Russell, Daniel <daniel_russell@fws.gov>

Re: Request for Peer Review - Panamint Alligator Lizard

Adam Clause <adamclause@gmail.com> Sun, Dec 17, 2017 at 10:13 PM
To: "Russell, Daniel" <daniel_russell@fws.gov>
Cc: Deborah Giglio <Deborah_Giglio@fws.gov>, Gjon Hazard <gjon_hazard@fws.gov>

Dear Mr. Russell,

I hope this message finds you well. Please accept my apology for my late response, but I have now completed my review of the 2017 Draft Species Status Assessment for the Panamint Alligator Lizard. Attached is my marked-up version, with all changes tracked. Per your instructions, I am also attaching my CV and my Conflict of Interest form. Lastly, I am attaching two literature sources that I reference in my review.

If you have any questions or concerns about my edits to the SSA, please don't hesitate to reach out. In closing, allow me to commend you on your superb work in assembling this highly detailed, thorough, and accurate SSA. I am impressed with the quality of this document. As you'll see, my comments and suggested changes are generally very minor, and mostly involve clarifications about what can be considered a reasonable inference from the limited available data.

Best wishes for a peaceful Holiday season. Sincerely,

Adam

10 attachments

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U.S. Fish & Wildlife Service

Draft

Species Status Assessment Report

Panamint Alligator Lizard (*Elgaria panamintina*)

External Peer and Partner Review

November 2017

Please Do Not Cite or Distribute

Cover Photos

Top: Adult male (left) and adult female (right) Panamint alligator lizards photographed in upper Silver Canyon, White Mountains, California by permitted biologist Adam G. Clause. The photo illustrates some of the color variation in the Panamint alligator lizard, including tail re-growth. However, it does not illustrate sexual dichromatism; many females have coloration similar to the male shown in this photo, and vice versa. (Photo © A.G. Clause, used with permission)

Bottom: Talus rockpile and arroyo willow (*Salix lasiolepis*) riparian vegetation in upper Piute Creek, White Mountains, California. This locality illustrates a classic duality of occupied Panamint alligator lizard habitat: expansive, poorly vegetated rockpiles and dense riparian thickets. (Photo © A.G. Clause, used with permission)

Comment [a1]: Very flattered that you chose to use these photos! Thank you.

Recommended Citation

U.S. Fish and Wildlife Service. 2017. Species status assessment report for the Panamint alligator lizard (*Elgaria panamintina*). November 2017. U.S. Fish and Wildlife Service, Pacific Southwest Region, Sacramento, California.

Acknowledgements

This document was prepared by Gjon Hazard with contributions and assistance from Deborah Giglio, Bradd Bridges, Erin Nordin, ___XXX___.

The U.S. Fish and Wildlife Service provided funding to Professor H. Bradley Shaffer and his Ph.D. candidate student Erin Toffelmier of University of California, Los Angeles, to do a genomic study of the Panamint alligator lizard. We thank them for providing expedited preliminary results to help inform this Species Status Assessment Report.

We appreciate the helpful comments provided by peer and partner reviewers, who included ___XXX____.

Adam G. Clause generously shared his photographs and other information.

EXECUTIVE SUMMARY

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1.0 INTRODUCTION

We, the U.S. Fish and Wildlife Service (Service or USFWS), are reviewing the status of the Panamint alligator lizard (*Elgaria panamintina*) in response to a petition to list the species under the Endangered Species Act of 1973, as amended (Act). As part of this process, we are using an integrated and conservation-focused analytical approach, the Species Status Assessment, to assess the species' biological status for the purpose of informing our decision under the Act. The initial product of this process is this document, the Species Status Assessment (SSA) Report. As envisioned by our guidance document, the Species Status Assessment Framework (USFWS 2016, entire), an SSA begins with a compilation of the best available information on the species (taxonomy, life history, and habitat) and its ecological needs at the individual, population, and/or species levels based on how environmental factors are understood to act on the species and its habitat. Next, an SSA Report describes the current condition of the species' habitat and demographics, and the probable explanations for past and ongoing changes in abundance and distribution within the species' ecological settings (that is, areas representative of geographic, genetic, or life history variation across the range of the species). Lastly, an SSA forecasts the species' response to probable future scenarios of environmental conditions and conservation efforts. Overall, an SSA Report uses the conservation biology principles of resiliency, redundancy, and representation (collectively known as the "3Rs") as a lens through which we can evaluate the current and future condition of the species. As a result, the SSA Report characterizes a species' ability to sustain populations in the wild over time based on the best scientific understanding of current and future abundance and distribution within the species' ecological settings.

An SSA Report is, in essence, a summary of the available information about a species and, simultaneously, a biological risk assessment to aid decision makers who must use the best available scientific information to make policy-guided decisions. The SSA Report provides decision makers with a scientifically rigorous characterization of the species' biological and conservation status, focusing on the likelihood of whether the species will sustain populations within its ecological settings while also explicitly acknowledging uncertainties in that characterization. The SSA Report does not result in a decision directly, but it provides the best available scientific information for comparison to policy standards to guide decisions under the Act.

Previous Federal Actions under the Act

We identified the Panamint alligator lizard (under the scientific name *Elgaria panamintinus* (*sic*)) as a Category 2 candidate species in our September 18, 1985, Review of Vertebrate Wildlife (USFWS 1985, entire). Category 2 candidates were defined as species for which we had information that proposed listing was possibly appropriate, but conclusive data on biological vulnerability and threats were not available to support a proposed rule at the time. The species remained a Category 2 candidate in subsequent annual candidate notices of review (CNOR) (USFWS 1989, entire; USFWS 1991, entire (under the scientific name *E. panamintina* and thenceforth); and USFWS 1994, entire). In the February 28, 1996, CNOR (USFWS 1996a, entire), we discontinued the designation of Category 2 species as candidates (the practice of which was finalized in a separate final rule (USFWS 1996b, entire)); at that point, the Panamint alligator lizard was no longer a candidate species.

On July 11, 2012, we received a petition dated July 11, 2012, from the Center for Biological Diversity (CBD 2012, entire), requesting that 53 species of amphibians and reptiles, including the Panamint alligator lizard, be listed as endangered or threatened and that critical habitat be designated for those species under the Act. On September 18, 2015, we published a finding affirming that the petition presented substantial scientific or commercial information indicating that the petitioned action may be warranted for the Panamint alligator lizard (USFWS 2015a, p. 56428). This conclusion was based on information in the available literature suggesting that there may be threats to the species from (1) present or threatened destruction, modification, or curtailment of the species' habitat or range from mining, off-highway vehicle activity, grazing, and introduction of invasive plant species; and (2) overutilization (illegal collecting) for commercial uses (USFWS 2015b, entire). As part of that finding, we solicited information from governmental agencies, Native American Tribes, the scientific community, industry, and any other interested parties on various aspects of the species' biology; any potential threats to the species, including possible effects from climate change; any past and ongoing conservation measures; and any information that may help us designate critical habitat for the species, should we determine that listing the species is warranted and that designating critical habitat for the species is prudent and determinable.

2.0 METHODOLOGY

This document draws scientific information from resources such as primary peer-reviewed literature, reports submitted to the Service and other public agencies, species occurrence information in GIS databases, and expert experience and observations. It is preceded by and draws upon analyses presented in other Service documents including the 90-day finding (USFWS 2015a, entire). Finally, we coordinated closely with our partners engaged in ongoing research and conservation efforts. This assures consideration of the most current scientific and conservation status information.

Comment [a2]: Yes, excellent.

Analytical Framework

The SSA analytical framework is designed for assessing a species' biological condition and level of viability. Building on the best of our current analytical processes and the latest in conservation biology, this framework integrates analyses that are common to all Act functions, eliminates duplicative and costly processes, and allows us to strategically focus on our core mission of preventing extinction and achieving recovery. The document is temporally structured, generally walking the reader through what is known from past data, how data inform current species' status, and what potential changes to this status may occur in the future based on data and models. The future condition analysis includes the potential conditions that the species or its habitat may face and discusses the most probable scenario if those conditions come to fruition. This most probable scenario includes consideration of the sources most likely to impact the species at the population or rangewide scales in the future, including potential cumulative impacts.

For the purpose of this assessment, we generally define viability as the ability for a species to sustain populations in the natural ecosystem up through and beyond a biologically meaningful timeframe, in this case, 50 years. We chose 50 years because that is long enough to capture the temporal range of the available climate model projections; however, beyond that timeframe, the level of uncertainty becomes overwhelming, making prognostications of the future unrealistic.

Using the SSA Framework (Figure 1), we consider what the species needs to maintain viability by characterizing the status of the species in terms of resiliency, redundancy, and representation (Wolf *et al.* 2015, entire).

We begin an SSA by describing the species' life history, and from that evaluate the species' resource needs or biological requirements at the scales of individuals, populations, and the species-as-a-whole using the principles of redundancy, representation, and resiliency. In general, these three concepts (or analogous ones) apply at the population-level and species-level, and are explained that way below for simplicity and clarity as we introduce them. Throughout the rest of the document we will use "resiliency" as a population-level term, and "redundancy" and "representation" as species-level terms to avoid confusion.

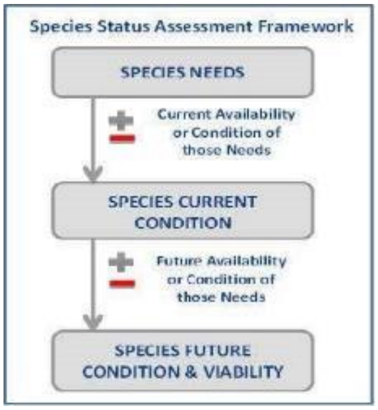

Figure 1. *The step-wise process for assessing a species' status, as envisioned by the Service's SSA Framework (USFWS 2016, entire).*

- *Redundancy* is the number of individuals in a population (population size), or number of populations in a species' range. It spreads risk among multiple individuals or populations to minimize the potential loss of the population or species from catastrophic events.

- *Representation* has two components, genetic and environmental. It is defined by the amount of genetic and habitat diversity within a population and its distribution or among populations within the species' range. There must be enough genetic diversity remaining to avoid inbreeding depression and maintain micro (population level) or macro (species level) habitats to provide refugia during extreme environmental events. To maintain representation at either level, conservation should occur within the array of environments in which a population or species occurs, or within areas of significant geographic, genetic, or life history variation.

- *Resiliency* depends on representation and redundancy. It is the capacity of a population or species (hereafter called "species viability") to withstand stochastic disturbance events, that is, to rebound from relatively extreme numerical lows (individuals or populations).

Using the SSA framework, we consider what the species needs to maintain viability by characterizing the status of the species in terms of its resiliency, redundancy, and representation.

3.0 SPECIES' DESCRIPTION AND TAXONOMY

The Panamint alligator lizard (*Elgaria panamintina*) (Figure 2) is a secretive~~, endemic~~ species ~~limited to a~~known only from a remote region in eastern California. Growing to be about 6 inches (in.) (15 centimeters (cm)) long from snout to vent (Stebbins and McGinnis 2012, p. 330), they can have a tail that may extend ~~up to~~ to nearly twice that length ~~(Stebbins and McGinnis 2012, p. 330~~ (Banta *et al.* 1996, p. 629.1)~~)~~. Dorsally, they range in color from beige to brown and have 7 to 8 darker cross bands; ventrally, they are whitish with gray splotches (Mahrdt and

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Figure 2. *A young adult male Panamint alligator lizard, White Mountains, California.*

Beam~~mn~~an 2009, p. 488).

Taxonomy

The Panamint alligator lizard is a member of the reptilian family Anguidae, which includes alligator lizards and legless lizards. First discovered in ~~the mid-~~1954~~0s~~, Stebbins (1958, entire) described *Gerrhontus panamintinus* as a new species based on type specimens from the Panamint Mountains, Inyo County. Prior to and after Stebbins' publication, the taxonomy of alligator lizards and their close allies was unstable. Good (1985, pp. 70 and 76) reorganized the western North American *Gerrhontus* species, recognizing them as members of the genus *Elgaria*. This included the Panamint alligator lizard, consequently changing the specific epithet of that taxon to *panamintina* to match the gender of the "new" genus. Since then, the nomenclature of *E. panamintina* has been stable in the literature (Clause *et al.* 2015, 6th page (unpaginated)). No subspecies have been described (Banta *et al.* 1996, p. 629.1).

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While the species-level nomenclature of *Elgaria panamintina* has been constant for several decades, the taxonomic relationships among the alligator lizards continue to be a subject of research. Based on several separate analyses of different molecular datasets, authors have come to differing conclusions about the relationship of *E. panamintina* to other alligator lizard species. Briefly, Good (1988, entire) concluded *E. panamintina* was closely related to the Madrean alligator lizard, *E. kingii*, of the sky islands of the Sonoran Desert, while Macey *et al.* (1999, entire), Feldman and Spicer (2006, entire), and Pyron *et al.* (2013, entire) concluded that *E. panamintina* was more closely related to the southern alligator lizard, *E. multicarinata*, which occurs in the Pacific states and whose range is geographically closest to *E. panamintina*. However, the conclusions of the latter three studies do not wholly agree on the taxonomic status of the populations comprising *E. multicarinata*, with Feldman and Spicer (2006, p. 2208) even suggesting that *E. panamintina* is nested within *E. multicarinata*. This does not necessarily indicate that the ~~taxonomic status of~~validity of *E. panamintina* as a species is doubtful; instead, it suggests that the alligator lizard populations that comprise what has traditionally been recognized as *E. multicarinata* may actually constitute more than one species. This interpretation is further supported by morphological evidence in a separate study (Telemeco 2014, p. 44–45).

Recently, Leavitt *et al.* (2017, entire) published a more in-depth genetic assessment of the genus *Elgaria,* using samples of both nuclear and mitochondrial DNA. They confirmed and elaborated on the earlier findings on the relationship of *E. panamintina* with other species in the genus. Their results separated *Elgaria multicarinata* into a northern clade and a southern clade (again suggesting *E. multicarinata* is actually two species), with *E. panamintina* forming a third clade related to both *E. multicarinata* clades (that is, the three entities appear to be derived from a common ancestor). Looking at the current ranges of the three "species"—*E. panamintina, "E. multicarinata* North," and "*E. multicarinata* South"—*E. panamintina* and *E. multicarinata* South are geographically closest (Leavitt *et al.* (2017, p. 112), with *E. multicarinata* South occurring only a few miles to the west (Mahrdt and Beaman 2009, p. 489). Interestingly, Leavitt *et al.* (2017) also found that the *E. panamintina* clade alternately clustered with the *E. multicarinata* North clade and the *E. multicarinata* South clade, depending on the type of DNA (nuclear vs. mitochondrial) being analyzed. This pattern suggested to the authors that *E. panamintina* diverged from the *E. multicarinata* North clade at some point in the very distant past (millions of years ago, during the Pliocene), but then, at some subsequent point (tens- to hundreds-of-thousands of years ago, during the Pleistocene), there was contact and hybridization with the *E. multicarinata* South clade (Leavitt *et al.* 2017, p. 114). Despite ~~apparent~~ evidence suggesting past hybridization, Leavitt *et al.* (2017, entire) recognized *E. panamintina* as diagnosable from other *Elgaria* species, including *E. multicarinata* (*sensu lato*).

Comment [a3]: My suggested replacement language here is based on trying to better account for uncertainty in the data, and reflects language used by Leavitt et al. (2017).

Morafka *et al.* (2001, 4th page (unpaginated)) noted that some *Elgaria panamintina* in the White Mountains (and only that mountain range) (see the Panamint Alligator Lizard Range section below) had some phenotypic characteristics that resembled *E. multicarinata*; they speculated that there could be some hybridization there, which they characterized as "limited." It is unclear whether this hypothesized hybridization event is at all related to the evidence for hybridization found by Leavitt *et al.* (2017, entire), although we infer from the limited information provided by Morafka *et al.* (2001, 4th and 8th pages (unpaginated)) that the purported hybridization was the result of a more recent or on-going event. Additionally, Stebbins (1958, p. 9–10) noted that an *E. multicarinata* specimen from the north side of the San Bernardino Mountains (a location some 130 miles (210 kilometers) south of the Panamint alligator lizard's range) had phenotypic characteristics suggestive of *E. panamintina* and occurred in a desert area similar to the areas where *E. panamintina* occurs. This caused Leavitt *et al.* (2017, p. 113) to speculate whether it could be from a population that could be displaying characteristics indicative of past hybridization. More information is needed to determine the extent to which hybridization has occurred in the past and whether there is any hybridization occurring currently between *E. panamintina* and *E. multicarinata*, and the potential taxonomic implications thereof.

Comment [a4]: Excellent concluding sentence.

Additionally, as the preparation of this SSA Report was nearing completion, Toffelmier and Shaffer (2017, entire) provided preliminary results from a recent population-level genomics study on *Elgaria panamintina*. While the information available at the time this SSA Report was prepared provides no information as to the relationship of *E. panamintina* to any other *Elgaria* species, the results showed reduced genetic exchange across the species' range. Specifically, at the genetic level, *E. panamintina* is arranged across the landscape in multiple groupings where the amount of gene flow is, in most cases, much greater within a given group than the amount of gene flow is between the other groups (Toffelmier and Shaffer 2017, 6th page (unpaginated) and Figure 8 therein). In general, these groups fairly closely align with the mountain ranges where the species occurs (for more details, see the Biogeography section, below). Moreover, these preliminary data suggest that the amount of genetic differentiation across the species' range is substantial, potentially foreshadowing taxonomic implications in the future (when there are more data); however, the available information from this study does not address the species' taxonomic status. More research is needed, but at this point, we are recognizing *Elgaria panamintina* as a diagnosable taxon at the species level.

4.0 BIOGEOGRAPHY

Panamint Alligator Lizard Range

The overall geographical extent of where the Panamint alligator lizard occurs is not well known, but it does appear to be geographically limited (Figure 3). The species is currently known to occur in ~~and around~~ the White, Inyo, Nelson, Coso, Argus, and Panamint mountain ranges in Mono and Inyo Counties, in eastern California (Cunningham and Emmerich 2001, Appendix 4 (unpaginated); Mahrdt and Beaman 2009,

Comment [a5]: I am unaware of any localities that are not objectively nestled within these named mountain ranges, so I suggest that the language "and around" be deleted from this sentence.

Figure 3. *Overview of the Panamint alligator lizard's range.*

p. 490; Clause *et al.* 2015, 3rd page (unpaginated)); however, the precise geographical limits of the species' range is unclear. Although seemingly ~~apparently~~ suitable habitat occurs in Nevada, in the northern continuation of the White Mountains and elsewhere, no Panamint alligator lizards have been found in that State (Banta 1965, p. 7; NDOW 2013, p. 141; Clause *et al.* 2015, 3rd page (unpaginated); NDOW 2017 *in litt.*).

Given the limited information, the available literature portrays the Panamint alligator lizard's range fairly generally and not entirely consistently, at least with respect to the peripheral boundary. One source that is more explicit is the California Wildlife Habitat Relationships (CWHR) System (CWHR 2014, entire). Although inherently limited to California, it appears to capture ~~most~~ nearly all of the detection sites known to us (Figure 4). However, it also includes the Last Chance Range east of the Eureka Valley. We are not aware of any Panamint alligator lizard detections ~~sites~~ in that mountain range at this time. Additionally, we are not aware of any Panamint alligator lizards ~~occurring~~ detections in the Cottonwood Mountains (the northern extension of the Panamint Range) or the Saline Range (Figure 4), but these mountains (unlike the Last Chance Range) have direct connections with mountain ranges where the species is known to occur.

Comment [a6]: A few comments on Figure 4, which also apply to subsequent figures based on that dataset. First, the point that is mapped for Barrel Springs (located just the east of the first "L" in "Owens Valley") is incorrect. The correct coordinates for this locality, which I have personally visited several times, are: 36.89°, -118.08° (datum: WGS 84). If mapped using these corrected coordinates, the point for Barrel Springs will shift NE such that it lies completely within, not outside, the CWHR boundary line. Second, in late November I received information from a collaborator (Chris Norment, professor at the University of Brockport) documenting a new locality for PAL. This new locality is the north fork of Union Wash, coordinates 36.714°, -118.002° (WGS 84). A photo voucher confirms that the lizard observed by Dr. Norment is, indeed, a PAL. This photo voucher, and all accompanying data, have been deposited at the Natural History Museum of Los Angeles County, under photo voucher reference number LACM PC 2351. Please add this new locality to Figure 4 and the subsequent figures.

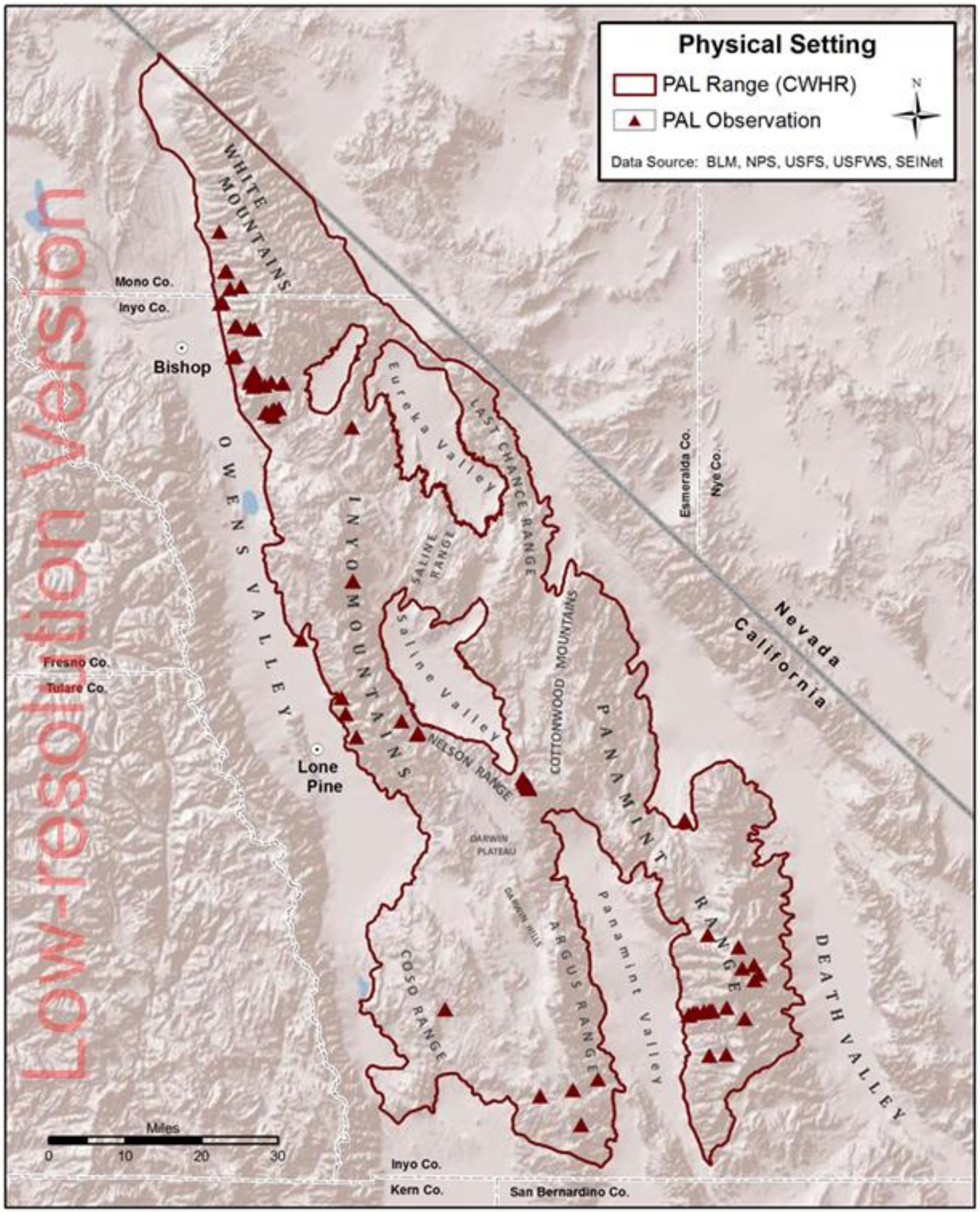

Figure 4. *Range of the Panamint alligator lizard (PAL) in the context of its physical setting. The range is based on the California Wildlife Habitats Relationships System (see text). The depicted observation sites are for general reference only; the precision and accuracy of the available detection site data are variable (see the Panamint Alligator Lizard Distribution section).*

Another investigator estimated the species' range using an ecological niche model (MaxEnt) (Yasuda 2015, p. 38, Figure 4 therein). It appears to capture known detection sites and aligns fairly well with the CWHR range, including the White, Inyo, Saline, Nelson, Coso, Argus, and Panamint ranges. However, this model also suggested that favorable conditions for Panamint alligator lizards extend farther to the northwest than indicated by the CWHR map or by currently known detections. Specifically, Yasuda's model suggested the areas southeast of Mono Lake, including in and around the Benton Range and the Adobe Hills, as areas with potential for Panamint alligator lizard to occur. In this area, Yasuda's model does not agree with known detection sites; it is unclear whether the model over-estimated the species' range or whether current detection data are incomplete. Yasuda's model also suggested that there is low probability for Panamint alligator lizards to occur in the Last Chance Range, which is in agreement with existing detection data but not with the CWHR range. Likewise, Yasuda's model suggested that there is higher probability for Panamint alligator lizards to occur in the Cottonwood Mountains and Saline Range, which is in agreement with the CWHR range; however, we have no detection data in those mountains.

Wright *et al.* (2013, p. 234) produced another ecological niche model for the species, although this product, like the CWHR polygon, is also geographically restricted to California and does not consider potential habitat areas in Nevada. The Wright *et al.* (2013) model depicts a much broader potential range than Yasuda's model, including areas well beyond any known or otherwise anticipated occurrence. While the limited number of Panamint alligator lizard detections makes it is difficult to state with certainty, the Wright *et al.* (2013, p. 234) model nevertheless appears to substantially over-predict the potential range of the species. This suggests that readers should heed the authors' caution (Wright *et al.* 2013, p. 13) when interpreting model results for species with limited data, which was the case for the Panamint alligator lizard (Wright *et al.* 2013, p. 28).

For the purposes of this SSA Report, we are defining the range of the Panamint alligator lizard, given the available information, as the area depicted by the CWHR System (Figure 4). However, we recognize that it might be overly inclusive in places, (especially in the Last Chance Range region), and overly exclusive in others (especially the northeastern White Mountains of Nevada). While this source is appealing, in part, because the range it depicts is a polygon with definitive boundaries, we also recognize that the precision in the boundaries it depicts may exceed the available information. In other words, interested parties working on-the-ground should not consider the CWHR range to be the immutable final word, but rather, it should be considered as a hypothesis for future research in refining the species' range.

To put the range of the Panamint alligator lizard in context of the seven species in the genus *Elgaria* (as currently recognized by most authors, but see Leavitt *et al.* (2017, entire)), the overall size of its range is relatively small. Three *Elgaria* species have large ranges, the northern alligator lizard (*E. coerulea*), the southern alligator lizard (*E. multicarinata* (*sensu lato*)), and the Madrean alligator lizard (*E. kingii*)). The remaining four species are endemics with small ranges, which includes the Panamint alligator lizard plus three species confined to the Baja California peninsula, Mexico (see Leavitt *et al.* (2017, p. 105)).

Comment [a7]: I think it is important to note that the CHWR could err on both sides of the spectrum (overpredicting and underpredicting), hence my suggested edit here. It is important to recognize that limiting the predicted range of PAL to the California side of the White Mountains, but not the Nevada side, is a completely arbitrary boundary that has no basis in biological reality. I say this not to criticize your use of the CWHR boundary (I think it is good, and justifiable). But rather, I merely want to emphasize that overprediction and underprediction are likely when using this boundary.

Comment [a8]: Yes, an excellent qualifying sentence.

In all, the overall range of the Panamint alligator lizard is ~~fairly~~ comparatively geographically limited and includes the above-listed mountain ranges, but more field surveys are needed to refine the boundaries of the species' current range. While acknowledging the limitations of the available data, there is little to suggest that the species' range is substantially larger than what is portrayed by most sources, nor do the available data suggest that the species' range has changed substantially over the past several hundred years.

Panamint Alligator Lizard Distribution

The geographical and seasonal ~~arrangement~~ distribution of the Panamint alligator lizard within its range is also poorly known. Extensive surveys are often needed to ~~adequately~~ confidently determine presence or absence of the Panamint alligator lizard (Cunningham and Emmerich 2001, p. 24; Clause 2015, 8th page (unpaginated)). Few rigorous surveys have been conducted. More common are detection data from anecdotal observations and from less rigorous surveys. Geographically, many of these efforts are haphazard in nature, while others reflect repeated efforts at sites known to have previous detections. The quality of the associated substantiating data ranges from voucher-supported records with detailed documentation to sight-only records ~~with modest or meager~~that lack independently verifiable documentation. Some records (both vouchered and un-vouchered) are also difficult to georeference, due to imprecise locality data and/or lack of GPS coordinates. As a result of thi~~se~~is variable data quality, some of the depicted points in the figures may not be accurate at fine scales, but they are suitable for conveying larger-scale patterns of occurrence for the species.

In all, the sites where Panamint alligator lizards have been detected are geographically scattered across the species' range (Figure 4). The species occurs ~~primarily~~ entirely in mountainous areas. Detection sites are well represented across ~~(in or near)~~ multiple canyons on the west slope of the White Mountains. There are fewer detections in the Inyo Mountains, where they are widely scattered, including one in the northeast extension of the Inyo Range. In the Nelson Range, the species has been detected at multiple sites in one canyon. There is only one detection in the Coso Range and a handful in the Argus Range. The species is well represented in the southern part of the Panamint Range (which is where the species was first discovered), but we are not aware of any detections in the northern Panamint Range (Cottonwood Mountains). Likewise, we have no observation data for the Saline Range or the Last Chance Range.

Comment [a9]: Again, my two edits to these two sentences reflect my understanding that all detections for PAL come from mountainous areas, based on my own personal knowledge and as reflected in your own Figure 4.

Clause *et al.* (2015, 3rd page (unpaginated)) reports that the elevational range of the species, as supported by vouchered museum specimens, is from about 3,450 feet (ft) (1,050 meters (m)) to about 7,650 ft (2,330 m). While there is little data to support the oft-reported lower elevation of 2,500 ft (760 m), it may not be unrealistic; Clause *et al.* (2015, 4th page (unpaginated)) noted that ~~apparently~~ seemingly suitable Panamint alligator lizard habitat extends down to about 2,300 ft (700 m) elevation in at least one location in the Panamint Mountains. Similarly, the upper elevation limit may be higher than currently known; at one locality in the White Mountains, seemingly suitable Panamint alligator lizard habitat extends up to about 8,200 ft (2,500 m) (Clause *et al.* 2015, 4th page (unpaginated)). With limited data of varying quality, it is difficult to firmly establish the species' geographic distribution or even the full breadth of its

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habitat associations. However, Panamint alligator lizards have been most often detected in or near areas of riparian vegetation, frequently with surface water (e.g., Stebbins 1958, p. 15; Macey and Papenfuss 1991, p. 303; Mahrdt and Beaman 2009, p. 489; Parker and Brito 2013, p. 70; Thomson *et al.* 2016, p. 205). Within the species' range, riparian vegetation is typically limited to narrow bands or small patches and is often (but not always) at or near the bottom of steep-sided canyons; these areas of riparian vegetation contrast sharply with the surrounding dry, sparsely vegetated landscape (Phillips-Brandt-Reddick 1983, p. 84; Spira 1991, p. 77). Areas with riparian vegetation are often associated with seeps or springs (including springbrooks) and are scarce in the region's desert landscape (Phillips-Brandt-Reddick 1983, p. 3; Pister 1991, p. 272; NPS 2002, p. 21) (see the Vegetation section, below, for more information).

The concept of the species' distribution has changed through time. Initially it was thought Panamint alligator lizards only occurred in or near the geographically restricted riparian areas, which was interpreted to mean that there was no population connectivity between canyons (Stebbins 1958, p. 10). However, later detections revealed that Panamint alligator lizards also occurred on talus slopes, sometimes near riparian areas, other times not (Banta 1963, p. 6–7; Banta *et al.* 1996, p. 629.2; Cunningham and Emmerich 2001, Appendix 4 therein). One encounter in a talus-filled dry canyon prompted the authors of one report to exclaim, "It is questionable how water-dependent this species is" (Cunningham and Emmerich 2001, unpaginated, Appendix 4 therein, at Gunter Canyon). Areas of talus (including, for the purposes of this assessment, all rocky areas that have interstitial spaces or hollows) are numerous in the high-relief mountains within the species' range (see Stebbins 1958, p. 10; Cunningham and Emmerich 2001, entire). Through time, the number of detections in more xeric (dry) sites far from surface water has increased and included dry canyons, ridges, and areas of open desert (Cunningham and Emmerich 2001, Appendix 4 therein; Morafka *et al.* 2001, 4th page (unpaginated); Clause *et al.* 2015, 9th page (unpaginated); Yasuda 2015, p. 52; Clause 2017 *in litt.*). To date, documentation exists for voucher-supported detections of 10 individual Panamint alligator lizards, at six separate sites, that were found in or adjacent to talus habitat 1.7–4 miles from the nearest perennial surface water or riparian habitat (Clause *et al.* 2017, 4th page (unpaginated)). These detections include a mating pair (Morafka *et al.* 2001, 7th and 8th pages (unpaginated)), and a likely gravid (pregnant) adult female (Clause *et al.* 2017, 4th page (unpaginated)), suggesting that at least some of those sightings represent populations, not merely isolated individuals.

Thus, the available information, although limited, nevertheless shows that the geographical arrangement of Panamint alligator lizard detections are concentrated in riparian and talus areas; yet, the available information also indicates that the Panamint alligator lizard is not solely limited to riparian areas (*contra* Stebbins 1958, p. 10; *contra* Jennings and Hayes 1994, p. 116; *contra* CWHR 2000, p. 1). Instead, it appears that individuals (and perhaps populations) can and do occur in a wide range of ecological settings within the species' range, although the amount of use of those areas may vary geographically and temporally. For example, the extent to which the lizards use areas outside of riparian areas may vary by elevation (Papenfuss 1985, p. 130). Also, some authors have speculated that there may be seasonal movements of Panamint alligator lizards, with individuals dispersing more widely in the spring when

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environmental conditions are moderate and then retreating into more mesic (wetter) areas during the hot season (Cunningham and Emmerich 2001, p. 25; Yasuda 2015, p. 52), although ~~but this has not been specifically studied~~preliminary radio telemetry data contradicts those hypotheses (Clause *et al.* 2015, 8th and 9th pages (unpaginated)). More study is needed on the seasonal movements of Panamint alligator lizards. Also, the available information, suggests that not all areas that have what appears to be suitable habitat are necessarily occupied by Panamint alligator lizards—including even riparian areas. More research is needed to refine the species' fine-scale distribution.

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Regional Setting

The geographical range of the Panamint alligator lizard spans the transition zone between the Great Basin Desert (Central Basin and Range) to the north and the Mojave Desert (Mojave Basin and Range) to the south (Figure 5). It encompasses several high-relief mountain ranges. Although the line of transition between the two ecotypes is diffuse and somewhat interdigitated depending on elevation, the biota in the White and Inyo mountains is generally more aligned with the Great Basin, while the biota in the Nelson, Coso, Argus, and Panamint mountain ranges is more aligned with the Mojave Desert. In general, the Great Basin in the north is colder and the Mojave Desert is warmer (Baldwin and Martens 2002, p. 36). Elevation affects the vegetation and invertebrate communities (Elliott-Fisk and Peterson 1991, entire; Smiley and Giuliani 1991, entire; Spira 1991, entire; Baldwin and Martens 2002, p. 37), which directly and indirectly affects the food and shelter options for the Panamint alligator lizard.

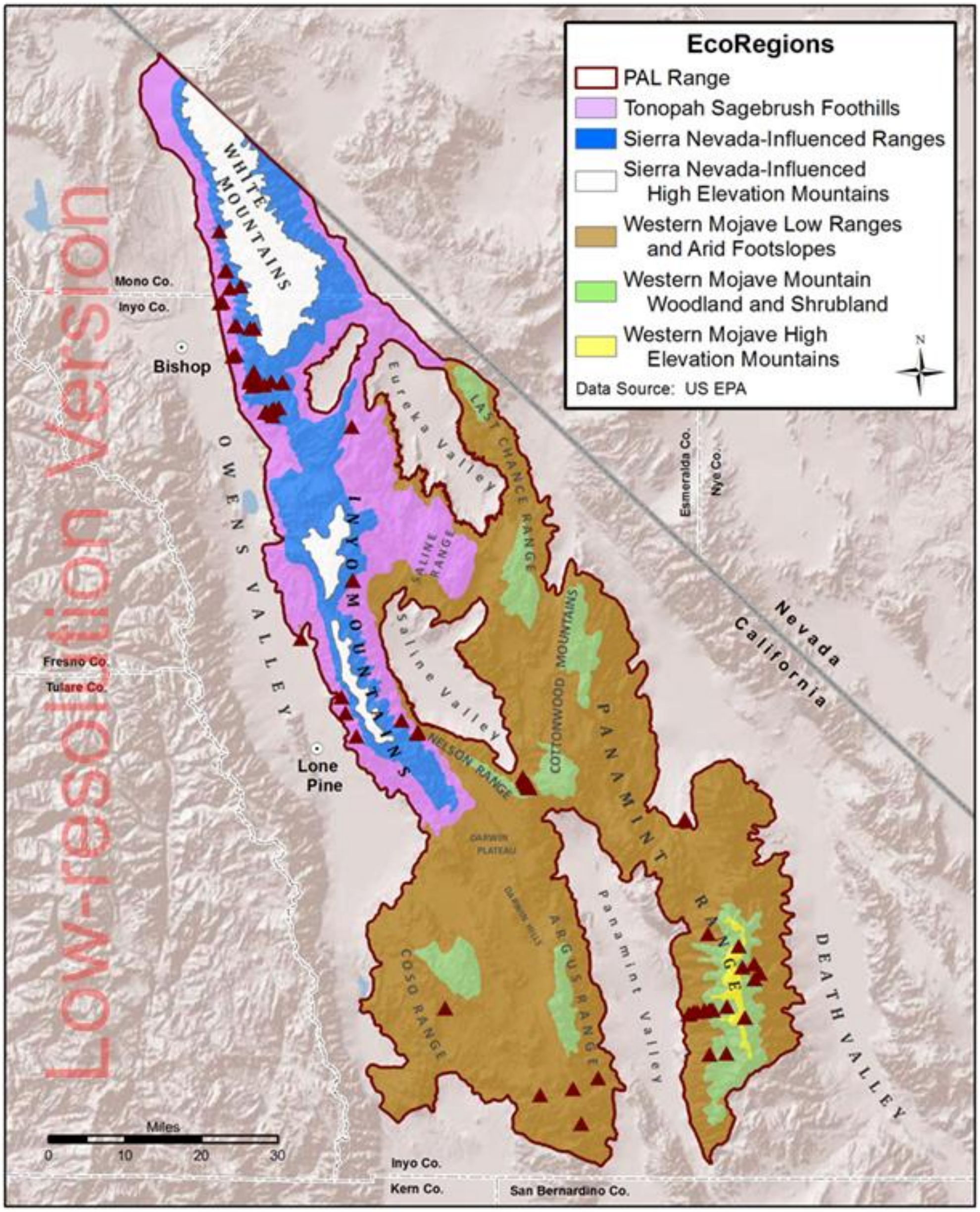

__Figure 5.__ Level IV ecoregions (Omernik and Griffith 2014; entire, and associated GIS data) within the range of the Panamint alligator lizard (PAL) (CWHR 2014, entire). The northern Level IV ecoregions within the species' range (pink, blue, and white) are in the Great Basin, and the southern ecoregions (brown, green, and yellow) are in the Mojave Desert.

Topography

The mountains where the Panamint alligator lizard occurs are typically steep and carved by many narrow canyons. The maximum elevations of these mountain ranges vary, with the tallest, the White Mountains, summiting out at 14,246 ft (4,342 m), about 250 ft (76 m) shy of Mount Whitney in the Sierra Nevada, the highest peak in the 48 contiguous States. The Inyo and Panamint Mountains each attain summits over 11,000 ft (3,350 m). The Argus and Coso Ranges achieve heights in excess of 8,000 ft (2,440 m), while the height of the Nelson Range falls a little below that. Although the highest portions of the taller mountain ranges well exceed the known upper elevational limit of the Panamint alligator lizard, most of the acreage within the species' geographical range lies within the species' known elevational span.

Comment [a10]: Is this phrase necessary? I suggest it might best be deleted, for lack of direct relevance.

As is typical for the basin and range region, the lower reaches of these mountain ranges meet large, isolated valleys that are, roughly speaking, shallow-bowl-shaped in cross-section, with their sides and bottoms at different elevations but displaying very little relief. The westernmost basin for the region (Figure 4) is the Owens Valley starting at about 4,000 ft (1,200 m) (at the bowl's lip or edge) and leveling off at about 3,600 ft (1,100 m) (at the bowl's flat bottom). This pattern repeats in the other large basins in the region: Deep Springs Valley (not mapped; west and north of Eureka Valley) from 5,200 to 5,000 ft (1,600 to 1,500 m), Eureka Valley from 4,000 to 2,900 ft (1,200 to 900 m), Saline Valley from 1,500 to 1,200 ft (450 to 360 m), and Panamint Valley from 2,000 to 1,000 ft (600 to 300 m). The east side the Panamint Range opens out into Death Valley at about 1,500 ft (450 m), which famously descends to below sea level at its lowest point. We are unaware of any~~No~~ Panamint alligator lizards ~~have been found~~being documented in these basins. Furthermore,~~ and~~ the range of the Panamint alligator lizard, as defined by the CWHR, excludes the larger basins, generally stopping at or about the respective mountain range's toe slopes.

Despite generally following the basin-and-range pattern, the mountain ranges where Panamint alligator lizards occur are not "sky islands" wholly isolated from each other. Instead, they are geographically close together or connected via plateaus (Figure 4), as follows: There is little separating the White and Inyo mountains (they are sometimes referred to in combination, the White-Inyo Range). The Panamint Range (which includes the Cottonwood Mountains at its north end) is connected to the Inyo Mountains by two bridging ranges, the Saline Range north of the Saline Valley, and the Nelson Range south of Saline Valley. The region where the Inyo, Nelson, and Cottonwood Mountains come together is connected to the Coso and Argus Mountains by a region within the elevational range of the Panamint alligator lizard, including the Darwin Plateau and the Darwin Hills. The Coso and Argus Mountains, in turn, are close to each other, with little topographical separation.

Comment [a11]: Yes, an important and relevant paragraph to include. Excellent.

In all, the overall region inhabited by the Panamint alligator lizard displays some of the highest topographic relief on the continent. Although the species' elevational range is only a subset of the larger region's relief, it nevertheless extends some 5,000 ft (1,500 m) up the steep mountains, excluding the low valley floors and the tallest mountains' highest reaches. The configuration of the mountain ranges allows for a fairly continuous species range, although the topography contributes to the species' seemingly less-than-even distribution.

Climate

Temperatures range widely on a daily and seasonal basis, being further influenced by elevation (Powell and Klieforth 1991, p. 16–18). Table 1 provides a rough summary of the data from the Panamint alligator lizard's range and within the species' elevational span. Rainfall in the region is generally scant, but increasing with elevation, and variable over time. Most of the precipitation comes in the winter. To the west, the Sierra Nevada creates a rain-shadow that blocks much of the winter precipitation, which comes from the Pacific Ocean (Powell and Klieforth 1991, p. 6). Within the range of the species, snow regularly falls at higher elevations, and the highest peaks (in the White, Inyo, and Panamint Ranges) typically support a snowpack that provides meltwater that lasts into the warmer months (Powell and Klieforth 1991, p. 19). Rain can also come in the summertime, with humid monsoonal airflows coming from the south and east. This pattern can result in occasional thunderstorms that are often localized and sometimes intense, which can result in flash flooding (Powell and Klieforth 1991, p. 9; Redmond 2000, pp. 21–22, see also Beaty 1963, entire).

Table 1. *Rough temperature ranges for the seasonal extremes (summer versus winter) within the geographical range of the Panamint alligator lizard and within the known elevational span of the species (source: Western Region Climate Center 2017, entire). The presented temperature ranges are of average temperatures; short-term extremes regularly fall well outside of the presented ranges on a regional or site-specific basis.*

	Lower Elevations		Higher Elevations	
	Average Lows	Average Highs	Average Lows	Average Highs
Summer	65 °F to 75 °F (13 °C to 14 °C)	90 °F to 100+ °F (32 °C to 38+ °C)	55 °F to 65 °F (13 °C to 18 °C)	80 °F to 90 °F (27 °C to 32 °C)
Winter	20 °F to 30 °F (-7 °C to -1 °C)	50 °F to 60 °F (10 °C to 16 °C)	20 °F to 30 °F (-7 °C to -1 °C)	40 °F to 50 °F (4 °C to 10 °C)

Vegetation

Plant growth varies across the dry, mountainous terrain within the range of the Panamint alligator lizard. The resulting vegetation patterns are largely based on the availability of water at a given site and the temperature regimes (daily, seasonally) to which it is subjected (Spira 1991, p. 77). The vegetation where Panamint alligator lizards occur varies regionally (Mojave Desert versus Great Basin Desert), elevationally, and situationally (reflecting site-specific characters, such as water availability, slope, aspect, soil type and depth, and disturbance regime).

Upland vegetation is typically sparse at base of the mountains, where desert scrub predominates (Spira 1991, pp. 77–79). It increases in density with elevation, transitioning in the higher elevational mountains to sagebrush (*Artemisia* spp.) scrub and eventually open pinyon-juniper woodlands at the upper elevation of the species' range (Spira 1991, pp. 77–79). Upland vegetation on the lower elevational mountains, especially in the southern end of the species' range, often remains sparse. Areas of talus typically offer little in the way of substrate or lack long-term stability for much plant growth, such that plant density is low (regardless of other factors).

The vegetation in riparian areas is typically more dense and often with greater vertical structure than the surrounding uplands. Riparian plants of the region often include willows (*Salix* spp.), ~~mesquite (*Prosopis* spp.),~~cottonwoods (*Populus* spp.), and baccharis (*Baccharis* spp.), and with the addition of some vining species in some areas, such as grape (*Vitis girdiana*) and clematis (*Clematis ligusticifolia*), these areas can become dense tangles (Phillips-Brandt-Reddick 1983, entire; Spira 1991, pp. 77; Cunningham and Emmerich 2001, p. 27). Within the species' range, most of the watercourses are ephemeral streams, desert washes, and watercourses with a subsurface flow. Many of the riparian areas are spring-fed, where underground geology forces water to the surface (Phillips-Brandt-Reddick 1983, p. 3; Pister 1991, p. 272; NPS 2002, p. 21). Riparian vegetation grows in some areas with perennial or episodic (or ephemeral) surface flow. Often, areas with limited surface flow but with greater subsurface water can support phreatophytic riparian vegetation. Thus, areas of riparian vegetation may be along watercourses that only rarely have surface flow, and also at seeps and springs that may not necessarily have standing or flowing water at the surface.

Comment [a12]: I have never visited a locality for Panamint alligator lizards that supports mesquite (Prosopis spp.), but many known localities for the lizard support cottonwoods (Populus spp.). I have also encountered numerous Panamint alligator lizards under cottonwood canopies. These facts are what motivated my suggested edit here.

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Comment [a13]: This is all completely true and accurate. But in the context of Panamint alligator lizards, perhaps somewhat misleading. Riparian habitats inhabited by these lizards are almost invariably fed by perennial creeks/springs with at least seepy (if not measurably flowing) surface water all year round. Maybe add a qualifying statement to this effect at the end of the paragraph?

Panamint Alligator Lizard Geographic Variation

There is only one source within the available literature suggesting phenotypic variation across the Panamint alligator lizard's range. As noted above, a preliminary report (Morafka *et al.* 2001, 4th page (unpaginated)) noted with little elaboration that the Panamint alligator lizards in the White Mountains (and only that mountain range) had some phenotypic characteristics that resembled southern alligator lizards, suggesting to the authors that there may be "limited" hybridization there (see also the Taxonomy section).[1] While acknowledging the available data are limited because there are so few museum specimens that allow for detailed evaluations (Clause *et al.* 2015, 7th page (unpaginated)), the observation by Morafka *et al.* (2001) is not corroborated by other available sources; instead, they imply or suggest the contrary. For instance, Mahrdt and Beaman (2009, p. 491) state, "[phenotypic] variation within this species is minimal."

Recent studies based on genetic data suggest that there is some population-level structuring across the species' range. Preliminary results from a genome-wide assessment (Toffelmier and Shaffer 2017, entire), indicate that populations[2] in the White Mountains in the northern part of the species' range, differ from the Inyo Mountains in the central part (Toffelmier and Shaffer

[1] Although the details are scant, we infer that the potential hybridization suggested by Morafka *et al.* (2001) was a relatively recent event and possibly ongoing. In comparison, Leavitt *et al.* (2017, p. 114) put the time of hybridization they detected through genetic data as occurring at thousands of years ago, during the Pleistocene.

[2] A *population* is typically defined as a group of interbreeding individuals or organisms that are more apt to breed among that group than outside the group, but the term is important in a variety of contexts. For instance, a population may be circumscribed by a set of experimental conditions, or it may approximate an ideal natural group of organisms with approximately equal breeding opportunities among its members, or it may refer to a loosely bounded, regionally distributed collection of organisms. Thus the term is flexible and its use and precise meaning depends on its context.

2017, 3rd page (unpaginated), and Figures 3A and 9 therein). These populations, in turn, differ from the populations in the Argus, Nelson, and Panamint Ranges (the study did not sample the Coso Range) (Toffelmier and Shaffer 2017, Figure 2 therein). Multiple samples from a number of canyons in the White Mountains and Inyo Mountains suggest some ongoing gene flow between neighboring sites but at very low levels, with the amount of exchange decreasing with distance between populations (Toffelmier and Shaffer 2017, 6th page (unpaginated), and Figures 3 and 9 therein). Only single samples were obtained from each of the Argus, Nelson, and Panamint Ranges, so the amount of exchange there is unknown; however, there were marked differences among the genomes from the three mountain ranges suggesting very little between-mountain genetic exchange (Toffelmier and Shaffer 2017, Figure 2 therein). Although the study did not address the Coso Range, if it follows a similar pattern, the Panamint alligator lizards there also likely differ from the other mountain ranges, but it could be surmised that they might be more aligned with the lizards from the nearby Argus Mountains. For the purposes of this SSA Report, we are considering the Panamint alligator lizards in each of the six mountain ranges to be separate (genetically separable) groups—or populations (in the broad sense).

The results from Toffelmier and Shaffer (2017) are generally consistent with the information depicted by Leavitt *et al.* (2017, pp. 109–110, Figures 2 and 3 therein), which provide broad-brush support for some level of range-wide genetic variation across the range of the Panamint alligator lizard. Although the study design used by Leavitt *et al.* (2017) was not necessarily intended to illuminate population-level variation, the data from the few Panamint alligator lizard populations sampled (using a small number of genes from nuclear and mitochondrial DNA) suggest that there is a slightly deeper genetic divide (see Leavitt *et al.* 2017, Figure 2 therein) between the White Mountains (their Panamint alligator lizard samples 3, 5, 4, and 2) and the other sampled sites, which are from the Nelson Range, Argus Range, and southern Panamint Range (see Leavitt *et al.* 2017, Appendix A therein). Leavitt *et al.* (2017) did not sample the intervening Inyo Mountains, nor did they sample the Coso Range, so there are geographical gaps in their data; however, the focus of their study was species-level diagnosis at much larger geographic scale (see the Taxonomy section).

Thus, genetic data indicate considerable population-level variation along the north-south axis of the species' range and between mountain ranges. The large amount of differentiation between and among Panamint alligator lizard populations (in the broad sense) identified in these studies suggest that these populations have had reduced levels of genetic exchange for some time. Although not addressed by the genetic studies, the large amount of differentiation that occurs between the Panamint alligator lizards in the White and Inyo Ranges and the Panamint alligator lizards in the Argus, Nelson, Panamint, and presumably Coso Ranges coincides with the region's larger, ecoregion-scale environmental differences—that is, between the Great Basin Desert and Mojave Desert. However,~~, but~~ it is not clear whether the observed differences reflect site-specific adaptations relative to these broad-scale ecological settings. More research is necessary.

5.0 LIFE HISTORY

Many details are not yet known for the Panamint alligator lizard. More is known about the similar and related southern alligator lizard (*sensu lato*[3]), which occurs to the west of the Panamint alligator lizard. We draw upon that knowledge in particular, along with information about other species, to inform our assumptions and expectations for the Panamint alligator lizard. More research is needed on the important, basic life-history traits of the Panamint alligator lizard.

Life Cycle

The basic life cycle of the Panamint alligator lizard is typical of most oviparous (egg-laying) lizards: eggs hatch to become non-breeding juveniles, which then grow and mature to become breeding adults (Figure 6). In general, mating occurs in the spring (May) (Banta and Leviton 1961, p. 205; Morafka *et al.* 2001, 7th page (unpaginated); Clause *et al.* 2015, 7th page (unpaginated)). Eggs are laid several weeks later, generally in the early summer. However, one female collected in September had oviductal eggs (Goldberg and Beaman 2003, p. 143), suggesting that later egg-laying dates are possible (see also below). To date, only one clutch of Panamint alligator lizard eggs has been observed: a clutch of 4 eggs was laid by a female in captivity (Morafka *et al.* 2001, 3rd page (unpaginated)). Additionally, one female that was collected for scientific examination contained 4 eggs (Goldberg and Beaman 2003, p. 143) and another contained 12 eggs (Banta 1963, p. 8), the latter indicating that larger clutches are possible. In comparison, the slightly larger southern alligator lizard lays clutches of varying quantity, typically about a dozen eggs but sometimes considerably more (Burrage 1965, p. 512). Clutch size in the Panamint alligator lizard is probably like other lizards in that it varies with the amount of fat reserves a given female has to draw upon during egg formation, which is itself influenced by food availability the preceding year (Whitford and Creusere 1977, p. 64).

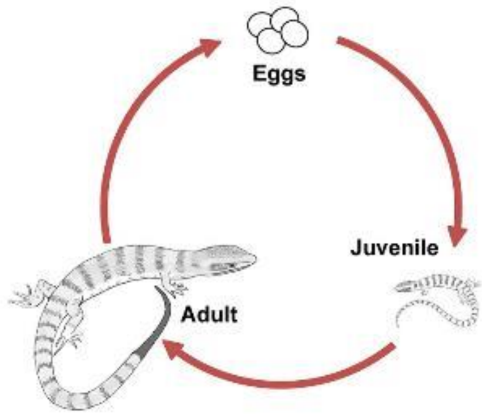

Figure 6. *Life cycle of the Panamint alligator lizard.*

It is not known how frequently Panamint alligator lizards lay eggs. So little is known about the Panamint alligator lizard that, potentially, the species might not reproduce every year, as is the case for some desert-dwelling lizard species (Pianka 1986, p. 60); however, this pattern has not been suggested in the literature for the Panamint alligator lizard. We infer from the literature that most species-experts anticipate that this species typically lays at least one clutch per year. It is also possible that Panamint alligator lizards might lay more than one clutch per year, but this, too, is not known for sure (Thomson *et al.* 2016, p. 204). Laying multiple clutches per year

Comment [a14]: I am unaware of any literature to support this statement, nor do I personally support it. The bottom line is that we know next to nothing about how frequently Panamint alligator lizards lay eggs. I would suggest that you delete this sentence, and the one that follows it, while adopting my suggested modifications to the sentence after that.

[3] See the Taxonomy section for additional information on the taxonomic status of the southern alligator lizard.

has been observed in southern alligator lizards, especially populations in coastal areas with a mild climate (Burrage 1965, p. 512; Goldberg 1972, p. 271), and so it is possible that Panamint alligator lizards might also lay multiple clutches per year. As discussed above, egg laying in Panamint alligator lizards has been observed in spring, but the specimen that had eggs in the oviduct in September suggests that some clutches may be laid in the fall. There is no way to know whether this could have been a second clutch or just a late-season clutch, but the timing is similar to the laying of second clutches in southern alligator lizards (Burrage 1965, p. 512). The harsh climate where the Panamint alligator lizard occurs might suggest that a second clutch would be less likely, but much of the species' range is sometimes subject to summer monsoonal rains (Powell and Klieforth 1991, p. 9). It may be possible that these summer rains result in conditions allowing Panamint alligator lizards to extend its reproductive period and, potentially, to lay multiple clutches. This appears to be the pattern for the Madrean alligator lizard, which occurs in the monsoon-influenced mountain ranges of the Sonoran Desert (Goldberg 1975, entire; Bezy 2011, entire). We assume, at this point, that the Panamint alligator lizard typically lays one clutch per year.

Indirect evidence suggests that fFemale Panamint alligator lizards appear to lay their clutches in secluded areas with microclimates that are not subject to environmental extremes (Clause *et al.* 2015, 7th page (unpaginated)), which is consistent with the behavior of the southern alligator lizard (Mulroy and Wiseman 2012, p. 484). The microhabitat conditions needed for eggs in nest sites are likely to be the most restrictive compared to any of the other life stages (Telemeco 2014, p. 115). Females also ~~appear to~~may attend the clutch as the eggs incubate (Clause *et al.* 2015, 7th page (unpaginated)), which matches the behavior of observed nests of southern alligator lizard (Mulroy and Wiseman 2012, p. 484). The incubation period is not known in the Panamint alligator lizard, but for southern alligator lizards it is temperature dependent (shorter if warmer, longer if cooler) and can take roughly 1 to 2 months (Telemeco 2014, p. 128). The sex of some reptiles is determined by temperature during development, but this is not the case for the southern alligator lizard (Telemeco 2015, p. 9); consequently, we expect that temperature does not affect sex determination in the Panamint alligator lizard.

Comment [a15]: Since I never actually observed any nesting female PAL, and can only speculate that the immobile radio telemetry signals I received represented egg-guarding behavior, I have made suggested edits to the language in two of the sentences in this paragraph to better indicate that high degree of uncertainty.

Juvenile Panamint alligator lizards probably do not become sexually mature adults until their second spring, roughly 18 months after hatching, which is the pattern observed in southern alligator lizards (Goldberg 1972, p. 272). Little is known about juvenile Panamint alligator lizard behavior. ~~Looking to the literature on~~Based on available data for other reptiles, juveniles could potentially have different daily or seasonal activity patterns compared to adults (allochronicity) (Whitford and Creusere 1977, p. 59). Juveniles may also be more likely to experience higher mortality rates than adults (Whitford and Creusere 1977, p. 63), and also, they might be more likely to move longer distances than adults (disperse) (Andrews *et al.* 2006, p. 19). Additionally, the life span of the Panamint alligator lizard is not known, but the southern alligator lizard can live up to a decade or more (San Diego Zoo 2008, unpaginated).

Preliminary data suggest adult Panamint alligator lizards have home ranges of less than a quarter acre, at least within riparian areas during the spring breeding season (Clause *et al.* 2015, 9th page (unpaginated)). Territoriality has not been reported in the Panamint alligator

Comment [a16]: I think this is an important qualification to add to this sentence.

lizard or the southern alligator lizard, and this behavior (non-territoriality) appears to be a trait of the taxonomic family (Martins 1994, p. 121). However, northern alligator lizards are known to have high site fidelity (Rutherford and Gregory 2003a, p. 103–104).

Thermoregulation

Very little is known about Panamint alligator lizard thermoregulation behavior. Cunningham (1966, p. 4) noted that southern alligator lizards are probably seldom exposed to temperature extremes because individuals stay within their microhabitat. Huey *et al.* (1989, entire) and Rutherford and Gregory (2003b, entire) provide summaries of how an ectothermic reptile, through its behavior, can keep its body temperature within its preferred range, including effective use of basking and seeking retreat sites (thermal refugia).

Panamint alligator lizards are ectothermic and use a variety of behaviors to control their body temperature. It appears that Panamint alligator lizards bask to some extent (Cunningham and Emmerich 2001, p. 11; Mahrdt and Beaman 2009, p. 490; Clause *et al.* 2015, 8th page (unpaginated); Yasuda 2015, p. 43; *contra* Jennings and Hays 1994, p. 116), which the southern alligator lizard also does (Cunningham 1966, p. 3; Kingsbury 1994, p. 268). This behavior, among others, allows alligator lizards to maintain their preferred body temperature, even when the surrounding environmental temperature is lower (Kingsbury 1994, p. 270). Basking may be seasonally important for sperm formation in males, which is the case for other reptiles (Vitt 1973, p. 183).

As described by Huey *et al.* (1989, entire), effective use of certain retreat sites, such as hollows under rocks of particular size and shape, can further allow ectothermic species to maintain their preferred body temperature for long periods of time, even in areas with wide-ranging daily temperature shifts. For example, protective rocks of appropriate size and shape, after cooling all night, take time to absorb heat. Thus, the rock provides protection from high temperatures during the day. As the environmental temperatures drop at the end of the day, the rock then becomes a source of heat, radiating what it absorbed during the day and providing protection from cooler temperatures at night. A reptile may fine-tune its temperature regulation through movements within the hollow. Although refugia use has not been studied in the Panamint alligator lizard, we expect individual Panamint alligator lizards regularly employ this behavior.

Moreover, the southern alligator lizard is a *facultative* thermoregulator, which means individuals maintain their preferred body temperatures when conditions permit, but they can continue to be active at lower temperatures, even when other behavioral options are not available (Kingsbury 1994, p. 270). Southern alligator lizards can remain active at temperatures lower than many other species, and can survive short periods close to freezing (Cunningham 1966, p. 6). It is likely that Panamint alligator lizards share similar traits. Conversely, the critical maximum body temperature for southern alligator lizards, and thus probably also Panamint alligator lizards, is lower than for many other desert-dwelling lizard species (Cunningham 1966, p. 5). This accentuates the Panamint alligator lizard's need for thermal refugia during periods of peak temperatures in its desert environment.

As we infer from the literature, it is generally assumed that the Panamint alligator lizard hibernates (bruminates) to some extent during the region's cold winters (Jennings and Hayes 1994, p. 116; Thomson *et al.* 2016, p. 204). The timing of the species' period of inactivity is not entirely clear, but it is probably from October to March (Banta 1963, p. 8; Morafka *et al.* 2001, 3rd page (unpaginated)), although that likelymight variesy somewhat depending on elevation and a given lizard's physiological condition in a given year—that is, the amount of fat or similar metabolic reserves it has been able to accumulate (Whitford and Creusere 1977, p. 64). Some alligator lizard species have incomplete hibernation and can be active on warmer days, even during the winter (Fitch 1935, p. 37), which might also apply to the Panamint alligator lizard and could be more likely for individuals at lower elevations. Although hibernation sites (hibernacula) have not been described for Panamint alligator lizards, we expect that they use sheltering sites (refugia) that provide wintertime protection.

Within the range of the Panamint alligator lizard, summertime temperatures can be very warm, especially at lower elevations (Powell and Klieforth 1991, p. 16). During this time, Panamint alligator lizards can shift their daily activity cycle from diurnal (daytime) to crepuscular (morning and evening) or nocturnal (nighttime) (Dixon 1975, p. 45; Cunningham and Emmerich 2001, p. 25; Morafka *et al.* 2001, 4th page (unpaginated); Clause *et al.* 2015, 7th page (unpaginated); Clause *et al.* 2017, 4th page (unpaginaged)). Moreover, detections of Panamint alligator lizards late in the hot season (August and September), though limited, suggest that the species does not have a summer period of inactivity—that is, apparently it does not aestivate (Cunningham and Emmerich 2001, p. 25; *contra* Banta 1963, p. 8). Longer-term studies across varying altitudes would help clarify this species' seasonal activity (Clause *et al.* 2015, 7th page (unpaginated)).

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Foraging

Alligator lizards are predators. Observations of Panamint alligator lizards suggest that they use both active-search and sit-and-wait methods of hunting (Cunningham and Emmerich 2001, p. 13; Clause *et al.* 2015, 8th page (unpaginated)). Few specific data are available, but Panamint alligator lizards are known to eat insects (Cunningham and Emmerich 2001, p. 13; Morafka *et al.* 2001, 4th page (unpaginated); Clause *et al.* 2015, 8th page (unpaginated)). Panamint alligator lizards are roughly similar in size to Madrean alligator lizards and, thus, are moderately sized lizards (as adults) with a bite force that is probably sufficient to consume a wide range of arthropods, although probably not those with the hardest shells (exoskeletons) (Meyers and Irschick 2015, p. 865). Southern alligator lizards are known to be generalists, eating insects and other arthropods (such as spiders and scorpions) and small vertebrates (such as mammals and other lizards), including some of these same food items in carrion form (Cunningham 1956, entire). The ability of alligator lizards to move and hunt at lower environmental temperatures than most other lizard species found at a given location may allow alligator lizards to more easily eat other reptiles (Cunningham 1956, p. 229). Southern alligator lizards are also known to be cannibalistic (Cunningham 1956, p. 229), and there is some evidence suggesting this in the Panamint alligator lizard (J. Richmond, as quoted in Cunningham and Emmerich 2001, 56th page (unpaginated)). We expect Panamint alligator lizards to also exhibit all of these behaviors.

Panamint alligator lizards are primarily terrestrial but are capable climbers (Stebbins 1958, p. 15; Banta 1963, p. 8; Cunningham and Emmerich 2001, p. 15; Clause *et al.* 2015, 7th page (unpaginated)). This suggests that they may also depredate eggs or flightless young in birds' nests; southern alligator lizards, which are also good climbers, are suspected of this behavior (Stebbins 1972, p. 109; Pike and Hays 2000, p. 30; Kus *et al.* 2008, p. 278) and, through examinations of stomach content, are known to have consumed birds (Cunningham 1956, p. 229).

The number of potential prey items varies over time depending on local conditions, particularly precipitation and temperature (Pianka 1970, p. 705). For example, in the variable environment where Panamint alligator lizards occur, many insects are most active in the spring and are dormant during the cold of winter and the heat and drought of summer; furthermore, the seasons themselves are influenced by elevation (Smiley and Giuliani 1991, p. 250). Given that weather patterns can vary considerably from year to year, including being influenced by longer-term weather patterns such as El Niño (Redmond 2000, p. 21–22), the inter-annual availability of prey is probably also quite variable at many sites where Panamint alligator lizards occur. However, sites with more consistent water, like spring-fed riparian areas, could be expected to be less susceptible to the vagaries of the region's precipitation.

Comment [a17]: Yes, great point. This is corroborated by my field survey data over the past few years, which consistently led to PAL detections in spring-fed riparian zones despite the intense multi-year drought that was gripping California at the time.

Hydration

Southern alligator lizards cool themselves to some extent through evaporative cooling, which results in water loss; this loss, moreover, exceeds the amount of water an individual lizard can create through its metabolism (Dawson and Templeton 1966, p. 765). Thus, a southern alligator lizard needs to get water from its food or through drinking (surface water, rain, or dew) (Dawson and Templeton 1966, p. 765; Kingsbury 1995, p. 158), and it is likely Panamint alligator lizards need to do this as well, for which there is some evidence. For example, captive Panamint alligator lizards have been observed to drink from water bowls (Cunningham and Emmerich 2001, p. 14) and one Panamint alligator lizard, on the same day of its mid-August capture, even submerged itself in a water bowl with only its nose above water (Cunningham and Emmerich 2001, p. 15). Thus, it appears that Panamint alligator lizards need to have at least some supplemental water. It is unclear how often and how much supplemental water is needed by Panamint alligator lizards; we expect that it depends on environmental conditions and the availability of various food items. Given that ~~some~~ individuals (and perhaps populations) are found in areas without consistent surface water, we expect that they opportunistically consume rain or dew water, or take advantage of pockets of moisture deep in talus piles.

Comment [a18]: This is one of the suspected reasons why all of the open-desert observations, far from surface water, have come from areas with extensive talus. I suggest adding this concluding phrase in this sentence to reflect this idea, which you expound upon in the subsequent paragraph.

Riparian areas in desert environments are inherently more mesic (wetter) than their xeric surroundings. Areas of talus provide interstitial spaces between and under rocks where precipitation can accumulate and, through reduced evaporation, remain moister and cooler than non-protected areas (Perez 1991, p. 229–230; Rutherford and Gregory 2003b, p. 26). Thus, many of the same microhabitat areas that serve as thermal refugia for the Panamint alligator lizard may also serve as hydrological refugia as well.

Comment [a19]: Yes, exactly.

Movements and Dispersal

There is littleno specific information on movement patterns and dispersal abilities in the Panamint alligator lizard and few details are available for other alligator lizard species. Northern alligator lizards, at least in one study, remained in fixed areas, although one longer-distance movement (nearly half a mile (750 m)) was observed (Rutherford and Gregory 2003a, pp. 103). That study also captured multiple individuals at the same trap location through time (Rutherford and Gregory 2003a, pp. 103–104), suggesting that individuals can live close enough together for home ranges to overlap. As noted in the Panamint Alligator Lizard Distribution section, Panamint alligator lizards might have seasonal differences in use areas, moving away from mesic sites during mild environmental conditions and towards mesic sites during periods of hot, dry conditions, although the limited available evidence does not support those hypotheses. Yet, because of intraspecific competition for food, mates, and refugia, and because of the Panamint alligator lizard's expected behavior of cannibalistic predation, it is likely that the higher densities that occur after reproduction are not sustainable. As such, we expect that there are survival benefits for individual Panamint alligator lizards, especially smaller juveniles, to move to new areas—that is, to disperse.[4] However, doing so also incurs costs. Lizards on the move are subject to increased exposure to predation and unsuitable environmental conditions. Preliminary analysis of genetic data suggests that there is a low level of gene flow between neighboring (canyon-scale) populations (Toffelmier and Shaffer 2017, 6th page (unpaginated)), indicating that a small amount of dispersal (immigration, emigration) is successfully occurring between nearby populations. In support of this conclusion, preliminary radio telemetry data showed that Panamint alligator lizards originally captured in riparian zones rarely strayed far from those riparian zones during the breeding season, with the exception of one young, possibly dispersing male that traveled over 80 m upslope away from the riparian zone (Clause et al. 2017, 8th and 9th pages (unpaginated)).

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Predators and Predator Avoidance

Known predators of Panamint alligator lizards include California kingsnakes (*Lampropeltis getula*) and Panamint rattlesnakes (*Crotalus stephensi*) (Clause *et al.* 2015, 8th page (unpaginated)), although there are likely many more. Potential predators include other reptiles, such as coachwhip (*Coluber flagellum*), striped whipsnake (*C. taeniatus*), western patch-nosed snake (*Salvadora*

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Figure 7. *An scansorialarboreal Panamint alligator lizard blends in with its riparian vegetation*

Comment [a20]: A very pedantic comment, but the genus name for the coachwhip and striped whipsnake has been changed back to Masticophis by Myers et al. (2017) (see pdf copy attached to my submission email). As the authors note, the recent change from Masticophis to Coluber was highly controversial, and not followed by many practicing herpetologists. The new data brought to bear by Myers et al. strongly indicate that Masticophis should be retained as the genus for these snakes.

[4] We are using the terms *disperse* and *dispersal* in a general sense in this SSA Report. It is not necessarily distance dependent, but it does imply a change in the dispersing individual's home range or regular use-area. At its extreme, dispersal may involve movement between populations (immigration, emigration).

hexalepis), long-nosed snake (*Rhinocheilus lecontei*); birds, such as loggerhead shrike (*Lanius ludovicianus*), red-tailed hawk (*Buteo jamaicensis*), greater roadrunner (*Geococcyx californianus*), common raven (*Corvus corax*); and mammals, such as coyote (*Canis latrans*), bobcat (*Lynx rufus*), skunks (*Mephitis mephitis* and *Spilogale gracilis*), and possibly also ringtails (*Bassariscus astutus*) (Jennings and Hayes 1994, p. 116; Mahrdt and Beaman 2002, p. 2; Clause *et al.* 2015, 8th page (unpaginated)). Very small Panamint alligator lizards (neonates and young juveniles) may fall prey to a wider range of animals, including invertebrates. Also, as noted in the Foraging section, some level of cannibalism may also occur.

Comment [a21]: This comment relates to my edit in Figure 7. The lizard in the photo is not in a tree, but rather is in a thicket of dead twigs only a few inches above the soil surface. For this reason, "scansorial" is a more appropriate word than "arboreal" to describe its behavior.

Panamint alligator lizards employ a range of anti-predator strategies. They are very secretive (Stebbins 1958, p. 26; Cunningham and Emmerich 2001, p. 24; Clause 2015, 8th page (unpaginated)), and are cryptically colored, at least when in vegetated areas (Clause 2017 *in litt.*) (Figure 7). Being able to move when they are not at their preferred body temperature (see the Thermoregulation section) allows alligator lizards to abandon basking to avoid detection (Rutherford and Gregory 2003b, p. 25). Refugia also serve as anti-predator retreat sites (Downes and Shine 1998, p. 1393; Rutherford and Gregory 2003a, p. 105). Additionally, southern alligator lizards can discard (self-amputate; autotomize) their tails as a way to distract would-be predators (Fitch 1935, p. 17; Cunningham 1956, p. 228), and Panamint alligator lizards apparently do this too (Banta 1963, p. 9). Indeed, Banta (1963, p. 9) noted the paucity of Panamint alligator lizards without regenerated tails. A high proportion of lizards with regrown tails might suggest a high level of predation pressure (Pianka 1970, p. 712).

6.0 HABITAT

Use Areas

Anecdotal evidence suggests the Panamint alligator lizard is most often detected in or near areas of riparian vegetation (Figure 8), nearly always~~often~~ with surface water (Stebbins 1958, p. 15; Phillips-Brandt-Reddick 1983, p. 89; Macey and Papenfuss 1991, p. 303; Mahrdt and Beaman 2009, p. 489; Clause 2013, 5th page (unpaginated); Parker and Brito 2013, p. 70; Thomson *et al.* 2016, p. 205). However, this may simply be due to sampling bias. No effective method exists for sampling this species in talus except for the expensive, labor intensive, and low yield method of

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Figure 8. *Riparian vegetation occupied by Panamint alligator lizards in the upper part of Silver Canyon, White Mountains.*

pitfall trapping (Banta 1963, entire; Cunningham and Emmerich 2001, entire; Morafka et al. 2001, entire). Riparian areas contrast markedly with the conditions in the rest of the species' range (open desert and dry, rugged mountain slopes). Areas of riparian vegetation likely offer the greatest opportunities for food and hydration, often having microhabitat sites (refugia) suitable for sheltering and nesting (such as concentrations of large rocks or woody material). Although no data currently exists on Panamint alligator lizard densities in any habitat~~quantitative data are lacking~~, this pattern suggests the species could achieve~~s~~ its highest density in riparian areas, implying that ~~implying that Panamint alligator lizard~~ populations near riparian areas might be~~are likely~~ "subsidized" by the higher productivity of those sites compared to dry sites (for example, see Sabo and Power 2002, entire). However, not all areas with riparian vegetation necessarily support populations of Panamint alligator lizards, or at least do not support high densities, which in turn has made detections at these sites more difficult (for example, Clause 2015, 6th page (unpaginated); see also Cunningham and Emmerich 2001, Site Reports therein).

It also appears that areas of talus (separate from riparian areas) are important to the species (Banta 1963, p. 6, see also Figure 6 therein; Clause *et al.* 2015, 8th and 9th pages (unpaginated); Clause 2017 *in litt.*) (Figure 9). Talus areas, with their abundant interstitial spaces between and under the jumbled rocks, provide abundant options for refugia and moisture (Cunningham and Emmerich 2001, p. 26; Clause *et al.* 2015, 9th page (unpaginated)). Again, there are no quantitative data, but areas of talus (including other very rocky areas) appear to support moderate densities of Panamint alligator lizards. Moreover, many sites where Panamint alligator lizards were detected had riparian and talus together in close proximity (Giuliani 1977, p. 7; LaBerteaux and Garlinger 1998, p. 85; Cunningham and Emmerich 2001, pp. 6, 26, see also Appendix 4 therein; Morafka *et al.* 2001, 4th page (unpaginated); Clause 2015, 8th page (unpaginated); Clause 2017 *in litt.*), suggesting the combination may be important for higher population densities.

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Figure 9. *Rock-filled talus area occupied by Panamint alligator lizards in the upper part of Silver Canyon, White Mountains.*

Beyond the riparian and talus areas, other more xeric sites are used by Panamint alligator lizards, including dry canyons, ridges, and open desert (Cunningham and Emmerich 2001, Appendix 4 therein; Morafka *et al.* 2001, 4th page (unpaginated); Clause *et al.* 2015, 9th page (unpaginated); Yasuda 2015, p. 52). The infrequency of detections in these other (non-riparian,

Comment [a22]: I suggest the inclusion of these sentences, to better clarify the reasons behind the preponderance of the available data for this species.

Comment [a23]: Because none of the citations in this sentence mention or speculate on Panamint alligator lizard densities, I suggest that the language highlighted here be removed.

Comment [a24]: Again, because there is no data whatsoever regarding densities of Panamint alligator lizards, I don't think you can say this. I would suggest either deleting this sentence entirely, or qualifying your language more strongly.

Comment [a25]: See earlier comment in this paragraph. I suggest you delete this highlighted passage entirely.

non-talus) upland areas suggests that densities of Panamint alligator lizards are low; moreover, it is probable that their occurrence is patchy, with some areas unoccupied.

Thus, the Panamint alligator lizard occupies heterogeneous habitat areas. In this document, we often discuss the different ecological settings (riparian, talus, and other upland) that the species uses. There is no information to suggest that there are differences in macrohabitat needs based on sex or age. As noted previously, the extent to which the Panamint alligator lizard may use these different areas might vary by season, although this remains speculative. Additionally, it is likely that there is some level of regular interchange of individuals (dispersal) between and among these ecological settings within a (canyon-scale) population. In other words, despite the convenience of identifying different ecological settings, it is unlikely that these ecological settings *define* a given Panamint alligator lizard population—that is, there probably is not, for instance, a "riparian Panamint alligator lizard" as compared to, say, a "talus Panamint alligator lizard." Similarly, there is nothing to suggest that populations should be defined by elevation, which is another potential difference in ecological setting.

On the other hand, the combination of habitat heterogeneity within the Panamint alligator lizard's range and differences in the species' observed density (anecdotal though the data may be), suggests that Panamint alligator lizards have different levels of productivity across these ecological settings. While the available information suggests that riparian areas, with their apparent resource subsidies, may (often) serve as source populations (see Dias 1996, entire, for a discussion on "source" versus "sink" populations), it is not clear where on the source–sink spectrum the other ecological settings lie. Populations of Panamint alligator lizards in talus areas (assuming that available sightings do, indeed, reflect the presence of populations) ~~areas~~ appear to survive even when miles~~well~~ away from riparian vegetation. Given the environmental variability of the region (geographically and temporally), particularly in precipitation but also in the context of flash floods (see Climate section), it is possible~~likely~~ that a given site, regardless of the ecological setting, shifts back and forth on this hypothetical source–sink spectrum. This is an important topic for future research for the Panamint alligator lizard.

Refugia

As we noted at various points in the preceding discussion, Panamint alligator lizards, as part of their natural behavior, seek refugia. These microhabitat features provide protection from one or more external ~~sources of~~ stressors. Refugia can serve different needs. They can be transitory sanctuaries, such as a spot of shade that offers thermal relief on a sunny day or a patch of leaf litter that provides concealment from a passing predator. However, for the topics addressed in this SSA Report, when we use this term, we are typically referring more to established shelters, such as hollows between and under rocks, that simultaneously provide some level of protection from temperature extremes, desiccation, and predators. Not all refugia are equal; we expect that only a subset meet the more restrictive (and potentially incompatible) needs for nesting or hibernation.

At a larger geographic scale, it is possible that riparian areas might serve as *macrohabitat* refugia during periods of drought. For the purposes of this SSA, we will explicitly refer to this

Comment [a26]: I may be mistaken, but I am unware of any Panamint alligator lizard observation that has been made far from riparian or talus. All localities are either in, or immediately adjacent to, one or both of those habitat types. To my reading, none of the references cited in the first sentence of this paragraph indicate otherwise. I suggest that this entire paragraph be deleted.

Comment [a27]: See earlier comment. To my knowledge, there is no evidence that Panamint alligator lizards use "other upland' habitat types far from the two core habitat types of riparian and talus.

Comment [a28]: Yes, excellent. This is exactly right. Many if not most, riparian habitats occupied by Panamint alligator lizards also support talus immediately adjacent.

Comment [a29]: See earlier comment regarding what we know about densities.

Comment [a30]: Perhaps more defensible to replace these two words with the word "could."

type of refugia as *macrohabitat refugia* to distinguish it from microhabitat refugia, discussed above. The subsidizing higher productivity of riparian areas could potentially allow populations of Panamint alligator lizards to survive periods when food and supplemental water are in short supply in this region with naturally high variation in climate parameters. At this point, this is speculative; we have no data to support or refute this supposition. It depends on the level of productivity at talus and other upland areas, although it appears that some areas of talus, at least, may be self-supporting. This is another topic for future research.

Natural Stochastic Disturbance

As noted in the Climate section, the region is periodically subject to severe, localized floods ~~from time to time~~. This type of stochastic event can result in debris flows that scour canyon bottoms and, over time, create alluvial fans at the canyon mouths, in the process often altering a canyon's hydrogeomorphology and sometimes severely affecting any riparian vegetation that may be growing there (Beaty 1963, entire). A cursory examination of satellite imagery shows that all (or nearly so) of the canyons in the region have alluvial fans at their mouths, indicating that this type of flood event has occurred repeatedly to varying degrees throughout the region. The average rate of accumulation on these slopes is low, indicating that it these alluvial fans have been growing over many millennia (Jayco 2005, entire). The size of the watershed and the height of the mountains are factors that contribute to the volume of water, and thus the amount of sediment transport, within a given canyon (Jayco 2005, entire). Severe flood events occur rarely in any given canyon~~; many times going~~, and often go undocumented in this remote region (Powell and Klieforth 1991, p. 10; Clause *et al.* 2015, 18th page). Several known flood events have occurred in recent history in canyons known to be occupied by~~where~~ Panamint alligator lizards~~ are known to occur~~; yet, despite the floods, these canyons continue to be occupied by the species (Clause *et al.* 2015, 18th page).

Land-use Context

Most of the Panamint alligator lizard's range is remote with little in the way of human settlement and no areas of significant urbanization. For example, Inyo and Mono Counties, with less than 20,000 and 15,000 people respectively, are some of the least-populated counties in the State, ranking 52 and 54 out the State's 58 counties (California Department of Finance 2017a, entire). Also, human population growth is expected to be negligible in these counties over the next 40 years (California Department of Finance 2017b, entire), due in large part to the limited availability of private land—for example, less tha~~t~~n 2 percent of Inyo County is privately held and available for development (Inyo County Board of Supervisors 2015 *in litt.*).

The vast majority (98.7 percent) of the Panamint alligator lizard's range (CWHR 2014, entire; see the Panamint Alligator Lizard Range section for details) occurs on Federal land (Table 2; Figure 10). Moreover, 64.7 percent is designated as Wilderness under the Wilderness Act of 1964 (16 U.S.C. 1131 *et seq.*) (see also the California Desert Protection Act of 1994 (Public Law 103-433), and the Omnibus Public Land Management Act of 2009 (Public Law 111-11)), and 5.8 percent is designated as Areas of Critical Environmental Concern (ACECs) (Table 3; Figure 11) under the Federal Land Policy and Management Act (FLPMA) of 1976 and the California Desert Conservation Area Plan of 1980. Some of the ACECs overlap areas designated as Wilderness, so the acreages of the two areas are not mutually exclusive. Only 0.5 percent of the species' range is private land (Table 2; Figure 10); most of which appears to comprise small inholdings associated with mining interests (such as patented mining claims). State land is only 0.8 percent of the Panamint alligator lizard's range (Table 2; Figure 10), nearly all of which, through a provision in the California Desert Protection Act of 1994, is anticipated to be exchanged with other Federal lands outside of the species' range (NPS 2002, p. 65; BLM 2016, Figure 1 therein and Appendix F therein). Thus, most of the State land within the species' range will eventually become Federal land. Local and tribal trust lands are each less than 0.1 percent of the species' range.

Nearly all of the BLM land within the range of the Panamint alligator lizard is within the California Desert Conservation Area (CDCA). As part of the Desert Renewable Energy Conservation Plan (DRECP), the BLM has prepared a Land Use Plan Amendment (LUPA) to the CDCA Plan (BLM 2016, entire). The goal of the DRECP is to provide a streamlined process for the development of utility-scale renewable energy generation and transmission, while simultaneously providing for the long-term conservation and management of certain species (BLM 2016, p. 2). Through the plan's design, the DRECP-related development activities will only occur in the DRECP Plan Area. However, the DRECP Plan Area is geographically smaller than the DRECP LUPA Decision Area (BLM 2016, see glossary therein and Figure 1 therein). In other words, the DRECP Plan Area is a subset of the larger DRECP LUPA Planning Area. The range of the Panamint alligator lizard is outside of the DRECP Plan Area but within the DRECP LUPA Planning Area. As such, land-use planning and management activities called for in the DRECP LUPA also apply to the Panamint alligator lizard's range, even though no areas designated by the DRECP as Development Focus Areas (solar, wind, geothermal) are within the species' range. However, an existing geothermal development occurs within the species' range in the Coso Range on China Lake Naval Weapons Center; other untapped geothermal resources also occur nearby (BLM 2012, entire).

Much of the range of the Panamint alligator lizard is devoid of maintained roads. Only two paved highways cross the area, State Routes 168 and 190, both two-lane roadways that receive little use compared to many other State highways (Caltrans 2015, entire). A handful of smaller roads also occur, most of which are unpaved. A scattering of unimproved "jeep trails" sprawl through the region, some of which are unauthorized and some are in areas now closed to vehicular access. Many of the existing roads and trails provide access to private inholdings that are currently or were historically mined. As a consequence of the rugged terrain, most roads meander through canyon bottoms; these areas are also where the bulk of the riparian vegetation occurs, although some patches of riparian vegetation are at springs or seeps on the sides of canyons. Many of these roads and trails parallel or bisect riparian and talus habitat known or suspected to be occupied by Panamint alligator lizards, but the overall density of roads is comparatively limited in the region, in keeping with the low human population.

Comment [a31]: Just a suggested sentence here to put things into context.

Table 2. *Acres, hectares, and the percentage of the species' range by major land-owner (jurisdictional) categories within the range of the Panamint alligator lizard (PAL) (CWHR 2014, entire; see the Panamint Alligator Lizard Range section in text for details).*

Owner	Acres	Hectares	Percentage of PAL
Federal Total*	2,585,494.2	1,046,312.4	98.7%
State	19,745.7	7,990.8	0.8%
Local	1,783.9	721.9	<0.1%
Private	13,356.8	5,405.3	0.5%
TOTAL PAL RANGE	**2,620,380.6**	**1,060,430.4**	**100.0%**

* See Table 3 for details.

Table 3. *Acres, hectares, and the percentage of the species' range of Federal ownership by agency, including as a subset Federal Wilderness and, for the BLM, Areas of Critical Environmental Concern (ACECs), within the range of the Panamint alligator lizard (PAL) (CWHR 2014, entire; see the Panamint Alligator Lizard Range section in text for details). Abbreviations: BLM = Bureau of Land Management, NPS = National Park Service, USFS = U.S. Forest Service, DOD = Department of Defense, BIA = Bureau of Indian Affairs.*

Federal Owner	Acres	Hectares	Percentage of PAL
BLM (Total)	611,056.5	247,285.8	23.3%
BLM Wilderness*	346,246.0	140,120.8	13.2%
BLM ACEC†	151,776.1	61,421.6	5.8%
NPS (Total)	1,109,096.9	448,835.6	42.3%
NPS Wilderness*	1,068,844.7	432,546.1	40.8%
USFS (Total)	538,723.3	218,013.6	20.6%
USFS Wilderness*	279,776.2	113,221.4	10.7%
DOD	325,991.8	131,924.2	12.4%
BIA (Tribal Trust)	625.7	253.2	<0.1%
Federal Total	**2,585,494.2**	**1,046,312.4**	**98.7%**
Wilderness Total*	**1,694,866.9**	**685,888.3**	**64.7%**

* Wilderness designations overlay the existing land ownership (by agency) and, in this case, include a few State Lands Commission inholdings within those Federal lands. (See text for details.)

† ACECs are separate management designations on certain BLM lands and may also include areas designated as Wilderness (that is, the area values for Wilderness and ACECs are not mutually exclusive but do not overlap completely).

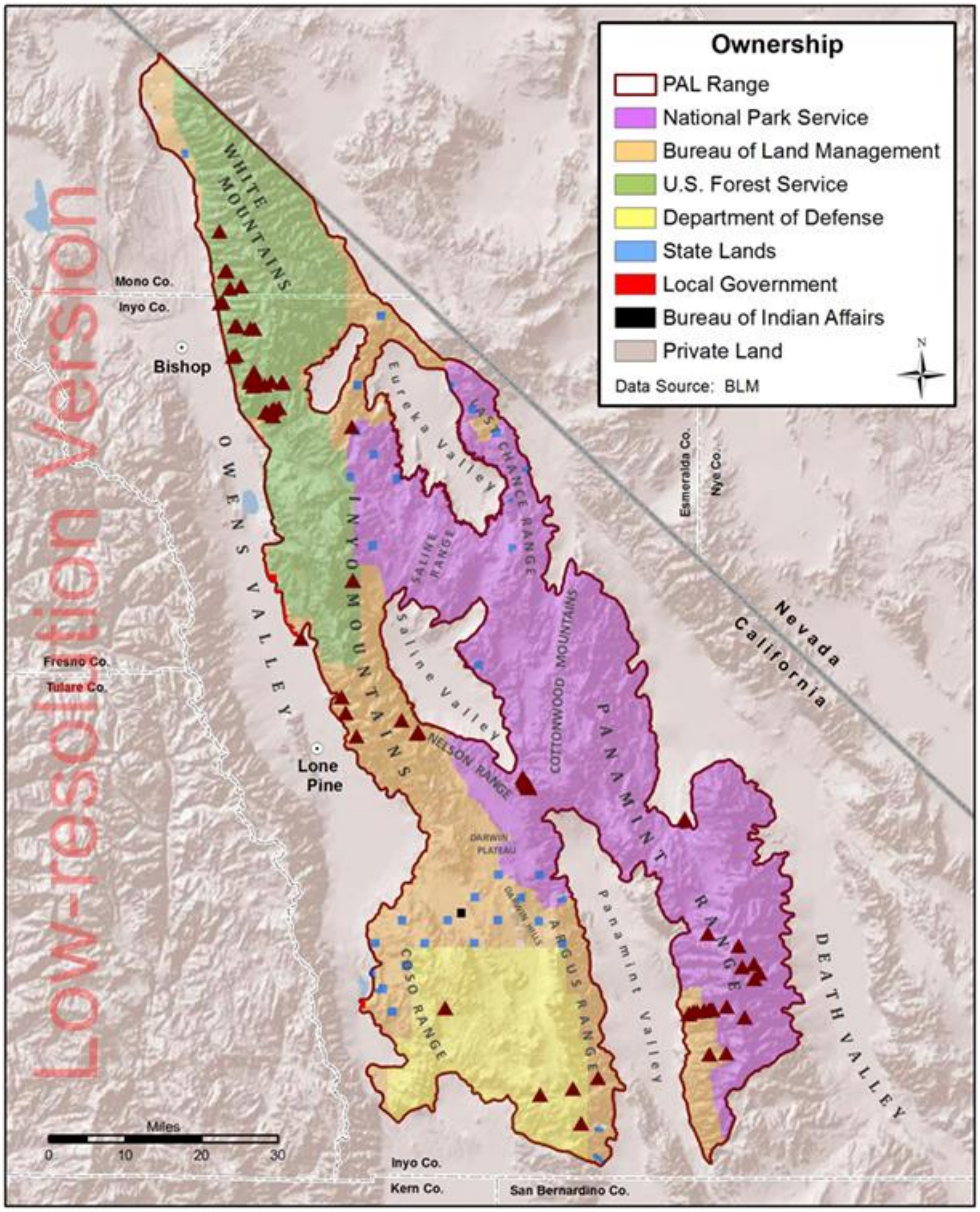

Figure 10. *Land ownership within the range of the Panamint alligator lizard.*

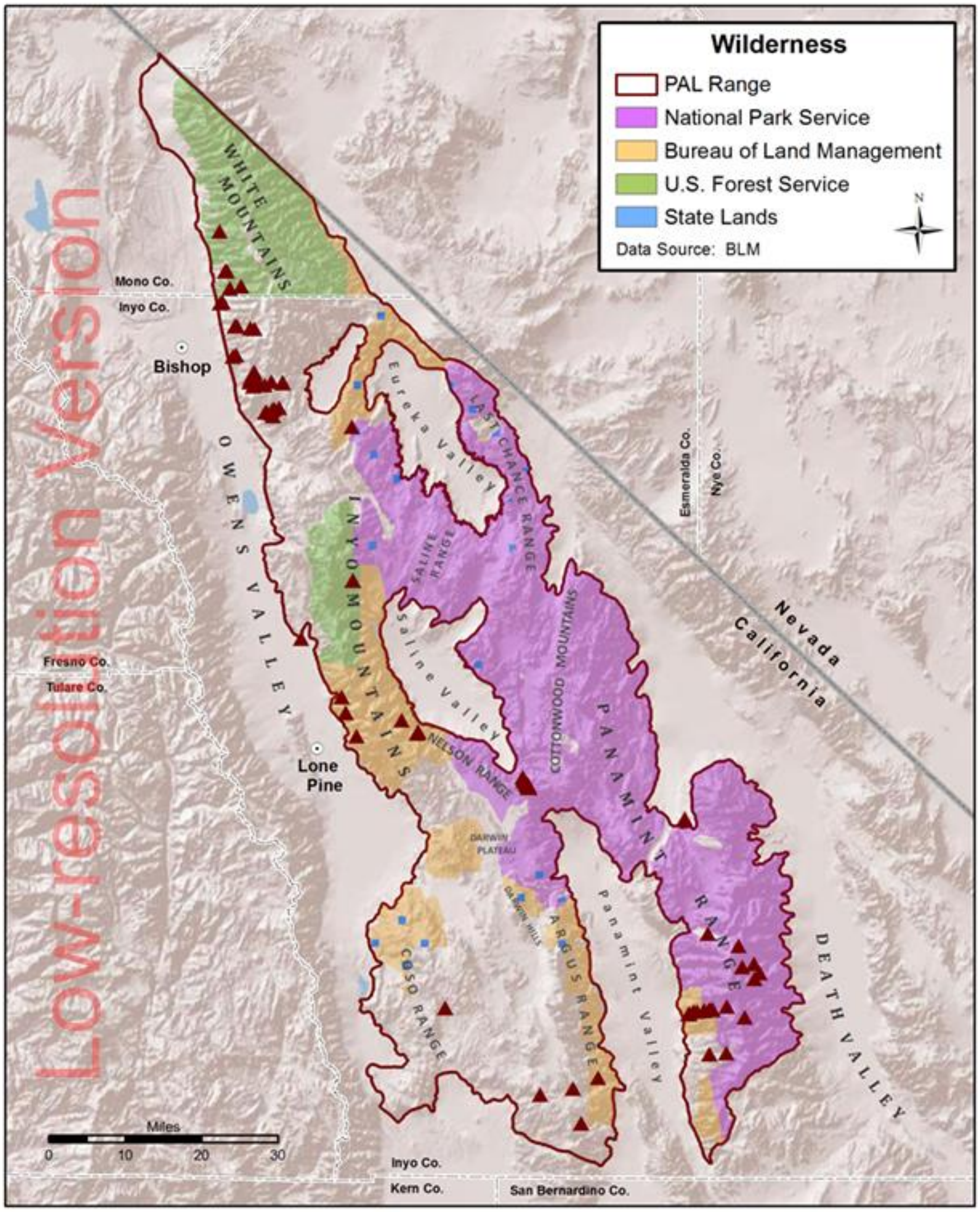

Figure 11. *Designated Federal Wilderness Areas, by agency, within the range of the Panamint alligator lizard.*

7.0 SPECIES' NEEDS

In this section we synthesize the information in the preceding sections to highlight the overall needs of the species. We start with the individual level, then move to the population level, and then finally to the species level. The needs for each level address that level; for example, if the needs of the species cannot be met, the species will eventually go extinct. The needs are also cumulative across levels. That is, if the needs of an individual cannot be met, then that individual will not survive, and as such, it will not contribute to a population. Extrapolating up, if the needs of all the individuals in a population are not met over time, the population will not persist. Similarly, if the needs of a population cannot be met, that population will not persist, and in turn, it will not contribute to the species. Thus, failure to meet individual-level or population-level needs (on a large enough scale) can ultimately lead to species extinction as well.

If the needs of some number of individuals in a population are being met, allowing for an adequate population size and with sufficient rate of growth, then that population is resilient. The number of resilient populations and their distribution (and their level of connectivity) will determine the species' level of redundancy. Similarly, the breadth of genetic or environmental diversity within and among populations will determine the species' level of representation. Thus, for the species to sustain populations in the wild over time and be viable, the populations need to be able to withstand stochastic events (to have resiliency), and the species-as-a-whole needs to be able to withstand catastrophic events (to have redundancy) and to adapt to changing environmental conditions (to have representation).

Individual-level Needs

Feeding

Individual Panamint alligator lizards of all ages need to regularly eat and drink, but it is unclear how frequently supplemental water may be needed. No differences in food needs between ages and sexes have been reported, although the physical size of the lizard (especially when very young) will influence the size of prey it can attack and consume, as well as the volume of prey needed for the lizard to reach satiation. Panamint alligator lizards are carnivorous, and likely feed~~ing~~ primarily on insects as well as other kinds of arthropods and small vertebrates. Food availability varies geographically, seasonally, and inter-annually. The productivity of riparian areas ~~appears to~~could subsidize the Panamint alligator lizards living in or near them. Food items provide not only sustenance but also water. Additional supplemental water is most likely opportunistically consumed and might be necessary for an individual to survive over the long term. The availability of supplemental water varies geographically and temporally. Not every occupied site has flowing surface water, which is an obvious source of supplemental water. Other water may be obtained from rain or dew, the quantity and timing of which varies geographically, seasonally, and inter-annually.

Comment [a32]: Again, because we have no evidence that Panamint alligator lizard populations are highest in riparan areas, I think "could" is a more appropriate qualification than "appears to."

Breeding

A given Panamint alligator lizard individual does not need to reproduce to survive, so reproduction could be considered a population-level need. However, the activities needed for reproduction (mating, egg-laying) happens at the individual level. Mating occurs in the spring and eggs are laid several weeks later (late-spring or summer). Females lay eggs in suitable nest-site refugia (see also the Sheltering section, below), and may guarding the clutch as the eggs incubate. Clutch sizes of 4 eggs are known, and larger clutches, perhaps a dozen or more, are suspected. Females could possibly lay more than one clutch per year, but this has never been observed in this species. Clutch size (and potentially the number of clutches per year) is likely affected by the availability of food and water, which in turn is affected by annually variable environmental conditions (precipitation, temperature). Therefore, the number of young produced (fecundity) is affected by both the size and number of clutches individual females have per year, which in turn, is likely affected by food availability prior to egg formation (primarily the preceding year). Juvenile Panamint alligator lizards do not breed until they are mature, at approximately 18 months after they hatch. Adults likely breed throughout their lives, which might be for a decade or more.

Sheltering

Individual Panamint alligator lizards need refugia—areas that provide protection from environmental conditions and disturbance from other organisms (especially potential predators). The environment where the Panamint alligator lizard occurs is typified by large expanses of dry, rocky areas with sparse-to-modest vegetation, and occasional wetter, riparian areas with locally dense vegetation. Environmental conditions in this mountainous desert region vary temporally and geographically. For example, low-elevation sites can often experience intense heat during the summer, while high-elevation sites can sometimes be subjected to acute cold during the winter. Temperatures can also range widely on a daily time scale. These temperature ranges, especially when considered on the geographic scale of an individual Panamint alligator lizard, can exceed that lizard's tolerance range. Thus, individual Panamint alligator lizards need to seek refuge to avoid temperature extremes when they occur.

Established-shelter type refugia (as opposed to transitory type), such as hollows between or under rocks, simultaneously provide some level of protection from temperature extremes, desiccation, and predators (potentially including conspecifics). A smaller subset of these sheltering refugia are also important as hibernacula or nest sites, the latter providing a suitable microclimate conditions for the incubation of externally laid eggs and, simultaneously, physical protection for eggs and the attending female.

Thus, refugia are important to the survival of individual Panamint alligator lizards and are also important for populations (see below). Specifically, these refugia may be found in vegetated areas (especially but not limited to riparian areas), and rocky areas that have interstitial spaces between and under rocks (especially but not limited to areas of talus).

Population-level Needs

Populations need abundant individuals within habitat patches of adequate area and quality to maintain survival and reproduction in spite of disturbance. Such populations can be considered to be resilient. The abundance within a population is influenced by fecundity (and other reproduction-related demographic factors), survival, and dispersal (immigration and emigration). Such movement between populations (or lack thereof) also promotes (or hinders) gene flow, which can influence whether or to what extent there is geographic variation among populations and across the species-as-a-whole.

As noted in the Use Areas section, ~~anecdotal evidence suggests that~~ the density of Panamint alligator lizards could be~~is~~ greatest in riparian areas, although no quantitative data exist. The presence of surface water and the high-productivity of riparian vegetation ~~appear to~~potentially subsidize the Panamint alligator lizard populations living there. Areas of talus have abundant refugia options (including potential nest sites and hibernacula), but ~~appear to support more moderate densities~~are usually more arid and poorly vegetated and thus likely are less productive and offer fewer food resources. On the other hand, Panamint alligator lizards are also known to occur away from areas of riparian vegetation and talus. This indicates that the species is not solely restricted to these two areas, but the other upland (non-riparian, non-talus) areas support lower population densities that are probably patchily distributed.

Comment [a33]: See earlier comment. I think these two sentences are probably best deleted, due to lack of supporting evidence.

Dispersal

A given area can support up to some maximum density of Panamint alligator lizards. Individuals compete for food and suitable refugia sites; adults in that area may also compete for mates. Predators also prowl the area and Panamint alligator lizards may also be cannibalistic. Thus, from time to time, the available resources may be limiting or predation pressure may be too high, especially for juveniles—at which point, some proportion of individuals in a given area likely need to disperse in order to find suitable conditions to survive and reproduce.

A moving Panamint alligator lizard has energetic costs and is subject to increased exposure to predation and unsuitable environmental conditions (primarily temperature). Whether an individual Panamint alligator lizard disperses at a given point in time will depend on that individual's situation (the potential costs of staying versus the potential costs of going). Dispersal is inherently an action undertaken by individuals, but its success, on average, is important for (1) the status of populations through immigration and emigration, (2) promoting movement of individuals into areas of different macrohabitat conditions (such as, riparian versus upland), and (3) for genetic exchange within the species (see the Species-level Needs section). It is likely that dispersal over longer distances is less successful (on average) during periods of extreme environmental conditions (particularly temperature); movements are more likely to be successful during periods of moderate environmental conditions.

Species-level Needs

The Panamint alligator lizard has a fairly small range when compared to some of its congeners, yet the range, as we have defined it herein, covers more than 2.6 million acres (1 million hectares) and spans six rugged mountain ranges. Abundance and fecundity (and other reproduction-related factors) promotes population persistence, which improves resiliency. Connectivity between and among populations over time through the dispersal of individuals is important for movement of genes, which helps prevent the erosion of resiliency, but also promotes redundancy by allowing for multiple, genetically similar populations, which in turn allows the species to better survive population-destroying catastrophic events. Thus, the level of redundancy for this species depends on the persistence through time of connected populations (via dispersal) in each of the mountain ranges. The species' level of representation is expressed by having and maintaining the full breadth of genetic diversity across the species' population-as-a-whole. Evidence suggests that the Panamint alligator lizard generally exhibits genetic variation along the north-to-south axis of the species' range and from mountain range to mountain range, encompassing broad-scale ecoregional differences (Great Basin vs. Mojave Desert) and other, more subtle environmental differences between mountain ranges.

Species' Needs Summary

In all, we believe Panamint alligator lizards need food, water, and shelter (refugia) for basic survival and reproduction, which results in resiliency. Reproduction (fecundity) and survival allow for populations of adequate abundance to promote population persistence and dispersal. The amount of successful dispersal (on average, over time) is important because (1) it promotes immigration and emigration, which improves population persistence and resiliency, and (2) it promotes gene flow, which maintains or increases redundancy, allowing the species to better withstand catastrophic events. Periods of moderate environmental conditions will increase the likelihood of dispersal success and allow for greater dispersal distances. The species exhibits wide genetic diversity across its geographic range which includes six mountain ranges that span the transition from the Great Basin to the Mojave Desert. The species' needs are summarized in Table 4.

Table 4. *Summary of the species' needs for the Panamint alligator lizard.*

Need	Details and Comments	Need Level
Food (prey base)	Predominantly insects	• Individual
Hydration	Water in food items; additional supplemental water (surface water, rain, or dew)	• Individual
Refugia (for sheltering, nesting, and hibernation)	Dense vegetation (predominantly riparian); rocky areas with interstitial spaces	• Individual • Population
Abundance, fecundity, and survival	Promotes population persistence and dispersal	• Population • Species
Dispersal	Promotes immigration and emigration (contributing to population persistence) and gene flow	• Population • Species
Periods of moderate environmental conditions	Increases likelihood of dispersal success, allows for greater dispersal distances	• Individual • Population • Species
Multiple populations across all mountain ranges	Maintains breadth of genetic diversity	• Species

8.0 CURRENT CONDITIONS

Population Condition

Similar to other alligator lizard species, the Panamint alligator lizard is secretive and difficult to detect; extensive survey effort is often needed to merely determine presence or absence (Cunningham and Emmerich 2001, p. 24; Clause 2015, 8th page (unpaginated)). Moreover, much of the Panamint alligator lizard's range is difficult to access and the level of research on this species has been modest at best (Clause *et al.* 2015, 7th page (unpaginated); Thomson *et al.* 2016, p. 205). As a result, very little is known about the overall abundance of the Panamint alligator lizard and there are no data to indicate any kind of trend.

Faced with this lack of quantified data, we can gain some insight by looking at the Panamint alligator lizard's range and distribution, which are discussed in the Biogeography section above. The available information indicates that the species' range is geographically limited compared to some other species of alligator lizards. That alone restricts the overall abundance of the species. Moreover, as discussed in the Panamint Alligator Lizard Distribution section, the available information suggests that the species seems to be most often detected in or near areas of riparian vegetation and areas of talus, which implies higher population densities in these areas. Few riparian areas occur in the desert mountain ranges where the species occurs, but talus areas are much more numerous. The abundance of talus means that many existing

Comment [a34]: This is language regarding the issue of density that I think is justified, defensible, and fits the available evidence.

riparian areas are also in or near rocky areas. The species can also be found in dry canyons, ridges, and areas of open desert, but apparently, based on the infrequent detections in such areas, Panamint alligator lizards occur in those areas at lower densities. Thus, the species' small range and heterogeneous (and mostly sparse) distribution suggest that the overall numerical abundance of the Panamint alligator lizard is relatively small, which would not be surprising for an endemic species (Lawton 1994, pp. 61–62). On the other hand, with an estimated range of roughly 2.6 million ac (1 million ha), even if the CWHR range is perhaps overly inclusive, the Panamint alligator lizard is not a narrow endemic with an extremely small range. Additionally, there is little to suggest that there has been a substantial change in the range or population size since the mid-1800s when the region was settled by people of European origin.

Comment [a35]: Again, I suggest this sentence be removed due to lack of supporting evidence.

Several sources have reported or implied that the Panamint alligator lizard has recently experienced or is facing population declines; although some authors noted the lack of baseline data, most have presented an inventory of possible threats that potentially portend a declining population (for example, Jennings and Hayes 1994, p. 118; Mahrdt and Beaman 2002, p. 3; Hammerson 2007, unpaginated; Mahrdt and Beaman 2009, p. 491; Hammerson 2013, unpaginated; Yasuda 2015, pp. 14–20). Clause *et al.* (2015, 5th page (unpaginated)) pointed out that these purported sources of potential declines are presented with little or no species-specific substantiation by the authors. Some of these sources also included or repeated fact errors, such as the land-ownership within the species' range (nearly all of which is, in fact, on public land (Table 1; *contra* Jennings and Hayes 1994, p. 118)), or cite literature sources with outdated information on impacts to the species (see Clause *et al.* 2015, 4th and 5th pages, for more details). While we acknowledge and admit that it is difficult to get current information from such a remote area (having faced the problem ourselves in the preparation of this SSA Report), it is nevertheless important to discern between past and present on-the-ground situations.

Comment [a36]: Yes, this is a valid point.

With the lack of quantified abundance data and with potentially spurious information about the species' conservation status presented in much of the available literature, we look to other measures that might suggest a decline. A numerical decline in individuals could potentially become evident in the contraction of the species' range (Lawton 1994, p. 62; Rodda 2012, p. 283), but no information exists suggesting that the range of the species, albeit relatively small, has changed since historical times.

Loss of populations or failure to detect the species at previously occupied locations might also suggest a numerical decrease. Available information—again, limited though it is—suggests this has not occurred (Table 5, Figure 12). Indeed, since the species' discovery in the 1950s, the number of sites known to be occupied has grown, even with only modest on-the-ground efforts, including the discovery of new locations in the past few years. While not all known Panamint alligator lizard locations have received repeated survey effort, many canyons where Panamint alligator lizards have been detected in the past have yielded positive results in subsequent searches; no (canyon-scale) populations are known to have suffered extirpation (Clause *et al.* 2015, 5th and 10th pages (unpaginated)).

In summary, the overall abundance of the endemic Panamint alligator lizard is unknown but appears to be relatively small because it likely occurs at low densities over a restricted range. While the lack of data makes it difficult to know for sure, there is no evidence to suggest that the species' overall abundance has declined substantially since historical times. In fact, as described above, available evidence suggests that the Panamint alligator lizard's overall abundance is probably stable.

Comment [a37]: Just an idea for a concluding sentence for this paragraph.

Table 5. *Summary of Panamint alligator lizard "populations," their detection history, and current status across the six mountain ranges in the species' geographical range. As used here, a* population *is loosely defined and does not necessarily indicate panmictic interbreeding; however, available information suggests that some amount of genetic exchange (interbreeding) occurs between and among canyons within at least some of the mountain ranges (see text). Not all detections are in canyons* per se*. The data quality for the detection history is quite variable; some sites have had good coverage with precise reporting through time, while others have had spotty coverage, imprecise reporting, or both. We have no rigorous data to establish "absence" (regardless of location); detection history is highly dependent on level of effort. We consider mountain-range-scale populations that have had detections since 2010 to be extant; populations without recent detections but for which there is little evidence to suggest population loss are presumed to be extant.*

Mountain Range (Population)	Major Land Owners	Eco-region	Canyons with detections (in or near)	≤1969	1970s	1980s	1990s	2000s	2010s	Status	Comments
White	USFS	Great Basin	Piute Creek, Coldwater Canyon, Gunter Creek, Silver Canyon, Redding Canyon, Black Canyon, Marble Canyon, Westgard Pass	X	X	X	X	X	X	Extant	Multiple sites with multiple detections each. Long history of detections. Vouchers.
Inyo	USFS, BLM	Great Basin	Joshua Flats, Lead Canyon, Mazourka Canyon, Union Wash, French Spring, Long John Canyon, Craig Canyon, Daisy Canyon	X	X	X	X	X	X	Extant	Multiple sites, some with multiple detections each. Long history of detections. Vouchers.
Nelson	NPS	Mojave Desert	Grapevine Canyon	X		X		X		Presumed Extant	One canyon with multiple detections before 1969. Single detections in the 1980s and 2000s. Vouchers.
Coso	Navy, BLM	Mojave Desert	Haiwee Spring				X			Presumed Extant	One ~~advantageous~~ un-vouchered visual detection at one site. No other detections in the Coso Range.
Argus	Navy, BLM	Mojave Desert	Mountain Springs Canyon, Water Canyon, Homewood Canyon			X	X	X	X	Extant	Several sites with 1 to 2 detections each. Moderate history of detections. Vouchers.
Panamint	NPS, BLM	Mojave Desert	Telephone Canyon, Wildrose Canyon, Hanaupah Canyon, Surprise Canyon, Pleasant Canyon	X	X	X	X	X	X	Extant	Multiple sites, some with multiple detections each. Long history of detections. Vouchers.

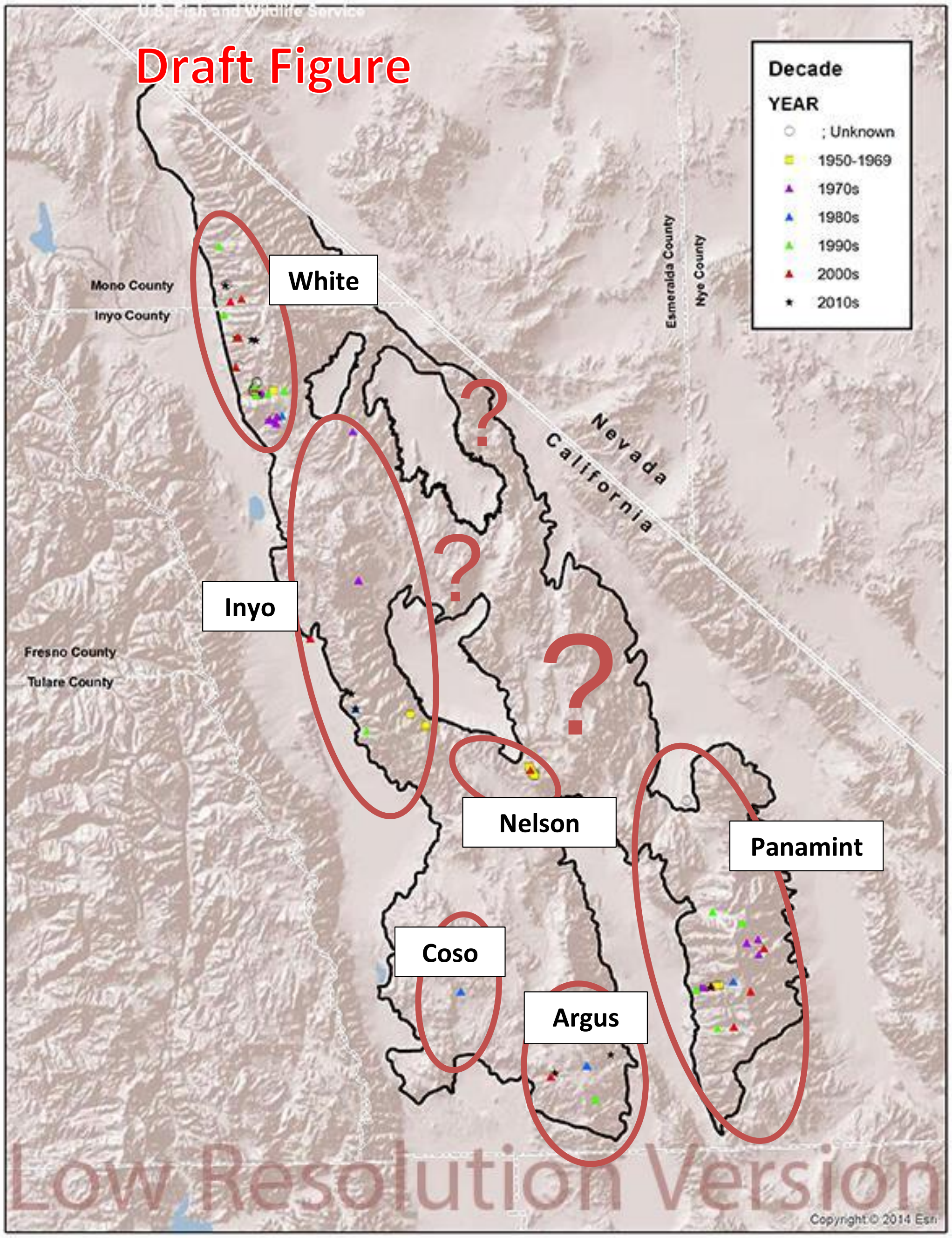

Figure 11. *Panamint alligator lizard detection history, roughly by decade, with mountain-range-scale populations. The mountain-range-scale "populations" (as defined herein) are identified by name. It is not clear whether species occurs in the mountain ranges with question marks.*

Cause and Effects

In this section we identify the threats to the species. We use the term *threat* to refer to any action or condition that is known to or is reasonably likely to negatively affect individuals of a species. This includes those actions or conditions that have a direct impact on individuals (direct impacts), as well as those that affect individuals through alteration of their habitat or resources (stressors). We use the term generally to describe—either together or separately—the source of the action or condition that negatively affects the species, or the action or condition itself. A *source* is the origin of the stressor or direct impact. This may be a human activity or natural phenomenon that results in the stressor or direct impact.

Based on the available literature, we identified a series of possible sources, which may serve as the origin of potential stressors or potential direct impacts to the Panamint alligator lizard. These stressors or direct impacts, in turn, may negatively affect the species' habitat needs or demographic needs. The effects pathways are illustrated in Figure 12. Several of these identified possible sources have the potential to contribute to multiple stressors or direct impacts and are, thus, more complex. These are discussed separately in Appendix A. All of the stressors that are closely linked (one-to-one, or nearly so) with individual sources are discussed together. Additionally, changes in the world's climate have the potential to affect the species and its habitat, simultaneously serving as a potential source and stressor. The potential effects associated with climate change are largely discussed in specific climate change sections.

We examine these sources and stressors under two timeframes, (1) the situation as it is now, currently, as informed by the recent past, and (2) the situation as we anticipate it to be in the future, based on what we know of current conditions and what we can reasonably expect to occur as time goes forward. These two timeframes are discussed separately in separate sections. We describe the effect pathways under current conditions as follows.

All Identified Possible Sources and Potential Stressors that May Affect the Panamint Alligator Lizard, Now or in the Future

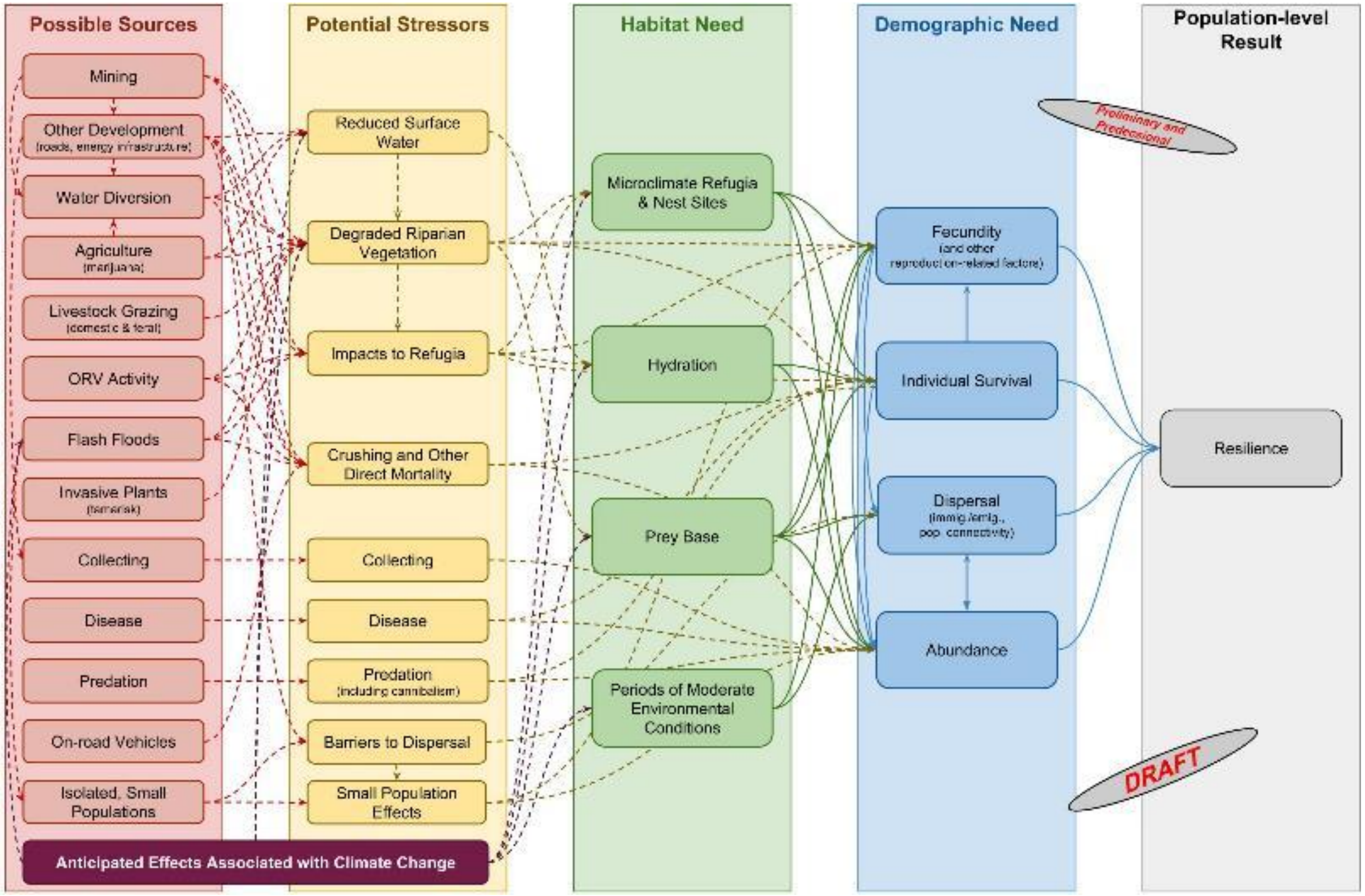

Figure 12. Conceptual model showing the plausible connections between possible sources, potential stressors and direct impacts, habitat needs, demographic needs, and resiliency for the Panamint alligator lizard. The effects associated with the dashed lines have not yet been evaluated (see text).

Evaluated Stressors

Reduced Surface Water

Many of the region's riparian areas have permanent (often spring-fed) or episodic surface flow, which can provide supplemental hydration for Panamint alligator lizards. Also, riparian plants are dependent on having access to water; a reduction in surface flow means a reduction in the overall amount of water in that hydrologic system. As such, any sources that result in a reduction of surface flow, especially during the hot, dry summer, may (1) affect Panamint alligator lizards directly by potentially reducing their ability to stay adequately hydrated or (2) reduce the quantity or quality of riparian vegetation. These two stressors are closely intertwined biologically, but because the potential impacts and the effect pathways differ (Figure 12), we treat the latter stressor in a separate section, below.

A reduction in surface water could be caused by development activities (roads and infrastructure, which is often associated with mining in this region) and existing water diversions (primarily to provide water for human consumption and associated with various development activities). As discussed in Appendix A, mining-related development, especially evidence of past activities, is prevalent in the region; however, current, active mines within and near the Panamint alligator lizard's range are few in number and geographically limited to a few discrete sites. Likewise, there are very few paved or improved dirt roads, and even the unimproved roads are sparse on the landscape; while roads can have an impact on surface flow, not all of them substantially affect surface flow. As such, overall impact to surface water within the species' range is limited. Existing energy-related infrastructure within the range of the species consists of one existing geothermal facility and linear features (pipelines, powerlines) that cross the area. The geothermal facility is geographically discrete and small compared to the species' range, and linear features are few with limited overall impact.

Although areas with surface water are important to the species, individual Panamint alligator lizards do not appear to solely depend on those areas for hydration. That is, in some areas where the species occurs, the only water an individual Panamint alligator lizard is likely to encounter is from precipitation or condensation, even in the absence of identified potential stressors or direct impact. Thus, a reduction in surface water would only have a limited impact on individual Panamint alligator lizards' needs for supplemental water. Moreover, current activities that may result in a reduction of surface water are few and geographically limited within the range of the Panamint alligator lizard. Therefore, the identified potential stressor of Reduced Surface Water is only likely to affect a few individual Panamint alligator lizards at scattered locations throughout the species' range.

Degraded Riparian Vegetation

This stressor is closely related to the identified potential stressor of Reduced Surface Water. We treat the two separately because (1) there are more possible sources that can result in degradation to riparian vegetation, an important component of the Panamint alligator lizard's heterogeneous habitat, and (2) the potential impacts to the species' resiliency follow different pathways (Figure 12).

As discussed in the Use Areas section, Panamint alligator lizards ~~appear to~~could be at their highest densities in areas with riparian vegetation, many of which have perennial or seasonal surface flow. A reduction in the quality or quantity of riparian vegetation may reduce the level at which Panamint alligator lizard populations at or near those sites are subsidized, thereby reducing abundance, fecundity, and survival of those site-specific populations.

Riparian vegetation can be impacted by several possible sources. These include mining activities, other development, and agriculture, which can result in destruction of riparian plants (Figure 12). Additionally, they may also affect a site's hydrology, resulting in a reduction in surface flow, which can subsequently affect the quality or quantity of riparian vegetation by causing riparian plants to die or to become stressed. Other sources include, grazing and browsing by livestock (primarily domestic cattle and sheep, and feral horses and burros), which can eat and trample riparian plants and alter an area's hydrology. Off-road vehicle (ORV) activity can crush riparian plants. Flash floods can physically destroy or remove (wash away) riparian plants or result in avulsive changes in a stream's channel, leaving existing stands of vegetation dewatered. Invasive, nonnative plants, such as tamarisk (*Tamarix* spp.), can replace native plant species that are likely to be superior as habitat to support the Panamint alligator lizard.

Reviewed in detail in Appendix A and summarized below, the following possible sources are currently making limited contributions to the identified potential stressor of Degraded Riparian Vegetation:

- Mining activities and other development activities are often concentrated in the canyon bottoms and valley floors, where riparian vegetation also grows. Once more common throughout the range of the Panamint alligator lizard, mining activity is now rare and typically localized on the landscape within the species' range, affecting a small amount of the region's riparian vegetation. Thus, these possible sources of impact are making limited contributions to the identified potential stressor of Degraded Riparian Vegetation.

- Agriculture (illegal marijuana cultivation) in the region occurs exclusively in riparian areas, where associated activities result in destruction of native riparian plants and, more importantly, can result in diversion of water which can affect native riparian vegetation downstream. However, current levels of illegal marijuana cultivation are limited and much localized. This activity is making a limited contribution to the identified potential stressor of Degraded Riparian Vegetation.

- Grazing and trampling by feral and domestic livestock can have substantial impacts on riparian areas in particular. Although formerly more common throughout the Panamint alligator lizard's range, ongoing agency review and management on Federal land has reduced the level of impact and, as a result, has improved the quality and quantity of riparian vegetation throughout the species' range, although the amount of impact from feral equines is higher in the southern mountain ranges (Coso, Argus, and Panamint). Thus, grazing by domestic and feral livestock is affecting riparian areas within the species' range, but it is doing so only in localized areas and is subject to management to reduce impacts; as such, grazing is making a limited contribution to the identified potential stressor of Degraded Riparian Vegetation.

- Flash flooding is affecting riparian areas within the species' range, but it is doing so only very locally and infrequently with temporary impacts throughout the species' range; as such, it is making a limited contribution to the identified potential stressor of Degraded Riparian Vegetation.

We now assess the extent to which this potential stressor is currently resulting in an impact on the Panamint alligator lizard. Degraded riparian vegetation can impact the Panamint alligator lizard's habitat needs of microclimate refugia, hydration, and prey base, and the species' demographic needs of suitable levels of fecundity, individual survival, and abundance (Figure 12). Areas of riparian vegetation provide thermal and hydrological refugia; however, as discussed in the Use Areas section, Panamint alligator lizards also occur in areas of talus, apparently at moderate densities, and in other upland areas within the species' range, albeit at much lower densities. Thus, areas of riparian vegetation are important sources of microclimate refugia for breeding and sheltering, but the species is not solely restricted to riparian areas and can find refugia in areas without riparian vegetation. The subsidizing nature of riparian areas also makes them important sources of food and water for Panamint alligator lizards, but similarly, they find enough resources in non-riparian areas to live and survive. This is exemplified by the apparent lack of any extirpations of local (canyon-scale) populations even where riparian vegetation has been severely impacted in the past. Thus, areas of riparian vegetation are important but not relied upon entirely to provide the Panamint alligator lizard with its habitat and demographic needs. Given that riparian vegetation is not the sole source of the species' needs, and given that the current extent of impacts to riparian vegetation are geographically limited in scope, the current level of loss and degradation of riparian vegetation from the identified stressors is likely to only affect a small number of Panamint alligator lizards rangewide.

Comment [a38]: I suggest that this highlighted passage be deleted, for reasons discussed previously.

Comment [a39]: Yes, this is excellent and well supported.

Impacts to Refugia

As noted above, degradations in riparian vegetation can affect Panamint alligator lizard refugia and contribute to the identified stressor of Impacts to Refugia. Additionally, mining, other development, ORV activity, and flash floods may contribute directly to this stressor (Figure 12). As discussed in Appendix A, only flash flooding is likely to make a substantive contribution to this stressor, but it is doing so only very locally and infrequently, and this is limited to those refugia that occur within the flood zone. However, Panamint alligator lizard refugia are not geographically limited to the flood zone or to riparian areas; they may also occur in areas of talus, in particular. There are many areas of talus in the rugged, rocky mountains where this species primarily occurs. While refugia are important components of the species' habitat needs that, in turn, allow for important demographic needs, refugia are not limiting on the landscape and do not occur only in areas that may be affected by flash floods or by the degradation of riparian vegetation. As such, the potential sources that currently may result in impacts to refugia are of small magnitude rangewide and are likely to only affect a small number of Panamint alligator lizards.

Crushing and Other Direct Mortality
Individual Panamint alligator lizards have the potential to be crushed or otherwise directly killed by mining activity, other development, drowning in water diversions structures, ORV activity, flash flooding, and on-road vehicle activity (Figure 12). On-road vehicle activity is not addressed in Appendix A, but the others are, with only flash flooding making a limited contribution to this stressor. However, impacts associated with flash floods are very local and infrequent. On-road vehicle activity is addressed as follows.

State Route 168, one of the two highways that occur in the species' range, goes through a canyon that supports Panamint alligator lizards. Individual Panamint alligator lizards crushed by (on-road) vehicles have been detected along this paved highway (Morrison and Hall 1999, p. 235; Cunningham and Emmerich 2001, 56th page (unpaginated); Clause *et al.* 2015, 14th page (unpaginated); Clause *et al.* 2017, 4th page (unpaginated)). Pavement retains heat and may serve as an attractant to ectothermic reptiles as a heat source, which may increase the likelihood that a Panamint alligator lizard will be crushed. Although the available data are anecdotal, the Panamint alligator lizard population in this area does not appear to have declined despite these ongoing impacts (Clause *et al.* 2015, 14th page (unpaginated)). Panamint alligator lizards have not been detected in the immediate vicinity of the other highway in the area, and few other roads in the region are paved. The region also has a dispersed network of maintained dirt roads, including in canyons where Panamint alligator lizards are known to occur (such as Silver Canyon in the White Mountains). Any Panamint alligator lizard crossing a road, regardless of its surface, has an increased exposure to being crushed by a vehicle; however, we do not expect Panamint alligator lizard will be attracted to unpaved roads, which means they will spend less time on them. Beyond the aforementioned observations, we are not aware of any other Panamint alligator lizards having been crushed by vehicles. Such events elsewhere in the species' range are likely very rare, impacting only the occasional individual, and occurring much less often than along the relatively more-traveled State Route 168, where it is infrequent. Similarly, the geographically and temporally limited impacts of flash flooding and the *de minimis* impacts by the other identified potential sources (Appendix A) are currently not of sufficient magnitude to result in much more than small or localized impacts to the Panamint alligator lizard.

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Collecting
Collecting for commercial, recreational, scientific, or educational purposes has been suggested in the literature as a possible impact to the Panamint alligator lizard (Mahrdt and Beaman 2002, p. 3; Mahrdt and Beaman 2009, p. 491, Yasuda 2015, p. 49). The State of California designated the Panamint alligator lizard as a Reptile Species of Special Concern (Jennings and Hays 1994, pp. 116–118; Thomson *et al.* 2016, pp. 202–206), which means among others, that the species may not be collected without State authorization. Legal collecting for scientific and educational purposes has occurred in the past, but currently there are no live specimens in captivity at educational institutions, and the number of preserved specimens is limited (Clause *et al.* 2015,

14th page (unpaginated)). While Yasuda (2015, pp. 49) notes that some illegal collecting has occurred, it is not clear how frequently it happens. Clause *et al.* (2015, 14th–16th pages (unpaginated)) report finding little in the way of large-scale collecting infrastructure (cover boards, pitfall traps) during recent fieldwork, although such items have been noted in the past (Morafka *et al.* 2001, 4th page (unpaginated)). Clause *et al.* (2015, 15th page (unpaginated)) also failed to find any Panamint alligator lizards for sale from on-line sources, suggesting a limited market. Thus, if illegal collecting is occurring, it does not appear to be rampant at the current time. Moreover, Panamint alligator lizards continue to be comparatively easily found at the most readily accessible and widely known site, which is where the effects of overcollection (if it were occurring) would presumably be the most noticeable (Clause *et al.* 2015, 15th page (unpaginated)). Thus, only a small number of Panamint alligator lizards, at most, are being affected by illegal collecting, and those impacts are localized.

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Disease
Some level of disease is undoubtedly natural in the Panamint alligator lizard; however, no ailments or afflictions have been found to have a population-level effect on the species (Morafka *et al.* 2001, 4th page (unpaginated); Clause *et al.* 2015, 16th page (unpaginated); Yasuda 2015, p. 19). Therefore, the current impacts of disease are affecting only a few Panamint alligator lizards.

Predation
Nearly all animal species are exposed to predation; predation by itself does not necessarily have a population-level impact on a species. As discussed in the Predators and Predator Avoidance section, Panamint alligator lizards are subject to some level of natural predation by a wide range of taxa. Additionally, as discussed in the Foraging section, some level of cannibalism also probably occurs in Panamint alligator lizard populations. If the proportion of Panamint alligator lizards with re-grown tails is an indication, there is some evidence to suggest that many individuals have been exposed to (and survived) predation attempts. We need to ascertain whether the current predation level is substantially affecting a large number of individuals across a wide area beyond normal and natural levels. In the absence of direct data, information on whether the level of predation has increased substantially can help inform this analysis.

Human activity can subsidize certain predators, such as common ravens and coyotes, inflating their populations. This pattern has been noted with other prey species elsewhere in the Mojave Desert (Kristan and Boarman 2003, entire). It is also possible that changes in prey availability due to environmental variation (such as drought) can drive subsidized predators to seek other prey (Esque *et al.* 2010 entire), which could potentially include Panamint alligator lizards. However, past field surveys in the range of the Panamint alligator lizard have noted few subsidized predators (Cunningham and Emmerich 2001, Site Reports therein; Morafka *et al.* 2001, 4th page (unpaginated)). Also, there is no information to suggest that the level of predation has changed significantly over time, nor does predation appear to have caused any reduction in Panamint alligator lizard populations (Morafka *et al.* 2001, 4th page (unpaginated); Clause *et al.* 2015, 16th page (unpaginated)). Therefore, the current level of predation does not appear to be substantially above natural levels.

Barriers to Dispersal
As noted in the Species' Needs section, dispersal is important to the Panamint alligator lizard at the individual, population, and species levels. Something that prevents dispersal-related movement would be a barrier. Barriers may be physical (like a wall) or conditional (such as adverse environmental conditions). However, environmental conditions can often exceed an individual lizard's tolerance levels. The species' behavior of seeking refugia (transitory and established; see the Refugia section) allows individuals to readily cope with such conditions. An individual Panamint alligator lizard will likely have better success in moving the larger distances implied in dispersal (including moving away from known, established refugia) when environmental conditions are more moderate. As noted in the Thermoregulation section, individuals can and do take advantage of daily and seasonal periods of moderate conditions, for example, adjusting daily activity patterns from diurnal to crepuscular or nocturnal. Similarly, longer-term (seasonal) periods of moderate environmental conditions can occur during the spring and autumn, and there is suspicion that some Panamint alligator lizards seasonally move to and from riparian areas. While subject to annual variation, we expect that these periods offer opportunities for dispersal. Even with favorable environmental conditions, dispersal nevertheless involves risk to the individual—such as from increased likelihood of predation or exposure. Thus, if an individual can tolerate the existing levels of competition and predation in its home range, it is unlikely to disperse (though it may venture forth and move larger distances to seek a mate). If, on the other hand, an individual is pressured by competition or predation in its preferred home range, it may disperse. In such cases, any physical or conditional barriers preventing dispersal would increase that individual's likelihood of death. Thus, extrapolating upwards from the individual level to the population level, barriers can potentially serve as a stressor at the population level (see also the Population-level Needs and Species-level Needs sections).

Panamint alligator lizards are typically faced with few natural physical barriers that would have a population-level effect (although a given individual at a particular site might face an insurmountable physical barrier that may limit its ability to disperse). As noted in Appendix A and above, we do not consider roads and vehicular traffic manmade physical barriers. Under current conditions, there is little to suggest that conditional barriers occur for long enough periods of time (within the annual cycle) to prevent dispersal-related movement; that is, seasonal conditions (typically during spring and autumn) are, on average, of adequate duration for dispersal. This is exemplified by populations persisting in areas that have been subject to severe disturbance (such as historical mining, flash floods). Therefore, under current conditions, the identified potential stressor of Barriers to Movement is not a threat.

Small Population Effects
The decline of a population is determined by a number of forces and factors that are often described as being intrinsic or extrinsic. As described by Soulé and Simberloff (1986, pp. 27–28):

> Extrinsic forces include deleterious interactions with other species (increases in predation, competition, parasitism, disease or decreases in mutualistic interactions) and deleterious events or changes to habitat or the physical

> environment. Intrinsic factors include random variation in genetically based traits of the species and interactions of these traits with the environment. These include: (1) demographic stochasticity, which is random variation in sex ratio [and] in birth and death rates, . . . (2) social dysfunction or behaviors that become maladaptive at small population sizes; [and] (3) genetic deterioration brought on by inbreeding, genetic drift and other factors.

For a population to become extirpated (extinction at the population scale), these extrinsic and intrinsic forces and factors must substantially affect the population. These forces and factors are more likely to be substantial for small populations (Goodman 1987, pp. 11–34; Pimm *et al.* 1988, pp. 757–785; Lande 1993, pp. 911–927; Frankham 1996, pp. 1500–1508; Henle *et al.* 2004, pp. 207–251).

The point at which a population becomes a “small population” is not clear and varies by species-specific or situational-specific factors. There is disagreement among scientists and considerable uncertainty as to the population size adequate for long-term persistence of wildlife populations. As stated by Thomas (1990, p. 324), “there is no ‘magic’ population size that guarantees the persistence of animal populations.” He went on to note that populations of some vertebrates have survived for decades with population sizes of hundreds or even dozens of individuals, adding “populations that occupy habitat fragments that are far too small to hold thousands of individuals may still possess great conservation potential” (Thomas 1990, p. 326). Frankham *et al.* (2014, entire) recommended the effective population size[5] should be at least 100 individuals to avoid inbreeding depression over the short term (5 generations) and 1,000 individuals to maintain evolutionary potential over the long term. The amount of time that most authors consider to be “long term” may be many decades or centuries or even in perpetuity (for example, see Shaffer 1981, p. 132; Soule and Simberloff 1986, p. 28; Traill *et al*. 2010, p. 31; see also Reed *et al.* 2003, p. 30, Table 3 therein; Frankham *et al.* 2014, p. 58). Frankham *et al.* (2014, p. 59) noted that populations with effective populations sizes of less than 1,000 individuals are “not doomed to extinction in the short to medium term, but their ability to evolve to cope with environmental change will erode with time and this will reduce their long-term viability.” While these intrinsic forces and factors can substantially affect a population through a series of cascading effects, the initiation of such effects, as noted in the quote at the start of this section, is inherently random (Soulé and Simberloff 1986, pp. 27–28).

Panamint alligator lizards are not evenly distributed across the landscape. Preliminary results from a recent genomic study indicate that the Panamint alligator lizard occurs as a number of genetically distinguishable groups (Toffelmier and Shaffer 2017, entire). We have no data on the number of Panamint alligator lizards in any of these groups at this time, but it seems unlikely that the effective population size of any of the interbreeding populations is in the thousands. The preceding sections (individual evaluated stressors) largely address the extrinsic

[5] At its simplest, the ***effective population size*** is the number of individuals that contribute offspring to the next generation. For a variety of reasons, the effective population size is a subset (often a much smaller subset) of the total number of individuals in a given interbreeding population (see Scribner *et al.* 2006, p. 387).

forces and factors. We address the intrinsic factors of demographic stochasticity, social dysfunction or behaviors, and genetic deterioration for the Panamint alligator lizard.

As mentioned above, demographic stochasticity, social dysfunction, and genetic deterioration are potential intrinsic factors that may affect small populations. While there is little specific information to inform the situation for the Panamint alligator lizard, we are not aware of any demographic patterns that may be debilitating to the Panamint alligator lizard populations. For example, at the few sites where multiple Panamint alligator lizards have been detected, none of the investigators have reported a skewed age or sex ratio. Moreover, the sex of individual Panamint alligator lizards does not appear to be temperature dependent in this species, so population demographics are not complicated by direct environmental effects. Thus, we are not aware of any demographic needs that are being negatively affected by demographic stochasticity, but more research would help definitively determine this.

There is little in the species' life history to suggest that it is particularly susceptible to social dysfunction. The species does not appear to have, for instance, a complex mate-selection behavior that might become dysfunctional at low population densities. It seems unlikely the species exhibits social behaviors that may be negatively affected by small population sizes.

It is unclear whether the observed population-level genetic structuring found throughout the species' range (Toffelmier and Shaffer 2017, entire) is indicative of "genetic deterioration." However, the relatively little gene flow between even neighboring populations, let alone across larger (between mountain-range) distances, suggests that the species' resiliency may be lower than it would have been had there been more gene flow. That said, there is little to suggest in the species' observed phenotypic traits across its range that might indicate that it has suffered from genetic deterioration. More research is needed to determine whether there are any less observable effects.

In sum, the pattern of distribution of the Panamint alligator lizard has suggested to many authors that it may be susceptible to the deleterious effects of small population size. However, the available information suggests that there is some gene flow, at least between neighboring canyon-scale populations within a mountain range, although it occurs rarely and appears to decrease with distance. The available information also suggests that there is virtually no gene flow between mountain-range-scale populations. The available information, although extremely limited, further suggests that the effective population sizes are probably smaller than what is considered to be sufficient to maintain evolutionary potential over the long term. Despite this, no deleterious effects associated with small population size have been detected. Moreover, there is little to suggest that much has changed in the populations of the Panamint alligator lizard over the recent past. While we agree that the species' distribution pattern could make it more susceptible to the random effects of small population sizes, it is not currently exhibiting those potential effects to a great extent.

Climate Change Effects

There is some evidence to suggest that the region's temperatures have increased over the past several decades; for example, Gonzalez (2016, entire), although short on details, reported a statistically significant increase of 1.3 ± 0.5 °C/100 yr (2.3 ± 0.9 °F/100 yr) for Death Valley National Park for the period 1950–2010. As discussed in greater detail in the Climate Change Effects section under the Future Conditions and Status, other authors have also noted similar temperature increases in the greater Mojave Desert region over the 20th century. Although these increases may potentially have occurred as a result of global climate change, the cause and effect relationship for this observed increase is not yet clear. There is little information to suggest that these noted temperature increases or any other climate change effects are currently having a substantial impact on the Panamint alligator lizard or its habitat. We expect any effects associated with global climate change, should they occur, will manifest themselves more fully in the future. Thus, we do not address potential effects associated with global climate change in the Current Conditions section. Please see the Future Conditions and Status section for more information on this topic.

Uncertainties

We know very little about the Panamint alligator lizard itself because the region where it occurs is rugged and remote, with very little of its range easily accessible. This inaccessibility (1) has limited the level of scientific inquiry on the species, and (2) has limited the amount of up-to-date on-the-ground information on potential activities or stressors impacting the species throughout its range. On the other hand, this inaccessibility also has limited the quantity and magnitude of anthropogenic threats in the region. We know a good deal more about the management environment within the species' range. About 98.7 percent of the range is federally owned. All of the Federal landowners have existing guidance documents, which are derived from or implement existing regulatory mechanisms (Appendix B). These guidance documents include measures that directly or indirectly benefit the Panamint alligator lizard or its habitat through avoidance, minimization, or other conservation measures.

Current Condition Summation

The amount of data on the Panamint alligator lizard is limited, hampering most aspects of this evaluation. The species first became known to science in the 1950s; the number of sites where they have been found has fairly steadily increased over that time. The species is known to be distributed across six desert mountain ranges in eastern California: the White, Inyo, Nelson, Coso, Argus, and Panamint Ranges. Existing data show Panamint alligator lizards have a considerable amount genetic variation across five of the six mountain ranges, and we assume the Panamint alligator lizards in the sixth, the Coso Range, which was not sampled, will follow the pattern and have genetic differences as well. The species' range spans two major ecoregions: the White and Inyo mountain ranges are in the Great Basin (in the north); the remaining mountain ranges are in the Mojave Desert (in the south). The White, Inyo, and Panamint Ranges achieve high elevations (more than 11,000 ft (3,350 m)), while the Nelson, Coso, and Argus ranges attain more modest heights (about 7,700 to 8,800 ft (2,350 to 2,680 m)).

The species occurs nearly entirely on Federal lands; moreover, 64.7 percent of its range designated as Wilderness (Table 3). Some of the potential stressors identified above (Figure 12) used to be affecting the species at a higher magnitude or had a greater likelihood of occurring in the past; however, the identified stressors are currently only affecting small numbers of individuals, are much localized in their effects, or both. The effects of the potential sources and stressors under current conditions have little effect on the species' habitat and demographic needs (Figure 13).

Many of the sources and stressors are closely allied and have the potential to work in combination. In particular, mining, other development, water diversions, and agriculture all can impact the amount or availability of surface (or near-surface) water, which in turn can affect riparian vegetation. Water and the riparian vegetation it supports are important habitat resources for the Panamint alligator lizard because they promote high levels of primary productivity, which appears to subsidize Panamint alligator lizard populations. Yet, even cumulatively, there is little to suggest that anything more than a few individuals are being currently affected.

Data on the species' population size are insufficient to indicate any population trend. None of the Panamint alligator lizard populations (mountain-range-scale or canyon-scale) are known to have suffered extirpation, although we have no recent data for two (mountain-range-scale) populations and we presume them to be extant (Table 5). The current information indicates that the species' habitat needs are broader than once thought; that is, Panamint alligator lizards are not solely restricted to the region's few, isolated riparian areas. Genetic data suggests there is low-level gene flow between neighboring (canyon-scale) populations, indicating that a small amount of dispersal (immigration, emigration) is successfully occurring between nearby populations.

The representation of the Panamint alligator lizard is portrayed by its genetic variation across six mountain ranges that exhibit a north-south environmental gradient from the Great Basin ecoregion in the north to the Mojave Desert ecoregion in the south. At the species level, redundancy is illustrated by four of the six mountain ranges having more than one canyon-scale population, although the number of interbreeding (narrow-sense) populations in a given mountain range is unclear. Two mountain ranges are known to have only one canyon-scale population each, although this may emphasize the species' secrecy more than its actual distribution. While the quality of the available site-specific detection data is inconsistent and largely anecdotal or haphazard, the lack of any known extirpations suggests the Panamint alligator lizard is resilient, even at the smaller, canyon-scale. Similarly, the apparent lack of extirpations also suggests that the species' levels of redundancy and representation has not decreased over the past half-century or so since the species was discovered, and there is no information to suggest that it suffered substantial losses prior to that.

Existing Sources and Stressors That May Affect the Panamint Alligator Lizard

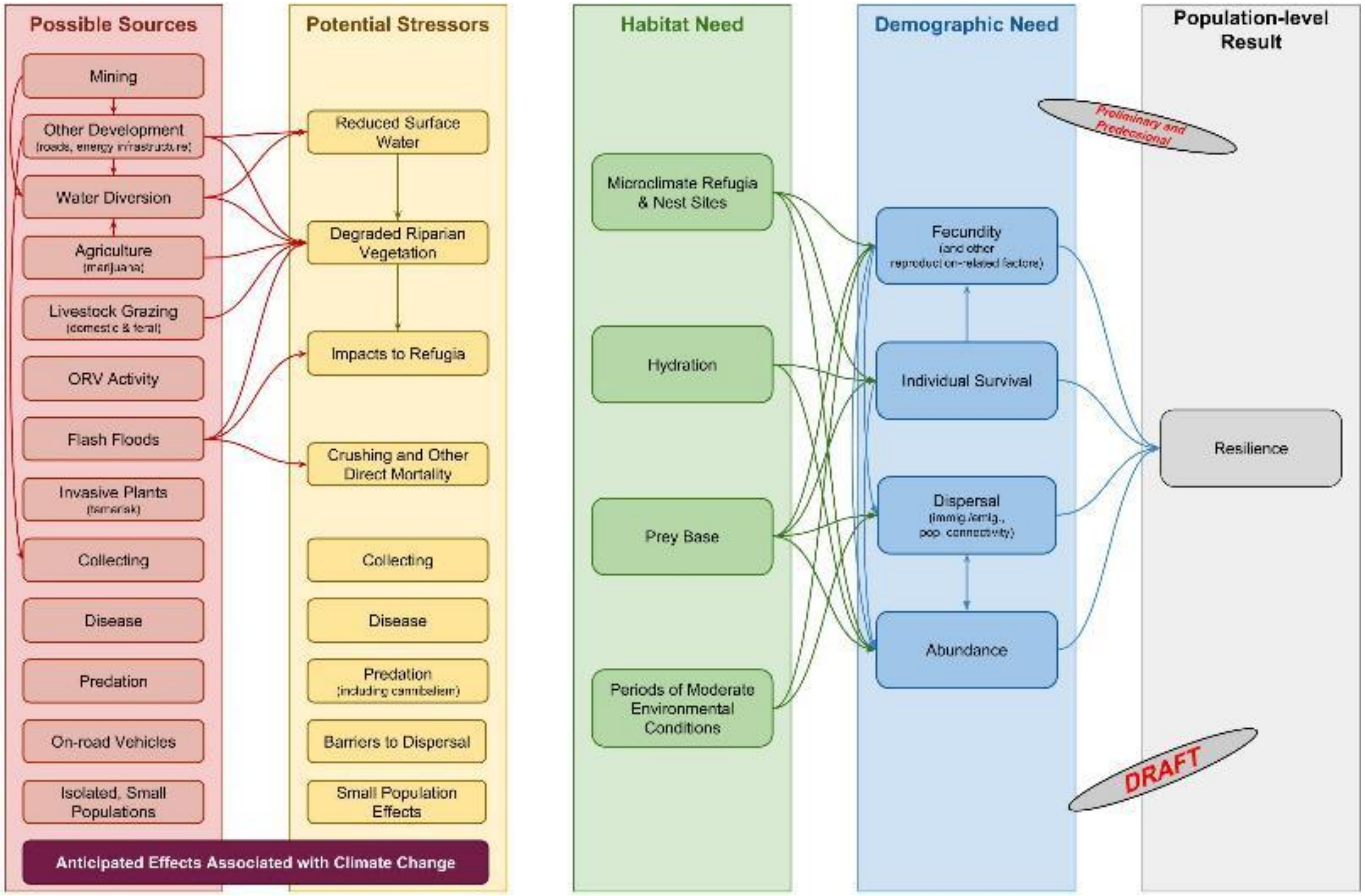

Figure 13. *Conceptual model showing the analyzed connections between existing (not future) sources and stressors and the habitat needs, demographic needs, and resiliency for the Panamint alligator lizard. After analysis (see text), we determined that none of the identified potential stressors are currently having a substantial impact on the species' population-level resiliency.*

9.0 FUTURE CONDITIONS AND STATUS

In this section, we assess the *future* threats to the Panamint alligator lizard. Drawing upon the information and evaluations in the Current Conditions section, we consider the potential contributions of sources on stressors in the future and, correspondingly, how those stressors may negatively impact the species' habitat and demographic needs (Figure 13). We evaluate these sources and stressors in the context of (1) any existing regulatory mechanisms that may reduce impacts to the species or its habitat and (2) other existing efforts to protect or conserve the species (or any such efforts, if and where applicable, that are planned but not yet implemented). Like in the Current Conditions section, the effects of more complex sources are discussed separately in Appendix A.

Evaluated Stressors
Future changes in the global climate have the potential to affect a number of possible sources and potential stressors (Figure 13). For this reason, we evaluate this topic first. We then review the possible effects of the other identified potential stressors in the future. These evaluations follow two general formats. Some of the topics are addressed in detail here. Others are less detailed. This latter group, to reduce redundant text, tier closely from the discussions presented in the Evaluated Stressors section under Current Conditions, and the discussions of current and future conditions of certain possible sources presented in Appendix A.

Climate Change Effects
As defined by the Intergovernmental Panel on Climate Change (IPCC), the term "climate" refers to the mean and variability of different types of weather conditions over time, with 30 to 50 years being a typical period for such measurements, although shorter or longer periods also may be used (IPCC 2013a, p. 1450). The term "climate change" thus refers to a change in the mean or the variability of relevant properties, which persists for an extended period, typically decades or longer, due to natural conditions (such as solar cycles) or human-caused changes in the composition of atmosphere or in land use (IPCC 2013a, p. 1,450).

Scientific measurements spanning several decades demonstrate that changes in climate are occurring. In particular, warming of the climate system is unequivocal, and many of the observed changes in the last 60 years are unprecedented over decades to millennia (IPCC 2013b, p. 4). The current rate of climate change may be as fast as any extended warming period over the past 65 million years and is projected to accelerate in the next 30 to 80 years (NRC 2013, p. 5). Thus, rapid climate change is adding to other sources of extinction pressures, such as land use and invasive species, which will likely place extinction rates in this era among just a handful of the severe biodiversity events observed in Earth's geological record (American Association for the Advancement of Sciences 2014, p. 17).

Examples of various other observed and projected changes in climate and associated effects and risks, and the bases for them, are provided for global and regional scales in recent reports issued by the IPCC (2013c, 2014, entire), and similar types of information for the United States and regions within it can be found in the National Climate Assessment (Melillo *et al*. 2014, entire).

Results of scientific analyses presented by the IPCC show that most of the observed increase in global average temperature since the mid-20th century cannot be explained by natural variability in climate and is "extremely likely" (defined by the IPCC as 95 to 100 percent likelihood) due to the observed increase in greenhouse gas concentrations in the atmosphere as a result of human activities, particularly carbon dioxide emissions from fossil fuel use (IPCC 2013b, p. 17 and related citations).

Scientists use a variety of climate models, which include consideration of natural processes and variability, as well as various scenarios of potential levels and timing of greenhouse gas emissions, to evaluate the causes of changes already observed and to project future changes in temperature and other climate conditions. Model results yield very similar projections of average global warming until about 2030, and thereafter the magnitude and rate of warming vary through the end of the century depending on the assumptions about population levels, emissions of greenhouse gases, and other factors that influence climate change. Thus, absent extremely rapid stabilization of greenhouse gases at a global level, there is strong scientific support for projections that warming will continue through the 21st century, and that the magnitude and rate of change will be influenced substantially by human actions regarding greenhouse gas emissions (IPCC 2013b, 2014; entire).

Global-scale climate projections are informative, and often the best scientific information available for some geographical locations. However, projected changes in climate and related impacts can vary substantially across and within different regions of the world (e.g., IPCC 2013c, 2014; entire) and within the United States (Melillo *et al*. 2014, entire). Therefore, we use "downscaled" projections when they are available and have been developed through appropriate scientific procedures, because such projections provide higher resolution information that is more relevant to spatial scales used for analyses of a given species (for additional discussion on downscaling, see Glick *et al*. 2011, pp. 58–61; Behnke *et al.* 2016, entire).

Various changes in climate may have direct or indirect effects on a species. These may be positive, neutral, or negative, and they may change over time, depending on the species and other relevant considerations, such as interactions of climate with other variables such as habitat fragmentation (for examples, see Franco *et al.* 2006; Forister *et al*. 2010; Galbraith *et al*. 2010; Chen *et al*. 2011; Bertelsmeier *et al*. 2013, entire). In addition to considering individual species, scientists are evaluating potential climate change-related impacts to, and responses of, ecological systems, habitat conditions, and groups of species (such as, Deutsch *et al*. 2008; Euskirchen *et al.* 2009; Berg *et al*. 2010; McKechnie and Wolf 2010; Sinervo *et al*. 2010; Beaumont *et al*. 2011; McKelvey *et al*. 2011; Rogers and Schindler 2011; Bellard *et al*. 2012, entire).

Regional temperature observations for assessing climate change are often used as an indicator of how climate is changing. The Western Regional Climate Center (WRCC) has defined 11 climate regions for evaluating various climate trends in California (Abatzoglou *et al*. 2009, p. 1,535). Two indicators of temperature, the increase in mean temperature and the increase in maximum temperature, are important for evaluating trends in climate change in California. For the climate region that encompasses the western Mojave Desert (Mojave, California), the 100-year linear trends provided by the WRCC indicate an increase in mean temperatures (Jan–Dec) of approximately 2.09 °F ± 0.52 °F/100 yr (1.16 °C/100 yr) since 1895, and 3.94 °F ± 1.22 °F/100 yr (2.19 °C/100 yr) since 1949 (WRCC 2016, entire). Similarly, the maximum temperature 100-year linear trend for the Desert Region shows an increase of about 1.87 °F ± 0.61 °F/100 yr (1.04 °C/100 yr) since 1895, and 3.31 °F ± 1.53 °F/100 yr (1.84 °C/100 yr) since 1949 (WRCC 2016, entire). We assume the rate of temperature increase for this region is higher for the second time period (since 1949) than for the first time period (since 1895) due to the increased use of fossil fuels in the 20th century. Additionally, Gonzalez (2016, p. 4) reported that there has been an increase of 2.3 ± 0.9 °F/100 yr (1.3 ± 0.5 °C/100 yr) in Death Valley National Park for the period 1950–2010.

Although these observed trends provide information as to how climate has changed in the past, climate models can be used to simulate and develop future climate projections. Pierce *et al*. (2013, entire) presented both State-wide and regional probabilistic estimates of temperature and precipitation changes for California (by the 2060s) using downscaled data from 16 global circulation models and 3 nested regional climate models. The study looked at a historical (1985–1994) and a future (2060–2069) time period using the IPCC Special Report on Emission Scenarios A2 (Pierce *et al*. 2013, p. 841), which is an IPCC-defined scenario used for the IPCC's Third and Fourth Assessment reports and is based on a global population growth scenario and economic conditions that result in a relatively high level of atmospheric greenhouse gases by 2100 (IPCC 2000, pp. 4–5; see Stocker *et al*. 2013, pp. 60–68, and Walsh *et al*. 2014, pp. 25–28, for discussions and comparisons of the prior and current IPCC approaches and outcomes). Importantly, the projections by Pierce *et al*. (2013, pp. 852–853) include daily distributions and natural internal climate variability.

Simulations using these downscaling methods project yearly averaged warming for the area that encompasses the Mojave Desert ranging to be from 4.5 °F (2.5 °C) to 5.4 °F (3.0 °C) by the 2060s time period (Pierce *et al*. 2013, p. 844, Figure 3 therein), compared to 1985–1994. The simulations indicated a temperature increase for this area of 4.86 °F (2.7 °C) from 1985–1994 to 2060–2069 (averaged across models using seasonally averaged data) (Pierce *et al*. 2013, p. 842, Figure 1 therein).

Increasing temperature can affect precipitation patterns. The effects of global climate change appears to have already reduced the amount of precipitation that fell as snow throughout most of the western United States (although apparently less so in eastern California), and this trend is likely to continue into the future (Pierce *et al.* 2008, entire; Kapnick and Hall 2012, entire). A greater ratio of precipitation falling as rain and earlier melt times in the spring are expected to reduce the amount of groundwater recharge, which can affect upwelling at springs (Konikow and Kendy 2005, entire), although site-specific conditions (including, among others, such features as soil, slope, and aspect) will determine whether or to what extent this general process will transpire at the local level. The amount of groundwater is important to maintaining the spring-fed areas of riparian vegetation within the range of the Panamint alligator lizard.

Although 3-year droughts are not unusual when evaluated over the past 1,000 years in California (Griffin and Anchukaitis 2014, p. 9,020), beginning in 2012 and continuing through 2016, California experienced a severe drought throughout most of the State. Griffin and Anchukaitis (2014, entire) evaluated how unusual this drought event was in the context of the last millennium using blue oak (*Quercus douglasii*) tree-ring data from four sampling sites (with additional tree sampling following the 2014 growth season). Their paleoclimate drought and precipitation reconstructions for Central and Southern California show that, although the precipitation during this drought was anomalously low (based on tree ring chronologies), it was not outside the range of variability (Griffin and Anchukaitis 2014, p. 9,017). However, when evaluated on an annual basis, the 2014 drought was the worst single drought year of at least the last 1,200 years in California. The severity of this drought condition was demonstrated in the 2014 summer Palmer Drought Severity Index, which was calculated to be the lowest (driest) on record (1901–2014) (Williams *et al*. 2015, p. 6,823). In addition, the 2012–2014 drought event was the most severe of three consecutive drought years, based on three events found in the record for the last 1,200 years (Griffin and Anchukaitis 2014, pp. 9,020–9,021). The study concluded that low precipitation combined with high temperatures was responsible for creating this extreme short-term drought episode, which the authors characterized as “the worst drought on record” (Griffin and Anchukaitis 2014, pp. 9,021–9,022).

Williams *et al.* (2015, entire) recently estimated the anthropogenic contribution to California’s drought during 2012–2014. They found that the intensifying effect of high potential evapotranspiration on this drought event (measured by summer Palmer Drought Severity Index levels) was almost entirely the result of high temperatures (18–27 percent in 2012–2014; 20–26 percent in 2014) (Williams *et al*. 2015, p. 6,825). Another study evaluating the influence of temperature on the drought in water year 2014 in California found that, although the low level of precipitation was the primary driver for the drought conditions, temperature was an important factor in exacerbating the drought, noting that the water year 2014 was the third year of the multiyear drought event and therefore conditions were drier than normal at the beginning of the water year (Shukla *et al*. 2015, p. 4,392).

In sum, these projections indicate that increased temperatures ranging from 4.5 °F (2.5 °C) to 5.4 °F (3.0 °C) are likely to occur in the western Mojave Desert by the 2060s due to the effects of climate change. Droughts occur naturally in the region and are sometimes severe, but the anticipated temperature increases are expected to contribute to future drought severity.

Statewide and regional probabilistic estimates of precipitation changes for California were also evaluated by Pierce *et al*. (2013, entire). When averaged across all models and downscaling methods, small annual mean decreases in precipitation were found for the southern part of California, but there was significant disagreement across the models (Pierce *et al*. 2013, pp. 849, 854). Some simulations indicate an increase in summer rainfall within the Mojave Desert region, and dynamic downscaled simulations, when compared to statistical downscaling methods, found larger increases in summer precipitation in the region of California affected by the North America monsoonal flow, including portions of the Mojave Desert region (Pierce *et al*. 2013, pp. 851, 855).

Tagestad *et al*. (2016, pp. 394, 396) also found a projected increase in precipitation for the Mojave Desert region using four global climate change models and two IPCC scenarios—A1 (high emissions) and B2 (low emissions). Relatedly, projections of differences between precipitation and evapotranspiration (water availability) in 2070–2099 as compared to 1975–2004 by Gao *et al*. (2014, pp. 1,746–1,747) found a decrease in the availability of water in southern California during spring months, but an increase or no change for winter and summer months.

In sum, there is much disagreement among models of future changes in precipitation amounts and timing; there is a possibility that overall rainfall could decrease in the region but monsoon-related summer rain events could become more frequent.

<u>Potential Effects of Climate Change on the Panamint Alligator Lizard</u>
As discussed in the Life History and Species' Needs sections, the Panamint alligator lizard is ectothermic and an individual needs to rely on its behavior to maintain its preferred body temperature—such as basking to warm itself, seeking refugia to avoid temperature extremes, entering into hibernation during the cold of winter, and changing its daily activity patterns (diurnal, crepuscular, nocturnal) in response to seasonal or short-term changes in temperatures. In other words, the Panamint alligator lizard already copes with environmental temperatures that can be well outside (above or below) its preferred body temperature. Any increase in the average environmental temperature within the region, as is predicted to occur in the future, has the potential to affect the species on a seasonal and daily basis. Under a warmer future, for example, we expect that a Panamint alligator lizard's period of hibernation may become shorter or that it may spend more of its active time being nocturnal. The Panamint alligator lizard likely has a lower critical maximum body temperature compared to other co-occurring lizard species. This could put the Panamint alligator lizard at a competitive disadvantage in the future. Likewise, under a warmer future, periods of moderate environmental conditions will likely shift seasonally, but it is not clear whether or how dispersal opportunities for the Panamint alligator lizard might be affected.

Reduced overall precipitation, if that transpires in the future, could be expected to reduce the quantity and timing of surface flow and, subsequently, the quality and quantity of riparian vegetation, which depends on water availability. Even spring-fed systems could be affected because groundwater levels could decrease. The intensity and frequency of droughts have the potential to increase in the future, but it is not clear how much this will affect the Panamint alligator lizard. While we do not have detailed demographic data for any Panamint alligator lizard populations, we have presence data during and after the extreme 2012–2014 drought. In 2014, at the peak of the drought, Panamint alligator lizards were detected at five sites (canyon-scale or smaller) in the White, Inyo, Argus, and Panamint Ranges in 2014 (Clause 2015, 6th page (unpaginated)). Additionally, in 2017, after the drought, Panamint alligator lizards were detected at multiple specific sites from six canyons in the White Mountains (Clause 2017, unpaginated, Table 1 therein). While the conclusions we can draw from this “presence only” data are limited, it is clear that despite the drought (at its peak and shortly afterwards) Panamint alligator lizards were still detectable and that these canyon-scale populations had not become extirpated. This suggests that Panamint alligator lizard populations (in a broad sense) can survive very severe droughts, at least over the short term.

Comment [a41]: Yes, excellent.

Increased frequency of summer rains, which often manifest themselves as torrential thunderstorms in the region, could also result in more frequent flash floods in a given canyon, but there is much uncertainty around future precipitation predictions. While the frequency or severity of floods could potentially increase, Panamint alligator lizards still occur in canyons that have endured severe flash floods in the past.

On the other hand, there are efforts to reduce the potential future impacts associated with global climate change. At various governmental levels as well as by nongovernmental entities, there are efforts to limit the rise of average global temperatures, but it is not clear whether or to what extent these efforts will be successful. With the high levels of uncertainty inherent in the potential effect of global climate change and the world’s response, it is difficult to make on-the-ground predictions for the Panamint alligator lizard and its habitat.

In all, we have little in the way of solid information from which to base our prognosis. There is some uncertainty in the amount and type of environmental change that is likely to occur in the region at the geographical scale of the species’ range; the farther out in time the models look, the greater the amount of uncertainty in the projections. Additionally, there are few data on the Panamint alligator lizard’s needs and responses to environmental stressors. More research is needed on these topics. However, with that noted, the amount of uncertainty in the projections over the next half-century is lower. As such, we anticipate that global climate change may potentially contribute to or exacerbate existing sources and stressors, including increasing flash flood frequency, reducing surface water, and degrading riparian vegetation. These are discussed separately in their respective sections, below or in Appendix A.

Additionally, effects associated with climate change may serve as stressors affecting the habitat requirements of the species, including the need to have suitable microclimate refugia and nest sites, the need to have a sufficient prey base, and the need to have periods of moderate environmental conditions. We discuss these here.

Microclimate Refugia and Nest Sites

As discussed in the Species’ Needs section and as mentioned in several sections preceding that, refugia are important because they are places where individual Panamint alligator lizards may seek protection from predators and extreme environmental conditions (particularly temperature and related desiccating effects). A subset of available refugia also serve as nest sites and hibernacula. The anticipated increase in environmental temperatures in the future (circa 50 years) may make the availability of suitable refugia more important to individual lizards. Although we know little about the specific qualities of the species’ established refugia, it is likely that the rocky environment where the Panamint alligator lizard occurs offers many options for refugia. Sites with riparian vegetation will offer additional refugia options. This is not to say that premium refugia are necessarily in surplus; there will likely always be competition (intraspecific and interspecific) for refugia, especially in a warmer future, but we expect that the often boulder-strewn sites where this species typically occurs will provide enough refugia for the Panamint alligator lizard to meet its life-history needs, including nesting and hibernation.

Prey Base

As noted in the Foraging section, populations of Panamint alligator lizard prey species (primarily insects) naturally fluctuate seasonally and annually based in large part on temperature and precipitation patterns. Anticipated changes in future environmental conditions will likely have some effect on insect abundance and timing (Kingsolver *et al.* 2011, entire), but it is not clear the extent to which this will occur in the Panamint alligator lizard's range. Given that the environmental conditions that drive prey availability are naturally variable in the region, alterations due to climate change would likely need to be pronounced to have a long-term population-level effect on the Panamint alligator lizard; however, there are few data available at this point. More research on Panamint alligator lizard prey and the prey species' responses to climate change would be helpful.

Additionally, anticipated increases in temperatures may result in changes in the Panamint alligator lizard's ability to hunt. That is, individuals may need to spend more time in refugia to avoid excessive temperatures at the expense of foraging time. However, the Panamint alligator lizard's life history already gives individual lizards options, which allows them to be more flexible. They already have the ability to shift their daily activity patterns (from diurnal to crepuscular or nocturnal) to avoid the heat of the day. Also, they have the option of using sit-and-wait hunting, giving them a greater ability to advantageously use transitory refugia (as compared to a lizard species whose life history is such that it can only use active-search hunting). Moreover, many of the Panamint alligator lizard's prey items are ectothermic organisms as well; while the prey items behavior would not necessarily change in lock-step with the Panamint alligator lizard's behavior, the change in the environment would not unilaterally affect one side of the predator-prey relationship, suggesting that the projected environmental changes would not necessarily be completely to the lizard's disadvantage. Thus, the Panamint alligator lizard's behavioral flexibility suggests that its ability to hunt will not be dramatically affected by increasing environmental temperatures.

Periods of Moderate Environmental Conditions

As described in the Population-level Needs section, there is evidence to suggest that periods of moderate environmental conditions (primarily temperature) are important for Panamint alligator lizard survival and dispersal. The anticipated increase in environmental temperatures due to effects associated with climate change has the potential to affect the timing and duration of these periods. It is likely that seasonal temperature regimes will shift, with springtime temperatures happening earlier in a given year and autumnal temperatures happening later. It is not clear whether these periods will be substantially shorter. We expect there will also be an upward elevational shift in temperatures. Over most of the Panamint alligator lizard's range, the species occurs on the low-to-mid elevation portions of mountain ranges. As such, the species has the potential to shift upwards as the moderate environmental conditions shift. The extent to which conditions will shift with time or with elevation is unclear, and the species' response to any such changes is also unclear. However, despite the uncertainties, the Panamint alligator lizard appears to have life-history and geographical options that may allow it to cope with changing environmental conditions. As such, we do not expect the species' survival and dispersal abilities will be substantially affected.

Reduced Surface Water
As discussed in the Evaluated Stressors section under Current Conditions, identified possible sources that may contribute to this potential stressor include Other Development and Water Diversion. We expect future impacts from these activities will be limited because of the amount of designated Wilderness and other regulatory mechanisms that limit impacts in the region. However, the few activities that may transpire in the future will do so in conjunction with a potential overall decrease in precipitation or with an increased likelihood of severe droughts. As discussed in the Evaluated Stressors section under Current Conditions, the Panamint alligator lizard may not need flowing surface water to meet its supplemental hydration needs. Indeed, Panamint alligator lizards were detected at multiple locations during and after the extremely severe 2012–2014 drought event. Thus, reduced surface water may not have a direct effect on the species, but the loss of surface flow may indicate an overall reduction in the amount of water, which in turn may result in the degradation of riparian vegetation; this topic is discussed next.

Degraded Riparian Vegetation
As discussed in the Evaluated Stressors section under Current Conditions, the quality and quantity of riparian vegetation may be reduced from a number of sources. Because the amount of degradation of riparian vegetation is limited, and because the species is not solely dependent on riparian vegetation for its habitat, we concluded that the impacts of this stressor is likely only affecting a small number of individual Panamint alligator lizards. In the future, we anticipate that the same possible sources may contribute to this stressor, along with impacts associated with invasive nonnative plants. Also, effects associated with climate change, including reduced precipitation and groundwater and the increased severity of droughts could result in the degradation of riparian vegetation in the future.

Following from the discussions in Appendix A, we expect development of roads and energy infrastructure and water diversion activities, including effects associated with mining and illegal marijuana cultivation, are likely to continue in the future but at a small scale given the remoteness of the area and because of implementation and enforcement of the existing regulatory mechanisms on Federal land that will help avoid and minimize potential impacts. Grazing by domestic and feral livestock is also likely to continue into the future, and be managed by Federal agencies under existing regulatory mechanisms. The elimination of burros in the greater Coso-Argus-Panamint region (the stated management goal for that area) would greatly reduce the amount of grazing pressure in that area, but that is unlikely to occur in the short term. Feral horses will continue to need ongoing management. Given that populations of feral equines are more unpredictable and agency funding is not likely to be sufficient to fully implement the existing plans every year, monitoring and management will be needed to keep populations from returning to the very high densities of the past. Similarly, invasion by nonnative plants, primarily tamarisk, is also unpredictable, so even though we do not anticipate tamarisk to become a large-scale problem within the range of the Panamint alligator lizard, agency vigilance will be needed for the existing management mechanisms to be effective.

As discussed in the Climate Change Effects section, predictions suggest that flash floods might become more frequent in the Panamint alligator lizard's range in the future. There is much uncertainty around the likelihood of this prediction; even if summer thunderstorms become more frequent, flash floods will still likely be localized and rare within a given canyon (see Flash Floods section in Appendix A). Even with some level of increase, not all areas of riparian vegetation are within the floodplain, instead being associated with seeps and springs on canyon walls. Moreover, when scouring from floods occurs, it is often a temporary impact, with riparian vegetation adapted to the naturally dynamic systems, although changes in hydrogeomorphology can sometimes result in longer-term or permanent changes. As such, impacts to the species' riparian habitat would likely to be local and typically temporary.

Also as discussed in the Climate Change Effects section, predictions suggest that groundwater levels might decrease as result of a decrease in overall precipitation or through a reduction in the percentage of precipitation that falls as snow (rain being more likely to flow away on the surface rather than sink into the soil). Also, warmer temperatures will result in earlier snowmelt, again increasing surface flow and reducing water percolation into the soil. If the predicted conditions were to transpire in the future, the amount and timing of water surfacing at downslope springs and seeps would likely decrease, which could reduce the quantity and quality of riparian vegetation. The models for overall precipitation provide little certainty. More certain are the predictions for temperature increases, which is likely to affect the percentage of precipitation as snow and the timing of snowmelt. While future precipitation is uncertain, there has been and currently are other human activities that are affecting groundwater levels, but as discussed in Appendix A, the remoteness of the region and the predominance of Federal land, including designated Wilderness, suggest that such activities will be limited in scope and scale.

Thus, there is a potential for climate change to affect the amount of water at the sites that support riparian vegetation within the range of the Panamint alligator lizard. It is not clear, however, how much riparian vegetation will be impacted. For example, a reduction in groundwater levels could, at its worst, result in the loss of all riparian vegetation at a given site, but at non-worst-case levels, less dramatic effects could also ensue, such as a reduction (but not elimination) in the areal extent of riparian vegetation, or a change in plant species composition (such as switching from plant species that draw water from shallow sources to plant species that can draw from deeper sources). Such conditions could also promote tamarisk growth or other invasive, nonnative plant species. A reduction in area would likely have a corresponding decrease in the Panamint alligator lizard population in that area. The effects from a change in plant species composition is less clear, but it will probably result in a decrease in habitat quality (reduced primary productivity) and thus a diminished Panamint alligator lizard population.

Therefore, the anticipated degradation of riparian vegetation in the future has a potential to reduce the population-level resiliency of the Panamint alligator lizard by reducing the fecundity (and other reproduction-related factors) and survival of the individual Panamint alligator lizards that (would have otherwise, absent the degradation and loss of habitat) lived in areas of riparian vegetation. The extent to which this affects the Panamint alligator lizard population-as-a-whole is unclear because (1) there is uncertainty over the extent to which riparian areas will be degraded in the future, and (2) there is uncertainty as to whether or how much Panamint alligator lizard populations outside of riparian areas depend on the "subsidized" productivity within riparian areas; although, it is clear, as discussed in the Degraded Riparian Vegetation section under Current Conditions and elsewhere, that Panamint alligator lizards can and do live in areas that are naturally devoid of riparian vegetation.

Crushing and Other Direct Mortality

As discussed in the Evaluated Stressors section under Current Conditions, Panamint alligator lizards are known to have been run over by vehicles on State Route 168, ~~without apparent~~but there is no evidence of population-level effects. Forecasted use of this portion of the highway is expected to decrease by 2035 (Caltrans 2017, p. 15), but it is not clear from the available information why a decrease is anticipated. Even if use increases, it is unlikely that use will increase substantially because the region is remote and sparsely inhabited, as are the areas that the highway connects. Like under current conditions, vehicle activity on other roads is not expected to result in a population-level effect on the Panamint alligator lizard in the future.

As discussed in Appendix A, there is a potential for an increase in the frequency of flash floods, which could result in an increase in the number of Panamint alligator lizard deaths. However, this possible increase is not certain and the frequency of flash floods occurring in a particular canyon is rare. Thus, crushing and other direct causes of mortality of Panamint alligator lizards in the future are expected to be geographically localized or rare.

Collecting

As discussed in the Evaluated Stressors section under Current Conditions, we concluded that current levels of collecting, regardless of purpose, were only affecting a small number of Panamint alligator lizards at only a few locations. Yet, the available information shows that there has been some legal and illegal collecting. Because of existing regulatory mechanisms currently being implemented by the State and by Federal landowners, we expect future *legal* collecting to occur at sustainable levels. While it is difficult to predict future *illegal* activities, the available information suggests that past illegal collecting activities were limited. There is nothing at this point to suggest that the levels of illegal collection will substantially increase in the future. Thus, we do not expect future collecting activities, for whatever reason, will be substantially larger than current levels.

Disease
Some diseases have been known to have significant impacts on other reptile species (Gibbons *et al.* 2000, pp. 657–658; Lorch *et al.* 2015, entire), and climate change might possibly increase the risk of a pathogen becoming a significant problem (Wake 2007, entire; Bickford *et al.* 2010, p. 1050); however, there is little to suggest that future impacts from disease are likely to occur. We are aware that some novel diseases can be particularly virulent; as such, we recommend that researchers working with Panamint alligator lizard populations should be mindful of this possible but unlikely stressor and watch for potential signs of diseases in the future.

Comment [a42]: An excellent recommendation.

Predation
The current level of predation does not appear to be substantially above natural levels, but it is possible the level of predation could increase in the future. As discussed in the Predation section under Current Conditions, if the amount of human activity were to increase in the region, the number of subsidized predators could also increase. However, due to high amount of Federal ownership and extremely low level of private ownership within the Panamint alligator lizard's range, it is unlikely that the amount of human habitation will increase over the next 40 years or more (see the Land-use Context section). Also, due to the remote nature of the region, where about 64.7 percent is designated as Wilderness, the amount of human visitation to the region is also likely to be limited. This is especially true in the remote areas that Panamint alligator lizards occupy. As such, there is little likelihood that predation pressure by subsidized predators will increase in the future. It is also unlikely that environmental changes would be sufficient to shift predation pressures enough to have long-term effects on populations of the highly secretive Panamint alligator lizard in its range where refugia are abundant in most areas. Therefore, there is little to suggest that possible changes of predation pressure in the future will exceed the level the Panamint alligator lizard is already facing.

Barriers to Dispersal
As discussed in the Evaluated Stressors section under Current Conditions, we concluded that any potential "barriers" are not currently completely impenetrable and thus are unlikely to be a threat to the Panamint alligator lizard. There is little to suggest that future conditions will be such that the identified potential stressor of Barriers to Movement will be of sufficient magnitude to substantially affect the species.

Small Population Effects
As discussed in the Evaluated Stressors section under Current Conditions, many Panamint alligator lizard populations are probably "small" and, thus, are more likely to be affected by random deleterious effects associated with small population size; however, there is little suggest that these populations are suffering from those effects or have suffered from them over the recent past. In the future, it is likely that these populations will continue to remain "small" and will continue to be more susceptible to the random intrinsic forces and factors that may negatively affect small populations. However, because these forces and factors are primarily the result of random events, it is not clear whether or to what extent they will manifest themselves on the Panamint alligator lizard in the future.

Summary of Future Conditions

Similar to current conditions, future conditions for the Panamint alligator lizard will continue to hinge upon the remoteness of the area and the existing regulatory mechanisms governing or implemented by the various Federal agencies that own and manage nearly all of the species' range. While there may be some changes in this regulatory environment in the future, we expect them to be fairly minor with respect to the future physical environment within the region. In all, we expect future, non-climate-change-related sources and stressors to be geographically limited or to impact only a few Panamint alligator lizard individuals. Catastrophic disease could possibly affect the Panamint alligator lizard in the future (Figure 14), but there is little to suggest that a highly virulent outbreak is likely. The amount of future impact from grazing will primarily be dependent on the level of management of feral equines, primarily in the Coso and Argus Ranges. The other non-climate-change-related sources and stressors are related to water and its influence on the species' habitat, including other development activities, water diversions, and illegal cannabis cultivation.

Moreover, the effects of future climate change have the potential to influence and add to (in combination) many of the other possible threats to the species. The expected increase in temperatures and the uncertain status of future precipitation may contribute to changes to the amount and timing of surface and groundwater availability, including flash floods. These, in turn, have the potential to result in the loss or degradation of riparian vegetation (Figure 14).

The severity or likelihood of these potential future impacts are unknown at this time. In the next section, we examine the possibilities in greater detail.

Future Sources and Stressors That May Substantially Affect Population-level Resiliency

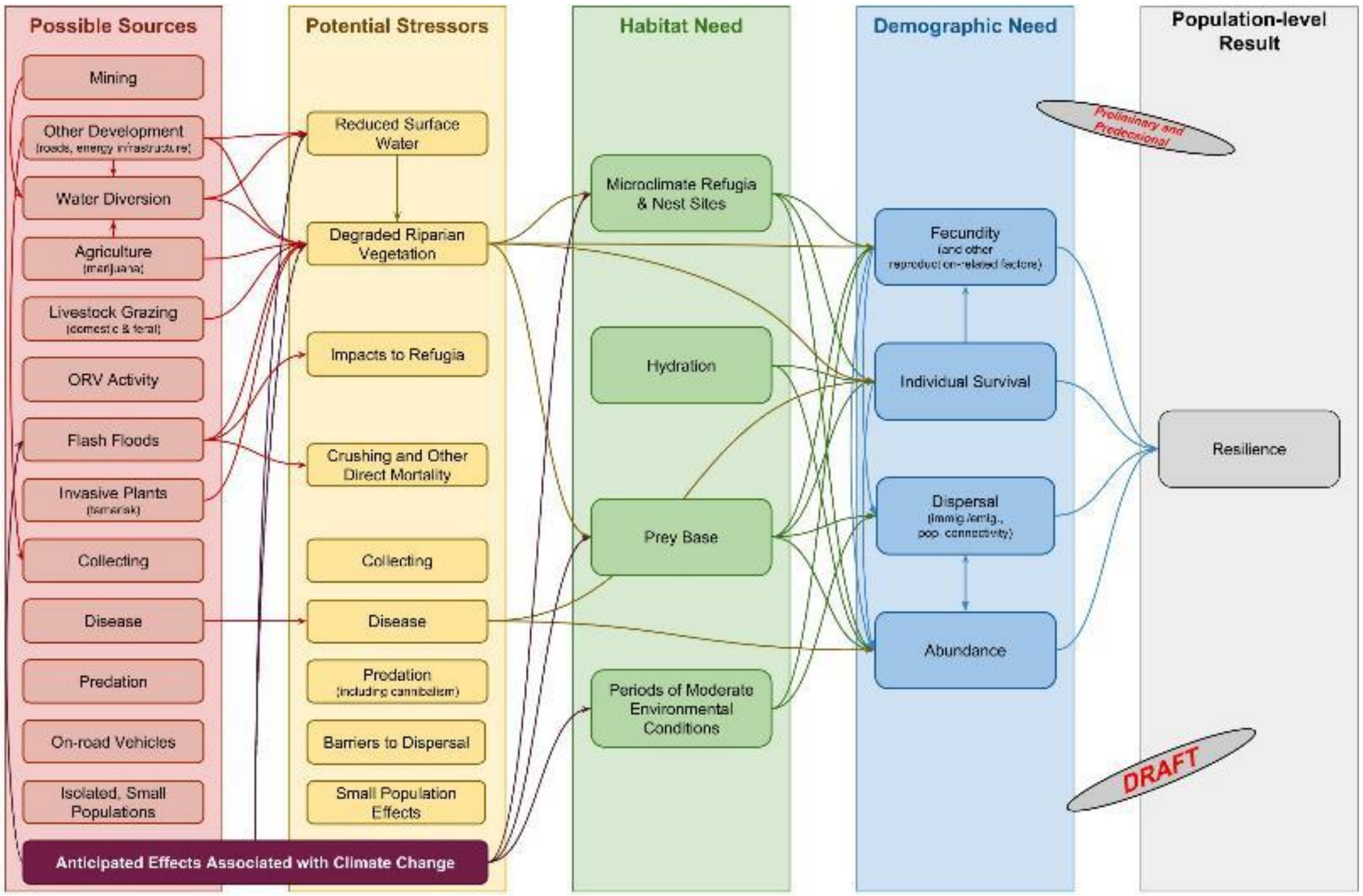

Figure 14. *Conceptual model showing the anticipated connections between sources and stressors and the habitat needs, demographic needs, and population-level resiliency for the Panamint alligator lizard in the future. See the Description of Future Scenarios section for additional interpretation.*

10.0 DESCRIPTION OF FUTURE SCENARIOS

In the preceding sections we identified possible sources and stressors that could potentially impact the Panamint alligator lizard (Figure 12), and we assessed them under current conditions (Figure 13) and in the future (Figure 14). Under current conditions, taking into account the existing regulatory mechanisms and efforts being undertaken to protect the species or its habitat, the available information suggests that the potential sources and stressors are resulting in quantitative or geographically small impacts on the Panamint alligator lizard. In the future, we anticipate that some potential sources and stressors will have some level of impact on Panamint alligator lizards. Depending on how the future plays out, it is possible that a few of these stressors could be substantial. Given that the future is uncertain, in this section we assess the potential impacts to the species under various scenarios that attempt to capture a realistic range of possibilities.

Scenarios

We examine three possible scenarios to give the reader an idea of the breadth of possible future outcomes for the viability of the Panamint alligator lizard. For these scenarios, we chose a forecast timeframe of 50 years because that is long enough to capture the temporal range of the available climate model projections; however, beyond that timeframe, the level of uncertainty becomes overwhelming, making prognostications of the future unrealistic. The three scenarios include (1) the Status Quo, (2) the Moderate Case, and (3) the Worst Case.

Scenario 1—Status Quo

Under this scenario, we take the existing conditions and project them forward into the future without any changes. As discussed in the Current Conditions section, a few of the stressors are occurring but the number of Panamint alligator lizards impacted is small or the geographical extent is limited. This level of impact is smaller than it was historically, which is in part the result of ongoing implementation of existing regulatory mechanisms or other protective measures by, primarily, the Federal landowners and managers within the species' range.

Under Scenario 1, we predict the identified stressors will manifest themselves as follows. Reductions in surface water are not likely to be occur, and moreover, the species can get supplemental water from rain or condensation. Also, a substantial amount of degradation of riparian vegetation is not likely because, in part, there will be few reductions in the amount of surface water because (1) mining and other development will be limited and (2) there will be few effects from climate change. Degradation of riparian vegetation by domestic and feral livestock—burros, in particular—will continue in this scenario in the Coso, Argus, and Panamint ranges; however, management by the Navy, the BLM, and the NPS, which has reduced this impact over the past few decades, will also continue, reining in the level of impact to riparian vegetation. Impacts to refugia sites are unlikely now and not likely to increase in the future. Refugia will continue to be plentiful and any impacts to them will not be limiting to the species. Under this scenario, crushing by vehicles and illegal collecting will continue, particularly at easy-access sites in the White Mountains near State Route 168, but only small a number of Panamint alligator lizards will be affected.

Diseases will continue at natural levels, which appears to be sustainable for the Panamint alligator lizard. While novel diseases are possible in the future, including potentially virulent ones, there is little data to suggest that any such outbreak is likely to occur. If it was to occur, it would likely be confined to a single mountain range, at least initially, because of the apparent lack of Panamint alligator lizard movement between mountain ranges that is displayed in the available genetic data. Predation is undoubtedly occurring, but even with evidence that many individuals have escaped by autotomizing their tails, there is no indication that there has been an increase in the number of subsidized predators, nor is there information suggesting that predation is having a population-level effect on the species. Under this scenario, these conditions continue into the future. There is no indication that there are anthropogenic barriers preventing Panamint alligator lizards from dispersing, although dispersal by this terrestrial organism is currently limited to relatively short distances (such as, between neighboring canyon-scale populations) and it appears to have been this way for some time.

The intrinsic forces and factors that may be more likely to manifest themselves in small population size are inherently random. The species appears to have occurred in populations with limited connectivity for some time, yet there is little evidence that the species is suffering from the deleterious effects that may be associated with small populations. Such effects, should they occur in a population in the future, would be geographically limited to that population. However, as other (extrinsic) impacts under this scenario occur, reducing a given population's size, the likelihood that the intrinsic factors become significant increases. Thus, we expect the effects of small population size will increase proportionally, on average.

Scenario 2—The Moderate Case

Under this scenario, we take into consideration the anticipated-but-at-an-uncertain-extent changes and the possible-but-at-unknown-likelihood changes and apply them at a moderate level. Many of the potential changes are associated with or are ramifications of global climate change. Indeed, under Scenario 2, we predict that many of the identified stressors will be similar to Scenario 1, except those that depend on climate change. This is because many of the sources that influence the identified stressor are not likely to change much in the future. For example, new mining activity in the future will be limited to certain locations and will likely be subject to environmental review under existing regulatory mechanisms. Although some existing regulatory mechanisms may change in the future, we do not expect broad-scale changes to those mechanisms. Other activities, such as development and ORV activities will also be geographically limited because 64.7 percent of the species' range is designated Wilderness, where no development or ORV activity is likely, and in the remaining Federal land (approximately 34 percent of the species' range), such activities will be reviewed, managed, and subject to enforcement. Anthropogenic crushing and collecting of Panamint alligator lizards are not likely to increase because access by people will be limited by a paucity of roads and developable lands and the general remoteness of the region. This will similarly keep the subsidization of predators low. Also, there will be little to change the status of barriers. Like

Scenario 1, we expect the likelihood that the effects of small population size will increase proportionally, on average, with amount of population-size reduction from the other impacts under Scenario 2, thereby adding to the overall level of impact.

However, we expect, given the available information, that effects associated with climate change will be likely to affect surface water and riparian vegetation. Under this scenario, we are assuming moderate changes in precipitation and temperature in the future. While there is much uncertainty in the amount and timing of future precipitation in the region, there is more certainty about increasing temperatures. We anticipate from the available information that, in this scenario's future, more water will fall as rain rather than snow. We also expect that snowmelt from the higher elevations recharges the groundwater that supplies the springs and seeps that support riparian vegetation. Less snow and more rain can be expected to result in greater runoff and less percolation. Similarly, if the snows melt faster, more water will flow on the surface and less will sink in. Warmer conditions also increase the amount of evaporation. These changes will (on average) reduce the amount of groundwater, which will (over time) result in less water at the springs and seeps that support riparian vegetation. Also under this scenario, periods of drought would be more severe and longer, further reducing groundwater and affecting prey species availability. There would also likely be an upward shift in elevation where periods of moderate environmental conditions would occur long enough for longer-distance dispersal and movement by Panamint alligator lizards.

While we have no way to quantify the future effects to riparian areas under this scenario, we anticipate that most the riparian areas will become smaller (for example, water will be at or near the surface over a smaller area for seeps or over a shorter length of streambed for springbrooks). Some areas of riparian vegetation likely will also undergo shifts in plant species composition. And some of the smaller sites may disappear completely. However, under this scenario, we expect there will continue to be areas of riparian vegetation within the range of the Panamint alligator lizard in the future. These remaining areas, moreover, will be subject to grazing pressures, particularly in Coso, Argus, and Panamint ranges, because feral equines are likely to continue to occur at varying population levels, at least over the short term.

As such, we are anticipating under this scenario, degradation of riparian vegetation, particularly in the Coso, Argus, and Panamint ranges where grazing pressures are likely to be added on top of environmental pressures. However, it is not clear that Panamint alligator lizard populations depend on riparian areas for population maintenance. Currently, Panamint alligator lizards occur in talus areas that are well away from riparian vegetation in ~~apparently~~ what could be self-sustaining populations. Talus areas are less likely to be affected by climate change and are abundant within the species' range. However, it may be that riparian areas are or will become important marcohabitat refugia during periods of drought. A reduction in the quantity and quality of riparian vegetation would reduce the amount Panamint alligator lizards that would be subsidized, leading to lower population sizes, and which, in turn, may allow populations of Panamint alligator lizards in some areas to become extirpated during periods of additional stress, such as prolonged droughts. Yet, under this scenario, we are expecting that some riparian areas will continue to exist. This may be most likely in the mountain ranges that have high elevation peaks that capture more precipitation. Thus, under this scenario, the species could be expected to undergo an elevational shift and a range contraction, but many individual populations would continue to exist.

Scenario 3—The Worst Case
This scenario is the extension of Scenario 2 under more aggressive climate change predictions. The goal is not to contemplate the absolutely worst possible scenario, where every stressor is "maxed out"; instead, the goal, given the level of uncertainty in the available information, is to examine the potential impacts of stressors that may occur at levels substantially higher than in Scenario 2. Like Scenario 2, we expect the stressors that are largely unaffected by climate change will continue at about those same levels. Thus, we will focus our attention on the identified stressors of reduced surface water and degraded riparian vegetation.

Under this scenario, we are assuming large amounts of change in precipitation and temperature in the future. Winter precipitation will be more variable in timing and quantity, and monsoon-related summer rains will be more frequent, although the overall quantity of precipitation will not increase and probably decrease on average over time. Snow will be infrequent and short-lived at all but the highest elevations as temperatures increase.

These changes, should they come to pass, would result in much lower amounts of persistent surface or near-surface water. Seeps and springs, we predict, would only have water for short periods, if at all. They may also be subject to increased pressures of manmade water diversions as water (for all uses) becomes increasingly scarcer in the region. In any case, under this scenario we expect that there will be drastic changes in the quantity and quality of riparian vegetation, reducing the subsidies and, thus, impacting the number of Panamint alligator lizards in a given area. If riparian areas are or will become macrohabitat refugia, the drastic loss of these areas under this scenario, coupled with increased effects of persistent drought and, indeed, increased variability in precipitation in general, could result in the extirpation of many Panamint alligator lizard populations. Summertime floods would scour canyon bottoms more frequently, although probably with years between events in a given canyon, further affecting any remaining riparian vegetation. Panamint alligator lizards within a flood's path would be affected at more frequent intervals, although we expect talus slopes would continue to provide microhabitat refugia outside the flood zone. Thus, under this scenario, there would be a steady decline in the resiliency of Panamint alligator lizard populations, allowing them to become extirpated over time. This would reduce the amount of immigration and emigration. A few isolated populations would likely linger, but would eventually succumb to floods or other catastrophic events.

Scenario Likelihood
Based on the best available information, the most likely future scenario is Scenario 2 because the amount of on-the-ground change over the next 50 years is likely to occur slowly at first. Farther into the future, the amount of change can be expected to be more severe (more resembling Scenario 3), but the amount of uncertainty increases. It is not likely that future, on-

the-ground conditions will resemble Scenario 1, primarily because anticipated changes associated with global climate change are expected to have some effect.

Future Conditions and Scenarios Summation

The region where the Panamint alligator lizard is found is remote. There are no urban areas in the desert mountains it occupies. Roads are few and most are unpaved. Nearly all of the species' range is Federal land, and about two-thirds is designated Wilderness. While existing mining claims are plentiful, the vast majority are unpatented (still on Federal land and subject to Federal review prior to significant mining activity). We do not expect this to change in the future.

The region used to have higher levels of grazing. Grazing in riparian areas, in particular, may reduce the quality and quantity of riparian vegetation. The number of domestic livestock has gone down over time, and Federal agencies are managing the remaining allotments to avoid and minimize impacts to sensitive resources, including features important to the Panamint alligator lizard. The Coso and Argus Ranges (and to a lesser extent, the Panamint Range) used to have a very high number of feral equines, particularly burros. The amount of impact from feral equines has been reduced as a result management; however, future feral equine population levels will depend on ongoing implementation of existing management plans, which are dependent on funding cycles and adoption rates.

The region is dry. Precipitation is generally low and variable from year to year. Persistent water at or near the surface is only found in certain areas and is typically spring-fed. Riparian vegetation grows in a few narrow canyons (along springbrooks) or at isolated seeps and springs. These areas are often downslope and sometimes far removed from taller mountains that capture more precipitation, often as winter snow. While Panamint alligator lizards may be found in dry areas, they achieve their highest densities at or near riparian areas. Subsidized by higher productivity, Panamint alligator lizards in areas of riparian vegetation may serve as "source populations." Riparian areas may also serve as macrohabitat refugia during periods of adverse conditions.

In the future, anticipated changes in the climate may result in less snow (due to increasing temperatures) and more variability in precipitation in general. We expect this will, over time, reduce the amount of groundwater, but it is unclear how long that would take. A reduction in groundwater would, in turn, be likely to reduce the quantity or quality of riparian vegetation, reducing the subsidies these areas provide to the Panamint alligator lizards living there. Thus, through this pathway, climate change may affect Panamint alligator lizard productivity in riparian areas, reducing their value as (1) potential source populations and (2) potential macrohabitat refugia. This would lower the resiliency of the various Panamint alligator lizard populations affected. Over time, we expect that it would ultimately result in the loss of Panamint alligator lizard populations, reducing redundancy in the species. Because the species is genetically variable across its range, the loss of populations would also erode the species' level of representation.

We expect the Panamint alligator lizard will experience a range contraction towards the mountain ranges with high-elevation peaks. The loss and degradation of riparian vegetation due to climate-change-related changes in precipitation would likely occur more quickly in the Coso and Argus Ranges in particular, because they lack the high-elevation peaks that capture precipitation. The Nelson Range is also low-elevation, but Grapevine Canyon (the only place in that mountain range where the species is currently known to occur) appears to be hydrologically connected with taller peaks in the Cottonwood Mountains (the northern extension of the Panamint Range). Thus, the riparian vegetation in Grapevine Canyon would be likely to persist longer there than in the Coso and Argus Ranges. The White, Inyo, and southern Panamint Ranges all have high-elevation peaks, which would be more likely to capture precipitation. Thus, the loss and degradation of riparian vegetation in those mountain ranges would be likely to take even longer, suggesting that Panamint alligator lizard populations in those mountains stay resilient longer.

Additionally, the Panamint alligator lizard appears to be adaptable to naturally changing conditions. It currently experiences and survives in areas that get very cold in the winter and very hot in the summer. It survives these temperature extremes through its behavior. For example, it uses microhabitat refugia to avoid extreme conditions; it hibernates in the winter; and it is known to shift its daily behavior patterns (switching between diurnal and nocturnal in response to changes in temperature). Genetic data indicates that there is some connectivity (albeit low-level) between neighboring (canyon-scale) populations, confirming that individuals can disperse. Thus, there is the possibility that the Panamint alligator lizard could, in some areas, shift its distribution upward in the taller mountain ranges. This would further suggest a range-contraction towards the taller mountain ranges.

11.0 APPENDIX A

Details of Possible Sources

We have identified from the available literature a list of actions that may possibly impact the Panamint alligator lizard (see Figure 12). These possible impacts serve as sources to one or more stressors that, in turn, have the potential to affect the species' population-level resiliency. Several of these identified sources have the potential to contribute to multiple stressors and are, thus, more complex. We provide here, in this Appendix, details on the more complex possible sources. How the stressors may affect the species is addressed under the Current Conditions and Future Conditions and Status sections in the SSA Report.

Mining

Mining and associated ground-disturbing activities have the potential to result in water diversions, which may result in the reduction or elimination of surface water (see Figure 12). This, in turn, may result in the degradation or loss of riparian vegetation—that is, a reduction in the quality or quantity of riparian vegetation (or both). Mining and associated ground disturbing activities can also directly impact riparian vegetation or impact refugia. Mining may take place in many forms, from subsurface (such as shaft mining) to surface (such as open-pit). Under some regulatory situations, oil and gas extraction are treated in the same context as mining. Such activities could even result in the crushing of individual Panamint alligator lizards. Mining can also result in water diversions; this possible stressor source is addressed separately, below.

Existing

Mining claims are prevalent in the region and evidence of past mining activity is pervasive (Giuliani 1977, entire; McKee *et al.* 1985, p. 1; Papenfuss and Macey 1986, p. 12; Cunningham and Emmerich 2001, entire; NPS 2002, p. 65). However, the level of mining activity within the range of the species has decreased over the past few decades, if not longer (McKee *et al.* 1985, p. 5; NPS 2012, p. 102, Clause *et al.* 2015, 11th page (unpaginated)), a trend which has also been noted statewide in California (Causey 2011, p. 3). Although there is some recent evidence of increased interest in mining in the region (NPS 2017 *in litt.*), researchers investigating Panamint alligator lizards have not observed active mines in areas where concentrations of Panamint alligator lizards occur (Clause *et al.* 2015, 11th page (unpaginated)). This suggests that *current* mining activity is not pervasive. While active mines exist within and near the Panamint alligator lizard's range, they are few in number and geographically limited to a few discrete sites. Thus, mining and mining-related ground disturbance currently has a limited impact and is only likely affecting a few individual Panamint alligator lizards at scattered locations throughout most of the species' range. Indirect effects—where mining activities can contribute to other sources—are discussed in those respective sources, below.

Future

It is not entirely clear how pervasive this possible source may be in the future. As noted in the Land-use Context section, only about 0.5 percent of the species' range is private land (Table 2), which in the range of the species is often associated with mining interests (patented mining claims). Not all patented mining claims will necessarily result in active mines in the future. Thus, it does not appear that mining on private land is going to have a substantial impact to the species in the future. Similarly, State land is only 0.8 percent of the Panamint alligator lizard's range, nearly all of which is anticipated to be exchanged with other Federal lands outside of the species' range and thus will become part of the Federal land base (see the Land-use Context section). Even if that did not happen and all of the State land was mined in the future, the acreage alone would suggest that the impact would not be substantial.

Nearly all of the species' range—98.7 percent—is Federal land, with about 42.3 percent as National Park Service (NPS) land, 12.4 percent as Department of Defense land (Naval Air Weapons Station China Lake), 23.3 percent as Bureau of Land Management (BLM) land, and 20.6 percent as U.S. Forest Service (USFS) land (Table 3).

National Park Service

About 42.3 percent of the Panamint alligator lizard's range is in Death Valley National Park (Table 3). Future mining activities on most of the National Park Service (NPS) land will be unlikely. Congress withdrew the lands within Death Valley National Park from new mining claims (Section 305 of the California Desert Protection Act), although 36 existing mining claims were grandfathered in (NPS 2012, p. 17). Most of these are in the Park's western edge (NPS 2002, p. 76), and many are within the range of the Panamint alligator lizard. The Park has only 535 acres (216 ha) of unpatented mining claims (where the claimant does not hold title to the land), and of that area, 147 ac (59 ha) are located in Wilderness (NPS 2012, p. 17). However, should the holders decide to mine these claims, the actions would be subject to (1) applicable laws (such as, 54 USC 1007; the California Desert Protection Act (Public Law 103-433); and in some areas, the Wilderness Act of 1964 (16 U.S.C. 1131 *et seq.*)), and (2) applicable regulations (particularly 36 CFR 9). They would also undergo NPS review and impact analysis (NPS 2002, pp. 65–66, 103). While interest in mining may have recently increased (NPS 2017 *in litt.*), the overall potential impact of future mining activity on National Park Service lands is likely to be localized and small overall, affecting few Panamint alligator lizards.

Department of the Navy

Mining occurred historically on what is now Naval Air Weapons Station China Lake, but those operations were closed when the Navy took control of the area during the 1940s (Navy 2014, p. 3-53). The northern portion of the installation's North Range is within the Panamint alligator lizard's range, representing about 12.4 percent of the species' range Table 3). We do not expect mining to occur on the Station in the future because public access is restricted. We do not expect mining to affect the Panamint alligator lizard or its habitat on Navy land.

Bureau of Land Management

About 23.3 percent of the Panamint alligator lizard's range is on BLM land (Table 3). The BLM has a multiple-use mandate that allows for existing and future mining activities (with restrictions). As mentioned in the Land-use Context section, management of most of the BLM land that is within the range of the Panamint alligator lizard is currently guided by the DRECP LUPA. Significant modification of the existing LUPA or the adoption of a new LUPA, should either be desired, is an involved process that requires public review; as such, we expect the current DRECP-associated LUPA to be in effect for at least several years. The DRECP LUPA includes Conservation Management Actions (CMAs), which comprise the specific set of avoidance, minimization, and compensation measures, and allowable and non-allowable actions for siting, design, pre-construction, construction, maintenance, implementation, operation, and decommissioning activities on BLM land (BLM 2016, p. *xii*). Specific CMAs apply to mineral resources, and surface and groundwater resources, among others (BLM 2016, pp. 135–161). The level of review for future mining activities on BLM land will depend on its location. New mining claims cannot be made in designated Wilderness on BLM Land (BLM 2002, p. K-10), which represents about 13.2 percent of the species' range (Table 3). About 5.8 percent of the species' range has an ACEC designation (including some that overlap Wilderness Areas) (Table 3). ACEC designations highlight areas where special management attention is needed to protect and prevent irreparable damage to important resources, including wildlife (BLM 2016, p. B-1). The BLM will analyze on a case-by-case basis land use authorization proposals (new, renewal, and amendment) to assess whether they are compatible with a given ACEC and its management goals, and many ACECs have a 1 percent disturbance cap (BLM 2016, Appendix B). Future mining activities on other BLM lands (less than 10 percent of the species' range) will be subject to existing laws and regulations and DRECP LUPA requirements (BLM 2016, p. 137). Thus, the overall potential impact of future mining activity on BLM lands is likely to be localized and limited overall, affecting few Panamint alligator lizards.

<u>U.S. Forest Service</u>
The USFS has a multiple-use mandate that allows for existing and future mining activities (with restrictions). About 20.6 percent of the Panamint alligator lizard's range is on the Inyo National Forest (Forest) in the White Mountain Ranger District (Table 3). The Forest's resources are managed per its Land and Resource Management Plan (USFS 1988, entire), which is currently undergoing revision. Under the existing plan, proposed impacts from mining activities will be assessed to ensure adequate protection of other resources and environmental values (USFS 1988, p. 820), which includes standards for riparian areas (USFS 1988, p. 89) and sensitive species (p. 98). The Panamint alligator lizard is a considered a sensitive species by the U.S. Forest Service (USFS 2013, p. 2), although this status could change with the current revision of the existing forest plan. New mining claims cannot be made in designated Wilderness on USFS land (USFS 1988, p. 108), which currently represents about 10.7 percent of the species' range (Table 3). Thus, the remainder of USFS, about 10 percent of the species' range, is not within designated Wilderness and subject to future mining claims and activity. Given the Forest's review process, we do not expect future mining to be rampant on USFS lands, even in non-wilderness areas. Thus, the overall potential impact of future mining activity on USFS lands is likely to be localized and limited overall, affecting few Panamint alligator lizards.

Summary of Future Mining
About 64.7 percent of the Panamint alligator lizard's range is within designated Wilderness, which has been withdrawn from future mining claims. We do not expect any future mining on DOD lands (12.4 percent). Thus, roughly three-quarters of the species' range will not be subject to new mining claims. Any future impacts from new developments at existing claims or future

claims on Federal land will be subject to agency review per existing regulatory mechanisms. While there may be mining activity in the future, we do not expect mining impacts to be geographically extensive, and any associated development (such as roads) likely will not add significantly to the areas already developed (see also Roads below). As discussed in more detail in the Water Diversion section, below, potential impacts that may directly reduce surface water or degrade riparian vegetation will be scrutinized and minimized through agency review. Thus, the identified possible source of mining is not likely to substantially contribute to other development in the future, nor is it likely to substantially and directly contribute to the identified potential stressors of Degraded Riparian Vegetation, Impacts to Refugia, or Crushing and Other Direct Mortality. However, mining will likely contribute to future water diversions.

Other Development
In addition to mines, there are other sources of man-made ground disturbance in the range of the Panamint alligator lizard. Roads and energy-related infrastructure can potentially divert water and result in reduced surface flow. This, in turn, may result in the degradation or loss of riparian vegetation. Roads and energy-related infrastructure can also directly impact riparian vegetation or impact refugia. There are number of road-specific potential impacts. Roadways could serve as barriers to Panamint alligator lizard movement by physically blocking movement or by traffic on the roads crushing individuals before they can get to the other side. Additionally, roads can provide easy (or easier) public access to Panamint alligator lizard populations, potentially exposing them to increased collection pressures. We examine roads and energy-related development below.

Roads

<u>Existing</u>
There are few roads in the Panamint alligator lizard's range and most are unpaved. Many are access routes to historical or ongoing mining activities. By virtue of the region's rugged terrain, many roads follow nature's pre-made paths of least resistance—water-created canyons and valleys (Powell and Klieforth 1991, p. 10). These geographical features are also the primary place where riparian vegetation grows, which is where Panamint alligator lizards likely achieve their highest densities.

Where roads compete for space with (perennial or episodic) watercourses, the construction of the road often results in diversion of streams. More-improved roads include structures, such as culverts, to keep flowing water from damaging the road. These structures can channelize a watercourse, potentially affecting surface flow downstream. It may also restrict the stream's natural lateral movements (meandering). While this may allow for less downstream disturbance of riparian vegetation in the short term, it could limit the long-term productivity of riparian vegetation that is adapted to naturally dynamic systems. Regardless of the potential level of impact from improved roads, we expect such impacts to be minor because there are very few improved roadways in the Panamint alligator lizard's range.

Many of the roads in the range of the Panamint alligator lizard are unsurfaced and have little in the way of improvements. When such roads come to a watercourse, they may simply cross it;

vehicles must ford the stream (when there is water). In narrow canyons, which occur in many of the rugged mountain ranges in the species' range, roads and watercourses may compete for much of the same space—that is, the roadway and the watercourse may co-occur for long stretches (Inyo NF 2012, p. 3; Klingler 2015 *in litt.*). Surface flow in such watercourses is typically episodic or seasonal, but there may be limited stretches where there is perennial surface water flow. In such areas, a road's original construction likely resulted in destruction of any then-existing riparian vegetation, and the disturbance caused by that road's maintenance (Klingler 2015 *in litt.*), or simply its use, likely results in the destruction of any nascent regrowth of riparian vegetation or prevents it from growing at all. It may also affect the hydrology, reducing or redirecting surface flow, including down the compacted roadway (Inyo NF 2012, p. 3; Klingler 2015 *in litt.*), where riparian vegetation cannot grow or is prevented from growing.

While the installation, maintenance, and use of roadways can result in a reduction in the quality or quantity of riparian vegetation, such activities have a limited impact overall. Many canyons with Panamint alligator lizards do not have any roads at all or the roads do not continue far into the canyon (Clause *et al.* 2015, 14th page (unpaginated); Cunningham and Emmerich 2001, Site Reports therein). In those canyons that do have roads, the roadways do not necessarily affect any or all of the riparian vegetation (Clause *et al.* 2015, 14th page (unpaginated)). Moreover, not all riparian areas in the region are restricted to canyon bottoms and can instead be associated with seeps and springs on the sides of canyons. Thus, roads and road use are affecting riparian areas within the species' range, but they are doing so only at a low level; as such, they are making a limited contribution to the identified potential stressors of Reduced Surface Water and Degraded Riparian Vegetation.

Additionally, past road construction could have potentially impacted Panamint alligator lizard refugia, but once the road was constructed, there is little likelihood that features on a road's surface (even little used, unimproved roads) would serve as anything more than transient refugia. Thus, roads and road use currently do not directly and substantively contribute to the Impacts to Refugia stressor.

It is unlikely that roads serve as barriers to Panamint alligator lizard movement because even the most-used roads in region are two-lane highways that see only moderate use (far less than many other State highways)(Caltrans 2015, entire), and have little in the way of additional infrastructure (such as traffic barriers) (Caltrans 2013, entire; 2017, entire). Thus, roads and road use currently do not directly and substantively contribute to the Barriers to Movement stressor. The direct effect of crushing by vehicles is considered separately, below.

<u>Future</u>

About 64.7 percent of the Panamint alligator lizard's range is within designated Wilderness, where new road construction is prohibited. However, designated Wilderness is not all one uninterrupted, conterminous area, even within a given agency's holdings. Instead, the Wilderness Areas throughout much of the region are composed of a patchwork of generally large but separate tracts. Many of the Wilderness Area tracts are separated from their neighbors by the width of an existing roadway (the narrow separations are generally not visible

at the scale portrayed in Figure 11). These roadways existed prior to the designation of Wilderness and, thus, were not included in the Wilderness Areas. Most of these roads are unpaved and many lead to existing or formerly active mines. While these existing roads break up the continuity of the designated wilderness (and, to some extent, the habitat of species occurring therein), the fact that these roads exist means that many future roads will not need to be constructed, even to access future mines in remote areas (should they be developed), inside the general areas of Wilderness or out. Yet, as noted in current conditions, roads and their maintenance can result in impacts to riparian plants and can divert surface flow; thus, they are likely to make limited contributions to the identified potential stressors of Reduced Surface Water and Degraded Riparian Vegetation in the future.

Energy-related Infrastructure

Existing

Infrastructure for utilities (such as wind, solar, geothermal, pipelines, and powerlines) can result in ground disturbance, causing impacts to Panamint alligator lizard habitat. No significant solar or wind generating facilities are within the species range. An existing geothermal facility is at the south end of the species' range within Naval Air Weapons Station (NAWS) China Lake in the 6,400-acre (2,590-ha) Coso geothermal field (Open Energy Information 2015, unpaginated). This area has little in the way of riparian vegetation, but there are talus slopes in the area, and the nearby Haiwee Spring is a site where a Panamint alligator lizard was seen (Giuliani 1993, p. 7; Clause *et al.* 2015, 13th page (unpaginated)). This is the only existing geothermal facility in the species' range. There is little evidence of coal, oil, or natural gas in the region (Brady 1984, entire; Brady 1989, p. F46), and we are not aware of any extraction efforts within the species' range.

Linear utility projects, such as pipelines and powerlines, have the potential to impact large total areas, even if narrow (Lovich and Bainbridge 1999, p. 313). Installation of underground utilities disturbs the surface, as can any associated access roads. This could affect riparian vegetation or refugia. Installation of powerlines causes less ground disturbance, but can provide perches for potential avian predators (Lovich and Bainbridge 1999, p. 313). While a scattering of utilities cross the area, we are not aware of any having been identified as a substantial threat to the Panamint alligator lizard or its habitat. Thus, energy-related infrastructure currently does not substantially contribute to any potential stressors.

Future

The range of the Panamint alligator lizard is outside the DRECP, so there are no Development Focus Areas (DFAs) where renewable energy generation is an incentivized, allowable use through the DRECP (BLM 2016, p. 19). Thus, we do not expect large-scale wind or solar facilities within the range of the species. The proposed 23,000-acre (9,308-ha) Haiwee Geothermal Leasing Area overlaps the extreme western part of the species' range (BLM 2012, p. 1-3), but the draft plan for this leasing area is not yet finalized. Although the Panamint alligator lizard is a BLM Sensitive Species (BLM 2010, p. 2), the species is not addressed by the draft plan (BLM 2012, pp. 3-63 to 3-65). It is not clear whether the species occurs in the proposed leasing area, but the nearby Haiwee Spring is a site where a Panamint alligator lizard was seen (Giuliani 1993, p. 7; Clause *et al.* 2015, 13th page (unpaginated)). While it is not likely that all of the leasing area would be developed, it is not clear the extent to which Panamint alligator lizard habitat might be affected by any geothermal installations in the area; however, the draft plan does take into consideration riparian areas (BLM 2012, p. 4-191). Considering other areas of the Panamint alligator lizard's range, about 64.7 percent is designated Wilderness, where large-scale energy development is unlikely. Should there be any future oil or natural gas extraction operations in the species' range, such activities on Federal land would be subject to the regulatory review (BLM and USFS 2007, p. 2; see also 36 CFR 9; 43 CFR 3160); however, given that there is no evidence of any substantial hydrocarbon resources in the region (Brady 1984, entire; Bedinger *et al.* 1989, pp. F46), we are anticipating such activities to be few (if any). Thus, future energy development has the potential to make limited contributions to the identified potential stressors of Reduced Surface Water and Degraded Riparian Vegetation.

Water Diversion

Existing

Water diversion can reduce or eliminate surface flow, which in turn can reduce the quantity or quality of riparian vegetation. Panamint alligator lizards will also have fewer options for supplemental drinking water should surface flow permanently or temporarily vanish at a given location. Such losses would be most likely during the dry summer when flow naturally declines and a lizard's water needs are greatest.

There is a long history of water diversion in the greater region (Babb 1991, entire; Martin 1991, entire). Water diversions that may affect the Panamint alligator lizard and its habitat have often been associated with mining activities but may have also been implemented to supply water to urban developments or for other uses (Giuliani 1990, 27th page (unpaginated); Cunningham and Emmerich 2001, pp. 27–28; Clause *et al.* 2015, 10th page (unpaginated); Yasuda 2015, p. 20, NPS 2017 *in litt.*). Groundwater pumping may lower water tables and thereby affect surface water, especially if the surface water is from spring-fed sources (DeDecker 1991, p. 225). Illegal marijuana grow operations also typically divert water to irrigate the crop (Bauer *et al.* 2015, entire), and this practice has been observed where cannabis cultivation has occurred in the region (NPS 2017 *in litt.*) (other impacts of marijuana cultivation are addressed in the Agriculture section, below).

Water diversions continue to be a concern. Researchers investigating Panamint alligator lizards have recently observed a number of water diversions for a variety of uses within the species' range (Clause *et al.* 2015, 10th page (unpaginated)), and interest in tapping into existing water sources appears to be increasing in the region (NPS 2017 *in litt.*). Impacts to riparian vegetation from such activities can be substantial, with dead trees and shrubs extending along "sometimes lengthy" stretches (Clause *et al.* 2015, 10th page (unpaginated)). Drying of desert watercourses can affect diversity and abundance of ground-dwelling arthropods (McCluney and Sabo 2012, p. 91), which could potentially affect Panamint alligator lizard prey options and availability. Lack of surface water limits the availability of supplemental drinking water for Panamint alligator lizards. Such impacts result in the reduction in the quantity and quality of Panamint alligator lizard habitat. Thus, water diversion, whether intentional or a consequence of other activities, has the potential to contribute to the identified potential stressors of Reduced Surface Water and Degraded Riparian Vegetation.

In a related impact, individual Panamint alligator lizards can potentially be harmed by water diversion structures, including wildlife guzzlers. Individual lizards have the potential to become trapped inside the structures used for diverting water and die (Hoover 1996, p. 39). Yasuda (2015, p. 17 and 20) observed such structures at many sites within the Panamint alligator lizard's range and noted that none of them had built-in methods of escape for small animals. However, there is no evidence that Panamint alligator lizards have been killed by falling into these structures (Clause *et al.* 2015, 10th page (unpaginated); Yasuda 2015, p. 20), and the overall impact to reptiles appears to be limited (Hoover 1996, p. 39; Andrew *et al.* 2001, p. 277). Guzzlers may also contribute to the subsidization of potential predators, artificially boosting their populations and leading to increased levels of predation on Panamint alligator lizards; however, as discussed in the Predation section, there is little evidence that this is occurring within the Panamint alligator lizard's range. Conversely, it is possible that wildlife guzzlers may serve as artificial sources of supplemental water and be beneficial to Panamint alligator lizards, but there is no evidence for this either. Additionally, wildlife guzzlers may attract native and nonnative grazers, artificially increasing their density at a given site over time and, consequently, encouraging increased herbivory and degradation of vegetation, but there is little to suggest that these fixtures are substantially adding to existing herbivory levels. While the presence of wildlife guzzlers is a possible source of stress, the available information suggests that it currently does not substantially contribute to the identified potential stressor of Crushing and Other Direct Mortality or Degraded Riparian Vegetation.

Future

Activities that may result in water diversions are likely to continue into the future. Given that much of the region is remote, and given that about 64.7 percent of the Panamint alligator lizard's range is designated Wilderness, we do not expect activities that result in water diversions to be rampant. However, because surface or near surface water is very limited in this desert region, it is likely to be the subject of ongoing and future development interest where it does occur, which may also include activities that affect groundwater levels, such as pumping and diversion. About 98.7 percent of the Panamint alligator lizard's range is on Federal land (Table 3). Depending on where the water is located, future water diversion actions are likely to be subject to environmental review and management.

<u>Bureau of Land Management</u>

About 23.3 percent of the Panamint alligator lizard's range is on BLM land (Table 3). As discussed in the BLM section under future mining, above, nearly all of the BLM lands within the range of the Panamint alligator lizard are subject to DRECP LUPA-wide CMAs. For instance, surface water diversion for beneficial use will not occur on BLM lands without a State water right (BLM 2016, p. 141). Additionally, certain ACECs within the Panamint alligator lizard's range, including Great Falls Basin and Panamint/Argus, include provisions such that existing water diversions, pipelines, and wells on public lands will be checked for legitimacy of use (BLM

2016, Appendix B therein, pp. 35 and 58), and no water diversion will be allowed in the Surprise Canyon ACEC (BLM 2016, Appendix B therein, p. 83). Thus, water diversions could occur on BLM land in the future, but such activities are likely to be limited.

U.S. Forest Service
About 20.6 percent of the Panamint alligator lizard's range is on the Inyo National Forest (Forest) in the White Mountain Ranger District (Table 3). As discussed in the USFS section under future mining, above, the Forest's resources are managed per its Land and Resource Management Plan (Plan) (USFS 1988, entire). The plan recognizes water diversion as an impact to riparian areas (USFS 1988, p. 15), and the plan provides standards and guidelines to maintain resource conditions for riparian areas (USFS 1988, pp. 89–91), including a provision to maintain the integrity of desert springs in the White and Inyo Mountains to conserve plant and wildlife habitat. The Forest's plan also addresses Wilderness Areas and sensitive animal species (USFS 1988, pp. 97–102). About 10.7 percent of the Panamint alligator lizard's range is designated as Wilderness within the Forest (Table 3), and the Panamint alligator lizard is a USFS sensitive animal species (USFS 2013, p. 2). Thus, water diversions could occur on USFS land in the future, but such activities are likely to be limited.

National Park Service
About 42.3 percent of the Panamint alligator lizard's range is in Death Valley National Park (Table 3). Impacts to water resources within the Park are of concern to the NPS (NPS 2002, pp. 21–24). Demand for water associated with existing mining claims and other uses within the Park has recently increased and is expected to continue into the future (NPS 2017 *in litt.*). However, nearly all of the Panamint alligator lizard's range within the Park is designated Wilderness; about 40.8 percent of the species' range is designated as Wilderness within the Park (Table 3). The California Desert Protection Act (CDPA) of 1994 reserves a quantity of water sufficient to fulfill the purposes of the CDPA in the Wilderness Areas it designated. The NPS is working with the BLM and other stakeholders to manage and protect federal reserved water rights (NPS 2002, p. 24). Thus, water diversions could occur on NPS land in the future, but such activities are likely to be limited.

Department of the Navy
About 12.4 percent of the Panamint alligator lizard's range is on DOD land in NAWS China Lake (Table 3). The federally listed Inyo California towhee, a species associated with riparian vegetation, also occurs on NAWS China Lake within the Argus Range. The Navy is an active partner working to recover the towhee (USFWS 2008, p. 16; Navy 2014, pp. 3-83 to 3-86). In part due to the towhee's high profile, but also in response to the needs of the Panamint alligator lizard, the Navy is well aware of the wildlife value of water resources and incorporates provisions to minimize impacts into its land stewardship activities, including reviewing and limiting water diversions (Navy 2014, pp. 3-86, 4-16 to 4-18, and 4-29). Thus, water diversions could occur on DOD land in the future, but such activities are likely to be limited.

Summary of Future Water Diversions
About 98.7 percent of the Panamint alligator lizard's range is federally owned, and about 64.7 percent is designated as Wilderness (Table 3). Thus, nearly all future actions that may result in water diversions will be subject to the review of agencies that have guidance or requirements under existing regulatory mechanisms that are intended to protect water resources and riparian vegetation. While we expect some impacts to occur in the future, we do not expect such impacts to occur on a large scale, even relative to the small amount of surface water and riparian vegetation in the region.

Agriculture

Existing
Agriculture in the form of illegal marijuana grow operations have been noted in Panamint alligator lizard habitat, but at low levels (Clause *et al.* 2015, 12th page (unpaginated); NPS 2017 *in litt.*). No other agricultural activities are known to occur in Panamint alligator lizard habitat (grazing, sometimes categorized with agriculture, is considered separately, below). Cannabis cultivation results in destruction of existing riparian vegetation and water diversions, which can result in impacts to downstream riparian areas (Bauer *et al.* 2015, entire) (see the Water Diversion section, above). Thus, agriculture (marijuana cultivation) is affecting riparian areas within the species' range, but it is doing so only at a low level; as such, it is making a limited contribution to the identified potential stressors Degraded Riparian Vegetation and Reduced Surface Water (the latter is primarily by way of water diversions).

Future
With the legalization of marijuana in California and in other States, there is the potential for this impact to increase in the future (Eth 2008, pp. 469–470; Carah *et al.* 2915, p. 825). In response, California State law has increased penalties for environmental impacts associated with illegal cannabis cultivation (McGreevy 2015, entire). Additionally, given that this region is predominantly desert with only a few riparian areas with consistent surface water, and much of the region is remote with limited access, we do not expect future cultivation to be extensive in the species' range. On the other hand, the region's remoteness also limits the potential for monitoring and enforcement (NPS 2017 *in litt.*). Thus, we expect this activity to continue to affect riparian areas within the species' range, but at a low level; it will likely be a limited contribution to the identified potential stressors of reduced surface water and degraded riparian.

Livestock

Existing
Livestock are prevalent in some areas of the Panamint alligator lizard's range. Livestock, in this case, primarily includes domestic cattle and sheep, and feral horses and burros, among others. Grazing and browsing by livestock, plus trampling and other physical impacts, can substantially affect riparian vegetation (see George *et al.* 2012, p. 217), but the amount of grazing has been "dramatically reduced from historical levels" in much of the Panamint alligator lizard's range (Clause *et al.* 2015, 11th page (unpaginated)).

Nearly all of the land in the Panamint alligator lizard's range is under Federal management. There are existing grazing allotments for domestic cattle and sheep, mostly on BLM and USFS land, but also grandfathered in on NPS land. Grazing of domestic livestock on these lands was once more prevalent, but today it is restricted to certain areas and is managed to maintain rangeland quality and to avoid and minimize impacts to sensitive resources, such as riparian areas (USFS 1988, p. 84–86, as amended in USFS 1995, entire; NPS 2002, p. 16–17; BLM 2016, pp. 130–136). Of the grazing allotments on NPS land, several have been permanently retired; only one is ongoing (NPS 2002, p. 67). Many of the grazing allotments on USFS lands are at higher elevations, generally higher than where Panamint alligator lizards are known to occur (Schlick 2017 *in litt.*). Grazing of domestic livestock no longer occurs on NAWS China Lake (Navy 2014, p. 2-11).

In addition to domestic livestock, feral horses and burros occur within the range of the Panamint alligator lizard (such as BLM 2017 *in litt.*). In some areas, feral equines have caused substantial impacts to the vegetation, especially in riparian areas (LaBerteaux 2013 *in litt.*; Navy 2014, p. 3-86; Clause *et al.* 2015, 11th page (unpaginated)). The BLM and USFS are managing wild, free-roaming horses and burros under the Wild Free-Roaming Horses and Burros Act of 1971, as amended (16 USC 1331–1340). The California Desert Conservation Area Plan of 1980, as amended, also addresses the management of feral equines on Federal land in the region. These are implemented through various plans including the BLM's DRECP LUPA, and the Navy has incorporated the 2013 NAWS China Lake Wild Horse and Burro Management Plan into the facility's Integrated Natural Resources Management Plan, which was developed per the Sikes Act (as amended) (16 USC 670(a)). As a result (in part), a partnership comprising the Navy, BLM, and NPS is managing feral equine populations in the southern part of the Panamint alligator lizard's range by removing horses and burros from the wild and putting them up for adoption (Navy and BLM 2005, p. 2-25; Navy 2014, p. 3-64 to 3-69).

Gathering feral equines is costly and there are constraints associated with the adoption program, which has limited the extent of such actions (Navy 2014, p. 3-67), yet equine populations have been lowered dramatically over the past several decades (McGill 1984, entire; Navy 2014, p. 3-66). For example, from 1980 through 2009, a total of 3,541 horses and 10,496 burros were removed from NAWS China Lake (Navy 2014, p. 3-66), which covers much of the Coso and Argus Ranges in the southern portion of the Panamint alligator lizard's range. The goal for the management region covering the southern part of the Panamint alligator lizard's range is to have a horse herd of no more than 168 animals and burro herd of zero (Navy 2014, p. 3-67). For comparison, the equine population data we have indicates that there were 454 horses and 390 burros in the Coso, Argus, and western Panamint Ranges in 2015 (BLM 2017 *in litt.*), which includes NAWS China Lake.

Other management actions in use include fencing riparian vegetation to exclude livestock, which are intended to benefit the Panamint alligator lizard, as well as the federally listed Inyo California towhee, among others (Navy 2014, pp. 4-5 to 4-6; BLM 2017, pp. 33, 55, and 105 in Appendix B therein). While fencing is being used in some areas, many riparian areas with grazing pressure from feral equines (in particular) are not yet fenced and more fencing is needed (LaBerteaux 2013 *in litt*.; Navy 2014, p. 4-5). Although grazing by feral equines is especially evident at the south end of the Panamint alligator lizard's range, there are many areas known or suspected to be occupied by Panamint alligator lizards where evidence of recent grazing is limited or lacking (Clause *et al.* 2015, 12th page (unpaginated)).

Additionally, in the southern portion of the Panamint alligator lizard's range, primarily in the Argus Mountains but also (to a much lesser extent) portions of the Panamint Mountains, riparian areas also serve as the primary habitat for the federally listed Inyo California towhee (*Melozone* (= *Pipilo*) *crissalis eremophilus*) (USFWS 2008, p. 9). Many of the riparian areas in the Argus Mountains have been designated as critical habitat for the towhee (USFWS 1987, entire). As a result, there is increased management of riparian areas on Federal land (primarily Navy and BLM) within the range of the Inyo California towhee, which benefits all species in riparian areas, including the Panamint alligator lizard. The towhee has been proposed for delisting, in part due to ongoing management of the species' riparian habitat on Federal land (USFWS 2013, pp. 65941–65946). However, even in the areas being managed to benefit the towhee, the on-going level of management has not eliminated all of the impacts from feral equines in areas of riparian vegetation (LaBerteaux 2013 *in litt.*).

Thus, livestock grazing by domestic and feral animals is affecting riparian areas within the species' range, but it is doing so only in localized areas and is subject to management to limit or reduce impacts; as such, grazing is making a limited contribution to the identified potential stressor of Degraded Riparian Vegetation.

Future

Many of the impacts from grazing and related activities of domestic and feral livestock that were noted in the past (see above), are currently being reduced through management and review by Federal landowners under existing regulatory mechanisms. We expect future grazing levels will ebb and flow, but the average impact will remain about the same through time because the Federal agencies' plans are being implemented and the physical infrastructure is already in place. For example, some allotments may not be filled every year, but grazing by domestic livestock, where it does occur, will be implemented per existing plans that limits impacts to Panamint alligator lizard habitat. The NPS's management goal is to eventually achieve the permanent retirement of domestic grazing allotments in Death Valley National Park (NPS 2002, p. 67). For feral livestock, we expect impacts to Panamint alligator lizard habitat will vary more widely based on the grazers' population size and foraging conditions, which are less predictable. We also anticipate agency funding will vary through time, but this is similar to conditions over the recent past. Once the goal for the Coso, Argus, and Panamint Mountains is achieved—and in particular, burros have been removed from these areas—then the amount of grazing pressure will be reduced considerably, but this ambitious goal will take a sustained, concerted effort among the Navy, BLM, and NPS, and recent history suggests it will likely take more than a few years to achieve. Thus, livestock grazing in the near future will likely continue making limited contributions to the identified stressor of Degraded Riparian Vegetation, especially in the Coso, Argus, and Panamint Mountains, although it may be greatly reduced over the long term.

ORV Activity

Existing

The potential impact associated with vehicle travel on existing roads, including improved dirt roads, primarily consists of crushing individual Panamint alligator lizards that are on the surface. This impact is addressed separately in the SSA Report.

In this section, we focus on potential impacts that may incur from off-road vehicle (ORV) activity on existing unimproved "jeep trails" and vehicle activity that is not associated with any existing roads or trails. ORV activity can potentially crush lizards on the surface, although this is unlikely because we expect vehicles to be moving slowly when traversing the rugged terrain where Panamint alligator lizards generally occur. ORV activity can also potentially crush Panamint alligator lizards in refugia (such as under rocks). We are not aware of any incidents of this. We expect such events to be very infrequent because it is unlikely that all of the necessary preconditions for in-refugia crushing to occur—for instance, a lizard would have to be under a rock that is in the path of the vehicle's tires, and that rock's footing would have to be insufficient to protect the lizard from the weight or motion of the vehicle, and that lizard would have to be unable or unwilling to flee as the vehicle is approaching the refuge-providing rock. Moreover, recent observations suggest that most vehicle travel in the Panamint alligator lizard's range is on existing roadways and jeep trails (Clause *et al.* 2015, 14th page (unpaginated); Yasuda 2015, p. 16), where refugia are unlikely (see Other Developments section, above). Thus, ORV activity does not substantially contribute to the identified potential stressors of Impacts to Refugia or Crushing and Other Direct Mortality.

ORV activity can also impact Panamint alligator lizard habitat. The region's rugged terrain often limits vehicular travel to certain areas—predominantly canyon bottoms and valley floors. This is where many of the existing roads and tracks are (see Roads under Other Development, above). This is also often where riparian vegetation grows (if it occurs at all). ORV activity has impacted riparian vegetation in the region in the past (Cunningham and Emmerich 2001, p. 27); however, as noted above, much of the vehicle travel these days is occurring on existing roadways and jeep trails (Clause *et al.* 2015, 14th page (unpaginated); Yasuda 2015, p. 16). We also expect that existing management by Federal landowners is contributing to this pattern as well. As such, ORV impacts to riparian vegetation are unlikely to be much beyond what is occurring with roadway travel (see above). Thus, ORV activity does not substantially contribute to the identified potential stressor of Degraded Riparian Vegetation.

Future

We expect ORV activity in the region to increase in future, following State-wide trends associated with human population growth (OHMVR Commission 2014, p. 107). Yet, as discussed in the Existing ORV section above, areas for ORV activity are limited by the steep, rocky terrain, which in turn translates into vehicle activity being largely contained to existing roads and trails. Further, about 98.7 percent of the Panamint alligator lizard's range is on Federal land, and we expect management by Federal landowners will help keep ORV activity within designated areas (USFS 1988, p. 87; NPS 2002, p. 59; BLM 2016, p. 124). ORV activity is not permitted in Wilderness Areas (16 U.S.C. 1133(c)), which total about 64.7 percent of the Panamint alligator lizard's range. Future ORV impacts to riparian vegetation are not likely to be much more than what will be occurring with roadway travel (see above). Thus, we do not expect ORV activity in the future to substantially contribute to any of the identified potential stressors.

Flash Floods

Existing
Flash floods occur naturally in the region and have the potential to impact riparian vegetation and Panamint alligator lizards (Beaty 1963, entire; Giuliani 1977, entire; Clause *et al.* 2015, 18th page (unpaginated)). Typically associated with summer monsoon-influenced rains, they are sporadic, unpredictable, and often violent (Beaty 1963, p. 518; Powell and Klieforth 1991, p. 10). They are also usually localized, typically affecting a single canyon or a few nearby canyons at a time (Beaty 1963, p. 521; Powell and Klieforth 1991, p. 10). Thus, the combination of being irregular and isolated means that, for a given canyon, flash floods are typically rare events (Herbst 2004, p. 12).

Riparian vegetation can be physically destroyed from scouring (Giuliani 1990, 28th page (unpaginated)) or through local changes in hydrogeomorphology (Beaty 1963, p. 525, see also Figure 9 therein). If the hydrology remains, then we expect riparian vegetation will eventually regrow. However, when the hydrology is affected, such impacts could be long term (permanent or effectively so). Without riparian vegetation, the Panamint alligator lizard carrying capacity for that area will likely be lower. However, riparian areas in the region are not all restricted to canyon bottoms and can be associated with seeps and springs on the sides of canyons. Thus not all riparian areas are subject to flash flooding (Stebbins 1958, p. 13). Moreover, the Panamint alligator lizard is not solely restricted to riparian areas; they also occur in talus and other upland areas away from flood zones. Similarly, Panamint alligator lizard refugia could be affected by flash floods. While there may be some in the flood zone, many others are in areas of talus that generally occurs on the slopes, above the flood zone. There are several examples in the literature of occupied sites that have been affected by flash floods—yet none have been extirpated as a result (Stebbins and McGinnis 2012, p. 331; Clause *et al.* 2015, 18th page (unpaginated)).

Thus, flash flooding is affecting riparian areas within the species' range, but it is doing so only very locally and infrequently; as such, it is making a limited contribution to the identified potential stressors of Degraded Riparian Vegetation, Impacts to Refugia, and Crushing and Other Direct Mortality.

Future
As noted above, flooding in this region typically occurs with rare and localized summer, monsoon-related rains. As discussed in the Climate Change Effects section, future summer precipitation is difficult to predict, but monsoon-related summer rains might become more frequent in eastern California, including much of the range of the Panamint alligator lizard. However, given that such floods are thunderstorm related, they are likely to continue to be geographically localized. As such, we expect the frequency that a given canyon will be subject to flash floods will increase. Thus, like under current conditions, we are anticipating that flash

floods will continue to be geographically limited, but they possibly could become more frequent in the region, resulting in equal or slightly increased contributions to the identified stressors of Degraded Riparian Vegetation, Impacts to Refugia, and Crushing and Other Direct Mortality in the future.

Invasive Plants

Existing

Invasive, nonnative plant species, particularly tamarisk (*Tamarix* spp.), has been identified in the literature as having the potential to degrade riparian vegetation and thus affect the Panamint alligator lizard (Mahrdt and Beaman 2009, p. 491; Yasuda 2015, p. 17). Other species of potentially invasive, nonnative plants have been observed in the region, but have not been identified as potential threats to the Panamint alligator lizard; as such, we focus on tamarisk. While tamarisk can occur in high densities in some areas within the greater region (NPS 2002, p. 34; Navy 2014, p. 3-8), its occurrence is rare within the Panamint alligator lizard's range, and it is often limited to a few individual plants where it does occur (LaBerteaux and Garlinger 1998, Table 4 therein; Cunningham and Emmerich 2001, Site Reports therein; Clause *et al.* 2015, 13th page (unpaginated); Yasuda 2015, p. 18). Thus, invasive, nonnative plants currently do not substantially contribute to any potential stressors.

Future

As discussed above, tamarisk is not currently widespread within habitat areas used by the Panamint alligator lizard. Because invasive, nonnative species can quickly degrade areas of native vegetation, this potential stressor source may become more significant in the future, especially after disturbance events. Global climate change may also promote tamarisk. For instance, tamarisk is more drought tolerant than many obligate riparian species, which could allow tamarisk to have a competitive edge should precipitation become more unpredictable (Kominoski *et al.* 2013, p. 428). On the other hand, about 98.7 percent of the Panamint alligator lizard's range is Federal land, and Federal landowners are aware of the potential impacts of invasive plants, especially in riparian areas; as such, we expect implementation of management under existing plans and guidance documents will help limit future growth (such as NPS 2002, p. 34; USFS 2004, p. 32; Navy 2014, p. 3-43; BLM 2016, p. 72). Thus, there is a chance that tamarisk will become a problem at some riparian areas, but there is little to suggest that the species will become a problem at a large number of riparian areas within the Panamint alligator lizard's range, in part because there is little history of tamarisk being a problem at these sites, and in part because existing mechanisms for management could be employed to address an invasion should it occur. We note that vigilance and monitoring will need to continue for future management options to be effective.

12.0 APPENDIX B

Existing Regulatory Mechanisms
To be added…

13.0 APPENDIX C

Summary of recent genetic data
To be added…

14.0 REFERENCE CITED

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Russell, Daniel <daniel_russell@fws.gov>

Re: Request for Peer Review - Panamint Alligator Lizard

Ted Papenfuss <asiaherp@berkeley.edu> Wed, Jan 3, 2018 at 8:17 PM
To: "Hazard, Gjon" <gjon_hazard@fws.gov>
Cc: Bradd Bridges <bradd_bridges@fws.gov>, "Russell, Daniel" <daniel_russell@fws.gov>, Deborah Giglio <deborah_giglio@fws.gov>

Dear Gjon,

I have reviewed the Panamint Alligator Lizard Report. It is a very excellent and detailed account. I see no need for any revision. I am familiar with this species in the field as I have conducted research in the region where these lizards occur for more than 30 years. If you want me to comment on the final version, I am willing.

Sincerely,

Theodore Papenfuss
Theodore J. Papenfuss
Museum of Vertebrate Zoology
University of California
Berkeley, CA 94720 USA
Phone: 510-643-7706
FAX: 510-643-8238
asiaherp@berkeley.edu

On Dec 21, 2017, at 3:37 PM, Hazard, Gjon <gjon_hazard@fws.gov> wrote:

Dr. Papenfuss:

I look forward to your comments on the Panamint alligator lizard SSA Report. However, we are fast approaching an internal deadline. The sooner you can submit your comments after the New Year, the better. Depending on the timing, we might not be able to incorporate all of your comments into our revision of the document, but we will make every effort to do so. If it looks as though you will need additional time, please contact me so that we can coordinate the scheduling.

I will be back in the office on January 2nd. Should you have any questions, I will be able respond to them then. In the mean time, Bradd Bridges (cc'd; 760-431-9440 x221) will be here a couple of days next week and would be happy to help you sooner, should that be necessary.

I appreciate your time and willingness to share you expertise.

Thank you very much.

Sincerely,
-Gjon

* * *
Gjon C. Hazard
Fish and Wildlife Biologist
U.S. Fish and Wildlife Service, Carlsbad Fish and Wildlife Office
2177 Salk Avenue, Suite 250, Carlsbad, CA 92008 USA
Voice: 760-431-9440 x287; FAX: 760-431-5901
E-mail: Gjon_Hazard@fws.gov
http://carlsbad.fws.gov/

---------- Forwarded message ----------
From: **Russell, Daniel** <daniel_russell@fws.gov>
Date: Thu, Dec 21, 2017 at 8:35 AM
Subject: Fwd: Request for Peer Review - Panamint Alligator Lizard
To: Deborah Giglio <Deborah_Giglio@fws.gov>, Gjon Hazard <gjon_hazard@fws.gov>

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Daniel Russell - Regional Listing Coordinator
Pacific Southwest Regional Office, Region 8
U.S. Fish and Wildlife Service
2800 Cottage Way, Room W-2606
Sacramento, CA 95825

Office (916) 978-6191
Cell (916) 335-9060
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---------- Forwarded message ----------
From: **Ted Papenfuss** <asiaherp@berkeley.edu>
Date: Wed, Dec 20, 2017 at 8:08 PM
Subject: Re: Request for Peer Review - Panamint Alligator Lizard
To: "Russell, Daniel" <daniel_russell@fws.gov>

Dear Dan,

I now have time to review the Panamint Alligator Lizard document. Attached is a recent CV. I will print the conflict of interest form, sign it and send it to you.

Sincerely,

Ted