension of delegated authority, Order No. 3395. U.S. Department of the Interior.

DeDecker, M. 1966. Mines of the Eastern Sierra. La Siesta Press, Glendale, CA, USA.

Dettinger, M., H. Alpert, J. Battles, J. Kusel, H. Safford, D. Fougeres, C. Knight, L. Miller, and S. Sawyer. 2018. Sierra Nevada summary report. California's fourth climate change assessment. Publication number: SUM-CCCA4-2018-004.

Dodson, R., and D. Marks. 1997. Daily air temperature interpolated at high spatial resolution over a large mountainous region. Climate Research 8:1–20.

Downey, C., C. Higgins, and P. Schruben. 2007. Cerro Gordo. U.S. Geological Survey, Mineral Resource Data System. Available from: https://mrdata.usgs.gov/mrds/show-mrds.php?dep_id=10310600 (Accessed: 19 July 2022).

Ellstrand, N., and D. Elam. 1993. Population genetic consequences of small population size: implications for plant conservation. Annual Review of Ecology and Systematics 24:217–242.

Evans, R., R. Rimer, L. Sperry, and J. Belnap. 2001. Exotic plant invasion alters nitrogen dynamics in an arid grassland. Ecological Applications 11:1301–1310.

Facelli, J., and S. Pickett. 1991. Plant litter: its dynamics and effects on plant community structure. Review 57:1–32.

Ferris, R. 1958. *Laphamia inyoensis*. Contributions from the Dudley Herbarium 5:104–105.

Gaertner, M., A. Breeyen, C. Hui, and D. Richardson. 2009. Impacts of alien plant invasions on species richness in Mediterranean-type ecosystems: a meta-analysis. Progress in Physical Geography 33:319–338.

Goldberg, D., and R. Turner. 1986. Vegetation change and plant demography in permanent plots in the Sonoran Desert. Ecology 67:695–712.

Green, F., and R. Harding. 1980. The altitudinal gradients of air temperature in southern Norway. Geografiska Annaler. Series A, Physical Geography 62:29–36.

Griffith, G., J. Omernik, D. Smith, T. Cook, E. Tallyn, K. Moseley, and C. Johnson. 2016. Ecoregions of California (poster): U.S. Geological Survey open-file report 2016-1021, with map, scale 1:1,100,000.

Hall, W., and E. MacKevett Jr. 1962. Geology and ore deposits of the Darwin Quadrangle, Inyo County, California. Geological Survey Professional Paper 368. Washington, DC, USA.

Harnik, P., C. Simpson, and J. Payne. 2012. Long-term differences in extinction risk among the seven forms of rarity. Proceedings of the Royal Society B: Biological Sciences 279:4969–4976.

Harpold, A., and N. Molotch. 2015. Sensitivity of soil water availability to changing snowmelt timing in the western U.S. Geophysical Research Letters 42:8011–8020.

Hawkins, B., S. Sharrock, and K. Havens. 2008. Plants and climate change: which future? Richmond, UK.

Hedrick, P., and S. Kalinowski. 2000. Inbreeding depression in conservation biology. Annual Review of Ecology and Systematics 31:139–162.

Hopper, S. 2000. Creation of conservation reserves and managing fire on granite outcrops- a case study of Chiddarcooping Nature Reserve in the Western Australian wheatbelt. Journal of the Royal Society of Western Australia 83:173–186.

Horton, J., and C. San Juan. 2022. Prospect- and mine-related features from U.S. Geological Survey 7.5- and 15-minute topographic quadrangle maps of the United States (ver. 8.0, September 2022): U.S. Geological Survey data release, https://doi.org/10.5066/F78W3CHG. U.S. Geological Survey, Denver, CO, USA.

Iacobellis, S., D. Cayan, J. Abatzoglou, and H. Mooney. 2016. Climate. Pages 9-26 *in* H. Mooney and E. Zavaleta, editors. Ecosystems of California. 1st edition. University of California Press, Berkeley, CA, USA.

IPCC. 2014. Climate change 2014: synthesis report. Contribution of working groups I, II and III to the fifth assessment report of the intergovernmental panel on climate change [core writing team, R.K. Pachauri and L.A. Meyer (eds.)]. IPCC, Geneva, Switzerland. 151 pp.

IPCC. 2021. Climate change 2021: the physical science basis. Contribution of working group I to the sixth assessment report of the intergovernmental panel on climate change. V. Masson-Delmotte, P. Zhai, A. Pirani, S. Connors, C. Péan, S. Berger, N. Caud, Y. Chen, L. Goldfarb, M. Gomis, M. Huang, K. Leitzell, E. Lonnoy, J. Matthews, T. Maycock, T. Waterfield, O. Yelekçi, R. Yu, and B. Zhou, editors. Cambridge University Press, Cambridge, UK and New York, NY, USA.

IPCC. 2022. Climate change 2022: impacts, adaptation, and vulnerability. Contributions of working group II to the sixth assessment report of the intergovernmental panel on climate change. H. Pörtner, D. Roberts, M. Tignor, E. Poloczanska, K. Mintenbeck, A. Alegría, M. Craig, S. Langsdorf, S. Löschke, V. Möller, A. Okem, and B. Rama, editors. Cambridge University Press, Cambridge, UK and New York, NY, USA.

Jennings, C., C. Gutierrez, W. Bryant, G. Saucedo, and C. Wills. 2010. Geologic map of California. California Geological Survey.

Jesus, M. 2021. A vascular flora of the southern Inyo Mountains, Inyo County, California. Thesis, Claremont Graduate University, Claremont, CA, USA.

Jesus, M., B. Cummings, and N. Jensen. 2022a. Comments on the petition to list Inyo rock daisy as threatened or endangered under the California Endangered Species Act.

Jesus, M., The Center for Biological Diversity, and California Native Plant Society. 2022b. A petition to list the Inyo rock daisy (*Perityle inyoensis*, synonym *Laphamia inyoensis*) as threatened or endangered under the California Endangered Species Act (CESA). 42 pp.

Jump, A., and J. Peñuelas. 2005. Running to stand still: adaptation and the response of plants to rapid climate change. Ecology Letters 8:1010–1020.

K2 Gold. 2020. News release: K2 Gold announces high grade samples from new target at Mojave. Available from: https://k2gold.com/news-media/news/k2-gold-announces-high-grade-samples-from-new-target-at-mojave/ (Accessed: 15 September 2022).

K2 Gold. 2021. News release: K2 announces two new gold targets at Mojave and launches 2021 exploration program. Available from: https://k2gold.com/news-media/news/k2-announces-two-new-gold-targets-at-mojave-and-launches-2021-exploration-program/ (Accessed: 24 February 2022).

K2 Gold. 2022. K2 Gold: Mojave Project. Available from: https://k2gold.com/projects/mojave-project/ (Accessed: 15 September 2022).

Keil, D. 2012. *Perityle*. In Jepson Flora Project (eds.), Jepson eflora. Available from: https://ucjeps.berkeley.edu/eflora/eflora_display.php?tid=549 (Accessed: 22 November 2022).

Kelly, A., and M. Goulden. 2008. Rapid shifts in plant distribution with recent climate change. Proceedings of the National Academy of Sciences 105:11823–11826.

Kerns, B., and M. Day. 2017. The importance of disturbance by fire and other abiotic and biotic factors in driving cheatgrass invasion varies based on invasion stage. Biological Invasions 19:1853–1862.

Khatri-Chhetri, P., S. Hendryx, K. Hartfield, M. Crimmins, W. van Leeuwen, and V. Kane. 2021. Assessing vegetation response to multi-scalar drought across the Mojave, Sonoran, Chihuahuan deserts and Apache Highlands in the Southwest United States. Remote Sensing 13:1103.

Knapp, P. 1996. Cheatgrass (*Bromus tectorum* L) dominance in the Great Basin Desert: history, persistence, and influences to human activities. Global Environmental Change 6:37–52.

Lande, R. 1993. Risks of population extinction from demographic and environmental stochasticity and random catastrophes. The American Naturalist 142:911–927.

Larson, D., U. Matthes, J. A. Gerrath, J. M. Gerrath, J. Nekola, G. Walker, S. Porembski, A. Charlton, and N. Larson. 1999. Ancient stunted trees on cliffs. Nature 398:382–383.

Larson, D., U. Matthes, J. A. Gerrath, N. Larson, J. M. Gerrath, J. Nekola, G. Walker, S. Porembski, and A. Charlton. 2000a. Evidence for the widespread occurrence of ancient forests on cliffs. Journal of Biogeography 27:319–331.

Larson, D., U. Matthes, and P. Kelly. 2000b. Cliff ecology: pattern and process in cliff ecosystems. Cambridge University Press, Cambridge, UK.

Lee, J., D. Stockli, L. Owen, R. Finkel, and R. Kislitsyn. 2009. Exhumation of the Inyo Mountains, California: implications for the timing of extension along the western boundary of the Basin and Range Province and distribution of dextral fault slip rates across the Eastern California shear zone. Tectonics 28:1–20.

Levin, D. 1984. Inbreeding depression and proximity-dependent crossing success in *Phlox drummondii*. Evolution 38:116–127.

Levine, J., M. Vilà, C. D'Antonio, J. Dukes, K. Grigulis, and S. Lavorel. 2003. Mechanisms underlying the impacts of exotic plant invasions. Proceedings of the Royal Society B: Biological Sciences 270:775–781.

Lichter-Marck, I. 2018. Email communication between Maria Jesus and Isaac Lichter-Marck regarding field observations of *Perityle inyoensis* and insect visitors.

Lichter-Marck, I., and B. Baldwin. 2022. A phylogenetically informed reclassification of the rock daisies (Perityleae; Compositae). Systematic Botany 47:802–816.

Lichter-Marck, I., and B. Baldwin. 2023. Edaphic specialization onto bare, rocky outcrops as a factor in the evolution of desert angiosperms. PNAS 120:e2214729120.

Lichter-Marck, I., W. Freyman, C. Siniscalchi, J. Mandel, A. Castro-Castro, G. Johnson, and B. Baldwin. 2020. Phylogenomics of Perityleae (Compositae) provides new insights into morphological and chromosomal evolution of the rock daisies. Journal of Systematics and Evolution 58:853–880.

Lueders, L. 2019. For the sake of salt: a landscape-level management approach for the Saline Valley Salt Tram. Thesis, Sonoma State University, Rohnert Park, CA, USA.

Lynch, M., J. Conery, and R. Burger. 1995. Mutation accumulation and the extinction of small populations. The American Naturalist 146:489–518.

Mack, R. 1981. Invasion of *Bromus tectorum* L. into western North America: an ecological chronicle. Agro-Ecosystems 7:146–165.

MacKevett, E. 1953. Geology of the Santa Rosa lead mine, Inyo County, California. Special Report 34. San Francisco, CA, USA.

Manning, T., and D. Kappes. 2016. Heap leaching of gold and silver ores. Pages 413–428 *in* M. Adams, editor. Gold Ore Processing, project development and operations. 2nd edition. Elsevier Science, Amsterdam, Netherlands.

Master, L., D. Faber-Langendoen, R. Bittman, G. Hammerson, B. Heidel, L. Ramsay, K. Snow, A. Teucher, and A. Tomaino. 2012. NatureServe conservation status assessments: factors for evaluating species and ecosystem risk. Arlington, VA, USA.

Matthies, D., I. Bräuer, W. Maibom, and T. Tscharntke. 2004. Population size and the risk of local extinction: empirical evidence from rare plants. Oikos 105:481–488.

McNab, W., D. Cleland, J. Freeouf, J. Keys Jr., G. Nowacki, and C. Carpenter. 2007. Description of "Ecological subregions: sections of the conterminous United States." Gen. Tech. Report WO-76B. Washington, DC, USA.

Melbourne, B., and A. Hastings. 2008. Extinction risk depends strongly on factors contributing to stochasticity. Nature 454:100–103.

Menges, E. 1991. The application of minimum viable population theory to plants. Pages 45–61 *in* D. Falk and K. Holsinger, editors. Genetics and conservation of rare plants. Oxford University Press, Inc., New York, NY, USA.

Merriam, C. 1963. Geology of the Cerro Gordo mining district, Inyo County, California. Geological Survey Professional Paper 408. U.S. Department of the Interior, Geological Survey.

Miles, S., and C. Goudey. 1997. Ecological subregions of California: section and subsection descriptions. San Francisco, CA, USA.

Monsen, S. 1994. The competitive influences of cheatgrass (*Bromus tectorum*) on site restoration. Pages 43–50 *in* S. Monsen and S. Ketchum, editors. Proceedings-Ecology and Management of Annual Rangelands. General Technical Report INT-GTR-313. U.S. Department of Agriculture, Forest Service, Intermountain Research Station.

Morrow, L., and P. Stahlman. 1984. The history and distribution of downy brome (*Bromus tectorum*) in North America. Weed Science 32:2–6.

MPM, (Mojave Precious Metals, Inc.), and Benchmark Resources. 2021. Mojave Project exploration drilling, plan of operations modification, plan of operations CACA-056495.

NatureServe. 2022. Climate change vulnerability index. Available from: https://www.natureserve.org/ccvi-species (Accessed: 28 November 2022).

NDMC, (National Drought Mitigation Center). 2022. U.S. Drought Monitor time series for Inyo County. Available from: https://droughtmonitor.unl.edu/DmData/TimeSeries.aspx (Accessed: 1 December 2022).

Omernik, J. 1987. Ecoregions of the conterminous United States. Annals of the Association of American Geographers 77:118–125.

Parmesan, C. 2006. Ecological and evolutionary responses to recent climate change. Annual Review of Ecology, Evolution, and Systematics 37:637–669.

Parmesan, C., and G. Yohe. 2003. A globally coherent fingerprint of climate change impacts across natural systems. Nature 421:37–42.

Pavlik, B. 2008. The California deserts: an ecological rediscovery. University of California Press, Berkeley, CA, USA.

Payne, J., and S. Finnegan. 2007. The effect of geographic range on extinction risk during background and mass extinction. Proceedings of the National Academy of Sciences of the United States of America 104:10506–10511.

Pearson, R., J. Stanton, K. Shoemaker, M. Aiello-Lammens, P. Ersts, N. Horning, D. Fordham, C. Raxworthy, H. Y. Ryu, J. Mcnees, and H. Akçakaya. 2014. Life history and spatial traits predict extinction risk due to climate change. Nature Climate Change 4:217–221.

Peters, E., and S. Bunting. 1994. Fire conditions and pre- and postoccurrence of annual grasses on the Snake River Plain. Pages 31–36 *in* Proceedings-Ecology and Management of Annual Rangelands. General Technical Report INT-GTR-313. U.S. Department of Agriculture, Forest Service, Intermountain Research Station.

Pierce, D., J. Kalansky, and D. Cayan. 2018. Climate, drought, and sea level rise scenarios for the fourth California Climate Assessment. California's Fourth Climate Change Assessment, California Energy Commission. Publication Number: CCCA4-CEC-2018-006.

Polade, S., A. Gershunov, D. Cayan, M. Dettinger, and D. Pierce. 2017. Precipitation in a warming world: assessing projected hydro-climate changes in California and other Mediterranean climate regions. Scientific Reports 7:1–10.

Poot, P., S. Hopper, and J. van Diggelen. 2012. Exploring rock fissures: does a specialized root morphology explain endemism on granite outcrops? Annals of Botany 110:291–300.

Powell, A. 1968. Additional discussions pertaining to the congeneric status of *Perityle* and *Laphamia* (Compositae). SIDA, Contributions to Botany 3:270–278.

Powell, A. 1972. Artificial hybridization in the subtribe Peritylanae (Compositae-Helenieae). American Journal of Botany 59:760–768.

Powell, A. 1973. Taxonomy of "*Perityle*" section "*Laphamia*" (Compositae-Helenieae-Peritylinae). SIDA, Contributions to Botany 5:61–128.

Powell, D., and H. Klieforth. 1991. Weather and climate. Pages 3–26 *in* C. Hall Jr., editor. Natural history of the White-Inyo Range, Eastern California. University of California Press, Berkeley, CA, USA.

PRISM Climate Group. 2022. PRISM Climate Group, Oregon State University. Available from: https://prism.oregonstate.edu (Accessed: 8 December 2022).

Rathcke, B., and E. Jules. 1993. Habitat fragmentation and plant-pollinator interactions. Current Science 65:273–277.

Riba, M., M. Mayol, B. Giles, O. Ronce, E. Imbert, M. van der Velde, S. Chauvet, L. Ericson, R. Bijlsma, B. Vosman, M. Smulders, and I. Olivieri. 2009. Darwin's wind hypothesis: does it work for plant dispersal in fragmented habitats? New Phytologist 183:667–677.

Rimer, R., and R. Evans. 2006. Invasion of downy brome (*Bromus tectorum* L.) causes rapid changes in the nitrogen cycle. American Midland Naturalist 156:252–258.

Rolland, C. 2003. Spatial and seasonal variations of air temperature lapse rates in alpine regions. Journal of Climate 16:1032–1046.

Rosan, M. 2019. Cerro Gordo Mine and surrounding mine areas. Available from: http://www.owensvalleyhistory.com/stories/Max Rosan01_Cerro Gordo Handout_COMPRESSED.pdf (Accessed: 12 September 2022).

Rose, M., S. Velazco, H. Regan, and J. Franklin. 2022. Rarity, geography, and plant exposure to global change in the California Floristic Province. Global Ecology and Biogeography 1–15.

Scheffers, B., L. de Meester, T. Bridge, A. Hoffmann, J. Pandolfi, R. Corlett, S. Butchart, P. Pearce-Kelly, K. Kovacs, D. Dudgeon, M. Pacifici, C. Rondinini, W. Foden, T. Martin, C. Mora, D. Bickford, and J. Watson. 2016. The broad footprint of climate change from genes to biomes to people. Science 354:aaf7671.

Schenk, J. J. 2013. Evolution of limited seed dispersal ability on gypsum islands. American Journal of Botany 100:1811–1822.

Shaffer, M. 1981. Minimum population sizes for species conservation. BioScience 31:131–134.

Shaffer, M. 1987. Minimum viable populations: coping with uncertainty. Pages 69–86 *in* M. Soule, editor. Viable populations for conservation. Cambridge University Press, Cambridge.

Sheldon, J., and F. Burrows. 1973. The dispersal effectiveness of the achene-pappus units of selected compositae in steady winds with convection. New Phytologist 72:665–675.

Shumway, G., L. Vredenburgh, and R. Hartill. 1980. Desert fever: an overview of mining history of the California Desert Conservation Area.

Sierra Club. 2021. Blog: DRECP draft amendment opens up areas of critical concern. Available from: https://www.sierraclub.org/toiyabe/range-light/blog/2021/02/drecp-draft-amendment-opens-areas-critical-concerns (Accessed: 12 December 2022).

Snyder, M., and L. Sloan. 2005. Transient future climate over the Western United States using a regional climate model. Earth Interactions 9(11):1–21.

Soil Survey Staff. 2022. Web Soil Survey. Natural Resources Conservation Service, U.S. Department of Agriculture. Available from: http://websoilsurvey.sc.egov.usda.gov (Accessed: 17 November 2022).

Solbrig, O. 1982. Plant Adaptations. Pages 419-432 *in* G. Bender, editor. Reference handbook on the deserts of North America. Greenwood Press.

Staude, I., L. Navarro, and H. Pereira. 2020. Range size predicts the risk of local extinction from habitat loss. Global Ecology and Biogeography 29:16–25.

Stitt, R. 2020. K2 Gold Corp. (TSXV: KTO) - Canadian gold junior exploring next to gold giants. Available from: https://www.baystreet.ca/articles/research_reports/Couloir/KTO-113020.PDF (Accessed: 18 November 2022).

Stone, P., G. Dunne, J. Conrad, B. Swanson, C. Stevens, and Z. Valin. 2004. Geologic map of the Cerro Gordo Peak 7.5’ Quadrangle, Inyo County, California: U.S. Geological Survey Scientific Investigations Map 2851, scale 1:24,000, 1 sheet, includes 16 p. pamphlet.

Stone, P., B. Swanson, C. Stevens, G. Dunne, and S. Priest. 2009. Geologic map of the southern Inyo Mountains and vicinity, Inyo County, California (ver. 1.1, September, 2014): U.S. Geological Survey Scientific Investigations Map 3094, scale 1:24,000, 1 sheet, includes 22 p. pamphlet.

Suggitt, A., R. Wilson, N. Isaac, C. Beale, A. Auffret, T. August, J. Bennie, H. Crick, S. Duffield, R. Fox, J. Hopkins, N. Macgregor, M. Morecroft, K. Walker, and I. Maclean. 2018. Extinction risk from climate change is reduced by microclimatic buffering. Nature Climate Change 8:713–717.

Symons, C. 2018. Decision record for environmental assessment, DOI-BLM-CA-D050-2017-0037-EA. Bureau of Land Management, Ridgecrest Field Office.

Symons, C. 2022. Letter to Mojave Precious Metals, Inc. regarding determination by BLM that an environmental impact statement will need to be prepared after review of plan of operations modification. Bureau of Land Management, Ridgecrest Field Office.

Thomas, K. 2002. Vegetation - central Mojave Desert (ds166). Available from: http://bios.dfg.ca.gov (Accessed: 14 March 2022).

Thomas, K., T. Keeler-Wolf, J. Franklin, and P. Stine. 2004. Mojave Desert ecosystem program: Central Mojave vegetation database. Sacramento, CA, USA.

Thuiller, W., S. Lavorel, and M. Araújo. 2005. Niche properties and geographical extent as predictors of species sensitivity to climate change. Global Ecology and Biogeography 14:347–357.

Tinker, R., and C. Riganti. 2023. National drought summary for January 10, 2023. U.S. Drought Monitor. Available from: https://droughtmonitor.unl.edu/Summary.aspx (Accessed: 13 January 2023).

UCIPM, (University of California Integrated Pest Management). 2023. California Weather Database: Owens Lake North climate station (Owens_Lake_North.A, CIMIS #183). Available from: http://ipm.ucanr.edu/calludt.cgi/WXSTATIONDATA?STN=Owens_Lake_North.A. (Accessed: 4 January 2023).

USFWS, (United States Fish and Wildlife Service). 1975. Threatened or endangered fauna or flora; review of status of over 3000 vascular plants and determination of “critical habitat.” Federal Register 40:27824–27924.

USFWS, (United States Fish and Wildlife Service). 1980. Endangered and threatened wildlife and plants; review of plant taxa for listing as endangered or threatened species. Federal Register 45:82480–82569.

USFWS, (United States Fish and Wildlife Service). 1985. Endangered and threatened wildlife and plants; review of plant taxa for listing as endangered or threatened species. Federal Register 50:39526–39584.

USFWS, (United States Fish and Wildlife Service). 1990. Endangered and threatened wildlife and plants; review of plant taxa for listing as endangered or threatened species. Federal Register 55:6184–6229.

USFWS, (United States Fish and Wildlife Service). 1993a. Endangered and threatened species; policy on candidate categories relative to petition findings. Federal Register 58:28034–28035.

USFWS, (United States Fish and Wildlife Service). 1993b. Endangered and threatened wildlife and plants; review of plant taxa for listing as endangered or threatened species. Federal Register 58:51144–51190.

USFWS, (United States Fish and Wildlife Service). 1996. Endangered and threatened wildlife and plants; review of plant and animal taxa that are candidates for listing as endangered or threatened species. Federal Register 61:7596–7613.

USFWS, (United States Fish and Wildlife Service). 2023. Endangered and threatened wildlife and plants; 90-day findings for 4 species. Federal Register 88:16933–16937.

USGS, (United States Geological Survey). 2018. USGS National Hydrography Dataset Plus High Resolution (NHDPlus HR) for 4-digit Hydrologic Unit-1809. Available from: https://www.usgs.gov/national-hydrography/access-national-hydrography-products (Accessed: 28 December 2022).

Vitousek, P. 1990. Biological invasions and ecosystem processes: towards an integration of population biology and ecosystem studies. Oikos 57:7–13.

Warren, R., J. Price, A. Fischlin, S. de la Nava Santos, and G. Midgley. 2011. Increasing impacts of climate change upon ecosystems with increasing global mean temperature rise. Climatic Change 106:141–177.

Whisenant, S. 1990. Changing fire frequencies on Idaho's Snake River Plains: ecological and management implications. Pages 4–10 *in* E. McArthur, E. Romney, S. Smith, and P. Tueller, editors. Proceedings-Symposium on cheatgrass invasion, shrub die-off, and other aspects of shrub biology and management. General Technical Report INT-GTR-276. United States Department of Agriculture, Forest Service, Ogden, UT, USA.

Wiens, J. 2016. Climate-related local extinctions are already widespread among plant and animal species. PLOS Biology 14:1–18.

Wilcove, D., D. Rothstein, J. Dubow, A. Phillips, and E. Losos. 1998. Quantifying threats to imperiled species in the United States. Bioscience 48:607–615.

Williams, A., B. Cook, and J. Smerdon. 2022. Rapid intensification of the emerging Southwestern North American megadrought in 2020–2021. Nature Climate Change 12:232–234.

Yarborough, S., and A. Powell. 2006. *Perityle*. In Flora of North America Editorial Committee, eds. 1993+. Flora of North America North of Mexico. 20+ vols. New York and Oxford. Vol. 3, pp. 317-323. Available from: http://www.efloras.org/florataxon.aspx?flora_id=1&taxon_id=250067325 (Accessed: 22 November 2022).

Young, J., and R. Evans. 1973. Downy brome- intruder in the plant succession of big sagebrush communities in the Great Basin. Journal of Range Management 26:410–415.

Zurbuchen, A., L. Landert, J. Klaiber, A. Müller, S. Hein, and S. Dorn. 2010. Maximum foraging ranges in solitary bees: only few individuals have the capability to cover long foraging distances. Biological Conservation 143:669–676.

Personal Communication

Birker, Cheryl. 2022. Email message regarding seed collection information for *Laphamia inyoensis* from the California Botanic Garden.

Carson, Sean. 2022a. Email message regarding seed collection information for *Laphamia inyoensis* from the Santa Barbara Botanic Garden.

Carson, Sean. 2022b. Email messages regarding additional information on Inyo rock daisy at CNDDB occurrence #7.

Jesus, Maria. 2022. Email messages with additional information on Inyo rock daisy.

Lichter-Marck, Isaac. 2022. Email messages clarifying Inyo rock daisy survey details and putative hybrid information.

Lynch, Emma. 2023. Excel table of comments on the Inyo rock daisy status review.

Porter, Randall. 2022. Phone conversation regarding Mojave Precious Metals proposed project at Conglomerate Mesa and status of the Santa Rosa Mine at Malpais Mesa.

Wiegmann, Max. 2022. Email message clarifying status of Mojave Precious Metals proposed project at Conglomerate Mesa.

APPENDIX A. SUMMARY OF INYO ROCK DAISY OCCURRENCES

CNDDB occurrences of Inyo rock daisy as of March 2023 (CNDDB 2023)

CNDDB EO number*	Number of subpopulations/ polygons**	Population sizes reported***	CNDDB occurrence rank	First Seen	Last Seen
1	6	100+ in 1996 Unknown number in 2018 5 in 2019 6 in 2020 221 in 2021	Excellent	1957	2021
2	2	80 in 1996 Unknown number in 2018	Good	1940	2018
3	1	100+ in 2022	Good	1939	2022
4	2	Unknown number in or prior to 1979 Unknown number in 2018	Unknown	Prior to 1979	2018
5	1	<100 in 1994 18 in 1996	Excellent	1994	1996
6	3	<100 in 1994 50 in 1996 Unknown number in 2011 Unknown number in 2013 Unknown number in 2018	Good	1986	2018
7	2	35 in 1996 127-167 in 2022	Excellent	1996	2022
8 (Includes former occurrence #10)	4	Unknown number in 2011 60+ in 2018	Excellent	2011	2018
9	4	73+ in 2017 91 in 2020	Good	2017	2020
11	5	Unknown number in 2014 Unknown number in 2016 3+ in 2018 Unknown number in 2019	Good	2014	2019
12	3	24+ in 2018	Unknown	2018	2018

CNDDB EO number*	Number of subpopulations/ polygons**	Population sizes reported***	CNDDB occurrence rank	First Seen	Last Seen
13 (includes former occurrences #14, #15, & #26)	25	512+ in 2018 56+ in 2019 12 in 2020 680+ in 2022	Good	2018	2022
16	5	500+ in 2018 ~116 in 2019	Good	2018	2019
17	1	Unknown number in 2018 50 in 2019.	Fair	2018	2019
18	1	Few in 2018	Unknown	2018	2018
19	5	Unknown number in 2014 Unknown number in 2016 37 in 2017 64 in 2020	Fair	2014	2020
20	1	60 in 2020	Good	2020	2020
21	1	3 in 2020	Fair	2020	2020
22	1	Unknown number in 2018	Excellent	2018	2018
23	4	Unknown number in 2014 Unknown number in 2016 40 in 2019	Good	2014	2019
24	2	Unknown number in 2018 Unknown number in 2019	Good	2018	2019
25	7	13 in 2019 485+ in 2020	Excellent	2019	2020
27	2	58 in 2019	Good	2019	2019
28	1	Unknown number in 2020	Unknown	1964	2020
29	2	Unknown number in 2018 <50 in 2019	Good	2018	2019
30	1	~30 in 2022	Good	2022	2022
31	1	30 in 2022	Good	2022	2022

CNDDB EO number*	Number of subpopulations/ polygons**	Population sizes reported***	CNDDB occurrence rank	First Seen	Last Seen
32	1	~12 in 2018	Unknown	2018	2018

*CNDDB occurrence numbers are assigned in sequential order. As more information becomes available, occurrences are sometimes merged giving the appearance of skipped occurrence numbers. Occurrences that have been merged are noted in this column in parentheses.

**Number of subpopulations/polygons in the CNDDB is a result of mapping methodology (not a reflection of biologically significant populations). However, for Inyo rock daisy, occurrences with more subpopulations/polygons generally extend over larger distances.

***Most population estimates are for portions of a given occurrence and do not reflect exhaustive survey efforts.

APPENDIX B. COMMENTS FROM AFFECTED AND INTERESTED PARTIES ON THE PETITIONED ACTION

APPENDIX C. COMMENTS FROM PEER REVIEWERS ON THE INYO ROCK DAISY STATUS REVIEW REPORT