U.S. FISH AND WILDLIFE SERVICE
SPECIES ASSESSMENT
AND LISTING PRIORITY ASSIGNMENT FORM
Joshua Tree

SCIENTIFIC NAME(S): *Yucca brevifolia* and *Yucca jaegeriana*

COMMON NAME: Joshua tree

LEAD REGION: Region 8

ASSIST REGIONS: Regions 2 and 6

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DATE INFORMATION CURRENT AS OF: January 23, 2023

STATUS/ACTION

___Species petitioned for listing which we have determined is not a listable entity

X__Species petitioned for listing which we have determined does not warrant listing (does not meet the definition of a threatened or endangered species)

___Non-listed species for which we have not received a petition but for which we have undertaken a species status assessment on our own initiative and which we have determined does not warrant listing (does not meet the definition of a threatened or endangered species)

___Listed species petitioned for delisting which we have determined does not warrant delisting

___Listed species petitioned for downlisting which we have determined does not warrant downlisting

___Listed species petitioned for uplisting for which we have made a warranted-but-precluded finding for uplisting (this is part of the annual resubmitted-petition finding)

___ Listed species petitioned for uplisting which we have determined does not warrant uplisting

___ New candidate
___ Continuing candidate
Date when the species first became a candidate (as currently defined):

___ Listing priority number change
Former LPN: ___
New LPN: ___

___ Candidate removal: Former LPN: ___
____Taxon does not meet the Act's definition of "endangered species" or "threatened species" because it is more abundant or widespread than previously believed or not subject to the degree of threats sufficient to warrant issuance of a proposed listing or continuance of candidate status.
____Taxon does not meet the Act's definition of "endangered species" or "threatened species" because it is not subject to the degree of threats sufficient to warrant issuance of a proposed listing or continuance of candidate status due, in part or totally, to conservation efforts that remove or reduce the threats to the species.
___ Taxon does not meet the Act's definition of "species."
___ Taxon mistakenly included in past notice of review.
___ Taxon believed to be extinct.

Petition Information:
___ Non-petitioned
_X_Petitioned; Date petition received: September 29, 2015
90-day "substantial" finding FR publication date; citation: September 14, 2016; (81 FR 63160) (Service 2016, entire)
12-month "not warranted" finding FR publication date; citation: August 15, 2019; (84 FR 41694) (Service 2019, entire)

PREVIOUS FEDERAL ACTIONS:

On September 29, 2015, we received a petition from Taylor Jones (representing WildEarth Guardians), requesting that *Yucca brevifolia* – either as a full species (*Y. brevifolia*) or as two subspecies (*Y. b. brevifolia*, and *Y. b. jaegeriana*) – be listed as threatened and, if applicable, critical habitat be designated. On September 14, 2016, we published a 90-day finding in the *Federal Register* (81 FR 63160) concluding that the petition presented substantial information indicating that listing the Joshua tree may be warranted. On August 15, 2019, we published a 12-month finding (84 FR 41694) concluding that listing either *Y. brevifolia* or *Y. jaegeriana* was not warranted. On November 4, 2019, WildEarth Guardians filed a complaint in the Central District of California challenging the analyses and listing decisions. The court vacated and remanded the listing decisions back to the Service (*WildEarth Guardians* v. *Haaland*, 2021 WL 4263831 (C.D. Cal. September 20, 2021)), ordering us to reconsider whether the two species of Joshua tree should be listed under the Act.

The Service has reassessed its August 2019 12-month finding and revised the species status assessment report (SSA). This document complies with the September 20, 2021, court-ordered remand of the August 2019 “not warranted” 12-month findings for the two species of Joshua tree (*Yucca. brevifolia and* Y. *jaegeriana*) and constitutes our new 12-month findings on the September 29, 2015, petition to list the Joshua tree species under the Act.

ANIMAL/PLANT GROUP, ORDER AND FAMILY:

Group: Flowering plants, Order: Asparagales, Family: Asparagaceae

BIOLOGICAL INFORMATION:

To assess the Joshua trees’ viability, we conducted a species status assessment (SSA) using the three conservation biology principles of resiliency, redundancy, and representation (Shaffer and Stein 2000, pp. 306–311). Briefly, resiliency is the ability of the species to withstand environmental and demographic stochasticity (for example, wet or dry, warm or cold years), redundancy is the ability of the species to withstand catastrophic events (for example, droughts, large pollution events), and representation is the ability of the species to adapt to both near-term and long-term changes in its physical and biological environment (for example, climate conditions, pathogens). In general, species viability will increase with increases in resiliency, redundancy, and representation (Smith et al. 2018, p. 306). Using these principles, we identified the species’ ecological requirements for survival and reproduction at the individual, population, and species levels, and described the beneficial and risk factors influencing the species’ viability.

The SSA process can be categorized into three sequential stages. During the first stage, we evaluated the individual species’ life-history needs. The next stage involved an assessment of the historical and current condition of the species’ demographics and habitat characteristics, including an explanation of how the species arrived at its current condition. The final stage of the SSA involved making predictions about the species’ responses to positive and negative environmental and anthropogenic influences. Throughout these stages, we used the best available information to characterize viability as the ability of a species to sustain populations in the wild over time.

The SSA report for the Joshua Tree (*Yucca brevifolia* and *Yucca jaegeriana*) – January 2023, Version 2 (SSA report) is a summary of the information we have assembled and the following is a summary of the key results and conclusions based on the SSA report and data evaluated. The SSA report (Service 2023, entire) is incorporated herein by reference. Excerpts of the SSA report are provided in the sections below. For more detailed information, please refer to the full SSA report.

Species Description

Joshua trees are long-lived plants that occur in desert regions of the southwestern United States including portions of California, Arizona, Nevada, and Utah, well beyond the Joshua Tree National Park in California. Joshua trees are found throughout the Mojave, Great Basin, and Sonoran Deserts. Joshua trees have generally been addressed in the literature as a single species; however, recent references have identified at least two varieties or subspecies (*Yucca brevifolia* var. *brevifolia* and *Y. b*. var. *jaegeriana*). We consider the two entities to be two distinct species, the western Joshua tree (*Yucca brevifolia*) and eastern Joshua tree (*Y. jaegeriana*) based on expert analysis and we treat them as two separate, listable entities. For the purposes of this analysis, we discuss both species together using the common name—Joshua tree(s)—when the discussion of information pertains to both species. Literature or conclusions specific to a single species are indicated by the species' scientific name, where applicable. The SSA report has additional detailed descriptive information on Joshua trees (*Y. brevifolia* and *Y. jaegeriana*) (Service 2023, entire).

Yucca brevifolia

Yucca brevifolia is a 16–40 feet (ft) (5–12 meters (m)) tall, evergreen, tree-like monocot. The leaves are between 7.5 and 14.6 inches (in) (19–37 centimeters (cm)) long and are clustered in rosettes at the branch ends. Branching only occurs following flowering events where one or more lateral shoots develop from the base of the inflorescence (cluster of flowers) (McKelvey 1938, p. 130; Simpson 1975, p. 32). The flowers on the inflorescence are nearly spherical with short, wide petals that curve over the tip of the pistil and occur in dense, heavy panicles. *Tegeticula synthetica*, a species of yucca moth, pollinates the flowers; and the resulting seed pods require mechanical action (e.g., a rodent) to open and for the seeds to be dispersed. In addition to sexual reproduction, the species can also reproduce asexually through basal resprouts, particularly when under stress. *Yucca brevifolia* is long-lived (100 to several hundred years old), with a generation time of 50 to 70 years.

Yucca jaegeriana

Yucca jaegeriana is a shorter (9–20 ft; 3–6 m), evergreen, tree-like monocot. *Yucca jaegeriana* has shorter leaves (less than 8.7 in (22 cm)) and shorter height to first branching at 2.3–3.3 ft (0.75–1.0 m) than *Y. brevifolia*, which results in a denser canopy (see figure 3-1 in the SSA report; McKelvey 1938, p. 138; Service 2023, p. 9). The flower is elongate with narrow petals that wrap around the pistil forming a corolla tube. *Tegeticula antithetica*, a species of yucca moth, pollinates the flowers. The variation in floral morphology, specifically style length, between *Y. brevifolia* and *Y. jaegeriana* is strongly correlated with the physical characteristics of its obligate moth pollinator due to coevolution with *Tegeticula antithetica* having a shorter ovipositor than the *Y. brevifolia* pollinator, *T. synthetica* (see figure 3-1 in the SSA report; Godsoe et al. 2009, p. 820; Yoder et al. 2013, p. 11; Service 2023, p. 9). The resulting seed pods require mechanical action (e.g., a rodent) to open and for the seeds to be dispersed. In addition to sexual reproduction, the species can also reproduce asexually through basal resprouts, particularly when under stress. *Yucca jaegeriana* is long-lived (100 to several hundred years old), with a generation time of 50 to 70 years.

Hybrids

Hybrids occur in a smaller geographic area compared to the rest of the range, toward Joshua trees' northern limit, where the distribution of both species overlap, and are not reliably identifiable from morphological characteristics alone (Smith 2022, pers. comm.). The hybrid zone was not included in our assessment of viability for *Yucca brevifolia* and *Y. jaegeriana*, although that zone confers additional resiliency, redundancy, and representation to both species.

Taxonomy

Yucca brevifolia var. *jaegeriana* was determined to be a distinct species based on morphological and pollinator differences (Lenz 2007, p. 100) and restriction-site-associated DNA (RAD)-sequencing (Royer et al. 2016, p. 1730). These analyses concluded that *Y. b.* var. *jaegeriana* should be raised to specific rank (Lenz 2007, p. 97) and that it is genetically distinct from *Y. b.* var. *brevifolia* (Royer et al. 2016, p. 1736). Additionally, *Y. brevifolia* diverged at least 5 million years ago, possibly due to geographic separation by the Bouse Embayment (a Pliocene Era chain of lakes) (Smith et al. 2008a, p. 2682). As described above, the two taxa, and their obligate moth pollinators, come into contact and plant hybridization occurs in the Tikaboo Valley, Nevada, (Starr et al. 2013, p. 4; Royer et al. 2016, p. 136).

Based on these analyses (Lenz 2007, entire; Smith et al. 2008b, entire; Royer et al. 2016, entire), and correspondence between the Service and editors of the Jepson Manual (Wallace 2017, p. 2), we consider *Yucca brevifolia* var. *brevifolia* and *Y. b.* var. *jaegeriana* to be two distinct species, and we treat them as two separate listable entities: *Y. brevifolia* and *Y. jaegeriana*, respectively. For additional information on Joshua tree taxonomy, see section 3.2 of the SSA report (Service 2023, p. 9).

Habitat/Life History

Joshua trees occur in desert regions of the southwestern United States and are located on alluvial fans, plains, and bajadas throughout the Mojave, Great Basin, and Sonoran Deserts. Joshua trees occur throughout a wide range of vegetation communities between approximately 1,279 and 8,775 ft (390 and 2,675 m) elevation. Joshua trees are often the tallest plant on the landscape where they occur but are not typically dominant in terms of vegetation cover. Joshua trees are a slow growing, desert plant. Because they do not have growth rings, accurately determining the age of Joshua trees is difficult. The height of a Joshua tree divided by an estimate of growth per year is used to estimate age. Joshua trees can live for several hundred years, though a more common lifespan is about 150 years, and have a generation time of 50 to 70 years. They can reproduce via several mechanisms, have unique habitat and ecological needs, and can disperse through environmental and biological means. Joshua trees' life cycle includes seedling, established individual, juvenile, and adult stages (see figure 3-2 in the SSA report (Service 2023, p. 11)).

The life history of both *Yucca brevifolia* and *Y. jaegeriana* relies on a complex set of interactions between individual plants, yucca moths, seed dispersers, herbivores/predators, and abiotic conditions for successful reproduction and survival to a reproductively mature adult (see figure 3-2 in the SSA report (Service 2023, p. 11)). Joshua trees reproduce sexually through pollination and seed production as well as asexually through vegetative growth (clones). The relative contribution of sexual and asexual reproduction and whether the proportion varies regionally is not known. The clonal growth strategy likely increases persistence of individuals and populations when under stress. Optimal reproduction and recruitment of Joshua trees requires a convergence of events, including fertilization by its obligate pollinators (Pellmyr and Segraves 2003, p. 721), seed dispersal and caching by rodents (Vander Wall et al. 2006, p. 543; Waitman et al. 2012, p. 5), seedling emergence from a short-lived seed bank triggered by isolated late-summer rainfall (Reynolds et al. 2012, p. 1652), and exposure to cold temperatures that improve seedling and juvenile growth and survival (Went 1957, p. 173). For additional information, see the SSA report's section 3.4 (Service 2023, p. 10).

<u>Historical and Current Range/Distribution</u>

Historical Distribution

Joshua trees have occurred in southwestern deserts for at least 6 million years (Smith et al. 2008a, p. 255), persisting through several geologic time periods characterized by variable climate conditions (temperature and precipitation patterns). Joshua trees' historical distributions are based on a 2022 empirical study conducted throughout the range of *Yucca brevifolia* and *Y. jaegeriana* and we estimate 9,642,136 acres (ac) (3,903,699 hectares (ha)) were occupied historically (see figure 4-1 in the SSA report; Esque 2022b, pers. comm.). All areas where adult Joshua trees were recorded are considered part of the historical range over an approximate time period of 1900 to 1950, based on the lifespan of Joshua trees and development trends in the region. Presence, absence, and status (alive, dead, or ornamental) of adult Joshua trees were assessed through aerial interpretation and ground truthing of aerial imagery within quarter square kilometer (500 m by 500 m) grid cells. This method could not be applied in the northern portion of the species' range near Nellis Air Force Base in southern Nevada. Therefore, for the species' range near Nellis Air Force Base, we rely on the distribution from the 2018 Joshua tree SSA report (Service 2018, p. 11), which provides the best available data for Joshua tree distribution in this area.

Current Distribution

The current range of Joshua trees extends from northwestern Arizona to southwestern Utah west to southern Nevada and southeastern California (see figure 4-1 in the SSA report (Service 2023, p. 31)). Joshua trees are currently distributed over several large discontinuous areas totaling 9,447,883 ac (3,825,054 ha) of a much larger region. The refined distribution presented in the SSA report is based on a 2022 USGS empirical study conducted throughout the range of *Yucca brevifolia* and *Y. jaegeriana* (Esque 2022b, pers. comm.; Service 2023, pp. 30–31). Very little of the historical range has been lost; the current distribution of Joshua trees is reduced by approximately 3 percent compared to the historical distribution. The current distribution is less acreage than we reported in the previous 2019 SSA report (12,144,840 ac; 4,906,749 ha). The previous distribution was based on the records and reports available at that time (Service 2019, p. 14). Although our updated current distribution is less than previously reported, it is not based on a loss of habitat; rather it is an updated estimate of current distribution of the species based on new, more accurate, information. Please see sections 4.1 and 4.2 of the SSA report for further information on Joshua trees' historical and current distributions (Service 2023, pp. 30–31)

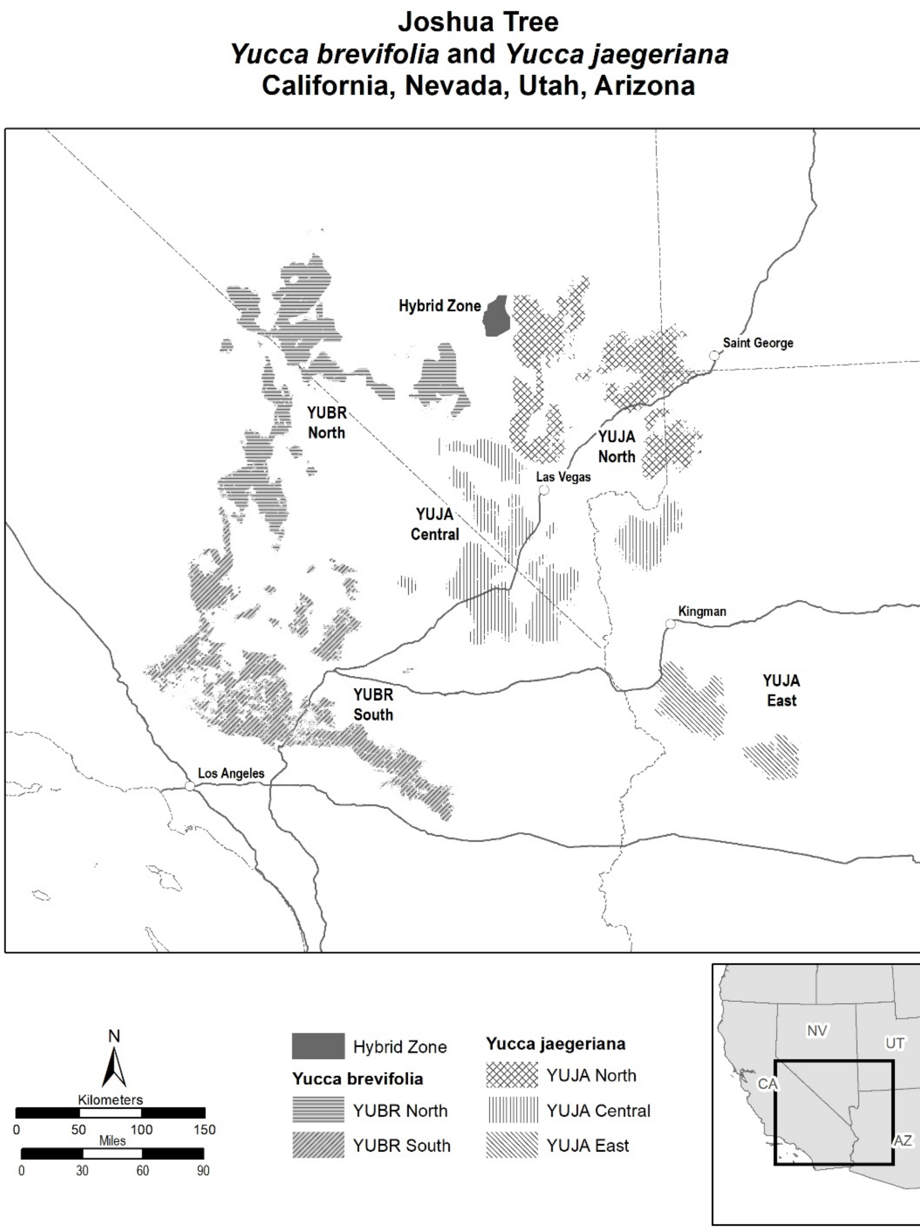

Figure 1. Joshua tree distribution including analysis units occupied by Yucca brevifolia and Y. jaegeriana.

Species Ecological Needs

A species' biological condition should be evaluated relative to the three conservation biology principles of resiliency, redundancy, and representation (Shaffer and Stein 2000, pp. 306–311). Below we describe the population- and species-level needs for Joshua trees that were used to evaluate resiliency.

Population Needs

Joshua trees require that habitat and demographic needs are met for population resiliency. Joshua trees rely on habitat elements that include appropriate substrate, appropriate climatic conditions, yucca moth pollinators, rodent seed-caches, nurse plants, and dispersal. Appropriate climatic conditions include adequate amounts of annual precipitation (4.7–16.9 in (11.8–42.9 cm)), summer monthly precipitation in excess of 1.1 in (2.9 cm) in the months of July and August, average summer temperatures based on the range experienced historically (67 to 91 degrees Fahrenheit (°F); 19.4 to 32.8 degrees Celsius (°C), and winter temperatures between 29 and 50°F (-1.7 and 10°C). To reproduce successfully, Joshua trees need yucca moth pollinators, nurse plants, and seed-caching rodents. The demographic needs that Joshua trees require are: survival, abundance, recruitment, and dispersal. Sufficient growth and survival at all life stages is required for an individual to reach sexual maturity and to maintain an abundant population. A diverse age structure is important for withstanding variability in climate and the pressures of threats such as drought, herbivory, and wildfire because young age-classes are more susceptible to mortality during these events than adults.

Joshua trees require populations of sufficient abundance to be maintained over time with stable or increasing population growth. Sufficient abundance is achieved through survival of young age-classes to adult, successful reproduction, and recruitment to support the next generation. There must be adequate survival at all life stages to support an abundant adult population. We currently lack a population viability analysis and information on the abundance at each age class required to maintain resiliency. Sufficient recruitment is necessary to maintain the population over the long term. In particular, seed set needs to be high enough to ensure future recruitment considering seed predation and the low percentage of viable seed that germinate and survive to reproduce. Dispersal of propagules is important for gene flow to maintain appropriate levels of genetic variability. Dispersal also allows for potential recolonization of sites following disturbance. See chapter 5 of the SSA report for further information on population needs (Service 2023, pp. 41–50).

The 2023 SSA report analyzes resiliency within six analysis units including two populations of *Yucca brevifolia* (YUBR North and YUBR South), three populations of *Y. jaegeriana* (YUJA North, YUJA East, and YUJA Central), and a hybrid zone (described further in section 4.5 of the SSA report (Service 2023, pp. 36–40)). With the exception of the hybrid zone, we use these five analysis units to analyze both current conditions and future conditions in this document and the SSA report (Figure 1, Table 1).

Table 1. Summary of analysis units used in the SSA report. (This table appears in the SSA report as table 4-1; Service 2023, p. 37)

Population	Occupied Habitat ac (ha)	Elevation Range ft (m)	Land Ownership (%)
YUBR North	2,129,113 (861,989)	2,475-8,775 (754-2675)	Federal: 97.6 State: 0.51 Private: 1.6
YUBR South	2,288,162 (926,381)	1,922-7,640 (586-2,328)	Federal: 52.3 State: 2.1 Private: 45.6
YUJA North	2,065,476 (836,225)	1,540-7,961 (469-2,426)	Federal: 98 State: 0.9 Private: 1.1
YUJA Central	2,089,163 (845,815)	1,626-7,627 (495-2,325)	Federal: 91 State: 1.9 Private: 7.9
YUJA East	754,821 (305,595)	1,279-5,067 (390-1,544)	Federal: 59.8 State: 16.7 Private: 23.5

* Local ownership was less than 1 percent for all analysis units.

Species Needs

Species needs are an exploration of what influences redundancy, and representation for Joshua trees. This requires an examination of the Joshua trees' evolutionary history and historical distribution to understand how Joshua trees function across their range. To maintain redundancy, numerous local Joshua tree populations need to be distributed widely across the landscape with some degree of connectivity to withstand catastrophic events. Finally, to maintain representation, which is needed by the species to respond to changing environmental conditions, genetic diversity must be maintained by preserving populations that are morphologically, geographically, or ecologically diverse. In general, Joshua trees need multiple, large, sufficiently resilient populations distributed across the range of ecological variability to have the redundancy and representation to withstand catastrophic events and adapt to environmental change given the trees' moderate adaptive capacity. See chapter 5 of the SSA report for further information on population needs (Service 2023, pp. 41–50).

FORESEEABLE FUTURE:

The Act does not define the term "foreseeable future," which appears in the statutory definition of "threatened species." Our implementing regulations at 50 CFR 424.11(d) set forth a framework for evaluating the foreseeable future on a case-by-case basis. The term "foreseeable future" extends only so far into the future as we can reasonably determine that both the future threats and the species' responses to those threats are likely. In other words, the foreseeable future is the period of time in which we can make reliable predictions. "Reliable" does not mean "certain"; it means sufficient to provide a reasonable degree of confidence in the prediction. Thus, a prediction is reliable if it is reasonable to depend on it when making decisions.

It is not always possible or necessary to define the foreseeable future as a particular number of years. Analysis of the foreseeable future uses the best scientific and commercial data available and should consider the timeframes applicable to the relevant threats and to the species' likely responses to those threats in view of its life-history characteristics. Data that are typically relevant to assessing the species' biological response include species-specific factors such as lifespan, reproductive rates or productivity, certain behaviors, and other demographic factors.

We considered time horizons at mid-century (2040–2069) and end of century (2070–2100) for analyzing future conditions for Joshua trees. In the SSA report, we developed two future scenarios (Scenario I and Scenario II) to help us understand the plausible range of threats and their potential impacts on the two Joshua tree species and their habitat between now and the end of the century (2070–2099). The two scenarios differ in the amount of projected future change in habitat loss, invasive grasses, wildfire, and drought and increased temperatures associated with climate change. Scenario I modeled future conditions as a continuation of current threats under, an approximate 5.4°F (3°C) increase (RCP 4.5) in average temperature. Scenario II modeled an increase in threats under much warmer climate conditions, an approximate 9°F (5°C) increase (RCP 8.5) in average temperature. When applying the best available information to a listing context in considering what the foreseeable future for Joshua trees is, we considered that 1) the data sources for invasive grass cover, climate change, wildfire, and development provide reliable information without further extrapolation for the time period 2050–2070; 2) the species' response to projected climate change becomes more uncertain the further out we project because we lack information on physiological thresholds; 3) the forecasts for occupied habitat begin to diverge around 2050 due to the differences in RCP projections (Hawkins 2013, entire; Bamzai-Dodson and Rangwala 2019, pp. 31 and 32); and 4) the effects of wildfire at the end of the century depend on where wildfires occur and the time between fires. Upon subsequent review it was determined that although there are climate projections available that project climatically favorable and unfavorable areas through the end of century, climate change is the only threat where we have reliable information for that time period. The best available science for threats to Joshua trees and the species' response to projected climate change and wildfire supported evaluating future conditions out to 2040–2069 when we can reliably characterize the species' response and status, which is a key element in determining the foreseeable future. Beyond 50 years, human decisions that affect global greenhouse gas (GHG) emissions and the species' response to future conditions are a major source of uncertainty (Terando *et al.* 2020, pp. 14–15). Therefore, for our evaluation of future condition, we rely on the same assumptions about the extent and magnitude of threats projected over time in Scenarios I and II of the SSA report for the primary threats and consider an earlier time period (2040–2069) along the trajectory projected for Scenarios I and II. The data sources and rationale that support this decision are summarized below.

Climate change and wildfire are the primary threats driving the future condition of Joshua trees at 2040–2069, which is consistent with the primary threats at the end of century in the SSA. Although all the bioclimatic models project significant losses of climatically favorable habitat, and increased temperatures and drought associated with climate change are generally forecasted to have negative effects, the timing and magnitude of the species' response to climate change are not well established. The literature, and bioclimatic models in particular, provide information on the potential timing of future climate change without sufficient empirical data on physiological thresholds to reasonably forecast the magnitude of the species' response or future distribution at the end of the century (Hampe 2004, entire; Pearson and Dawson 2004, entire; Araujo and Townsend Peterson 2012, pp. 1527, 1528; Garcia et al. 2016, pp. 65, 69–72). We consider the bioclimatic models to provide an initial inference or working assumption about the potential effects of climate change to the Joshua trees based on the limited, available information about the two species' response to climate variables (Petru and Tielborger 2008, pp. 717–718, 723–726; Araujo and Townsend Peterson 2012, pp. 1527–1528; Franks et al. 2014, entire; Garcia et al. 2016, pp. 65, 69–72; Thompson et al. 2023, pp. 1–7). We note that our future projections (2040–2069) are generally consistent with the limited available empirical information about Joshua trees' response to drought and climate change, and the stable distribution of the two species over the last 40 to 50 years under warmer climate conditions. Therefore, given the uncertainty of the Joshua trees' response to future climate conditions, we did not rely solely on the bioclimatic model results for our 2040–2069 projections of Joshua trees' distribution.

There is high uncertainty in the timing and magnitude of the species' responses because information about physiological thresholds for temperature and other physiological, phenotypic (change in form or shape), and genetic responses that may confer tolerance, local adaption, and adaptive capacity are unknown, and the potential exists for climate refugia in topographically diverse areas. Also, the demographic data are not sufficiently reliable to provide an understanding of when Joshua tree individuals or populations may begin to respond to the effects of climatically unfavorable conditions identified in the bioclimatic models and how long adult trees may persist in modeled climatically unfavorable conditions at the end of century (Thomas 2022, pers. comm; Shafer et al. 2001, p. 207). There is limited monitoring data available for a small area of the range of *Yucca brevifolia* in Joshua Tree National Park (the park represents approximately 18 percent of the entire range for YUBR). Because we do not have historical context to evaluate the data, it is not clear whether the site-specific declines noted are an indication of natural population variability in this portion of the distribution or the early effects of climate change. The best available science indicates that both species are long-lived (150–300 years), adapted to hot and dry conditions, and have been exposed to a range of environmental conditions over thousands of years. Both species continue to occupy most of their historical ranges, despite recent increases in temperature on the order of 1.8ºF (1ºC) over the last 40 to 50 years (Figure 4-1 in Service 2023, p. 31). However, we also consider the potential loss of occupied habitat in localized areas within the warmest and driest portions of the ranges of both species. Also, the best available science does not provide information on the population dynamics and environmental thresholds for the yucca moth species, which are the pollinators for both Joshua tree species. Therefore, we presumed that yucca moth populations will track Joshua tree flowering, as has been experienced in the past, and the moth will experience similar threat effects as described for the Joshua tree including recent site-specific declines in Joshua tree National Park. We note the high degree of uncertainty regarding these assumptions about the Joshua trees' and the yucca moths' responses to climate change introduce uncertainty into our future projections of species' status that we cannot quantify at this time; but have used the best available science in developing them, as the Act requires.

In addition, there is further uncertainty the further into the future we project potential effects to both species because future climate projections and the rate of warming and maximum exposure temperatures varies depending on the global emission trajectory evaluated (e.g., RCP 4.5 compared to RCP 8.5) (Knutti and Sedláček 2013, p. 370). At the end of the century, RCP 4.5 and 8.5 project an approximate 5.4°F (3°C) and 9°F (5°C) increase in average temperature, respectively; and the magnitude of this difference continues to increase through time. Therefore, most of the difference between the present climate and the climate at 2040–2069 and beyond will be determined by decisions made by policy makers today and during the next few years (Terando et al., 2020, p. 15). At this time, we have little clarity on what decisions will be made by policy makers in the next few decades. Given the long lifespan of Joshua trees, combined with uncertainty around future policy, we determined the climate projections and the response of Joshua trees at the end of century time horizon were too uncertain to make reasonable, reliable predictions of future condition. The climate models used in the SSA project increases in average summer temperatures of approximately 3.6–5.4°F (2–3°C) in 2040–2069, depending on the location within the Joshua trees' range (Wang et al. 2016, unpaginated). This temperature range is slightly less than the future climate condition projected in Scenario I of the SSA and within the range of variability that Joshua trees have experienced and were resilient to in the past. Therefore, we consider the mid-century (2040–2069) climate projections to be more reliable than end of century projections (Hawkins 2013, entire; Bamzai-Dodson and Rangwala 2019, pp. 31–32).

The data sources evaluated in the SSA also allow us to make more reliable projections of the species' response to wildfire for the time period 2040–2069. The wildfire models used in the SSA characterized current wildfire risk as low to moderate and are considered reliable until 2050–2070 (Klinger 2022, pers. comm). Longer term wildfire risk is dependent on past fire trends, specifically, where and how frequently fires occurred. The best available data provide a range of acreage that may burn at the end of the century but do not inform where those wildfires might occur or how frequently occupied habitat might burn. Therefore, we can more confidently assess the threat of wildfire through 2070, based on currently available models. For wildfire, we project 12 to 18 percent of the current ranges of Joshua trees to be the maximum extent of wildfire at the end of century and we are not able to further refine these extents; but we project the maximum extent to be less for the time period 2040–2069. Wildfire effects on Joshua trees are well documented, and we project effects to be the same as analyzed in the SSA and summarized in the threat section below.

When applying the best available information to develop a reasonable and reliable projection of the Joshua trees' future condition, the projections of occupied Joshua trees' habitats (i.e., future distribution) begin to diverge around 2050 based in large part on RCP projections. As we mentioned earlier, after 2040–2069, there is too much uncertainty in the amount of occupied habitat based on the variability in plausible global emissions trajectories, wildfire risk, and the two species' responses for us to make a reliable projection of the Joshua trees' future condition. Although our SSA report used future scenarios that provide a range of plausible conditions projected to the end of century, we determined that projections within the 2070–2099 timeframe did not provide a reasonable basis to reliably predict the impact of future threats and the species' response to them due to the identified uncertainties. Regardless of how far into the future we could extrapolate the expanding scope of the threats, our confidence is greatest at 2040–2069, the period over which we can make reliable predictions about threats and the species' response to those threats.

FACTORS INFLUENCING THE STATUS:

The Act directs us to determine whether any species is an endangered species or a threatened species because of any factors (or threats) affecting its continued existence (i.e., whether it meets the definition of a threatened species or an endangered species). We use the term "threat" to refer in general to actions or conditions that are known to or are reasonably likely to negatively affect individuals of a species. The term "threat" includes actions or conditions that have a direct impact on individuals, as well as those that affect individuals through alteration of their habitat or required resources. The term "threat" may encompass—either together or separately—the source of the action or condition, or the action or condition itself.

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

Summary of Biological Status and Threats

In the following discussions, we review the biological condition of the species and their resources, and threats that influence the species' current and future conditions, to assess the species' overall viability and the risks to that viability. In this section, we summarize the Joshua trees' future condition to 2069 when we can reliably forecast threats and the species' response to those threats. This is a shorter timeframe than we evaluated future scenarios in the SSA report. Over the next 47 years (approximately one generation and when trees can reproduce sexually), we can reliably characterize the Joshua trees' viability where our confidence is greatest with respect to the range of projected plausible threats and the species' response. There are key areas of uncertainty, primarily regarding the two species' response to projected future wildfire and climate conditions, that do not allow us to reliably project the Joshua trees' status to end of century, as discussed above and in the **Finding**.

<u>Threats</u>

In the Joshua tree SSA report, we identified the following threats for both *Yucca brevifolia* and *Y. jaegeriana*: (1) habitat loss and degradation (from urbanization, military training, renewable energy, grazing, and off highway vehicle (OHV) use) (Factor A); (2) invasive grasses (Factor A); (3) increased risk of wildfire (Factor A); (4) seed predation and herbivory (Factor C); and (5) changing climatic trends (e.g., increased temperatures and longer more frequent drought periods) (Factor A). Of these threats, we determined that the primary threats or those threats which have the capacity to potentially drive any population or status trends for the two species are the risk of wildfire (Factor A), invasive grasses (Factor A), and climate effects (increasing temperature, precipitation changes, drought) (Factor A) summarized below both currently and for the foreseeable future (2040–2069). Because the life history, habitat needs, demographic needs, species needs, and general ecology of the two species are congruent, we assumed the effects pathways and threat impacts are the same for both species. Although habitat loss and degradation (from urbanization, military training, renewable energy, grazing, and OHV use) (Factor A) and seed predation and herbivory (Factor C) were identified as potential threats in the SSA report that may impact individuals or portions of the population, the best available information indicates that these threats have not negatively influenced population dynamics on a population- or species-level scale now and are not projected to negatively influence population dynamics in the foreseeable future.

Overutilization (Factor B), disease (Factor C), and small population size (Factor E) were not identified as threats in the SSA report. In appendix B of the SSA report, we examined the existing regulatory mechanisms, regulations, and policies (Factor D) that affect the species, including those that relate to climate change (Service 2023, pp. 152–161). We found that the regulatory mechanisms, such as the Clean Air Act (42 U.S.C. 7401 et seq.), which regulates air emissions from both stationary and mobile sources, and hazardous air pollutants to protect public health, as well as California climate policies that help to reduce GHG emissions through the State's Climate Adaptation and Resiliency Program (funds projects that provide climate adaptation and resilience on California's natural and working lands), all contribute toward reduced GHG emissions in the United States. The National Environmental Policy Act (NEPA;

42 U.S.C. 4321 et seq.) also provides some protections for listed species that may be affected by activities undertaken, authorized, or funded by Federal agencies, which may result in the development of avoidance and mitigation measures for the threats that affect special status species. For the purposes of this document, the primary threats are the focus of the threats discussion for the two species which are summarized below both currently and for the foreseeable future (2040–2069). For a complete description of all the threats and existing regulatory mechanisms, refer to chapter 6 and appendix B of the SSA report (Service 2023, pp. 50–87, 152–161).

Habitat Loss and Degradation

The loss of habitat and degradation by urbanization, military training, renewable energy development, grazing, and OHV use are occurring in varying degrees across the range of the Joshua trees and are currently considered a low magnitude threat. The higher severity impacts of urbanization, military training, and renewable energy development are localized and have a limited scope in terms of acreage of impacts and the analysis units where they occur. The YUBR South analysis unit is most affected by habitat loss and degradation both now and in the future due to its proximity to larger, metropolitan centers with increased development and edge effects, along with the amount of the analysis unit that is privately owned (45.6 percent), designated for renewable energy development, and subject to military training. Privately owned landownership is low (7 percent) throughout the range of Yucca jaegeriana and is highest in YUJA East (23.5 percent). No information was available to categorize the threat of renewable energy development in Arizona, Nevada, and Utah. Grazing and OHV use are more widespread, but the intensity of the impacts is currently low and diffuse; and impacts are projected to remain low and diffuse in the future.

The best available information indicates that substantial habitat loss due to development, military training, or renewable energy development is unlikely in the future. Habitat loss due to development was projected for 2060 based on the average of two models available through the Integrated Climate and Land Use Scenarios (ICLUS) database for RCP 4.5 and 8.5 (Environmental Protection Agency 2015) to be less than 8 percent of the current distribution of *Yucca brevifolia* and less than one percent of the distribution of *Y. jaegeriana*. In addition, estimates include 2040–2069 projections for renewable energy development in California for *Y. brevifolia* (approximately 100,000 ac; 40,469 ha), based on the acreage of current and permitted projects that is forecasted to be approximately half the development projected for the end of century (Service 2023, pp. 53). However, we lacked sufficient information to project renewable energy development outside of California. Habitat loss is forecasted to be a low-magnitude threat in the future.

In addition, impacts to Joshua trees are avoided, minimized, or mitigated on Federal lands and within several jurisdictions in California to varying degrees as discussed in appendix B and section 6.1.6 of the SSA report (Service 2023, pp. 57, 152–161). We anticipate that these measures and regulations will continue to address potential losses in that region now and in the future, particularly on military and federally managed lands, which currently account for 74 percent of the current distribution of *Yucca brevifolia* and 89 percent of the distribution of *Y jaegeriana* (Table 4-1 in Service 2023, p. 33). However, in Arizona, Nevada, and Utah, there are fewer regulatory protections in place on private land, though private land in these states represents a small percentage of the species' range. Overall, these effects are localized and constitute a small portion of the range, such that they are not likely to have a population- or species-level impact. Therefore, there is no indication that current or future effects (2040–2069) resulting from habitat loss and degradation by urbanization, military training, renewable energy development, grazing, or OHV use, or a combination of these, would significantly reduce the redundancy, representation, or resiliency of *Y. brevifolia* or *Y. jaegeriana*. See chapter 6 of the SSA report for more detailed information (Service 2023, pp. 50–87).

Wildfire

Wildfires are not historically a common occurrence in the desert regions of the southwestern United States. Due to the low, discontinuous vegetative cover and fuel loads, wildfires are typically infrequent and small in size (Brooks and Matchett 2006, p. 148). Fire return intervals of greater than 100 years or more were estimated for *Artemisia tridentata* (Great Basin sagebrush) plant communities in the Southwest, and similar historical return intervals or longer are presumed for the range of Joshua trees (Mensing et al. 2006, p. 75). As a result, native scrub vegetation communities in the desert Southwest, including Joshua trees, have not evolved with wildfire and are generally considered to not be well-adapted to fire (Abella 2010, p. 1249). Wildfires may cause numerous potential direct and indirect effects on Joshua trees and the associated plant community, including immediate mortality, reduced survivorship over time, loss of nurse plants, reduced native cover, lower native plant diversity, damage to the protective bark-like periderm, mortality of the seed bank, and potential disruption of the pollinator and rodent communities. Joshua trees' habitat is estimated to require approximately 100 years to reach densities, cover and stature similar to pre-burn conditions, though nurse plant cover and the understory may attain pre-burn conditions in as little as a few years to several decades depending on whether the root crown survives (Minnich 1995, p. 104). Wildfires also promote colonization by invasive grasses, discussed further below.

The magnitude of the impact varies with the size, severity, and frequency of wildfires; amount of invasive grass cover; and weather conditions both during and after the event (DeFalco et al. 2010, entire; Barrios et al. 2017, entire; Klinger et al. 2019, p. 10). Joshua tree mortality can be high following wildfire (64 to 95 percent) with increased impacts to young age-classes and when wildfires were followed by drought conditions (Minnich 1995, p. 102; DeFalco et al. 2010, p. 246). Habitat recovery is similarly impacted by subsequent climate conditions and may take 100 years to reach densities, cover, and stature similar to pre-burn conditions (Minnich 1995, p. 104), though habitat recovery may be sooner in low severity wildfires where individual trees persist and can reproduce (flower and resprout) under appropriate climate conditions. Joshua trees also may respond to wildfire by producing resprouts from the trunk or from the primary roots (Minnich 1995, p. 102; Barrios et al. 2017, p. 103; St. Clair et al. 2022, p. 4). Resprouting requires the tree or root system to be viable post-fire. Resprouting is more frequent in areas with a high proportion of surviving trees and decreases with increasing burn severity (Minnich 1995, p. 103). Resprouting and the clonal growth strategy increases persistence of the individual under stress, such as wildfire (Rowlands 1978, p. 50; Harrower and Gilbert 2021, p. 11; Esque 2022a, pers. comm.), and facilitates the ability of Joshua trees to continue to occupy habitat even when the main stem has died. Also, within the burn perimeter, small patches with trees, nurse plants, and a seedbank may persist to facilitate recovery of the species and its habitat post-fire (Klinger 2022, pers. comm.).

The wildfire risk and potential impacts to Joshua trees were characterized based on low (less than 4,000 ft; 1,200 m), middle (4,000–6,000 ft; 1,200–1,800 m) or high (greater than 6,000 ft; 1,800 m) elevation plant communities (see table 6-1 and appendix D in the SSA report (Service 2023, pp. 67, 165; Klinger et al. 2019, entire)). Low elevations tend to have low severity fires due to low vegetative cover. In areas subject to low severity fire, adult Joshua trees have a lower probability of dying from direct mortality, and trees may avoid being burned due to their taller stature, particularly for *Yucca brevifolia*. However, repeated low severity events promoted by invasive grasses contribute to increased charring over time that can increase the risk of mortality, particularly to young plants that are more vulnerable to fire. Middle elevation vegetation communities are correlated with increasing fires, acres burned, and the invasive grass-wildfire cycle (Brooks and Matchett 2006, pp. 153, 155). The invasive grass-fire cycle is well documented in the literature as a positive feedback loop, and invasive grasses alter the fire regime in several ways (discussed further in section 6.3 of the SSA report (Service 2023, pp. 60–70)). Middle elevations typically have a higher fuel load, with sufficient native vegetative cover to carry fires; therefore, wildfires can be more severe and are often associated with increased invasive grass cover. Moderate severity burns may result in adult mortality and are projected to char trees, including singeing the crown, which may contribute to increased mortality and decreased tree densities over time. In moderate severity burns, nurse plants may be burned and die, and the Joshua tree and nurse plant seedbank may also be negatively impacted. Though fires are less frequent in high-elevation vegetation communities with heavier fuels, when they do occur, wildfires tend to have higher severity and can result in direct tree mortality or alter the subsequent vegetation composition and cover. However, most Joshua trees occur in low and middle elevation vegetation communities that are unlikely to experience high severity burns.

Based on the wildfire history and modeled wildfire risk, increased wildfires are an imminent, low-to-moderate magnitude threat currently and in the foreseeable future (2040–2069). Since 1960, only 9 percent of the total acreage across the range of Joshua trees has burned, including 24 percent of the YUJA North analysis unit. We project recovery of the species and habitat to take up to 100 years in areas that do not have an altered invasive grass-wildfire cycle. The modeled risk of wildfires and the modeled wildfire regimes are estimated for current and future conditions through approximately 2070 (Klinger et al. 2021, entire). We project that the acreage of the range of both species of Joshua tree that will burn between 2040–2069 will be less than our end of century projections of 12 to 18 percent of the range of both species of Joshua tree; this estimate is based on a moderate increase in the acreage that has burned in the last 50 years (9 percent on average), and wildfires are more likely to occur in areas that have previously burned (Klinger 2022, pers. comm.). Although the risk of wildfires was modeled, there is uncertainty in where wildfires will occur and how the fire return interval will be affected; though increased impacts from wildfire are projected for middle- and high-elevation plant communities. We project the potential for tree mortality, reduced tree densities, and limited recruitment following wildfires, while the habitat recovers. Post-fire habitat recovery may occur more quickly in more mesic areas; but the time required for recovery may be extended beyond 100 years due to drought conditions.

Overall, there is limited evidence of the invasive grass-wildfire cycle currently but it is most prevalent in the northern portion of the range of *Yucca jaegeriana*. *Yucca jaegeriana* is also at higher risk of wildfires due to a high proportion of the analysis units with estimated high ignition probability, fire frequency, and burn severity. Areas of predicted high burn severity occur near predicted high frequency wildfire areas, increasing the probability of large wildfire events that could impact Joshua trees. Wildfire is a low magnitude threat in YUJA East because this area is at low elevation with lower vegetative cover and a low probability of natural ignitions.

The risk of wildfires is a low to moderate threat throughout the range of *Yucca brevifolia* and lower than for *Y. jaegeriana*. YUBR North is at moderate risk for a moderate- to high-severity fire that could alter the vegetation composition and cover in areas adjacent to higher invasive grass cover. The probability of natural ignition is lower in this analysis unit, but there are population centers and high areas of visitation that are likely to increase human-caused ignitions. YUBR South is also considered to be at moderate risk. Approximately 9 percent of the analysis unit has burned in the last 50 years, but most of the analysis unit is at low elevation with wildfire risk characterized by low frequency and severity. Ignition sources may be higher than predicted in the models due to the high frequency of wildfires along the urban-wildland interface consistent with correlations between increasing human population density and fire ignitions (Keely and Fotheringham 2001, p. 1541).

Under projected future climate conditions, areas previously burned have a high probability of being colonized by invasive grasses, particularly cheat grass in the north and northeast, and the elevation limit of the distribution of invasive grasses may increase with increasing temperatures and the potential for increased fire frequency. We forecast vegetation cover to decrease at lower elevations over time with extended droughts and increased fire frequency in previously burned areas, particularly to the east and northeast, though extreme rainfall events have the potential to reestablish high invasive grass cover. Overall, we project there to be a high probability of large, infrequent, high severity wildfires at middle and high elevations in areas that have not burned, and lower potential and frequency of wildfires at low elevations. Small patches of unburned habitat may remain within burned areas at middle- and high-elevation zones due to topographic heterogeneity and hydrological refugia.

We are not able to accurately predict areas that will burn in the future; however, we project areas that burn once at low to moderate severity may recover slowly (up to 100 years post-burn) and continue to support Joshua trees. We project high severity fires and areas that burn repeatedly are not likely to support the species in the future (Klinger 2022, pers. comm.). Both species occur mostly on Federal lands and existing regulatory mechanisms include BMPs to help protect against wildfire (see *Conservation Measures and Existing Regulatory Mechanisms*, below, and appendix B of the SSA report (Service 2023, pp. 152–161)).

After examining the extent and impact of the risk of wildfire, we project that wildfire conditions in 2040–2069 will be similar or slightly increased relative to current conditions. We determined that while this threat could occur throughout the range, our projections indicate less than 12 to 18 percent of the ranges of the Joshua trees may be at risk of burning by 2040–2069, including areas that have burned previously. Due to the limited portions of the ranges that are anticipated to burn and fire suppression efforts that are implemented on Federal lands, the threat of wildfire would be unlikely to impact either of the two species at a population- or species-level scale. The threat of wildfire does not have the projected extent to drive any declines in status trends for the two species during our evaluation period. As a result, there is no indication that the current or future effects of wildfire would significantly reduce the redundancy, representation, or resiliency of *Yucca brevifolia* or *Y. jaegeriana*. See chapter 6 of the SSA report for more detailed information (Service 2023, pp. 50–87).

Invasive Annual Grasses

Nonnative plant species, particularly invasive grasses spread by humans and anthropogenic disturbance, have the potential to substantially degrade desert habitats and affect the frequency of fire. The potential effects to Joshua trees include competition, perturbations in the natural disturbance and fire regime, plant community composition, vegetation structure, and a microclimate shift (Gordon 1998, p. 976). The severity of the nonnative plant invasion is dependent on the influence of local site factors including soil type, elevation, and disturbance history (Chambers 2000, pp. 1403–1412; Gelbard and Belnap 2003, p. 429; Chambers et al. 2007, entire; Davies 2008, pp. 113–114; Chambers et al. 2013, entire; Davies and Hulet, 2014, pp. 1–2). Disturbed soils provide additional safe sites for weed establishment, and the removal of the existing vegetation alleviates resource competition and promotes the successful invasion of weeds (Case 1990, pp. 9610, 9613–9614; Masters and Sheley 2001, p. 505; Novak and Mack 2001, p. 115; Leonard 2007, pp. iii, 61–62; Hornbeck et al. 2019, entire). Once established, invasive grass cover can increase rapidly in response to rainfall, particularly periods of high winter precipitation typical of El Niño oscillation events and following wildfire (Brooks and Machett 2006, p. 149). In the future, invasive grasses have the potential to expand their competitive edge over native species and benefit under conditions of drought, increased carbon dioxide concentration, extreme precipitation events, and atmospheric nitrogen (Archer and Predick 2008, p. 25). As a result, invasive grasses are projected to increase in the future, particularly in disturbed or burned areas, although they may be constrained by extended drought, with the potential to shift toward longer fire return intervals in the most arid areas of the Mojave Desert (Comer et al. 2013, p. 7).

There are no published studies on the competitive effects of nonnative plant species to the germination, growth, and reproduction of the Joshua trees; however, we project competitive effects to increase with increasing nonnative plant cover and seedlings to be the most vulnerable life stage if they share the same root niche space and their soil water needs are high at a time of active nonnative plant growth and reproduction (Schwinning and Kelly 2013, pp. 888, 894; Craine and Dybzinksi 2013, pp. 837, 839; Gioria and Osborne 2014, pp. 5 – 6). The largest, potential negative effect of nonnative invasive grasses to the Joshua trees is their contribution to wildfire risk and an altered wildfire regime (see Wildfire, above; Brooks and Matchett 2006, p. 149; Service 2023, pp. 60–70).

We evaluated the potential for nonnative plant species to contribute to the risk of wildfire and an altered fire regime within Joshua trees' habitat based on information on the abundance (in terms of percent cover) of invasive grasses including cheatgrass (*Bromus tectorum*), red brome (*Bromus rubens*), and other invasive grasses). Currently, invasive grasses are present in approximately half of the Joshua trees' habitat. We categorized 37 percent (3,539,813 ac; 1,432,511 ha) of the range as low abundance (based on the threshold of less than 15 percent cover of invasive grasses) and 12 percent (1,176,966 ac; 476,301 ha) of the range as high abundance (greater than 15 percent cover), based on the Bureau of Land Management (BLM) Rapid Ecological Assessment (REA) models of potential invasive grass cover for 2025 (Comer et al. 2013, p. 10). We defined these categories based on several studies; although low levels of invasive grasses may increase the risk of fire (Comer et al. 2013, p. 78), higher cover is needed to sustain wildfires and alter the natural fire regime consistent with our high abundance category (Link et al. 2006, pp. 114, 116). YUJA North has the greatest proportion of habitat characterized as high abundance (30 percent), followed by YUBR North (15 percent). Areas of high abundance of invasive grass cover tend to occur along the interface between the Mojave and Central Basin and Range ecoregions near the northern limit of *Yucca brevifolia* and *Y. jaegeriana* distribution and represent 7 percent of the ranges of Joshua trees (see figure 6-2 in the SSA report (Service 2023, p. 62)). Throughout the range of Joshua trees, high abundance areas are located in recently burned areas and along the urban-wildland interface (Comer et al. 2013, p. 79).

Although invasive grasses are highly pervasive and beyond the ability of any agency to eradicate, they and other nonnative plant species are managed on Federal and State lands to varying degrees. In particular, more than half of the distribution of Joshua trees occurs on BLM land (54 percent). BLM has best management practices (BMPs) for invasive and nonnative species that focus on the prevention of further spread and/or establishment of these species (BLM 2008, pp. 76–77). BMPs should be considered and applied where applicable to promote healthy, functioning native plant communities, or to meet regulatory requirements. BMPs include inventorying weed infestations, prioritizing treatment areas, minimizing soil disturbance, and cleaning vehicles and equipment (BLM 2008, pp. 76–77).

Invasive grasses are a low to moderate, pervasive, ongoing threat that affects approximately half of the range of Joshua trees to some degree. The severity ranges from low to moderate depending on the cover and is highest in YUJA North and YUBR North. In the future (2040–2069), invasive grasses are projected to expand their competitive edge over native species and are likely to benefit under conditions of drought, increased carbon dioxide concentration, extreme precipitation events, and atmospheric nitrogen (Archer and Predick 2008, p. 25). As a result, we predict that the threat of invasive grasses will increase, although extended droughts have also been hypothesized to result in decreased biomass and the potential to shift toward longer fire return intervals in the most arid areas of the Mojave Desert (Comer et al. 2013, p. 7). Using the BLM REA models described above, as well as modeled future invasiveness from the same publication, minor increases in invasive grass cover are projected for 2040-2069. Low invasive grass cover increased by approximately 5 percent as areas with no previous invasive grass cover become invaded; and the acreage at high risk increased by 1 percent to 13 percent of the range of Joshua trees.

After examining the extent and rangewide impact of invasive grasses on Joshua tree, we determined that invasive grasses are a low magnitude threat. Projected impacts are low throughout approximately 80 percent of the Joshua trees' range where invasive grasses are not present or occur in low abundance currently and are projected to remain at low abundance in the future. A smaller portion of the range (approximately 12 to 13 percent) currently has or is projected to have a higher abundance of invasive grass and moderate degree of threat affecting these localized areas, particularly to the north and northeast in burned habitat and along the urban interface. The effect of invasive grasses on competition, soil moisture, and vegetation community composition and structure is not currently influencing population- or species-level dynamics, and we do not project effects to increase in the future in unburned, intact habitat. This threat individually is unlikely to drive any declines in status trends for either species in the future except in developed or burned habitat. The contribution of invasive grasses to the increased risk of wildfire is discussed above. As a result, there is no indication that the current or future effects of invasive grasses associated with competition with Joshua trees or potential effects on habitat structure would significantly reduce the redundancy, representation, or resiliency of *Yucca. brevifolia* or *Y. jaegeriana*. See chapter 6 of the SSA report for more detailed information (Service 2023, pp. 50–87).

Climate Change

Temperatures have been increasing in the desert southwest for decades; since 1950, the region experienced hotter temperatures than in any period during the past 600 years (Garfin et al. 2014, p. 464). Current summer temperatures (1991–2010) have increased by approximately 1 °C relative to historical temperatures (1961–1990) (figure 6-5 in Service 2023, p. 72; Wang et al. 2016, unpaginated). The southwestern United States is projected to be affected particularly severely by prolonged drought, fewer frost days, warmer temperatures, greater water demand by plants, and an increase in extreme weather events (Archer and Predick 2008, pp. 23–24; Cook et al. 2015, entire; Jepson et al. 2016, p. 49). For *Yucca brevifolia* and *Y. jaegeriana*, the main threats associated with the current and future effects of climate change are temperature increases (increasing maximum summer temperatures and increasing minimum winter temperatures), changes in summer and winter precipitation, and prolonged drought that contribute to increased drought stress. Climate models forecast an increase in the variability of precipitation, including the potential of high precipitation events generally tied to El Niño-Southern Oscillation and the potential increase of prolonged drought conditions in the intervening period. Increasing temperatures may increase moisture stress on adults, potentially limit flowering at lower elevations, and may limit seedling survival and establishment. The most dramatic temperature increases are predicted to occur along the southern edge of the two species' ranges, at lower latitudes and elevations such as in YUJA East, which is warmer on average than the rest of the analysis units. Similarly, YUBR South is currently experiencing higher moisture stress in areas with recent, localized observations (from a 12-year period) of reduced recruitment and survival, though we lack historical data to confirm a declining trend. YUJA East is already experiencing the warmest cold season temperatures under current conditions within its range (see section 5.1.5 in the SSA report (Service 2023, p. 44)) and is projected to be warmer in the future, potentially resulting in reduced seedling growth and establishment (see figure 6-5 in the SSA report (Service 2023, p. 72)). Overall, the pattern of increasing drought stress is likely to occur across all analysis units to varying degrees depending on elevation and latitude. Forecasted changes in climate conditions also have the potential to influence or exacerbate other threats such as increased risk of wildfire. See chapter 6 of the SSA report for more detailed information (Service 2023, pp. 70–80).

We evaluated current and projected changes in climatic parameters averaged across 13 general circulation models (GCMs) from the Climate Model Intercomparison Project 6 (CMIP6) (Mahoney et al. 2003, entire) compiled using the ClimateNA tool (version 7.21, *https://climatena.ca/*) (Wang et al. 2016, entire). We also evaluated six Joshua tree-specific bioclimatic models that forecast the degree to which the current species' range will contain the same climate conditions for both species in the future (2040–2069) or where parts of the species' ranges will not support current climatic conditions, referred to as climatically unfavorable throughout the rest of the document (Shafer et al. 2001, entire; Dole et al. 2003, entire; Cole et al. 2011, entire; Thomas et al. 2012, entire; Barrows and Murphy-Mariscal 2012, entire; Sweet et al. 2019, entire). We did not thoroughly address these models in the 2018 Joshua tree SSA report because earlier models used coarse-scale climate data and the most recent model, using smaller-scale climate data, was limited to a relatively small portion of the Joshua trees' range and, at the time, we determined that the data could not be extrapolated to the entire range due to the lack of demographic data. Since our last review, additional bioclimatic models were evaluated that support the earlier models. However, two of these models used finer-scale data and identified the potential for climate refugia in topographically diverse habitat that does not appear to have been captured in the coarse-scale climate models. We evaluate the combined results of these bioclimatic models below (see also table 6-3 of the SSA report (Service 2023 p. 82)).

There is consistency across the bioclimatic models that the southern portion of the ranges of both species and lower elevation habitat areas may not support current climate conditions for Joshua trees in the future. The models forecast that 66 to 88.6 percent of the current range will be climatically unfavorable, meaning different than the current climate conditions that Joshua trees occupy, in 2040–2069. However, these models do not include estimates of Joshua trees' future distribution and the best available science does not provide physiological temperature thresholds to inform the timing and magnitude of the species' response and when species viability may be affected, as we discussed earlier (see *Foreseeable Future*, above), though we acknowledge the potential for long-term negative effects to both species. The best available science indicates that both species are long-lived (150–300 years), adapted to hot and dry desert conditions, and have been exposed to extreme and variable climate conditions over thousands of years. Also, individual adult trees have experienced a range of environmental conditions over the typical lifespan of 100 to several hundred years. Both species also continue to occupy most of their historical ranges, despite recent increases (approximately 1.8ºF (1ºC)) in average summer temperatures over the last 40–50 years (Figure 4-1 in Service 2023, p. 31).

Joshua trees are projected to experience increases in average summer temperature of approximately 3.6–5.4ºF (2-3ºC) by 2040–2069, depending on the location (Wang et al. 2016, unpaginated). These temperature ranges are anticipated to be within the range of variability that Joshua trees have experienced in the recent past. Therefore, we consider that the majority (approximately 90 percent) of the current range of both species will continue to be occupied and viable in 2040–2069 and acknowledge the potential for the localized loss of occupied habitat in the warmest and driest portions of the ranges of both species. In the last decade several masting events (large flowering events where the majority of trees within a region flower) were recorded despite recent temperature increases, even at the southern limit of their distribution (Service 2023, p. 79); and we project masting events to continue to occur throughout the majority of the ranges of both species. Modeled climatically unfavorable areas, areas projected to experience warmer and drier climate conditions than current climate conditions, may have reduced ability to support species needs with the potential for reduced growth, lower recruitment, increased predation, and tree mortality that may contribute to localized losses at low elevations and latitudes. We cannot reliably assess or characterize the degree of reduction in these demographic parameters; but we do assume and project that recruitment will be reduced throughout portions of the currently occupied habitat modeled as climatically unfavorable in 2040–2069 (66–88.6 percent) based on a projected increase of approximately 3.6–5.4ºF (2–3ºC)(Barrows and Murphy-Mariscal 2012, entire; Thomas et al. 2012, entire). We project recruitment will be reduced relative to current conditions; we assumed no to low recruitment for the warmest and driest portions of the range and an increasing reliance on clonal growth to support occupancy and viability.

The potential effects of increasing temperatures and drought on Joshua trees' habitat are complex and are dependent on the direct effects of future climatic conditions described above, as well as the strength and magnitude of the interaction with their specialist pollinators, the yucca moths, and rodent seed dispersers. In the last decade several mast flowering events were recorded despite recent temperature increases, even at the southern limit of their distribution (Service 2023, p. 79), though there is a limited understanding of yucca moth abundance during these events. Overall, the best available science does not include information on the population dynamics and environmental thresholds for the yucca moth species. Therefore, we presumed that yucca moth populations will track Joshua tree flowering, as has been experienced in the past, and will experience similar threat effects as described for the Joshua tree. We note that there is a high degree of uncertainty regarding these assumptions which limits our ability to reliably project the

Joshua trees' future condition beyond 2040–2069. Prolonged drought conditions may increase seed predation and herbivory as water and food resources are limited; and we project that drought and drought-exacerbated seed predation and herbivory may increase in the future. Currently there is evidence of localized effects of predation and herbivory; but the best available science does not support the potential for population- or species- level effects currently or in the future. Prolonged droughts may have the potential to reduce rodent populations due to limited availability of water and food resources, but we have no reliable means to evaluate future climate effects to the suite of rodents that forage on Joshua trees nor future changes in seed dispersal. Recent mast flowering events in the last decade appeared to satiate rodent populations (Service 2023, p. 79); but any projections that we would develop about the future predation and herbivory effects to Joshua trees or future seed dispersal would be speculative.

The existing regulatory mechanisms in place help protect habitat and provide protective measures for Joshua trees; however, few regulations specifically address the threat of climate change (see appendix B of the SSA report (Service 2023, pp. 152–161)). Therefore, while existing regulatory mechanisms and current conservation efforts may contribute to reduced GHG emissions in the United States, impacts from climate change are forecasted to increase in the future.

The cumulative effects of climate change are complex and ongoing. Currently, climate change is a low-to-moderate magnitude threat with primarily localized effects on individual Joshua trees and portions of populations; there is no indication that climate change is currently reducing redundancy, representation, and resiliency of the Joshua trees. There is the potential for higher magnitude effects in the future, particularly for habitat at low elevation and latitudes along the southern edge of the Joshua trees' ranges. Based on the best available science we project that Joshua trees will still occupy and maintain viability in the majority of the species' current distribution in 2040–2069. Therefore, we project climate change over this time period to be a low to moderate magnitude threat in the foreseeable future with the greatest impacts at lower latitudes and elevations. Forecasted reductions in recruitment may decrease resiliency in portions of populations but there is no indication that climate change will result in a reduction in redundancy and representation that would impact the viability of the species through the years 2040–2069.

Summary of Threats

We evaluated the current threat of habitat loss and degradation, invasive grasses, increased risk of wildfire, climate change, and predation and herbivory within the distribution of Joshua trees, including how threats varied by analysis unit (see table 6-4 of the SSA report (Service 2023, p. 86)). Habitat loss and degradation is generally focused in localized areas within the range of Joshua trees and is currently considered a low magnitude threat overall and across each of the analysis units, despite the intensity of impacts being potentially severe in some localized areas. In the future, we project the threat of habitat loss and degradation to increase, but the effects will continue to be localized.

We consider invasive grasses to have a low-to-moderate potential threat to degrade habitat; moderate potential threat was defined in analysis units with approximately 12 to 13 percent of the area with high invasive grass abundance. Our analysis indicated that there is evidence of an invasive grass-wildfire cycle currently in the northern range of *Yucca jaegeriana*. Wildfire models estimate an increase in the frequency of wildfires to the northeast and high likelihood of more severe fires at northern latitudes and higher elevations, although the area anticipated to burn is likely to be less than 12 to 18 percent (including areas previously burned). Current climate conditions are warmer than historical climate conditions and warmer climate conditions may be increasing drought stress at lower elevations. It is not clear from the limited monitoring data (from a 12-year period) if YUBR South, the southernmost and warmest analysis unit, is experiencing a declining trend caused by climatic conditions or if it is experiencing a natural fluctuation in population. We do not have information on the effect of warmer climate conditions and the current mega-drought in the rest of the species' range; but masting reproductive events continue to occur several times a decade, even in the southern portion of the ranges of both Joshua tree species. Therefore, we consider climate change a low-to-moderate threat. Predation and herbivory are considered a low-to-moderate potential threat across the species' range. Several regulations, planning documents, and management plans in place help ameliorate the magnitude of these threats on Joshua trees and are further described in appendix B of the SSA report (Service 2023, pp. 152–161). Cumulatively, these threats are not projected to result in population- or species-level declines by 2040–2069, because the majority of the range of both species is projected to remain occupied and viable (Service 2023, figure 6-5, p. 87; Wang et al. 2016, unpaginated).

Table 2. Summary of the current and future (2040–2069) magnitude of the threats to Joshua tree based on the scope, intensity, likelihood, and immediacy (Service 2023, p. 51). (This table appears in the SSA report as table 6-5 (p. 87)).

Population/ Analysis Unit	**Habitat Loss and Degradation**	**Invasive Grasses**	**Risk of Wildfires**	**Climate Change**	**Predation and Herbivory**
Yucca brevifolia					
YUBR North	Low	Low to Moderate	Moderate	Low to Moderate	Low
YUBR South	Low+	Low	Moderate+	Moderate+	Low to Moderate+
YUBR Summary	**Low**	**Low to Moderate**	**Low to Moderate**	**Low to Moderate**	**Low to Moderate**
Yucca jaegeriana					
YUJA North	Low	Moderate+	Moderate to High+	Low to Moderate	Low
YUJA Central	Low	Low	Moderate to High	Low to Moderate	Low
YUJA East	Low	Low	Low	Low to Moderate	Low
YUJA Summary	**Low**	**Low to Moderate**	**Moderate**	**Low to Moderate**	**Low**
Overall Magnitude of Threat	**Low**	**Low to Moderate**	**Moderate**	**Low to Moderate**	**Low**

*Level of threat: low refers to impacts to the individuals; moderate refers to impacts affecting portions of an analysis unit; high refers to impacts that may result in population level effects to the analysis unit.

+ Indicates those analysis units where the magnitude of the threat is the greatest.

Conservation Measures and Existing Regulatory Mechanisms

Threats may be ameliorated or reduced through the implementation of existing regulatory mechanisms or other conservation measures that benefit Joshua trees and their habitat. Federal agencies, State agencies, and several local communities have adopted and implemented laws, regulations, or ordinances and conservation measures that protect native habitat and plants such as Joshua trees. Conservation measures that assist in reducing or ameliorating individual threats are discussed at the end of each of the discussions of individual threats in this document and in the SSA report (Service 2023, appendix B, pp. 152–161).

For the Joshua trees, a high percentage of occupied habitat includes lands conserved as open space and resource lands owned by the Federal government, State agencies, and nonprofit organizations, including lands covered by conservation easements, which provide a high level of protection for the species and their habitat. Conservation is categorized by the protected area database (USGS 2018, unpaginated) and is based on how the lands are managed. Approximately 3 million ac (1.2 million ha; 32 percent) of habitat occupied by the Joshua trees is fully conserved, including 23 percent of *Yucca brevifolia*'s and 41 percent *Y. jaegeriana*'s distribution. Considering lands that are protected with allowable low-intensity or isolated impacts (e.g., OHV use), the percentage increases to 75 percent, including 59 percent of the range of *Y. brevifolia* and 89 percent of the range of *Y. jaegeriana*. Additionally, approximately 82 percent of the land within the distribution of Joshua trees is federally owned by the Service, BLM, National Park Service (NPS), U.S. Forest Service (USFS), and Department of Defense (DoD) (see tables 4-1 and 6-5 in the SSA report (Service 2023, pp. 33, 87)).

Federal lands are less likely to be developed and each agency follows established regulations and policies that provide for the consideration or management of Joshua trees or their habitat, including the following Federal regulations and policies: NEPA, Federal Land Policy and Management Act of 1976 (43 U.S.C. 1701 et seq.), National Forest Management Act (16 U.S.C. 1600 et seq.), Sikes Act and Sikes Act Improvement Act of 1997 (16 U.S.C. 670 et seq.), National Park Service Organic Act of 1916 (54 U.S.C. 100101 et seq.), Organic Administration Act of 1897 (16 U.S.C. 475, 477–478, 479–481, and 551) and the Multiple-Use, Sustained-Yield Act of 1960 (16 U.S.C. 528 et seq.), Wilderness Act (16 U.S.C. 1131 et seq.), Endangered Species Act (i.e., protections for other listed species may benefit the Joshua tree or its habitat), California Desert Protection Act (43 U.S.C. 1781 and 1781a), and the Desert Renewable Energy Conservation Plan.

Joshua trees are currently addressed under the California Environmental Quality Act and several local jurisdictions in California have enacted specific tree ordinances for the Joshua trees. The Clean Air Act and California climate policies that help to mitigate climate change may also contribute to improved habitat conditions for Joshua trees in the future (see appendix B of the SSA report (Service 2023, pp. 152–161)). Though Joshua trees are not listed under the California Endangered Species Act (CESA), *Yucca brevifolia* has been considered a candidate for listing since 2020 (CDFW 2020, p. 1). As a candidate for listing under CESA, *Y. brevifolia* is temporarily afforded the same protections as a State-listed endangered or threatened species. The California Department of Fish and Wildlife (CDFW) has since completed their Status review of the *Y. brevifolia* and recommended that listing *Y. brevifolia* was not warranted (CDFW 2022, entire); the issue is now with the California Fish and Game Commission for a final decision. The Commission plans to make a final decision on whether to list the western Joshua tree under CESA in February 2023, to allow for additional Tribal consultation and deliberation time (CALSPAN, 2022). If the Commission accepts CDFW's recommendation, the *Y. brevifolia* would no longer be a candidate for listing under CESA.

The States of Arizona, Nevada, and Utah have no special designation or protection for Joshua trees as a state listed species, however there are regulations in place that limit collection of native desert plants. In Arizona, Joshua trees are a salvage restricted native plant, as prescribed in title 3, chapter 7, of the Arizona Revised Statutes at section 3-903B.2., which means that a permit is required for removal/collection (Arizona Department of Agriculture, 2016). Similarly, Joshua trees, and all members of the Yucca genus, are protected in the State of Nevada from commercial collection (see title 47, chapter 527, of the Nevada Revised Statutes, at section 527.060 et seq.); commercial removal and sale of Yucca harvested from State, county, or privately owned land requires a permit from the Nevada State Forester Firewarden.

Cumulative and Synergistic Effects

We note that, by using the SSA framework to guide our analysis of the scientific information reviewed and documented in the SSA report, we have not only analyzed individual effects on the species, but we have also analyzed their potential cumulative effects. We incorporate the cumulative effects into our SSA analysis when we characterize the current and future conditions of the species. To assess the current and future condition of the species, we undertake an iterative analysis that encompasses and incorporates the threats individually and then accumulates and evaluates the effects of all the relevant factors that may be influencing the species, including threats and conservation efforts. Because the SSA framework considers not just the presence of the factors, but to what degree they collectively influence risk to the entire species, our assessment integrates the cumulative effects of the factors and replaces a standalone cumulative effects analysis.

The threats acting on a species or its habitat do not typically operate in isolation but could impact the species or its habitat in conjunction with other threats. Individually identified threats may not rise to a level of concern or be insignificant in nature and not influence a decline in the species' status on the landscape. However, combined, these threats may result in a greater overall cumulative impact to a species or its habitat. In some cases, threats may also act synergistically, with the resulting impact being greater than if the threats were merely combined. These cumulative or synergistic impacts could result in an increased reduction in individual and habitat resource needs that may result in a loss of resiliency for a species. For example, the severity of drought events could increase under future climate conditions, which would further dry and stress vegetation and potentially make vegetation more vulnerable to wildfire, and predation. In our analysis of the threats facing *Yucca brevifolia* and *Y. jaegeriana*, we took the potential cumulative or synergistic effects of threats into consideration, and they are part of our discussion and conclusions regarding each threat currently and into the future.

CURRENT AND FUTURE CONDITION:

To evaluate the biological status of *Yucca brevifolia and Y. jaegeriana* both currently and into the future, we assess a range of conditions to allow us to consider the species' resiliency, redundancy, and representation. We evaluate how anthropogenic threats such as habitat loss and degradation, invasive grasses, increased risk of wildfire, climate change, and predation influence the resiliency, redundancy, and representation of Joshua trees in regional analysis units to describe the species' future viability. The viability of *Y. brevifolia and Y. jaegeriana* depends on maintaining multiple populations with sufficient redundancy and resiliency over time across each species' distribution.

Current Condition

We assess the Joshua trees' current condition by evaluating resiliency, representation, and redundancy. To assess current conditions for *Yucca brevifolia* and *Y. jaegeriana*, each species' range was divided into analysis units that are representative of the range of biotic and abiotic features of Joshua trees' habitat. A high overall resiliency condition score means all population needs are clearly met and that the species in that unit is sufficiently resilient to environmental variation in the range experienced by the species in the recent past; a highly resilient analysis unit is unlikely to become in danger of extinction and is more likely to contribute to species viability. A medium overall resiliency condition score means some habitat or demographic needs are minimally present while others may be met in the analysis unit, but we project that the analysis unit likely has the resiliency necessary to recover from stochastic variability. For units with a medium overall resiliency condition score, although occupancy may be lost in some areas, these units are unlikely to become in danger of extinction, and the functionality of the unit is likely to be retained and contribute to species viability. An overall low population resiliency condition score means that one or more habitat or demographic needs were not met, or all needs are at such low condition that there is a higher probability that the analysis unit may be in danger of extinction; a low resiliency analysis unit is unlikely to contribute substantially to species viability.

Current Resiliency, Redundancy, and Representation

Resiliency is the ability of populations to respond to stochastic variation despite the current level of threat. Based on the habitat and demographic needs identified in the SSA report, condition categories were defined where there was sufficient information to describe low, moderate, and high condition (see table 7-2 in the SSA report (Service 2023, p. 92)). We identified four condition categories including habitat quantity (availability of occupied habitat), habitat quality (invasive grass cover), and two demographic parameters (tree density and recruitment). The analysis units were then assessed to evaluate population resiliency based on these categories (see table 7-3 in the SSA report (Service 2023, p. 93)). Chapter 7 of the SSA report describes the parameters and assessment methodology (Service 2023, pp. 87–100).

We evaluated the Joshua trees' redundancy and representation in the context of the species' needs (see chapters 5 and 7 of the SSA report for a description of the assessment methodology (Service 2023, pp. 41–50, 87–100)). Redundancy describes the ability of a species to withstand catastrophic events that would result in the loss of a substantial component of the species' total overall population and can be assessed based on the number of populations and their resiliency, distribution, and connectivity. Representation is the ability of a species to withstand and adapt to long-term changes in environmental conditions (i.e., significant changes outside the range of normal year-to-year variations). It is measured by the breadth of genetic or ecological diversity within and among populations and is used to evaluate the probability that a species can adapt to environmental changes.

I. *Yucca brevifolia*

Resiliency: Yucca brevifolia occupies a large and diverse area of 4.4 million ac (1.8 million ha) in two analysis units of similar size within the western Mojave Desert. We consider both YUBR North and YUBR South highly resilient due to moderate to high condition for both habitat (e.g., quantity and quality) and demographic (e.g., tree density and recruitment) parameters (see table 7-3 in the SSA report (Service 2023, p. 93)). The range of *Y. brevifolia* is comprised of approximately 3.3 million ac (1.3 million ha: 74 percent) of Federal lands that are administered by the NPS, BLM, USFS, and Department of Energy, as well as military lands. The species' distribution also includes several National Parks (Joshua Tree National Park, Death Valley National Park), California State Parks (Red Rock Canyon State Park), and County parks and preserves where Joshua trees are protected and managed. The southern analysis unit (YUBR South) has a higher proportion of the area privately owned (45.6 percent) and potentially subject to development, but half (52 percent) of the unit is under Federal management. The species' distribution in this unit occurs along a latitudinal gradient, and the southern analysis unit is currently, and likely historically, more drought-stressed and has a higher magnitude of threat associated with drought-exacerbated predation and herbivory. There is recent site-specific evidence of reduced survival, recruitment and the availability of recruitment habitat at lower elevations in YUBR South. However, the available data is limited both spatially and temporally and cannot be evaluated in a historical context; therefore, it is not clear if these data points from a 12-year period represent natural variability or are an early indication of the potential effects of increased temperatures and prolonged drought. We also lack data and information on population trend and recruitment for the rest of the species' ranges; therefore these trends were not extrapolated rangewide. Based on the best available data the current demographic condition for YUBR South is moderate to high. In contrast, YUBR North is characterized by lower temperatures and higher precipitation, which contribute to higher recruitment condition and moderate to high demography overall. Although there is site-specific evidence that demographic and habitat conditions may have declined in recent years, these changes have not been to the level that puts Joshua trees at risk; we consider that both populations currently have a high capacity to withstand or recover from stochastic variability due to the large distribution, moderate to high demography, and large percentage of the distribution conserved or managed on Federal lands. *Yucca brevifolia*'s resiliency is moderate-high to high throughout its range and for all condition categories (habitat quantity, habitat quality, tree density, and recruitment), and overall high for YUBR North and YUBR South (see table 7-3 in the SSA report (Service 2023, p. 93)).

Redundancy: We consider *Yucca brevifolia* to have sufficient redundancy to withstand catastrophic events. YUBR South and YUBR North are spread across a very large area of mostly intact habitat that supports resource needs and contributes to a high level of redundancy. No range contraction has occurred over the last 30 to 40 years, based on distribution mapping (Rowlands 1978, p. 52; Esque 2022a, pers. comm.). The large amount of occupied habitat indicates that the range is occupied by millions of Joshua trees distributed across a latitudinal gradient of approximately 300 miles (mi) (483 kilometers (km)).

Additionally, the majority of occupied habitat is located on Federal lands—with some degree of regulatory protection, management, and reduced probability of anthropogenic disturbance—and is less likely to be impacted by anthropogenic development. For example, NPS prohibits removal of Joshua trees in National Parks, actively monitors the species, and conducts habitat restoration for the species. The risk of catastrophic loss is very low because the species is spread across a 4.4-million-ac (1.8-million-ha) area. Across the range of *Y. brevifolia*, approximately 80 percent of the occupied habitat is characterized by a natural fire regime (i.e., fire return interval of greater than 100 years), and greater than 50 percent of the species' range is characterized as no or low risk from invasive grasses. Although there is recent evidence of reduced recruitment and survival under extreme drought conditions, these effects are documented on a limited to relatively small area of the range; thus, we do not anticipate that current redundancy is substantially reduced such that wildfire, prolonged drought, or extreme predation and herbivory places either analysis unit in danger of extinction.

Representation: We evaluated representation in *Yucca brevifolia* based on the ecological diversity of the habitats it occupies, as a surrogate for genetic diversity, and the species' life-history characteristics that support or hinder adaptive capacity (see appendix A in the SSA report (Service 2023, p. 150). Adaptive capacity was evaluated following Thurman et al. 2020 (entire) to characterize *Y. brevifolia*'s ability to persist in place or shift in space in response to changes in its environment. Representation, as measured by the ecological diversity of habitats, is high for *Y. brevifolia*, as the two analysis units occupy highly diverse areas within the Mojave and Great Basin Deserts that include differences in elevation, aspect, soil type, temperature, rainfall, and vegetation communities. The large area that the species occupies, its broad distribution, and its ability as a habitat generalist promote higher adaptive capacity. We do not anticipate current site-specific reductions in recruitment to substantially reduce abundance or representation. Across these different environmental gradients, *Y. brevifolia* exhibits variability in growth and reproductive strategies, including increased asexual production. The clonal growth strategy increases persistence of the individual under stress, such as wildfire (Rowlands 1978, p. 50; Harrower and Gilbert 2021, p. 11; Esque 2022a, pers. comm.), which along with the Joshua trees' long lifespan, facilitates the ability of *Y. brevifolia* to persist in place in response to long-term or slow changes in its environment (Thurman et al. 2020, entire). Conversely, Joshua trees' long lifespan, limited reproductive events, long generation time, and extended age of sexual maturity limit the ability of *Y. brevifolia* to adapt to short-term changes in its environment. Its adaptive capacity and the extent that its populations can persist in place in the face of variable environmental conditions may also be constrained by its obligate mutualism with the yucca moth; we do not have information to assess the adaptive capacity of the yucca moth. Lastly, we conclude that the species has limited dispersal capabilities based on the average dispersal distances of the rodent seed dispersers and through the absence of substantial range expansion in the last several thousand years. Therefore, *Y. brevifolia* is unlikely to be able to shift in space beyond average dispersal rates in response to changing environmental conditions. However, the species has other life-history characteristics that confer representation, including high ecological variability and the capacity to persist under similar environmental conditions as it has experienced in the past. Although there is recent site-specific evidence of reduced recruitment and survival under extreme drought conditions, the species currently has the capacity to withstand and adapt to changes in environmental conditions.

Viability: Currently, we consider *Yucca brevifolia* to have adequate resiliency, redundancy, and representation throughout its range to maintain species viability. The species' current distribution is large (approximately 4.4 million ac (1.8 million ha)), occupies a diverse region of topographic and ecological diversity, and spans a large latitudinal gradient of approximately 300 mi (483 km), which collectively confers both redundancy and representation. We consider total abundance across the species' range to be high, although tree densities vary and recruitment may already be reduced in the southern portion of the range. Population resiliency is currently high in the YUBR North and YUBR South analysis units based on the current low-to-moderate level of threat. Drought stress at lower latitudes and elevations due to rising temperatures and drought conditions resulting in decreased tree vigor, mortality, reduced recruitment, and increased herbivory and predation may impact individuals or localized areas but are not anticipated to reduce the viability of the species.

II. *Yucca jaegeriana*

Resiliency: Yucca jaegeriana is distributed across a 4.9-million-acre (1.9-million-ha) area in three analysis units across the eastern Mojave Desert and a small portion of the southern Great Basin Desert and western Sonoran Desert, which we consider in high condition for habitat quantity. Approximately 89 percent of *Y. jaegeriana*'s distribution occurs on federally owned or managed land; private land ownership accounts for only 7 percent of modeled habitat that primarily occurs in YUJA East (23.5 percent). Like *Y. brevifolia*, *Y. jaegeriana* occurs along a latitudinal gradient, and the southernmost analysis unit is exposed to more drought stress and has the potential for higher drought-exacerbated predation and herbivory, although we have limited data on how prevalent this threat is in *Y. jaegeriana* relative to historical conditions. YUJA North has moderate resiliency due to lower demographic condition, though the unit has a large quantity of occupied habitat. YUJA Central has high population resiliency despite lower condition for habitat quality and demographic condition. YUJA East has moderate resiliency overall, due to the smaller size of the analysis unit and lower tree density and recruitment. Therefore, we consider *Y. jaegeriana* analysis units to have moderate to high resiliency and able to withstand environmental stochasticity (see table 7-3 in the SSA report (Service 2023, p. 93)), due to high habitat quality and quantity associated with the large percentage of the distribution of conserved or managed habitat on Federal lands.

Redundancy: We conclude that current redundancy is high in *Yucca jaegeriana* because YUJA Central, YUJA North, and YUJA East analysis units occur across a very large area of mostly intact habitat that supports resource needs. No range contraction has occurred over the last 40 years based on distribution mapping (Rowlands 1978, p. 52; Esque 2022a, pers. comm.), though wildfire has impacted trees in localized areas in YUJA North and YUJA Central. Additionally, plants are located primarily on Federal lands with less probability of development. The risk of catastrophic loss is very low because the species is spread across a 4.9-million-acre

(1.9-million-ha) area distributed over a latitudinal gradient of approximately 300 mi (483 km) and includes potentially millions of individual trees. Despite recent evidence of localized wildfire impacts and the invasive grass-wildfire cycle, we conclude that current redundancy is sufficiently high such that wildfire, prolonged drought, or extreme predation and herbivory does not place any analysis unit of *Y. jaegeriana* in danger of extinction.

Representation: We evaluated representation in *Yucca jaegeriana* with respect to ecological diversity and life-history characteristics that support or hinder adaptive capacity. Adaptive capacity was evaluated following Thurman et al. (2020, entire) to characterize *Y. jaegeriana*'s ability to persist in place or shift in space in response to changes in its environment. The large area that the species occupies, its broad distribution, and its ability as a habitat generalist promote higher adaptive capacity. The clonal growth strategy increases persistence of the individual under stress, such as wildfire (Rowlands 1978, p. 50; Harrower and Gilbert 2021, p. 11; Esque 2022a, pers. comm.), which along with the Joshua trees' long lifespan, facilitates the ability of *Y. jaegeriana* to persist in place in response to long-term or slow changes in its environment (Thurman et al. 2020, entire). Conversely, Joshua trees' long lifespan, limited reproductive events, long generation time, and extended age of sexual maturity limit the ability of *Y. jaegeriana* to adapt to short-term changes in its environment. Its adaptive capacity and the extent that its populations can persist in place in the face of variable environmental conditions may also be constrained by its obligate mutualism with the yucca moth; we do not have information to assess the adaptive capacity of the yucca moth. Lastly, we conclude that the species has limited dispersal capabilities based on the average dispersal distances of the rodent seed dispersers and through the absence of substantial range expansion in the last several thousand years. Therefore, *Y. jaegeriana* is unlikely to be able to shift in space beyond average dispersal rates in response to changing environmental conditions. The species has other life-history characteristics that confer representation, including high ecological variability and the capacity to persist under similar environmental conditions as it has experienced in the past. However, there is some preliminary evidence that *Y. jaegeriana*'s shorter stature and extensive branching closer to the ground may make it more susceptible to wildfire than *Y. brevifolia* (Cornett 2022, pp. 186–188). Ecological diversity is high, as *Y. jaegeriana* occupies an extensive area covering approximately 300 mi (483 km) from north to south and there is a high degree of variability in abiotic and biotic conditions within these habitats. YUJA North has high ecological diversity, as this unit is topographically diverse with areas of low, medium, and high elevation. Ecological variability is moderate to high both in topographic heterogeneity and the number of ecoregions. Therefore, we consider *Y. jaegeriana* to have sufficient representation to adapt to environmental conditions over time; however, we conclude that *Y. jaegeriana* has limited capacity to shift in space to overcome more rapid or extreme variability.

Viability: Currently, we consider *Yucca jaegeriana* to have adequate resiliency, redundancy, and representation throughout its range to maintain species viability. The species' distribution is currently large, approximately 4.9 million ac (1.9 million ha), and it occupies a diverse region of topographic and ecological diversity that spans a large latitudinal gradient of approximately 300 mi (483 km), which confers both redundancy and representation. We characterize abundance as low to moderate condition across the three analysis units based on available tree density information; although tree densities vary and we assumed them to be lower in warm environments. Population resiliency is currently moderate to high across the three analysis units based on the amount and quality of habitat available, and the current low to moderate levels of threat. Although drought stress at lower latitudes and elevations due to rising temperatures and drought conditions may be impacting individuals or localized areas; we conclude that overall, they do not reduce the viability of the species. Thus, the species has sufficient viability to withstand the current level of threats.

<u>Future Condition</u>

In this section, we summarized the Joshua trees' future condition to 2069 where we can reliably forecast threats and the species' response to those threats. Over the next 47 years (approximately one generation and when trees can reproduce sexually), we can reliably characterize Joshua trees' viability where our confidence is greatest with respect to the range of projected plausible threats and the species' response. There are key areas of uncertainty, primarily regarding the two species' responses to projected future climate conditions, that do not allow us to reliably project the Joshua trees' status to end of century, discussed above in *Foreseeable Future* and below in the **Finding**. This is a shorter timeframe than we evaluated for future scenarios in the SSA report. For our evaluation of future condition (2040–2069), we rely on the same assumptions and data sources about the extent and magnitude of threats projected over time in Scenarios I and II of the SSA report for the primary threats—habitat loss, invasive grasses, wildfire, and future climate change— considering the time period from 2040–2069 along the trajectory projected for Scenarios I and II. Our evaluation of future condition summarized below considered the effects of threats individually and cumulatively to both species of Joshua tree.

In 2040–2069, we project the two species to continue to occupy and maintain viability in most of their current ranges, despite forecasted temperature increases (Figure 4-1 in Service 2023, p. 31). We project adult plant survival and persistence, and clonal growth to continue; and the species distribution to remain similar or slightly reduced relative to current conditions in unburned habitats across their ranges. We project seedling recruitment will continue to occur at reduced levels relative to current conditions due to increased drought stress in areas modeled to be climatically unfavorable, with the greatest reduction projected at lower elevations and latitudes. In low and moderate severity burned habitats, we project recovery of the two species in habitats that do not have an invasive grass-wildfire cycle, though recovery times may take longer due to projected drought conditions. We project localized losses of Joshua trees in developed areas and in areas with an invasive grass-wildfire cycle. We forecast the conditions for 2040–2069 to be similar to current conditions but with slight reductions in resiliency from declines in recruitment, tree density and possibly occupied habitat.

I. *Yucca brevifolia*

Resiliency: Based on its long persistence across large areas with varied environmental conditions, we project that *Yucca brevifolia* will continue to occupy a large and diverse area of approximately 4 million ac (1.6 million ha) in two analysis units of similar size within the western Mojave Desert. We project the species' distribution will continue to occur along a latitudinal gradient, similar to its current distribution. We project the condition of the habitat and demographic parameters to be slightly reduced in more arid areas, including at low elevations within the analysis unit and at lower latitude (YUBR South), with potential localized areas of habitat loss. We consider both YUBR North and YUBR South to be highly resilient, due to moderate to high condition for habitat (e.g., quantity and quality) and demographic (e.g., tree density and recruitment) parameters, and accounting for the potential for localized reductions in recruitment and survival in YUBR South. This species will continue to occupy habitat primarily in Federal ownership and we project current management protections afforded to the species will continue. The southern analysis unit (YUBR South) has a higher proportion of privately owned land (45.6 percent) and we project approximately 11 percent of the analysis unit may be lost to development in low elevation areas projected to have reduced recruitment. However, approximately 50 percent of the unit is under Federal management and most of that area is likely to continue to support the species in 2040–2069. YUBR South will continue to experience more drought-stress with localized areas of reduced recruitment and tree mortality, with a higher magnitude of threat associated with drought-exacerbated predation and herbivory. Based on our projections, the future demographic condition for YUBR South is moderate and reduced from current conditions; and the analysis unit is forecasted to maintain high resiliency in the foreseeable future. YUBR North will continue to experience lower temperatures and higher precipitation than YUBR South which contributes to higher recruitment condition and high demography as well as high population resiliency.

Overall, our analysis indicated that occupancy will be maintained throughout the range of *Yucca brevifolia*, and approximately 90 percent of the current distribution will be viable in the foreseeable future (2040–2069). We project that high resiliency for *Y. brevifolia* will continue to be maintained in both analysis units; and will be similar or slightly reduced relative to current conditions because tree densities may be lower, and recruitment reduced. We project that these changes in resiliency will not put the *Y. brevifolia* in danger of extinction, as both analysis units are likely to be able to withstand stochastic events and contribute to species viability.

Redundancy: We consider future redundancy in *Yucca brevifolia* to be high and similar to current redundancy. YUBR South and YUBR North will continue to occupy a very large area of mostly intact habitat that supports the species' resource needs. We project small, localized areas of habitat loss will occur (approximately 10 percent of the current range) and that 90 percent of the range will maintain viability by 2040–2069. The large amount of occupied habitat indicates that the range is occupied by millions of Joshua trees distributed across a latitudinal gradient of approximately 300 miles (mi) (483 kilometers (km)).

Additionally, the majority of occupied habitat will be located on Federal lands—with some degree of regulatory protection, management, and reduced probability of anthropogenic disturbance—and is less likely to be impacted by anthropogenic development. The risk of catastrophic loss is very low because the species is spread across an approximately 4-million-ac (1.6-million-ha) area. Across the range of *Y. brevifolia*, we project approximately 80 percent of the occupied habitat is characterized by a natural fire regime (i.e., fire return interval of greater than 100 years), and approximately 80 percent of the species' range is characterized as no or low risk from invasive grasses. Although we project reduced tree density and recruitment under extreme drought conditions, both analysis units are forecasted to be highly resilient. Therefore, we anticipate that future redundancy will be sufficient to withstand catastrophic events associated with threats (e.g., wildfire, prolonged drought, or extreme predation and herbivory).

Representation: Representation, as measured by the ecological diversity of habitats, remains high and we project it to be similar or slightly reduced from current condition, as we project the two analysis units to occupy highly diverse areas within the Mojave and Great Basin Deserts that include differences in elevation, aspect, soil type, temperature, rainfall, and vegetation communities. The large area that the species occupies, its broad distribution, and its ability as a habitat generalist promote higher adaptive capacity. We do not anticipate projected reductions in tree density and recruitment to substantially reduce abundance or representation. Across these different environmental gradients, *Y. brevifolia* will continue to exhibit variability in growth and reproductive strategies, including the potential for increased asexual production to support persistence of individuals under stress. Its adaptive capacity and the extent that its populations can persist in place in the face of variable environmental conditions may also be constrained by its obligate mutualism with the yucca moth; but we were not able to reliably project changes to this mutualism. Lastly, we project that the species' dispersal capabilities will remain limited and similar to current conditions. Although we project reduced tree density and recruitment, we forecast the species to retain the capacity to withstand and adapt to changes in environmental conditions.

Viability: Our analysis indicates that approximately 90 percent of the current distribution will be viable in the foreseeable future (2040–2069), though tree densities may be lower and recruitment reduced. We predict that resiliency, redundancy, and representation for *Yucca brevifolia* would continue to be viable and similar or slightly reduced relative to current conditions. All analysis units will be occupied, and the distribution includes a large and diverse area of mostly intact habitat that supports resource needs and the ability to withstand stochastic variability in environmental conditions. We project the species to have sufficient population resiliency and the ability to respond to stochastic and year-to-year variability. Because *Y. brevifolia* is long-lived, occupies a broad distribution, is a habitat generalist, is capable of asexual reproduction, and occupies numerous ecological settings, we project that the species has sufficient adaptive capacity and representation to adapt to changing environmental conditions. Therefore, future events, such as severe wildfire due to invasive grasses, or the effects of predation and moisture deficit due to long-term drought and increased temperatures due to climate changes would not lead to population- or species-level declines that would limit species viability.

Under the range of threats forecasted, we project that *Yucca brevifolia* will maintain high population resiliency. We project redundancy to be similar to the current condition with a similar distribution and similar population size. Our analysis indicates that at least 90 percent (4 million ac (1.6 million ha)) of the current distribution will be occupied. We consider this acreage and the species' broad distribution to confer sufficient redundancy for the species to withstand large-scale wildfires, prolonged drought, and episodes of severe predation. No analysis unit is forecasted to be in danger of extinction under a catastrophic event. Similarly, we project representation to be similar or slightly reduced compared to current conditions and that *Y. brevifolia* will retain adequate representation, despite the increased risk of wildfires, increased temperatures, and potential for prolonged drought. We considered the possibility of potential habitat expansion in the future, but we project that it will be limited by dispersal distance and the general lack of continuity between currently occupied habitat and habitat forecasted to be climatically favorable in the future. Therefore, we did not include potential habitat expansion in our projections for resiliency, redundancy, or representation. We project that future resiliency, redundancy, and representation contribute to a viability that does not place *Y. brevifolia* in danger of extinction.

II. *Yucca jaegeriana*

Resiliency: Based on its long persistence across large areas with varied environmental conditions, we project that *Yucca jaegeriana* will continue to occupy a large and diverse area of approximately 4.4 million ac (1.8 million ha) in three analysis units of similar size within the eastern Mojave Desert, the southern Great Basin Desert, and western Sonoran Desert. We project that the species' distribution in the future will be similar to its current distribution along a latitudinal gradient. We consider all three units, YUJA North, YUJA Central, and YUJA East to be moderately resilient due to moderate to high condition for habitat parameters (e.g., quantity and quality), despite low to moderate demographic (e.g., tree density and recruitment) condition projected due to the forecasted increases in drought stress and reduced recruitment. We project the condition of the habitat and demographic parameters to be slightly reduced in more arid areas, including at low elevations and in the analysis unit at lower latitude (YUJA East), with localized areas of habitat loss. We forecast greater potential for negative impacts to YUJA East due to the increasing temperatures and drought affecting habitat quantity, habitat quality, and demographic parameters due to its lower latitude and elevation. YUJA North and YUJA Central have higher but still moderate resiliency because they occur at higher latitudes, but portions of these analysis units also occur at lower elevation and are subject to the increased aridity and greater effects from climate change. In addition, these analysis units (YUJA North and YUJA Central) in the northern portion of the range have burned, have higher invasive grass cover, and are at increased risk of wildfire in the future with potential impacts to both habitat and demographic parameters. This species will continue to occupy habitat primarily in Federal ownership and we project current management protections afforded to the species will continue.

Overall, our analysis indicated that occupancy will be maintained throughout the range of *Yucca jaegeriana* and approximately 90 percent of the current distribution will be viable in the foreseeable future (2040–2069). We project moderate resiliency for *Y. jaegeriana* in all three analysis units that will be similar or slightly reduced relative to current conditions because tree densities may be lower and recruitment reduced. These changes in resiliency are not projected to put *Y. jaegeriana* at risk of extinction, as all three analysis units are likely to be able to withstand stochastic events and contribute to species viability.

Redundancy: Future redundancy will remain high for *Yucca jaegeriana* and similar or slightly reduced relative to current redundancy. YUJA Central, YUJA North, and YUJA East analysis units will continue to be occupied and viable across a very large area of mostly intact habitat that supports the species' resource needs. Additionally, plants are located primarily on Federal lands with less probability of development. The risk of catastrophic loss is very low because we project the species to occur across an approximately 4.4-million-acre (1.8-million-ha) area distributed over a latitudinal gradient of approximately 300 mi (483 km) and include potentially millions of individual trees. Despite projected wildfire impacts and the invasive grass-wildfire cycle, we conclude that future redundancy is sufficiently high to withstand catastrophic events associated with wildfire, prolonged drought, or extreme predation and herbivory.

Representation: Representation, as measured by the ecological diversity of habitats, remains high and slightly reduced from current condition, as we project the three analysis units to occupy highly diverse areas within the Mojave, Great Basin, and Sonoran Deserts that include differences in elevation, aspect, soil type, temperature, rainfall, and vegetation communities. The large area that the species occupies, its broad distribution, and the fact that it is a habitat generalist promotes higher adaptive capacity. We do not anticipate reductions in tree density and recruitment to substantially reduce abundance or representation. Across these different environmental gradients, *Yucca jaegeriana* will continue to exhibit variability in growth and reproductive strategies, including increased asexual production to support persistence of the individual under stress. Its adaptive capacity and the extent that its populations can persist in place in the face of variable environmental conditions may also be constrained by its obligate mutualism with the yucca moth; but we were not able to reliably project changes to this mutualism. Lastly, we project that the species' dispersal capabilities will remain limited and similar to the current condition. Although we project reduced tree density and recruitment, we project the species to retain the capacity to withstand and adapt to changes in environmental conditions.

Viability: Our analysis indicates that approximately 90 percent of the current distribution will be viable in the foreseeable future (2040–2069), though densities of plants on the landscape may be lower and recruitment reduced at lower latitudes and elevations. We predict that resiliency, redundancy, and representation for *Yucca jaegeriana* will continue to be maintained and will be similar or slightly reduced relative to current conditions. All analysis units will be occupied, and the distribution will include a large and diverse area of mostly intact habitat that supports resource needs and the ability to withstand stochastic variability in environmental conditions and catastrophic events. Because *Y. jaegeriana* is long-lived, occupies a broad distribution, is a habitat generalist, is capable of asexual reproduction, and occupies numerous ecological settings, we project that the species has sufficient adaptive capacity and representation to adapt to changing environmental conditions. Therefore, future events, such as severe wildfire due to nonnative grasses, or the effects of predation and moisture deficit due to long-term drought and increased temperatures due to climate changes in 2040–2069, would not lead to population- or species-level declines that would limit species viability.

Under the range of threats forecasted, we project that *Yucca jaegeriana* will maintain moderate population resiliency across its range. Redundancy is projected to be similar to or slightly reduced relative to current condition with a similar distribution and population size considering the potential for decreases in distribution and population size as a result of forecasted localized loss of occupied habitat in developed areas and at lower elevations and latitudes. Our analysis indicates that approximately 90 percent (4.4 million ac; 1.8 million ha) of the current distribution will be occupied and viable. We consider this acreage and the species' broad distribution to confer sufficient redundancy for the species to withstand potential large-scale wildfires, prolonged drought, and episodes of severe predation. No analysis unit is projected to be in danger of extinction due to a stochastic or catastrophic event. We project representation to be sufficient and slightly reduced relative to current conditions, despite the increased risk of wildfires, increased temperatures, and potential for prolonged drought. We considered the possibility of potential habitat expansion in the future; but project that habitat expansion will be limited by dispersal capability and the general lack of continuity between currently occupied habitat and habitat forecasted to be climatically favorable in the future. Therefore, we did not include potential habitat expansion in our projections for resiliency, redundancy, or representation. We project that future resiliency, redundancy, and representation will continue to contribute to viability that does not place *Y. jaegeriana* in danger of extinction.

<u>Overall Synthesis of Future Viability</u>

Our analyses of the threats in the future support reasonably reliable projections of the future status of *Yucca brevifolia* and *Y. jaegeriana* from 2040–2069. Population resiliency for both species will be similar or slightly reduced relative to current conditions, ranging from moderate to high. Although there is the potential for localized habitat loss, the majority of the range of both species will continue to be occupied and viable, including approximately 4 million ac (1.6 million ha) for *Y. brevifolia* and 4.4 million ac (1.8 million ha) for *Y. jaegeriana*. All species needs are projected to be met throughout the majority of the occupied habitat, including reproduction through masting events and asexual/clonal reproduction, although recruitment may be lower in some areas. Future resiliency is similar or slightly reduced relative to current conditions and we project both species will have the ability to withstand environmental stochasticity. Localized habitat loss and reductions in recruitment are not projected to substantially decrease redundancy and representation. Therefore, both species are projected to have the ability to adapt to changes in environmental conditions and be able to withstand catastrophic events.

FINDING

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

(A) The present or threatened destruction, modification, or curtailment of its habitat or range;

(B) Overutilization for commercial, recreational, scientific, or educational purposes;

(C) Disease or predation;

(D) The inadequacy of existing regulatory mechanisms; or

(E) Other natural or manmade factors affecting its continued existence.

These factors represent broad categories of natural or human-caused actions or conditions that could have an effect on a species' continued existence. In evaluating these actions and conditions, we look for those that may have a negative effect on individuals of the species, as well as other actions or conditions that may ameliorate any negative effects or may have positive effects.

The Act does not define the term "foreseeable future, which appears in the statutory definition of "threatened species." The regulatory language that is applicable to determinations of the foreseeable future is contained in the regulations at 50 CFR 424.11(d) promulgated in 2019. Although there was a period in the interim—between July 5, 2022, and September 21, 2022—when the 2019 regulations became vacated and the pre-2019 regulations therefore governed, the 2019 regulations are now in effect and govern listing and critical habitat decisions (*see Center for Biological Diversity v. Haaland*, No. 4:19-cv-05206-JST, Doc. 168 (N.D. Cal. July 5, 2022) (CBD v. Haaland) (vacating the 2019 regulations and thereby reinstating the pre-2019 regulations)); *In re: Cattlemen's Ass'n*, No. 22-70194 (9th Cir. Sept. 21, 2022) (staying the district court's order vacating the 2019 regulations until the district court resolved a pending motion to amend the order); *Center for Biological Diversity v. Haaland*, No. 4:19-cv-5206-JST, Doc. Nos. 197, 198 (N.D. Cal. Nov. 16, 2022) (granting plaintiffs' motion to amend July 5, 2022 order and granting government's motion for remand without vacatur).

Status Throughout All of Their Ranges

After evaluating threats to both of the species and assessing the cumulative effect of the threats under the Act's section 4(a)(1) factors, we found that while there are threats that are currently acting on *Yucca brevifolia* and *Y. jaegeriana* such as habitat loss and degradation (from urbanization, military training, renewable energy, grazing, and OHV use) (Factor A), increased risk of wildfire (Factor A), seed predation and herbivory (Factor C), invasive grasses (Factor A), and changing climatic trends (e.g., increased temperatures and longer more frequent drought periods) (Factor A), including cumulative effects, we did not find that the threats are currently acting on either of the two species at either a population- or species-level scale such that the species are in danger of extinction throughout all of their range. The two species are occupying most of their historical ranges—which currently extends to over 4.4 million ac (1.8 million ha) for *Y. brevifolia* and 4.9 million ac (1.9 million ha) for *Y. jaegeriana*, as well as a hybrid zone of approximately 121,147 ac (49,048 ha). We also considered the inadequacy of existing regulatory mechanisms (Factor D) to address the primary threats to Joshua trees from the other four factors (Factors A, B, C, and E). We found no information to indicate that existing regulatory mechanisms (Factor D) in combination with other threats are not helping to address the effects of the threats to the species or would negatively affect the status of the species. Furthermore, as discussed above, we found various Federal and State regulatory mechanisms do currently exist that do provide some level of protection for Joshua trees and their habitat.

Current population resiliency is high for *Yucca brevifolia* due to the large amounts of moderate- to high-quality habitat occupied by the species, as well as moderate to high tree density and recruitment observed throughout the range. The high level of population resiliency indicates that habitat and demographic resource needs are not limiting, and the species is currently able to withstand stochastic events. Similarly, current population resiliency ranges from moderate to high for *Y. jaegeriana*. Although there is also a large amount of habitat occupied by the species, the quality of habitat, tree density, and recruitment are reduced due in part to recent wildfires and higher levels of invasive grass cover within burned habitat, particularly in the northern portion of its range. However, all analysis units of *Y. brevifolia* and *Y. jaegeriana* currently retain resiliency sufficient to withstand stochastic variability because of the quantity of moderate- to high-condition habitat occupied by both species.

While warming and drying climate conditions have been observed, there is no evidence to support substantial population size reductions and range contraction over the last 40 years based on distribution mapping (Rowlands 1978, p. 52; Esque 2022b, pers. comm.). Overall, recruitment of both *Yucca brevifolia* and *Y. jaegeriana* is currently occurring across their respective ranges; although we acknowledge the potential for recent, small, and localized declines along the southern limit of *Y. brevifolia* in Joshua Tree National Park, the data does not support a population decline. The large area that the two species occupy, the broad latitudinal distribution, and the fact that they are habitat generalists promote higher adaptive capacity and representation. Current reductions in recruitment are not anticipated to reduce abundance or representation to the extent of limiting viability. *Yucca brevifolia* and *Y. jaegeriana* exhibit variability in density and reproductive strategies across these different environmental gradients, including the relative proportion of asexual reproduction. The clonal growth strategy increases persistence of the individual under stress (e.g., wildfire), which along with the Joshua trees' long lifespan, is anticipated to facilitate the ability of *Y. brevifolia* and *Y. jaegeriana* to continue to occur in place in response to long-term or slow changes in its environment. Additionally, Joshua trees are located primarily on Federal lands, which inherently have less pressure from anthropogenic development and often provide for management of the species. Potential adverse impacts to both species are dispersed across their ranges in large, occupied areas that span millions of acres across a latitude gradient of approximately 300 mi (483 km). This broad distribution and high number of individuals occupying the landscape provides redundancy to withstand catastrophic events (e.g. wildfire; Factor A) such that these events are not likely to place any population of *Y. brevifolia* or *Y. jaegeriana* in danger of extinction. In addition to the existing regulatory mechanisms already in place, several Federal, State, and county agencies have been implementing conservation measures through best management practices specific to the Joshua trees (*Y. brevifolia* and *Y. jaegeriana*), to protect and help sustain the species and their habitats where possible. The net effect of current and predictable threats to the species, after considering applicable conservation measures and existing regulatory mechanisms, is not sufficient to cause the species to meet the definition of an endangered species. Thus, after assessing the best available information, we have determined that Joshua trees (*Y. brevifolia* and *Y. jaegeriana*) are not currently in danger of extinction throughout all of their ranges.

Therefore, we proceed with determining whether Joshua trees (*Yucca brevifolia* or *Y. jaegeriana*) are likely to become endangered within the foreseeable future throughout their ranges. The two species face a variety of future threats, including the threats of habitat loss and degradation (from urbanization, military training, renewable energy, livestock grazing, and OHV use) (Factor A), increased risk of wildfire (Factor A), seed predation and herbivory (Factor C), invasive grasses (Factor A), and changing climatic trends, (e.g., increased temperatures and longer more frequent drought periods) (Factor A) that have the potential to reduce the viability of the two species. Of these threats, the primary future threats are the risk of wildfire (Factor A), invasive grasses (Factor A), and climate effects (increasing temperature, precipitation changes, drought) (Factor A). In the SSA report, we evaluated environmental conditions and primary threat factors acting on the two species and developed two future scenarios projecting to end of century to assist in determining the range of potential future conditions.

We examined the best available data that allow predictions into the future which extends as far as those predictions are sufficiently reliable to provide a reasonable degree of confidence. Many available data sources for the threats evaluated provided specific projections out 30 to 50 years. We based our analysis on future projections of habitat loss (including renewable energy development, invasive grass cover, climate change, and wildfire) and the potential impacts of those changes to species needs and habitat conditions. For example, invasive grass cover was modeled to 2050 (Comer et al. 2013, Figure 2). Wildfire modeling was based on current conditions and is considered accurate for the next 30 to 50 years (Klinger 2022, pers. comm.), and development and habitat loss projections are available f 2060 (Environmental Protection Agency 2015, entire). The climate change analysis considered bioclimatic models that provided projections for 2040–2069 (Thomas et al. 2012, entire; Barrows and Murphy-Mariscal 2012, entire).

Future climate projections for RCP 4.5 and 8.5 and the associated species response are more similar until 2050 and then begin to diverge after 2050 based on the different socio-economic and mitigation assumptions included in each RCP. Joshua trees' exposure to climatically unfavorable conditions and the species' response is also more tractable over a shorter time period, which provides greater certainty related to threats and the species' responses to those threats, as discussed below. We determined the climate projections and the response of Joshua trees at the end of century time horizon were too uncertain to rely on to analyze future condition. There is a high degree of variability in future climate forecasts depending on the global emission scenario evaluated at the end of the century and the magnitude of the forecasted temperature increase diverge after 2050. There is also a high degree of uncertainty in the timing and magnitude of the species' response to climatically unfavorable conditions at the end of the century. As a result, it is not clear how and when Joshua tree individuals or populations may begin to experience the effects of climatically unfavorable conditions, including when reduced recruitment may affect species viability, how long adult trees may persist in climatically unfavorable conditions, and what the physiological thresholds are for the species (Thomas 2022, pers. comm; Shafer et al. 2001, p. 207).

We determined that the best available science regarding the status of the species only supports reliable projections to 2040–2069. It was noted that beyond 50 years, human decisions that affect global GHG emissions are a major source of uncertainty (Terando *et al.* 2020, pp. 14-15). Although our SSA report captured the best available information on all key influences and the future scenarios provided a range of plausible conditions projected to the end of century, we determined that using 2040 to 2069 as the foreseeable future for these listing determinations is more appropriate considering the uncertainties identified above and our ability to reliably predict threats and the species' response.

In the foreseeable future (2040–2069), we predict that resiliency, redundancy, and representation for *Yucca brevifolia* and *Y. jaegeriana* would continue to be maintained in all analysis units. Because the two species are long-lived, occupy broad distributions, are habitat generalists, are capable of asexual reproduction, and occupy numerous ecological settings, we determined that future stochastic variability and catastrophic events, such as severe wildfire due to invasive grasses, or the effects of predation and moisture deficit due to long-term drought and increased temperatures due to climate changes, would not lead to population- or species-level declines that would limit species viability or persistence. Therefore, in 2040–2069, both species are likely to maintain occupancy throughout each analysis unit, within a distribution that is similar to or slightly reduced relative to current conditions. As a result, each Joshua tree analysis unit is likely to contribute representation and redundancy for species viability. In addition, most of the habitat occupied by Joshua trees occurs on Federal land with existing regulatory mechanisms in place. Several Federal, State, and county agencies have been implementing conservation measures through BMPs, specific to the Joshua trees (*Y. brevifolia* and *Y. jaegeriana*), to protect and help sustain the species and its habitat where possible and into the future. The net effect of predictable future threats to the species, after considering applicable conservation measures and the existing regulatory mechanisms, is not sufficient to cause the species to meet the definition of a threatened species. Thus, after assessing the best available information, we have determined that *Y. brevifolia* and *Y. jaegeriana* are not likely to become endangered within the foreseeable future throughout all of their ranges.

<u>Status Throughout a Significant Portion of Its Range</u>

Under the Act and our implementing regulations, a species may warrant listing if it is in danger of extinction or likely to become so in the foreseeable future throughout all or a significant portion of its range. Having determined that the two species of Joshua tree are not in danger of extinction or likely to become so in the foreseeable future throughout all of their ranges, we now consider whether they may be in danger of extinction or likely to become so in the foreseeable future in a significant portion of their ranges—that is, whether there is any portion of the species' ranges for which it is true that both (1) the portion is significant; and (2) the species is in danger of extinction now or likely to become so in the foreseeable future in that portion. Depending on the case, it might be more efficient for us to address the "significance" question or the "status" question first. We can choose to address either question first. Regardless of which question we address first, if we reach a negative answer with respect to the first question that we address, we do not need to evaluate the other question for that portion of the species' range.

In undertaking this analysis for Joshua trees, we chose to address the status question first. We began by identifying any portions of the species' ranges where the biological status of the species may be different from its biological status elsewhere in its range. For this purpose, we considered information pertaining to the geographic distribution of (a) individuals of the species, (b) the threats that the species face, and (c) the resiliency condition of populations.

We evaluated the range of both Joshua tree species to determine if either of the species is in danger of extinction now or likely to become so in the foreseeable future in any portion of its range. The range of a species can be divided into portions in an infinite number of ways. We focused our analysis on portions of the species' range that may meet the definition of an endangered species or a threatened species. For both Joshua tree species, we considered whether the threats or their effects on the species are greater in any biologically meaningful portion of the species' range than in other portions such that the species is in danger of extinction now or likely to become so in the foreseeable future in that portion. We examined the following threats on both species: habitat loss and degradation (from urbanization, military training, renewable energy, grazing, and OHV use), invasive grasses, increased risk of wildfire, changing climatic trends (e.g., increased temperatures and longer more frequent drought periods), and seed predation and herbivory, including cumulative effects. As noted above, we defined foreseeable future as 2040–2069, the time period for which we can reliably predict the threats and the species' response to the threats.

I. Yucca brevifolia

Yucca brevifolia occupies two distinct areas, which we have identified as a northern analysis unit (YUBR North) and a southern analysis unit (YUBR South). As discussed in our rangewide analysis, the threats of habitat loss and degradation (from urbanization, military training, renewable energy, grazing, and OHV use), invasive grasses, increased risk of wildfire, changing climatic trends (e.g., increased temperatures and longer more frequent drought periods), and seed predation and herbivory are known to negatively affect the YUBR North and YUBR South analysis units, currently and into the future. All these threats are rangewide, meaning that they are acting throughout the species' range across all analysis units. We identified areas that may have a concentration of threats, including threats with the largest potential impacts to the species, which may be occurring on a biologically meaningful scale. The concentration of threats is more likely to result from increased temperatures and drought associated with projected climate change (modeled areas of climatically unfavorable habitat), increased risk of wildfire, and associated habitat loss in the future. These threats occur throughout the YUBR North and YUBR South analysis units to varying degrees, but have the highest potential impact to the species in the lower elevation habitat areas generally defined as less than 1,200 m. Therefore, we determined that there may be a geographical concentration of threats due to the combination of climate change, risk of wildfire, and habitat loss in lower elevation habitat both now and in the future.

Approximately 66 to 88.6 percent of the range of *Yucca brevifolia* is projected to be climatically unfavorable between 2040 and 2069. While modeling predicts a large decline in climatically favorable habitat, we project that habitat loss will be localized in these modeled areas due to uncertainties in the species' response and because modeled climatically unfavorable habitat does not equate to an immediate loss of occupied habitat or a potential range contraction between 2040 and 2069 (Shafer et al. 2001, p. 207). The potential species' response is greatest at lower elevation areas that are currently experiencing higher levels of drought stress with a projected increase in aridity in the foreseeable future. Although there is a low probability of natural wildfire ignitions and low frequency of wildfires projected for lower elevation areas, habitat recovery post-fire may be further hindered in these lower elevation zones under drought conditions, and human-induced ignitions are projected to be higher in YUBR South along the urban-wildland interface. In addition, habitat loss due to urbanization and renewable energy development is likely to occur in the level terrain that occurs at lower elevation in localized areas projected to have reduced recruitment and survival, particularly in YUBR South. The effects of these threats on the YUBR North and YUBR South analysis units are discussed further above (see *Threats*).

We next examined the status of the low-elevation areas of the YUBR North and YUBR South analysis units, either in total (41 percent of the species range) or within each analysis unit (5 and 74 percent respectively) by examining the species' response at low elevation and the resiliency, redundancy, and representation of *Yucca brevifolia* in these portions. As we evaluate effects to the species in the foreseeable future, the cumulative threats at low elevation may result in reduced growth and recruitment, with the potential for localized tree mortality and thinning across the low-elevation areas. We forecast asexual reproduction to be maintained, particularly when trees are stressed by drought or in response to wildfire, which supports the persistence of the species at low elevations. We project habitat loss to be localized, including in a small proportion of the low-elevation habitat area. Therefore, Joshua trees are projected to maintain viability throughout the majority of the habitat in each analysis unit at low elevations into the foreseeable future.

Population resiliency at low elevations is projected to decrease slightly relative to current conditions, including the potential for reduced tree densities and recruitment, but is projected to be moderate overall because of the large quantity of occupied habitat and moderate to high habitat quality. As such, the species will continue to be able to withstand stochastic events and normal year-to-year variation in environmental conditions within low-elevation areas. In the foreseeable future, forecasted tree mortality and localized habitat loss may reduce abundance but are not anticipated to result in range contractions or cause the species to be more vulnerable to catastrophic events such as prolonged drought and wildfire. As a result, redundancy would be maintained in low-elevation areas. Similarly, the species' latitudinal range is projected to be maintained, and no substantial losses of ecological diversity are forecasted at low elevations; therefore, representation would be minimally impacted.

In the foreseeable future, we forecast that the species will continue to occupy habitat in lower elevation areas, even in the more southern latitudes of *Yucca brevifolia*'s range, where models consistently predict a loss of climatically favorable habitat (YUBR South). We project that asexual and sexual reproduction will occur throughout all analysis units and that ecological diversity will be maintained at low elevations. Therefore, resiliency, redundancy, and representation for the species would continue to be maintained in the lower elevation areas of both analysis units despite the concentration of threats in these areas. Overall, the species will continue to maintain viability in the foreseeable future within the low-elevation areas of each analysis unit, despite the potential for projected reductions in demographic measures (tree density and reduced recruitment) resulting from all the threats, but particularly from changing climatic trends, wildfire, urbanization, and renewable energy development threats, which will be more concentrated in the lower elevation areas.

The best scientific and commercial information available indicates that in the lower elevations of YUBR North and YUBR South analysis units, *Yucca brevifolia* does not have a different status from its rangewide status, so there are no portions of the species' range that meet the Act's definition of an endangered species or a threatened species. Therefore, we do not need to consider whether any portions are significant.

II. Yucca jaegeriana

Yucca jaegeriana occupies three distinct areas, which we have identified as a northern analysis unit (YUJA North), a central analysis unit (YUJA Central), and an eastern analysis unit (YUJA East). As discussed in our rangewide analyses, the threats of habitat loss and degradation (from urbanization, military training, renewable energy, grazing, and OHV use), invasive grasses, increased risk of wildfire, changing climatic trends (e.g., increased temperatures and longer more frequent drought periods), and seed predation and herbivory are known to negatively affect the YUJA North, YUJA Central, and YUJA East analysis units, currently and into the future. All these threats are rangewide, meaning that they are acting throughout the species' range across all analysis units. We have identified areas that may have a concentration of threats, including threats with the largest potential impact to the species, which may be occurring at a biologically meaningful scale. This is more likely to result from increased risk of invasive grasses and associated wildfire, increased temperatures and drought associated with projected climate change in the future (modeled areas of climatically unfavorable habitat), and habitat loss from urbanization and renewable energy development. These threats occur throughout the range to varying degrees but have the highest magnitude impact and potential species' response in the lower elevation habitat areas (generally defined as less than 1,200 m). Therefore, we determined that there may be a geographical concentration of threats due to the combination of climate change, risk of wildfire, and habitat loss in lower elevation habitat both now and in the future.

Approximately 66 to 88.6 percent of the range of *Yucca jaegeriana* is projected to be climatically unfavorable in the foreseeable future. Although we do not forecast that climatically unfavorable habitat will translate to the loss of occupied habitat due to the magnitude of the temperature increases forecasted and the timeframe over which the species is exposed to climatically unfavorable conditions, the potential species' response is greatest in lower elevation areas. Low elevation areas are currently experiencing higher levels of drought stress with a projected increase in aridity in the foreseeable future. There is a higher probability of natural wildfire ignitions in YUJA North and YUJA Central due to lightning associated with monsoonal storm events. The frequency of wildfires is projected to be higher at lower elevation areas, including in portions that have burned recently and have higher invasive grass cover. Although fire severity will be lower at low elevations, habitat recovery post-fire may be further hindered in the future due to drought stress, such as in YUJA East, which occurs at both lower elevation and latitude. In addition, habitat loss due to urbanization is likely to occur in the level terrain that occurs at lower elevation, particularly in YUJA East. Approximately 23.5 percent of the analysis unit is under private land ownership (Service 2023, p. 37), but less than 1 percent of the area of the analysis unit is anticipated for further development in the foreseeable future. The effects of these threats on the YUJA North, YUJA Central, and YUJA East analysis units are discussed further above (see *Threats*).

We next examined the status in the low-elevation areas in the YUJA North, YUJA Central, and YUJA East analysis units, either in total (60 percent of the species range) or within each analysis unit (56, 51, and 98 percent, respectively), by examining the species' response at low elevation and the resiliency, redundancy, and representation of *Yucca jaegeriana* in these portions. As we evaluate effects to the species in the foreseeable future (2040–2069), the cumulative threats at low elevation may result in reduced growth and recruitment, with the potential for tree mortality and thinning across the low-elevation areas. We forecast asexual reproduction to be maintained, particularly when trees are stressed by drought or in response to wildfire, that will support the persistence of the species at low elevations. We project habitat loss to be localized, including in a small proportion of the low-elevation habitat area. Therefore, Joshua trees are projected to maintain viability throughout the majority of the habitat in each analysis unit at low elevations into the foreseeable future as defined.

Population resiliency at low elevations is projected to decrease slightly relative to current conditions, including the potential for reduced tree densities and recruitment, but is projected to be moderate overall because of the large quantity of occupied habitat and moderate habitat quality. As such, the species will continue to be able to withstand stochastic events and normal year-to-year variation in environmental conditions within the low-elevation areas. In the foreseeable future, forecasted tree loss and localized habitat loss may reduce abundance; but are not anticipated to result in range contractions or cause the species to be more vulnerable to catastrophic events such as prolonged drought and wildfire. As a result, redundancy would be maintained in the low-elevation areas. Similarly, the species' latitudinal range is projected to be maintained in 2040–2069, and no substantial losses of ecological diversity or potential arid-adapted genotypes are forecasted at low elevations; therefore, representation would be minimally impacted.

In the foreseeable future, we forecast that the species will continue to occupy habitat in lower elevation areas, even in the more southern latitudes of *Yucca jaegeriana*'s range where models consistently predict a decline in climatically favorable habitat (YUJA East). We project that asexual and sexual reproduction will occur throughout all analysis units and that ecological diversity will be maintained at low elevations. Therefore, resiliency, redundancy, and representation for the species would continue to be maintained in the lower elevation areas of all analysis units despite the concentration of threats in these areas. Overall, the species will continue to maintain viability in the foreseeable future within the low-elevation areas of each analysis unit, despite the potential for projected reductions in demographic measures (range thinning and reduced recruitment) resulting from all the threats, but particularly from changing climatic trends, wildfire, invasive grasses, and urbanization threats, which will be more concentrated in the lower elevation areas.

The best scientific and commercial information available indicates that in the lower elevations of the YUJA North, YUJA Central, and YUJA East analysis units, *Yucca jaegeriana* does not have a different status from its rangewide status, so there are no portions of the species' range that meet the Act's definition of an endangered species or a threatened species. Therefore, we do not need to consider whether any portions are significant.

Therefore, we find that *Yucca brevifolia* and *Y. jaegeriana* are not in danger of extinction now or likely to become so in the foreseeable future in any significant portion of their ranges. This does not conflict with the courts' holdings in *Desert Survivors* v. *Department of the Interior*, 321 F. Supp. 3d 1011, 1070-74 (N.D. Cal. 2018), and *Center for Biological Diversity* v. *Jewell*, 248 F. Supp. 3d 946, 959 (D. Ariz. 2017) because, in reaching this conclusion, we did not apply the aspects of the Final Policy on Interpretation of the Phrase "Significant Portion of Its Range" in the Endangered Species Act's Definitions of "Endangered Species" and "Threatened Species" (79 FR 37578; July 1, 2014), including the definition of "significant" that those court decisions held to be invalid.

In 2040–2069, we project the two species to continue to occupy and maintain viability in most of their current ranges (Figure 4-1 in Service 2023, p. 30). We project adult plant survival and persistence and clonal growth to continue and remain similar to current conditions in intact, unburned habitats across their ranges. We project seedling recruitment will continue to occur but may be reduced from current conditions due to increased drought stress, particularly at lower elevations. Our projections of future condition are similar to current conditions but with slight reductions in resiliency from declines in recruitment and localized losses of occupied habitat.

Determination of Status

Our review of the best available scientific and commercial information indicates that *Yucca brevifolia* and *Y. jaegeriana* do not meet the definition of an endangered species or a threatened species in accordance with sections 3(6) and 3(20) of the Act. Therefore, we find that listing either of the Joshua tree species is not warranted at this time. Further discussion of the basis for these findings can be found in the Joshua trees' species assessment form, the revised SSA report (Service 2023, entire), and other supporting documents that capture the scientific information upon which our decision was based.

COORDINATION WITH STATES

We reached out to the California Department of Fish and Wildlife (CDFW) while working on the SSA for the two Joshua tree species. CDFW was also working on a status assessment for *Yucca brevifolia*. We discussed the species, but CDFW was not available for many follow-up discussions because CDFW was working to complete their assessment under a deadline that was similar to ours. We also asked for the State to review our SSA report during partner review and they provided comments that are incorporated into our SSA report.

In Arizona, we requested information and coordinated review of the SSA report with the Arizona Department of Agriculture's Environmental Services Division. We sent the draft SSA report to the Arizona Department of Agriculture's Environmental Services Division during partner review but did not receive comments.

In Nevada, we requested information and coordinated review of the SSA report with the Nevada Department of Wildlife. We sent the draft SSA report to the Nevada Department of Wildlife during partner review, and they provided comments that are incorporated into our SSA report.

In Utah, we requested information and coordinated review of the SSA report with the State's Department of Natural Resources and Natural Heritage Program. We sent the draft SSA report to the Utah Department of Natural Resources during partner review, and they provided comments that are incorporated into our SSA report.

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Appendix A - Protected Native Plants by Category A. Highly safeguarded native plants as prescribed in A.R.S. § 3-903(B)(1), for which removal is not allowed except as provided in R3-3-1105.

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Director,
U.S. Fish and Wildlife Service

Date of annual review: February 9, 2023
Conducted by: Deborah Giglio, Species Assessment Team Project Manager, R8 Pacific Southwest Region