EMERGENCY PETITION TO LIST THE WESTERN JOSHUA TREE (*Yucca brevifolia*) UNDER THE ENDANGERED SPECIES ACT

The Joshua tree (*Yucca brevifolia*) pictured on the 1987 U2 album cover of the same name. The tree fell around 2000. Photo: Wikimedia

Petition Submitted to the U.S. Secretary of the Interior Acting through the U.S. Fish and Wildlife Service

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INTRODUCTION

WildEarth Guardians (Guardians) respectfully requests that the Secretary of the Interior, acting through the U.S. Fish and Wildlife Service (Service) protect the western Joshua tree (*Yucca brevifolia*) on an emergency basis under the U.S. Endangered Species Act (ESA) (16 U.S.C. §§ 1531-1544). As detailed throughout this petition, the western Joshua tree, found only in the Mojave Desert of California and Nevada, faces imminent threat of extinction from unmitigated climate change impacts, increasingly frequent, higher intensity fires throughout its range, and habitat loss and degradation. Emergency action by the Service to list the Joshua tree as "threatened" or "endangered" under the ESA is necessary to prevent the impending extinction of this prehistoric and iconic species. Guardians believes that emergency listing is warranted, but should the Service decline to provide emergency protections for the species, then we alternatively request that the Service still consider this petition and issue a decision as to whether the western Joshua tree warrants listing as either a "threatened" or "endangered" species under the ESA within one year from the date of the petition, pursuant to 16 U.S.C. § 1533(b)(3)(B). Guardians also requests that the Service designate critical habitat for the species concurrent with listing, pursuant to 16 U.S.C. § 1533(a)(3)(A) and 50 C.F.R. § 424.12.

ENDANGERED SPECIES ACT AND IMPLEMENTING REGULATIONS

Despite being long-lived, hardy desert plants, Joshua trees only thrive within a narrow range of environmental conditions. Though they can survive high temperatures, drought decreases survivorship and recruitment. Extreme cold events limit their distribution, but they also need a period of cooler minimum winter temperature to maximize growth. Scientists postulate that these limiting factors likely explain why the species is restricted to the Mojave's slightly cooler, mid-elevation zone. But this mid-elevation zone has been compromised by invasive grasses, which now frequently carry uncharacteristically large fires across the species' range. Climate models predict that Joshua trees will soon be deprived of the temperature and precipitation levels they require to successfully germinate and reach adulthood. In fact, recent studies show Joshua tree abundance in the southern Mojave is already declining, likely due to fire, drought, and other climatic changes, with no active recruitment of new young Joshua trees detected in study areas over the past three decades.

In 2015, Guardians submitted a petition to list both varieties of Joshua tree as threatened under the ESA (WildEarth Guardians 2015, *entire*). The petition received a positive 90-day finding in 2016. 81 Fed. Reg. 63,160-65 (Sept. 14, 2016). The Service then denied the petition three years later, finding that listing *Y. brevifolia* and/or *Y. jaegariana* was "not warranted." 84 Fed. Reg. 41,694, at 41,697 (Aug. 15, 2019) (negative "12-Month Finding"). The Service's "not warranted" listing determination for both species of Joshua tree was primarily based on its July 2018 Species Status Assessment ("2018 SSA"). Litigation brought by Guardians challenging the negative listing decision is currently pending in federal district court. *See WildEarth Guardians v. Bernhardt, et. al*. No. 2:19-cv-09473-ODW (C.D. Cal. filed Nov. 4, 2019).

Several notable occurrences have taken place since Guardians submitted its 2015 petition. The past couple years have proven to be especially devastating for the Joshua tree. Indeed, recognizing the peril Joshua trees face from unmitigated climate change impacts, fire, habitat

loss and degradation, last spring the California Department of Fish & Wildlife ("CDFW") recommended listing the western Joshua tree (*Yucca brevifolia*) as an endangered species under the California Endangered Species Act ("CESA"). On September 22, 2020, the California Fish & Game Commission unanimously voted to grant western Joshua trees candidate status under the CESA, giving them temporary legal protection during the yearlong review to determine whether the species should be formally protected. *See infra*, Factor D. Second, as the Service knows from its 2018 SSA, Joshua trees and their surrounding ecosystems are not fire-adapted. The best available science confirms that increasingly frequent, higher intensity fires have resulted in significant, widespread mortality of Joshua trees. Last summer, the Mojave reached a record-breaking 130 degrees and the Dome Fire alone killed an estimated 1.3 million more Joshua trees. *See infra*, Factor A. Third, new climate science has emerged since the Service prepared its 2018 SSA. For instance, Sweet *et al*. 2019 employs the most sophisticated species distribution modeling efforts to date, further validating the results of several previously published, peer-reviewed modeling efforts, all of which show a significant amount of the Joshua tree's current habitat will be rendered climatically unsuitable over the next 30 to 70 years. *See infra*, Factor E. Because climate change impacts, far more frequent and severe fire, along with the species' naturally low germination rates and extremely limited dispersal capability, imminently threaten the ability of the western Joshua tree to successfully reproduce and persist, delay in federally protecting this species under the Act poses "a significant risk" to its continued well-being. 16 USC § 1533(b)(3)(C)(iii). As such, the standard for emergency listing the western Joshua tree is met. *Id*.

ENDANGERED SPECIES ACT AND IMPLEMENTING REGULATIONS

The ESA, 16 U.S.C. §§ 1531-1544, was enacted in 1973 "to provide a means whereby the ecosystems upon which endangered species and threatened species depend may be conserved, [and] to provide a program for the conservation of such endangered species and threatened species." 16 U.S.C. § 1531(b). The protections of the ESA only apply to species that have been listed as endangered or threatened according to the provisions of the statute. The ESA delegates authority to determine whether a species should be listed as endangered or threatened to the Secretary of Interior, who has in turn delegated authority to the Director of the U.S. Fish & Wildlife Service. As defined in the ESA, an "endangered" species is one that is "in danger of extinction throughout all or a significant portion of its range." 16 U.S.C. § 1532(6); *see also* 16 U.S.C. § 533(a)(1). A "threatened species" is one that "is likely to become an endangered species within the foreseeable future throughout all or a significant portion of its range." 16 U.S.C. § 1532(20). The Service must evaluate whether a species is threatened or endangered as a result of any of the five listing factors set forth in 16 U.S.C. § 1533(a)(1):

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.

A taxon need only meet one of the listing criteria outlined in the ESA to qualify for federal listing. 50 C.F.R. § 424.11.

The Service is required to make these listing determinations "solely on the basis of the best

scientific and commercial data available to [it] after conducting a review of the status of the species and after taking into account" existing efforts to protect the species without reference to the possible economic or other impacts of such a determination. 16 U.S.C. § 1533(b)(1)(A); 50 C.F.R. § 424.11(b). "The obvious purpose of [this requirement] is to ensure that the ESA not be implemented haphazardly, on the basis of speculation or surmise." *Bennett v. Spear*, 520 U.S. 154, 175 (1997). "Reliance upon the best available scientific data, as opposed to requiring absolute scientific certainty, 'is in keeping with congressional intent' that an agency 'take preventive measures' *before* a species is 'conclusively' headed for extinction." *Ctr. for Biological Diversity v. Lohn*, 296 F. Supp. 2d 1223, 1236 (W.D. Wash. 2003) (*emphasis in original*).

In making a listing determination, the Secretary must give consideration to species which have been "identified as in danger of extinction, or likely to become so within the foreseeable future, by any State agency or by any agency of a foreign nation that is responsible for the conservation of fish or wildlife or plants." 16 U.S.C. § 1533(b)(1)(B)(ii); *see also* 50 C.F.R. § 424.11(e) (stating that the fact that a species has been identified by any State agency as being in danger of extinction may constitute evidence that the species is endangered or threatened). Listing may be done at the initiative of the Secretary or in response to a petition. 16 U.S.C. § 1533(b)(3)(A).

In determining if a species should be listed as "threatened," the Service must consider whether it is likely to become an endangered species within the "foreseeable future." Courts have held that the definition of foreseeable future is species-specific, depending on the species' life history characteristics. In *Otter v. Salazar*, No. 1:11-cv-00358-CWD, 2012 WL 3257843 (D. Idaho Aug. 8, 2012) the court held that "the definition of foreseeable future is to be made on a species-by-species basis and through an analysis of the time frames applicable to the particular species at issue." *Id.* at 19. In *W. Watersheds Project v. Foss*, No. CV 04-168-MHW, 2005 WL 2002473, at 16 (Aug. 19, 2005) the court stated: "the definition of 'foreseeable future' may vary depending on the particular species." *Id.* In order to list a species as "threatened," the ESA only requires a showing that the species is likely to be in danger of extinction in the foreseeable future, not that it be at "high risk" of extinction. *Id.* at 17. As both the life span and the generation time of Joshua trees are long, it may take four to five decades to detect demographic changes in the population. We consider the timeframe of approximately 100 years discussed in this petition (*see* "Factor E: Climate change," *infra*) to be a reasonable definition of "foreseeable future" for this long-lived, slow-growing species. If anything, this timeframe is too short, but we are limited by the predictive ability of climate models.

After receiving a petition to list a species, the Secretary is required to determine "whether the petition presents substantial scientific or commercial information indicating that the petitioned action may be warranted." 16 U.S.C. § 1533(b)(3)(A). Such a finding is termed a "90-day finding." A "positive" 90-day finding leads to a status review and a determination whether the species will be listed, to be completed within twelve months. 16 U.S.C. §1533(b)(3)(B). A "negative" initial finding ends the listing process, and the ESA authorizes judicial review of such a finding. 16 U.S.C. § 1533(b)(3)(C)(ii). The applicable regulations define "substantial information," for purposes of consideration of petitions, as "that amount of information that would lead a reasonable person to believe that the measure proposed in the petition may be warranted." 50 C.F.R. § 424.14(b)(1).

The regulations further specify four factors to guide the Service's consideration on whether a particular listing petition provides "substantial" information:

i. Clearly indicates the administrative measure recommended and gives the scientific and any common name of the species involved;
ii. Contains detailed narrative justification for the recommended measure; describing, based on available information, past and present numbers and distribution of the species involved and any threats faced by the species;
iii. Provides information regarding the status of the species over all or significant portion of its range; and
iv. Is accompanied by appropriate supporting documentation in the form of bibliographic references, reprints of pertinent publications, copies of reports or letters from authorities, and maps. 50 C.F.R. §§ 424.14(b)(2)(i)-(iv).

Both the language of the regulation itself (by setting the "reasonable person" standard for substantial information) and the relevant case law underscore the point that the ESA does not require "conclusive evidence of a high probability of species extinction" in order to support a positive 90-day finding. *Ctr. for Biological Diversity v. Morgenweck*, 351 F. Supp. 2d 1137, 1140 (D. Colo. 2004); *see also Moden v. U.S. Fish & Wildlife Serv.*, 281 F. Supp. 2d 1193, 1203 (D. Or. 2003) (holding that the substantial information standard is defined in "non-stringent terms"). Rather, the courts have held that the ESA contemplates a "lesser standard by which a petitioner must simply show that the substantial information in the Petition demonstrates that listing of the species may be warranted." Morgenweck, 351 F. Supp. 2d, p. 1141 (*quoting* 16 U.S.C. § 1533(b)(3)(A)); *see also Ctr. for Biological Diversity v. Kempthorne*, No. C 06-04186 WHA, 2007 WL 163244 at 3 (N.D. Cal. Jan. 19, 2007) (holding that in issuing negative 90-day findings for two species of salamander, the Service "once again" erroneously applied "a more stringent standard" than that of the reasonable person).

CLASSIFICATION AND NOMENCLATURE

Common name. Common names for *Yucca brevifolia* include "Joshua tree" or more rarely "Joshuatree yucca" (Petrides, 1998, p. 383). We refer to the species as "western Joshua tree" throughout this petition.

Taxonomy. The petitioned species is *Yucca brevifolia* (Engelm 1871). The full taxonomic classification is shown in Table 1. It is within the monotypic Clistocarpa section of the genus *Yucca*, defined by a spongy, indehiscent fruit (Pellmyr et al., 2007, p. 496). In 2018, based on recent literature and expert interviews, the U.S. Fish and Wildlife Service "determined that *Yucca brevifolia* var. *brevifolia* and *Y. b.* var. *jaegeriana* [were] two distinct species" (Sirchia et al. 2018, p. 6), and began treating them as two separate listable entities. The majority of the literature on Joshua trees treats the two species as varieties; therefore, information in this petition on general life history, reproduction, etc., is drawn from literature on both newly recognized species unless otherwise noted. Both former varieties were grouped under the scientific name *Y. brevifolia*, and thus literature about both species may make reference to *Y. brevifolia* when discussing both species as a single entity.

Table 1. Taxonomy of *Yucca brevifolia* (ITIS 2015a-d).

Kingdom	Plantae
Division	Magnoliophyta
Class	Lilopsida
Order	Liliales
Family	Agavaceae
Genus	*Yucca*
Species	*brevifolia*

This petition to emergency list the western Joshua tree hereby incorporates the information from Guardians' 2015 petition on the species' life history. *See* WildEarth Guardians 2015, pp. 4-18 (species description, reproduction and growth, habitat requirements and geographic distribution).

Herein, we focus only on studies, data, and recent occurrences that have emerged since Guardians' first petition, and which, in combination with the information contained in our 2015 petition, support the need for the Service to emergency list the western Joshua tree and immediately afford it the protections of the ESA. Alternatively, should the Service decline to emergency list the species, we request that the agency still consider this second petition and issue a decision as to whether the western Joshua tree warrants listing as either a "threatened" or "endangered" species under the ESA within one year.

POPULATION STATUS: HISTORIC AND CURRENT

There are no population number estimates available for the western Joshua tree. From climate modeling, it appears that suitable habitat for successful recruitment has contracted since the early 1900s due to the +1 °C (+1.8 °F) change in mean high July temperatures since that time (Barrows & Murphy-Mariscal, 2012, p. 35; *see* "Factor E: Climate change: impacts on Joshua trees," *infra*). Long-term decline is estimated to be 10-30% (NatureServe 2021, p. 4).

NatureServe conservation status. NatureServe lists the western Joshua tree as G3, "vulnerable," stating that it "is threatened by fire, drought, climate change, and numerous threats related to habitat loss including off road vehicle use" (NatureServe 2021, p. 2)

IDENTIFIED THREATS TO THE PETITIONED SPECIES: CRITERIA FOR LISTING

The Service must evaluate whether a species is "threatened" or "endangered" as a result of any of the five listing factors set forth in 16 U.S.C. § 1533(a)(1):

> 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.

<u>(Factor A) The Present or Threatened Destruction, Modification, or Curtailment of Habitat or Range</u>

Please see Guardians' 2015 petition for preexisting information on identified threats to the petitioned species (Guardians 2015, pp. 19-41).

Wildfire. As described in Guardians 2015 petition (Guardians 2015, pp. 20-24), wildfire is one of the greatest threats to the Joshua tree's continued survival, particularly as the species' range contracts in the face of climate change and the frequency and severity of fire in the species' range increases (citing *e.g.*, DeFalco *et al*. 2010; Holmgren *et al*. 2009; Vamstad and Rotenberry 2010; Cole *et al*. 2011; Barrows & Murphy-Mariscal 2012). Sadly, the dire forecasts of the best available science have played out, with the devastating impacts of wildfire on this species and its surrounding ecosystems substantially increasing over the past few years.

Blackbrush (*Coleogyne ramosissima*)—one of the most important nurse plants for Joshua tree seedlings—is one of the most vulnerable shrubs to fire (Brooks et al. 2018, p. 365). Blackbrush are highly flammable, and once ignited tend to completely combust and are killed. Blackbrush stands can take centuries to recover, with the fastest documented recovery being on the order of 50 to 75 years (Brooks et al. 2018, p. 365). Because of their extreme flammability and slow recovery, the mid-elevation zone dominated by blackbrush and home to Joshua trees is likely the most susceptible area to type conversion via the grass/fire cycle as a result of the arrival of non-native grasses (Brooks et al. 2018, p. 366). Additional recent studies further confirm that the recent increase in fire size and frequency in the Joshua tree's range is largely driven by the invasion of highly flammable exotic grasses, principally *Bromus spp*. and *Schismus spp*. (*see* Klinger & Brooks 2017; Syphard *et al*. 2017; Brooks *et al*. 2018; Moloney *et al*. 2019).

The Dome Fire. The Dome Fire of 2020 further demonstrates that invasive grass-fueled wildfire is an imminent threat to the Joshua tree's ability to persist. "Cima Dome in Mojave National Preserve supports one of the most extensive stands of Joshua trees in existence" (Cornett 2018, p. 84). In 2020, the Dome Fire, a lightning-caused fire, burned approximately 43,273 acres, extensively impacting the Joshua tree woodland (InciWeb 2020, p. 1). Invasive red brome appears to have fueled the intense fire (Boxall 2020, p. 7).

> Much of Cima Dome is now a graveyard of Joshua tree skeletons. It is estimated that as many as 1.3 million Joshua trees were killed in the fire, as well as countless cactuses, bushes, shrubs, and grasses. About 25% of the contiguous Joshua tree forest burned, which includes the portion of the forest that extends beyond the Preserve's boundaries north of I-15. Research suggests that if the top 1/3 of Joshua trees are unburned, the plant has a chance of fire survival. However, since the Dome Fire fully scorched most of the plants it touched, it's unlikely that many of the 1.3 million Joshua trees will recover. (NPS 2020, p. 3)

The Cima Dome fire is illustrative of a larger pattern of increased wildfire risk caused by climate change and invasive species.

> One of the more severe threats to [the western Joshua tree] is an increase in fire frequency, which causes direct mortality and reduced survivorship over time. A greater

> presence of non-native annual grasses, which produce a fuel load in the environment, have increased the frequency of fire in the deserts where this species occurs. The plant communities and Joshua Tree itself are not especially tolerant of fire. (NatureServe 2021, p. 3)

Threats from fire and invasive species contributed to the recent listing of the western Joshua tree under the California Endangered Species Act:

> Invasive plant species are widely established in the Mojave Desert throughout the range of western Joshua tree, and represent a large percentage of the biomass on the landscape. The abundance of invasive plant species in the Mojave Desert is positively correlated with disturbances such as livestock grazing, off-road vehicle use, fire, urbanization, roads, and agriculture. These invasive species are also aided by nitrogen deposition as a result of air pollution. Although it is possible that invasive plant species may compete with emergent western Joshua tree seedlings, the biggest impact to western Joshua tree from invasive plant species is through altered fire dynamics. Invasive plant species in the Mojave Desert have resulted in larger and more frequent fires that are killing a large number of western Joshua trees. (CDFW 2020, p. 16)
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> [L]arge fires have been historically infrequent in Joshua tree woodlands, and recent increases in fire size and frequency are partially due to invasion of non-native annual grasses. Winters with relatively high amounts of precipitation produce an increase in biomass of native and especially non-native annual plants that carry fire in invaded habitats, dramatically changing middle elevation shrublands dominated by creosote bush, blackbrush, and western Joshua trees. Precipitation has been recognized as a primary driver of fire frequency and extent in the Mojave Desert, with wetter periods fostering the growth of invasive grasses which carry fire, and drier periods leading to fewer and smaller fires. Fires in the Mojave Desert are started by a mix of accidental and intentional human activities, as well as lightning. Most wildfires are human-caused and start along roadsides. Less frequent large fires typically start by lightning and occur in remote areas far from major roads. The Petition also notes the impact of fire on western Joshua tree seedling and juvenile survival is particularly exacerbated because fires tend to track the same heavy precipitation years that are most suitable for western Joshua tree seedling emergence. (CDFW 2020, pp. 17-18)

"Joshua trees have relatively low post-fire survival, are slow to repopulate burned areas, and successful recruitment from resprouting requires sufficient precipitation in the years following fire" (Cummings 2019, p. 24, *internal citations omitted*).

> Recruitment of new Joshua trees into burned areas is infrequent and slow. In one study no seedlings or saplings were observed in burned areas less than 10 years old, and fewer than 10 individuals per hectare were present on burned areas more than 40 years old in Joshua Tree National Park. Another study found that Joshua trees were still rare on a site 65 years after a fire… Among the factors inhibiting Joshua tree recolonization of burned sites are the lack of seeds due to mortality of seed-producing adults and the loss of suitable establishment sites due to the burning of nurse plants… The increase in fine, flashy fuel biomass from exotic plant species has increased the fire potential of these

> habitats sufficiently to allow for more frequent large fires than were carried by native vegetation alone. The exotic grasses are of particular concern as they can form a continuous fuelbed for fire well into the hot, dry summer months and tend to not disarticulate as quickly as the native annual plants. While annuals, desiccated upright *Bromus* stems can be found on the landscape upwards of three years after senescence (Jurand and Abella 2013) and *Schismus* remnants can persist as fuel on the landscape for over a year (Brooks et al. 2018). Increased cover of invasive annual grass increases both the chance of a fire igniting and facilitates fire spread. (Cummings 2019, p. 27, *internal citations omitted*)

According to the petition to list the western Joshua tree under CESA, the Service, in its 2018 SSA and subsequent 2019 "not warranted" listing decision, "downplays the risks of fire to *Y. brevifolia*. Using modeling to estimate invasive grass cover and link high coverage ratios (15-45%) as a proxy for increased fire frequency and severity, the agency estimated that approximately 1.4 percent of the YUBR South and 8.8 percent of the YUBR North current mapped distribution would be at risk in the next several decades. In contrast, Sweet *et al*. (2019) documented that half of the area of Joshua tree habitat in JTNP identified as refugia for the species under an RCP 4.5 pathway had already burned in recent decades. The total recent burn area in the park represents well over 10% of the current range of the species in the park and such fires are likely to increase within JTNP and throughout the range of the species" (Cummings 2019, pp. 58-59).

Moreover, the Service's 2018 SSA purported to rely upon the Bureau of Land Management's ("BLM") Ecoregional Assessment of the Mojave Basin and Range (2013), but that assessment describes how even "trace" amounts of grass cover can carry fire across open spaces between shrubs, affecting vast amounts of the Mojave's mid-elevation shrublands where Joshua tree predominantly occur. *See* Comer *et. al*. 2013, p. 110. Consequently, the Service's assumption in the 2018 SSA that only areas with greater than 15% invasive grass cover pose a fire risk to Joshua tree was unsupported by, and contradicted by, the best available science.

In its 2018 SSA, the Service also failed to gather, assess, and disclose data on how much of the current range of each species of Joshua tree had already burned. Much of this data is available through CalFire and other existing sources. Were the Service to properly gather and assess this data now, particularly in light of the 2020 Dome Fire and other large fires over the past couple years that have consumed a substantial amount of acreage in the Joshua tree's range (*e.g.* the massive 2020 Bobcat fire that swept into the Mojave's Juniper Hills area, burning an additional 20,000+ acres of Joshua tree habitat in its western range), the imminent and "significant risk" that this grass/fire cycle poses to the continued survival of the species would be plainly evident, supporting the need for an emergency listing. *See* 16 USC § 1533(b)(3)(C)(iii).

(Factor D) The Inadequacy of Existing Regulatory Mechanisms

Federal. No regulations exist to ameliorate the negative impacts of climate change, as the Service has acknowledged in its "warranted but precluded" finding for the meltwater lednian stonefly, which is primarily threatened by climate change:

> The United States is only now beginning to address global climate change through the

> regulatory process (*e.g.*, Clean Air Act). We have no information on what regulations may eventually be adopted, and when implemented, if they would address the changes in meltwater lednian stonefly habitat that are likely to occur in the foreseeable future. Consequently, we conclude that existing regulatory mechanisms are not adequate to address the threat of habitat loss and modification resulting from the environmental changes due to climate change to the meltwater lednian stonefly in the foreseeable future. (USFWS, 2011a, p. 18,694)

Joshua trees are protected from harvest on U.S. Forest Service and National Park Service lands, and a permit is required for collection on Bureau of Land Management lands (NDF, undated, p. 1). Federal lands provide some protection from development or urbanization for trees in projected climate refugia:

> [A] majority of the areas predicted to be sustainable, within migrational range, or potential assisted migration sites, are already on federal lands or other protected areas. Ninety-six percent (739 km^2 out of 772 km^2) of the area predicted to allow survival of current stands, and 91% (378 km^2 out of 414 km^2) of the area predicted within the range of natural migration are on Federal lands that are not expected to be at risk of development or urbanization. Further, 83% of the areas predicted as potential relocation sites (17,909 km^2 out of 21,578 km^2) occur on Federal lands.

Of the area with ownership data (75% of total area), BLM land contains the largest amount of current Joshua tree habitat (~42%), followed by National Park Service land (~14%) and private land (~5%).[1] No other land ownership type contains more than 4% of total habitat. Neither the BLM nor the Forest Service lists the Joshua tree as a "sensitive species" in any of the regions where it is found. Joshua trees are not listed as "threatened" or "endangered" federally or in any state within the species' range.

Arizona. Both Joshua tree subspecies are "salvage protected restricted native plants;" they are "not included in the highly safeguarded category but are subject to damage by theft or vandalism" (ADOA, 2015, pp. 3-4), and can be collected only with a permit (AZGFD, 2015, p. 3).

California. The California Desert Native Plants Act prohibits harvesting of desert plants, including yucca, without a permit in Imperial, Inyo, Kern, Los Angeles, Mono, Riverside, San Bernardino, and San Diego Counties.[2] California recently listed the western Joshua tree (*Y. brevifolia*) as a candidate species under the California Endangered Species Act (CESA) (Miller-Henson 2020, *entire*). However, this listing status is only temporary as a final decision as to the status of the western Joshua tree in California has not yet been made by the California Department of Fish and Wildlife. Further, even if the western Joshua tree is listed in the state, CESA offers inadequate protection relative to the federal ESA. CESA has no mandatory Section 7 consultation provision and would not require consultation for federal projects (and questionable consultation for state projects). Moreover, considering that Joshua trees' habitat is largely on federal land, it is unclear if state CESA protection would guarantee protections for the majority of western Joshua trees.

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[1] Calculated by Kurt Menke, Bird's Eye View GIS, from data provided in Cole et al., 2003.

[2] For the full provisions of the law, see: https://www.wildlife.ca.gov/Conservation/Plants/CA-Desert-Plant-Act

Nevada. *Y. brevifolia* is not included in the Nevada Natural Heritage Progam "At-risk (Tracked) Species" or "Watch Species" list.[3] Collecting requires a permit. "Digging up cactus and yucca on public or private land in Nevada is a regulated activity. On federal land owned by the [BLM], permits and tags are required. U.S. Forest Service and National Park Service do not allow harvest of native plants on their lands" (NDF, undated, p. 1).

The Great Basin Bird Observatory (GBBO), identifying threats to bird habitats in Nevada, identified seven conservation concerns for Joshua Tree habitat: 1) Change in precipitation and snowmelt related to climate change 2) Change in temperature related to climate change 3) Increased fire frequency or intensity 4) Invasive weeds 5) Urban, suburban, and industrial development 6) Motorized recreation 7) Livestock/wild horse and burro grazing (GBBO, 2010, p. Hab-8-3). Since Joshua tree stands in Nevada are not fully mapped yet, the GBBO recommends that:

> Clark County's Desert Conservation Program's current effort to map these habitats in Clark County be expanded into Nye and Esmeralda counties through a multi-agency inventory effort, and further that other Joshua tree mapping efforts underway by [the U.S. Geological Survey] be used to generate the best possible GIS maps of Joshua tree occurrence, density, and condition. Monitoring stand conditions and habitat loss will be critical for effective adaptive management efforts in light of climate change and increased fire frequency. Therefore, we recommend that a comprehensive monitoring plan for Joshua tree habitats, perhaps similar to forestry monitoring practices, be developed and implemented. (GBBO, 2010, p. Hab-8-6)

In summary, there are few specific protections for Joshua trees. In some states they are protected from collecting; however, overutilization does not appear to be a serious threat. Other protections are attached to the land on which Joshua trees are found, providing limited insulation from certain types of development. However, no existing regulations assist in identifying and protecting climate refugia or otherwise address the threats of fire, invasive species, and climate change.

(Factor E) Other Natural or Man-made Factors Affecting its Continued Existence

New information on climate change. Studies of climate change's impact on Joshua trees are discussed at length in Guardians 2015, CDFW 2020, and Cummings 2019. We hereby incorporate those discussions by reference and highlight some of this new information below.

In a 2018 Special Report on Global Warming of 1.5°C from the Intergovernmental Panel on Climate Change (IPCC), the leading international scientific body for the assessment of climate change, the IPCC describes the devastating harms that would occur at 2°C warming above pre-industrial levels, highlighting the necessity of limiting warming to 1.5°C to avoid catastrophic impacts to people and life on Earth (IPCC 2018). Average global temperature has already risen approximately 1°C (IPCC 2018). In addition to warming, many other aspects of global climate are changing. Thousands of studies conducted by researchers around the world have documented changes in surface, atmospheric, and oceanic temperatures; melting glaciers; diminishing snow

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[3] For the complete lists, see http://heritage.nv.gov/species/lists.php.

cover; shrinking sea ice; rising sea levels; ocean acidification; and increasing atmospheric water vapor (USGCRP 2017).

New climate studies released since the 2015 petition show the alarmingly rapid impact climate change has had on ecosystems, particularly desert ecosystems, in instigating local extinctions. A 2016 analysis found that climate -related local extinctions are already widespread and have occurred in hundreds of species, including almost half of the 976 species surveyed (Wiens 2016). A 2016 meta-analysis reported that climate change is already impacting 82% of key ecological processes that form the foundation of healthy ecosystems and on which humans depend for basic needs (Scheffers et al. 2016). Notably, the Mojave Desert has already experienced many of these impacts, with, for example, bird occupancy and site-level species richness declining by about 50% over the past century (Iknayan and Beissinger 2018), and this decline linked to water stress related to increased cooling needs (Riddell et al. 2019).

Deserts have warmed and dried more rapidly over the last 50 years than other ecoregions, both globally and in the contiguous United States (USGCRP 2017). According to California's Fourth Climate Change Assessment: Inland Deserts Summary Report (Hopkins 2018), the California Desert – where a substantial part of the western Joshua tree lives has already experienced significant warming. Over the second half of the 20th century, daily maximum temperatures warmed by 0.4-0.7ºF [0.22-0.39ºC], comparing 1976-2005 with 1961-1990, and daily minimum temperatures warmed by 0.3-0.6 ºF [0.17-0.33ºC] over the same period.

Other studies have documented even greater warming in the range of the Joshua tree. The Washington Post, using NASA and NOAA county-level temperature datasets from 1895 to 2018, demonstrated that many areas of the United States have already had temperature increases well above the global average (Mufson et al. 2019). The four California counties in which western Joshua tree occurs — San Bernardino, Los Angeles, Kern and Inyo — have already experienced average annual temperature increases of 1.9, 2.3, 1.7 and 2.3ºC respectively.

Hopkins (2018) projects that daily maximum temperatures will increase by 5-6ºF [2.8- 3.3ºC] for 2006-2039, by 6-10ºF [3.3-5.6ºC] for 2040-2069, and 8-14ºF [4.4-7.8ºC] for 2070- 2100 on average for the region, with ranges depending on future greenhouse gas emissions (RCP 4.5 and RCP 8.5 scenarios). By the end of the century, the hottest day of the year is projected to rise by at least 6ºF [3.3ºC], and up to 9ºF [5ºC] on average. Extremely hot days, defined as temperatures >95ºF [35ºC], averaged 90 per year in the Mojave during the 1981-2000 period, and will increase to up to 141 days by the end of the century under RCP 8.5.

While the models predict a straight increase in temperatures over time in the Mojave Desert, these models show a more complicated story related to precipitation. The various downscaled climate models used by Hopkins (2018), show little projected change in average rainfall each year to the end of the century (<10%), but they do show an increase in interannual variability, meaning, they show wildly different predictions of amount of precipitation per year, increased periods of droughts, and more periods of high amounts of rainfall in between. These projects show with reductions in minimum annual precipitation of up to 50% and increases in maximum annual precipitation of 40-65% by the end of the century, as well as an increase of winter precipitation (falling mainly in December, January, and February).

The Tagestad et al. (2016) study also showed increased winter precipitation in the future within the Mojave ecoregion. Tagestad et al. (2016), using climate models that best matched historic annual and seasonal precipitation records in the Mojave (GFDL_CM2.1) (from US Dept. of Commerce/NOAA/Geophysical Dynamics Fluid Lab) and (IPSL_CM4) (from Institute Pierre Simon Laplace, France), found that average annual precipitation is predicted to be higher than the historical average, although with greater annual and decadal variation, that there would be numerous, extended periods of high precipitation, and due to the invasive grass fueled link between winter precipitation and fire, concluded that "fire will be more prevalent in the Mojave Desert for many periods during the next century."

These studies show that the daily maximum temperatures in the range of the western Joshua tree under current emissions trajectories will increase by over 7ºC for the remainder of the century (Hopkins 2018). Coupled with this increase in temperature will be an increase in precipitation variability, with more extreme and prolonged droughts, while an overall increase in winter precipitation will foster more growth of invasive grasses, leading to more frequent and more intense fire (Hopkins 2018; Tagestad et al. 2016), posing grave threat to the continued existence of the Joshua tree.

Sweet et al. 2019, a recent addition to the literature on Joshua trees and climate change, supports the hypothesis that under current emissions trajectories, suitable Joshua tree habitat will be almost entirely eliminated from Joshua Tree National Park. As summarized by CDFW:

> Similar to Barrows and Murphy-Mariscal (2012), Sweet et al. (2019) sought to identify the existence and extent of potential climate refugia for western Joshua tree within Joshua Tree National Park via species distribution models validated with field data. Sweet et al. (2019) used Joshua tree presence points, a database of nine environmental variables, and end-of-century (2070–2099) greenhouse gas emissions under highly mitigated, moderately mitigated, and unmitigated scenarios. Under highly mitigated and moderately mitigated greenhouse gas emissions scenarios, 18.6 percent and 13.9 percent, respectively, of current occupied western Joshua tree habitat remained as refugia. However, under the unmitigated greenhouse gas emissions scenario, which is closest to current emissions trajectories, suitable habitat for western Joshua tree was almost completely eliminated from Joshua Tree National Park, with only 15 hectares (37 acres), or 0.02 percent of western Joshua tree habitat remaining as refugia. Sweet et al. (2019) also used field data on distribution of juvenile western Joshua trees (defined as smaller than 60 cm tall) to validate their modeling results as the current recruitment patterns may be foretelling of future changes in the population of western Joshua trees on the landscape. (CDFW 2020, pp. 20-21)

Habitat suitability modeling and climate change. The Service's 2019 "not warranted" listing decision and supporting 2018 SSA disregarded, without adequate explanation, every published, peer-reviewed species distribution model (SDM, also referred to as "ecological niche models") available, all of which support the need to list the Joshua tree under the ESA due to climate change impacts (s*ee WildEarth Guardians v. Bernhardt, et. al*. No. 2:19-cv-09473-ODW (Dkt. Nos. 42 & 51) (Plaintiff's motion for summary judgment and supporting memorandum and Plaintiff's reply brief)). Peer- and agency partner-review experts criticized the Service's 2018 SSA for this reason, as did the 2019 petition to list the western Joshua tree under CESA.

In fact, one expert peer-reviewer of the 2018 SSA concluded: "I consider the current assessment to not be based on the best available science, and its conclusion have no valid scientific basis" (Smith 2018, peer-review feedback). Partner-review feedback from the Superintendent of Joshua Tree National Park (JTNP) echoed this sentiment, explaining: the widespread habitat loss predicted by recent SDMs, Cole *et al*. (2011) and Barrows *et al*. (2012), and the Park's own estimates based on habitat already lost to fire, are "in broad contradiction" to FWS's unsupported conclusion that "a large expanse of habitat supporting a high number of individuals should remain." (JTNP 2018 partner-review feedback); *see also* Cummings 2019, p. 59.

"Habitat suitability modeling" (interchangeably referred to as "ecological niche modelling") is performed when "a statistical link is established between the locations where the target species has been observed and a series of variables describing the environmental conditions in those sites" (Aizpurua et al. 2015, p. 1,609). "[E]cological niche modeling, which takes advantage of the rapidly growing body of accessible museum locality data and geographic information system–based climate layers, has become increasingly important in ecological and conservation-related research" (Searcy & Shaffer 2016, p. 423). "[Species distribution models] relate the presence/absence records of species to relevant environmental variables and subsequently project modelled relationships across geographical space using gridded layers of environmental data, producing a map indicating areas of potential species distribution" (Manzoor *et al*. 2018 p. 1).

In regards to Joshua tree distribution, Cole *et al*. (2011), Shafer *et al*. (2001), Barrows & Murphy-Mariscal (2012), and Dole *et al*. (2003) use various types of ecological niche models or habitat suitability models to predict where suitable habitat for the Joshua tree will be located under various climate change scenarios. In contrast, the Service used two different potential climate scenarios to perform a "qualitative evaluation of the impact of climate change on the current distribution" (Sirchia *et al*. 2018, p. 71) by overlaying the climate scenarios on the Joshua tree's current range. Here we present evidence for ecological niche models being the "best available science" as opposed to the Service's methodology.

There is considerable support for using ecological niche models (*see infra*, excerpts from Pearson & Dawson 2003), and they "have been used with relatively good success to investigate a variety of scientific issues" (Guisan & Thuiller 2005, p. 995), though "[i]nsights from ecological theory should be used more systematically to underpin decisions made at all stages of the model building process" (*Id.,* p. 997). "[H]abitat suitability models have been shown to be highly predictive in determining climate niches for a variety of species" (Chai et al. 2016, p. 4), even outperforming expert review in predicting where habitat might be found: "model-based sampling strategy significantly outperformed the expert-based strategy, increasing the number of new shrike territories found per km^2 in Luxembourg by a factor 1-4" (Aizpurua et al. 2015, p. 1,615). Climate is a key factor in range limits: "where biotic interactions exert an effect on range limits, they do so at spatial scales commensurate with broad-scale climatic variables. Likewise, as these effects would have to be associated with climate to influence model predictions, our results indicate that the role of climate on range limits, though possibly indirect, is important" (Lee-Yaw *et al*. 2016, p. 8). This suggests that ecological niche models can give important, if imperfect, insights into potential future distribution.

In its 2018 SSA, the Service pointed to Pearson & Dawson 2003 to argue that ecological niche models are often inaccurate or spurious,[4] but this study actually supports using ecological niche models in certain situations, which would most likely include modelling Joshua tree distribution. A literature review in the paper suggests that "bioclimatic models applied at the macro-scale are suitable for making broad predictions as to the likely impacts of climate change on the distribution of species" (Pearson & Dawson 2003, p. 364) and that "applications of bioclimate envelope models for predicting distribution changes over the next century are most appropriate for species not expected to be able to undergo rapid evolutionary change over this timescale. This is most likely to be the case for long-lived species and poor dispersers" (Pearson & Dawson 2003, p. 365). Indeed, "extremely poor dispersers will occupy only those current distributional areas that remain suitable under future climates" (Pearson & Dawson 2003, p. 366). The Joshua tree is both long-lived and a poor disperser, as discussed at length in both this and the 2015 petition.

Pearson & Dawson 2003 also supports using models to drive policy:

> In many cases, bioclimate envelope models provide perhaps the best available guide for policy making at the current time. They have been usefully employed to identify possible magnitudes of future changes to distributions, and to suggest which species, habitats and regions are most at risk from climate change. (Pearson & Dawson 2003, p. 365, internal citations omitted)

The second paper cited by the Service (Fitzpatrick & Hargrove 2009) states that the validity of forecasts of potential changes in distribution of species under climatic change "is subject to many widely acknowledged uncertainties" (Fitzpatrick & Hargrove 2009, p. 2,256). The paper raises the valid point that "[f]orecasting future distributions of species from current species-climate relationships is problematic because the observed distribution of a species alone provides no information about how the species might respond under novel environments" (*Id.*). The authors suggest addressing this potential problem by calibrating models "on the entire study area" (*Id.*, p. 2,257) and "indicat[ing] where extrapolation has occurred rather than report[ing] a spurious projection" (*Id.*, p. 2,258). Yet, the Service simply dismissed all SDMs outright, failing to recognize whether the most recent and sophisticated SDMs/ecological niche models like Cole *et. al*. 2011 and Sweet *et. al.* 2019 adequately address the shortcomings of climate niche models that have been raised by some (*e.g.* Pearson and Dawson 2003; Fitzpatrick and Hargrove 2009).

Sweet et al. (2019) used the SDM modeling platform Maxent to develop relationships between Joshua tree presence points and a database of nine environmental variables including minimum and maximum temperature, precipitation, climatic water deficit (CWD), topography, and soil characteristics. They used the end-of-century (2070–2099) CMIP5 MIROC RCP 4.5, 6.0, and 8.5 emissions scenarios, representing CO2 emissions under highly mitigated, moderately mitigated, and unmitigated scenarios, respectively. The results showed loss of the vast majority of western

[4] *See* Sirchia et al. 2018, p. 71, stating: "[E]cological niche models are often criticized for inaccurate projections of future occurrence (Fitzpatrick and Hargrove 2009, p. 2256). This is especially true for species where current distribution data are not extensive across the species range or information about physiological thresholds is lacking, such as Joshua tree (Pearson and Dawson 2003). Given the absence of information about the adaptive capacity of Joshua tree, in combination with gaps in the occurrence data across the species' range, the probability of spurious conclusions seemed high"

Joshua Treee suitable habitat under all scenarios. Under the RCP 4.5 and 6.0 scenarios, 18.6% and 13.9% of current occupied areas remained as refugia. However, under the RCP 8.5 scenario, which is closest to current emissions trajectories, suitable habitat was almost completely eliminated, with only 15 ha, or 0.02% remaining as refugia

As with those identified by Barrows and Murphy-Mariscal (2012), the refugia identified by Sweet et al. (2019) are in areas of high fire risk, with the authors noting that the "areas mapped as Joshua tree refugia, which are found at higher elevation wetter areas, also tend to have the highest covers of invasive annual grasses." Approximately half of the refugia mapped under the 41 RCP 4.5 scenario have already experienced fire in recent decades. As discussed supra, fire fueled by invasive grasses is a significant source of Joshua tree mortality and creates conditions that delay or preclude recruitment, and therefore has the potential to diminish the effectiveness of any climate refugia for the species.

As summarized in the CESA petition, the Service also downplayed the threat of climate change and likely overstated the Joshua tree's resilience:

> Additionally, several of the analyses and conclusions contained in USFWS (2018) are flawed and served to downplay the threats and overstate the likely resilience of the species. For example, the agency used an upper "appropriate temperature range" for the species of 59°C (138°F). The same metric was used for all age classes, from seedlings to adults. This threshold was based on a laboratory studies by Smith et al. (1983) in which detached leaves were placed in hot water for an hour and then examined for heat damage. The temperature at which a severed leaf demonstrates cell damage in a lab is a far different metric than the ambient temperature in which a Joshua tree can survive and successfully reproduce in the wild. The temperature used by USFWS (2018) is higher than the hottest temperature (56.7°C; 134.1°F) ever measured on Earth. Notably, the highest lab air temperature that Smith et al. (1983) actually successfully reared Joshua trees was 45°C (113°F). (Cummings 2019, p. 58)

Life history factors and climate change. Cronk (2016, p. 447) asks: "If human actions over the past 25 years have set in train a mass extinction that will take 100 years or more to play out, then how do we identify the living dead and what should be our response?" Regarding the process of plant extinctions, "[m]any plant species may be on an inevitable path to extinction, even though isolated specimens can survive for decades or more" (Cronk, 2016, p. 446). For plant species, "there may be a long extinction lag time" (Cronk, 2016, p. 446). Many Joshua tree populations may be functionally extinct despite mature individuals persisting; that lack of recruitment means those populations are the "living dead."

For whitebark pine (*Pinus albicaulis*), which has a similar generation time to Joshua trees, the Service found that climate change would likely be too rapid for the species to adapt:

> Historical (paleoecological) evidence indicates that plant species have generally responded to past climate change through migration, and that adaptation to changing climate conditions is less likely to occur. Adaptation to a change in habitat conditions as a result of a changing climate is even more unlikely for *P. albicaulis,* given its very long generation time of approximately 60 years. The rate of latitudinal plant migration during

> past warming and cooling events is estimated to have been on the order of [328 feet] per year. Given the current and anticipated rates of global climate change, migration rates will potentially need to be substantially higher than those measured in historic pollen records to sustain the species over time. A migration rate of at least a magnitude higher ([3,280 feet] per year) is estimated to be necessary in order for tree species to be capable of tracking suitable habitats under projected warming trends. (USFWS 2011b, p. 42,637, *internal citations omitted*)

The whitebark pine has since been proposed for listing as "threatened," in part due to climate change (USFWS 2020, *entire*).

Borchert & DeFalco (2016) supports the hypothesis that Joshua trees require specific environmental cues to synchronize reproduction. If changing weather patterns due to human-caused climate change disrupt those environmental cues, this may negatively affect Joshua tree reproduction and recruitment. "Joshua trees will have the greatest reproductive success with a combination of heat to stimulate seed germination and cold to support seedling establishment, but temperature extremes in either direction may result in death" (Harrower & Gilbert 2018, p. 11).

Warmer temperatures are positively correlated to Joshua tree reproduction but negatively correlated to stand density:

> Our analysis of 10 Joshua tree populations with broad coverage across its range shows for the first time strong variation in reproductive success and stand structure that is tightly linked to variability in temperature across the Mojave Desert. Our hypothesis that warmer temperatures would be positively correlated with reproduction but negatively correlated with population density was generally supported by the data. Flower production, and fruit and seed mass were all positively correlated with warmer temperatures, while stand density was negatively related to higher temperatures. While correlation analysis suggests a role for temperature in influencing Joshua tree reproduction and stand density, controlled studies are needed to test any causal relationship between temperature and Joshua tree reproduction and establishment. (Clair & Hoines 2018, p. 8)

These correlations suggest that "even if there are positive effects of warmer temperatures on reproductive potential of Joshua tree, they may be offset if there are negative effects of warmer temperature on stand density" (Clair & Hoines 2018, p. 11).

Mutualism and climate change. New evidence suggests that the mutualism between Joshua trees and Yucca moths makes the species more vulnerable to climate change impacts. Joshua trees need a minimum number of moths to successfully reproduce sexually: "Areas with a greater number of moths produced pods with more fertile seeds than in areas with low moth numbers, suggesting that seed production is pollen limited" (Harrower & Gilbert 2018, p. 13).

At elevation extremes, Yucca moths are rare or absent, precluding seed set:

> At elevation extremes [both high and low elevation], Joshua tree reproduction is almost exclusively clonal. This agrees with studies which found that Joshua tree clonality

> increases with elevation, but the lack of seedling recruitment and enhanced clonality at low elevations has not been previously reported. Seedlings may be unable to establish due to drought stress and heat at the lower elevation and freezing temperatures at the higher elevation. Trees produced flowers at both of the extremes, but we found no moths, no fruit development, and no seed set. Therefore, the lack of seedlings could also be explained by the lack of pollinators and viable seeds. (Harrower & Gilbert 2018, p. 10, *internal citations omitted*)

Models indicate that climate shifts may enable Joshua trees to expand their range into higher elevations. However, it is uncertain whether Yucca moths can also expand their range into higher elevations:

> Specifically, the outcome of the mutualism (viable seed set) is congruent with optimum host vigor under current conditions, around the middle of the elevation range. Joshua trees seem to be dying back at low elevations as predicted, but they do not seem to be moving successfully into higher elevations, where the mutualism is not successful. Having robust, dense, flowering trees is important to support and attract enough moths for successful seed set, leading to a higher percentage of fertile seeds per pod and a higher magnitude positive interaction outcome. It remains to be seen if Joshua tree performance can improve at higher elevations and if it will be able to attract enough moths to successfully reproduce, or if moths can migrate to and survive at those locations. (Harrower & Gilbert 2018, p. 13)

CONCLUSION AND REQUESTED DESIGNATION

ESA listing for the western Joshua tree must be prompt. The ESA empowers the Service to take emergency listing action when there is a significant risk to the well-being of a species. The western Joshua tree is imminently threatened by at least three of the five listing factors under the ESA: the present or threatened destruction, modification, or curtailment of its habitat or range; inadequate regulatory mechanisms; and other natural or manmade factors affecting its continued existence. Recent record-breaking temperatures, droughts, devastating wildfires, and evidence of declining recruitment of new young Joshua trees demonstrate the acuteness of the threats facing this species. Prompt regulatory protection could help address these threats.

Consequently, Guardians hereby requests immediate emergency listing of the western Joshua tree under the ESA in order to provide the species interim protection. While the species is emergency listed, the Service should issue a final listing rule for the western Joshua tree and concurrently designate critical habitat for the species in occupied and unoccupied suitable habitat. Designating critical habitat for this species will support its recovery and protect areas crucial to the long-term survival of western Joshua tree populations. As noted, should the Service decline to afford the eastern Joshua tree emergency protections under the Act, we respectfully request that it consider this petition, along with the information incorporated by reference from the 2015 petition and all supporting attachments, and issue a final listing determination within one year. 16 U.S.C. § 1533(b)(3)(B).

References

[ADOA] Arizona Department of Agriculture (2015). Protected native plants by categories. Online at: https://agriculture.az.gov/protected-native-plants-categories [June 29, 2015]

Aizpurua, O., Cantú-Salazar, L., San Martin, G., Biver, G., Brotons, L., & Titeux, N. (2015). Reconciling expert judgement and habitat suitability models as tools for guiding sampling of threatened species. *Journal of Applied Ecology 52*, 1,608-1,616.

[AZGFD] Arizona Game and Fish Department (2015). Status definitions. Online at: http://www.azgfd.gov/w_c/edits/hdms_status_definitions.shtml [June 29, 2015].

Barrows, C. W., & Murphy-Mariscal, M. L. (2012). Modeling impacts of climate change on Joshua trees at their southern boundary: How scale impacts predictions. *Biological Conservation, 152*, 29-36.

Borchert, M. I., & DeFalco, L. (2016). *Yucca brevifolia* fruit production, predispersal seed predation, and fruit removal by rodents during two years of contrasting reproduction. *American Journal of Botany 103*(5), 830-836.

Boxall, B. (2020, Sept. 6). Mojave Desert fire in August destroyed the heart of a beloved Joshua tree forest. *Los Angeles Times*. Online at: https://www.latimes.com/environment/story/2020-09-06/mojave-desert-fire-destroys-the-heart-of-a-beloved-joshua-tree-forest [Feb. 11, 2021].

Brooks, M. L., Minnich, R. A., & Matchett, J. (2018). "Southeastern Deserts Bioregion." In van Wagtendonk (Ed.), *Fire in California's Ecosystems, 2nd Edition*. University of California Press.

[CDFW] California Department of Fish and Wildlife (2020). *Evaluation of a Petition from the Center for Biological Diversity to List Western Joshua Tree (*Yucca brevifolia*) as Threatened Under the California Endangered Species Act.* State of California Natural Resources Agency, Department of Fish and Wildlife.

Chai, S.-L., Zhang, J., Nixon, A., & Nielsen, S. (2016). Using Risk Assessment and Habitat Suitability Models to Prioritize Invasive Species for Management in a Changing Climate. *PloS ONE 11*(10), e0165292.

Clair, S. B. St., & Hoines, J. (2018). Reproductive ecology and stand structure of Joshua tree forests across climate gradients of the Mojave Desert*. PLoS ONE 13*(2), e0193248.

Cole, K. L., Ironside, K., Eischeid, J., Garfin, G., Duffy, P. B., & Toney, C. (2011). Past and ongoing shifts in Joshua tree distribution support future modeled range contraction. *Ecological Applications 21*(1), 137-14

Cole, K. L., Pohs, K., & Cannella, J. A. (2003). *Digital range map of Joshua tree* (Yucca brevifolia). U.S. Geological Survey. Online at: http://sbsc.wr.usgs.gov/cprs/research/projects/global_change/RangeMaps.asp [June 27, 2015].

Cornett, J. W. (2018). "Eastern Joshua tree (*Yucca jaegeriana*) growth rates and survivability on Cima Dome, Mojave National Preserve." In D. M. Miller (Ed.), *Against the Current: The Mojave River from Sink to Source.* The 2018 Desert Symposium Field Guide and Proceedings.

Cronk, Q. (2016). Plant extinctions take time. *Science 353*(6298), 446-447.

Cummings, B. (2019). *A Petition to List the Western Joshua Tree (*Yucca brevifolia*) as Threatened under the California Endangered Species Act (CESA)*. Joshua Tree, CA: Center for Biological Diversity.

DeFalco, L. A., Esque, T. C., Scoles-Sciulla, S. J., & Rodgers, J. (2010). Desert wildfire and severe drought diminish survivorship of the long-lived Joshua tree (*Yucca brevifolia*; Agavaceae). *American Journal of Botany 97*(2), 243-250.

Dole, K., Loik, M., & Sloan, L. (2003). The relative importance of climate change and the physiological effects of CO_2 on freezing tolerance for the future distribution of *Yucca brevifolia*. *Global and Planetary Change 36*(137-146).

Fitzpatrick, M. C., & Hargrove, W. W. (2009). The projection of species distribution models and the problem of non-analog climate. *Biodiversity Conservation 18*, 2,255-2,261.

[GBBO] Great Basin Bird Observatory (2010). *Nevada Comprehensive Bird Conservation Plan, V. 1.0*. Reno, NV: Great Basin Bird Observatory.

Guisan, A., & Thuiller, W. (2005). Predicting species distribution: offering more than simple habitat models. *Ecology Letters 8*, 993-1,009.

Harrower, J., & Gilbert, G. (2018) Context-dependent mutualisms in the Joshua tree–yucca moth system shift along a climate gradient. *Ecosphere 9*(9), e02439.

Holmgren, C. A., Betancourt, J. L., & Rylander, K. A. (2009). A long-term vegetation history of the Mojave-Colorado Desert ecotone at Joshua Tree National Park. *Journal of Quarternary Science*, unpaginated.

Hopkins, F. (University of California, Riverside). 2018. Inland Deserts Summary Report. California's Fourth Climate Change Assessment. Publication number: SUM-CCCA4-2018-008.

[InciWeb] Incident Information System (2020). *Dome Fire Incident Overview*. Online at: https://inciweb.nwcg.gov/incident/7000/ [Jan. 31, 2021]

Iknayan, K.J. and S.R. Beissinger. 2018. Collapse of a desert bird community over the past century driven by climate change. Proc. Natl. Acad. Sci. U.S.A. 115:8597–8602.

[IPCC] Intergovernmental Panel on Climate Change (IPCC). 2018. Global Warming of 1.5° C: An IPCC Special Report on the Impacts of Global Warming of 1.5° C Above Pre-industrial Levels and Related Global Greenhouse Gas Emission Pathways, in the Context of Strengthening the Global Response to the Threat of Climate Change, Sustainable Development, and Efforts to Eradicate Poverty. Intergovernmental Panel on Climate Change. Available at: http://www.ipcc.ch/report/sr15/.

Klinger, R., & Brooks, M. (2017). Alternative pathways to landscape transformation: invasive grasses, burn severity and fire frequency in arid ecosystems. *Journal of Ecology 105*, 1521-1533.

Lee-Yaw, J. A., Kharouba, H. M., Bontrager, M., Mahony, C., Csergö, A. M., Noreen, A. M. E., Li, Q., Schuster, R., & Angert, A. L. (2016). A synthesis of transplant experiments and ecological niche models suggests that range limits are often niche limits. *Ecology Letters*, doi: 10.1111/ele.12604.

Manzoor, S. A., Griffiths, G., & Lukac, M. (2018). Species distribution model transferability and model grain size – finer may not always be better. *Scientific Reports 8*, doi:10.1038/s41598-018-25437-1.

Miller-Henson, M. (2020). *Notice of Findings: Western Joshua Tree (*Yucca brevifolia*).* California Fish and Game Commission.

Moloney, K. A., Mudrak, E. L., Fuentes-Ramirez, A., Parag, H., Schat, M., & Holzapfel, C. (2019). Increased fire risk in Mojave and Sonoran shrublands due to exotic species and extreme rainfall events. *Ecosphere 10*(2), e02592.

Mufson, S., C. Mooney, J. Eilperin, and J. Muyskens. 2019. 2°C: Beyond the Limit: Extreme climate change has arrived in America. Washington Post. https://www.washingtonpost.com/graphics/2019/national/climate-environment/climate-change-america/

NatureServe (2021). *Yucca jaegeriana*: Eastern Joshua tree. *NatureServe Explorer: An online encyclopedia of life (web application).* NatureServe, Arlington, Virginia. Online at: https://explorer.natureserve.org/Taxon/ELEMENT_GLOBAL.2.156126/Yucca_jaegeriana [Feb. 21, 2021].

[NDF] Nevada Department of Forestry (undated). *State of Nevada Native Plant Laws*. Las Vegas, NV: Nevada Department of Forestry, Department of Conservation & Natural Resources.

[NPS] National Park Service (2020). *Dome Fire.* Online at: https://www.nps.gov/moja/learn/nature/dome-fire.htm [Feb. 11, 2021].

Pearson, R. G., & Dawson, T. P. (2003). Predicting the impacts of climate change on the distribution of species: are bioclimate envelope models useful? *Global Ecology & Biogeography 12,* 361-371.

Pellmyr, O., Segraves, K. A., Althoff, D. M., Balcázar-Lara, M. & Leebens-Mack, J. (2007). The phylogeny of yuccas. *Molecular Phylogenetics and Evolution 43*, 493–501.

Riddell, E.A., K.J. Iknayana, B.O. Wolfc, B.S., and Steven R. Beissinger. 2019. Cooling requirements fueled the collapse of a desert bird community from climate change. Proc. Natl. Acad. Sci. U.S.A. https://doi.org/10.1073/pnas.1908791116115, 8597–8602.

Sanchez, M. J., & Weber, C. (2020, Sept. 19). Winds push California fire into Mojave Desert. *Portland Press Herald.* Online at: https://www.pressherald.com/2020/09/19/winds-push-california-fire-into-mojave-desert/ [Feb. 11, 2021].

Scheffers, B. R., L. De Meester, T.C.L. Bridge, A.A. Hoffmann, J.M. Pandolfi, R.T. Corlett, S.H.M. Butchart, P. Pearce-Kelly, K.M. Kovacs, D. Dudgeon, M. Pacifici, C. Rondinini, W.B. Foden, T. G. Martin, C. Mora, D. Bickford and J.E.M. Watson. 2016. The broad footprint of climate change from genes to biomes to people. Science 354:6313.

Searcy, C.A, & Shaffer, H. B. (2016). Do ecological niche models accurately identify climatic determinants of species ranges? *The American Naturalist 187*(4), 423-435.

Shafer, S. L., Bartlein, P. J., & Thompson, R. S. (2001). Potential changes in the distributions of western North America tree and shrub taxa under future climate scenarios. *Ecosystems 4*, 200-215.

Sirchia, F., Hoffmann, S., & Wilkening, J. (2018). *Joshua Tree Species Status Assessment.* U.S. Fish and Wildlife Service.

Smith, S. D., Hartsock, T. L., & Nobel, P. S. (1983). Ecophysiology of *Yucca brevifolia*, an arborescent monocot of the Mojave Desert. *Oecologia 60*, 10-17.

Starr, T. N., Gadek, K. E., Yoder, J. B., Flatz, R., & Smith, C. I. (2012). Asymmetric hybridization and gene flow between Joshua trees (Agavaceae: *Yucca*) reflect differences in pollinator host specificity. *Molecular Ecology*, 1-13.

Sweet, L. C., Green, T., Heintz, J. G. C., Frakes, N., Graver, N., Rangitsch, J. S., Rodgers, J. E., Heacox, S., & Barrows, C. W. (2019). Congruence between future distribution models and empirical data for an iconic species at Joshua Tree National Park. *Ecosphere 10*(6): e02763.10.1002/ecs2.2763.

Syphard, A. D., Keeley, J. E., & Abatzoglou, J. T. (2017). Trends and drivers of fire activity vary across California aridland ecosystems. *Journal of Arid Environments 144,*110-122.

Tagestad J., M. Brooks, V. Cullinan, J. Downs, and R. Mckinley. 2016. Precipitation Regime Classification for the Mojave Desert: Implications for fire occurrence. Journal of Arid Environments 124:388–397.

[USFWS] U.S. Fish and Wildlife Service (2011a). 12-month finding on a petition to list the Bearmouth mountainsnail, Byrne Resort mountainsnail, and meltwater lednian stonefly as endangered or threatened. *Federal Register 76*(65), 18,684-18,701.

___ (2011b). 12-month finding on a petition to list *Pinus albicaulis* as endangered or threatened with critical habitat. *Federal Register 76*(138), 42,631-42,654.

___ (2016). 90-day findings on 10 petitions. *Federal Register 81*(178), 63,160- 63,165.

___ (2019). 12-month findings on petitions to list eight species as endangered or threatened species. *Federal Register 84*(158), 41,694-41,699.

___ (2020). Threatened species status for *Pinus albicaulis* (whitebark pine) with Section 4(d) rule. *Federal Register 85*(232), 77,408-77424.

[USGCRP] U.S. Global Change Research Program. 2017. Climate Science Special Report, Fourth National Climate Assessment, Volume I. https://science2017.globalchange.gov/.

Vamstad, M. S., & Rotenberry, J. T. (2010). Effects of fire on vegetation and small mammal communities in a Mojave Desert Joshua tree woodland. *Journal of Arid Environments 74*, 1,309-1,318.

Wiens, J. J. 2016. Climate-related local extinctions are already widespread among plant and animal species. PLoS Biology 14(12):1–18.

WildEarth Guardians (2015). *Petition to List the Joshua Tree* (Yucca brevifolia) *Under the Endangered Species Act.* Denver, CO: WildEarth Guardians.

WildEarth Guardians v. Bernhardt, No. 2:19-cv-09473-ODW-KS (CD Cal. August 13, 2019).