Jemez Mountains salamander
(Plethodon neomexicanus)
5-Year Status Review:
Summary and Evaluation

U.S. Fish and Wildlife Service
New Mexico Ecological Services Field Office
Albuquerque, New Mexico
August 30, 2024

5-YEAR REVIEW
Jemez Mountains salamander (*Plethodon neomexicanus*)

1.0 GENERAL INFORMATION

1.1 Reviewers:

Lead Regional or Headquarters Office:
Janess Vartanian, Recovery Biologist, Recovery and Restoration, Ecological Services

Lead Field Office:
Clinton P. Smith, Fish and Wildlife Biologist, Aquatic and Terrestrial Ecosystem Conservation Branch, New Mexico Ecological Services Field Office (505) 761-4743

1.2 Purpose of 5-Year Reviews:

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

1.3 Methodology used to complete the review:

In accordance with section 4(c)(2) of the Endangered Species Act of 1973, as amended (ESA), the purpose of a 5-year review is to assess each threatened species and endangered species to determine whether its status has changed and it should be classified differently or removed from the List of Threatened and Endangered Wildlife and Plants. The USFWS evaluated the biology and status of the Jemez Mountains salamander as part of a draft Species Status Assessment (SSA: in review) and announced this status review through a Federal Register notice (88 FR 1602), published on January 11, 2023. During the 90-day comment period of the Federal Register notice, new information about species' biology, habitat conditions, conservation measures implemented, threats, and trends was solicited from Federal and State agencies, tribes, nongovernmental organizations, academia, and the general public. This review was informed through the public review notification, a comprehensive review of documents regarding the Jemez Mountains salamander available to the USFWS's New Mexico Ecological Services Field Office (NMESFO), and

information and analyses in the draft SSA. The primary sources of information used in this analysis were the 2010 12-month finding (75 FR 54822), 2013 final listing rule (78 FR 55600), 2013 designated critical habitat final rule (78 FR 69569), and peer reviewed scientific publications, published and unpublished reports, and information and communications from other qualified biologists or experts utilized within the draft SSA.

Development of the draft SSA was guided by the SSA Core Team. The SSA Core Team is comprised of species experts from state and federal agencies, including the State of New Mexico; the United States Forest Service (Forest Service); and the National Park Service (Park Service), and species experts who actively work with the Jemez Mountains salamander. That team reviewed the SSA report before we used it as the scientific basis to support our 5-year review. The draft SSA represents our evaluation of the best available scientific information, including the resource needs and the current and future condition of the species.

1.4 Background:

1.4.1 FR Notice citation announcing initiation of this review:

88 FR 1602, Endangered and Threatened Wildlife and Plants; Initiation of 5-Year Status Reviews of 31 Species in the Southwest, January 11, 2023:

84 FR 36113, Endangered and Threatened Wildlife and Plants; Initiation of 5-Year Status Reviews of 36 Species in Arizona, New Mexico, Texas, Utah, and Mexico, July 26, 2019.

1.4.2 Listing history:

Original Listing
FR notice: 78 FR 55600
Date listed: September 10, 2013
Entity listed: species, Jemez Mountains salamander
Classification: Endangered

Revised Listing, if applicable
FR notice: N/A
Date listed: N/A
Entity listed: N/A
Classification: N/A

1.4.3 Associated Rulemakings:

78 FR 69569, Endangered and Threatened Wildlife and Plants; Designation of Critical Habitat for the Jemez Mountains Salamander, November 20, 2013

1.4.4 Review History:

This is the first 5-year review for this species since the species was listed in 2013.

1.4.5 Species' Recovery Priority Number at start of 5-year review:

The Recovery Priority Number was not assigned prior to this 5-year review, it is discussed below under Section 3.0.

1.4.6 Recovery Plan or Outline

Name of plan or outline: N/A
Date issued: N/A
Dates of previous plans/amendment or outline, if applicable: N/A

2.0 REVIEW ANALYSIS

Section 4 of the ESA (16 U.S.C. 1533) and its implementing regulations (50 CFR part 424) set forth the procedures for determining whether a species meets the definition of "endangered species" or "threatened species." The ESA defines an "endangered species" as a species that is "in danger of extinction throughout all or a significant portion of its range," and a "threatened species" as a species that is "likely to become an endangered species within the foreseeable future throughout all or a significant portion of its range." The ESA requires that we determine whether a species meets the definition of "endangered species" or "threatened species" due to any of the five factors described below.

Section 4(a) of the ESA describes five factors that may lead to endangered or threatened status for a species. These include: A) the present or threatened destruction, modification, or curtailment of its habitat or range; B) overutilization for commercial, recreational, scientific, or educational purposes; C) disease or predation; D) the inadequacy of existing regulatory mechanisms; or E) other natural or manmade factors affecting its continued existence.

The identification of any threat(s) does not necessarily mean that the species meets the statutory definition of an "endangered species" or a "threatened species." In assessing whether a species meets either definition, we must evaluate all identified threats by considering the expected response of the species, and the effects of the threats—in light of those actions and conditions that will ameliorate the threats—on an individual, population, and species level. We evaluate each threat and its expected effects on the species, then analyze the cumulative effect of all of the threats on the species as a whole. We also consider the cumulative effect of the threats in light of those actions and conditions that will have positive effects on the species—such as any existing regulatory mechanisms or conservation efforts. The Service recommends whether the species meets the definition of an "endangered species" or a "threatened species" only after conducting this cumulative analysis and describing the expected effect on the species now and in the foreseeable future.

2.1 Distinct Population Segment (DPS) policy (1996):

The ESA defines "species" as including any subspecies of fish or wildlife or plant, and any distinct population segment of any species of vertebrate wildlife. This definition limits

listing Distinct Population Segments (DPS) to only vertebrate species of fish and wildlife. The Jemez Mountains salamander is a vertebrate species; however it is not listed as a DPS under the ESA.

2.2 Updated Information and Current Species Status

2.2.1 Biology and Habitat

2.2.1.1 New information on the species' biology and life history:

The 2013 listing rule contains the most accurate information on the behavior, reproduction, feeding, and movement of the Jemez Mountains salamander. Recent research is in agreement with the information in the 2013 listing rule. Since the listing rule, research has shown that physical characteristics can be used to determine sex of individuals (Karraker et al. 2023, pp. 206-207).

2.2.1.2 Abundance, population trends (e.g. increasing, decreasing, stable), demographic features (e.g., age structure, sex ratio, birth rate, seed set, germination rate, age at mortality, mortality rate, etc.), or demographic trends:

Jemez Mountains salamander surveys have been sporadically conducted over the years since the species was first described by science in 1950, and survey methodologies have varied over time. Historical survey data (prior to 1987) was collected via a mix of observational and visual methods without a set protocol or data standard. More recent survey data (1987 to present) are collected using set protocols. In the 2013 listing rule we stated "*available data and qualitative observations of salamanders at surveyed sites during wet environmental conditions indicate that salamanders are now more difficult to find during most surveys than they were 20 years ago and earlier, and the number of areas with surveys resulting in no salamander detections is increasing*". This statement remains true to date. Although survey methods varied and survey effort prior to 1987 is not known, assessment of the raw data, by decade, suggests that salamander densities may have declined over time (Figure 1).

Since the 2013 listing rule, numbers of salamanders found within the known range have not remained lower below historic levels. In 1970, 659 individual salamanders were collected outside the Valles Caldera National Preserve (Preserve) at one location in Sandoval County, and 394 of the 659 were collected in a single month (Williams 1976, p. 26). In 2005, the maximum number of salamanders captured range-wide was 68. Since 2018, one researcher has been working exclusively with the salamander and most salamander detections have occurred in historically occupied documented locations (Table 1). The total number of salamanders documented across all locations for the 2023 season was 9 individuals (Karraker 2024).

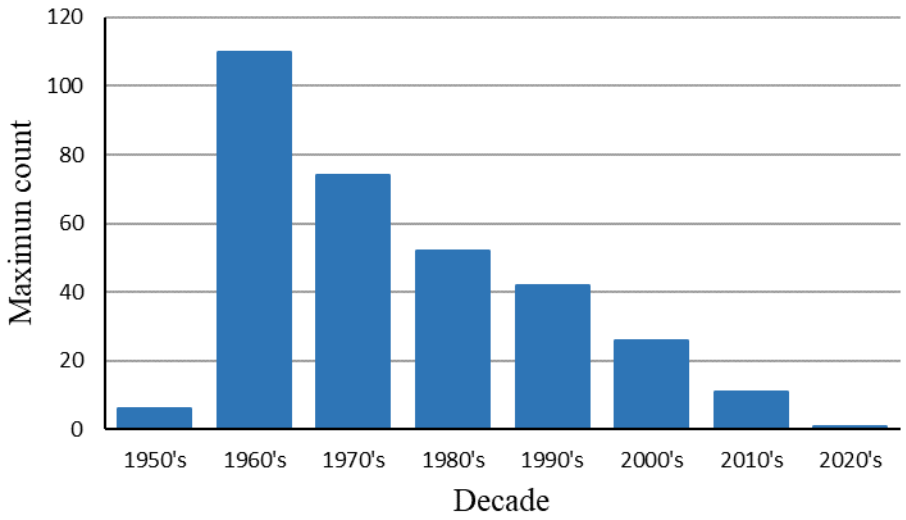

Figure 1. Maximum number of Jemez Mountains salamanders detected at a single location during a survey by decade. Note: Although the species was known, attempts to locate the salamander prior to the 1960s were few.

For Table 1 below, presence or absence surveys have been used when attempting to determine whether an area is occupied. Following this protocol, surveys cease after 2 ‘‘person hours’’ of effort (e.g., one person searching for 2 hours or two people searching for 1 hour, etc.) or when the first salamander is observed, whichever comes first. If a salamander is detected before the 2 person hours are complete, then observers will typically complete the survey after taking biological measurements on salamanders. Additionally, the USFWS is working with our partners to obtain recent survey information for detection and non-detection surveys. Effort in Table 1 is estimated based on current detection and non-detection survey data held by New Mexico Heritage Program.

Table 1. Number of Jemez Mountains salamander detections since the species was federally listed in 2013. Detections are typically from federally owned lands in the Jemez Mountains in Los Alamos, Rio Arriba, and Sandoval counties, New Mexico. Note: Survey effort person hours for the 2023 season are not yet available.

Year	No. salamanders detected	Survey effort person hours
2013	22	176
2014	20	88
2015	7	52
2016	11	34
2017	6	22

2018	7	96
2019	25	90
2020	32	100
2021	40	89
2022	32	160
2023	9	NA

Due to the lack of systematic surveys across the species range and the difficulty of species detection, we do not have the data to accurately assess the current abundance, population trend, or demographic trends (i.e., distribution) for the species. Therefore, in the draft SSA we describe current distribution and recruitment based on Jemez Mountains salamander detections documented within the past 14 years (which is the estimated lifespan of the species) or through direct observation and inference. We assume that a single detection of a salamander over the 14 year time span, detection of multiple adults, or detection of a juvenile (adult and juvenile salamanders can be differentiated through morphological assessment of snout-to-vent length during surveys) conveys our best understanding of where the species may occur today. We infer recruitment is occurring in two ways. First, we assume that if multiple adult salamanders are located close together in space and time that it is possible for them to interact and breed. Second, if an area with historical detection(s) also includes a detection within the last 15 years, this documents persistence over time and indicates recruitment is occurring. We used the maximum distance a Jemez Mountains salamander has been documented moving of 43.9 m (144 ft) (Ramotnik 1988, p. 28) to buffer salamander detections and identify where buffered salamander detections overlapped in ArcGIS Pro 2.9.4. These areas of overlap and direct observations of juvenile salamanders are defined as "locations" for the purposes of evaluating recruitment in the SSA. Additionally, we acknowledge that salamanders may not persist in all locations or may be present in unsurveyed areas.

For the draft SSA, we used historical and recent survey data in combination with subsurface geology information associated with GPS location data (2000-2021) to identify an analysis area consisting of units and subunits that contain suitable salamander habitat (Figure 2). Areas within the outer bound of the identified analysis area that extended below 2103 m (6900 ft), which are below the elevational threshold for Jemez Mountains salamanders, or included Tribal lands were subsequently removed. We divided the identified analysis area into five Geographic Units (Figure 2), using features identified as likely barriers to salamander movement (i.e., perennial waterways, then roads (from most to least improved)). The Units are large in comparison to the species dispersal

capabilities and thus may capture genetic or ecological variability across the species' range. The Units were further divided into subunits using features identified as likely barriers to salamander movement on a smaller scale (i.e, perennial waterways, roads (from most to least improved), intermittent or ephemeral stream segments upstream of perennial reaches, and topography such as ridges and valleys). Use of these features resulted in the designation of 34 subunits, six or seven subunits in each Unit (Figure 2).

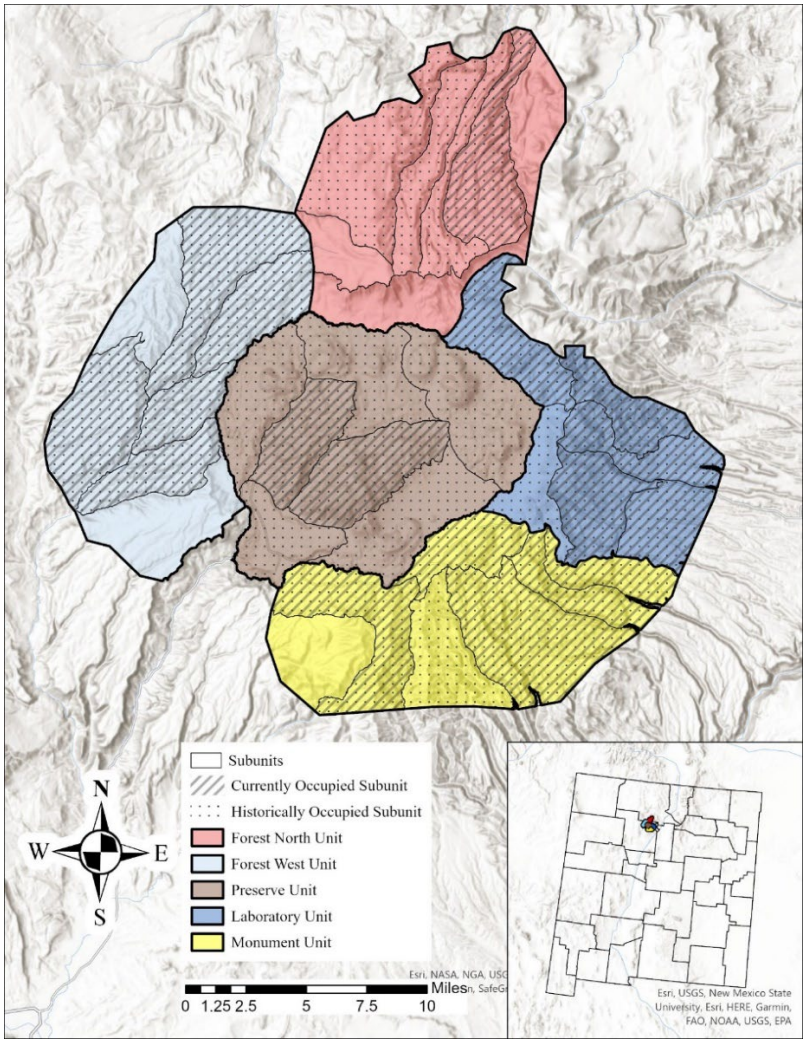

Figure 2. Jemez Mountains salamander subunits and current distribution (using detection information from 2008 to 2022).

2.2.1.3 Genetics, genetic variation, or trends in genetic variation (e.g., loss of genetic variation, genetic drift, inbreeding, etc.):

The 2013 listing rule contains the most accurate information on genetic studies of plethodontid salamanders in North America which was used for taxonomic classification of the Jemez Mountains salamander. Specific information on Jemez Mountains salamander historical or current genetic diversity is lacking.

However, information suggestive of density and the distribution of areas with recruitment can provide insight into potential changes in genetic diversity over time.

During the SSA we determined that salamanders have only been reliably detected in the same locations within three subunits (Forest West 2 and 7; and Preserve 3) since 2018. These subunits, within two of five Geographic Units (Forest West and Preserve), are considered species strongholds or hot spots with reliable recruitment. Although survey effort has varied over time, evaluation of historical and current salamander detections during survey efforts suggests that salamander densities and their distribution have decreased over time (see section 2.2.1.2, above). Such declines have likely resulted in the loss of genetic diversity.

2.2.1.4 Taxonomic classification or changes in nomenclature:

The taxonomic classification of the Jemez Mountains salamander has not changed since it was redescribed in 1950 (Stebbins and Riemer 1950, p. 73). The species was originally described as *Spelerpes* (*Eurycea*) *multiplicate* in 1913 (Degenhardt et al. 1996)

2.2.1.5 Spatial distribution, trends in spatial distribution (e.g. increasingly fragmented, increased numbers of corridors, pollinator availability, etc.), or historic range (e.g. corrections to the historical range, change in distribution of the species' within its historic range, etc.):

Since the salamander was listed it has not been found outside the range included in the 2013 listing rule. In 2021, we mapped the historical range of the salamander using historical salamander survey data (from 1950s – 2022), aspect, slope, percent tree canopy cover, depth to bedrock, and average annual precipitation (from 1981 – 2010; Figure 3). As described in section 2.2.1.2 above, survey effort has varied overtime. The USFWS does not have access to the majority of the field notes for data prior to 1987 and search effort associated with these data are unknown. However, given the declines in density described in section 2.2.1.2 above and the amount of habitat impacted from wildfires described in section 2.2.2.1 below, we assume that range contractions have likely occurred. Salamanders may be unable to persist in historically poor quality habitats, especially near the edge of the salamander's range and at lower elevations in historically Ponderosa pine (*Pinus ponderosa*) or dry-mixed conifer dominated habitat. Warming climates, droughts, and high severity wildfires have also impacted salamander habitat (especially at lower elevation), contributing to declines. If additional information can be obtained from historical field notes and environmental data, then statistical analyses may be possible and can provide a better understanding of range contraction and declines.

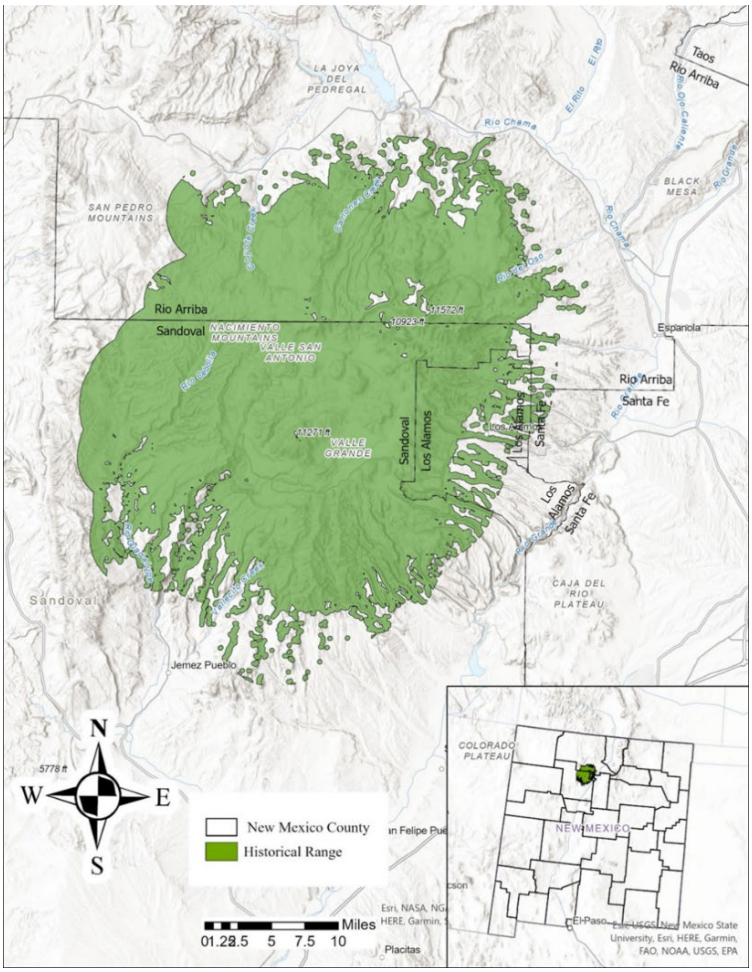

Figure 3. Historical range of the federally endangered Jemez Mountains salamander as determined from historical salamander survey data (1950 to 2022), aspect, slope, percent tree canopy cover, depth to bedrock, and average annual precipitation (from 1981 – 2010) in Los Alamos, Rio Arriba, and Sandoval counties, New Mexico.

2.2.1.6 Habitat or ecosystem conditions (e.g., amount, distribution, and suitability of the habitat or ecosystem):

Since the salamander was listed there have been multiple wildfires in the Jemez Mountains which has reduced the amount of available above ground habitat needed by the species. Since 2013, approximately 28,328 hectares (ha) (70,000 acres (ac)) within the species historical range has been impacted by wildfires. Section 2.2.2.1 below discusses wildfires in more detail. The percent of each subunit burned by moderate to high severity wildfire and direct impacts of wildfire to areas where salamanders have been detected in the last 14 years was assessed in the draft SSA. Currently 12 of 34 subunits have greater than 40% of the subunit's area burned by moderate to high severity fire, of this burned area between 20 and 70% was potentially impacted by high severity fire. Further, moderate to high severity fire may have impacted up to 90% of areas with

salamander detections over the last 14 years. Moderate to high severity wildfires have not impacted 8 of 34 subunits suggesting a higher risk of these subunits being impacted by these types of wildfires in the future (Service 2024, pp. 28-32).

In the draft SSA we analyzed remotely sensed macro habitat variables to evaluate the amount of favorable habitat compared to potential habitat (favorable, moderately favorable, and less favorable salamander habitat). Favorable habitat is thought to have the highest probability of containing on-the-ground conditions necessary for Jemez Mountains salamander to breed, feed, and shelter. The other two habitat types may also contain the conditions necessary for salamanders but to a lesser extent. Analyses in the SSA suggest that currently, most subunits within the species range are primarily comprised of lower quality salamander habitat. Currently at least 20% of potential habitat is ranked as favorable habitat in 6 of 34 subunits. Four subunits have between 15 and 20% favorable habitat and 24 subunits contain less than 15% favorable habitat (Service 2024, pp. 28-32).

2.2.1.7 Other:

From 2015 to present, the Park Service has set up and run four instrumented study sites to assess subsoil temperature, and moisture regimes and dynamics on the Preserve. These sites look at micro-habitat conditions mentioned previously in existing log and “non-log” features, such as subsoil temperature, and moisture regimes. In addition, a meteorological (weather) station was installed at each log to record atmospheric temperature, relative humidity, rainfall, wind speed and direction, and total solar radiation. Information obtained from these sites will help with upcoming thinning management on the Preserve. In 2019, the Park Service initiated a study to assess suitability of slash and woody piles as habitat for the salamander based on microenvironment conditions and whether these conditions are influenced by pile structure and fuel characteristics (Trader 2021, entire). The study continues but preliminary results of this study have led to improved fuels management considerations.

The New Mexico Department of Game and Fish (NMDGF), Forest Service, and Park Service have worked and continue to work with the USFWS and academic researchers on a variety of projects prior to and since the salamander was federally listed. These include monitoring of cover boards (periodically before and after the salamander was listed in 2013), assisting with a conservation canine survey (2013-2014), supporting/assisting with ongoing salamander occupancy surveys (from 2018 to present), permitting an artificial cover object study (Karraker 2018, entire), permitting a soil and litter dwelling micro-and mesofauna quantification study within different forest management treatments (Gibson *et al.* 2022, entire), installing temporary fencing to protect salamander cover objects from cattle trampling (2022), and permitting a fire management treatment study on salamander aboveground habitat (preliminary results

expected summer 2023). These projects have increased salamander detections throughout the range and helped improve our knowledge of survey techniques and how management practices impact salamanders, prey, and habitat.

Prior to the salamander's listing, federal and state partners participated in the New Mexico Endemic Salamander Working Group which was formed to provide information on issues affecting management and conservation of the Jemez Mountains salamander and the Sacramento Mountains salamander (*Aneides hardii*). Currently the working group meets annually and continues to provide information to federal, state, and academic partners on issues affecting management and conversation for both New Mexico endemic salamanders.

2.2.1.8 Conservation Measures:

Throughout the salamander's range, having a biologist on-site to conduct surveys is typically included for any ground disturbing activities. Above ground activities are typically limited to outside the monsoon season (from October – April, monsoon season typically occurs from May – September). Activities typically avoid moving or destroying salamander shelter objects (rocks, logs, and other woody debris). Decontamination protocols to prevent the spread of amphibian disease and fungus are required for equipment and personal gear.

2.2.2 Five-Factor Analysis (threats, conservation measures, and regulatory mechanisms):

2.2.2.1 Present or threatened destruction, modification or curtailment of its habitat or range:

The principal threats to Jemez Mountains salamander habitat in the 2013 listing rule included historical fire exclusion (the act of preventing fire), fire suppression (the act of putting out fire), and severe wildland fires (wildfire); forest composition and structure conversions; post-fire rehabilitation, forest and fire management; roads, trails, and habitat fragmentation; and recreation. The fire impacts are complex. Severe wildfires (those that burn hot, scorch soil, and remove all vegetation) pose a threat to the salamander and its habitat. Low-severity wildfire like prescribed fire or natural fires that burn in thinned forest, are usually beneficial to the salamander and its habitat due to the lack of soil scorching, lack of heat transfer into salamander underground refugia, and maintenance of canopy cover. Since the 2013 listing, the Forest Service and Park Service have been working with the USFWS to implement forest thinning and prescribed fire throughout the range of the Jemez Mountains salamander. These activities can help reduce impacts on salamander habitat from fire exclusion and fire suppression, and help address other threats including forest composition and structure conversion, post-fire rehabilitation, forest and fires management, and wildfire. In some cases, threats from roads, trails, habitat

fragmentation, and recreation have been reduced due to roads and trails being closed to the public.

Severe wildfires continue to be a principal threat to Jemez Mountains salamander habitat. Prior to the 2013 listing, the Jemez Mountains saw recent severe wildfires including the 2011 Las Conchas Fire that burned over 60,700 ha (150,000 ac) and the 2013 Thompson Ridge Fire that burned approximately 9,700 ha (24,000 ac). Since the 2013 listing, approximately 28,328 ha (70,000 ac) within the range of the Jemez Mountains salamander has burned (the recent Cero Pelado fire in 2022 accounted for over half this amount; Table 2). Wildfire data from the Forest Service and Park Service (2000-present) show that almost half of the range of the Jemez Mountains salamander has been impacted by one or more wildfires (Figure 4). Approximately 125,340 ha (309,724 ac or 54%) of the salamander's range has not been impacted by wildfire or habitat treatment to reduce wildfire risk (e.g. thinning, prescribed fire) over the last 20 years. This habitat is the most vulnerable to wildfire in the future but risk of high severity wildfires in this area likely varies across the landscape based on forest type and density. Modeling efforts can help us estimate the amount of above ground habitat impacted by wildfires, however, impacts to below ground habitat or direct impacts to salamanders from high intensity or severity wildfires are unknown to date.

Table 2. U.S. Forest Service and National Park Service wildfire information for the Jemez Mountains in Los Alamos, Rio Arriba, and Sandoval counties, New Mexico, from 2014 (after the Jemez Mountains salamander was federally listed) to 2022. Cumulative these 25 fires burned 70,229 acres.

Year	Fire Cause	Name	Acres
2014	Natural Ignition	Diego	3,615
2014	Natural Ignition	Bear Springs	26
2014	Natural Ignition	Pino	4,284
2016	Natural Ignition	Cuerno	699
2016	Natural Ignition	Virgin Mesa (Canyon)	96
2016	Natural Ignition	138	323
2016	Natural Ignition	Banco Bonito Cajete 3 & 5 North Big Hat	217
2016	Natural Ignition & Broadcast Burning	Virgin Mesa	1,276
2017	Natural Ignition	Deer Creek	1,022
2017	Natural Ignition	Borrego	11
2017	Human Ignition	Cajete	1,412
2017	Natural Ignition	Peggy	887
2017	Natural Ignition	Peggy WFU	887
2018	Natural Ignition	Chicoma	42
2018	Natural Ignition	Alamo	15

2018	Natural Ignition	Venado	4,063
2018	Natural Ignition	Bales (2)	14
2018	Natural Ignition	San Antonio (large)	412
2018	Natural Ignition	San Antonio (small)	5
2018	Natural Ignition	Hidden Valley	585
2018	Natural Ignition	Cabin	0
2018	Natural Ignition	Venado	2,945
2019	Natural Ignition	Conejos	777
2019	Natural Ignition	Naranjo	1,010
2022	Human Ignition	Cerro Pelado	45,605

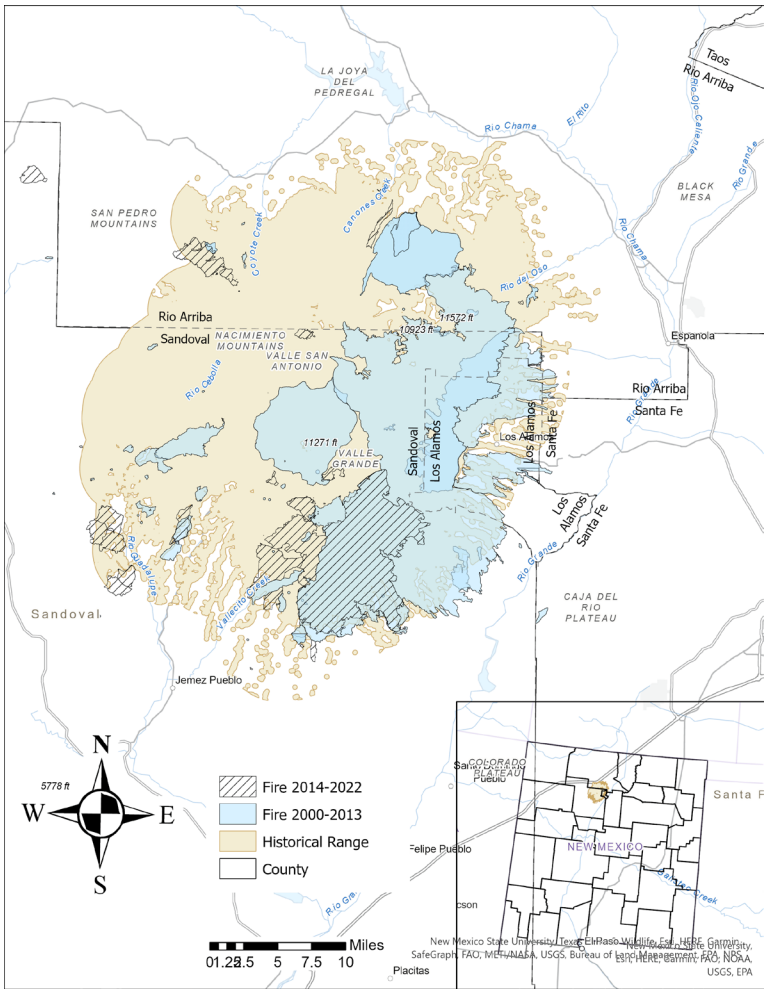

Figure 4. Historical range of the federally endangered Jemez Mountains salamander showing wildfire information (from Forest Service and National Park Service data) from the year 2000 to 2022 for the Jemez Mountains in Los Alamos, Rio Arriba, and Sandoval counties, New Mexico.

2.2.2.2 Overutilization for commercial, recreational, scientific, or educational purposes:

Before the salamander was listed in 2013, nearly 1,000 individuals were collected for scientific or educational purposes (Service 2013, p. 55620). Most of the collected salamanders occurred in 1970, when 659 individuals were collected outside the Preserve at one location in Sandoval County (394 of the 659 were collected in a single month; Williams 1976, p. 26). Recent surveys in this area have not yielded salamander detections. This collection effort and others that captured more than a few individuals are concerning since the number of salamanders observed during recent surveys is far less than numbers observed in historical surveys (see section 2.2.1.2 above). Since 2013, salamander collections have not been permitted and illegal collection is not considered to be a significant threat.

2.2.2.3 Disease or predation:

Refer back to the 2013 listing rule for predation information as no new information is known at this time. Jemez Mountains salamanders found during occupancy surveys are swabbed for pathogens including *Batrachochytrium salamandrivorans* and *B. dendrobatidis* (Bd). Positive detections have occurred in 2003, 2010 (Service 2013, p. 55620), 2012, and 2017 (Pierce 2022, entire). Subsequent sampling through 2022 has not resulted in additional Bd positive individuals, however some recently collected swabs still need to be tested. Detection of Bd in the Jemez Mountains salamander indicates the species has been exposed to the pathogen and could acquire infection. It is unknown how susceptible the salamander is to chytridiomycosis, or how the Bd positive salamanders encountered the fungus.

2.2.2.4 Inadequacy of existing regulatory mechanisms:

Inadequacy of existing regulatory mechanisms is not considered a threat for the salamander. The salamander was federally listed as endangered under the ESA by the Service in 2013 (Service 2013a, p. 55600). Additionally, it was reclassified by the State of New Mexico from threatened to endangered in 2005 (NMDGF 2005, p. 2) and there has been no change in the state classification status since (NMDGF 2022, p. 71). Refer back to the 2013 listing rule for additional state regulatory information. A total of 90,716 hectares (36,711 acres) of critical habitat within two units was designated for the salamander in 2013 (Service 2013b, p. 69569).

2.2.2.5 Other natural or manmade factors affecting its continued existence:

The southwestern United States has been and is expected to get hotter and drier into the future (Seager et al. 2007, entire; Gonzalez et al. 2018, pp. 1108-1114),

which may have profound effects on the amount, permanency, and quality of habitat for Jemez Mountains salamanders. Changes in amount or type of winter precipitation may affect snowpack levels which in turn would affect the amount of subsurface moisture. Low or no snowpack levels would jeopardize the amount and reliability of subsurface precipitation for the rest of the year, which would likely lead to an increase in aboveground and subsurface temperatures to unsuitable levels for the salamander.

The southwestern United States is currently experiencing long-term drought and the trend is predicted to continue, and the impacts are observable and likely to worsen. From 2000 to 2020, average temperatures in northern New Mexico have differed from the long-term average by an increase of approximately -17 degrees Celsius (°C; approximately 1.4 to 1.6 degrees Fahrenheit [°F]) and the region has been abnormally dry, experiencing increased moderate to severe drought conditions (EPA, entire accessed August 25, 2022). Drought conditions in and around the Jemez Mountains as of May 2023 are categorized as abnormally dry and/or moderate drought, which represent low to mid-level categories describing drought intensity with conditions being worse over the past year (National Oceanic and Atmospheric Administration 2023, entire); consequences of which may have profound effects on the amount, permanency, and quality of habitat for Jemez Mountains salamanders as well as contributing to conditions to the spread of wildfires.

Climate simulations of the Palmer Drought Severity Index (a calculation of the cumulative effects of precipitation and temperature on surface moisture balance) for the southwest for the periods of 2006–2030 and 2035–2060 predict an increase in drought severity with surface warming. Additionally, drought still increases during wetter simulations because of the effect of heat-related moisture loss (Hoerling and Eicheid 2007, p. 2). Annual average precipitation is likely to decrease in the southwest as well as the length of snow season and snow depth (Hicke et al. 2022, pp. 1953-1954). Most models project a widespread decrease in snow depth in the Rocky Mountains and earlier snowmelt (Hicke et al. 2022, pp. 1952-1954 and 1971). Changes in amount or type of winter precipitation may affect snowpack levels which in turn would affect the amount of subsurface moisture. Low or no snowpack levels would jeopardize the amount and reliability of subsurface moisture for the rest of the year, which would likely lead to an increase in aboveground and subsurface temperatures to unsuitable levels for the salamander. Additionally, since the salamander spends the majority of its time underground, it’s likely that low or no snowpack levels would provide less insulation for subsurface salamanders resulting in the need for salamanders to travel deeper underground (which may result in salamanders using more stored fat).

Exactly how climate change will affect precipitation is less certain, because precipitation predictions are based on continental-scale general circulation models that do not yet account for land use and land cover change effects on

climate or regional phenomena. Consistent with recent observations in climate changes, the outlook presented for the southwest and New Mexico predict warmer, drier, drought-like conditions (Hoerling and Eischeid 2007, p. 2; Seager et al. 2007, p. 1181). Climate change predictions do suggest overall warming temperatures throughout North America under all greenhouse gas emission scenarios (IPCC 2021, p. 14; 2022, p. 8). Rising temperatures are expected to increase evaporation and make microclimate conditions (humidity levels at soil surface and underground) less suitable for salamanders. If warmer temperatures are not counter-balanced by increased precipitation, the species would face increased drought-like conditions. Increases in drought frequency and intensity may increase habitat conversion (Garfin et al. 2014, p. 465), which may lead to a decrease in the extent of suitable habitat for salamanders.

Climate change may also increase precipitation events such as flooding and runoff, which may result in less ground infiltration. Climate models are projecting an increase in frequency of heavy downpours and some even show an increase in daily extreme summer precipitation (Gonzalez et al. 2018, p. 1110), although projection of summer total precipitation are uncertain (as stated previously). Drought has also caused earlier spring snowmelt and shifted runoff to earlier in the year. The southwestern U.S. has seen less late-winter precipitation falling as snow, snowmelts occurring earlier, and earlier arrival of most of the year's streamflow within the past 50 years (Pierce et al. 2008, entire; Hidalgo et al. 2009, entire; Garfin et al. 2014, p. 465; Gonzalez et al. 2018, p. 1109). Gonzalez et al. 2018 (p. 1110) states that "climate models also project an increase in daily extreme summer precipitation in the southwest region" but "projections of summer total precipitation are uncertain". Warmer winter temperatures in the Sierra Nevada are projected to increase winter runoff (Gonzalez et al. 2018, p. 1121) and similar impacts in the Jemez Mountains which could mean less ground infiltration during winter and drier subsurface conditions in the summer. Changes in precipitation, snowmelt, and runoff may impact how far underground salamanders travel or when they come aboveground.

Drought affects salamander physiology, behavior, and population viability; thus, drought will likely affect the Jemez Mountains salamander. Trends in climate change and drought conditions have contributed to temperature increases in the Jemez Mountains, with a corresponding decrease in precipitation. Because the salamander is terrestrial, constrained in range, and isolated to the higher elevations of the Jemez Mountains, increased ambient temperatures and reduced moisture could alter microclimate conditions such that they become insufficient for salamander movement or survival resulting in loss of cover objects or habitat loss at local or broader scales potentially impacting the range via elevation or aspect.

2.3 Synthesis

The Jemez Mountains salamander is a rare, terrestrial plethodontid salamander that's only found in the high elevations (2,140-2,900 meters [7,021-9,514 feet]; Regan 1972, p.487) of the Jemez Mountains in the north central counties of Los Alamos, Rio Arriba, and Sandoval counties, New Mexico. The salamander is typically active aboveground from mid-June through mid-September, during the monsoon season in New Mexico. Critical habitat was designated in 2013. Due to inconsistent survey efforts over the years, population size estimates using existing data cannot be made accurately. In the 2013 listing rule we stated, "*available data and qualitative observations of salamanders at surveyed sites during wet environmental conditions indicate that salamanders are now more difficult to find during most surveys than they were 20 years ago and earlier, and the number of areas with surveys resulting in no salamander detections is increasing*". This statement remains true to date; however, federal, state, and academic partners are continuing to conduct surveys for the salamander within its range. We used this survey information to talk about distribution and recruitment in this review and with regards to the 34 subunits discussed in the draft SSA but continued survey effort has not yielded increased detections. Recent survey efforts have failed to detect salamander numbers similar to historical survey effort (see section 2.2.1.2 above). In addition, several subunits have been impacted by moderate to high severity fires and climate change, which has led to reductions in favorable habitat for the salamander in most subunits. At least 8 subunits are at higher risk of being impacted by high severity large-scale wildfires in the future. Current overall resiliency condition of Jemez Mountains salamander subunits suggests that most of the species current range (23 of 34 subunits) is in a low or very low condition (Figure 5). Of 11 subunits in moderate or high overall condition, 2 are in high and 9 are in moderate overall condition (Figure 5); 3 of which have reliable salamander detections since 2018. Six are not known to be currently occupied by salamanders (Service 2024, pp. 31-35). There are 8 subunits in high or moderate recruitment condition. Four of these subunits have poor habitat conditions indicating that salamanders in these 4 subunits are at risk if additional habitat degradation or loss occurs and 26 of 34 subunits have low or very low recruitment condition. Therefore, we consider current redundancy to be poor for the Jemez Mountains salamander (Service 2024, p. 34). Although survey effort has varied over time, evaluation of historical and current salamander detections during survey efforts suggests that salamander densities and their distribution have decreased over time (see section 2.2.1.5, above). Such declines have likely resulted in the loss of genetic diversity and suggest that genetic representation is poor for the Jemez Mountains salamander (Service 2024, p. 36). Although we expect to find additional salamanders with increased survey effort, the species remains highly vulnerable to catastrophic wildfires that are increasing in frequency and have been larger and more severe than historically documented (Steel et al. 2015, pp. 12-15).

Climate change effects suggest that habitat for this salamander may become less suitable over time through increasing drought, rising temperatures, and altered precipitation patterns. Rising temperatures and continued drought could render existing habitat too arid for salamander persistence in some areas and altered precipitation patterns could impact the duration or timing of monsoons necessary for breeding and feeding (see section 2.2.2.5 above). Additionally, wildfire continues to be a primary threat to the species and remaining salamander habitat is at risk of catastrophic wildfires. Because this species only occurs in the high elevations of the Jemez Mountains where it could easily be extirpated by biological or environmental threats and based on the continued impacts from principal threats (including wildfire and climate change), the species meets the definition of "endangered" and we recommend that the Jemez Mountains salamander remain listed as endangered.

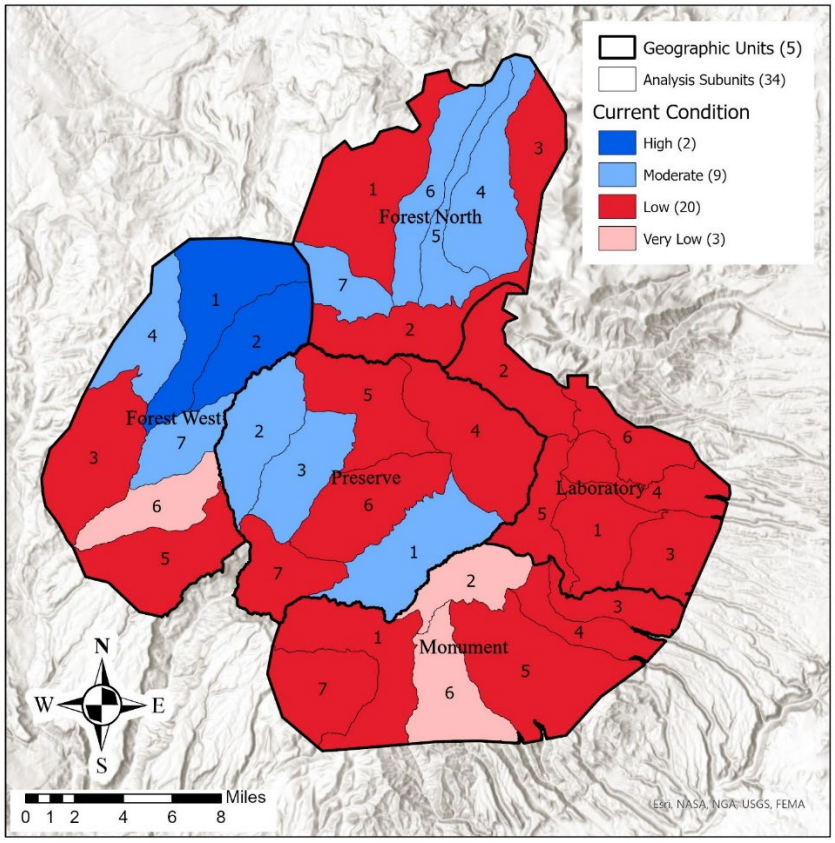

Figure 5. Overall resiliency condition of Jemez Mountains salamander subunits within the range of the species in the Jemez Mountains in northern New Mexico based on favorable habitat, recruitment, and wildfire condition categories discussed above and in the SSA.

3.0 RESULTS

3.1 Recommended Classification:

No change needed

3.2 New Recovery Priority Number (indicate if no change; see 48 FR 43098):

5

Brief Rationale:

A recovery priority number of 5 indicates a high degree of threat and low recovery potential. A species with a high degree of threat means extinction is almost certain in the immediate future because of a rapid population decline or habitat destruction. We believe this species has a high degree of threat because of the impacts of wildfire and drought on suitable habitat and lack of recent captures at historical locations. Additionally, threats including disease (see section 2.2.2.3 above) and climate change (see sections 2.2.2.5 and 2.3 above) may continue to severely impact the species or its habitat. Because this species is restricted to this one mountain range and based on climate change effects, the potential for range expansion or population replication is limited. Additional studies are needed on the biological and ecological factors for this species.

3.3 Listing and Reclassification Priority Number, if reclassification is recommended (see 48 FR 43098):

Reclassification (from Threatened to Endangered) Priority Number: N/A
Reclassification (from Endangered to Threatened) Priority Number: N/A
Delisting (Removal from list regardless of current classification) Priority Number: N/A

Brief Rationale:

N/A

4.0 RECOMMENDATIONS FOR FUTURE ACTIONS

When possible, given workloads, use the draft SSA to inform development of a Recovery Plan.

Expand research on underground activities. The Jemez Mountains salamander spends the majority of the year underground (from mid-September through mid-June) outside the monsoon season. Increased research during the "underground activity" time could help increase biological and ecological knowledge for the species.

Continue work with federal, state, tribal, academic, and private partners to address threats to the species across the range. Known and potential threats include wildfire, forest management, grazing, drought, and climate change impacts on salamander habitat.

Continue to monitor for pathogens including *Batrachochytrium salamandrivorans* and *B. dendrobatidis*.

Work with federal, state, tribal, academic, private partners, and other experts to determine if captive refugium populations are feasible.

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U.S. FISH AND WILDLIFE SERVICE

5-YEAR REVIEW **Jemez Mountains salamander (*Plethodon neomexicanus*)**

Current Classification: Endangered

Recommendation resulting from the 5-Year Review:

No change needed

Appropriate Listing/Reclassification Priority Number, if applicable: N/A

FIELD OFFICE APPROVAL:

Lead Field Supervisor, Fish and Wildlife Service, **New Mexico Ecological Services Field Office**

Approve SHAWN SARTORIUS Digitally signed by SHAWN SARTORIUS Date: 2024.08.30 12:33:10 -06'00'