HARRISON, TEMBLADOR
HUNGERFORD & JOHNSON LLP
Mark D. Harrison – SBN 142958
Bradley B. Johnson – SBN 257220
Adam K. Guernsey – SBN 282105
2801 T Street
Sacramento, CA 95816
Telephone: (916) 382-4377
Facsimile: (916) 382-4380
mharrison@hthjlaw.com
bjohnson@hthjlaw.com
aguernsey@hthjlaw.com

JEFFER MANGELS
BUTLER & MITCHELL LLP
Kerry Shapiro – SBN 133912
Matthew D. Hinks – SBN 200750
Daniel L. Quinley – SBN 312579
Two Embarcadero Center, 5th Floor
San Francisco, CA 94111
Telephone: (415) 984-9612
Facsimile: (877) 746-5619
kshapiro@jmbm.com
mhinks@jmbm.com
dq1@jmbm.com

Attorneys for Petitioners
California Construction and Industrial Materials Association; California Business Properties Association; California Cattlemen's Association; California Manufacturers and Technology Association; High Desert Association of Realtors; and City of Hesperia

SUPERIOR COURT OF CALIFORNIA

COUNTY OF FRESNO

CALIFORNIA CONSTRUCTION AND INDUSTRIAL MATERIALS ASSOCIATION; CALIFORNIA BUSINESS PROPERTIES ASSOCIATION; CALIFORNIA CATTLEMEN'S ASSOCIATION; CALIFORNIA MANUFACTURERS AND TECHNOLOGY ASSOCIATION; HIGH DESERT ASSOCIATION OF REALTORS; and CITY OF HESPERIA, *Petitioners*,	Case No.: **VERIFIED PETITION FOR WRIT OF MANDATE**

vs.

CALIFORNIA FISH AND GAME COMMISSION, a California Public Agency; and DOES 1-20,

Respondents.

INTRODUCTION

Petitioners California Construction and Industrial Materials Association ("CalCIMA"), California Business Properties Association ("CBPA"), California Cattlemen's Association ("CCA"), California Manufacturing and Technology Association ("CMTA"), High Desert Association of Realtors ("HDAOR"), and City of Hesperia ("Hesperia") (collectively, "Petitioners") respectfully request that the Court issue a Writ of Mandate directing the California Fish and Game Commission (the "Commission") to vacate its recent approval of the petition to list the western Joshua tree (*Yucca brevifolia*) (the "Listing Petition") as a "candidate species" under the California Endangered Species Act (Fish & G. Code, § 2050 *et seq.* ["CESA"]).

This Petition seeks to require the Commission to comply with the clear and mandatory listing petition rules set out in CESA and the Commission's own regulations. The Commission must vacate its acceptance of the Listing Petition and must not again consider listing of the western Joshua tree unless and until the Commission receives a new listing petition that satisfies all of CESA's substantive requirements.

This Petition is not about the factual merits of whether the western Joshua tree should ultimately be listed as threatened under CESA. This Petition concerns the legal question of whether the Commission may ignore fundamental data requirements required by statute when making this, and future, listing determinations.

CESA requires a listing petition to meet certain form and substance requirements before the Commission can exercise its jurisdiction or authority to make candidacy determinations. Substantively, at the first stage of the listing process, CESA requires the Commission to review whether a listing petition includes scientific information sufficient to demonstrate that a particular species' candidacy "may be warranted."[1] (Fish & G. Code, §§ 2072.3, 2074.2(e); Cal. Code Regs., tit. 14, § 670.1(b).)

The Commission must exercise its authority within the boundaries of twelve specific scientific data sets. (*Id.* at § 2072.3; see also Cal. Code Regs., tit. 14, §§ 670.1(b), 670.1(d).) Two of the most important categories of scientific information critical to this Petition are "abundance"[2] and "population trend." (*Ibid.*) The reason these two data sets are central to the Commission's decision-making derives from CESA's definition of a "threatened species." A "threatened species" is a species that, in the foreseeable future, is likely to fall into serious danger of extinction throughout all, or a significant portion, of its range. (See Fish & G. Code, §§ 2062, 2068 [defining "Endangered Species" and "Threatened Species"].)

As is logical, the Commission cannot make a determination that a species "is likely to become an endangered species in the foreseeable future" without data concerning a species' current population size or population trend within all, or a significant portion, of its range. The Commission does not have jurisdiction or authority to waive this critical data required by CESA section 2072.3 when determining whether listing may be warranted. (Cal. Code Regs., tit. 14, § 670.1(e)(1).)

As shown in this verified petition ("Petition"), the Commission acted in excess of its jurisdiction and abused its discretion by ignoring these key informational requirements. The Department of Fish and Wildlife ("Department"), in both the Department's report and in oral testimony before the Commission, confirmed the lack of this critical information.

The western Joshua tree's range, according to the Listing Petition, covers approximately 5.3 million acres in and around the Mojave Desert. The Listing Petition and the Department's *Evaluation of a Petition from the Center for Biological Diversity to List Western Joshua Tree*

[1]The Commission engages in a two-step process when determining whether to list a species. In summary, if the Commission decides during the first step that listing may be warranted, the California Department of Fish and Wildlife will then prepare a peer review report for the Commission. (Fish & G. Code, §§ 2074.2(e), 2074.6.) During the second step, the Commission will then determine whether the evidence supports a determination that listing is warranted. (*Id.* at § 2075.5(e).)

[2] "Abundance" is used interchangeably herein with "population" or "population size" consistent with the Listing Petition and the California Department of Fish and Wildlife's evaluation and recommendations to the Commission.

(Yucca brevifolia) as Threatened Under the California Endangered Species Act, dated February 2020 (the "Evaluation"),[3] state that the distribution of the western Joshua tree across its range has been remarkably stable for the last approximately 11,000 years. The Listing Petition also states that the Joshua Tree is not at imminent risk of extinction but may be impacted by global climate change in the coming decades.

The Listing Petition and Department's Evaluation do not, however, provide the Commission with scientific information on western Joshua tree with respect to abundance or population size.

The Listing Petition and the Department's Evaluation patently acknowledge that they do not present the Commission with any evidence of population trend within all, or a significant portion, of the western Joshua tree's range. The Listing Petition and the Department's Evaluation instead present only limited data on western Joshua tree population trend within a small portion of Joshua Tree National Park, which itself comprises a small area of the western Joshua tree's 5.3 million acre range. Limited studies within portions of Joshua Tree National Park do not, as a matter of law, comprise sufficient scientific information or demonstrate population trend in a "significant portion" of the western Joshua tree's approximately 5.3 million acre range.

The lack of any information on abundance and population trend within all, or a significant portion, of the western Joshua tree's range is not "sufficient scientific information." The Listing Petition, therefore, does not include sufficient information to allow the Commission to exercise its jurisdiction and authority in accordance with CESA.

The Commission acted in excess of its jurisdiction and authority by waiving statutorily mandated requirements when approving the Listing Petition. The Commission also abused its discretion by proceeding contrary to CESA's requirements and by making findings that listing may be warranted, when such findings were wholly unsupported by information on abundance and population trend—both range-wide and over a significant portion of the western Joshua tree's 5.3 million acre range.

[3] CESA requires the Department to evaluate the Petition and recommend to the Commission whether the Petition should be accepted and considered or rejected. (Fish & G. Code, § 2073.5.)

The Commission further abused its discretion because its findings are in violation of the *Topanga* Rule as they do not, and cannot, bridge the analytical gap between the evidence presented in the record and the Commission's decision, as two critical data elements are missing. (Code Civ. Proc., § 1094.5; *Topanga Ass'n for a Scenic Community v. County of Los Angeles* (1974) 11 Cal. 3d 506, 515 ["*Topanga*"].)

This case is important, in part, because the Listing Petition is largely based on the Petitioner's speculation of the effects of climate change on the western Joshua tree. While global climate change may impact the western Joshua tree—and nearly all species—in the coming decades, that potential does not exempt the Commission from CESA's statutory requirements. CESA requires specific information to be presented to the Commission in order for the Commission to make rational decisions. It is therefore critical that when the Commission assesses impacts on species resulting from global climate change, or any other purported threat, it adheres to its statutory bounds when making listing determinations.

PARTIES AND STANDING

1. Petitioners are a broad coalition of industry associations and a municipal corporation representing essential business properties, landholdings, cattle operations, and construction materials businesses, which own, manage and operate significant property and businesses that contribute building materials, beef production, jobs, and which have made significant investments in the regions of California that make up the western Joshua tree's range. The Commission's September 22, 2020 decision, by unlawfully granting immediate CESA protections to the western Joshua tree, jeopardizes, among other things, Petitioners' ability to manage and operate their properties and businesses, to produce building materials essential to the state's infrastructure and economic vitality, and to continue to provide jobs and economic investment in some of the most challenged regions of the state.

2. CalCIMA is a non-profit organization and trade association for the construction and material industries in California, which include aggregate, industrial minerals, and ready mixed concrete producers. These producers provide people and businesses with cement, concrete, and other materials used to build and repair California's homes, schools, roads, airports, bridges, rail

and water projects, and other public infrastructure; produce consumer products including electronics and batteries; assist in growing crops and feeding livestock; and ensure a ready supply of vital materials to ensure California meets its renewable energy, affordable housing, and infrastructure goals. CalCIMA serves its members by addressing legislative, regulatory, and judicial matters that affect the building materials industry.

3. CBPA is the recognized voice of all aspects of the commercial, retail, and industrial real estate industry in California — representing the largest commercial real estate consortium with over 10,000 industry members. CBPA is the designated legislative advocate for the International Council of Shopping Centers ("ICSC"), the California Chapters of the Commercial Real Estate Development Association ("NAIOP"), the Building Owners and Managers Association of California ("BOMA"), the Retail Industry Leaders Association ("RILA"), the Institute of Real Estate Management ("IREM"), and the Association of Commercial Real Estate – Northern and Southern California ("ACRE"), the National Association of Real Estate Investment Trusts ("NAREIT"), AIR Commercial Real Estate Association ("AIR CRE"), and the California Association for Local Economic Development ("CALED").

4. CCA, incorporated in 1917, is a nonprofit trade association representing more than 1,700 cattle ranchers and beef producers throughout the State of California. Acting in conjunction with its 35 affiliate local cattlemen's associations throughout the state, CCA endeavors to promote and defend the interests of cattle ranchers both large and small in legislative, regulatory, and legal affairs. Beef cattle producers manage more than 38 million acres of private and public rangelands throughout California, and pride themselves on the sustainable stewardship of the state's land, water, and wildlife resources. CCA members graze cattle on rangelands in every county of the state save for San Francisco, spanning varied climates and forage types, including the desert rangelands of southeastern California upon which western Joshua tree occur.

5. CMTA (formerly the California Manufacturers Association) works to improve and enhance a strong business climate for California's 30,000 manufacturing, processing, and technology-based companies. Since 1918, CMTA has worked with state government to develop balanced laws, effective regulations, and sound public policies to stimulate economic growth and

create new jobs while safeguarding the state's environmental resources. CMTA represents 400 businesses from the entire manufacturing community – an economic sector that generates more than $288 billion every year and employs more than 1.3 million Californians.

6. HDAOR, representing more than 1,300 REALTOR® members and affiliated members, is the source of essential business services and the association of choice for real estate professionals. The association is committed to excellence and, through collective action, promotes the preservation of real property rights.

7. Hesperia is a municipal corporation duly organized and validly existing under the laws of the State of California. Hesperia is represented by a five-member City Council that is elected by district. The City Council is responsible for representing the interests of nearly 100,000 citizens and is tasked with making decisions regarding economic development and land use within Hesperia.

8. Petitioners have standing to bring this Petition because Fish and Game Code section 2076 specifically authorizes this remedy, and Petitioners have a beneficial interest in the issuance of the writ requested in this Petition over and above the interest held in common with the public at large (Code Civ. Proc., § 1086), for the following reasons:

a. Petitioners' members own, manage, and operate significant business properties, landholdings, cattle operations, and mining operations within the geographic area affected by the Commission's decision and depend on the supply chain of materials produced in the impacted area which are directly and adversely impacted by the decision. The Commission's decision to accept the Listing Petition extended immediate CESA protections to the western Joshua tree, which restricts Petitioners' members continued use and operation of their business properties, ranches, public lands grazing leases, and landholdings, with direct impacts to jobs, investment, and the supply of construction and industrial materials, and beef production in the state. The imposition of CESA protections in the absence of a sound scientific basis, and in violation of the law, will irreparably harm Petitioners' members throughout the state. These interests are germane to Petitioners' purpose and will be directly and adversely affected by the Commission's decision, which violates provisions of law as set forth herein.

b. The Commission’s decision triggers immediate CESA protections, which impose additional, Department-administered processes redundant of existing management obligations under local and state regulations, including (i) the California Native Plant Protection Act (Fish & G. Code, §§ 1900-1913 ["CNPPA"]); (ii) the Desert Native Plant Act (Food & Ag. Code, § 800001 *et seq.* ["DNPA"]) and local ordinances implementing and supplementing the CNPPA and DNPA. These state level processes will cause Petitioners to incur significant increases to operating and mitigation costs or to cease activities or operations on some or all of their landholdings, even though such activities or operations are ongoing and authorized under existing land use entitlements.

c. Petitioners have an ongoing beneficial interest in the Commission’s compliance with CESA when reviewing listing petitions. Petitioners have already expended significant resources to challenge the Commission’s unlawful decision and have experienced significant harm resulting from the decision as described above. Petitioners have an interest in preventing the Commission from making similar unlawful decisions in the future, each of which could result in harm to Petitioners.

9. Petitioners also have public interest standing because the proper application of CESA to the Commission's species listing determinations is a matter of public right, with implications for future petitions to list species absent statutorily required information, and Petitioners are seeking to procure the enforcement of the Commission's duty to comply with CESA.

10. Petitioners have standing to bring this action on behalf of their members because each of Petitioners’ members would otherwise have standing to sue in their own right, the interests Petitioners seek to protect are germane to each Petitioner’s purpose, and neither the claim asserted, nor the relief requested, in this Petition requires the participation of individual members in this action.

11. Petitioners participated in the Commission's administrative process leading to the decision challenged in this Petition.

12. Respondent California Fish and Game Commission is an agency of the State of California, authorized to, among other things, accept and consider listing petitions consistent with CESA.

13. Petitioner does not know the true names and capacities of Respondents named as DOES 1 through 20 and therefore sues them by fictitious names. Petitioners are informed and believe that DOES 1 through 20 are in some way responsible for the events described in this Petition. Petitioners will seek to amend this Petition when the true names and capacities have been ascertained.

JURISDICTION AND VENUE

14. This Court has jurisdiction to issue the requested Writ of Mandate pursuant to Code of Civil Procedure section 1094.5 and Fish and Game Code section 2076. Fish and Game Code section 2076 states, specifically, that "[a]ny finding pursuant to this section is subject to judicial review under Section 1094.5 of the Code of Civil Procedure."

15. Venue for this action properly lies in the Superior Court of the State of California in and for the County of Fresno, pursuant to Code of Civil Procedure sections 395 and 401(1), because the Commission is a state agency based in Sacramento County and the California Attorney General has an office in Fresno.

16. This Petition has been filed within the time limits imposed for this action under Fish and Game Code section 2076 and Code of Civil Procedure section 1094.5.

EXHAUSTION OF ADMINISTRATIVE REMEDIES

17. Petitioners, as stated above, participated in the Commission's administrative process leading to the decision challenged in this Petition. No further administrative remedies exist for Petitioners to challenge Respondent's decision. Petitioners have thus performed all conditions precedent to filing this action and have exhausted all available administrative remedies.

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FACTS

The California Endangered Species Act

18. The California State Legislature enacted CESA "to conserve, protect, restore, and enhance any endangered species or any threatened species and its habitat." (Fish & G. Code, § 2052.)

19. CESA requires the Commission to establish a list of endangered species and a list of threatened species. (Fish & G. Code, § 2070.) CESA extends special protections to endangered and threatened species. (*Id*. at § 2080.)

20. CESA defines "endangered species" to mean "a native species or subspecies of a bird, mammal, fish, amphibian, reptile, or plant which is in serious danger of becoming extinct throughout all, or a significant portion, of its range due to one or more causes, including loss of habitat, change in habitat, overexploitation, predation, competition, or disease." (Fish & G. Code, § 2062.)

21. CESA defines "threatened species" to mean "a native species or subspecies of bird, mammal, fish, amphibian, reptile, or plant that, although not presently threatened with extinction, is likely to become an endangered species in the foreseeable future in the absence of the special protection and management efforts required by this chapter." (Fish & G. Code, § 2067.)

22. CESA defines "candidate species" to mean "a native species or subspecies of a bird, mammal, fish, amphibian, reptile, or plant that the commission has formally noticed as being under review by the department for addition to either the list of endangered species or the list of threatened species, or a species for which the commission has published a notice of proposed regulation to add the species to either list." (Fish & G. Code, § 2068.)

23. A species becomes a "candidate species" upon the Commission's publication of notice of findings that the petition is accepted for consideration. (Fish & G. Code, § 2074.2(e)(2).)

24. CESA and Commission regulations set out a multi-step process by which the Commission may add a new species to its list of threatened or endangered species. This process begins with either the filing of a listing petition with the Commission by any interested party, or

the filing of a listing recommendation by the Department, which CESA treats as a listing petition. (Fish & G. Code, §§ 2070, 2072.7.)

25. A listing petition must meet certain minimum form and substance requirements:

a. "The petition shall be written, shall be clearly identified as a petition, and shall clearly indicate the administrative measure recommended." (Fish & G. Code, § 2072.)

b. The petition must be submitted to the Commission on an authorized petition form. (Cal. Code Regs., tit. 14, § 670.1(a).)

c. The petition must include "sufficient scientific information," in each of the following twelve categories:

i. **Population trend**;
ii. Range;
iii. Distribution;
iv. **Abundance**;
v. Life history of a species;
vi. Factors affecting the ability to survive and reproduce;
vii. Degree and immediacy of threat;
viii. Impact of existing management efforts;
ix. Suggestions for future management;
x. Availability and sources of information;
xi. Kind of habitat necessary for survival; and
xii. A detailed distribution map.

(Fish & G. Code, §§ 2072.3, 2074.2; Cal. Code Regs., tit. 14, §§ 670.1(b), 670.1(d), 670.1(e)(1) [emphasis added].)

26. Upon receipt of a listing petition, the Commission forwards the listing petition to the Department. CESA requires the Department to prepare an "evaluation report," which must "contain an evaluation of whether or not the petition provides sufficient scientific information" on

each of the twelve required informational categories to indicate that listing "may be warranted." (Fish & G. Code, § 2073.5; Cal. Code Regs., tit. 14, § 670.1(d)(1).)

27. The Department's evaluation report must make one of two recommendations to the Commission: (1) reject the listing petition, on grounds that the petition does not present sufficient information to indicate that listing may be warranted; or (2) accept the listing petition for consideration, on grounds that the petition does present sufficient information to indicate that listing may be warranted. (*Ibid*.) CESA affords the Department 90 days to prepare its evaluation report and make its recommendation. (*Ibid*.)

28. The Commission must next hold a noticed public hearing to receive the Department's evaluation report, and to "consider the petition, the department's written report, written comments received, and oral testimony provided during public hearing," and decide whether to reject the petition or accept the petition for consideration. (Fish & G. Code, § 2074.2; Cal. Code Regs., tit. 14, § 670.1(e).)

29. Commission regulations require the Commission to reject a listing petition if the petition fails to include sufficient scientific information in any of the twelve categories set out in Fish and Game Code section 2072.3. (Cal. Code Regs., tit. 14, § 670.1(e)(1).)

30. If the Commission approves a listing petition for consideration, the subject species becomes a "candidate species," as defined above. (Fish & G. Code, § 2074.2(e)(2).) Importantly, a species is immediately granted CESA protections, even though the species has not been formally listed as either threatened or endangered, during the twelve-month "candidacy period" following the Commission's approval, during which time the Department must prepare its detailed evaluation. (Fish & G. Code, § 2085.)

31. CESA then requires the Department, within twelve months after the Commission accepts a listing petition for consideration, to prepare a more detailed evaluation report and to recommend to the Commission, whether, based on the best scientific information available to the Department, permanent listing is warranted. (Fish & G. Code, § 2074.6; Cal. Code Regs., tit. 14, § 670.1(f).)

32. CESA requires the Commission to hold another noticed public hearing for "final consideration" of the listing petition. (Fish & G. Code, § 2075.) After receiving evidence and testimony from Commission and Department staff and the public, CESA requires the Commission to decide whether or not to permanently list the species as threatened or endangered. (Fish & G. Code, § 2075.5; Cal. Code Regs., tit. 14, § 670.1(i).)

The Listing Petition and Commission Decision

33. The Center for Biological Diversity ("CBD") filed the Listing Petition with the Commission on October 21, 2019.

34. The western Joshua tree's range in California, according to the Listing Petition, encompasses approximately 5.3 million acres, touching numerous cities and counties, including the cities of Palmdale, Lancaster, Hesperia, Victorville, and Yucca Valley, and the counties of San Bernardino, Imperial, Inyo, Kern, Los Angeles, Mono, Riverside, and San Diego. (Portion of the Administrative Record ("AR") 024-025.)[4]

35. The Listing Petition states that while Joshua tree "may not currently be 'in serious danger of becoming extinct throughout all, or a significant portion, of its range,' it is likely to become so 'in the foreseeable future.'" (AR 053.) The Listing Petition also states such a danger is "likely decades away." (AR 053.) Nonetheless, the Listing Petition requests that the Commission list the western Joshua tree as threatened across its entire range in California. (AR 053.)

36. The Listing Petition, as required by CESA and Commission regulations, purports to provide "sufficient scientific information" in each of the twelve categories set out in Fish and Game Code section 2072.3. The Listing Petition separately discusses each of the twelve informational categories, including population trend and abundance.

37. The Petition does not, however, provide the required data on western Joshua tree abundance or population trend within all, or a significant portion, of its range.

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[4] Petitioners have filed herewith, attached as Appendix A, "part of the record of the proceedings" as permitted by Code of Civil Procedure section 1094.5(a).

38. As respects abundance, the Petition states that "a reliable estimate of Joshua tree population size is not available." (AR 024.)

39. As respects range-wide population trend, the Petition states that "no range-wide population trends have been documented." (AR 024.)

40. As respects population trend within a significant portion of the western Joshua tree's range, the Petition refers to limited, small-scale studies within portions of Joshua Tree National Park that show limited evidence of declining western Joshua tree populations. (AR 024-025.) These studies do not, as a matter of law, provide information on population trend within a "significant portion" of the western Joshua tree's 5.3 million acre range.

41. Following receipt of the Listing Petition, Commission staff transmitted the Listing Petition to the Department on November 1, 2019.

42. The Department thereafter prepared its required Evaluation.

43. The Evaluation, as required by CESA and Commission regulations, evaluates whether the Listing Petition contains "sufficient scientific information" in each of the twelve categories set out in Fish and Game Code section 2072.3. The Evaluation separately discusses each of the twelve informational categories, including population trend and abundance, and includes the Department's recommendation to the Commission.

44. The Evaluation does not provide information on western Joshua tree abundance or population trend within all, or a significant portion, of its range.

45. As respects abundance, the Evaluation states that "[t]he Petition does not present an estimate of western Joshua tree population size." (AR 091.)

46. As respects range-wide population trend, the Evaluation states that "[t]he Petition does not … provide evidence of range-wide population trend." (AR 091.)

47. As respects population trend within a significant portion of the western Joshua tree's range, the Evaluation states that "the Petition does provide information showing that some populations of western Joshua tree are declining, particularly within Joshua Tree National Park." (AR 091.) Again, these studies do not, as a matter of law, provide the required data on population trend within a significant portion of the western Joshua tree's range.

48. The Commission held a noticed public hearing on the Listing Petition on June 25, 2020, received written public comments, and continued the hearing to August 20, 2020. The Commission reopened the continued public hearing on the Listing Petition on August 20, 2020 and received additional written comments and oral testimony. (AR 275.)

49. Commission staff, during the August 20, 2020 public hearing, again acknowledged there was no information on western Joshua tree abundance or population trend within all, or a significant portion, of its range.

50. As respects abundance, Commission staff's presentation states that there are "no population size estimates." (AR 261.)

51. As respects range-wide population trend, Commission staff's presentation states there is "no evidence of a range-wide population trend." (AR 261.)

52. As respects population trend within a significant portion of the western Joshua tree's range, Commission staff's presentation states that "some populations [are] declining, particularly within Joshua Tree National Park." (AR 261.)

53. Significant written comments in opposition were submitted by a number interested parties, including Petitioners, in advance of the August 20, 2020 hearing. (E.g., AR 123 – 255.) These comments raised many issues, but the majority focused on the Listing Petition's failure to meet CESA's basic informational requirements including, specifically, the Listing Petition's failure to include any information regarding the species' abundance or population trend within all, or a significant portion, of the western Joshua tree's range, as required by CESA.

54. At the conclusion of the August 20, 2020 public hearing, the Commission closed the public hearing, and continued the matter until September 22, 2020.

55. At its September 22, 2020 hearing, the Commission approved the Listing Petition for consideration.

56. The Commission provided a notice of its findings to the Office of Administrative Law on September 24, 2020.

57. The Office of Administrative Law published the Commission's findings in Notice Register 2020, Number 41-Z, October 9, 2020 ("Findings"), thereby designating the western

Joshua tree as a candidate species, immediately extending full CESA protections. (AR 279; *see* Cal. Fish & G. Code, §§ 2074.2(e)(2), 2085.)

58. The Commission's Findings do not include any explicit statement of the underlying facts of record supporting the Commission's decision. (AR 279.)

59. More specifically, the Commission's Findings do not provide any underlying facts on western Joshua tree abundance or population trend within all, or a significant portion, of its range. (AR 283.)

FIRST CAUSE OF ACTION

(Writ of Mandate Under Code of Civil Procedure Section 1094.5

Violation of the California Endangered Species Act.)

60. Petitioners incorporate by this reference the allegations set out in paragraphs 1 through 59, inclusive, as though they were set forth fully herein.

61. The Commission's decision is subject to judicial review under Code of Civil Procedure section 1094.5. (Fish & G. Code, § 2076.) Code of Civil Procedure section 1094.5 provides a remedy to vacate the Commission's decision when the Commission acts in excess of its jurisdiction or abuses its discretion. (Code Civ. Proc., § 1094.5(b).)

62. The Commission acted in excess of its jurisdiction and authority when it approved the Listing Petition with no estimate of abundance. The Commission does not have legal jurisdiction or authority to waive a required element of data when deciding whether listing may be warranted.

63. The Commission also acted in excess of its jurisdiction and authority when it approved the Listing Petition with no information on range-wide population trend. The Commission does not have legal jurisdiction or authority to waive a required element of data when deciding whether listing may be warranted.

64. The Commission further acted in excess of its jurisdiction and authority when it approved the Listing Petition with no information on population trend within a significant portion of the western Joshua tree's range.

65. Small-scale studies within portions of Joshua Tree National Park, which is itself a small area of the western Joshua tree's range, that show limited evidence of declining western Joshua Tree populations do not, as a matter of law, provide information on population trend within a “significant portion” of the western Joshua tree’s range. The Commission does not have legal jurisdiction or authority to waive a required element of data when deciding of whether listing may be warranted.

66. The Commission abused its discretion by proceeding contrary to CESA’s requirements and by making findings that listing may be warranted, when such findings were wholly lacking information on abundance and population trend—both range-wide or over a significant portion of the western Joshua tree’s 5.3 million acre range. The Commission’s Findings are merely conclusory and inadequate to support its decision.

67. The Commission further abused its discretion because its Findings are in violation of the *Topanga* Rule as they do not, and cannot, bridge the analytical gap between the evidence presented in the record and the Commission’s decision, as two critical data elements are missing. (Code Civ. Proc., § 1094.5; *Topanga*, *supra*, at 515.)

68. Specifically, the Findings fail to include any explicit statement of the underlying facts of record supporting the Commission’s decision. (AR 283.)

69. The Findings further fail to: (1) show orderly analysis by the Commission; (2) provide information that would enable a reviewing court to trace and examine the Commission’s analysis; (3) enable parties to determine whether and on what basis to seek judicial review; (4) show that the Commission’s decision making is careful, reasoned, and equitable. (AR 279; *Topanga*, *supra*, at 516.)

70. Petitioners seek the writ requested in this Petition because Fish and Game Code section 2076 specifically authorizes this remedy and Petitioners have no plain, speedy, and adequate remedy in the ordinary course of law. (Code Civ. Proc., § 1086.)

71. Petitioners are beneficially interested in the Commission’s compliance with the clear and mandatory listing petition rules set out in CESA and the Commission’s own regulations

with regard to this Listing Petition and with regard to future listing petitions that may come before the Commission.

PRAYER FOR RELIEF

WHEREFORE, Petitioners pray for the following relief:

1. That this Court, upon Petitioners' application, stay the operation of the Commission's action under 1094.5(g), pending a decision on the merits;

2. That this Court issue a Writ of Mandate compelling the Commission to vacate its approval of the Listing Petition for consideration, and to vacate the Commission's designation of the western Joshua tree as a candidate species;

3. For a judgment to be entered in favor of Petitioners consistent with the Writ of Mandate;

4. For reasonable attorneys' fees pursuant to Code of Civil Procedure section 1021.5;

5. For costs of suit; and

6. For such other relief as the Court may deem just and proper.

Respectfully submitted,

DATED: October 21, 2020

HARRISON, TEMBLADOR,
HUNGERFORD & JOHNSON, LLP

By:______________________________
Mark D. Harrison
Bradley B. Johnson
Adam K. Guernsey

Attorneys for Petitioners California Construction and Industrial Materials Association, California Business Properties Association, California Cattlemen's Association, California Manufacturers and Technology Association, High Desert Association of Realtors, and City of Hesperia

DATED: October 21, 2020

JEFFER, MANGELS,
BUTLER & MITCHELL, LLP

By: ______________________
Kerry Shapiro
Matthew D. Hinks
Daniel L. Quinley

Attorneys for Petitioners California Construction and Industrial Materials Association, California Business Properties Association, California Cattlemen's Association, California Manufacturers and Technology Association, High Desert Association of Realtors, and City of Hesperia

VERIFICATION

I, Robert Dugan, declare that I am President/CEO of CalCIMA, a named Petitioner, and am authorized to execute this Verification on behalf of Petitioners. I have read the foregoing Petition and am familiar with its contents. The facts alleged in the above Petition are true of my own knowledge.

I declare under the penalty of perjury under the laws of the state of California that the foregoing is true and correct.

Dated: October 21, 2020.

Robert Dugan, President/CEO
CalCIMA
Petitioner

APPENDIX A

PORTION OF THE ADMINISTRATIVE RECORD
INDEX

Filed pursuant to Code Civ. Proc., § 1094.5, subd. (a)

Superior Court of California
County of Fresno

California Construction and Industrial Materials Association
v.
California Fish and Game Commission

Case No.:

Exhibit #	Document	Bates #
	Listing Petition	
1	Center for Biological Diversity, A Petition to List the Western Joshua Tree (*Yucca brevifolia*) as Threatened under the California Endangered Species Act (CESA), October 15, 2019.	AR 001
	California Department of Fish and Wildlife Evaluation	
2	California Department of Fish and Wildlife, Report to the Fish and Game Commission: 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, February 2020.	AR 081
	Selected Letters in Opposition	
3	Letter from Jose Mejia to Eric Sklar, May 8, 2020.	AR 123
4	Email from Daniela Bellissimo to Eric Sklar, May 29,2020 12:03 PM.	AR 126
5	Letter from Assembly member Jeff Miller (retired) to Eric Sklar, June 11, 2020.	AR 128
6	Letter from Paul S. Weiland to Eric Sklar, June 10, 2020.	AR 130
7	Letter from Jim Radich to Eric Sklar, June 11, 2020.	AR 142
8	Letter from Shaye Diveley and Thomas Jex to Eric Sklar, June 11, 2020.	AR 145
9	Letter from Steve Harris to Eric Sklar, June 12, 2020.	AR 161
10	Letter from Douglas E. Wance to Eric Sklar, June 19, 2020.	AR 166
11	Letter from Janice Moore, et al., to Eric Sklar, July 23, 2020.	AR 171
12	Letter from CalCIMA, et al., to Eric Sklar, August 5, 2020.	AR 175
13	Letter from David Ivester to Eric Sklar, August 5, 2020.	AR 179
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15	Letter from Mark McGaughey to Eric Sklar, August 6, 2020.	AR 200
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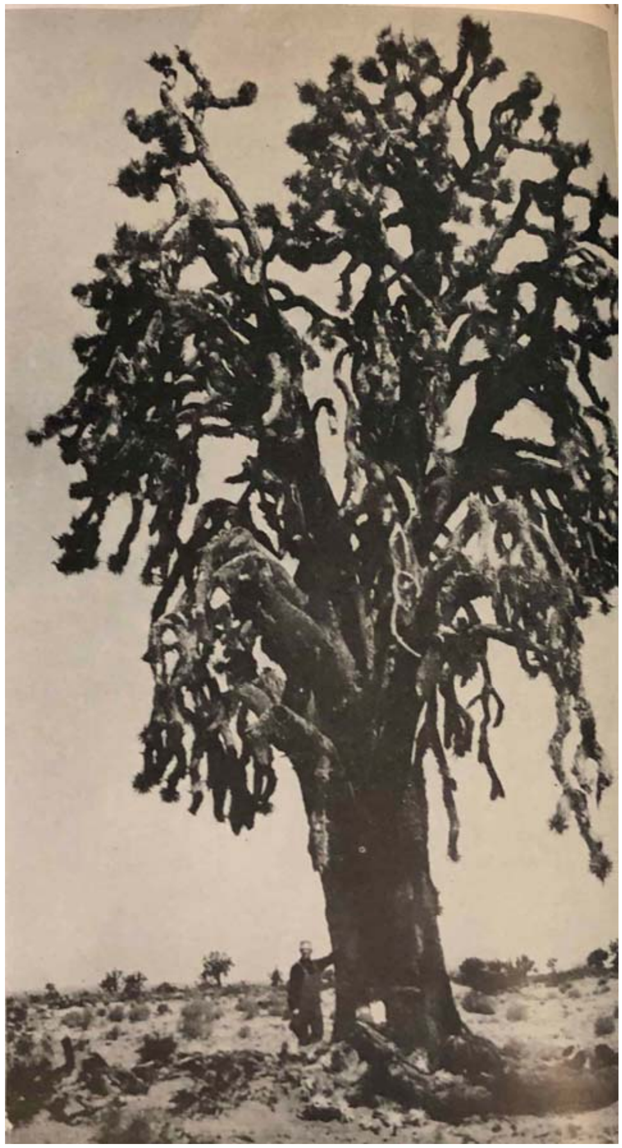
California Department of Fish and Wildlife Presentation		
20	Jeb McKay Bjerke, California Department of Fish and Wildlife (August 2020) Western Joshua Tree (*Yucca brevifolia*) [PowerPoint slides].	AR 256
California Fish and Game Commission Hearing		
21	California Fish and Game Commission. August 20, 2020 Hearing [Video]. *Available at*: https://cal-span.org/unipage/?site=cal-span&owner=CFG&date=2020-08-20.	AR 274
22	California Fish and Game Commission. September 22, 2020 Hearing [Video]. *Available at*: https://cal-span.org/unipage/?site=cal-span&owner=CFG&date=2020-09-22.	AR 276
California Fish and Game Commission Findings & Notice		
23	Cal. Reg. Notice Register 20, No. 41-Z, p. 1349.	AR 278
Selected Joshua Tree Studies Cited in Petition		
24	DeFalco, et al., *Desert Wildfire and Severe Drought Diminish Survivorship of the Long-Lived Joshua Tree* (2010) 97(2) Am. J. of Botany 243.	AR 282
25	Cornett, *Population Dynamics of the Joshua Tree (*Yucca brevifolia*): Twenty-Three Year Analysis, Queen Valley, Joshua Tree National Park* (2013), California State University 2013 Desert Symposium: Raising Questions in the Central Mojave Desert (ed. Robert E. Reynolds) 146.	AR 291
26	Cornett, *Population Dynamics of the Joshua Tree (*Yucca Brevifolia): *Twenty-Three-Year Analysis, Lost Horse Valley, Joshua Tree National Park* (2014), California State University 2014 Desert Symposium: Not a Drop Left to Drink (ed. Robert E. Reynolds) 71.	AR 296
27	Harrower and Gilbert, *Context-Dependent Mutualism in the Joshua Tree-Yucca Moth System Shift Along a Climate Gradient* (2018) 9(9) Ecosphere 1.	AR 304

EXHIBIT 1

BEFORE THE CALIFORNIA FISH AND GAME COMMISSION

A Petition to List the Western Joshua Tree (*Yucca brevifolia*) as Threatened under the California Endangered Species Act (CESA)



Center for Biological Diversity
October 15, 2019

Notice of Petition

For action pursuant to Section 670.1, Title 14, California Code of Regulations (CCR) and Division 3, Chapter 1.5, Article 2 of the California Fish and Game Code (Sections 2070 *et seq*.) relating to listing and delisting endangered and threatened species of plants and animals.

I. SPECIES BEING PETITIONED:

Species Name: Western Joshua tree (*Yucca brevifolia*) as either a full species, or as the subspecies *Yucca brevifolia brevifolia.*

II. RECOMMENDED ACTION: Listing as Threatened

The Center for Biological Diversity submits this petition to list the western Joshua tree (*Yucca brevifolia*) as Threatened pursuant to the California Endangered Species Act (California Fish and Game Code §§ 2050 et seq., "CESA"). The western Joshua tree (*Yucca brevifolia*), long recognized as a subspecies or variety (*Yucca brevifolia brevifolia*), has recently been recognized as a full species distinct from its close relative, the eastern Joshua tree (*Yucca jaegeriana*).

This petition demonstrates that the western Joshua tree is eligible for and warrants listing under CESA based on the factors specified in the statute and implementing regulations. Specifically, the western Joshua tree meets the definition of a "threatened species" since it is "a native species or subspecies of a … plant that, although not presently threatened with extinction, is likely to become an endangered species in the foreseeable future in the absence of the special protection and management efforts . . . ." Cal. Fish & Game Code § 2067.

In the event the Commission determines that full-species taxonomy is not sufficiently established, petitioners request listing of the taxa as a subspecies/variety *Yucca brevifolia brevifolia*. Additionally, while petitioners believe that the western Joshua tree warrants protection under CESA throughout its range in California, in the event the Commission determines that it does not, the Commission must assess whether either of the two population clusters of the species (denoted as *Y. brevifolia* North [YUBR North] and *Y. brevifolia* South [YUBR South] in the petition) separately warrant listing as ecologically significant units (ESUs).

Cover photo of tallest (25 m) known *Yucca brevifolia* in western Antelope Valley in 1925 from Webber (1953). The tree was burned by vandals in 1930, generating outrage and sparking early desert protection efforts culminating in the 1936 creation of Joshua Tree National Monument.

III. AUTHOR OF PETITION:

Brendan Cummings
Center for Biological Diversity
PO Box 549
Joshua Tree, CA 92252
(510) 844-7141
bcummings@biologicaldiversity.org

I hereby certify that, to the best of my knowledge, all statements made in this petition are true and complete.

Signature: ____________________________ Date: ____10/15/19___________

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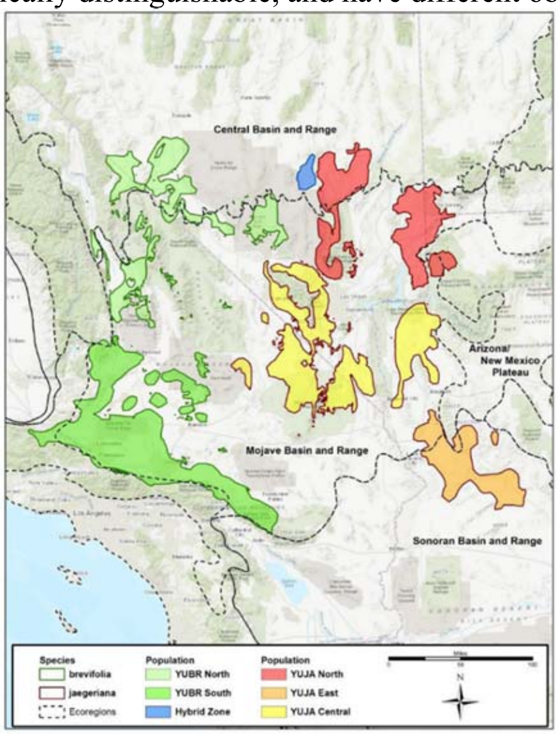
Executive Summary

The Center for Biological Diversity submits this petition to list the western Joshua tree (*Yucca brevifolia*) as Threatened pursuant to the California Endangered Species Act (CESA). This petition demonstrates that the western Joshua tree is eligible for and warrants listing under CESA based on the factors specified in the statute and implementing regulations.

Under CESA, a "threatened species" is "a native species or subspecies of a … plant that, although not presently threatened with extinction, is likely to become an endangered species in the foreseeable future in the absence of the special protection and management efforts…" A plant is an "endangered species" when it is "in serious danger of becoming extinct throughout all, or a significant portion, of its range due to one or more causes, including loss of habitat, change in habitat, overexploitation, predation, competition, or disease." While the western Joshua tree is not at imminent risk of extinction, it faces significant and growing threats, primarily from climate change, that ultimately threaten the viability of the species in all or a significant portion of its range in California; it consequently meets the definition of a "threatened species."

Long considered a single species with two subspecies or varieties, the Joshua tree has recently been recognized as comprised of two distinct species, the western Joshua tree (*Yucca brevifolia*) and the eastern Joshua tree (*Y. jaegeriana*). The two species are geographically separated, genetically and morphologically distinguishable, and have different obligate pollinators.



Both species occur in California, with the western Joshua tree having a boomerang-shaped range from Joshua Tree National Park, westward along the northern slopes of the San Bernardino and San Gabriel Mountains, through the Antelope Valley, northward along the eastern flanks of the southern Sierra Nevada and eastward to the edges of Death Valley National Park (green areas on map). The eastern Joshua tree's range in California is centered in the Mojave National Preserve (yellow areas on map).

While both the western and eastern species of Joshua tree are of conservation concern, the fate of the western Joshua tree in California is particularly alarming, as recent studies indicate that the species' range is contracting at lower elevations, recruitment is limited, and mortality is increasing, all of which would likely reflect a population already starting to decline due to recent warming. Even greater changes are projected to occur over the coming decades.

Climate change represents an existential threat to western Joshua trees. Even in the absence of climate change, the convergence of factors necessary for recruitment results in successful establishment of new seedlings only a few times in a century. Such recruitment has already largely stopped at the drier, lower limits of the species' range. Prolonged droughts, which are projected to occur with greater frequency and intensity over the coming decades, will not only preclude recruitment across ever-greater areas of the species' range, but will lead to higher adult mortality, either directly due to temperature and moisture stress or indirectly due to increased herbivory from hungry rodents lacking alternative forage. Whether or not the species' pollinating moth will be able to keep pace with a changing climate is highly questionable. The Joshua tree's ability to colonize new habitat at higher elevations or latitudes is extremely limited and no such range expansion is yet occurring, even as the lower elevation and southern edge of its range is already contracting. And there is no safe refuge, as the higher elevation areas in which Joshua trees are projected to best be able to survive increasing temperatures and drying conditions are at great risk of fire due to the prevalence of invasive non-native grasses. Absent rapid and substantial reductions in GHG emissions *and* protection of habitat, the species will likely be extirpated from all or most of California by the end of the century.

In addition to climate change and fire, the western Joshua tree is threatened by habitat loss and degradation from other human activities. The portion of the species' range where management is most protective—Joshua Tree National Park— is also the area where the early impacts of climate change are already being felt most severely. Other areas of federal land that are home to the species are subject to poorly-regulated activities including off-road vehicle use, cattle grazing, power and pipeline rights-of-way and large-scale energy projects that consume or degrade habitat. And while much of the western Joshua tree's range is on public lands, approximately 40% of its range in California is on private land, of which only a tiny fraction is protected from development. Under current growth projections, virtually all of this habitat will be lost in the coming decades absent strengthened protection under the law.

The Joshua tree has long been the most iconic species of the Mojave Desert. Given the well-publicized threats facing the species in the face of climate change, it has recently become an emblem of our society's failure to address the climate crisis. But the Joshua tree is also uniquely situated to become an example of successful action to save a species threatened by climate change. Action taken in and by California to save the species can serve as a model for proactive climate adaptation efforts not just in California but around the world. Listing the species under CESA is not just a symbolically important act of California recognizing the threats the species faces from climate change, but also can serve as the impetus for meaningful management actions that can help ensure the species remains a living icon in perpetuity.

The Western Joshua Tree Warrants Listing as Threatened under the California Endangered Species Act (CESA)

1 Introduction

This petition summarizes the available scientific information regarding the taxonomy and natural history of the western Joshua tree (*Yucca brevifolia*), its distribution and abundance in California, population trends and threats, and discusses the limitations of existing management measures in protecting the species. As demonstrated below, western Joshua trees meet the criteria for protection as "threatened" under the California Endangered Species Act (CESA) and would benefit greatly from such protection.

2 Life History

2.1 Taxonomy

Joshua tree taxonomy has long been subject to some dispute and confusion. Often referenced as being within the Families Liliaceae or Agavaceae, under the molecular-based taxonomic system developed by the Angiosperm Phylogeny Group, the species is now considered as being within the Asparagaceae (AGP IV 2016; ITIS 2019).

The Joshua tree has until recently been treated by most authorities as a single species, *Yucca brevifolia* Engelm., comprised of two varieties or subspecies, *Yucca brevifolia brevifolia* (western Joshua tree) and *Yucca brevifolia jaegeriana* (eastern Joshua tree) (ITIS 2019).[1] The two forms are for the most part geographically separated, genetically and morphologically distinguishable, and have different obligate pollinators. The two forms may be the result of allopatric speciation, though some gene flow between them has been documented in a small area in Nevada (Yoder et al. 2013; Royer et al. 2016). Lenz (2007) believed the differences in flower and fruit morphology between *Y. b. brevifolia* and *Y. b. jaegeriana* as well as each having different obligate pollinators were sufficient to recognize *Y. b. jaegeriana* as a full species, *Y. jaegeriana*.

More recent studies focused on pollinator interactions have confirmed significant morphological differences in the stylar canals of the flowers of the two forms, which correspond to differences in ovipositor length in their respective pollinators (Godsoe et al. 2008; Starr et al. 2013; Yoder et al. 2013). Smith et al. (2008) used genetic markers to determine that western and eastern Joshua trees likely diverged over 5 million years ago, which corresponds to the time when the Bouse Embayment, an extension of estuarine waters of the Gulf of California, extended into the Mojave, separating western and eastern areas (Pellmyr and Segraves 2003). Starr et al. (2013) and Yoder et al. (2013) also found genetic differentiation between the two forms but declined to recognize them as separate species.[2] Royer et al. (2016) expanded on these studies

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[1] Other previously described subspecies/varieties including *Y.b. herberti*, *Y.b. weberi* and *Y.b. wolfei* are considered synonyms of *Y. brevifolia* (ITIS 2019; Wallace 2017).

[2] Yoder et al. (2013) noted that whether *Y. b. brevifolia* and *Y. b. jaegeriana* represent full species "is heavily dependent on the species concept we use to make that judgment." Starr et al. (2013) noted that "[t]he validity of this

using molecular techniques and found "evidence for strong genome-wide patterns of divergence between the Joshua tree species" and noted their results "revealed extensive genetic differentiation between *Y. brevifolia* and *Y. jaegeriana*." Royer et al. (2016) followed Lenz (2007) and recognized *Y. brevifolia* and *Y. jaegeriana* as full species.

Most recently, in a broad review of the science regarding Joshua trees, the U.S. Fish and Wildlife Service treated *Y. brevifolia* and *Y. jaegeriana* as separate species for purposes of federal Endangered Species Act (ESA) consideration (Wallace 2017; USFWS 2018; USFWS 2019).[3] Petitioners follow Lenz (2007), Royer et al. (2016), Cole et al. (2017) and USFWS (2018) and treat *Y. brevifolia* and *Y. jaegeriana* as full species. However, since CESA provides for the protection of both species and subspecies, regardless of whether it is treated as a species (*Y. brevifolia*) or subspecies (*Y. b. brevifolia*), the western Joshua tree is eligible for and warrants listing under the statute.

2.2 Species Description[4]

The earliest known written description of the Joshua tree is an unflattering entry in the Fremont Report in which it was noted that "their stiff and ungraceful form makes them to the traveler the most repulsive tree in the vegetable kingdom . . .'' (Fremont 1845). Over time, Joshua trees became increasingly more appreciated, with Griffin (1930) referring to them as "one of the outstanding plants of the desert," Runyon (1930) characterizing them as "grotesque in the extreme…yet they are magnificent," Little (1950) somewhat undecidedly calling them "picturesque or grotesque," and Jaeger (1965) calling them "at once the most spectacular and most characteristic tree of the Mohave Desert."

More technically, the Jepson Flora describes Joshua trees as follows:

> *Habit*: Plant 1--15 m. *Stem*: erect, above ground, generally branched above, rosettes at tips, well above ground. *Leaf*: 15--35 cm, 0.7--1.5 cm wide, dark green, expanded base 2--4 cm, 4--5 cm wide, +- white, margins minute-serrate, yellow. *Inflorescence*: 3--5 dm, distal generally +- 1/2 exserted from rosettes. *Flower*: erect; perianth 4--7 cm, +- bell-shaped, parts lanceolate to oblong, +- fused at base, cream to +- green; filaments thick; pistil +- 3.5 cm. *Fruit*: capsule, spreading to erect in age, 6--8.5 cm, ellipsoid, dry, spongy, or leathery in youth. (Hess 2012).

Among the numerous natural history accounts of the Joshua tree, Gucker (2006), prepared for the U.S. Forest Service and readily available online,[5] is among the most comprehensive. The following is largely adapted from Gucker (2006).

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designation [two species] is not yet certain, and here, we conservatively refer to the two morphotypes as subspecies."

[3] As discussed *infra*, while the taxonomic and other life history discussions in USFWS (2018) represent a comprehensive summary of the available science, the threats analysis in the document is highly problematic and shows some evidence of political interference driving its ultimate conclusions.

[4] Because the bulk the scientific literature cited in this petition treats Joshua trees as a single species without distinction between *Y. brevifolia* and *Y. jaegeriana*, this petition generally refers just to the "Joshua tree," highlighting difference between the two taxa where appropriate.

The Joshua tree is a 5 to 20 meters tall, evergreen, tree-like plant. Trees exceeding 10 meters are rare. Tree size and growth form vary with site and climate conditions, as well as between the two species. *Y. brevifolia* typically have one main stout stem or trunk that measures 0.3 to 1 meter in diameter and have an expanded base. *Y. jaegeriana* typically have multiple stems. Trunks are fibrous, and the bark or periderm is soft and cork like. Bark plates measure 7.5 to 15 cm long and 2.5 to 5 cm in thickness. (Gucker 2006).

Figure 1. Western Joshua tree (*Yucca brevifolia*) and Easter Joshua tree (*Yucca jaegeriana*).

Older plants generally have extensive branching. Young trees typically lack branches and are covered with persistent reflexed leaves. Trees normally reach 1 to 3 meters tall before branching. Branches are 2 to 5 meters and fork at 0.5 to 1-meter intervals. Inner branches are typically erect, and outer branches can be horizontal or drooping. (Gucker 2006).

Leaves are clustered in rosettes at the branch ends. Clusters are commonly 0.3 to1.5 meters long and 0.3 to 0.5 meters in diameter. Leaves are linear, needle shaped and measure 15 to 35 cm long by 0.7 to 1.5 cm wide, with enlarged bases attaching them to the branch. Leaf shape is slightly triangular and leaf margins are lined with small teeth. Spines measuring 7 to 12 mm occur at the leaf tips. Leaf clusters are longer (1-1.5 meters) on juvenile plants than on mature plants (0.3-1 meters). Outer leaf layers are thick and waxy to reduce water loss. Dead leaves are persistent and fold down, covering the branches and coating the trunks of young trees. (Gucker 2006).

Joshua tree flowers occur in dense, heavy panicles that measure 20 to 40 cm long. Individual flowers are round to egg shaped and measure 2.5 to 5 cm wide. Flowers have a musky scent, with the early botanist Trelease (1893) describing the smell as “so oppressive as to render

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[5] https://www.fs.fed.us/database/feis/plants/tree/yucbre/all.html

the flowers intolerable in a room." Fruits are indehiscent capsules, which become spongy and dry with age. Egg-shaped capsules are 6 to 10 cm long and approximately 5 cm in diameter. Fruits develop at the base of the inflorescence while the upper portion is still in flower. Mature fruits contain 30 to 50 black seeds, which are flat to thickened with smooth to undulate surfaces. Seeds are 7 to 11 mm long. (Gucker 2006).

Figure 2. *Yucca brevifolia* fruit and seeds.

The two species of Joshua trees are morphologically distinguishable. *Y. jaegeriana* is sometimes referred to as dwarf Joshua tree as it is often smaller (3-6 meters tall), with shorter leaves (<22 cm) and shorter branches (0.7-1 meter) compared to *Y. brevifolia*. *Y. brevifolia* is less stocky, often 5 to 12 meters tall, with longer leaves (19-37 cm) and higher branches (2-3 meters above ground) compared to *Y. jaegeriana*. *Y. jaegeriana* displays true dichotomous branching while *Y. brevifolia* is not truly dichotomous. (Gucker 2006).

Lenz (2007) described the vegetative differences between the two species as follows:

> *Yucca brevifolia* s.s. is arborescent with a distinct trunk and, usually, stout branches; *Y. jaegeriana* is generally smaller and branched from near the base, the branches somewhat slender. The two possess dissimilar patterns of branching, *Y. brevifolia* having pseudodichotomous (monopodial) branching; *Y. jaegeriana,* until flowering, has true dichotomous branching. The species differ in leaf length; *Y. brevifolia* having leaves 15–35 cm long, those of *Y. jaegeriana* 10–20 cm. Leaf length is variable, depending at least in part on environmental conditions. (internal citations omitted)

Additionally, Lenz (2007) noted the differences in flower morphology between *Y. brevifolia* and *Y. jaegeriana*:

> Flowers of *Y. brevifolia* are nearly globular or depressed globular, the broadly ovate, fleshy, cream-colored perianth segments are strongly incurved, and the flowers never fully expand. Flowers of *Y. jaegeriana* are narrowly campanulate, conspicuously swollen at the base, somewhat constricted above, and the narrowly oblong perianth

segments are usually greenish, and recurved at their tips. The ovaries of *Y. brevifolia* are conical and taper from the base; those of *Y. jaegeriana* are lance-ovoid. Fruits of *Y. brevifolia* are ovoid to broadly ovoid; those of *Y. jaegeriana* are ellipsoid.

Figure 3: Flowers of *Y. brevifolia* (L) and *Y. jaegeriana* (R) above a 6" ruler. Source: Lenz 2007.

Studies on flower morphology in the context of pollination have concluded that the statistically greatest discernable difference between *Y. brevifolia* and *Y. jaegeriana* is in the length of the stylar canal—the path through which the female yucca moth inserts her ovipositor when laying eggs (Godsoe et al. 2008; Starr et al. 2013).

According to Warren et al. (2016), flower panicles grow primarily at the tips of branches that are oriented to the south, and when on branches that are not oriented in a southerly direction, the flower panicles themselves tend to bend or tilt toward the south. Such orientation may provide energetic and/or pollinator benefits (Warren et al. 2016).

2.3 Reproduction and Growth

Joshua trees reproduce both sexually and asexually, although patterns of sexual and clonal reproduction have not been thoroughly investigated (Sweet et al. 2019).

2.3.1 Asexual reproduction

Asexual reproduction is by rhizomes, branch sprouts, and/or basal sprouts. Rhizome production and clonal growth can be triggered by stem damage as well as certain environmental conditions. Dormant buds beneath the periderm may grow when older stems are bent or injured. Joshua trees with extensive rhizome growth and clonal form are typically shorter and have less branching than single-stemmed trees. In some cases, basal buds do not develop into distinct rhizomes, and stems grow adjacent to the main stem as sprouts. (Gucker 2006).

Some Joshua tree populations are largely if not entirely clonal, including in the Liebre Mountains and along the southern and western slopes of the Tehachapi Mountains. In these areas Joshua trees can occur in clumps nearly 30 feet (8 m) in diameter, with 30 to 40 trunk-like stems. A single clone in Gorman Creek was determined to occupy approximately one acre (0.4 ha) and was comprised of several hundred stems (Gucker 2006). Joshua trees with this growth form were previously classified as *Y. b.* var. *herbertii* (Webber 1953)(Figure 4) but are now known to be a clonal form of *Y. brevifolia* (ITIS 2019).

Figure 4: Type specimen of *Y. b.* var. *herbertii* in western Antelope Valley in 1946. Source: Webber (1953)

The extent of cloning apparently increases with increased elevation, with Joshua trees in low-elevation dry areas rarely forming more than 1 or 2 stems, but 2 to 3 stems are common, and some clumps are found, in higher, moister areas. A mix of temperature, high winds and abundant snowfall, as well as fire, may be the causal mechanisms of higher levels of Joshua tree cloning. (Gucker 2006). In a study following a large fire in Joshua Tree National Park in 1999, DeFalco et al. (2010) found that 33% of plants that were censused in burned areas sprouted from the root crown or stem after the fire compared with 15% in unburned areas. Recently, Harrower and Gilbert (2018) found enhanced clonality and lack of seedling recruitment on the lower elevation margins of the Joshua tree range in addition to the previously reported prevalence of cloning at higher elevation sites.

2.3.2 Sexual reproduction

Sexual reproduction of Joshua trees is by seed production. As described above, bisexual flowers occur in dense, heavy panicles that measure 20 to 40 cm long. Individual flowers are round to egg shaped and measure 2.5 to 5 cm by 1to 2 cm wide.

Esque et al. (2015) noted that while flowering has been observed in Joshua trees as small as 1 meter in some areas, trees that were over 30-years old at their study site had yet to flower. Flowering is considered episodic and rare, generally occurring only in wetter years (Gucker 2006). Reports differ on timing of flowering, with, for instance, Hess (2012) indicating April and May, Waitman et al. (2012) stating February through March, and Harrower and Gilbert (2018) indicating between February and April. Recently, Cornett (2018) reported an apparently unprecedented flowering event in November, following heavy October rains and warmer than usual temperatures immediately thereafter.

Irrespective of timing, Joshua tree flowers require insect pollination to produce seeds.

Pollination and seed production

Joshua tree, as with almost all yuccas, have an obligate pollination mutualism with yucca moths (Lepidoptera, Prodoxidae). Female moths carry pollen to Joshua tree flowers in specialized mouthparts, inject eggs into the floral ovaries using a bladelike ovipositor, and then actively apply pollen to the stigmatic surface to fertilize the flower. As a Joshua tree flower develops into a fruit, the moth eggs hatch and the emerging larvae eat a portion of the developing seeds. The moths are the sole pollinators of Joshua trees, and in turn, the Joshua tree seeds are the only food source for the moths (Pellmyr and Segraves 2003; Yoder et al. 2013).

Joshua trees are now known to be pollinated by two species of moth, *Tegeticula synthetica* and *T. antithetica*, the latter only described in 2003 by Pellmyr and Seagraves. Outside of the narrow region in Nevada where *Y. brevifolia* and *Y. jaegeriana* are sympatric and hybridize, *T. synthetica* is the sole pollinator of *Y. brevifolia* and *T. antithetica* is the sole pollinator of *Y. jaegeriana*. While *T. synthetica* is about 30% larger than *T. antithetica*, the apparently more important difference in the two moths is the size of their ovipositors, with the difference in length of each matching the difference in the length of the stylar canal of their respective host plants, with the ovipositor of the western moth (*T. synthetica*) being about 50% larger than that of the eastern species (*T. antithetica*) (Pellmyr and Segraves 2003; Godsoe et al. 2008).[6]

The parallel differences between stylar canal length and ovipositor length between the two species of moths and two types of Joshua tree suggest that selection exerted by their pollinators is the best explanation for the morphological divergence of the trees. Since the female moth's ovipositor must be long enough to reach the ovules but not so long as to injure them, coevolution acting upon moth and tree should favor matching between the length of the moth's ovipositor and the flower's stylar canal (Godsoe et al. 2008; Yoder et al. 2013; Cole et al. 2017). Using molecular clock techniques, Pellmyr and Segraves (2003) concluded that the two moths diverged approximately 10 million years ago, while Smith et al. (2008) later determined that the split between the moth species likely occurred 1.14 million years ago.

[6] In addition to the pollinating *Tegeticula* moths, bogus yucca moths of the sister genus *Prodoxus* also lay their eggs in Joshua tree flowers. Adult Prodoxus lack the specialized mouthparts used for pollination and the larvae feed on plant tissues other than seeds (Althoff et al. 2004).

Studies in Tikaboo Valley in Nevada where both the two moth species and the two types of Joshua trees are sympatric demonstrate that *T. antithetica* can successfully fertilize *Y. brevifolia* and reproduce in their fruits, but *T. synthetica* do not successfully rear larvae on *Y. jaegeriana* (Smith et al. 2009; Starr et al. 2013; Yoder et al. 2013). Consequently, gene flow is largely unidirectional, with flow from *Y. jaegeriana* into *Y. brevifolia* but not from *Y. brevifolia* into *Y. jaegeriana* (Starr et al. 2013).

Once pollinated, fruits form in early summer and seeds are mature in mid-summer (Waitman et al. 2012). Fruits are indehiscent capsules, which become spongy and dry with age. Egg-shaped capsules are 6 to 10 cm long and approximately 5 cm in diameter. Fruits develop at the base of the inflorescence while the upper portion is still in flower. Mature fruits contain 30 to 50 black seeds, which are flat to thickened with smooth to undulate surfaces. Seeds are 7 to 11 mm long. (Gucker 2006).

Seed predation and dispersal

While *Tegeticula* moths are necessary for pollination, their larvae are the first predators that Joshua tree seeds experience. In one study, the range of larvae per fruit was 0 to 6, with an average of 1.4. These larvae consumed or damaged 7% of seeds (Keeley et al. 1985). Borchert and DeFalco (2016) found much higher levels of larvae predation, with 19.5% damaged in a year of widespread fruiting and 42.8% damaged in a subsequent year of reduced flowering and fruiting. Seed production was more than 100 times greater in the first year of the study, leading the authors to speculate that Joshua trees may be a masting species.

Just as a portion of a Joshua tree's seed production goes to its pollinator, a large percentage of its seed production goes to its primary dispersers, various scatter-hoarding rodents. Among the current consumers (and likely dispersers) of Joshua tree seeds in California are the white-tailed antelope squirrel (*Ammospermophilus leucurus*), Mojave ground squirrel (*Xerospermophilus mohavensis*) and California ground squirrel (*Otospermophilus beecheyi*), all of which are known to climb Joshua trees to remove the fruits for later consumption and/or to eat through the desiccated fruits in situ to reach the seeds (Lenz 2001). Once fruits are on the ground, numerous other species will dismantle the fruits and eat and/or cache the seeds, including the round-tailed ground squirrel (*Xerospermophilus tereticaudus*), rock squirrel (*Otospermophilus variegatus*), Merriam's kangaroo rats (*Dipodymus merriami*), canyon mice (*Peromyscus crinitus*) and woodrats (*Neotoma sp.*) (Lenz 2001; Vander Wall et al. 2006; Waitman et al. 2012; Borchert and DeFalco 2016). Among these species, the white-tailed antelope squirrel and Merriam's kangaroo rats have been identified as the most frequent agents of seed removal and caching (Waitman et al. 2012; Borchert and DeFalco 2016).

Studies by Vander Wall et al. (2006), Waitman et al. (2012) and Borchert and DeFalco (2016) have all highlighted the importance of seed dispersal by scatter-hoarding rodents. In the study by Vander Wall et al. (2006), more than 99% of tracked seeds were removed by rodents from placement below Joshua trees, with 84% found in rodent caches at a mean maximum distance of 30 meters. Subsequent surveys found 46% of caches intact, 51% of caches missing entirely, a handful of caches largely empty but with a few remnant seeds below ground and numerous new secondary caches established. Over the subsequent months, rodents ate most of the cached seeds. Ultimately, well under 1% of cached seeds were documented as eventually germinating from identified caches the following spring. Nevertheless, Vander Wall et al. (2006) concluded that "the dismantling of yucca pods by rodents is very important because there is no other known mechanism for Joshua tree seeds to exit the indehiscent seed pods," and "that seeds that are not harvested by seed-caching rodents probably have no chance of establishing a seedling."

While a rodent eats the vast majority of the seeds it removes from a Joshua tree fruit, it also acts as the primary seed disperser, moving seeds upwards of 50 meters from the source tree (Vander Wall et al. 2006; Waitman et al. 2012; Borchert and DeFalco 2016). Waitman et al. (2012) concluded that rodents not only disperse seeds, but also, via the act of caching them, increase the likelihood of germination as seeds that have been buried in soil have a much greater chance of establishing seedlings than those left on the soil surface. Consequently, the Joshua tree's relationship with the predating rodent, which liberates its seeds from an otherwise inescapable pod, disperses them, and caches many where they have a higher chance of germination, may, as with the pollinating moth, be one of obligate mutualism (Vander Wall et al. 2006; Waitman et al. 2012).[7]

Waitman et al. (2012) also noted the limitations of the mutualistic relationship between Joshua trees and rodents, as it requires sufficient seed production such that the caching rodent collects more seeds than it can eat: "Small seed crop size along with an overabundance of rodents may shift this interaction from mutualism toward seed predation by rodents." Given seed production is apparently greatest in wetter years, in drought years virtually all seeds may be consumed by rodents, resulting in no seedlings being produced that year.

While almost all authors recognize the current importance of rodent seed dispersal, several have hypothesized that the large effort in fruit production by Joshua trees without a specialized dispersal agent may indicate that current fruit production is an evolutionarily relict designed to attract a now extinct megaherbivore dispersal agent, with Cole et al. (2011) identifying ground sloths and Lenz (2001) suggesting Columbian mammoths. Cole et al. (2011) note that evidence supports "the concept that the species' current mobility is constrained by the earlier extinction of the Shasta ground sloth and other possible seed vector(s)." However, Waitman et al. (2012) discount the role of the sloths in seed dispersal and conclude that "seed-caching rodents are responsible for seed dispersal today, and we suspect that they were an important, if not the sole, means of dispersal in the past."

Additionally, several authors have identified wind as an important seed dispersal agent (*e.g.* Lenz 2001, citing earlier accounts), with Gucker (2006) noting that as fruits become overmature, skins crack and moisture is released, making fruits lighter and more easily wind dispersed, and that finding clumps of 2 or more seedlings is likely evidence that the dried fruits

[7] However, unlike the Joshua tree's relationship with *Tegeticula* moths, where both tree and moth absolutely need each other to successfully reproduce, the tree's relationship with the rodent is more one-sided; the Joshua tree may be dependent upon the rodent to disperse its seeds, but the rodent – while certainly benefiting from the tree's seeds – can generally subsist on other food sources in its absence.

were wind dispersed. The largest known modern dispersal distances for Joshua trees of 151 meters in the Antelope Valley and 251 meters in Lanfair Valley were recorded by Lenz (2001) and ascribed to wind. However, Waitman et al. (2012), based upon wind tunnel tests of fruits and seeds, discount wind dispersal of seeds as playing a significant role for Joshua tree reproduction.

As further discussed *infra*, whether by wind or rodents, seed dispersal of Joshua trees is generally considered quite limited, likely constraining the ability of the species to extend it range in response to changing conditions (Lenz 2001; Cole et al. 2011).

<u>Germination and growth</u>

In laboratory conditions, Joshua tree seeds germinate readily and do not require any pretreatment (Gucker 2006). Waitman et al. (2012) had germination rates of 99% on freshly harvested seeds, while other experiments had germination rates of 98% and 72% after 6 months and 1.5 years of storage, respectively (Gucker 2006).

Longevity of viable seeds in the soil seed bank is limited. Waitman et al. (2012) reported that "a small fraction of seeds" emerged the year following their experiment, indicating that in some circumstances viability is at least two years. Reynolds et al. (2012) observed that seeds in the ground "rapidly lost germinability through time. Longevity of seeds in the soil declined by about 50% per year, which indicates that *Y. brevifolia* has little capacity for seed dormancy." Borchert and DeFalco (2016) noted that in most years when fruit production is enough to satiate predation by larvae and rodents, uneaten fruits may remain on the tree and "may function as a viable aerial seed bank well after fruit maturation," since seed germinability is likely longer in an intact fruit than in the soil.

Notwithstanding very high laboratory germination rates, seedling production in the field is extremely low. Of the 1000 seeds tracked by Vander Wall et al. (2006), 836 were cached by rodents, but only three of these were documented to ultimately produce seedlings. Of seeds planted in artificial caches in enclosures that precluded rodent harvest, only 14.8% germinated (Vander Wall et al. 2006). In another enclosure study, Waitman et al. (2012) reported only 3.2% of cached seeds produced seedlings in the field, while 36% of pots in an artificial growing chamber produced seedlings. Buried seeds, both in the field and laboratory, were most likely to produce emergent seedlings when 1 to 3 cm deep, depths similar to the caches rodents were observed making (Waitman et al. 2012). Both Vander Wall et al. (2006) and Waitman et al. (2012) reported higher seedling emergence rates from caches under shrub cover. However, both studies also found that rodents cache seeds without regard to shrub cover.

Reynolds et al. (2012) described the climate conditions supporting emergence and postulated that "there are fewer opportunities of emergence in the far western Mojave Desert, and under the current climate regime *Y. brevifolia* in that area may be most vulnerable to demographic change resulting from low and infrequent recruitment and may already have occurred." Subsequent studies (*e.g*. Sweet et al. 2019) have demonstrated that this demographic change due to low recruitment is already underway.

Once a seedling emerges, it faces a long, arduous path to adulthood, with high mortality until it exceeds 25 cm in height (Esque et al. 2015). Survival of seedlings requires periods of cool temperatures, little to no herbivory, summer rain, and some amount of yearly precipitation over a period of several years (USFWS 2018).

Growth rates are dependent on factors ranging from age, precipitation, presence of nurse plants, temperature and (at least in labs) photoperiod (Gucker 2006). Over the years various studies have indicated differing rates of growth. In one study in Joshua Tree National Park, unbranched seedlings grew at an average rate of 7.6 cm/year for the first 10 years and an average of 3.8 cm/year thereafter, with other studies showing annual growth rates of was 5.9 cm/year and 11.7 cm/year (Gucker 2006). More recently, Esque et al. (2015) measured a long-term mean annual growth rate of 3.12 ± 1.96 cm over 22 years and noted that long-term growth rates in other contemporaneous studies elsewhere in the Mojave were comparable.

Lab studies suggest that cold periods are required for optimal seedling growth, as 3-year old seedlings kept at 4 °C for 2 months produced twice as many new leaves after the cold treatment as seedlings without the cold treatment. Other lab experiments suggest that day length affects the growth of seedlings, with seedlings exposed to 10 hours of daylight producing the longest and most leaves, while seedlings grown in 16 hours of daylight produced the shortest and fewest leaves (Gucker 2006).

Perhaps the most important factor in seedling survival and growth is the presence of nurse plants. Several studies have found successful seedling emergence tied to shrub cover (Bittingham and Walker 2000; Vander Wall et al. 2006; Waitman et al. 2012), with blackbrush (*Coleogyne ramississima*) generally noted as the most important nurse plant. The benefits of a shrub canopy for a young Joshua tree include increased soil moisture, decreased insolation, reduced soil temperatures, decreased evapotranspiration, increased nutrients, decreased herbivory, and/or lower wind desiccation (Bittingham and Walker 2000; Gucker 2006).

Figure 5: Young Joshua tree emerging from nurse plant.

Once established, a Joshua tree is relatively long-lived. However, aging a Joshua tree or determining maximum lifespan is difficult as the plants lack annual growth rings. While one early report of a 20-meter tall Joshua tree estimated the plant to be 1000 years old (Little 1950), most early studies postulated that large trees can be 300 years old with an average life span of 150 years (Gucker 2006). More recent studies based on growth rate and long-term monitoring have reached similar conclusions. Gilliland et al. (2006), based upon growth rates generated from a 14-year census of a Joshua tree woodland, estimated that the oldest tree was 321 years, with mean age of trees of 62.2 years. Estimates based on observed patterns of survivorship produced similar results, with a median life expectancy of 89 years, with 5% of the population projected to reach 383 years. Esque et al. (2015) estimated a generation time of 50-70 years based on data collected during a 22-year study.

Summing up reproduction and recruitment by Joshua trees, Esque et al. (2015) highlighted the challenges Joshua trees face:

> [R]ecruitment of *Y. brevifolia* requires a convergence of events, including fertilization by unique pollinators, seed dispersal and caching by rodents, and seedling emergence from a transient seed bank triggered by isolated late-summer rainfall. Alignment of these convergent events likely results in successful establishment of new seedlings only a few times in a century. (internal citations omitted)

As further discussed *infra*, the Joshua tree's recruitment challenges make the species particularly vulnerable to climate change.

2.4 Habitat Requirements

Joshua trees occur in desert grasslands and shrublands in hot, dry sites on flats, mesas, bajadas, and gentle slopes in the Mojave Desert (Gucker 2006). Soils in Joshua tree habitats are silts, loams, and/or sands and variously described as fine, loose, well drained, and/or gravelly, while the plants can reportedly tolerate alkaline and saline soils (Gucker 2006). Cole et al. (2011) characterizes populations as discontinuous and reaching their highest density on the well-drained sandy to gravelly alluvial fans adjacent to desert mountain ranges.

Lenz (2001) reports that plants tolerate temperatures of -25°C to 51°C and annual precipitation ranges of 98 to 268 mm. According to USFWS (2018), the temperature range for western Joshua trees ranges from a low of -8.1°C to a mean summer high of 37.2°C and the species occurs in areas averaging more than 82 mm of rainfall and less than 738 mm of rainfall per year. Went (1957), based on field observations and laboratory experiments, noted that non-juvenile Joshua trees required annual exposure to low temperatures for optimal growth. Turner (1982) postulated that such a need for cold winter temperatures may explain why Joshua trees are largely limited to the higher and cooler periphery of the Mojave.

Temperature and precipitation are likely the prime constraints on the species, with Cole et al. (2011) noting that "the northern portion of Joshua tree's range is spatially limited by extreme winter cold events, but at lower elevations it is limited by extreme high temperature events in summer or winter. Mean precipitation patterns primarily limit the range from the east and west, as well as above and below its elevational range during various portions of the year. Low late-spring (April and May) precipitation seems to prevent Joshua tree from growing in lower elevation portions of the Mojave Desert." Temperature and precipitation requirements are further discussed *infra* with regard to climate impacts on the species.

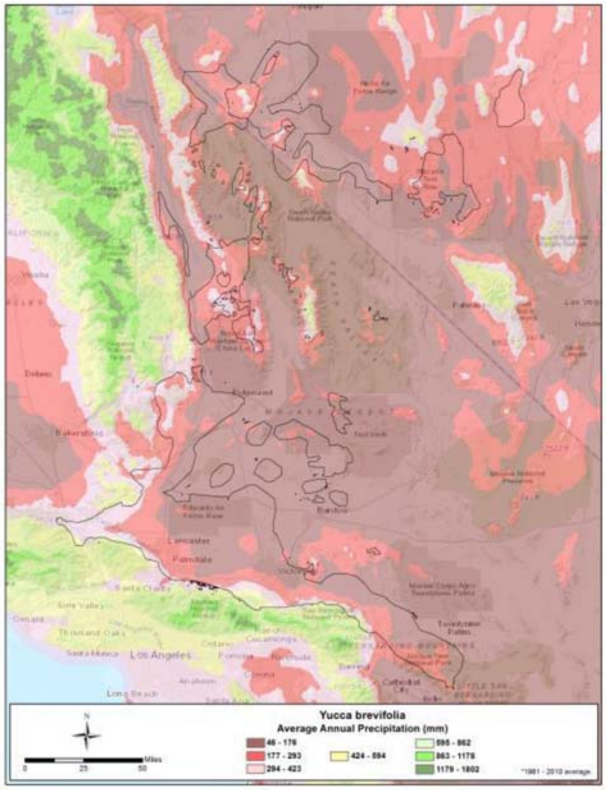

Figure 6. Average annual precipitation in range of *Y. brevifolia* (USFWS 2018).

The reported upper and lower elevation limits of Joshua trees vary significantly in the published literature (Gucker 2006). The recent Species Status Assessment by USFWS (2018) is based upon a comprehensive review of distribution records and describes the elevational range for *Y. brevifolia* as 750 meters (2461 ft) up to 2200 meters (7218 ft), and between 600 meters (1969 ft) and 2000 meters (6500 ft) for *Y. jaegeriana*.

Joshua trees are not restricted to any one desert scrub or xeric woodland community and can be found in many different plant alliances throughout their range (Turner 1982). For example, within Joshua Tree National Park, Harrower and Gilbert (2018) characterized their study area of Joshua trees as encompassing four broad eco-regional vegetation types: Sonoran–Colorado Desert scrub, Mojave–Sonoran creosote bush scrubland, Mojave mid-elevation desert, and pinyon–juniper woodland.

While Joshua tree habitat may not be limited by particular plant associations, as discussed *supra*, for successful reproduction and recruitment, Joshua trees require the presence of their obligate pollinator, rodents to disperse and cache seeds and nurse plants to shelter emerging seedlings.

3 Current and Historical Distribution

The current range of Joshua trees (both species)[8] extends from northwestern Arizona to southwestern Utah west to southern Nevada and southeastern California at elevations between 600 and 2200 meters of elevation and between 34° to 38° latitude (USFWS 2018). The current range of the Joshua tree is but a small fraction of its range during the late Pleistocene.

Plant material from Shasta ground sloth dung and packrat middens indicates that during the Pleistocene the Joshua tree had a much larger southern distribution extending well into the Sonoran Desert, where it range may have encompassed La Paz, Maricopa, Pinal, Yuma, and Pima counties in Arizona; Imperial and Riverside counties in California; mainland Mexico; and northern Baja California, Mexico (Cole et al. 2011) (Figure 7).

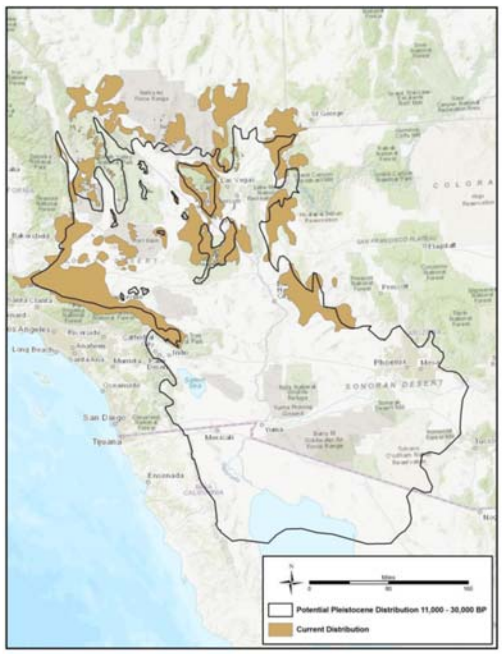

Figure 7: Current and Pleistocene range of the Joshua tree. Source: USFWS (2018), based on Cole et al. (2011).

The Joshua tree's historical range contracted northward along the southern edge of its range as climates warmed at the start of the Holocene. As noted by Cole et al. (2011), this contraction was not matched by northward expansion:

> Although the rapidly warming climate of the early Holocene would seem to have opened up vast new areas of potential range to the north, the fossil record does not record any significant northward expansion over the last 11,700 years.

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[8] Because the split of Joshua trees into two species has only recently been recognized, much of the literature describing their past and present range does not explicitly distinguish between the two. The current range of *Y. brevifolia* is readily discernable from that of *Y. jaegeriana* and is described *infra*. However, while the historic range of Joshua trees is broadly known from subfossil records, the portion of that range that is ascribable to each species has yet to be determined.

Cole et al. (2011) ascribed the lack of northward expansion to the Joshua tree's extremely limited dispersal ability, potentially a result of the extinction of the Shasta ground sloth which may have been a primary seed disperser for the species.

Since the end of the Pleistocene, the Joshua tree's distribution has been remarkably stable throughout the Holocene into the present day (Cole et al. 2011; Holmgren et al. 2010).

There are currently five regional populations of Joshua trees distributed across the Mojave, southern Great Basin, and western Sonoran Deserts, with the vast majority of trees occurring within the Mojave.[9] Of the five populations, two are of *Y. brevifolia* and three of *Y. jaegeriana*, with a sixth small hybrid population in Tikaboo Valley, Nevada. One of the *Y. brevifolia* populations is entirely in California (YUBR South in Figure 8), while the other is shared with Nevada (YUBR North in Figure 8). Only one of the three *Y. jaegeriana* populations occurs in California (primarily in the Mojave National Preserve), and this population is shared with Nevada and Arizona (YUJA Central in Figure 8) (USFWS 2018).

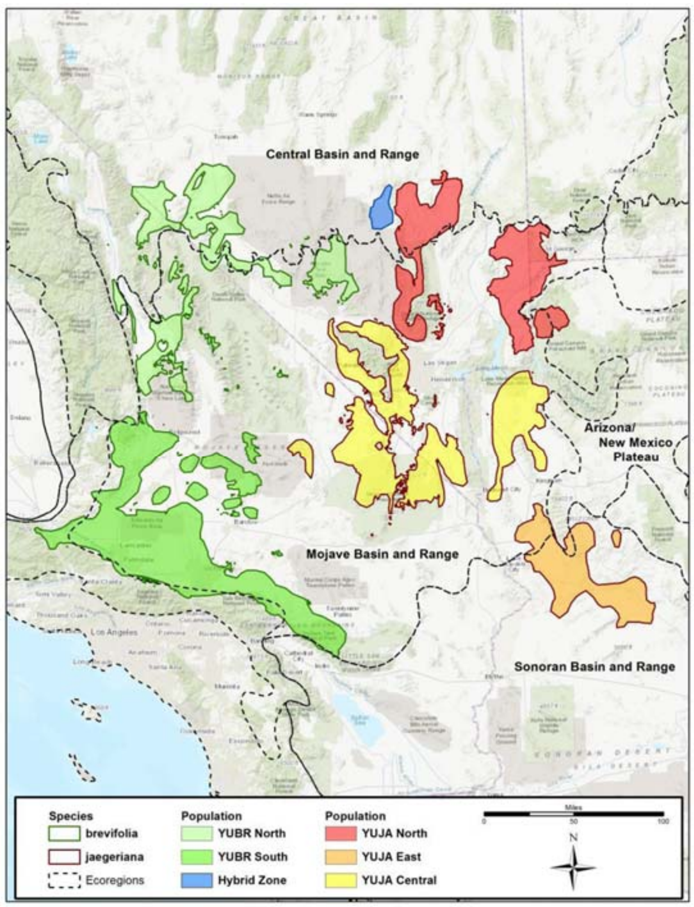

Figure 8. Current Joshua tree distribution. Source: USFWS 2018.

[9] While numerous published studies have characterized the range of Joshua trees, USFWS (2018) is the most complete synthesis of range data; consequently, petitioners cite primary to that document in this section.

Y. brevifolia occurs almost exclusively in the Mojave Desert in unevenly distributed populations. A small portion of its northern extent occurs within the Great Basin Desert (Figure 8). The primary distinguishing feature of these two desert regions is the presence of creosote bush in the Mojave Desert and Sagebrush steppe in the Great Basin. The southern extent of *Y. brevifolia's* range is in the Little San Bernardino Mountains of Joshua Tree National Park. The northern extent of its range is near Alkali, Nevada. The western extent is near the Hungry Valley State Vehicular Recreation Area near Gorman, California. The eastern extent of its range is in Tikaboo Valley, Nevada, where it co-occurs with *Y. jaegeriana* (USFWS 2018).

USFWS (2018), treats *Y. brevifolia* as comprised of two geographically separate populations, (YUBR) South and YUBR North.[10] YUBR South is entirely within California. This population occurs within the area stretching from Joshua Tree National Park, north to Ridgecrest and Red Mountain. This area is comprised of alluvial plains, fans, and bajadas of the major valleys lying between scattered mountain ranges. On the southern and western edge of the population boundary, *Y. brevifolia* occurs in transitional areas characterized by higher elevations and more rainfall with semi-desert montane chaparral to pinyon-California juniper woodlands. There is some variation in vegetation from north to south, but the basins typically are dominated by creosote bush (*Larrea tridentate*) and white bursage (*Ambrosia dumosa*) and the higher elevations are characterized by junipers and pinyons (USFWS 2018).

In the YUBR South range, average annual rainfall varies between 82.4 mm and 738.1 mm and minimum temperatures range from -5.7°C at the upper elevational limit (2200 meters) to 4.8°C at the lower elevational limit (750 meters). Mean summer high temperature are between 23.4–37.2°C. Less than 10 percent of annual precipitation occurs in summer in most areas occupied by *Yucca brevifolia* (USFWS 2018).

The geographic area in which YUBR South is situated is comprised of 3.7 million acres, with just over 50% in private ownership, 48% federally owned, and just under 2% state, county and local owned (USFWS 2018). USFWS (2018) estimates that 3,255,088 acres of this area was suitable for Joshua trees based on soils and other habitat factors.[11] However, Joshua tree do not occupy the entirety of this area, as they can have a patchy and disjunct distribution. Notably, the Bureau of Land Management's (BLM's) calculation of Joshua tree woodland on lands under its jurisdiction is substantially less than this larger area estimated by USFWS (2018). USFWS (2018) mapped 841,220 acres within the area of YUBR South as on BLM lands. BLM (2006) itself calculated that only 3275 acres of "Joshua tree woodland" occur on its lands in the West Mojave Plan (WEMO) area, which includes all of YUBR South. While this extreme difference between the two estimates is partly attributable to Joshua trees occurring in other plant community types that occupy much larger areas (e.g. "blackbrush scrub" and "creosote bush scrub"), it does highlight that areas of dense concentrations of Joshua trees occupy a relatively small fraction of the larger mapped areas.

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[10] As discussed *infra*, each of these populations may constitute an evolutionarily significant unit (ESU).

[11] A peer reviewer of USFWS (2018) pointed out that "the potential distribution of Joshua tree under current climate conditions is vastly overestimated" (Smith 2018). This is discussed in greater detail in the section of the federal ESA listing decision, *infra*.

Additionally, the cities of Palmdale, Lancaster, Hesperia, Victorville, and Yucca Valley, as well as numerous smaller communities are within the mapped YUBR South area. While *Y. brevifolia* currently persists in the less-developed areas of these communities, it is absent from the more developed areas as well as the agricultural lands in the region. The Antelope Valley, where the largest of these cities are situated, is the area where the greatest habitat loss of *Y. brevifolia* has already occurred.

The YUBR North population occurs in the area north of Inyokern, along the west and north margins of Death Valley, to Goldfield, Nevada, and east to the Nevada Test Site. In contrast to the mostly creosote bush shrubland of the lower elevations in YUBR South, the vegetation of this higher and cooler zone includes single-leaf pinyon, juniper, and sagebrush. The elevation range of the species in this population is between 1500 and 2200 meters. Average annual rainfall varies between 95.8 mm and 429 mm, minimum temperatures range from -8.1 to 3.6°C, mean summer temperatures range between 20.4 and 36.3°C, and summer precipitation comprises up to a quarter of the mean annual precipitation (USFWS 2018).

In contrast to the area of YUBR South, which is majority private land, the area of YUBR North is overwhelmingly (96%) federal land (USFWS 2018). The approximately 2 million acres comprising the YUBR North area is about evenly split between California and Nevada. USFWS (2018) estimates that almost all of this area (1,941,701 acres) is suitable for Joshua trees.

4 Abundance and Population Trends

Due to the species' patchy distribution within its range, highly variable population density (4 to 840 trees per acre) and lack of range-wide population surveys, a reliable estimate of Joshua tree population size is not available (USFWS 2018). Similarly, no range-wide population trends have been documented. However, recent studies carried out in portions of the species' range indicate that density is negatively correlated with increasing temperature, the species range is contracting at lower elevations, recruitment is limited, and mortality is increasing, all of which would likely reflect a population already starting to decline.

DeFalco et al. (2010), in a study in Joshua Tree National Park, found that recent drought and fire had resulted in significant mortality of *Y. brevifolia* in the park. Five years after a fire, 80% of burned trees in the study area had died, with smaller trees (<1 m tall) dying more rapidly. But perhaps more surprising, DeFalco et al. (2010) found that unburned trees also had high mortality rates during the same study period (1999-2004), with 26% of unburned trees also dying. As with post-fire mortality, smaller trees died in the initial years of the drought with mid-size and larger trees showing effects in later years. Mortality was ascribed both to water stress itself, as well as herbivory by pocket gophers (*Thomomys bottae*), which likely turned to Joshua tree stems, roots and periderm as alternative food sources due to reduced herbaceous cover during the drought (DeFalco et al. 2010).

In a recent study, Harrower and Gilbert (2018) investigated various life-history parameters of Joshua trees in Joshua Tree National Park and found the "ratio of dead to living trees was greater at the lower elevations where the sites are warmer and drier than sites at higher elevation." Their results "suggest that the range of Joshua trees is contracting at the lower elevations where there was no seedling recruitment and high tree mortality." Harrower and Gilbert (2018) also note that Joshua trees "do not seem to be moving successfully into higher elevations," potentially due to limitations on numbers of pollinating moths at these higher elevations. This finding is consistent with that of St. Clair and Hoines (2018) who found Joshua tree stand density negatively correlated with increasing temperature.

A series of small-scale studies in Joshua Tree National Park summarized in Cornett (2014) documented a 93% decline in Joshua tree abundance between 1990 and 2013 at one site, a 16% decline in Joshua tree numbers between 1988 and 2008 at second site, and a 73% decrease from 1990 through 2013 at a third site. Fire contributed to the decline at the third site, but even that site had declined by 18% prior to the fire. Cornett (2014) noted that declines at these three sites, which "represent a broad geographical sampling" of Joshua trees in the Park, and along with the documented mortality of some of the largest (and presumably oldest) trees in Park, "would seem to indicate *Yucca brevifolia* numbers are declining throughout the Park."

Regardless of whether Joshua tree abundance is already declining, it is virtually certain that abundance will decline in the foreseeable future. The impacts of climate change, fire, habitat loss and other sources of mortality are discussed further below.

5 Factors Affecting Ability to Survive and Reproduce

As discussed in the Life History sections *supra*, Joshua tree survival and reproductive success is tied to multiple factors, many of which are influenced by climate. Importantly, survival varies greatly by size class, with relatively high survival among adults, but very high mortality rates for seedlings and smaller individuals (DeFalco et al. 2010; Esque et al. 2015). As noted by Esque et al. (2015), because *Y. brevifolia* "is long lived the current distribution of reproductive adults may mask the effects of recent changes in climate on recruitment and survival of seedlings and juveniles, which are more sensitive to the vagaries of desert conditions." Consequently, while some impacts such as reduced recruitment may already be observable, impacts such as adult mortality and consequent population declines and range reductions may have a lag time before their presence is felt on the landscape (Svenning and Sandel 2013).

Among the factors affecting *Y. brevifolia's* ability to survive and reproduce are predation, invasive species, wildfire, drought, climate change and habitat loss due to development. These factors are often related, synergistic, and collectively threaten the continued viability of the species.

5.1 Predation

Predation plays an important role in Joshua tree survival at every life stage. Before a seed even leaves a fruit, *Tegeticula* moth larvae eat a portion of the seeds, with Keeley et al. (1985) observing 7% of seeds in a fruit consumed or damaged (Keeley et al. 1985). Borchert and DeFalco (2016) found much higher levels of larvae predation, with 19.5% damaged in a year of widespread fruiting and 42.8% damaged in a subsequent year of reduced flowering and fruiting. Rodents then cache and ultimately consume the vast majority of seeds, with fewer than 1% of seeds germinating (Vander Wall et al. 2006; Waitman et al. 2012; Borchert and DeFalco 2016). In drought years, virtually all seeds may be consumed by rodents, resulting in no seedlings being produced that year (Waitman et al. 2012).

Cattle have been documented grazing on the inflorescences of small Joshua trees. Lybbert and St. Clair (2017) documented floral herbivory by cows on *Yucca brevifolia* less than 2 m tall consumed 40% of inflorescences on their study plot. However, since the majority of Joshua trees flower above that 2 m threshold, only 6% of inflorescences overall were consumed by cattle. The fact that *Yucca brevifolia* evolved into a taller tree form than other yuccas might be a vestige of a growth-escape strategy to escape herbivory from a now extinct species, such as the Shasta ground sloth (Cole et al. 2011; Lybbert and St. Clair 2017).[12]

Drought years and fire also result in increased herbivory on seedlings and pre-reproductive Joshua trees (DeFalco et al. 2010; Esque et al. 2015), as the reduced availability of herbaceous forage forces small herbivores to use alternative food sources, including *Y. brevifolia* stems and leaves (DeFalco et al. 2010; Esque et al. 2015). DeFalco et al. (2010) found widespread evidence of tissue damage to Joshua trees in burned areas (28% of plants) from pocket gophers (*Thomomys bottae*), with lessor levels (16%) evident in unburned areas. Such damage occurred predominantly in lower elevation sites. In most areas Joshua tree survival rates dropped with evidence of rodent damage, with the effects most pronounced in burned areas.

In a separate study, Esque et al. (2015) found that herbivory by black-tailed jackrabbits (*L. californicus*) resulted in 55% mortality of pre-reproductive *Y. brevifolia* <25 cm tall on their study site in a single drought year. In addition to jackrabbits, Esque et al. (2015) documented damage to pre-reproductive plants from pocket gophers, white-tailed antelope squirrels (*Ammospermophilus leucurus*), and woodrats (*Neotoma sp*.).

While predation alone is likely not presently a threat to Joshua tree persistence, it can result in zero reproductive success in one or a sequence of dry years, as well as high mortality levels to seedlings and small plants (<25 cm tall), and even adults. This effect is magnified in areas that burn. Burned trees are likely physiologically more vulnerable to herbivore damage, while the lack of other herbaceous plants deprives young Joshua trees of nurse plants which shield them from herbivory. Moreover, jackrabbits, pocket gophers and other herbivores lack alternative food sources and turn to Joshua tree stems, roots and periderms for sustenance following such events (DeFalco et al. 2010; Esque et al. 2015). As discussed *infra*, both wildfire and droughts are predicted to increase in frequency and intensity in the coming decades, likely rendering the impacts of seed predation and herbivory on stressed and shrinking populations of Joshua trees more significant.

[12] Notably, cattle grazing can have significant impacts on other yuccas, with Lybbert and St. Clair (2017) documenting complete reproductive failure of *Y. baccata* and consequent apparent local extirpation of that species' pollinating moths on their study plot due to high levels of herbivory on the species' flowers by cows. *Y. baccata* is notably shorter than *Y. brevifolia* with its flowers within easy reach of cattle. The Joshua tree's evolutionary adaptation to survive sloth herbivory may have pre-adapted it to better survive cattle grazing.

5.2 Invasive species

Invasive plant species are widely established in the Mojave Desert throughout the range of *Yucca brevifolia*. And while invasive species represent a relatively small percentage of the flora, they represent a huge percentage of the biomass. Brooks and Berry (2006) found that in a high rainfall year (1995) nonnative annual species comprised 6% of the flora and 66% of the annual biomass, with those numbers increasing to 27% and 91% respectively in a low rainfall year (1999). The grasses red brome (*Bromus rubens*) and *Schismus* spp., along with the forb redstem fillaree/stork's bill (*Erodium cicutarium*) comprised 99% of the alien biomass. More recently, Sahara mustard (*Brassica tournefortii*) has spread into the Mojave, including into Joshua tree woodland (Frakes 2017; Brooks et al. 2018).

Figure 9: Carpet of desiccated invasive *Schismus* spp. between *Y. brevifolia.*

The abundance and diversity of alien species in the Mojave is positively correlated with disturbance, including livestock grazing, off-highway/off-road vehicle (OHV or ORV) use, fire, urbanization, roads, and agriculture. As summarized by Brooks and Berry (2006):

> Alien annuals had high density, biomass, or cover near roads, in an area of OHV use compared to an area where OHV use was lower, in an area where both OHV use and grazing were present compared to an area where both disturbances had been excluded for at least 10 years, in two grazed areas compared with ungrazed areas, and in areas near livestock watering sites…. These studies indicate that species richness and biomass of alien annual plants are positively correlated with disturbance (internal citations omitted).

Invasive species are also aided by nitrogen deposition as a result of air pollution (Brooks 2003). As noted by Allen et al. (2009), the "western Mojave Desert is affected by air pollution generated in the Los Angeles air basin that moves inland with the predominant westerly winds.

The pollution contains both oxidized and reduced forms of nitrogen (N), which are of concern because they are deposited on soil and plant surfaces and thus fertilize plants" (internal citations omitted). Fertilization disproportionally benefits nonnative species leading to increased abundance and biomass of invasive species such as *Bromus rubens* and *Schismus* spp. (Brooks 2003; Allen et al. 2009; Allen et al. 2011; Bytnerowicz et al. 2016).

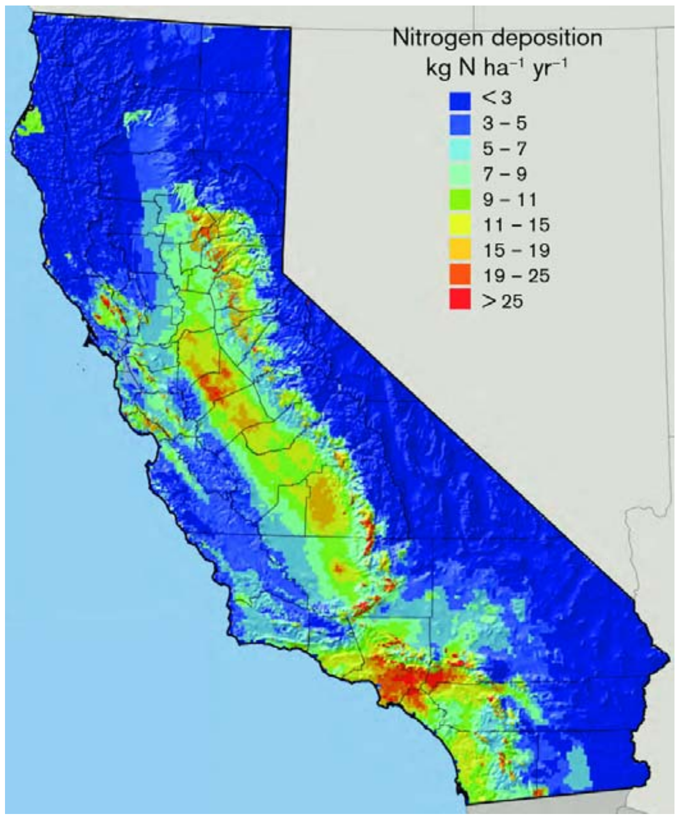

Figure 10: Map showing nitrogen deposition rates in California, with areas of high levels overlapping the range of YUBR South. Source: Bytnerowicz et al. 2016.

While the rapid spread of invasive species in the Mojave is resulting in competitive impacts on native annuals, and has also been demonstrated to have direct competitive impacts on native perennial species including creosote bush (*Larrea tridentata*) (DeFalco et al. 2007), direct competitive impacts of invasives on *Yucca brevifolia* have not been thoroughly studied. To the degree there is competition is would likely be most significant with emergent seedlings under nurse plants as this is the most vulnerable life stage of the Joshua tree (Reynolds et al. 2012).

The much bigger issue is that these invasive plants have altered fire dynamics, leading to larger and more frequent fires that are killing innumerable Joshua trees. As succinctly described by Barrows and Murphy-Mariscal (2012), "[m]ore frequent fires in the Mojave Desert are the result of the interaction of increased nitrogen deposition and the competitive advantage that nitrogen gives to invasive grasses such as red brome, *Bromus rubens*." Similarly, Pardo et al. (2011) highlighted the dire consequences for *Y. brevifolia*: "In Joshua Tree National Park in southern California, N deposition favors the production of sufficient invasive grass biomass to sustain fires that threaten the survival of the namesake species." As discussed below, the altered fire regimes in the Mojave represent a significant threat to the Joshua tree at the individual and population level.

Figure 11: Fire-killed *Y. brevifolia* in a carpet of *Bromus rubens*.

5.3 Wildfires

Wildfire is one of the greatest threats to the persistence of *Yucca brevifolia*, particularly as the species' range contracts in the face of climate change and the frequency and severity of fire in the species' range increases (DeFalco et al. 2010; Holmgren et al. 2010; Vamstad and Rotenberry 2010; Cole et al. 2011; Barrows & Murphy-Mariscal 2012; Sweet et al. 2019).

5.3.1 Joshua tree response to fire

Some early researchers suggested that Joshua trees are well-adapted to fire due to the fact that damaged trees can resprout after fire (Webber 1953). Older adult trees are more fire resistant than younger trees as the apical meristems grow above the level of most ground fires while the flammable dead leaves on the main truck that can facilitate fire spread into the crown are largely shed as the tree matures (Gunter 2006). And even if top-killed or damaged by fire, a Joshua tree can sprout from the root crown, rhizomes, and/or branches. Similarly, previous studies also found that Joshua trees can at least partially repopulate some burned areas via such sprouting (Loik et al. 2000a).

However, several longer-term studies have subsequently demonstrated that 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 (DeFalco et al. 2010; Vamstad and Rotenberry 2010; Abella et al. 2009).

As summarized by Brooks et al. (2018), "Yucca species such as Joshua tree and Mojave yucca (*Yucca schidigera*) often survive burning, but Joshua trees typically die within the first few years after fire due to drought and herbivory stress." Moreover, Joshua trees are particularly vulnerable to fires as the "relatively small size and dense packing ratio of dead Joshua tree leaves compared with dead Mojave or banana yucca leaves increase the frequency at which they are completely burned and may explain why Joshua trees are more frequently killed by fire" (Brooks et al. 2018). It can take several decades before a Joshua tree sheds the dead leaves on its trunk, leaving the adult tree more fire resistant.

DeFalco et al. (2010) carried out a detailed study of Joshua tree survival in both burned and unburned areas of Joshua Tree National Park that paints a grim picture for species' future in the face of increasing fire.

> Five years after the Juniper Fire Complex of May 1999, approximately 80% of burned *Y. brevifolia* died compared with 26% in adjacent unburned sites. This high postfire mortality of *Y. brevifolia* is consistent with other studies including 90% mortality six years after a 1978 fire in Lower Covington Flat at Joshua Tree National Park and 64 – 95% mortality at sites censused 1 to 47yr after fires in Mojave and Sonoran deserts of California. Declining survival during the first year is attributed to immediate losses of small *Y. brevifolia* (< 1 m tall) whose active meristems close to the ground are vulnerable to extreme fire temperatures and flames that consume whole plants. As they age and grow taller, *Y. brevifolia* shed leaves from the trunk and are less likely to burn, unlike younger plants whose aging leaves are still attached and provide ladder fuel. Thus, taller plants likely sustained less proportional burn injury to the outer periderm tissue during the fire, and steep declines in this size class occurred only after the consecutive dry periods that began in the autumn months during 1999 and 2000 (internal citations omitted).[13]

Post-fire mortality in this study was likely the result of the interplay of drought and herbivory with fire. During the dry years subsequent to the fire, herbaceous plants were scarce, and pocket gophers (*Thomomys bottae*) gnawed the periderm and hollowed stems of *Y. brevifolia* causing many of them to topple. Pocket gopher damage reduced plant survivorship at low-elevation, unburned sites and diminished survival of burned plants in all but the driest site, which already had low survival (DeFalco et al. 2010).

> The loss of *Y. brevifolia* was not only amplified by the lack of precipitation following the wildfire but also by herbivores that damaged burned plants. Herbaceous annual plants were scarce during the growing season following the 1999 fire, and many perennials were dormant due to low autumn through spring precipitation that triggers germination and breaks leaf dormancy. Widespread incidence of tissue damage by *T. bottae* in burned areas implies that the roots and periderm of *Y. brevifolia* that did not die immediately in the fire offered an

[13] Noteworthy in the DeFalco et al. (2010) study is the fact that mortality of even unburned trees was high (26%) over the five years of their study. This was ascribed to a combination of drought stress and herbivory by pocket gophers. As discussed *infra*, such prolonged droughts are likely to be more frequent in a changing climate.

> alternative succulent food source in denuded areas where shrubs and grasses were incinerated (DeFalco et al. 2010) (internal citations omitted).

DeFalco et al. (2010) observed that 33% of censused Joshua trees in burned areas sprouted from the root crown or stem after the fire. These are in line with other studies that found 25% of Joshua trees sprouting from the root crown after a 1978 fire (but with only 10% surviving five years later) and 28% sprouting from the root crown (and 2% from the stem) one year after a 1995 fire (Loik et al. 2000a).

Postfire sprouting prolonged Joshua tree survival in the DeFalco et al. (2010) study, but only at the wetter, high-elevation sites. As noted by DeFalco et al. (2010), "sprouting can provide some advantage to survival only when precipitation is sufficient (e.g., at higher-elevation sites or during wet years). Thus, sprouting of *Y. brevifolia* in the Mojave Desert presents an uncertain recovery strategy in postfire landscapes, especially in the face of herbivory and recurring low-precipitation years."

One area where Joshua trees may be more adapted to fire is along the far western edge of their range. As observed by Brooks et al. (2018),

> Joshua tree populations along the extreme western edge of the desert bioregion near the Sierra Nevada and Transverse Ranges often resprout and survive more readily after fire than those further east. A cycle of relatively frequent fire and resprouting can result in short, dense clusters of Joshua tree clones, such as those found near Walker Pass, in the western end of the Antelope Valley, and in pinyon-juniper woodlands at ecotones with the Transverse Ranges such as Cajon Pass. High resprouting rates of Joshua trees in these areas may have evolved in local ecotypes that became adapted to shorter fire return intervals along the western desert ecotones than in other parts of the desert bioregion.[14]

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 (Brooks et al. 2018). Another study found that Joshua trees were still rare on a site 65 years after a fire (Vamstad and Rotenberry 2010).

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 (DeFalco et al. 2010; Reynolds et al. 2012). Nurse plants in arid environments are known to moderate insolation, soil moisture, temperature, and humidity

[14] Notably, the distinguishable clonal form of Joshua trees in these areas was once recognized as its own subspecies or variety, *Y.b. herbertii*, which is now considered a synonym of *Y. brevifolia* (Wallace 2017). Regardless of taxonomy, Joshua trees in these areas warrant special monitoring and protection as they may hold adaptations that make them particularly resilient in the face of increasing fires and climate change.

beneath their canopies and improve conditions for seedling establishment (Reynolds et al. 2012). Nurse plants also shield seedlings from herbivory (Esque et al. 2015).

Blackbrush (*Coleogyne ramosissima*) is one of the most important nurse plants for Joshua tree seedlings (Brittingham and Walker 2000) but is also one of the most vulnerable shrubs to fire (Brooks et al. 2018). 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). 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).

In the Joshua Tree National Park fire studied by Loik et al. (2000a), blackbrush was eliminated from the burned area with no signs of recovery. Loik et al. (2000a) postulated that "the time required for Joshua trees to begin recruitment via seeds will be delayed until *C. ramosissima* becomes re-established."

As summarized by DeFalco et al. (2010), the "recruitment of *Y. brevifolia* is a slow process even without the impediments introduced by accelerated fire-return intervals." And with such accelerated return intervals it may be impossible: "The return of *Y. brevifolia* to prefire densities and demographic structure may take decades to centuries or be entirely unlikely, especially in light of potential changes to regional desert climate in combination with plant invasions and the potential for recurrence of subsequent fires" (Reynolds et al. 2012).

5.3.2 Increasing wildfire frequency and intensity in the Mojave

Large fires have been historically infrequent in Joshua tree woodlands, and the recent increase in fire size and frequency is partially due to invasion of exotic grasses, principally *Bromus* spp. and *Schismus* spp. (Brooks and Matchett, 2006; Vamstad and Rotenberry 2010; Klinger and Brooks 2017; Syphard et al. 2017; Brooks et al. 2018; Maloney et al. 2019).

Winters with relatively high amounts of precipitation produce an increase in biomass of native and especially non-native annual plants sufficient to carry fire in invaded habitats. The most dramatic changes have occurred in middle elevation shrublands dominated by creosote bush, blackbrush and Joshua trees. This zone is more susceptible than other areas of the Mojave Desert to increased fire size following years of high rainfall (Brooks and Matchett 2006).

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 (Brooks and Matchett 2006; Vamstad and Rotenberry 2010). 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. This can both decrease the time interval between the previous and subsequent fire as well as the extent of burning (Klinger and Brooks 2017).

Several recent reviews have documented fire frequency and extent in the Mojave over the past century (Tagestad et al. 2016; Syphard et al. 2017; Brooks et al. 2018). Each of these studies recognized that precipitation was a primary driver of fire frequency and extent, with wetter periods fostering the growth of invasive grasses which carry fire, and drier periods leading to fewer and smaller fires. Tagestad el al. (2016) summarized both short and long-term impacts of precipitation variation.

> Long-term drought or above-average precipitation periods can have landscape-scale effects on the health and distribution of perennial plant species and the frequency and size of fires. Short-term increases in winter and summer precipitation can have an even greater effect on the likelihood of fire. High winter precipitation creates ephemeral flushes of herbaceous biomass resulting in continuous fuelbeds that promote the spread of fire. High summer precipitation brings thunderstorms with accompanying lightning and high winds which contribute to the ignition and spread of fires. Cumulative years of higher than normal precipitation also appear to have an effect on the potential for fire. This is especially a concern in areas invaded by annual grasses which exhibit a profound response to increased cool-season precipitation (internal citations omitted).

Particularly worrisome is that a sequence of wet years can lead to enormous fires, such as happened throughout the Mojave, including in the range of *Y. brevifolia* in 2005:

> The 2005 Mojave Desert fire season, which burned an area equal to 132% of the total area that burned during the previous 25 years, was preceded by three extremely high precipitation years, suggesting that multiple years of high precipitation can have a cumulative effect on the accumulation of fuels (Tagestad el al. 2016).

According to Brooks et al. (2018), accounts by agency fire mangers of the 2005 fires "indicate that these fires exhibited extreme fire behavior not previously observed in the Mojave Desert," and they attributed this largely to continuous cover of taller than average red brome in the burn areas.

One consistent finding of recent California Desert fire studies is that fires are not evenly distributed by ecological zone or area, but that mid-elevation areas (the zone predominately occupied by Joshua trees) are particularly susceptible. Brooks et al. (2018) found, based upon fire data from 1972 to 2007, that "although fire occurrence across large parts of the warm deserts may be relatively low, they can be much higher and pose significant land management challenges in localized areas. The majority of fire area in the Mojave section of California occurred in the middle-elevation zone." Brooks et al. (2018) also noted that in "the middle elevations of the Mojave Desert there was also evidence of a significant increase in annual fire area."

Tagestad et al. (2016) similarly observed that between "1976 and 2010 there were 227 fires in the Mojave Desert greater than 405 ha (1000 acres). These fires burned a total of 758,477 ha (1,874,230 acres) with most of the burned area occurring in the middle elevation zones receiving sufficient precipitation for growth of fuels." Notably, blackbrush, a critical nurse plant for Joshua tree seedlings, experienced exceptional rates of burning, as "areas identified as historical blackbrush communities have experienced more multiple fires than all the other communities combined."

Brooks et al. (2018) also found that fires in the California Desert "are clustered in regional hot spots where they are more frequent and burn more proportional area than desert-wide averages. These areas all occur in the Mojave ecological section, with one hot spot at the ecotone with the Colorado section in the vicinity of Joshua Tree National Park." A recent mapping effort by Syphard et al. (2017) clearly shows that a disproportionate number of fires, including large fires, occur in the western Mojave range of *Y. brevifolia* (Figure 12).

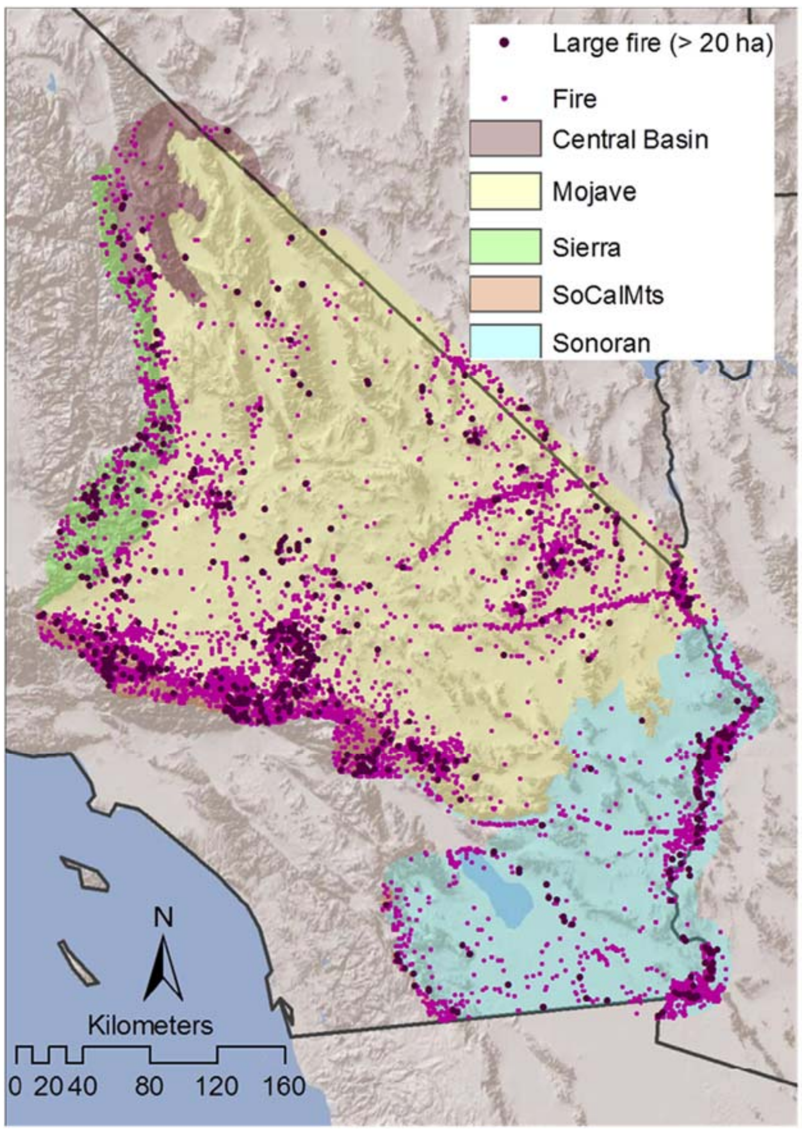

Figure 12. Fire occurrence between 1990-2010 in California Desert. Source: Syphard et al. (2019).

Fires in the Mojave are started by a mix of accidental and intentional human activities as well as lightening. Lightning frequency is higher in the desert than in any other California bioregion and is a significant source of fire (Brooks et al. 2018). Various studies have looked at the relationship of human caused versus lightening fires. One study found that the significant increase in fire frequency in the Mojave from 1980 to 1995 was associated with increased numbers of fires caused by humans, with the number of lightning-caused fires remaining constant. Although most human fires were small and started along roadsides, the less frequent large fires typically occurred in remote areas far from major roads and were started by lightning (Brooks et al. 2018). The influence of roads on fire ignitions is such that the outlines of Interstate Highways 5 and 40 can be discerned by the fire patterns reflected in the map in Figure 12.

Hopkins (2018), using data from Short (2017), tallied approximately 10,000 fires in the California desert from 1992 to 2015, and found that lighting accounted for only 10% of the fires, but 40% of the fires that burned more than 500 acres. Of the 90% that were human caused, equipment use was responsible for 22%, arson 8%, children 6%, smoking 5%, debris burning 5%, campfires 4%, and most of the remainder to unspecified miscellaneous causes.

A recent comprehensive analysis of fire records in the California Desert found that in "the Mojave, powerlines and other types of energy infrastructure (oil and gas wells, wind turbines, and power plants) were the most important anthropogenic land use contributors to large fires" (Syphard et al. 2017). The relationship between development and fire is also significant, with Syphard et al. (2019) warning that "[w]ith more fires occurring in close proximity to human infrastructure, there may also be devastating ecological impacts if development continues to grow farther into wildland vegetation."

Fire fueled by invasive grasses is already significantly affecting Joshua tree woodlands. As Holmgren et al. (2010) summarized regarding conditions in Joshua Tree National Park (JTNP),

> With each subsequent fire the native plants vanish but these invasive grasses thicken and expand, fuelling ever larger and more frequent wildfires, inducing what has been called the 'grass–fire cycle'. Prior to 1965, fire records at the park suggest that most lightning-caused fires, which happened in May through September, seldom spread more than a few tens of metres from the strike… [*B. rubens*] spread dramatically and began fuelling large fires in both the Mojave and Sonoran Deserts. At JTNP, fires measuring in the thousands of acres burned in 1979, 1995, 1999 and 2006. The increase in fire size and frequency could transform JTNP vegetation in a matter of decades.

The specific impacts of more frequent and intense fire on Joshua trees themselves are also significant. Esque et al. (2015) described these impacts:

> Recent increases in fire frequency caused by invasive species throughout the range of *Y. brevifolia* have also affected all life stages of the species, and survival from intense fires is low even among large individuals. The impact of fire on seedling and juvenile survival is particularly exacerbated because fires tend to track the same

heavy precipitation years that are most suitable for *Y. brevifolia* seedling emergence (internal citations omitted).

Perhaps most importantly, areas identified as potential late-century climate refugia for *Y. brevifolia* are particularly vulnerable to fire, with over a third of the area identified as refugia by Barrows and Murphy-Mariscal (2012) burned between 1967 and 2012, and half the refugia identified under a moderate warming scenario by Sweet et al. (2019) burned as of 2018 (Figure 13).

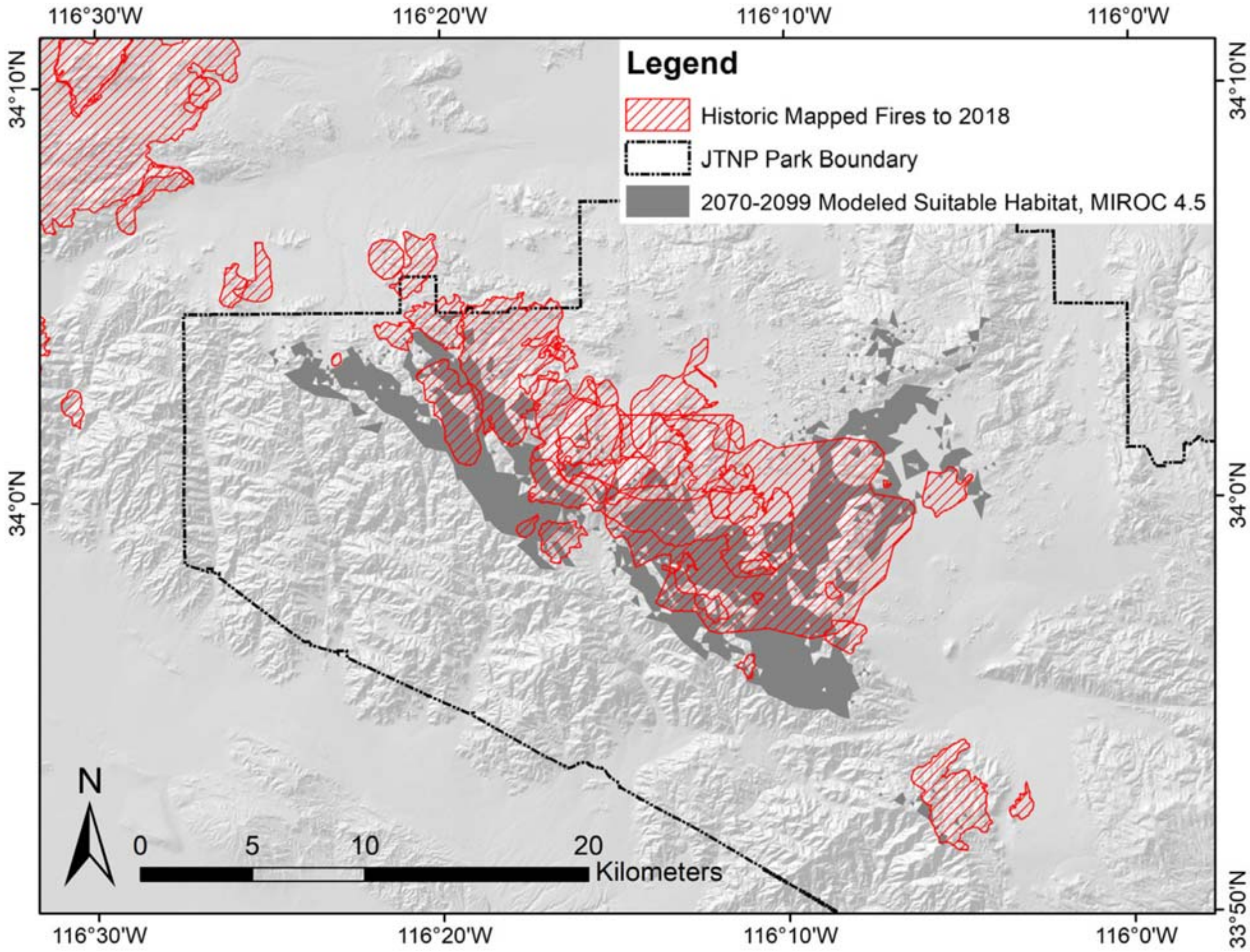

Figure 13. Historic fires in JTNP through 2018 in relation to modeled Joshua tree suitable habitat under a moderate warming scenario. Source: Sweet et al. (2019).

In sum, Joshua tree woodlands are generally not adapted to fire, and recover slowly, if at all (Abella et al. 2009; DeFalco et al. 2010; Vamstad and Rotenberry 2010; Brooks et al. 2018). Moreover, as noted by DeFalco et al. (2010), "the slower decline in survival for burned *Y. brevifolia* at the more mesic, high-elevation sites underscores the importance of postfire climate conditions on defining the demographic structure of recovering *Y. brevifolia* populations." As discussed *infra*, a rapidly changing climate with greater heat stress and more intense droughts will make postfire recovery increasing unlikely; and as fire increases in frequency and/or intensity, it will threaten the continued viability of ever-shrinking populations of *Y. brevifolia*.

5.4 Climate Change

Climate change represents the single greatest threat to the continued existence of *Yucca brevifoia*. Even under the most optimistic climate scenarios, western Joshua trees will be eliminated from significant portions of their range by the end of the century; under warming scenarios consistent with current domestic and global emissions trajectories, the species will likely be close to being functionally extinct in the wild in California by century's end (Dole et al. 2003; Cole et al. 2011; Sweet et al. 2019).

5.4.1 Current and projected climate change in the range of *Y. brevifolia*

A strong, international scientific consensus has established that human-caused climate change is causing widespread harms to human society and natural systems, and climate change threats are becoming increasingly dangerous. 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, 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 cover; shrinking sea ice; rising sea levels; ocean acidification; and increasing atmospheric water vapor (USGCRP 2017).

Climate change is increasing stress on species and ecosystems, causing changes in distribution, phenology, physiology, vital rates, genetics, ecosystem structure and processes, and increasing species extinction risk (Warren et al. 2011). 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). The Mojave Desert in which the Joshua tree resides 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 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).[15] The four California counties in which *Y. brevifolia* 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 temperature projections for the Mojave are unidirectional (it will be a lot hotter), precipitation projections are more complicated and divergent. For the suite of downscaled climate models used by Hopkins (2018), there is little projected change in average rainfall each year to the end of the century (<10%), even under different emissions scenarios. However, these projections show an increase in interannual variability, 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).

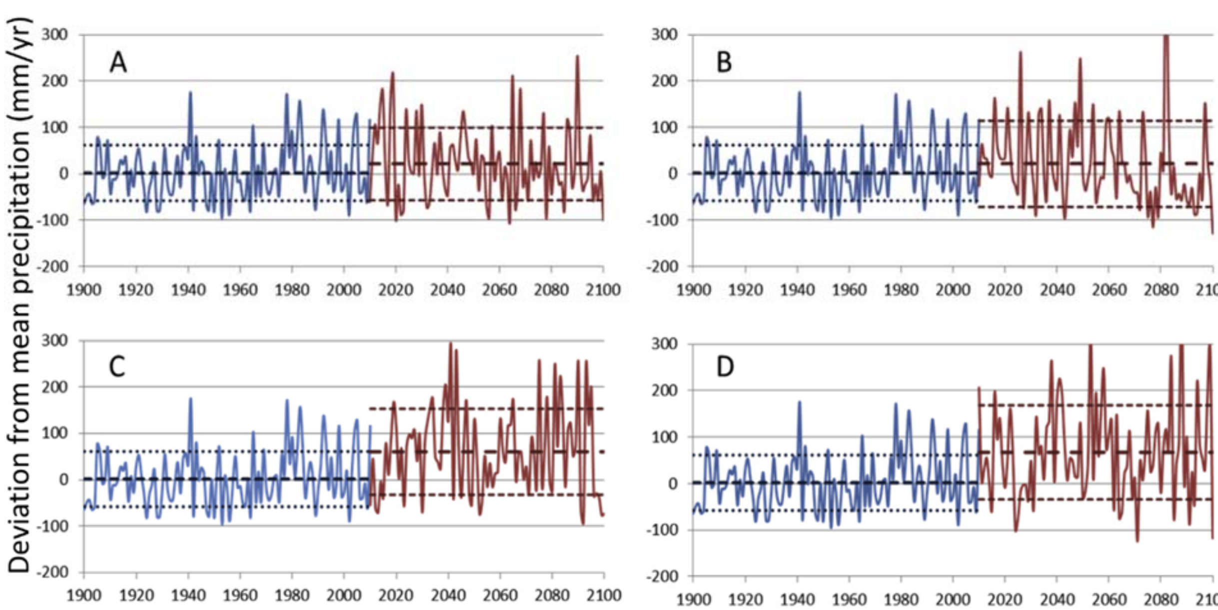

Figure 14: Plot of future modeled and historic precipitation in the Mojave Desert from global climate model/scenarios: A) GFDL/B1, B) GFDL/A2, C) IPSL/B1 and D) IPSL/A2. Source: Tagestad et al. (2016).

[15] Available at https://www.washingtonpost.com/graphics/2019/national/climate-environment/climate-change-america/

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Tagestad et al. (2016) came to similar conclusions, noting that "recent analysis of regional climate models over southwest North America indicate 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 and IPSL_CM4), 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 (Figure 14), 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."

In sum, average annual temperatures in the range of *Y. brevifolia* have already increased well over 1.5°C (Mufson et al. 2019), and daily maximum temperatures over the remainder of the 21st century under current emissions trajectories will increase by over 7ºC (Hopkins 2018). Precipitation will increase in 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). Given Joshua trees are already suffering from the warming that has occurred to date, these additional changes pose a significant threat to the persistence of *Y. brevifolia* in California.

5.4.2 Climate change impacts on Joshua trees

Researchers have been raising the alarm about threats to the Joshua trees for decades. More than half a century ago, Webber (1953) stated of the species that "[r]egardless of the present wide distribution and large concentration of yuccas, its future appears very dim. This gloomy outlook is mainly due to the plant's failure to reproduce and its destruction by man." In 2000, Loik et al. (2000a) raised the specter of climate change, predicting that "[c]hanges in the local climate due to anthropogenic greenhouse gases may cause warming of the microclimate near the soil surface thereby precluding the future establishment of *Yucca brevifolia*." A year later, Lenz (2001) noted that "Joshua trees in many areas appear physically stressed in all probability due to less than optimum growing conditions," and speculated that "depending upon the intensity and duration of global warming its long-range survival may depend upon the availability of a refugium."

Over the past 20 years, modeling of Joshua tree future distribution in a warming climate has become more sophisticated, has used more accurate and comprehensive distribution data, has produced projections at ever-finer spatial scales and has increasingly used field data to validate model performance. And while model projections of potential range expansion have varied greatly and have not distinguished between *Y. brevifolia* and *Y. jaegeriana*, *every* published modeling effort has predicted range contractions along the western edge of the Joshua tree's range in California, which largely corresponds to the range of *Y. brevifolia* in the state. A review of these studies demonstrates that *Y. brevifolia* will face massive range contractions within the foreseeable future that threaten the continued viability of the species.

Thompson et al. (1998) published the first modeled projection of the future range of Joshua trees under changing climate conditions. Using data on temperatures and precipitation levels where the species is currently found, Thompson et al. (1998) calculated that Joshua tree potential future habitat under doubled CO_2 conditions was almost 8-fold greater than present habitat, extending as far north as Washington state, south into Mexico and east into Texas. The modeling effort predicted retraction of range along its western edge in California. This study, which dealt with 16 different tree species, did not analyze other habitat variables or dispersal ability and used a model that poorly matched the current distribution of the species (e.g. the model predicted presence in the Coast Ranges under then current climate conditions).

Shafer et al. (2001) carried out a similar modeling effort looking at the future range of Joshua trees, finding that "[u]nder each of the future climate scenarios, its simulated potential range is fragmented and displaced northward and eastward." The Shafer et al. (2001) study addressed 15 different species of trees, used three climate variables (mean temperature of the coldest month, growing degree days, and a moisture index) and a 25-km grid scale.[16] Consequently, the results are course, but still roughly consistent with later modeling efforts (e.g. Cole et al. 2011), and most notably show almost complete extirpation of the species from California (Figure 15). The projected potential expanded range extending into northern Nevada and Utah as well as Washington state does not account for how the species might disperse into these new areas of potential habitat.

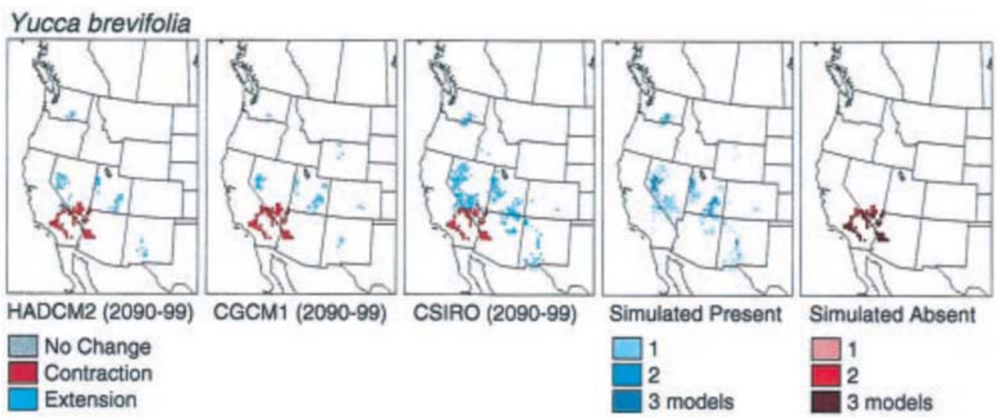

Figure 15: Modeled future range of Joshua Trees. Source: Shafer et al. (2001).

Dole et al. (2003) subsequently modeled future range for Joshua trees in a doubled CO_2 world, finding that "a considerable portion of the current range of *Y. brevifolia* will become climatically unfavorable for this species, but that significant amounts of new habitat may become available." While Dole et al. (2003) did not take dispersal into account in the modeling, they noted that it would be a factor in real-world application, and in "the worst-case scenario, *Y. brevifolia* will migrate too slowly to fill potential new habitat, while much of its current range will become climatically unfavorable."

Dole et al. (2003) also noted a further potential limitation in the model which assumed "the distribution of *Y. brevifolia* is in equilibrium with current climate." Significant subsequent research (e.g. Barrows and Murphy-Mariscal 2012; Harrower and Gilbert 2018; Sweet et al.

[16] The current distribution data used to develop the model in Shafer et al. (2001) is also questionable as the paper states "*Yucca brevifolia* (Joshua tree) is found in the deserts of the southwest US and northwest Mexico." The species has likely been absent from Mexico for thousands of years (Cole et al. 2011).

2019) has confirmed that at least in the southern part of its range, current climate conditions are already deleterious to Joshua tree survival and/or reproduction. Notwithstanding these model limitations, which almost certainly overestimate projected future habitat, modeled habitat loss is roughly congruent with the key results of Shafer et al. (2001) and Cole et al. (2011), with the species disappearing from 76% of its current range. Notably, much of the new area deemed climatically suitable for *Y. brevifolia* in California is developed agricultural land in the San Joaquin Valley and therefore highly unlikely to ever actually be occupied by the species.[17]

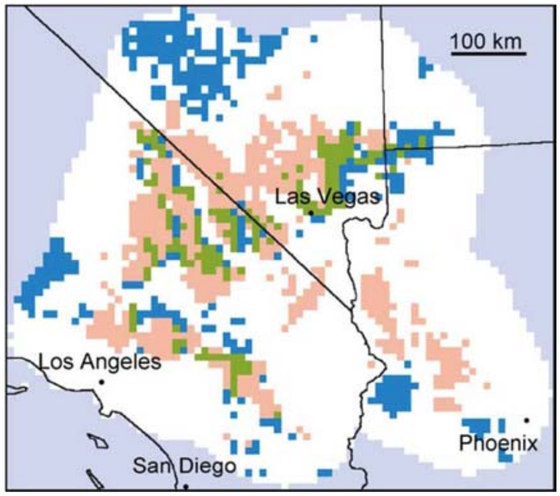

Figure 16: Modeled future range of Joshua Trees. Pink is lost range, green is maintained range and blue is expanded range. Source: Dole et al. (2003).

Cole et al. (2011) built a sophisticated species distribution model with climate and habitat variables derived from a comprehensive dataset of presence/absence data throughout the current range of the Joshua tree. Late Pleistocene and Holocene records were also compiled to generate a map of past distribution of the species. The study differed from previous models in its use of actual specific data points for presence and habitat variables for the species and the testing of the models to simulate the current range of the species.

> Construction of an independent test data set of Joshua tree current presence and absence allowed the evaluation of multiple suitable climate models for Joshua tree. Model concordance was found to increase with the inclusion of measures of monthly temperature variability (maximum and minimum rather than just mean), finer spatial scale (~1 km rather than ~4 km), and applying a 40-year mid-20th-century baseline (1930–1969) climate rather than a 30-year late-20th century baseline (1970–1999).[18]

[17] Dole et al. (2003) also modeled the impact of doubled CO_2 concentrations on the physiology of Joshua trees given there is some evidence that certain plant species are more resistant to freezing in high CO_2 conditions. Such modeling showed a 14% increase in projected new habitat and a slight increase (from 24% to 29%) of current habitat areas that would remain suitable. However, the authors recognized that the impacts of CO_2 induced warming were more significant than the physiological effects of CO_2 itself.

[18] Cole et al. (2011) selected 1930 to 1969 as their climatic baseline period "because evidence suggests that Joshua tree recruitment was greater during this interval than during the latter part of the 20th century. For instance, survey results show minimal to no recent Joshua tree recruitment within the southern Mojave Desert in recent years, and

The methodology of Cole et al. (2011) consequently address many of the shortcomings of climate niche models that have be raised by some (Pearson and Dawson 2003; Fitzpatrick and Hargrove 2009).

All of the individual climate models, as well as an ensemble of 22 global circulation models (GCMs) utilized by Cole et al. (2011), project a severe (~90%) decline in the area of suitable climates for Joshua trees by 2070 to 2099, as the southern parts of its range becomes climatically unsuitable.

Cole et al. (2011) also modeled areas where the species could potentially naturally expand its range in the future, as well as areas that might be suitable for relocation or assisted migration (Figure 17).

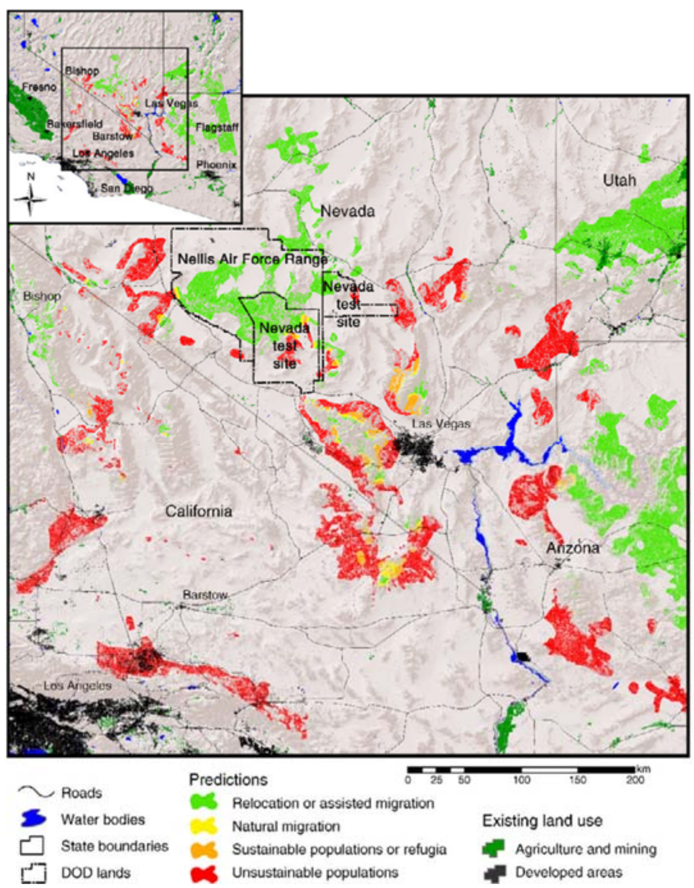

Figure 17. Areas with existing Joshua tree populations where a majority of the models used by Cole et al. (2011) predict future climates unsuitable for survival (red); current populations with future climates favorable for Joshua tree persistence (orange); areas within 2 km of current populations with future favorable climates and suitable substrates where natural migration could possibly occur (yellow); and protected areas with future favorable climates and suitable substrates where assisted migration might be possible (green). Source: Cole et al. (2011)

Joshua trees tall enough to be tallied in recent vegetation plots likely became established during this 1930–1969 interval or before."

In determining potential natural expansion areas, Cole et al. (2011) looked at rates of migration discernable from paleontological data as well as from modern studies of seed dispersal by rodents. Such data reveals minimal actual northward range shift over the Holocene, corresponding to a migration rate of 2 meters a year. Similar migration rates could be calculated based on studies of rodent seed caching activity and Joshua tree generation time. Cole et al. (2011) postulated that their results "suggest that the species migrational capacities have been ineffective following the extinction of Pleistocene megaherbivores that may have acted as seed vectors, especially the Shasta ground sloth." Given a 2-meters a year range expansion would total less than 200 meters by century's end and would be largely invisible in any mapping effort, Cole et al. (2011) used "a generous estimate of potential natural migration of 2 km over the next 60 to 90 years" to designate areas of potential natural migration. This suggests that the colonization of mapped areas of natural migration might in fact also require assisted migration to occur in a meaningful timeframe.

Cole et al. (2011) summed up the relationship between the Joshua tree's past, its present limited present dispersal abilities, and future projections to highlight the severe range contraction in will undergo in the coming decades.

> As climate rapidly warmed at the start of the Holocene, the widely dispersed range of Joshua tree severely contracted from the south, leaving only the populations near what had been its northernmost limit. The Holocene and recent history of Joshua tree suggests that its migrational capacity may be severely limited. Its ability to spread northward into new suitable habitats during the Holocene may have been inhibited by the somewhat earlier extinction of its primary megafaunal dispersers, especially the Shasta ground sloth. Because GCM models project a climate warming of a similar pace and magnitude to that of the early Holocene over the next 60 to 90 years, Joshua tree could undergo a similar decline in its southernmost populations to that of the early Holocene.

Cole et al. (2011) do not predict the complete extirpation of Joshua trees from their current range, noting that the "results predict the survival of some natural Joshua tree populations throughout the next century, but most will be greatly reduced in area." Importantly, because the authors modeled the Joshua tree present and future distribution as a single species, they did not distinguish between *Y. brevifolia* and *Y. jaegeriana*. From their mapping however, it appears that the majority of the areas for which Joshua trees are projected to persist are in the range of *Y. jaegeriana*. *Y. brevifolia* disappears almost entirely from its current range in California (Figure 17).[19]

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[19] A subsequent study by Notaro et al. (2012) included Joshua trees among 170 tree and shrub species for which they modeled projected range shifts by the end of the century. They noted that the projected northward shift of the species and decline in its southern range in response to warming was consistent with that described by Cole et al. (2011). However, unlike Cole et al. (2011), they did not consider dispersal ability in projecting range expansion and consequently concluded that the species would experience a "robust range expansion" of 143%. Importantly, their analysis was limited to the "Southwest United States" which did not include California. Consequently, regardless of other limitations of their analysis that may render the results suspect, the results shed no light on the future status of *Y. brevifolia* in California.

While the Cole et al. (2011) study looked at the future of Joshua trees throughout their range, Barrows and Murphy-Mariscal (2012) examined the status and fate of *Y. brevifolia* in Joshua Tree National Park (JTNP). The approach Barrows and Murphy-Mariscal (2012) took was one of niche modeling:

> In lieu of local-scale predictions of how precipitation or temperature will shift, modeling the sensitivity of species to a gradient of climate change scenarios can provide insights as to potential effects of local-scale changes in temperature and precipitation. A useful tool in assessing species sensitivity to changing conditions is niche modeling which includes habitat variables, such as climate and terrain, in an attempt to assess the complex interaction of factors that constrain a species' distribution (internal citations omitted).

To assess the validity of the niche models, Barrows and Murphy-Mariscal (2012) used "citizen scientist" volunteers to collect Joshua tree recruitment data throughout their range in the park to determine whether modeled shifts in suitable habitat coupled with recent temperature increases approximate current demographic response patterns, specifically successful seedling recruitment. The key climate variable used was summer maximum temperature, which was changed incrementally by increasing mean maximum July temperature by 1ºC, 2ºC, and then 3ºC.

Since the niche models were developed based on data of existing adult Joshua trees, the model projects the distribution of suitable habitat for the species when those individuals were recruited into the population, conditions when summer temperatures may have been up to 1ºC cooler than current conditions. Shifting mean maximum summer temperatures upwards by 1ºC, 2ºC, and then 3ºC resulted in modeled reductions in the extent of suitable habitat for Joshua trees of 30-35%, 66-78% and 90-98% respectively, depending upon the precipitation variables used.

The niche model Barrows and Murphy-Mariscal (2012) developed for juvenile Joshua trees (individuals 30 cm or less in height) based on their current distribution, resulted in a total suitable habitat area about half of that for adult trees. The juvenile model was a near match for the boundaries of the +1ºC adult model. The match between the current juvenile model and the +1ºC adult model provides some level of model validation consistent with the hypothesis that early levels of climate change may have already had an impact on Joshua tree recruitment. Put another way, adult Joshua trees in JTNP were recruited into the population under climate conditions where summer maximum temperature was approximately 1ºC cooler than present; warming to date may not be fatal to established adult Joshua trees, but it has apparently already shrunk the area of suitable habitat for recruitment by half.[20]

Barrows and Murphy-Mariscal (2012) contrasted their results to those of Dole et al. (2003)

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[20] Barrows and Murphy-Mariscal (2012) noted that "we searched for but did not find any areas of non-fire related mortality of Joshua trees within JTNP." This seems at odds with DeFalco et al. (2010) who reported 26% mortality of unburned Joshua trees following drought in their study area in JTNP. A subsequent study by Harrower and Gilbert (2018) also documented significant non-fire mortality in the park, indicating that the current climate, at least at lower elevations, is already deleterious to adult Joshua trees.

and Cole et al. (2011), both of which indicated that similar expected levels of climate change would result in no suitable habitat for Joshua trees within the central or southern portions of their current distribution. Barrows and Murphy-Mariscal (2012) ascribed the differences as being due to the scales of analyses rather than differences in models or model assumptions, since finer-scale analysis can incorporate local adaptations as well as topographic-climate complexities that may provide refugia.

Barrows and Murphy-Mariscal (2012) declared their analysis "represents a more optimistic scenario than previously published models of climate change impacts on Joshua trees." However, given their +3ºC model found that Joshua tree range in the park could be curtailed by 90 to 98% and noted that red brome fueled wildfires could burn any remaining refugia, it is somewhat difficult to share their optimism. Moreover, Barrows and Murphy-Mariscal (2012) used a +3ºC increase in summer maximum temperature as their "extreme" scenario, while Hopkins (2018) projects that summer maximum temperatures may hit that level before mid-century and may exceed +7ºC by century's end.

The most recent species distribution modeling effort for Joshua trees paints an even more concerning portrait of the species' future. Sweet et al. (2019) sought to identify the existence and extent of potential climate refugia for *Yucca brevifolia* within JTNP. Similar to Barrows and Murphy-Mariscal (2012), this study developed species distribution models (SDMs) validated with field data:

> By combining finer scale topographic and climate datasets, using more refined climate models and a more comprehensive set of Joshua tree location data, our objective was to construct SDMs to forecast this species' response to multiple future climate scenarios. Then, with the aid of volunteer community scientists, we collected Joshua tree demographic data across their range within the park. We aimed to identify the existence and extent of potential Joshua tree climate refugia and validate this prediction using empirical demographic data on Joshua tree recruitment along a gradient that falls within and outside modeled refugia.

Sweet et al. (2019) used the species distribution 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 *Y. brevifolia* 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 (Figure 18).

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

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.

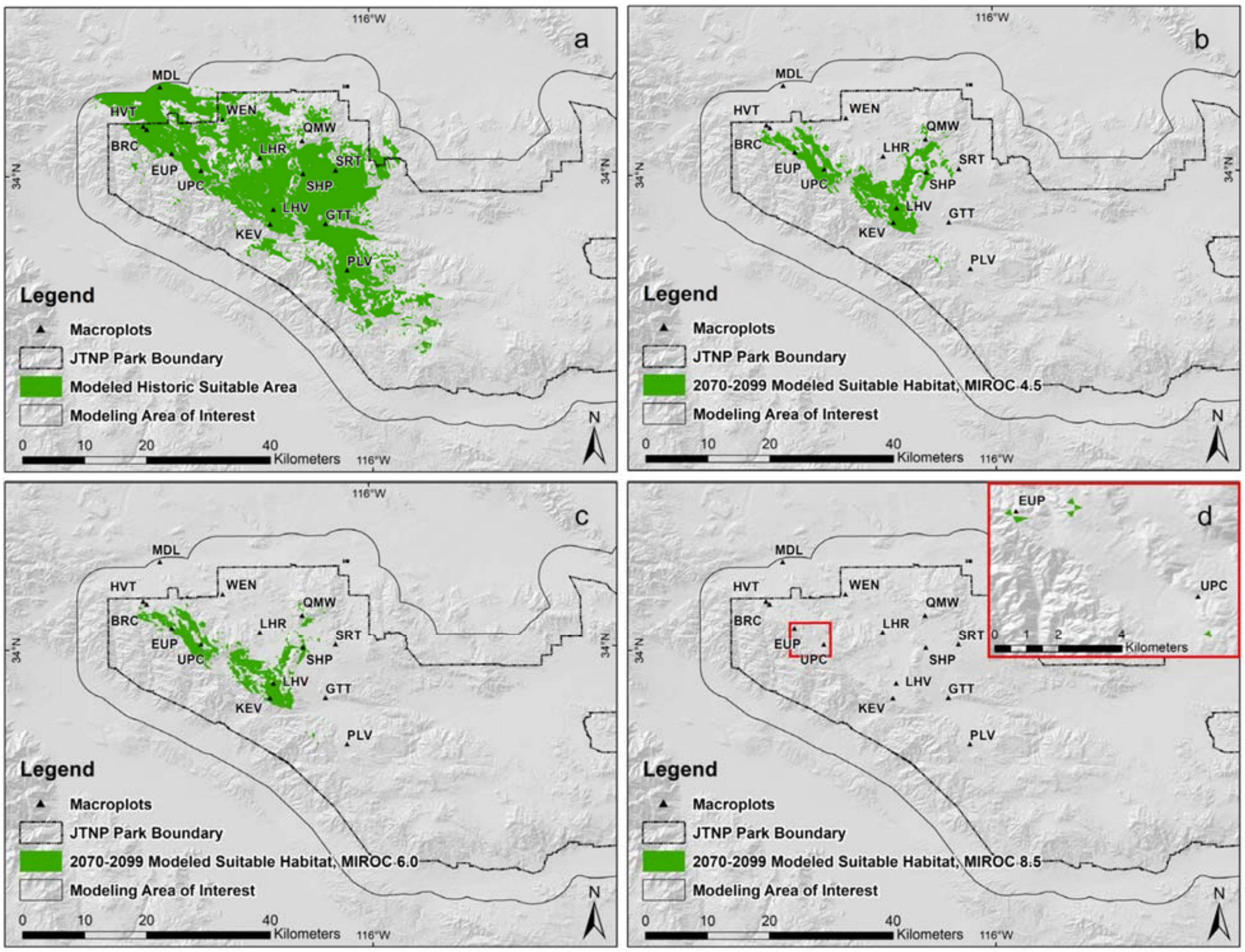

Figure 18: Map of historically suitable habitat (a) and end-of-century refugia for Joshua trees at JTNP. Modeled refugia are the area of overlap between current and future suitable habitat under 3 emission scenarios: RCP 4.5 (b), 6.0 (c), and 8.5 (d, with inset to display the modeled area). Source: Sweet et al. (2019).

The modeling results of Sweet et al. (2019) are similar to those of Barrows and Murphy-Mariscal (2012) in terms of overall trajectory and location of habitat loss in JTNP, but diverge in terms of how much area remains as refugia under their highest-warming scenarios. Barrows and Murphy-Mariscal (2012) projected between 2 and 10% of existing habitat would remain suitable in the park (916 to 4640 ha), while Sweet et al. (2019) projected only 0.02% would remain (15 ha). Sweet et al. (2019) ascribed the difference to finer scale habitat data, difference in climate scenarios used, and better and more dense information on Joshua tree presence. Put another way, the more detail we learn about the current status of Joshua trees, the bleaker their future appears.

Sweet et al. (2019) also used field data on distribution of juvenile trees (defined as smaller than 60 cm) to validate their modeling results.[21] They explained their rationale as follows:

> Large, long-lived species, such as Joshua trees, have an advantage over short-lived species, as they can weather year-to-year variation and short-term droughts. Still, long-term persistence, especially over the time reflected in climate change estimates, depends on where and when species reproduce, recruit, and establish on a landscape. Other studies have found differences between the adult distribution and the distribution of juveniles or seedlings on the landscape. Since the establishment stage of trees and other perennial species is a vulnerable and important stage, the density of seedlings in a given area can provide early indications of future distribution shifts.
>
> In order to study the future distribution of Joshua trees at JTNP, therefore, a field-based assessment of current recruitment patterns may be foretelling of changes in the population of Joshua trees on the landscape. Joshua tree annual survivorship is age- and precipitation-dependent; low precipitation levels have an inordinate negative impact on survivorship of smaller plants. With the levels of increased aridity that this region has already experienced, it follows that demographic shifts in Joshua trees should be apparent. The occurrence of young, healthy Joshua trees can therefore provide an empirical validation for modeled predictions of where climate refugia have already started to become established today (internal citations omitted).

Sweet et al. (2019) categorized 14 nine-hectare macroplots throughout the park that contained Joshua trees as high or low-recruiting depending on whether the density of documented juveniles was above or below the mean. They found that high-recruiting macroplots had significantly higher annual precipitation, and marginally significantly lower climatic water deficit and maximum summer temperature. Importantly, high-recruiting macroplots were geographically differentiated from low-recruiting macroplots in that they were located either within or significantly closer to predicted future refugia than low-recruiting macroplots. Moreover, when temperature and precipitation for refugia areas were plotted together with macroplots, there was considerable correspondence between the high-recruiting macroplots and the refugia. This result, which validated modeled predictions, was "not surprising—the factors that allow for recruitment (lower CWD, higher precipitation), especially in a desert environment, also differentiated, on a landscape scale, the areas supporting Joshua trees within the park."

Studying the density of tree recruitment, Sweet et al. (2019) found early indications of a shift in Joshua tree recruitment and noted that "[i]f recruitment patterns portend the future distribution of adults on the landscape, this type of analysis allows a glimpse into changes that may occur even before those outlined in the modeled future scenarios."

The Sweet et al. (2019) analysis was designed "to inform management with the most robust available predictions, focusing on areas where the species occurs already." These "occupied climate refugia are most relevant to the conservation of the species for the next 50 yr, and perhaps longer." Proper management and protection of these areas is critical the persistence

[21] Barrows and Murphy-Mariscal (2012) also used juvenile distribution to validate their models but used a 30 cm rather than 60 cm cutoff to define "juveniles".

of *Y. brevifolia*: "Since these refugia are also subject to threats such as fire and invasive species, management efforts aimed at reducing these threats provide on-the-ground actions that increase the likelihood that these areas will sustain this iconic species." Management and recovery actions are further discussed *infra*.

The species distribution modeling studies discussed above individually and collectively lay out a compelling warning about the difficult future facing *Y. brevifolia* in California. Two of those studies also looked at field data and concluded that recruitment of Joshua trees was *already* being hampered by warming (Barrows and Murphy-Mariscal 2012; Sweet et al. 2019).

Additionally, multiple other field studies documenting the *current* impacts of warming, drought, invasive species, fire and other impacts on Joshua tree survival and recruitment reinforce the findings of these modeling efforts. The more recent of these studies have specifically looked at such impacts in the of context climate change (*e.g.* DeFalco et al. 2010 [fire, drought and herbivory]; Reynolds et al. 2012 [seed germination and recruitment]; Esque et al. 2015 [recruitment and juvenile growth]; Borchert and Defalco 2016 [reproduction, seed predation and dispersal]; Harrower and Gilbert 2018 [pollination]; St. Clair and Hoines 2018 [reproduction]). These studies and the documented impacts on *Y. brevifolia* are described in the sections on Reproduction, Abundance and Population Trends, and Factors Affecting Ability to Survive and Reproduce, *supra*.

Joshua tree persistence on the landscape is dependent not just on survival of Joshua trees themselves, but on successful recruitment, which is dependent upon their obligate pollinating moths, seed dispersing rodents and the presence of nurse plants. As summarized by Sweet et al. (2019), "[r]ecruitment, survival of populations, and certainly migration of the species will be affected by factors such as the availability of pollinators, dispersers, seed and seedling predators and other mutualisms on the landscape." Climate change threatens to disrupt these essential relationships.

While multiple species can serve as its nurse plants, and a variety of rodents can act as seed dispersers, only a single species, *Tegeticula synthetica*, pollinates *Yucca brevifolia* in its California range (Pellmyr and Segraves 2003; Godsoe et al. 2008). And while clonal reproduction can prolong survival in certain locations and circumstances (DeFalco et al. 2010), ultimately long-term survival as a species likely requires the genetic diversity that sexual reproduction fosters (Harrower and Gilbert 2018). Consequently, the long-term viability of *Y. brevifolia* depends on maintaining its obligate mutualism relationship with *T. synthetica*.

A recent study by Harrower and Gilbert (2018) in JTNP sheds significant insight into the apparent fragility of the relationship between *Y. brevifolia* and *T. synthetica*. The authors succinctly lay out the problem:

> Obligate mutualisms like the Joshua tree–yucca moth interaction are acutely sensitive to changes in climate. The interacting partners may respond differently, creating an asynchrony in species phenology that can lead to population decline and local extinction. Environmental changes that shift the outcome to fewer viable seeds or greater seed predation could be detrimental to both species. However, the climate

> envelope within which this mutualism currently exists is narrow, and climate change effects in the Mojave Desert are expected to limit this envelope to only the highest elevations in Joshua Tree National Park (JTNP) within 90 yr, greatly reducing habitat with suitable climate and potentially extirpating the species from its namesake park (internal citations omitted).

Joshua trees are distributed across a 1200-m elevational range in JTNP from approximately 1000 m to 2200 m. Elevation gradients can serve as "natural experimental systems through systematic variation in abiotic and biotic factors," and average daily summer temperature per site in the Harrower and Gilbert (2018) study declined steadily along the elevation gradient with the warmest site at 30.2°C and the coolest at 19.9°C. Harrower and Gilbert (2018) examined how the abundance of *Y. brevifolia* and *T. synthetica* varies by elevation and quantified how the outcome of the Joshua tree–yucca moth interaction shifts depending on the context of where it occurs and the impacts that may have on Joshua tree fitness.

The authors found a sharp dichotomy between intermediate elevation sites versus the highest and lowest sites. Tree abundance was highest at intermediate elevations, with a "marked peak at around 1250 m where the trees were numerous and large and produced many flowers; this peak coincided with a high abundance of moths, as well as high production of pods, seeds, fertile seeds, and seedlings that grew from seeds." A positive relationship between moth abundance and successful sexual reproduction was found, with number of seedpods and fertile seeds per pod increasing with moth abundance. Moth abundance was significantly correlated with tree size, tree abundance, and number of flower panicles per tree, with larger trees having more panicles. These associations collectively indicate that reproductive success of both Joshua trees and yucca moths are greatest where the Joshua trees are abundant and vigorous, which currently is at intermediate elevations.

In stark contrast to intermediate elevation results, at the lowest and highest sites the number of dead Joshua trees peaked, while live trees were small and few and had few flowers, and no moths, seedpods, or seedlings were encountered. Reproduction was limited to clonal spread. Soil moisture was very low at the lower, warmer elevations and may have contributed to Joshua tree death. The authors noted that their observations were consistent with expectations from the models of Cole et al. (2011) and Barrows and Murphy-Mariscal (2012) and suggest that the range of Joshua trees is contracting at the lower elevations where there was no seedling recruitment and high tree mortality.

Harrower and Gilbert's (2018) finding that at elevation extremes Joshua tree reproduction is almost exclusively clonal is consistent with previous accounts finding that Joshua tree clonality increases with elevation, but the lack of seedling recruitment and enhanced clonality at low elevations had not been previously reported. Trees produced flowers at both of the extremes, but no moths, fruit development, or seed set were observed in these areas. Consequently, the lack of seedlings could be explained by the lack of pollinators.

The presence of only clonal populations at the low and high ends of *Y. brevifolia* distribution has several very significant potential repercussions:

> If trailing edge populations of (mostly clonal) Joshua trees are also those in the population that are best adapted to deal with the highest local temperatures, a lack of sexual outcrossing with populations at higher elevations could threaten overall species persistence due to reduced fitness of seedlings as the climate warms. Clones have reduced reproductive fitness, which could increase susceptibility to local extinction of the trees. The lack of pollinators, seed set, and seedlings at higher elevations suggests that Joshua trees are not currently expanding their range upslope (Harrower and Gilbert 2018) (internal citations omitted).

Harrower and Gilbert (2018) summarized the dilemma facing the *Y. brevifolia* and *T. synthetica* mutualism: "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." Moths are absent at these higher elevations and 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." Given "the survival of the species requires colonization of new habitats," the current lack of a functioning pollination mutualism at the high elevation margins of the Joshua tree's range raises serious doubts about the ability of the species to colonize new habitats, and ultimately to survive.[22]

In sum, climate change represents an existential threat to *Y. brevifolia* in its California range. Even in the absence of climate change, the convergence of biotic and abiotic factors necessary for recruitment "results in successful establishment of new seedlings only a few times in a century" (Esque et al. 2015). Such recruitment has already largely stopped at the drier, lower limits of the species' range (Barrows and Murphy-Mariscal 2012; Sweet et al. 2019). Prolonged droughts, which are projected to occur with greater frequency and intensity over the coming decades (Hopkins 2018), will not only preclude recruitment across ever-greater areas of the species' range, but will lead to higher adult mortality, either directly due to temperature and moisture stress or indirectly due to increased herbivory from hungry rodents lacking alternative forage (DeFalco et al. 2010; Harrower and Gilbert 2018). Whether or not the species' pollinating moth will be able to keep pace with a changing climate is highly-questionable (Harrower and Gilbert 2018). The Joshua tree's ability to colonize new habitat at higher elevations or latitudes is extremely limited and no such range expansion is yet occurring, even as the lower elevation and southern edge of its range is already contracting (Cole et al. 2011; Harrower and Gilbert 2018). And there is no safe refuge, as the higher elevation areas in which Joshua trees are projected to best be able to survive increasing temperatures and drying conditions are at great risk of fire due to the prevalence of invasive grasses (Barrows and Murphy-Mariscal 2012; Sweet et al. 2019). Absent rapid and substantial reductions in GHG emissions *and* protection of habitat, the species will likely be extirpated from all or most of California by the end of the century.

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[22] Interestingly, certain higher elevation areas (but not the highest elevations) had the highest density of trees in the study, but very low moth abundance. These higher elevation sites were dominated by trees reproducing asexually. It is not clear whether moths are unable to thrive at these higher elevations or if the low numbers of flowers meant that location was unable to attract or support the moths. Harrower and Gilbert (2018) postulated that this elevation range, from 1500 to 1600 m, "where trees thrive but moths do not, may be an important transition zone for future work on the details of the Joshua tree–yucca moth climate mismatch."

5.5 Habitat Loss to Development

While the overall outlook for *Y. brevifolia* is grim, the species has an advantage over many other climate-threatened species in that much of its habitat is at least nominally protected from other impacts. Its southernmost population is within the national park that bears its name, while some of its northernmost populations are in Death Valley National Park. As described in the Distribution section *supra*, YUBR North is 96% federal land, while, YUBR South is 48% federal land. Nevertheless, development presents a substantial threat to the species in a significant portion of its range.

Of the two *Y. brevifolia* populations, YUBR South has been the most impacted by human development and faces the greatest threats in its future. Over 50% of the land area comprising the habitat for this population is privately owned (USFWS 2018). The cities and towns of Apple Valley, Hesperia, Lancaster, Palmdale, Ridgecrest, Victorville, and Yucca Valley, along with many other smaller communities have been built in Joshua tree habitat in the YUBR South area. In recent decades these areas have grown rapidly, with the populations of Lancaster, Palmdale and Apple Valley all growing by approximately 36% between 2000 and 2018, Yucca Valley growing by 29.5% and Victorville by a staggering 93% during that same time period (SCAG 2019).

Human population growth in these areas and consequent loss of Joshua tree woodlands is expected to continue in the coming decades. The USFWS (2018), using the EPA's Integrated Climate and Land-Use Scenarios (ICLUS) modeling tool to predict future housing density growth in the range of the Joshua Tree, estimated that 41.6% of suitable habitat for *Y. brevifolia* in the YUBR South area would be lost to housing development by 2095 (Figure 19).[23] When combined with YUBR North, about a third of Joshua tree habitat would be lost for the species in California. Importantly, the ICLUS modeling done by USFWS only looks at housing density, not industrial, military or other development so likely represents an underestimate of development impacts.

In addition to urban growth, various other forms of development threaten Joshua tree habitat in California, including roads, highways, transmission lines, industrial facilities and large and small-scale renewable energy projects. While many of these impacts have been poorly quantified to date, according to USFWS (2018), renewable energy development has already resulted in the loss of 1.2% of mapped *Y. brevifolia* habitat, equating to about 68,000 acres. However, given USFWS included Nevada habitat in this calculation, while virtually all of the large-scale renewable energy development in the range of the species is in the YUBR South area, the actual total in California is likely closer to 2% of habitat lost to date. Under the Desert Renewable Energy Conservation Plan (DRECP) amendments to the California Desert Conservation Area (CDCA) Plan, of the 388,000 acres of development focus areas on BLM land subject to a streamlined review process to facilitate renewable energy development, approximately 50,000 acres fall within the mapped distribution for *Y. brevifolia* (USFWS 2018),

[23] In using the ICLUS model, USFWS (2018) ran development scenarios consistent with IPCC B1 and A2 climate scenarios. The 41.6% projection is from the A2 scenario which most closely matches current emissions trajectories. Under the lower-growth B1 scenario, 21.7% of YUBR South suitable habitat would be lost to housing development.

equating to more than 1% of additional habitat at risk from this type of development on federal lands and an unknown but potentially larger amount on private lands (Figure 19).[24]

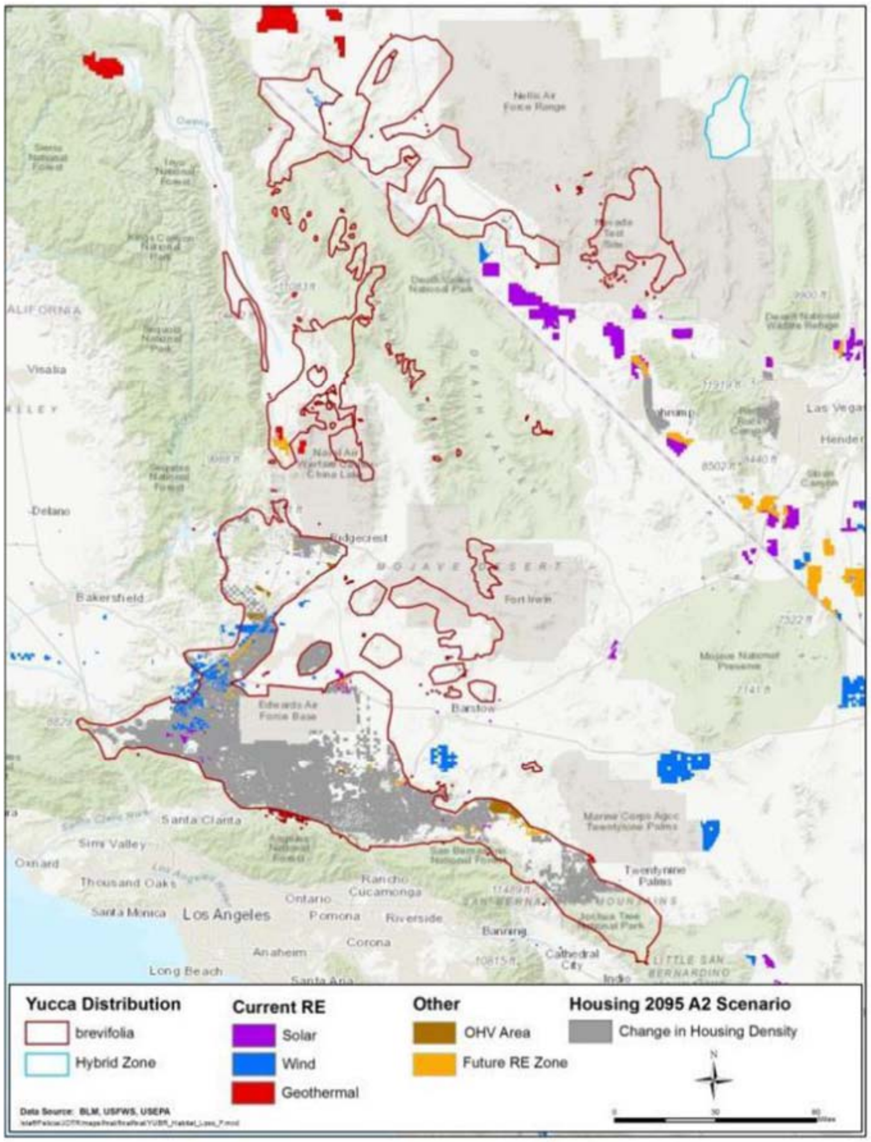

Figure 19: Map showing Joshua tree projected habitat loss due to urban grown, as well as current and projected habitat loss due to large-scale renewable energy projects. Source: USFWS (2018).

In sum, human development has already consumed hundreds of thousands of acres of habitat in the range of *Y. brevifolia*. Over the coming decades, over a million additional acres will be destroyed or degraded for housing, roads, energy projects and assorted other development (USFWS 2018). This large-scale loss or severe degradation of habitat is of conservation concern

[24] Notably, the Trump administration has initiated plans to roll back protections contained in the DRECP, which would likely subject additional areas of Joshua tree habitat to either renewable energy development or other forms of habitat degradation or destruction. https://www.blm.gov/california/BLM-to-consider-changes-desert-renewable-energy-conservation-plan.

for the species even absent the threats posed by climate change. However, given that *Y. brevifolia* in California will lose upwards of 90% of its range under likely climate scenarios, the added loss of habitat and the genetic resiliency and connectivity it provides will further push the species towards extirpation in California.

6 Degree and Immediacy of Threat

As demonstrated in the previous sections, the threats facing *Y. brevifolia* are severe and immediate. While extirpation is likely decades away, the species is already suffering the impacts of climate change, with recruitment failure and adult mortality at the hotter, lower elevation edges of its range (Barrows and Murphy-Mariscal 2012; Harrower and Gilbert 2018; Sweet et al. 2019). Moreover, the impacts of invasive grass fueled fire are already being felt, with approximately half of identified refugia areas in JTNP under moderate warming scenarios having burned in recent decades (Sweet et al. 2019). And perhaps most importantly, the impacts from current GHG emissions will continue to be felt for decades to come, with little time remaining to reduce such emissions before warming sufficient to drive *Y. brevifolia* to functional extinction becomes unavoidable. Consequently, while *Y. brevifolia* may not currently be "in serious danger of becoming extinct throughout all, or a significant portion, of its range," it is certainly likely to become so "in the foreseeable future." Cal. Fish & Game Code §§ 2062 & 2067.

7 Inadequacy of Existing Regulatory Mechanisms

No existing regulatory mechanism are currently in place at the international, national, state or local level that adequately address the threats facing *Y. brevifolia.*

7.1 Regulatory Mechanisms for Greenhouse Emissions Reductions

Given climate change is the greatest threat to the continued existence of the Joshua tree, ultimately the species cannot be saved absent global action to reduce such emissions. Unfortunately, such action is severely lacking in scale, speed and efficacy at all levels of government, both domestically and internationally.

The United States has contributed more to climate change than any other country. The U.S. is the world's biggest cumulative emitter of greenhouse gas pollution, responsible for 25 percent of cumulative global CO_2 emissions since 1850, and is currently the world's second highest emitter on an annual and per capita basis (Le Quéré et al. 2018). However, U.S. climate policy is wholly inadequate to meet the international Paris Agreement targets to avoid the worst dangers of climate change.

As summarized by the Fourth National Climate Assessment, efforts to mitigate greenhouse gas emissions do not approach the scale needed to avoid "substantial damages to the U.S. economy, environment, and human health and well-being over the coming decades":

> Climate-related risks will continue to grow without additional action. Decisions made today determine risk exposure for current and future generations and will either broaden or limit options to reduce the negative consequences of climate

> change. While Americans are responding in ways that can bolster resilience and improve livelihoods, neither global efforts to mitigate the causes of climate change nor regional efforts to adapt to the impacts currently approach the scales needed to avoid substantial damages to the U.S. economy, environment, and human health and well-being over the coming decades (USGCRP 2018).

In 2016, the U.S. committed to holding the long-term global average temperature to well below 2°C and "to pursue efforts to limit the temperature increase to 1.5°C above pre-industrial levels" under the international Paris Agreement. Existing U.S. domestic laws including the Clean Air Act, Energy Policy and Conservation Act and others provide authority to executive branch agencies to require greenhouse gas emissions reductions from virtually all major sources in the U.S., sufficient to meet the Paris Agreement temperature commitment.

However, the Trump administration has focused on pushing through harmful rollbacks of federal climate policy, and federal agencies are either failing to implement or only partially implementing domestic law and policy mandating greenhouse gas reductions. Trump administration rollbacks of federal climate policy include rescinding the Climate Action Plan, repealing and replacing the Clean Power Plan, a plan to dramatically expand offshore oil drilling in all oceans along U.S. coast, an attempt to rescind the Obama-era withdrawal of offshore drilling in U.S. federal waters in most of the Arctic and parts of the Atlantic, lifting of the moratorium on new federal coal leases, weakening emissions standards for cars and light duty trucks, delaying the implementation of methane emissions standards for new and modified oil and gas facilities, and the intended withdrawal from the Paris Agreement.

As a result, current U.S. climate policy has been ranked as "critically insufficient" by an international team of climate policy experts and climate scientists who concluded in September 2019:

> The Trump Administration has continued with its campaign to systematically walk back US federal climate policy. If it successfully implements all the proposed actions, greenhouse gas emissions projections for the year 2030 could increase by up to 400 MtCO2e over what was projected when President Trump first took office. That's almost as much as the entire state of California emitted in 2016 (CAT 2019).

To meet the carbon budget for keeping temperature rise below 1.5°C, most U.S. and global fossil fuels must remain undeveloped and fossil fuel production must be phased out globally within the next several decades (Rogelj et al. 2015). However, the U.S. is now the world's largest oil and gas producer and third-largest coal producer (OCI 2019) due to U.S. policies that aggressively promote ever greater fossil fuel production. For example, in 2005, Congress exempted fracking from the Safe Drinking Water Act in legislation known as the "Halliburton Loophole." Thereafter, fracking spread rapidly and facilitated a dramatic increase in U.S. natural gas and crude oil production (USEIA 2016). After Congress lifted the 40-year old crude oil export ban in December 2015, crude oil exports have skyrocketed and now hover at nearly three million barrels per day—about a quarter of all U.S. production (DiChristopher 2019). U.S. subsidies are also spurring fossil fuel production. A recent study assessing the impact of major federal and state subsidies on oil production found that these subsidies push nearly half of new oil investments into profitability, potentially increasing U.S. oil production by 17 billion barrels over the next few decades (Erikson et al. 2017). In short, U.S. policy is incentivizing rather than reducing fossil fuel production.

And while U.S. policy and emissions are going in the wrong direction under the Trump administration, the rest of the world is doing little better. As summarized by CAT (2019), current polices, if actually implemented by all nations, will still result in over 3°C of warming, and even if all pledges and targets make pursuant to the Paris Agreement were met, warming would still be on the order of 2.6 to 2.9°C (Figure 20). This level is far above the 1.5°C threshold the world needs to stay below to avoid the worst impacts of climate change.

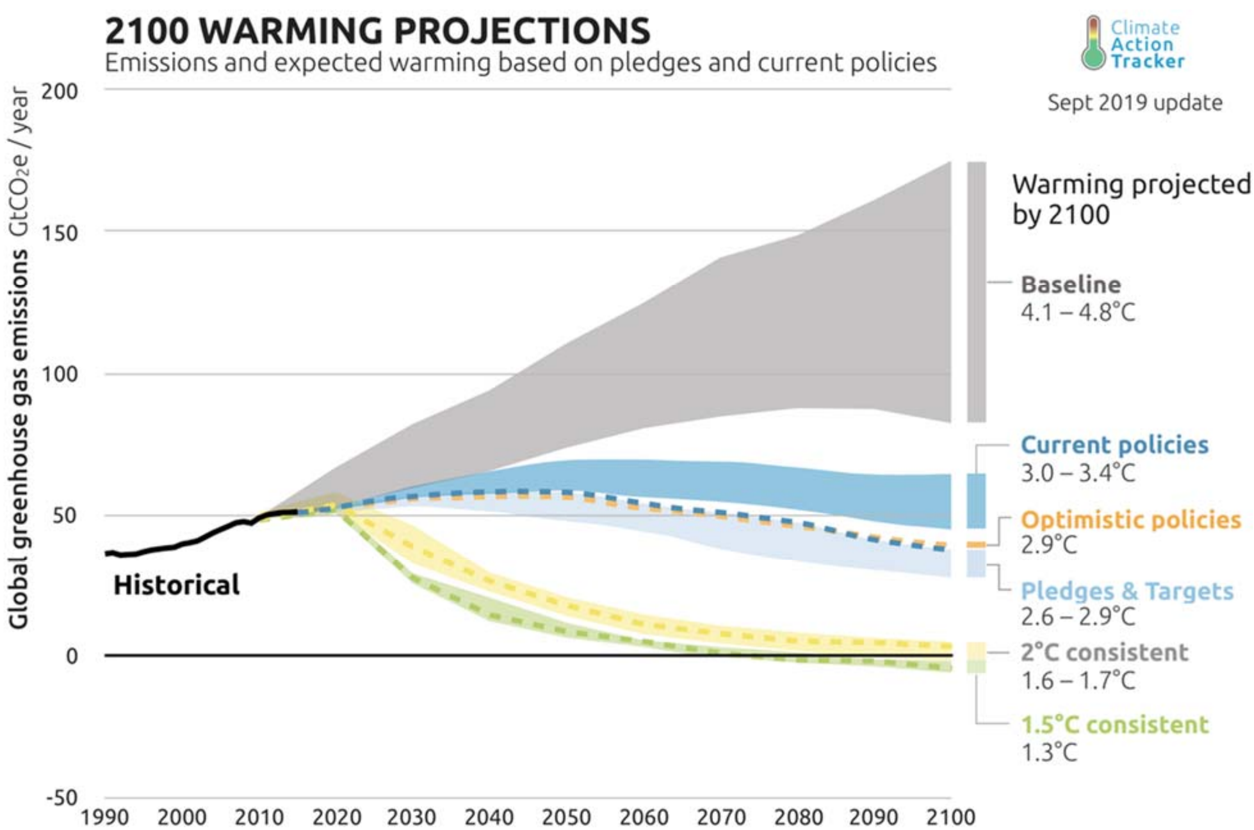

Figure 20: Graph showing mismatch between current emissions trajectories, international climate targets, and national policies and commitments. Source: CAT (2019).

In sum, both domestically and globally, government policies and commitments, not to mention actual actions, to avoid the worst impacts of climate change are woefully inadequate. These trends will lead to temperatures in the range of *Y. brevifolia* that are incompatible with reproduction and ultimately, survival of the species.

7.2 Mechanisms to protect habitat from fire, development and other threats

While the lack of effective regulatory mechanisms to address greenhouse pollution is largely determinative as to the question of whether *Y. brevifolia* qualifies for CESA protection, mechanisms to protect the species from other threats are also insufficient.

7.2.1 Invasive species and fire

To date no legal, regulatory or management efforts have demonstrative effectiveness at addressing the severe threat that invasive species and consequent altered fire regimes pose to Joshua trees. While the National Park Service (NPS) has updated it fire management plans to address the increased threat of fire to the species, large fires continue to be a significant threat in JTNP (Sweet et al. 2019). Other areas in the species' range lack species-specific fire management plans. And while immediate suppression of fires in *Y. brevifolia* habitat can limit the spread of fires, protection of the species from fire ultimately requires invasive species management to reduce the fuel load. Given invasive species spread and abundance is linked to both disturbance (e.g. roads, ORVs, cows, urbanization) (Brooks and Berry 2006) and nitrogen deposition (Allen et al. 2009; Allen et al. 2011), each of these contributing factors will need to be addressed.

Disturbance is somewhat limited in the portions of the range of *Y. brevifolia* within national parks, but these areas harbor only approximately 10% of the species' current suitable range in California. The vast majority of the species' range in the state is on BLM, military and private lands that are not managed primarily for species protection and include activities such as ORV use, cattle grazing, military training, urban sprawl and activities that foster the spread of invasive species and/or the ignition of fires (USFWS 2018).

Notably, BLM recently (10/3/19) approved a Record of Decision for a vehicle route network in the West Mojave Planning Area, which encompasses the entire range of YUBR South and a portion of YUBR North. About a quarter of mapped Joshua tree habitat in YUBR South is on BLM land, while over half of YUBR North habitat is on BLM land. BLM approved an expansive ORV route network of 6000 miles of open vehicle routes in the plan area, ensuring that any public lands outside of wilderness will be highly fragmented, directly degrading habitat, exacerbating the spread of invasive species and increasing the number of human-caused ignitions (BLM 2019).

Nitrogen deposition impacts both disturbed and relatively undisturbed areas, with JTNP being one of the areas in the range of *Y. brevifolia* worst impacted by nitrogen deposition (Allen et al. 2011; Figure 10). As summarized by, Pardo et al. (2011), the threat is dire: "In Joshua Tree National Park in southern California, N deposition favors the production of sufficient invasive grass biomass to sustain fires that threaten the survival of the namesake species."

It is unlikely that nitrogen deposition will be adequately reduced throughout the range of *Y. brevifolia* for at least several decades, if ever. In the western areas of JTNP, nitrogen deposition is largely derived from nitric oxides (HNO_3) coming from automobile and powerplant pollution blown in from the greater Los Angeles area (Allen et al. 2009). In the eastern part of the park, deposition is largely from ammonia (NH_3) from local agricultural sources in the Coachella and Imperial Valleys (Allen et al. 2009). High rate of nitrogen deposition in the far western Mojave likely originate from a mix of smokestack and tailpipe pollution and agricultural sources in the San Joaquin Valley (Bytnerowicz et al. 2016). Even if California successfully decarbonizes its vehicle fleet and power generation in the coming decades, nitrogen deposition from large-scale agriculture will likely continue to impact large areas of *Y. brevifolia* habitat for the foreseeable future.

Moreover, even if disturbance and nitrogen deposition are reduced and the further spread of invasive species can be curtailed, no fully-effective treatments currently exist to reduce or eliminate at a landscape scale the most pernicious invasive species (e.g. *Bromus* spp., *Schismus* spp., *Erodium cicutarium*), *Brassica tournefortii*) that have already become established in significant portions of the range of *Y. brevifolia* (Brooks et al. 2018).

7.2.2 Habitat loss and degradation

As discussed above, *Yucca brevifolia* stands to lose upwards of a third of its suitable habitat in California to development over the coming decades, including over 40% of its habitat in the YUBR South region. No existing state or federal regulatory mechanisms are currently operative in a manner that will meaningful reduce this threat.

State and local mechanisms

A relatively small portion of the range of *Yucca brevifolia* occurs within California State Parks, including Red Rock Canyon State Park and Eastern Kern County Onyx Ranch State Vehicular Recreation Area in Kern County and Saddleback Butte State Park, Arthur B. Ripley Desert Woodland State Park, and Antelope Valley California Poppy Reserve in Los Angeles County. Collectively these make up less than 1% of the species range in the state (USFWS 2018). While these areas are protected from urban development and are generally to be managed for the protection of park resources, they alone are unlikely to prevent the decline and eventual extirpation of Joshua trees from the region. Saddleback Butte and Arthur B. Ripley Desert Woodland State Parks are small and isolated islands of protected habitat, comprised of approximately 3000 and 500 acres respectively. Antelope Valley California Poppy Reserve is approximately 1800 acres but contains only a few isolated clusters of Joshua trees. Red Rock Canyon State Park at approximately 27,000 acres is much more substantial in size, but is faced with many management challenges similar to adjacent BLM lands, particularly a proposed increase in ORV use in the Park. Similarly, the newly-created Eastern Kern County Onyx Ranch State Vehicular Recreation Area contains some Joshua tree woodland but is managed primarily for ORV use.[25] In any event, even if all other threats to *Y. brevifolia* in these parks were effectively managed, climate change and fire still threatened to extirpate the species from these parks over the coming decades.

The California Desert Native Plants Act, Cal. Food & Agricultural Code §§ 80001 – 80201, was passed "to protect California desert native plants from unlawful harvesting on both public and privately owned lands." *Id*. at § 80002. Joshua trees are explicitly regulated under this provision. *Id*. at § 80073(a)("yuccas") & 80101(b)(1) (setting price for *Y. brevifolia* permits). The Act generally prohibits harvest of desert plants absent permits issued by the relevant county agricultural commissioner or sheriff. *Id*. at § 80073. Land clearing for agriculture and various

[25] Information on each of these parks is available at https://www.parks.ca.gov/.

other forms of development activities are generally exempted so long as the plants are not offered for sale and proper notice is given. *Id*. at § 80111. The statute also includes provisions designed to assure the survival and transplant of desert plants that are harvested pursuant to permits. *Id*. at § 80116. The Department of Fish and Wildlife is tasked with enforcing the statute. Cal. Fish & Game Code § 1925 ("The Department shall enforce the provisions of the California Desert Native Plants Act").[26]

Commercial collection was once seen as perhaps the greatest threat to the Joshua tree and other desert plants, As described in an early account about the threats commercial harvesters presented to the species in southern California, "As soon as they began to realize their beauty and unique character there began a wholesale foray into the desert to dig them up…At the present rate of destruction the cactus of the desert and the Joshua trees will be gone within two years" (Carr 1930). Various state and local laws and ordinances were ultimately passed to address this threat, including the California Desert Native Plants Act. While these measures have been largely effective at reducing the commercial harvest of Joshua trees, they have done little to slow the loss of habitat from agricultural conversation and development in the range of the species.

Among the local jurisdictions in the range of *Y. brevifolia* that currently have plant protection ordinances or other measures that nominally protect Joshua trees are Hesperia, Palmdale, Victorville, Yucca Valley, and Los Angeles and San Bernardino counties. While all of these provisions require consideration of Joshua tree retention in development plans, most exempt single-family homes and none act as an actual bar to tree removal, instead usually requiring transplantation, donation or making available for adoption trees removed from construction sites. *See, e.g*. Palmdale Municipal Code §§ 14.04.010 *et seq*. (requiring preservation of two Joshua trees per acre but allowing this metric to be met by donating removed trees to an offsite City-administered tree bank); Yucca Valley Ordinance 140 (allowing removal of Joshua trees for transplant if they interfere with "approved improvements or other ground disturbing activities" and "best efforts" are made to avoid the need to remove them).

The California Fish and Game Commission noted the inadequacy of these approaches when it adopted its California Policy for Native Plants in 2015:

> The State's policies and practices regarding native plants are in need of review and updating. More than 30 years ago state law focused on transplantation as a means of mitigating for listed plant species, however experience and numerous studies document that such practices are largely ineffectual over time and often damaging to species or population survival.[27]

In sum, the California Desert Native Plants Act and similar local ordinances are, as recognized by the Commission, "largely ineffectual" at protecting imperiled plant species from habitat loss. These provisions may result in the near-term preservation of individual adult Joshua

[26] A similar statute, the Native Plant Protection Act provides comparable protections for "endangered or rare" native plants. Cal. Fish & Game Code §§ 1900-1913. The Joshua tree is not among the species regulated by this statute.
[27] Available at https://fgc.ca.gov/About/Policies/Miscellaneous.

trees in urban and suburban neighborhoods, but these areas are less likely to remain habitat long-term. Successful recruitment in such areas is likely constrained by lack of nurse plants and it remains highly uncertain whether pollinating moths will be able to persist with the resultant low Joshua tree densities (Harrower and Gilbert 2018)("Having robust, dense, flowering trees is important to support and attract enough moths for successful seed set"). Consequently, these measures are inadequate to prevent extensive loss of Joshua tree habitat in the near-term and for the foreseeable future.

Other state statutes also are inadequate to protect Joshua trees from habitat loss. The California Environmental Quality Act (CEQA) is California's landmark environmental law and establishes a state policy to prevent the "elimination of fish or wildlife species due to man's activities, ensure that fish and wildlife populations do not drop below self-perpetuating levels, and preserve for future generations representations of all plant and animal communities...." Cal. Pub. Res. Code § 21001(c). Towards this end, state and local agencies are required to analyze and disclose the impacts of any discretionary decision or activity. CEQA contains a substantive mandate that agencies should not approve projects as proposed if there are feasible alternatives or mitigation measures which would substantially lessen the significant environmental effects of such projects. Cal. Pub. Res. Code § 21002.

CEQA requires a "mandatory finding of significance" if a project may "substantially reduce the number or restrict the range of an endangered, rare or threatened species." Cal. Code Regs., tit. 14, § 15065(a)(1). CDFW has interpreted this provision to apply to species of special concern, which are species that are "experiencing, or formerly experienced, serious (noncyclical) population declines or range retractions (not reversed) that, if continued or resumed, could qualify it for State threatened or endangered status."[28] CDFW further provides that species of special concern "should be considered during the environmental review process." *Id.*; Cal. Code Regs., tit. 14, § 15380. Thus, a potentially substantial impact on a species of special concern, threatened species, or endangered species could be construed as "per se" significant under CEQA. *Vineyard Area Citizens for Responsible Growth, Inc. v. City of Rancho Cordova* (2007) 40 Cal.4th 412, 449. And under CEQA, when an effect is "significant," the lead agency approving the project must make a finding that changes or alterations have been incorporated into the project to avoid or mitigate its significant impacts, or that such changes are within the responsibility of another agency, or that mitigation is infeasible. Cal. Pub. Res. Code § 21081(a). These provisions therefore provide some protections to species that are listed as species of special concern, threatened, or endangered.

However, Joshua trees are not listed as a species of special concern or as threatened or endangered, such that a project that has the potential to impact the species would not necessarily qualify as a "significant effect" under a lead agency's interpretation of CEQA. In such case, CEQA's substantive mandate to adopt all feasible alternatives or mitigation measures might not be triggered.

CEQA also requires a "mandatory finding of significance" if a project may "substantially

[28] California Department of Fish and Wildlife, *Species of Special Concern*, available at https://www.wildlife.ca.gov/Conservation/SSC.

reduce the habitat of a fish or wildlife species; cause a fish or wildlife population to drop below self-sustaining levels; threaten to eliminate a plant or animal community." Cal. Code Regs., tit. 14, § 15065. Moreover, CEQA's "Environmental Checklist" in Appendix G of the CEQA Guidelines characterizes a project's effects as "significant" if the project would "[c]onflict with any local policies or ordinances protecting biological resources, such as a tree preservation policy or ordinance."

While these provisions might theoretically offer some protection for Joshua trees, in practice they have not provided sufficient protection. Under CEQA, lead agencies have discretion to develop their own thresholds of significance. *East Sacramento Partnerships for a Livable City v. City of Sacramento* (2016) 5 Cal.App.5th 281, 300; Cal. Code Regs., tit. 14, § 15064(d). This allows local agencies—who are often under pressure from developers to approve projects—to make significance determinations that are inconsistent with independent scientific analysis, including CDFW's analysis.

Even when a lead agency acknowledges that an effect is "significant," CEQA allows a lead agency to adopt a "statement of overriding considerations" and approve a project if the agency finds that other factors outweigh the environmental costs of the project or that further mitigation is infeasible. Cal. Code Regs., tit. 14, § 15093(b); Cal. Pub. Res. Code § 21081. This means that even if a project may have a significant effect on a Joshua tree population, an agency could interpret CEQA as still allowing approval of the project. CEQA in practice is therefore inadequate to protect Joshua trees.

The Natural Community Conservation Planning Act is a voluntary conservation planning mechanism for proposed development projects within a planning area to avoid or minimize impacts to wildlife. Cal. Fish & Game Code §§ 2800-2835. The Act is designed to promote coordination among agencies and landowners to conserve unfragmented habitat areas and multihabitat management. Cal. Fish & Game Code § 2801(d).[29] The Act can also serve as a mechanism to authorize take of CESA listed species. *Id*. at § 2835.

There are no finalized Natural Community Conservation Plans (NCCPs) that cover the Joshua tree. One approved NCCP, the Coachella Valley MSHCP approaches the southern edge of the range of *Y. brevifolia* but does not include the species as a covered species. An NCCP that does overlap the range of the Joshua tree is the proposed Town of Apple Valley MSHCP.[30] This NCCP has been under development for several years with a planning agreement signed in 2017. However, *Y. brevifolia* is not on the proposed list of covered species for the NCCP. Previously, both the West Mojave Plan and the DRECP were intended to be joint plans covering both federal BLM lands and private lands subject to development, but each was ultimately implemented as a federal-only plan, neither of which treat the Joshua tree as a covered species. These plans are further discussed below. In sum, NCCPs may in the future provide some conservation benefit for Joshua trees, but have not done so to date and consequently cannot be considered as providing adequate protection in lieu of CESA listing.

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[29] The NCCP Act is described on CDFW's website at https://www.wildlife.ca.gov/conservation/planning/NCCP.
[30] Documents available at https://www.wildlife.ca.gov/Conservation/Planning/NCCP/Plans/Apple-Valley-MSHCP

Federal mechanisms

The primary federal regulatory mechanism with the potential to protect Joshua trees are management laws and plans governing federal lands. Almost all of the suitable habitat in YUBR north and half within YUBR South is on federal land. Consequently, management of these lands has an important role to play in determining the continued viability of Joshua trees in the state. As discussed above, approximately 10% of *Y. brevifolia* habitat is on NPS lands that are generally well-managed and should prevent significant habitat loss or degradation from activities such as ORV use, cattle grazing, road building or other forms of development. However, even within Death Valley National Park, the 86,400-acre Hunter Mountain Allotment is still active and overlaps with the range of *Y. brevifolia* in the park (NPS 2012). Nevertheless, these lands represent the best opportunities for active management measures to reduce the risk of fire and otherwise attempt to maintain *Y. brevifolia* on the landscape in the face of projected warming.

About 12 percent of the mapped distribution of the YUBR South population falls within military installations and a roughly comparable amount of the YUBR North population falls within such lands (USFWS 2018). The four bases in California with Joshua tree habitat - Edwards Air Force Base, Fort Irwin National Training Center, China Lake Naval Weapons Station and Twentynine Palms Marine Corps Air Ground Combat Center - have each developed Integrated Natural Resource Management Plans (INRMPs) pursuant to the Sikes Act, 6 U.S.C. §§ 670a-670o, that incorporate some avoidance and minimization measures that could reduce impacts to Joshua trees. These measures are summarized in USFWS (2018) and largely consist of avoidance where feasible and transplantation when conflicts are unavoidable. These measures largely mirror those required for private lands under state and local ordinances, which as discussed *supra*, are in the Commissions own words, “largely ineffectual.”

The majority of Joshua tree habitat on federal lands is on BLM lands. These areas are governed by the agency’s California Desert Conservation Area (CDCA) Plan as amended. The Northern and Eastern Mojave Plan (NEMO) area overlaps with most of the California range of the YUBR North populations and the West Mojave Plan (WEMO) area covers all of YUBR South and the southwestern portion on YUBR North. The 2016 Desert Renewable Energy Conservation Plan (DRECP) amendments cover the entirety of the species’ range in California. None of these plans provide adequate protection for *Y. brevifolia*. area

BLM’s NEMO plan does virtually nothing to specifically protect Joshua trees. The species is not mentioned in the Record of Decision (ROD) at all, and the only specific protection afforded to it is a prohibition on collecting downed trees for firewood (BLM 2002). Notably, Joshua tree protection is explicitly excluded from the plan’s measure to limit surface disturbance below certain thresholds:

> It should be noted that some important plants, such as Joshua trees, which are important as an overstory plant but are not dominant, would not be a part of the evaluation trigger. Reestablishment of such plants could, of course, be a restoration requirement for a particular project, but they would not be used to trigger an evaluation for the purposes of reducing the cumulative disturbance total (BLM 2002).

In short, the NEMO plan was not designed with the intent of protecting Joshua trees, and the BLM apparently did not wish to have protection of the species act a barrier to any potential land-disturbing activities.

The WEMO plan is little better. As with NEMO, its ROD does not mention Joshua trees at all. The FEIS for the plan amendment was developed when the project was to also be a habitat conservation plan (HCP) covering private development in the plan area. In this context it discusses existing and proposed preservation of Joshua tree woodlands in the Antelope Valley by state and local entities, but the only specific conservation measure for Joshua trees that BLM itself takes is to prohibit harvesting of Joshua trees in designated conservation areas (BLM 2006). Given state law already prevents such harvest, this conservation measure is illusory. BLM approved the WEMO plan as a federal only plan with no HCP component. Under this alternative, BLM estimated that 54.1% of Joshua tree woodland habitat could be lost (BLM 2006).[31]

BLM recently completed an amendment to the WEMO plan dealing with vehicle routes (BLM 2019). Under this plan amendment, the route network is expanded to approximately 6000 miles of roads and trails open to ORVs. The ROD does not mention Joshua trees, the FSEIS does not meaningfully address impacts to Joshua trees, and the plan amendments do not add any specific measures to protect the species. Mentions of Joshua trees are cursory in the FSEIS, with for example, in a chart of subregions of the plan area, for one area BLM states that it "has an extensive Joshua Tree forest," and immediately thereafter notes that "Gently terrain and good soils make ideal provide ideal OHV touring opportunities" [typos in original].[32] In the ROD, BLM also reaffirms cattle grazing on all active allotments (BLM 2019). As discussed *supra*, invasive species and consequently fuel loads, and well as human-caused ignitions increase in areas subject to disturbance such as cattle grazing and ORV use (e.g. Brooks and Berry 2006). The recent plan amendment will both directly degrade Joshua tree habitat via increased vehicle use, while also indirectly exacerbating the conditions that lead to more frequent and more intense fires.

The more recent DRECP started as both a BLM plan and a state NCCP. Consequently, the environmental documents associated with it address the conservation of Joshua trees more directly than the overlapping BLM plans. However, the DRECP was ultimately adopted as a BLM-only plan, rendering much of the proposed broader conservation uncertain. Among the Joshua tree measures BLM adopted are an objective listed as "Conserve unique landscape features, important landforms, and rare or unique vegetation types identified within the BLM Decision Area, including…Areas of dense Joshua Tree woodland." To meet this objective, the DRECP requires that for new actions, Joshua tree impacts are to be assessed in planning

[31] As discussed in the Distribution section *supra*, "Joshua tree woodland" represents only a portion of the habitat types where the species occurs. However, it is the densest and highest quality habitat for the species.

[32] The only other "analysis" of impacts to Joshua trees in the FSEIS, is an assertion repeated verbatim multiple time in the document that attempts to minimize harm from vehicles: "In remote or mountainous areas, most travel is confined to roads, so that the woodland communities (Joshua tree woodland, scrub oak, pinyon pine woodland, juniper woodland) suffer relatively fewer direct vehicle impacts" (BLM 2019).

decisions and "impacts to Joshua tree woodlands will be avoided to the maximum extent practicable, except for minor incursions" (BLM 2016).[33] In addition to the specific measures for Joshua trees, their habitat would likely gain better protection from various land designations made under the DRECP. However, the benefits for the species derived from the DRECP amendments to the CDCA Plan are in doubt, as the BLM announced that is was planning to revisit the conservations measures of the plan. *See* Notice of Intent to Amend the California Desert Conservation Area, Bakersfield, and Bishop Resource Management Plans and Prepare Associated Environmental Impact Statements or Environmental Assessments, 83 Fed. Reg. 4921 (February 2, 2018). That amendment process is currently ongoing.

In sum, outside of national parks and areas of congressionally designated wilderness, federal land management plans in the range of *Y. brevifolia*, if they address the species at all, at best provide for avoidance of harm to the extent "practicable" or "feasible." Such protection is inadequate in the face of the difficulties the species will face in a rapidly changing climate.

8 USFWS's Flawed Endangered Species Act Determination.

The strongest federal regulatory mechanism that could protect *Y. brevifolia* is the federal Endangered Species Act (ESA). However, on August 15, 2019 the USFWS found that listing Joshua trees (*Y. brevifolia* and *Y. jaegeriana*) throughout their multistate range was not warranted. Endangered and Threatened Wildlife and Plants; 12-Month Findings on Petitions to List Eight Species as Endangered or Threatened Species, 84 Fed. Reg. 41694 (August 15, 2019) (USFWS 2019). The finding was made in response to a 2015 petition by WildEarth Guardians seeking such listing.

While the 2018 species status assessment prepared by USFWS and relied upon by the agency in its decision is informative as to many aspects of Joshua tree taxonomy, natural history, distribution and threats, its conclusions are not at all determinative to the question of whether *Y. brevifolia* warrants listing under CESA. Most importantly, USFWS (2018) assessed whether Joshua Trees in their four-state range were threatened or endangered. And to the degree that the agency considered *Y. brevifolia* separately from *Y. jaegeriana*, it never examined the species' status in just California, rather than California and Nevada combined. Under CESA, the only question is whether the species in imperiled in California. As both CDFW and the Commission have concluded—and appellate courts have upheld—the term "range" under CESA is construed to refer to the range of a species *within* California, not the worldwide range of the taxa. *California Forestry Assn. v. California Fish & Game Com.* (2007) 156 Cal.App.4th 1535, 1550-551.

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 59ºC (138ºF). The same metric was used for all age classes, from seedlings to adults. This threshold

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[33] DRECP documents are available at https://eplanning.blm.gov/epl-front-office/eplanning/planAndProjectSite.do?methodName=dispatchToPatternPage&currentPageId=95675

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.[34] 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 45ºC (113ºF).[35]

USFWS (2018) also 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.

Another severe limitation of USFWS (2018) is the complete discounting of species distribution modeling, which currently represents the best available science on the future status of the western Joshua tree. The agency admits that it did not carry out any such modeling, claiming that having quantitative information is somehow at odds with its goals in carrying out a status assessment.

> We did not model future distribution based on predicted climate change scenarios. Instead, we used future scenarios to perform a qualitative evaluation of the impact of climate change on the current distribution. … Our goal was to present information related to future climate outcomes, not to evaluate quantitative assessments of climate change on future Joshua tree distribution, therefore we did not construct ecological niche models (e. g., species distribution models) (USFWS 2018).

What USFWS claims it did in lieu of deploying ecological niche modeling was scenario planning, citing to Star et al. (2016) for its rationale.

> Rather than focusing only on the most likely predictions, scenario planning identifies a range of possible future states. Scenarios are not predictions, and probabilities are not assigned to specific outcomes. By recognizing the limits of projections and acknowledging deep uncertainty, decision makers are not restricted to preparing for

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[34] By way of comparison, according to industrial safety standards, a human can safely touch items as hot a 140°F without burning their hand, but prolonged exposure to air temperature of 140°F would lead to heat stress and ultimately be fatal.

[35] Among the various temperature ranges listed for the species in the wild, the highest is reported by Lenz (2001) as 51°C (124°F), which presumably corresponds to a one-time daily maximum temperature recorded somewhere in the species' range; this temperature is well above the average summer maximum of the hottest place in the United States, Furnace Creek in Death Valley (July average of 47°C (116°F)).

> only one outcome, and can still act in the face of climate change while retaining flexibility.

USFWS (2018) also cites two older studies in an attempt to undermine the utility of such studies as well as the feasibility of doing them with regard to Joshua trees.[36]

> Furthermore, ecological 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, p. 362). 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.

The problems with USFWS's approach are many. First, USFWS did not *itself* need to model future distribution of Joshua trees, as this has already been done my multiple researchers, with Cole et al. (2011), Barrows and Murphy-Mariscal (2012) and Sweet et al. (2019) employing the most sophisticated of such efforts. Nowhere in USFWS (2018) is there even an acknowledgement that such modeling efforts have been undertaken and reported in these studies.[37]

Second, while scenario planning may be useful in recovery planning or otherwise preparing for management responses to climate change, it has little utility in determining whether a species is "likely" to become endangered in the foreseeable future, as required by the ESA and CESA. 16 U.S.C. § 1532(20); Cal. Fish & Game Code § 2067 (ESA and CESA definitions of threatened species). In effect, USFWS (2018) is acknowledging that "[r]ather than focusing only on the most likely predictions" it instead applied a more nebulous framework that allowed it to "retain flexibility" and disregard not just the best available science, but also the plain language of the ESA.

Third, USFWS's reliance upon Pearson and Dawson (2003) and Fitzpatrick and Hargrove (2009) for it critique of ecological niche models is misplaced. The concerns raised by Pearson and Dawson (2003) and Fitzpatrick and Hargrove (2009) about the limitations of certain niche modeling efforts may be valid, but Cole et al. (2011), Barrows and Murphy-Mariscal (2012) and Sweet et al. (2019) all employed the measures raised by these earlier authors to improve the accuracy of their modeling, including, most importantly, validating their models against the current distribution of the species. Pearson and Dawson (2003) also note that information on dispersal abilities should also be included in modeling where possible, a factor clearly addressed in Cole et al. (2011).

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[36]Neither of these studies, nor Star et al. (2016), appear in the references section of USFWS (2018), indicating that they may have been added at the last-minute in an attempt to justify a legally and scientifically dubious conclusion.

[37]Elsewhere in the document, USFWS (2018) cites to Cole et al. (2011) and Barrows and Murphy-Mariscal (2012) for other aspects of Joshua tree natural history or range. Sweet et al. (2019) had not been published at the time of USFWS (2018) but was released prior to the actual listing decision being published and should have factored into the final decision.

Additionally, the primary concern of Fitzpatrick and Hargrove (2009) is that climate change and future conditions will create novel environments with new species interactions, including many invasive species. This makes predictions about future species distribution less reliable, unless they account for such factors. But these concerns are addressed by Cole et al. (2011), Barrows and Murphy-Mariscal (2012) and Sweet et al. (2019) who examined the current and past status of *Y. brevifolia* across environmental gradients (elevation and latitude) and used increasingly finer-scale species distribution and climate data to refine their model outputs. Moreover, unlike USFWS who discarded such modeling entirely, Pearson and Dawson (2003) explicitly acknowledged the utility of such models: "In many cases, bioclimate envelope models provide perhaps the best available guide for policy making at the current time." In the decade and half since this statement was published, such models have improved greatly and are even more useful for informing policy decisions.

Finally, USFWS's failure to rely upon the published species distribution models was strongly criticized by one of the peer-reviewers of the status assessment.

> [T]he assessment has not completed, and does not incorporate, a species distribution model, and thus draws invalid conclusions about future distributions under various climate change scenarios. Unfortunately, the problems are significant enough that the assessment's conclusions are not scientifically sound, and should not be used for making a decision regarding whether to list Joshua trees under the ESA (Smith 2018).

Smith (2018) noted that species distribution models are the "accepted standard" for assessing future distribution of a species, described the finding of the various modeling efforts to date, compared these to the conclusions of the status assessment, and concluded that "[g]iven that the USFW assessment has not followed the conventional standards in the field for predicting future distributions, and makes predictions that are starkly different than those drawn by other workers making comparable model assumptions, I consider the assessment's conclusions to be highly dubious." Smith (2018) concluded with the recommendation that "[f]irst and foremost, the assessment simply MUST include a formal species distribution model." (emphasis in original).

Smith (2018) also pointed out that the estimation of "suitable habitat" for Joshua trees was overstated in the status assessment.

> [T]he way that 'suitable habitat' has been defined ignores important recent work on demographic trends in Joshua trees, with the result that the potential distribution of Joshua tree under current climate conditions is vastly overestimated.

Specifically, Smith (2018) pointed out USFWS (2018) had not taken into account climate change that has already occurred when it delineated such habitat.

> In identifying the climate requirements for Joshua tree, the assessment uses the current distribution to determine suitable habitat.… There are two significant, interrelated problems with these assumptions. First, the current distribution of Joshua

> tree includes individuals who are hundreds of years old, and that became established during pre-industrial climate conditions when global average temperatures were a full degree cooler than they are today, and about 0.75 degrees cooler than the 30-year average. Indeed, it is well established that long-lived trees can persist as relict stands of moribund adults that exist outsides the range of suitable habitats required for long term population persistence.
>
> In the case of Joshua trees in particular, we have very compelling evidence that the current distribution of mature trees does not reflect the climate requirements for successful germination and seedling establishment. For example, extensive mapping studies in Joshua Tree National Park found that seedlings occur only in a fraction of the area occupied by adults, and that this area corresponds to the predicted distribution under a 2-degree warming scenario (Barrows and Murphy-Mariscal, 2012). That is, the suitable habitat for seedlings is much smaller, includes a narrower range of climates, than would be predicted based adult presence data. Although the Barrows and Murphy-Mariscal study considered only a small portion of the geographic range of Joshua trees, other workers have found similar patterns across the Joshua trees range.

Smith (2018) concluded that these errors rendered the conclusions of the assessment unreliable: "I consider the current assessment to not be based on the best available science, and its conclusion have no valid scientific basis." USFWS did not address either of the primary problems identified by Smith (2018) when it finalized the status assessment.

In sum, USFWS's determination to not protect Joshua trees under the ESA should not, and legally cannot, be a basis to fail to protect *Y. brevifolia* under CESA.

9 The Western Joshua Tree Warrants Listing under CESA.

As detailed above, in conformance with the requirements of Cal. Code Regs., tit. 14, § 670.1, this petition presents scientific information regarding the western Joshua tree's life history, population trend, range, distribution, abundance, kind of habitat necessary for survival, factors affecting the ability to survive and reproduce, degree and immediacy of threat, impact of existing management efforts, suggestions for future management, availability of sources and information, and detailed distribution maps.[38]

That information clearly demonstrates that the western Joshua tree (*Yucca brevifolia*) is eligible for and warrants listing under CESA based on the factors specified in the statute and implementing regulations. While *Y. brevifolia* is not at imminent risk of extinction, it still faces significant and growing threats, primarily from climate change, that ultimately threaten the viability of the species in all or a significant portion of its range in California in the foreseeable future; it consequently meets the definition of a "threatened species."

[38] Information on suggestions for future management and availability of sources and information are contained in the Management Recommendations and References sections *infra*.

Under CESA, a "threatened species" is "a native species or subspecies of a … plant that, although not presently threatened with extinction, is likely to become an endangered species in the foreseeable future in the absence of the special protection and management efforts . . . ." Cal. Fish & Game Code § 2067. A plant is an "endangered species" when it is "in serious danger of becoming extinct throughout all, or a significant portion, of its range due to one or more causes, including loss of habitat, change in habitat, overexploitation, predation, competition, or disease." Cal. Fish & Game § 2062.

Moreover, CDFW has concluded—and appellate courts have upheld—that when determining whether a species is threatened or endangered under CESA, the term "range" is construed to refer to the range of a species or subspecies *within* California, not the worldwide range of the species or subspecies. *California Forestry Assn. v. California Fish & Game Com.* (2007) 156 Cal.App.4th 1535, 1550-551. This means that regardless of how *Y. brevifolia* may fair in Nevada, the Commission and CDFW can only consider the status and fate of the species in California.

Additionally, in determining the foreseeable future in the context of climate change, CDFW has treated the rest of the century as foreseeable.

> In considering what the 'foreseeable' future is for climate change effects, the Department relied on climate change projections to the end of the 21st century, as described by the Fourth Assessment Report of the Intergovernmental Panel on Climate Change (IPCC 2007). The IPCC models and projections have been thoroughly vetted and validated in the series of Assessment Reports produced over the past 12 years. The Department considers the climate change projections to be the best available information on global climate change (Bonham 2013).

As discussed in the climate sections above, absent rapid and substantial reductions in greenhouse gas emissions, the best available science demonstrates that by the end of this century *Y. brevifolia* will be extirpated from, at a minimum, a significant portion of its range in California. Any places it remains will be in small, isolated refugia. These areas, if any, will likely be populated with low numbers of non-reproductive adult trees, themselves threatened by fire. At such point, if not already extirpated from the state, the species will certainly be "in serious danger of becoming extinct throughout all, or a significant portion, of its range" in California and be an "endangered species." Consequently, it is a "threatened species" today.

In the event the Commission determines that full-species taxonomy for the western Joshua tree is not sufficiently established, petitioners request listing of the taxa as a subspecies/variety *Yucca brevifolia brevifolia*. Additionally, while petitioners believe that the western Joshua tree warrants protection under CESA throughout its range in California, if the Commission determines that it does not warrant range-wide listing, the Commission must assess whether either of the two population clusters of the species, YUBR North and YUBR South separately warrant listing as ecologically significant units (ESUs).

The Commission and CDFW have long recognized that ESUs can be designated and listed under CESA, and this interpretation of CESA has been upheld by the courts. *See California*

Forestry Assn. v. California Fish & Game Com. (2007) 156 Cal.App.4th 1535, 1540 ("Consistent with the policy of the CESA, we will hold that the term 'species or subspecies' includes evolutionarily significant units"); *Central Coast Forest Assn. v. Fish & Game Com.* (2018) 18 Cal.App.5th 1191, 1197, fn. 4 ["*CCFA II*"] ("An ESU is included within the term 'species or subspecies' in sections 2062 and 2067."). While the ESU concept has primarily been applied to fish, the Commission recently listed an ESU of a mammal, the Pacific Fisher, as a "threatened species." *See* 14 C.C.R. 670.5(b)(6)(J) ("Fisher (*Pekania pennant*) Southern Sierra Nevada Evolutionarily Significant Unit"). Moreover, unlike the federal ESA, where listing of distinct populations segments (DPSs), of which ESUs are subcategory, is restricted to vertebrate species (16 U.S.C. § 1532(16) (definition of "species"), the ESU concept under CESA has no such limitation and applies to all listable taxa, including plants.

The populations currently delineated as YUBR North and YUBR South have been recognized for over 40 years and recently confirmed by USFWS (2018).

> Rowlands (1978, p. 72) subdivided the Joshua tree range into five regions based on differences in geographic distribution, varieties (i.e., species in this SSA), vegetation, and temperature and rainfall amounts. Based on these regions and more current distribution models (Cole *et al*. 2011, pp. 139–140), we delineated two populations of *Yucca brevifolia* [*Y. brevifolia* south (YUBR South) and *Y. brevifolia* north (YUBR North)], and three populations of *Y. jaegeriana* [*Y. jaegeriana* central (YUJA Central), *Y. jaegeriana* north (YUJA North), and *Y. jaegeriana* east (YUJA East)]. We added a sixth population, the Hybrid Zone in Tikaboo Valley, to distinguish the geographic area where both species, and their pollinators, come into contact between YUBR North and YUJA North.

The two *Y. brevifolia* populations are separated by a small gap in their range, with the northern edge of YUBR South reaching the southern parts of China Lake and the southern boundary of YUBR North reaching the northern edge of the base (Figure 8). USFWS (2018) characterizes YUBR North habitats as "somewhat drier and less diverse than YUBR South," with the lower elevations of YUBR South comprised of mostly creosote bush shrubland, while YUBR North associated vegetation including single-leaf pinyon, juniper, and sagebrush. At its simplest, YUBR South occurs mostly in the creosote dominated Western Mojave while YUBR North occurs in the area where the Northern Mojave transitions to the Great Basin and sagebrush becomes more dominant. This significant difference in habitat between the two population is sufficient to recognize them as ESUs for separate evaluation in the event full species listing is ultimately not deemed warranted by the Commission.

10 Recommended Management and Recovery Actions

For all species imperiled due to the impending loss of their suitable habitat as a result of climate change, the most important recovery actions are those that lead to rapid and steep greenhouse gas emissions reductions so as to minimize the additional warming that will occur in the climate system. However, given inertia in both the climate system and society, significant additional warming is unavoidable even under the most optimistic climate scenarios. Species that are already showing the effects of warming will continue to suffer and decline. For many narrowly-endemic species with limited dispersal capabilities we will soon reach a point where little else can be done other than ex situ conservation in captivity and/or via assisted migration. It is hard to be optimistic about the fate of such species, as they will likely be lost from the wild even under more moderate warming scenarios.

While the threats facing *Y. brevifolia* in the coming decades are dire, unlike more narrowly-endemic species, the species has the benefit of being long-lived, with a relatively large current distribution spread across elevational and latitudinal gradients, much of which is in protected areas. Consequently, if the species and its habitat are protected early from other threats, and with active management to enhance recruitment and survival, and potentially dispersal, the western Joshua tree has a realistic chance of persisting in the wild. In this context, recommendations for the management and recovery of the western Joshua tree are as follows:

1. The governor declares a climate emergency and takes all necessary action to set California on a path to full decarbonization of our economy by no later than 2045 (e.g. banning the sale of new fossil fuel vehicles by 2030 and requiring the generation of all electricity from carbon-free sources by 2030).
2. CDFW prepares a recovery plan for *Y. brevifolia* pursuant to Cal. Fish & Game Code § 2079.1.
3. CDFW works with local jurisdictions within the range of *Y. brevifolia* to develop NCCPs that protect from development all high-density Joshua tree habitat remaining on private lands.
4. The California Department of Parks and Recreation develops and implements management plans (including fire management plans) focused on Joshua tree protection for state park units within the range of *Y. brevifolia* (Red Rock Canyon State Park and Eastern Kern County Onyx Ranch State Vehicular Recreation Area in Kern County and Saddleback Butte State Park, Arthur B. Ripley Desert Woodland State Park and Antelope Valley California Poppy Reserve in Los Angeles County).
5. The California Department of Parks and Recreation seeks to acquire habitat to expand and connect existing state parks for protection and restoration of Joshua tree habitat.
6. CDFW expands its cooperative work with relevant federal agencies (NPS, DoD, BLM, USFWS) to better protect Joshua trees on federal land.
7. CDFW works with the University of California, California Invasive Plants Council and other institutions and agencies to develop effective measures to control the spread of invasive grasses in *Y. brevifolia* habitat.
8. CDFW works with CAL-FIRE to develop protocols for fire suppression activities within the range of *Y. brevifolia* that maximize protection of the species, while minimizing ground disturbance that may foster the spread of non-native grasses and other invasive species.
9. CDFW works with relevant entities to establish and maintain a seed bank of *Y. brevifolia* collected throughout the range of the species to ensure protection of its genetic diversity.
10. CDFW works with relevant entities to identify potential sites for assisted migration and develop protocols for carrying out such activities.

11 Conclusion

The Joshua tree has long been the most iconic species of the Mojave Desert. Given the well-publicized threats facing the species in the face of climate change, it has recently become an emblem of our society's failure to address the climate crisis. But the Joshua tree is also uniquely situated to become an example of successful action to save a species threatened by climate change. Action taken in and by California to save the species can serve as a model for proactive climate adaptation efforts not just in California but around the world. Listing the species under CESA is not just a symbolically important act of California recognizing the threats the species faces from climate change, but also can serve as the impetus for meaningful management actions that can help ensure the species remains a living icon in perpetuity.

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EXHIBIT 2

State of California
Natural Resources Agency
Department of Fish and Wildlife

REPORT TO THE FISH AND GAME COMMISSION

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

Photo of *Yucca brevifolia* by Jeb McKay Bjerke

Prepared by
California Department of Fish and Wildlife

February 2020

I. EXECUTIVE SUMMARY

The Center for Biological Diversity (Petitioner) submitted a petition (Petition) to the Fish and Game Commission (Commission) to list the western Joshua tree (*Yucca brevifolia*) as threatened under the California Endangered Species Act (CESA). The Commission referred the Petition to the Department of Fish and Wildlife (Department) and the Department prepared this evaluation report (Petition Evaluation) to assess the scientific information discussed and cited in the Petition in relation to other relevant and available scientific information possessed or received by the Department during the evaluation period.

Western Joshua trees are evergreen tree-like plants that occur on flats and slopes in the Mojave Desert. The Petition does not present an estimate of western Joshua tree population size, nor does it provide evidence of a range-wide population trend; nevertheless, the Petition does provide information showing that some populations of western Joshua tree are declining, particularly within Joshua Tree National Park. Although a reliable estimate of western Joshua tree population size is not available, information available to the Department indicates that western Joshua tree is currently relatively abundant. Western Joshua tree likely relies on particular temperature and precipitation ranges, which in turn restricts the range of the species, and the habitat suitable for its survival. The Petition provides a significant amount of scientific information on factors affecting the ability of western Joshua tree to survive and reproduce. The Petition states that climate change is the greatest threat to the continued existence of western Joshua tree, with wildfires, invasive species, habitat loss due to human development, and predation as additional contributing factors that collectively threaten the continued viability of the species. Information in the Petition suggests that western Joshua tree is already being affected by threats, and these threats are likely to intensify significantly by the end of the century. The Petition describes the limitations of existing regulatory mechanisms as they relate to the factors affecting the ability of western Joshua tree to survive and reproduce.

After reviewing the Petition and other relevant information, the Department determined that the Petition contains sufficient information on population trend, range, distribution, abundance, life history, kind of habitat necessary for survival, factors affecting the ability to survive and reproduce, degree and immediacy of threat, impact of existing management efforts, suggestions for future management, and availability and sources of information, and also includes a detailed distribution map.

In completing its Petition Evaluation, the Department has determined the Petition provides sufficient scientific information to indicate that the petitioned action may be warranted for western Joshua tree. Therefore, the Department recommends the Commission accept the Petition for further consideration under CESA.

II. INTRODUCTION

A. Candidacy Evaluation

The Commission has the authority to list certain “species” or “subspecies” as threatened or endangered under CESA. (Fish & G. Code, §§ 2062, 2067, and 2070.) The listing process is the same for species and subspecies. (Fish & G. Code, §§ 2070-2079.1.)

CESA sets forth a two-step process for listing a species as threatened or endangered. First, the Commission determines whether to designate a species as a candidate for listing by evaluating whether the petition provides “sufficient information to indicate that the petitioned action may be warranted.” (Fish & G. Code, § 2074.2, subd. (e)(2).) If the petition is accepted for consideration, the second step requires the Department to produce, within 12 months of the Commission’s acceptance of the petition, a peer reviewed report based upon the best scientific information available that indicates whether the petitioned action is warranted. (Fish & G. Code, § 2074.6.) Finally, the Commission, based on that report and other information in the administrative record, determines whether the petitioned action to list the species as threatened or endangered is warranted. (Fish & G. Code, § 2075.5.)

A petition to list a species under CESA must include “information regarding the population trend, range, distribution, abundance, and life history of a species, the factors affecting the ability of the population to survive and reproduce, the degree and immediacy of the threat, the impact of existing management efforts, suggestions for future management, and the availability and sources of information. The petition shall also include information regarding the kind of habitat necessary for species survival, a detailed distribution map, and any other factors that the petitioner deems relevant.” (Fish & G. Code, § 2072.3; see also Cal. Code Regs., tit. 14, § 670.1, subd. (d)(1).) The range of a species for the Department’s petition evaluation and recommendation is the species’ California range. (*Cal. Forestry Assn. v. Cal. Fish and Game Com.* (2007) 156 Cal.App.4th 1535, 1551.)

Within 10 days of receipt of a petition, the Commission must refer the petition to the Department for evaluation. (Fish & G. Code, § 2073.) The Commission must also publish notice of receipt of the petition in the California Regulatory Notice Register. (Fish & G. Code, § 2073.3.) Within 90 days of receipt of the petition (or 120 days if the Commission grants an extension), the Department must evaluate the petition on its face and in relation to other relevant information and submit to the Commission a written evaluation report with one of the following recommendations:

- Based upon the information contained in the petition, there is not sufficient information to indicate that the petitioned action may be warranted, and the petition should be rejected; or

- Based upon the information contained in the petition, there is sufficient information to indicate that the petitioned action may be warranted, and the petition should be accepted and considered.

(Fish & G. Code, § 2073.5, subds. (a)-(b).) The Department's candidacy recommendation to the Commission is based on an evaluation of whether the petition provides sufficient scientific information relevant to the petition components set forth in Fish and Game Code Section 2072.3 and the California Code of Regulations, Title 14, Section 670.1, subdivision (d)(1).

In *Center for Biological Diversity v. California Fish and Game Commission* (2008) 166 Cal.App.4th 597, the California Court of Appeals addressed the parameters of the Commission's determination of whether a petitioned action should be accepted for consideration pursuant to Fish and Game Code Section 2074.2, subdivision (e), resulting in the species being listed as a candidate species. The court began its discussion by describing the standard for accepting a petition for consideration previously set forth in *Natural Resources Defense Council v. California Fish and Game Commission* (1994) 28 Cal.App.4th 1104:

> As we explained in *Natural Resources Defense Council*, "the term 'sufficient information' in section 2074.2 means that amount of information, when considered with the Department's written report and the comments received, that would lead a reasonable person to conclude the petitioned action may be warranted." The phrase "may be warranted" "is appropriately characterized as a 'substantial possibility that listing could occur.'" "Substantial possibility," in turn, means something more than the one-sided "reasonable possibility" test for an environmental impact report but does not require that listing be more likely than not.

(*Center for Biological Diversity*, *supra*, 166 Cal.App.4th at pp. 609-10 [internal citations omitted].) The court acknowledged that "the Commission is the finder of fact in the first instance in evaluating the information in the record." (*Id.* at p. 611.) However, the court clarified:

> [T]he standard, at this threshold in the listing process, requires only that a substantial possibility of listing could be found by an objective, reasonable person. The Commission is not free to choose between conflicting inferences on subordinate issues and thereafter rely upon those choices in assessing how a reasonable person would view the listing decision. Its decision turns not on rationally based doubt about listing, but on the absence of any substantial possibility that the species could be listed after

the requisite review of the status of the species by the Department under [Fish and Game Code] section 2074.6.

(*Ibid*.)

CESA defines the “species” eligible for listing to include “species or subspecies” (Fish and G. Code, §§ 2062, 2067, and 2068), and courts have held that the term “species or subspecies” includes “evolutionarily significant units.” (*Central Coast Forest Assn. v. Fish & Game Com.* (2018) 18 Cal.App.5th 1191, 1236, *citing Cal. Forestry Assn.*, *supra*, 156 Cal.App.4th at pp. 1542 and 1549.)

B. Petition History

Recent studies separate Joshua tree into two groups: western Joshua tree (*Yucca brevifolia* or *Yucca brevifolia* var. *brevifolia*) and eastern Joshua tree (*Yucca jaegerana* or *Yucca brevifolia* var. *jaegerana*). Both western Joshua tree and eastern Joshua tree were considered for listing under the federal Endangered Species Act (ESA), but on August 15, 2019, the U.S. Fish and Wildlife Service (USFWS) found that listing of the Joshua tree as a threatened or endangered species was not warranted (USFWS 2019).

On October 21, 2019, the Commission received a Petition to list any of the following as threatened under CESA: (1) the western Joshua tree (*Yucca brevifolia*) throughout its California range; or, in the event the Commission determines that listing of *Yucca brevifolia* throughout its California range is not warranted, (2) the western Joshua tree population within the northern part of western Joshua tree’s California range (YUBR North), or (3) the western Joshua tree population within the southern part of western Joshua tree’s California range (YUBR South). On November 1, 2019, the Commission referred the Petition to the Department for evaluation. At its meeting on December 11, 2019, the Commission officially received the Petition and approved a request from the Department for a 30-day extension to further analyze the Petition and complete its Petition Evaluation pursuant to Fish and Game Code Section 2073.5, subdivision (b).

The Department evaluated the scientific information presented in the Petition as well as other relevant information the Department possessed at the time of review. The Department received information from two people during the petition evaluation period pursuant to Fish and Game Code Section 2073.4. This Petition Evaluation includes copies of this information as Appendix 1, pursuant to Fish and Game Code Section 2073.5, subdivision (c). Pursuant to Fish and Game Code Section 2072.3 and Section 670.1, subdivision (d)(1), of Title 14 of the California Code of Regulations, the Department evaluated whether the Petition included sufficient scientific information regarding each of the following petition components to indicate that the petitioned action may be warranted:

- Population trend;
- Range;
- Distribution;
- Abundance;
- Life history;
- Kind of habitat necessary for survival;
- Factors affecting the ability to survive and reproduce;
- Degree and immediacy of threat;
- Impact of existing management efforts;
- Suggestions for future management;
- Availability and sources of information; and
- A detailed distribution map.

C. Overview of Western Joshua Tree Ecology

Western Joshua trees are evergreen, tree-like plants that have recently been treated as members of the asparagus family (Asparagaceae) (APG 2016, ITIS 2019). Western Joshua trees typically have a 5 to 15 meter (m) (16 to 50 feet (ft)) main stem with extensive branching on older plants. The tallest known western Joshua tree was 25 m (82 ft) tall, although trees exceeding 10 m (33 ft) are rare (Gucker 2006, Cummings 2019). Western Joshua tree is found in many different plant communities occurring on flats and slopes in the Mojave Desert at elevations between 400 and 2200 m (1300 to 7200 ft) (Turner 1982, Hess 2012, USFWS 2018, CNPS 2019). Lenz (2001) reports that Joshua tree plants tolerate temperatures of -25°C to 51°C (-13°F to 124°F) and annual precipitation ranges of 98 to 268 mm (3.9 to 10.6 inches (in)).

Western Joshua trees are capable of both sexual reproduction, and asexual reproduction via growth of rhizomes, branch sprouts, and/or basal sprouts. Significant examples of western Joshua tree asexual reproduction have been observed, with some clumps of plants being entirely clonal (Gucker 2006, DeFalco et al. 2010, Harrower and Gilbert 2018).

Western Joshua trees can reproduce sexually resulting in seed production. Flowering of western Joshua trees is considered episodic and rare, generally only occurring in wetter years (Gucker 2006). Flowers of Joshua trees are exclusively pollinated by specialized yucca moths (Trelease 1893, Pellmyr 2003, Pellmyr and Segraves 2003, Godsoe et al. 2008). In California, western Joshua tree is pollinated by one species of moth, *Tegeticula synthetica*. Female moths transfer pollen between western Joshua tree flowers in specialized mouthparts, inject eggs into the floral ovaries using a bladelike ovipositor, and then actively apply pollen to the stigmatic surface to fertilize the flower (Trelease 1892, Pellmyr 2003). As a western Joshua tree flower develops into a fruit, the moth eggs hatch and emerging larvae eat a portion of the developing seeds. These moths are the sole pollinators of western Joshua trees in California, and in turn, Joshua tree seeds are the only food source for these moths (Pellmyr and Segraves 2003, Yoder et al. 2013). This relationship represents an obligate mutualism, where each species relies on the other for survival of its own species. Western Joshua tree relies on the yucca moth for pollination, but in turn has to sacrifice some seeds to the developing moth larvae.

Once pollinated, fruits form in early summer and seeds are mature in mid-summer (Waitman et al. 2012). Mature fruits contain 30 to 50 black seeds, which are flat to thickened with a smooth to shallowly bumpy surface.

Western Joshua tree seeds germinate readily in laboratory conditions and do not require any pretreatment (Wallace and Romney 1972, Alexander et al. 2008, Reynolds et al. 2012, Waitman et al. 2012). Seeds do not appear to be long-lived in the soil and are therefore unlikely to form a soil seed bank (Reynolds et al. 2012). Joshua tree seeds are harvested by rodents directly from fruits in the tree canopy and gathered quickly from the ground, and these seeds have been found in caches up to 57 m (190 ft) away from the source plant (Vander Wall et al. 2006, Waitman et al. 2012). Seeds that have been buried in soil have a much greater chance of establishing seedlings than those left on the soil surface, but seed caches are also consumed and moved to different caches by rodents; therefore Joshua tree and dispersing rodents may form a mutualism (Vander Wall et al. 2006, Reynolds et al. 2012, Waitman et al. 2012). Western Joshua tree seedling emergence was most successful for seeds planted one centimeter (cm) (0.4 in) deep (Waitman et al. 2012), and the greatest seedling emergence occurs during spring and summer, when increased soil moisture is accompanied by warm soil temperatures (Reynolds et al. 2012).

It can take many years for western Joshua tree seedlings to reach reproductive maturity. Esque et al. (2015) monitored a cohort of 53 western Joshua tree seedlings beginning in May of 1989, and found that ten of them (19 percent) were still living after 22 years, with an average height of 100 cm (39 in), but these ten plants had yet to reproduce. Growth rates appear to be dependent on factors including age, precipitation, presence of nearby plants that help seedlings establish, temperature and (at least in the laboratory) photoperiod (Gucker 2006).

III. SUFFICIENCY OF SCIENTIFIC INFORMATION TO INDICATE THE PETITIONED ACTION FOR WESTERN JOSHUA TREE MAY BE WARRANTED

The Petition components are evaluated below, pursuant to Fish and Game Code Section 2072.3 and Section 670.1, subdivision (d)(1), of Title 14 of the California Code of Regulations.

A. Population Trend

1. Scientific Information in the Petition

The Petition discusses population trends for western Joshua tree on pages 19 and 20 under the heading “Abundance and Population Trends”.

The Petition acknowledges that a reliable estimate of western Joshua tree population size is not available and that no range-wide population trends have been documented. The Petition therefore relies on studies indicating that western Joshua tree density is negatively correlated with increasing temperature, the species range is contracting at lower elevations, recruitment is limited, and plant mortality is increasing.

The Petition cites a study by DeFalco et al. (2010) that examined the mortality of western Joshua tree across several study sites five years after a fire in Joshua Tree National Park burned nearly 5700 hectares (22 square miles (mi^2)) in May 1999. The study found that approximately 80 percent of western Joshua trees that were burned by the fire died by 2004, and approximately 26 percent of the unburned trees died as well, with drought a likely contributing factor.

The Petition cites a study by Harrower and Gilbert (2018) that found strong positive relationships between western Joshua tree abundance, size, abundance of its pollinating moth, and reproductive success at Joshua Tree National Park. The study found that peak performance of both western Joshua tree and its pollinating moth occurs at intermediate elevations of approximately 1200 to 1400 m (4,000 to 4,600 ft). The study also found that the proportion of infertile western Joshua tree seeds increased at the margins of its range in Joshua Tree National Park, with the observation that Joshua trees appear to be dying back at low elevations, but do not appear to be expanding their range into higher elevations.

The Petition cites a study by St. Clair and Hoines (2018) that found a positive relationship between temperature and greater production of western Joshua tree flowers and seeds, but a negative relationship between temperature and western Joshua tree stand density, which suggests that there may be constraints of warmer temperatures on western Joshua tree establishment success.

The Petition also cites studies summarized by Cornett (2014) that describe declining western Joshua tree populations at three study sites in Joshua Tree National Park over an approximately 20-year period.

2. Other Relevant Scientific Information

The Department received additional information on western Joshua tree population trend during the Petition Evaluation period pursuant to Fish and Game Code Section

2073.4. The Department received two reports on western Joshua tree populations at Edwards Air Force Base. One of these reports describes a geographic information system (GIS) based analysis that was conducted to determine population trends for western Joshua tree at Edwards Air Force Base between 1992 and 2015 (USAF 2017a). The report suggests that western Joshua tree populations on the base were stable to increasing; however, the report describes several issues that increase the uncertainty of the results. The second report describes a GIS analysis, literature review, and field survey conducted of a 1999 fire area on Edwards Air Force Base to evaluate western Joshua tree survivorship and/or regeneration (USAF 2017a). The report used aerial photography taken in 1992 to count all identifiable western Joshua trees present in two areas prior to the 1999 fire and compared this information with the results of a 2017 field survey that identified all western Joshua trees in these same two areas. This report concludes that Joshua tree populations were stable in the sampled areas of the fire area from 1992 to 2017.

3. Conclusion

The Petition does not present an estimate of western Joshua tree population size, nor does it provide evidence of a range-wide population trend; nevertheless, the Petition does provide information showing that some populations of western Joshua tree are declining, particularly within Joshua Tree National Park. The Petition provides sufficient information on the population trend of western Joshua tree for the Department to make the recommendation in Section IV of this Petition Evaluation.

B. Geographic Range

1. Scientific Information in the Petition

The Petition discusses the geographic range of western Joshua tree on pages 16 through 19, under the heading “Current and Historical Distribution”. The Petition extensively cites the range information summarized in the Joshua Tree Status Assessment prepared by the USFWS (2018).

As described in Section II(B) of this Petition Evaluation, recent studies separate Joshua tree into two groups: western Joshua tree (*Yucca brevifolia* or *Yucca brevifolia* var. *brevifolia*) and eastern Joshua tree (*Yucca jaegerana* or *Yucca brevifolia* var. *jaegerana*). Western Joshua tree and eastern Joshua tree are distinguished by genetic and morphological differences, and by different yucca moth pollinators. Considered collectively, the Petition describes the range of western Joshua tree and eastern Joshua tree as extending from northwestern Arizona to southwestern Utah, and west to southern Nevada and southeastern California at elevations between 600 and 2200 m (2000 to 7200 ft) and between 34° to 38° latitude. The ranges of both western Joshua tree, eastern Joshua tree, and populations of those two species are presented in the

Petition on page 17 as Figure 8. Western Joshua tree is described as comprising two geographically separate populations named YUBR South and YUBR North in the Petition, and the map showing these populations has been duplicated as Figure 1.

The Petition describes western Joshua tree as occurring almost exclusively in the Mojave Desert in unevenly distributed populations, with a small portion of its northern extent occurring within the Great Basin Desert. The southern extent of western Joshua tree's range is in the Little San Bernardino Mountains of Joshua Tree National Park, and the northern extent of its range is near Alkali, Nevada. The western extent is near the Hungry Valley State Vehicular Recreation Area near Gorman, California. The eastern extent of its range is in Tikaboo Valley, Nevada, where the species co-occurs with eastern Joshua tree (USFWS 2018).

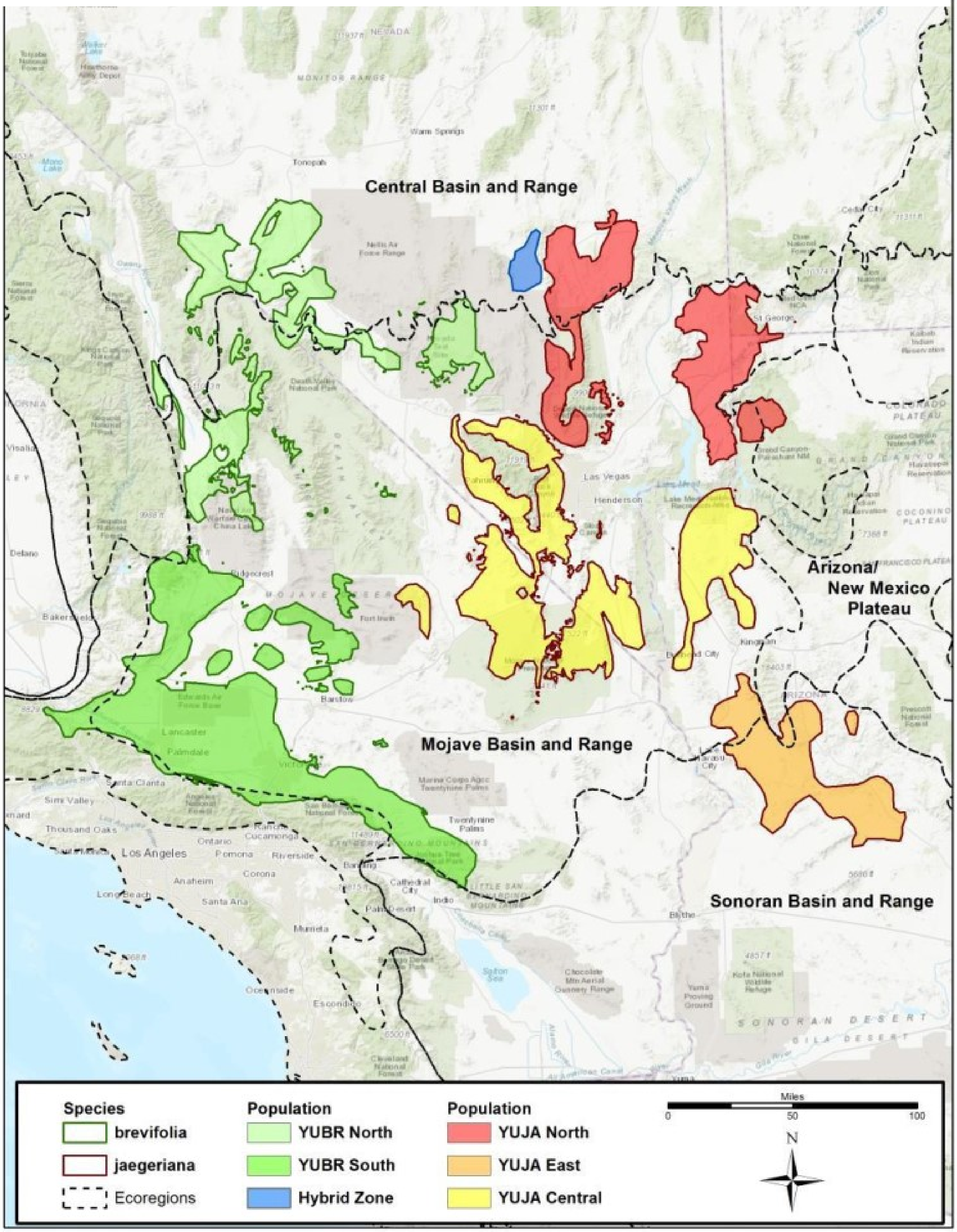
The Petition cites a study by Cole et al. (2011) that compiled locations and ages of late Pleistocene (22,000 to 13,000 years ago) Joshua trees from fossil packrat (*Neotoma* spp.) waste piles and Shasta ground sloth (*Nothrotheriops shastensis*) dung, and compared them with the current Joshua tree distribution. The study shows that as the climate rapidly warmed 11,700 years ago, the range of Joshua tree contracted, leaving only the populations near what had been its northernmost limit. Climate models for the next 60 to 90 years project a climate warming of a similar pace and magnitude to that which occurred in the early Holocene, approximately 11,700 years ago. The Cole et al. (2011) study includes models that project the future elimination of Joshua tree throughout most of the southern portions of its current range, with only a few populations within the current range predicted to be sustainable. Several models also project significant potential future expansion into new areas to the north and east of its current range and outside of California, but the species' historical and current rates of dispersal may conceivably prevent natural expansion into these new areas.

The Petition also cites a study by Holmgren et al. (2010) that examines the long-term vegetation history of Joshua Tree National Park via examination of fossil plants found in animal waste piles. Joshua tree is identified as a species that arrived fairly early in Joshua Tree National Park, about 13,880 years ago, and was stable in the Park throughout the Holocene (approximately 11,700 years ago to present).

2. Other Relevant Scientific Information

The Department possesses vegetation maps that cover a large portion of the California deserts where western Joshua tree generally occurs (Thomas 2002, Agri Chemical and Supply Inc. 2008, CDFW and USGS 2014, CDFW and Chico State University 2015, CDFW et al. 2017, CDFW and AIS 2019a, 2019b, and 2019c, CDFW 2019, NPS 2019). The *Yucca brevifolia* vegetation alliance is mapped with an approximate accuracy of 95

Figure 1: Current Distribution of Western Joshua Tree (USFWS 2018)



percent in the vegetation maps related to the Desert Renewable Energy Conservation Plan, and these maps also denote the cover of Joshua tree canopy in all vegetation polygons by cover class (0, >0-1%, >1-5%, and >5%) (VegCAMP 2013). Vegetation maps in the Department's possession may contribute to a relatively high-resolution western Joshua tree distribution map in many areas of California. These vegetation maps are likely to improve the current understanding of western Joshua tree's range.

3. Conclusion

The Petition provides sufficient information on the geographic range of western Joshua tree for the Department to make the recommendation in Section IV of this Petition Evaluation.

C. Distribution

1. Scientific Information in the Petition

The Petition discusses the distribution of western Joshua tree on pages 16 through 19, under the heading "Current and Historical Distribution". The Petition primarily relies on distribution information summarized in the Joshua Tree Status Assessment prepared by the USFWS (2018). The Petition describes western Joshua tree as comprising two geographically separate populations named YUBR South and YUBR North.

YUBR South is described as being entirely within California, and extending from Joshua Tree National Park, north to near Ridgecrest in Kern County. YUBR South is located on alluvial plains, fans, and bajadas of the major valleys lying between scattered mountain ranges. The elevation range of the YUBA South population is between 750 and 2200 m (2500 to 7200 ft), with creosote bush (*Larrea tridentata*) shrubland as the primary vegetation type. USFWS (2018) estimates that 3,255,088 acres within the YUBR South population distribution area are suitable for Joshua trees based on soils and other habitat factors; however, western Joshua trees have a patchy and disjunct distribution and do not occupy this entire area. Just over 50 percent of the YUBR South population is on private land, 48 percent is on federal land, and just under 2 percent is under state, county, or local ownership.

The YUBR North population occurs in the area north of Inyokern in Kern County, along the west and north margins of Death Valley, to Goldfield, Nevada, and east to the Nevada National Security Site (formerly the Nevada Test Site). The elevation range of western Joshua tree in the YUBR North population is between 1500 and 2200 m (4900 to 7200 ft), and the vegetation occurring nearby this higher and cooler population often includes singleleaf pinyon pine (*Pinus monophylla*), Utah juniper (*Juniperus osteosperma*), and big sagebrush (*Artemisia tridentata*) (USFWS 2018). The YUBR North population is about evenly split between California and Nevada. USFWS (2018) estimates that approximately 1,941,701 acres of the distribution area of the YUBR North population is suitable for western Joshua tree, and approximately 96 percent of the YUBR North population is on federal land (USFWS 2018).

2. Other Relevant Scientific Information

As described in Section III(B)(2) of this Petition Evaluation, the Department possesses vegetation maps that cover a large portion of the California deserts where western Joshua tree occurs, and these maps may contribute to a relatively high-resolution western Joshua tree distribution map in many areas of California. These vegetation maps are likely to improve the current understanding of western Joshua tree's distribution.

3. Conclusion

The Petition provides sufficient information on the distribution of western Joshua tree for the Department to make the recommendation in Section IV of this Petition Evaluation.

D. Abundance

1. Scientific Information in the Petition

The Petition discusses the abundance of western Joshua tree on pages 19 and 20 under the heading "Abundance and Population Trends". The Petition states that western Joshua tree has a patchy distribution and a variable population density of 4 to 840 trees per acre (10 to 2,070 trees per hectare) and cites USFWS (2018). The discussion of western Joshua tree's "Current and Historical Distribution" on pages 16 through 19 of the Petition includes information demonstrating that western Joshua tree currently has a relatively widespread distribution in southern California. The Petition acknowledges that a reliable estimate of western Joshua tree population size is not available.

2. Other Relevant Scientific Information

As described in Section III(B)(2) of this Petition Evaluation, the Department possesses vegetation maps that cover a large portion of the California deserts where western Joshua tree occurs. It may be possible to use cover estimates from these maps as a rough proxy for western Joshua tree abundance; however, the Department does not possess this information for the entire western Joshua tree distribution in California. The range, distribution, and density information available to the Department indicates that the abundance of western Joshua tree is currently relatively high.

3. Conclusion

The Petition acknowledges that a reliable estimate of western Joshua tree population size is not available; however, information available to the Department indicates that the abundance of western Joshua tree is currently relatively high. The Petition provides sufficient information on the abundance of western Joshua tree for the Department to make the recommendation in Section IV of this Petition Evaluation.

E. Life History

1. Scientific Information in the Petition

The Petition discusses the life history of western Joshua tree on pages 3 through 15 under the heading “Life History”. The Petition describes several aspects of western Joshua tree life history, including asexual reproduction, flowering, pollination, seed production, seed predation, seed dispersal, seed germination, and plant growth. In describing these aspects of western Joshua tree life history, the Petition cites several scientific studies and sources.

The Petition describes the ability of western Joshua tree to reproduce via asexual growth of rhizomes, branch sprouts, and/or basal sprouts. In discussing asexual reproduction, the Petition cites Webber (1953), Gucker (2006), DeFalco et al. (2010), and Harrower and Gilbert (2018).

The Petition describes the episodic and rare nature of western Joshua tree flowering events and the seasonal timing of flower production, and cites Gucker (2006), Hess (2012), Waitman et al. (2012), Esque et al. (2015), Cornett (2018), and Harrower and Gilbert (2018).

The Petition describes the obligate pollination mutualism between western Joshua tree and its specialized pollinating moth, *Tegeticula synthetica*, as well as the pollination mutualism between eastern Joshua tree and its pollinating moth, *Tegeticula antithetica*. The Petition also describes the narrow region in Nevada where western Joshua tree and eastern Joshua tree are sympatric and hybridize. The Petition describes the influence that two species of pollinating moth likely had on the morphological divergence of western Joshua tree and eastern Joshua tree. The Petition describes the formation and structure of western Joshua tree fruits. In discussing pollination and seed production, the Petition cites Pellmyr and Segraves (2003), Althoff et al. (2004), Gucker (2006), Godsoe et al. (2008), Smith et al. (2008a, 2008b), Smith et al. (2009), Waitman et al. (2012), Starr et al. (2013), Yoder et al. (2013), and Cole et al. (2017).

2. Conclusion

The Petition provides sufficient information on western Joshua tree life history for the Department to make the recommendation in Section IV of this Petition Evaluation.

F. Kind of Habitat Necessary for Survival

1. Scientific Information in the Petition

The Petition discusses the kind of habitat necessary for western Joshua tree survival on pages 14 and 15 under the heading “Habitat Requirements”.

The Petition describes Joshua trees as occurring in desert grasslands and shrublands in hot, dry sites on flats, mesas, bajadas, and gentle slopes in the Mojave Desert. Soils in Joshua tree habitats are described as silts, loams, and/or sands, variously described as fine, loose, well drained, and/or gravelly. The Petition describes temperature and precipitation ranges that have been reported for western Joshua tree, and states that these attributes are likely prime constraints on suitable habitat for the species and the species’ range. The Petition states that Joshua trees can be found in many different plant alliances throughout their range, and although they may not be limited by particular plant associations, Joshua trees require the presence of their obligate pollinator, rodents, to disperse and cache seeds, and nearby plants to shelter emerging seedlings for successful reproduction and recruitment.

In discussing the kind of habitat necessary for western Joshua tree survival, the Petition cites Went (1957), Turner (1982), Lenz (2001), Gucker (2006), Cole et al. (2011), Harrower and Gilbert (2018), and USFWS (2018).

2. Conclusion

The Petition provides sufficient information to support the conclusion that temperature and precipitation are likely critical for western Joshua tree survival and are likely prime constraints on suitable habitat for the species and the species’ range. The Petition provides sufficient information on the kind of habitat necessary for western Joshua tree survival for the Department to make the recommendation in Section IV of this Petition Evaluation.

G. Factors Affecting the Ability to Survive and Reproduce

1. Scientific Information in the Petition

The Petition discusses factors affecting the ability of western Joshua tree to survive and reproduce on pages 20 through 48 under the heading “Factors Affecting Ability to Survive and Reproduce”. The Petition identifies predation, invasive species, wildfires, climate change, and habitat loss to human development as the factors affecting the ability of western Joshua tree to survive and reproduce, stating that these factors are often related, synergistic, and collectively threaten the continued viability of the species. The information presented in the Petition for each of these factors is discussed separately below.

Predation

The Petition provides information on various impacts to western Joshua tree from predation and herbivory. Before dispersal, the larvae of the moth *Tegeticula synthetica* eat a portion of western Joshua tree's seeds. The Petition states that rodents cache and consume the vast majority of western Joshua tree seeds, with fewer than one percent of seeds germinating. Cattle have been observed grazing on the inflorescences of small western Joshua trees, and herbivory by black-tailed jackrabbits (*Lepus californicus*), pocket gophers (*Thomomys bottae*), white-tailed antelope squirrels (*Ammospermophilus leucurus*), and woodrats (*Neotoma* sp.) has been observed, which in some instances results in mortality of pre-reproductive plants. The Petition states that drought and fire result in increased herbivory on seedlings and pre-reproductive Joshua trees. The Petition acknowledges that predation alone is likely not presently a threat to western Joshua tree persistence, but the impact will be more significant as wildfire and drought frequency and intensity increase in the coming decades.

In discussing predation as a factor affecting the ability of western Joshua tree to survive and reproduce, the Petition cites Keeley et al. (1985), Vander Wall et al. (2006), DeFalco et al. (2010), Cole et al. (2011), Waitman et al. (2012), Borchert and DeFalco (2016), Esque et al. (2015), and Lybbert and St. Clair (2017).

Invasive Species

The Petition provides information on impacts to western Joshua tree from invasive species. 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. The Petition describes this as a significant threat to western Joshua tree at the individual and population level.

In discussing invasive species as a factor affecting the ability of western Joshua tree to survive and reproduce, the Petition cites Brooks (2003), Brooks and Berry (2006), DeFalco et al. (2007), Allen et al. (2009), Allen and Geiser (2011), Pardo et al. (2011), Barrows and Murphy-Mariscal (2012), Reynolds et al. (2012), Bytnerowicz et al. (2016), Frakes (2017), and Brooks et al. (2018).

Wildfires

The Petition provides information on impacts to western Joshua tree from wildfire, and states that wildfire is one of the greatest threats to the persistence of the species, particularly as the species' range contracts in the face of climate change and as the frequency and severity of fire in the species' range increases.

Under the Wildfires section, the Petition first discusses western Joshua tree's response to fire. Although some early researchers suggested that western Joshua tree was well adapted to fire due to the ability of fire-damaged trees to resprout, longer-term studies have demonstrated that Joshua trees have relatively low post-fire survival rates, are slow to repopulate burned areas, and require sufficient precipitation in the years following fire for successful resprouting. Older and taller western Joshua trees are less affected by fire than younger, shorter trees. Post-fire mortality of western Joshua tree can be high due to drought and increased herbivory, particularly in areas that have been denuded of other vegetation that could serve as an herbivore food source. Post-fire sprouting of burned trees has been observed to prolong Joshua tree survival at high-elevation sites, when precipitation is sufficient. Joshua tree populations along the extreme western edge of the desert bioregion, near the Sierra Nevada and Transverse Ranges, appear to survive more readily after fire than those further east, resulting in dense unique clumps of clonal plants. Recruitment of new western Joshua trees into burned areas is infrequent and slow. The Petition states that blackbrush (*Coleogyne ramosissima*) is one of the most important plants for aiding western Joshua tree seedling establishment, but it is also one of the most vulnerable shrubs to fire and can take centuries to fully recover. The Petition states that due to western Joshua tree's inherently slow recruitment process, accelerated fire return intervals, and climate change, a return to pre-fire western Joshua tree density and abundance in burned areas may take centuries or may never occur.

In discussing western Joshua tree's response to fire as a factor affecting the ability of western Joshua tree to survive and reproduce, the Petition cites Webber (1953), Brittingham and Walker (2000), Loik et al. (2000), Gunter (2006), Abella et al. (2009), DeFalco et al. (2010), Vamstad and Rotenberry (2010), Reynolds et al. (2012), Esque et al. (2015), Wallace (2017), and Brooks et al. (2018).

Under the Wildfires section, the Petition also discusses the increasing wildfire frequency and intensity in the Mojave Desert. The Petition states that large 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.

In discussing the increasing wildfire frequency and intensity in the Mojave Desert as a factor affecting the ability of western Joshua tree to survive and reproduce, the Petition cites Brooks and Matchett (2006), Holmgren et al. (2010), Vamstad and Rotenberry (2010), Barrows and Murphy-Mariscal (2012), Jurand and Abella (2013), Esque et al. (2015), Tagestad et al. (2016), Klinger and Brooks (2017), Short (2017), Syphard et al. (2017), Brooks et al. (2018), Hopkins (2018), Maloney et al. (2019), Sweet et al. (2019), and Syphard et al. (2019).

Climate Change

The Petition provides information on impacts to western Joshua tree from climate change, and states that climate change represents the single greatest threat to the continued existence of the species. The Petition states that even under the most optimistic reduced-emission climate scenarios, western Joshua trees will be eliminated from significant portions of their range by the end of the century, and under warming scenarios consistent with current domestic and global emissions trajectories, the species will likely be close to being functionally extinct in the wild in California by the century's end.

Under the Climate Change section, the Petition has a subsection that discusses current and projected climate change in the range of western Joshua tree. A strong, international scientific consensus has established that human-caused climate change is causing widespread harm to human society and natural systems, and climate change threats are becoming increasingly dangerous. Climate change is causing increasing stress on species and ecosystems, and deserts have warmed and dried more rapidly over the last 50 years than other ecoregions, both globally and in the contiguous United States. Since 1895, the counties supporting western Joshua tree have already experienced annual temperature increases of 1.7 - 2.3°C (3.1 - 4.1°F). In addition, the Mojave Desert has experienced impacts to species and ecosystems, with bird occupancy and site-level species richness declining by about fifty percent over the past century, with this decline linked to increased cooling needs, necessitating more water intake for survival. While all temperature projections predict that the Mojave Desert will become much hotter in the future, projections for future precipitation are less clear. Average annual rainfall is expected to be about the same, but interannual precipitation variability is expected to increase, as is the amount of winter precipitation.

In discussing current and projected climate change in the range of western Joshua tree as a factor affecting the ability of western Joshua tree to survive and reproduce, the Petition cites Warren et al. (2011), Scheffers et al. (2016), Tagestad et al. (2016), Wiens (2016), USGCRP (2017), Hopkins (2018), Iknayan and Beissinger (2018), IPCC (2018), Mufson et al. (2019), and Riddell et al. (2019).

Under the Climate Change section, the Petition has an additional subsection that discusses climate change impacts on western Joshua trees. Under this subsection, the Petition discusses six published models of future Joshua tree distribution: Thompson et al. (1998), Shafer et al. (2001), Dole et al. (2003), Cole et al. (2011), Barrows and Murphy-Mariscal (2012), and Sweet et al. (2019). Each of these models predict contractions of western Joshua tree at the western edge of its range. These six models are discussed separately in the following paragraphs.

Thompson et al. (1998) used temperature and precipitation data from the existing range of western and eastern Joshua tree to calculate potential future habitat under doubled carbon dioxide conditions. The Thompson et al. (1998) model predicted a retraction of Joshua tree range along its western edge in California, and predicted significant expansion of possible Joshua tree habitat extending as far north as Washington state, south into Mexico, and east into Texas; however this modeled projection of the future range of Joshua trees under changing climate conditions did not analyze other habitat variables or dispersal ability and used a model that poorly matched the current distribution of Joshua tree.

Shafer et al. (2001) carried out a similar modeling effort using three climate variables (mean temperature of the coldest month, a temperature index called growing degree days, and a moisture index) and a course grid scale. The results of this study were roughly consistent with the Thompson et al. (1998) model, but notably show an almost complete extirpation of western Joshua tree from California by 2090-2099 under several future climate scenarios.

Dole et al. (2003) also modeled the future range for Joshua trees under doubled carbon dioxide conditions, finding similarly to Thompson et al. (1998) models that a considerable portion of the current range of western Joshua tree will become climatically unfavorable for the species, although significant amounts of new habitat may become available. Like previous models, Dole et al. (2003) did not take dispersal ability into consideration and only focused on suitable habitat variables. This study also noted that current climate conditions may already be detrimental to Joshua tree survival and/or reproduction, which was later confirmed by other subsequent research in the southern part of western Joshua tree's range.

Cole et al. (2011) built a sophisticated species distribution model with climate and habitat variables derived from a comprehensive dataset of presence/absence data throughout the current range of western and eastern Joshua tree. Late Pleistocene and Holocene (22,000 to years ago to present) records were also compiled to generate a map of past Joshua tree distribution. The study differed from previous models in its use of specific data points for presence and habitat variables for the species and the testing of models to simulate the current range of the species. All of the individual climate models, as well as an ensemble of 22 global circulation models (GCMs) utilized by Cole et al. (2011), project a severe (~90%) decline in the area of suitable climates for Joshua trees by 2070 to 2099, as the southern parts of its range become climatically unsuitable. Cole et al. (2011) also modeled areas where the species could potentially expand its range naturally in the future, as well as areas that might be suitable for relocation or assisted migration. The Cole et al. (2011) study considered the ability of Joshua tree to colonize new areas of potentially suitable habitat, which appears to be very limited.

Barrows and Murphy-Mariscal (2012) constructed a finer-scale model of western Joshua tree's current distribution within and surrounding Joshua Tree National Park, and then assessed the sensitivity of western Joshua tree to a gradient of climate change scenarios. Under the most severe climate scenario modeled (3°C increase in mean July maximum temperature), there was a 90 percent reduction in the current distribution of western Joshua tree in Joshua Tree National Park, but refugium of suitable western Joshua tree habitat still remained. A niche model for juvenile Joshua trees also provides support for the hypothesis that climate change has already had an impact on western Joshua tree recruitment within Joshua Tree National Park.

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.

In addition to the findings of the modeling efforts described above, the Petition presents information from other field studies that document the current impacts of warming, drought, invasive species, fire and other impacts on western Joshua tree survival and recruitment. The convergence of biotic and abiotic factors necessary for western Joshua tree recruitment results in successful establishment of new seedlings just a few times in a century, and the Petition reports that such recruitment has already largely stopped at the drier, lower elevational limits of western Joshua tree's range. Prolonged droughts are projected to occur with greater frequency and intensity over the coming decades and are likely to preclude recruitment across large areas of western Joshua tree's range. The droughts will also likely lead to higher adult mortality, either directly due to temperature and moisture stress or indirectly due to increased herbivory from rodents lacking alternative forage. Western Joshua trees also do not appear to be moving successfully into higher elevations. Where yucca moth population density is low, plants appear to only be reproducing via clonal growth. The areas where western Joshua trees are projected to be most likely to survive increasing temperatures and drying conditions are also at great risk of fire due to the prevalence of invasive grasses that increase the size and severity of fires. The Petition claims that absent protection of habitat and rapid and substantial reductions in greenhouse gas emissions, western Joshua tree will likely be extirpated from all or most of California within 80 years.

In discussing climate change impacts on western Joshua tree as a factor affecting the ability of western Joshua tree to survive and reproduce, the Petition cites Webber (1953), Thompson et al. (1998), Loik et al. (2000), Lenz (2001), Shafer et al. (2001), Pearson and Dawson (2003), Pellmyr and Segraves (2003), Cole et al. (2011), Dole et al. (2003), Godsoe et al. (2008), Fitzpatrick and Hargrove (2009), DeFalco et al. (2010), Barrows and Murphy-Mariscal (2012), Notaro et al. (2012), Reynolds et al. (2012), Esque et al. (2015), Borchert and Defalco (2016), Harrower and Gilbert (2018), Hopkins (2018), St. Clair and Hoines (2018), Sweet et al. (2019).

Habitat Loss to Development

The Petition provides information on impacts to western Joshua tree from habitat loss due to human development, and states that development presents a substantial threat to the species in a significant portion of its range.

The Petition acknowledges that much of western Joshua tree's distribution is on federal land and is therefore protected to some degree from development impacts. 96 percent of the geographic area in which the YUBR North population is located is federal land. 48

percent of the YUBR South population is located on federal land, but over 50 percent of the YUBR South population is on private land (see Figure 1). Western Joshua trees on private land have been the most impacted by human development and face the greatest threats from human development in the future. The cities and towns of Apple Valley, Hesperia, Lancaster, Palmdale, Ridgecrest, Victorville, and Yucca Valley, along with many other smaller communities have been built in western Joshua tree habitat in the YUBR South area, and these areas have grown rapidly in the past decades. Human population growth in these areas and consequent loss of Joshua tree woodlands is expected to continue in the coming decades.

In addition to urban growth, the Petition states that various other forms of human development threaten western Joshua tree habitat in California, including roads, highways, transmission lines, industrial facilities and large and small-scale renewable energy projects, and these developments have resulted in significant western Joshua tree habitat loss.

A possible scenario for western Joshua tree habitat loss due to human development by the year 2095 is presented in the Petition on page 47 as Figure 19. The Petition states that human development has already consumed hundreds of thousands of acres of habitat in the range of western Joshua tree, and that over the coming decades, more than a million additional acres will be destroyed or degraded for housing, roads, energy projects and assorted other development projects. Combined with threats to western Joshua tree under likely climate scenarios, the Petition states that the added loss of habitat and the genetic resiliency and connectivity that habitat provides will further push the species towards extirpation in California.

In discussing habitat loss due to human development and its effects on western Joshua tree survival and reproduction, the Petition cites USFWS (2018) and SCAG (2019).

2. Other Relevant Scientific Information

The Department received additional information on wildfires as a factor affecting the ability of western Joshua tree to survive and reproduce during the Petition Evaluation period pursuant to Fish and Game Code Section 2073.4. The Department received a report that describes a GIS analysis, literature review, and field survey of a 1999 fire area on Edwards Air Force Base to evaluate western Joshua tree survivorship and/or regeneration (USAF 2017a). The report used aerial photography taken in 1992 to count all identifiable western Joshua trees present in two areas prior to the 1999 fire and compared this information with the results of a 2017 field survey that identified all western Joshua trees in these same two areas. This report concludes that Joshua tree populations were stable in the sampled areas of the fire area from 1992 to 2017.

3. Conclusion

The Petition provides a significant amount of scientific information on factors affecting the ability of western Joshua tree to survive and reproduce. The Petition states that climate change is the greatest threat to the continued existence of western Joshua tree, with wildfires, invasive species, habitat loss from human development, and predation as additional contributing factors that collectively threaten the continued viability of the species. The Petition provides sufficient information on factors affecting the ability of western Joshua tree to survive and reproduce for the Department to make the recommendation in Section IV of this Petition Evaluation.

H. Degree and Immediacy of Threat

1. Scientific Information in the Petition

The Petition discusses the degree and immediacy of threats to western Joshua tree on page 48, under the heading “Degree and Immediacy of Threat”. The Petition states that while extirpation is likely decades away, the species is already suffering the impacts of climate change, with recruitment failure and adult mortality at the hotter, lower elevation edges of its range. The Petition states that invasive grass-fueled fires are already impacting populations of western Joshua tree, and half of the habitat refugia area in Joshua Tree National Park (modeled under a moderate global warming scenario) have already burned in recent decades. The Petition claims that impacts from current greenhouse gas emissions will continue for decades to come, with little time remaining to reduce emissions before climate warming drives western Joshua tree to unavoidable functional extinction.

In discussing the degree and immediacy of threats to western Joshua tree, the Petition cites Barrows and Murphy-Mariscal (2012), Harrower and Gilbert (2018), and Sweet et al. (2019). The Petition also references the preceding section of the Petition on pages 20 through 48 under the heading “Factors Affecting Ability to Survive and Reproduce”.

2. Conclusion

Information provided in the Petition suggests that western Joshua tree is already being affected by threats described in the Petition, and these threats are likely to intensify significantly by the end of the century. The Petition provides sufficient information on the degree and immediacy of threat to western Joshua tree for the Department to make the recommendation in Section IV of this Petition Evaluation.

I. Impact of Existing Management Efforts

1. Scientific Information in the Petition

The Petition discusses the impact of existing management efforts for western Joshua tree on pages 48 through 58, under the heading “Inadequacy of Existing Regulatory Mechanisms”, and also discusses the USFWS decision to not list Joshua tree under the federal Endangered Species Act on pages 58 through 62 under the heading “USFWS’s Flawed Endangered Species Act Determination”. The discussion of existing management efforts in the Petition is focused on regulatory mechanisms of government agencies. The Petition states that no existing regulatory mechanisms are currently in place at the international, national, state or local level that adequately address the threats facing western Joshua tree. The Petition goes on to discuss (1) regulatory mechanisms for greenhouse emissions reductions, (2) regulatory mechanisms to protect habitat from invasive species and fire, (3) state and local mechanisms to protect habitat from loss and degradation, and (4) federal mechanisms to protect habitat from loss and degradation. Information presented in the Petition for each of these will be discussed separately below.

Regulatory Mechanisms for Greenhouse Emissions Reductions

The Petition states that climate change is the greatest threat to the continued existence of western Joshua tree, and that the species cannot be saved absent global action to reduce greenhouse gas emissions. The Petition states that the United States has contributed more to climate change than any other country, and highlights recent rollbacks of federal climate policy. The Petition states that both domestically and globally, government policies, commitments and actions to avoid the worst impacts of climate change are inadequate, and that trends will lead to temperatures that are incompatible with reproduction and survival of western Joshua tree in its current range.

In discussing regulatory mechanisms for greenhouse emissions reductions, the Petition cites Rogelj et al. (2015), USEIA (2016a, 2016b), Erikson et al. (2017), Le Quéré et al. (2018), USGCRP (2018), CAT (2019), DiChristopher (2019), and OCI (2019).

Regulatory Mechanisms to Protect Habitat from Invasive Species and Fire

The Petition states that, to date, no legal, regulatory or management efforts have demonstrated effectiveness at addressing the severe threat that invasive plant species and consequent altered fire regimes pose to western Joshua trees. Immediate suppression of fires in western Joshua tree habitat can limit the spread of fires, but protection of the species from fire ultimately requires invasive plant species management to reduce fuel load. The Petition states that the spread and abundance of invasive plant species are linked to both disturbance (e.g. roads, off road vehicles, cows, and urbanization) and nitrogen deposition, and therefore each of these contributing factors needs to be addressed. Although disturbance is limited in national parks, U.S. Bureau of Land Management (BLM), military, and private lands that compose the majority of western Joshua tree's range are often disturbed by projects and activities. It is also unlikely that nitrogen deposition will be adequately reduced throughout the range of western Joshua tree for at least several decades, if ever. The Petition states that even if disturbance and nitrogen deposition are reduced and the further spread of invasive species can be curtailed, no fully-effective treatments currently exist to reduce or eliminate the most harmful invasive plant species (e.g. *Bromus* spp., *Schismus* spp., *Erodium cicutarium*, *Brassica tournefortii*) that have already become established at a landscape scale in the range of western Joshua tree.

In discussing regulatory mechanisms to protect habitat from invasive species and fire, the Petition cites Brooks and Berry (2006), Allen et al. (2009), Allen et al. (2011), Pardo et al. (2011), Bytnerowicz et al. (2016), Brooks et al. (2018), USFWS (2018), BLM (2019), Sweet et al. (2019).

State and Local Mechanisms to Protect Habitat from Loss and Degradation

The Petition states that western Joshua tree stands to lose more than a third of its suitable habitat in California due to development over the coming decades, including over 40 percent of its habitat in the YUBR South region. Lands owned by the State of California make up less than one percent of western Joshua tree's range in the state, and the Petition states that protection of these lands alone is unlikely to prevent the decline and eventual extirpation of western Joshua tree.

The Petition discusses provisions of the California Desert Native Plants Act, which regulates commercial harvest of western Joshua tree. Commercial harvest was once considered a great threat to western Joshua tree and other desert plants. The Petition states that the California Desert Native Plants Act and various local laws and ordinances were ultimately passed to address this threat. These measures have been largely effective at reducing the commercial harvest of western Joshua tree, but have done little to slow the loss of western Joshua tree habitat from agricultural conversation and other human development. The Petition cites the California Fish and Game Commission's 2015 California Policy for Native Plants.

The Petition discusses the California Environmental Quality Act (CEQA). The Petition states that western Joshua tree is not a species of special concern or a candidate, threatened, or endangered species under CEQA, and therefore a project that has the potential to impact the species would not necessarily qualify as having a "significant effect" under a lead agency's interpretation of CEQA. The Petition identifies other limitations in the ability of CEQA to protect western Joshua tree habitat from loss and degradation and concludes that CEQA, in practice, is inadequate to protect western Joshua tree.

The Petition discusses the Natural Community Conservation Planning Act but states that there are no finalized Natural Community Conservation Plans (NCCPs) that cover western Joshua tree. The Petition states that NCCPs may in the future provide some conservation benefit for western Joshua tree, but have not done so to date and consequently cannot be considered as providing adequate protection in lieu of CESA listing.

In discussing state and local mechanisms to protect western Joshua tree habitat from loss and degradation, the Petition cites Harrower and Gilbert 2018, USFWS 2018, and several state and local laws and regulations.

Federal Mechanisms to Protect Habitat from Loss and Degradation

The Petition states that management laws and plans governing federal lands are the primary federal regulatory mechanism with the potential to protect western Joshua trees. Almost all suitable habitat for YUBR North and about half of suitable habitat for YUBR South is on federal land. Consequently, management of these lands has an important role in determining the continued viability of western Joshua trees in California.

The Petition states that approximately ten percent of western Joshua tree habitat is on National Park Service lands that are generally well-managed, which should prevent significant habitat loss or degradation from activities such as off-road vehicle use, cattle grazing, road building or other forms of development. Approximately 12 percent of the mapped distribution of the YUBR South population falls within military installations and a roughly comparable amount of the YUBR North population falls within such lands. The Petition states that Integrated Natural Resource Management Plans for military installations incorporate some avoidance and minimization measures that could reduce impacts to western Joshua tree, but these measures largely consist of avoidance where feasible and transplantation when conflicts are unavoidable.

The majority of western Joshua tree habitat on federal lands is on BLM land, which is governed by BLM's California Desert Conservation Area (CDCA) Plan. The Northern and Eastern Mojave Plan and West Mojave Plan are amendments to the CDCA Plan that cover the California range of western Joshua tree. The 2016 Desert Renewable Energy Conservation Plan (DRECP) amendments also cover the entirety of western Joshua tree's range in California. The Petition states that these plans do not provide adequate protection for western Joshua tree because the species is not addressed in the plans, the plans include weak or nonexistent avoidance and conservation measures, and/or the plans include activities that will actively degrade western Joshua tree habitat.

In discussing federal mechanisms to protect western Joshua tree habitat from loss and degradation the Petition cites BLM (2002, 2006, 2016, 2019), NPS (2012), USFWS (2018), and additional federal laws, regulations, and reports.

2. Conclusion

The Petition describes the limitations of existing regulatory mechanisms as they relate to the factors affecting the ability of western Joshua tree to survive and reproduce. The Petition provides sufficient information on the impact of existing management efforts on western Joshua tree for the Department to make the recommendation in Section IV of this Petition Evaluation.

J. Suggestions for Future Management

1. Scientific Information in the Petition

The Petition provides suggestions for future management of western Joshua tree on pages 64 through 65, under the heading “Recommended Management and Recovery Actions”. The Petition states that the most important recovery actions for western Joshua tree are those that lead to rapid and steep greenhouse gas emission reductions to minimize the additional warming that will occur in the climate system. The Petition also provides a list of ten additional recommendations for management and recovery of western Joshua tree. These additional recommendations include (1) declaration of a climate emergency and full decarbonization of California’s economy by 2045, (2) preparation of a state recovery plan for the species, (3) development of NCCPs, (4) management plans for western Joshua tree on California Department of Parks and Recreation land, (5) expansion and connection of existing state parks for protection and restoration of Joshua tree habitat, (6) expansion of cooperative work with federal agencies, (7) development of effective measures to control the spread of invasive grasses, (8) development of protocols for fire suppression activities that minimize ground disturbance and spread of invasive species, (9) establishment and maintenance of a western Joshua tree seed bank, and (10) assisted migration activities.

2. Conclusion

The Petition provides several suggestions for future management of western Joshua tree, although some of the suggestions are not within the Department’s jurisdiction. The Petition provides sufficient suggestions for future management of western Joshua tree for the Department to make the recommendation in Section IV of this Petition Evaluation.

K. Detailed Distribution Map

1. Scientific Information in the Petition

A distribution map is provided as Figure 8 on page 17 of the Petition. This distribution map was prepared by USFWS (2018) and includes a representation of the distribution of both western Joshua tree and eastern Joshua tree. This map has been duplicated as Figure 1 in this Petition Evaluation.

2. Other Relevant Scientific Information

As described in Section III(B)(2) of this Petition Evaluation, the Department possesses vegetation maps that cover a large portion of the California deserts where western Joshua tree occurs, and these maps may contribute to a relatively high-resolution western Joshua tree distribution map in many areas of California. These vegetation maps are likely to improve the current understanding of western Joshua tree's distribution.

3. Conclusion

The Petition provides a western Joshua tree distribution map that is sufficient for the Department to make the recommendation in Section IV of this Petition Evaluation.

L. Sources and Availability of Information

1. Scientific Information in the Petition

The Petition cites 114 scientific and administrative documents on pages 66 through 75, under the heading "References Cited". The Petitioner provided digital copies of these documents to the Commission, and they have been made available to the Department.

2. Other Relevant Scientific Information

The Department used additional sources of scientific information cited in this Petition Evaluation. The Department also received additional comments and information on the petitioned action from Mr. Robert R. Brown, Jr. and Mr. Larry Zimmerman, and these additional comments and information have been included as Attachment 1 to this Petition Evaluation.

3. Conclusion

The Petition provides sufficient information on the sources and availability of information used in the Petition for the Department to make the recommendation in Section IV of this Petition Evaluation.

IV. RECOMMENDATION TO THE COMMISSION

Pursuant to Section 2073.5 of the Fish and Game Code, the Department has evaluated the Petition on its face and in relation to other relevant information the Department possesses or received. In completing its Petition Evaluation, the Department has determined there is sufficient scientific information to indicate that the petitioned action for western Joshua tree may be warranted. Therefore, the Department recommends the Commission accept the Petition for further consideration under CESA.

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APPENDIX 1: INFORMATION SUBMITTED TO THE DEPARTMENT

EXHIBIT 3

California State Council of Laborers

Laborers' International Union of North America

LiUNA!

Feel the Power

1121 L Street, Suite 502
Sacramento, CA 95814

Phone: (916) 447-7018
Fax: (916) 447-4048
Email: cscl@calaborers.org

Jose Mejia
Director

Oscar De La Torre
LiUNA Vice President at Large
Business Manager
Northern California District
Council of Laborers

Jon P. Preciado
Business Manager
Southern California District
Council of Laborers

Rocco Davis
LiUNA Vice President at Large
Regional Manager
Pacific Southwest Region
Special Assistant to the
General President

Original on file, received May 8, 2020

May 8, 2020

Eric Sklar
President
California Fish and Game Commission
P.O. Box 944209
Sacramento, CA 94244

RE: Proposed Listing of the Joshua Tree Under the California Endangered Species Act—OPPOSITION

Dear President Sklar:

On behalf of the California State Council of Laborers, I write in strong **OPPOSITION** to the petition submitted by the Center for Biological Diversity to list the western Joshua Tree as a threatened species under the California Endangered Species Act. The Joshua Tree already receives protections at the federal, state, and local levels. This would add redundant protections that would place a significant financial burden on private landowners, while doing little to address the long-term threat to the species. We too live in these communities and are families that seek to protect our environment just like anybody else but feel this proposal is completely unnecessary!

The California desert is comprised of rural, underserved communities that face economic challenges unlike other areas of our state. Listing the Joshua Tree would effectively halt future development, which would impact not only the jobs of our members but the potential jobs and tax revenues to local governments providing essential services.

The petition submitted by the Center for Biological Diversity fails to provide scientific evidence to substantiate a decline of the Joshua Tree population, instead predicting a future decline due to global climate change. Additionally, much of the western Joshua Tree population is on federally protected lands and state preserves, giving them the highest level of protection. Outside of those jurisdictions, they are protected under state law through the California Desert Native Plants Act, which requires permitting for removal.

For these reasons, we respectfully ask that you deny this petition. Should you have any questions, please contact Katie Donahue-Duran or myself at (916) 447-7018.

Sincerely,

Jose Mejia
Director

cc: Secretary Wade Crowfoot, CA Natural Resources Agency

GCC/IBT

URGENT: PROPOSED LISTING OF THE JOSHUA TREE UNDER THE CALIFORNIA ENDANGERED SPECIES ACT

A proposal to list the western Joshua tree as a threatened species is under consideration by the California Fish and Game Commission. If this proposal is approved, the Joshua tree would be protected under the California Endangered Species Act, a move that would effectively halt the development of private property within large swaths of the California desert and bring the state government into the backyards of desert residents uninvited.

How will this impact me?
A threatened species designation requires private property owners to obtain California Environmental Quality Act (CEQA) compliance for any activity that may disturb a threatened species, including homebuilding. If the Joshua tree is listed, activities that may remove any amount of Joshua trees will require a CEQA compliance document, thereby forcing the property owner to employ biologists and specialists to prepare the environmental documents. This requirement would apply to ***any*** construction, or even yard work, that would not normally require a permit, adding tens of thousands of dollars to the cost of development. Complicating matters further is the need for mitigation, which may include financial contributions to various conservation funds or the mandated purchase of undisturbed land that is restricted from development in perpetuity. Once the environmental review is complete, property owners will be required to obtain an incidental take permit, again subjecting the project to additional state scrutiny and costs.

Background information
Much of the western Joshua tree population resides on federally protected lands and state preserves, giving them the highest level of protection. Outside those jurisdictions, they are protected under state law through the California Desert Native Plants Act, which requires permitting for removal. The Center for Biological Diversity recently filed a petition with the California Department of Fish and Wildlife to increase existing protections by listing the tree as threatened despite their own acknowledgment that the species is currently not in decline. Rather, the petition argues that the species may be threatened in the future by global climate change, a threat that will not be mitigated through increased regulations on local property owners.

Local communities take pride in the Joshua tree and have enacted additional protective measures through local ordinances. Moreover, the tree is considered an iconic species that generally adds property value. In fact, many builders go out of their way to plan developments around existing trees. Listing the Joshua tree on the California Endangered Species list will put unnecessary burdens on land owners, significantly limits development, and adversely impacts local economies.

What can you to do stop this shortsighted proposal?
The public is encouraged to send letters of opposition (sample letter attached) to the California Fish and Game Commission. Letters may be submitted by mail or email before **Wednesday, May 20, 2020**. Here is where to send your correspondence:

Mailing Address: California Fish and Game Commission, P.O. Box 944209, Sacramento, CA 94244
Email Address: fgc@fgc.ca.gov (Include "Petition to List the Western Joshua Tree" in the Subject Line)

EXHIBIT 4

From: Daniela Bellissimo
Sent: Friday, May 29, 2020 12:03 PM
To: FGC <FGC@fgc.ca.gov>
Subject: Petition to List the Western Joshua Tree

May 30 2020
Mr. Eric Sklar
President
California Fish and Wildlife Commission P.O. Box 944209
Sacramento, CA 94244-2090

Dear President Sklar,
I write in strong opposition to the petition submitted by the Center for Biological Diversity to list the western Joshua tree as a threatened species under the California Endangered Species Act. The Joshua tree already receives protections at the federal, state, and local levels.

Listing the tree would add redundant protections that place a significant financial burden on private land owners while doing little to address the long-term threat to the species.

The California desert is comprised of rural, underserved communities that face economic challenges unlike other areas of our state. Listing the Joshua tree would effectively halt future development at a time when California is grappling with housing shortages and rising homelessness.

Even more troubling is the fact that the petition submitted by the Center for Biological Diversity fails to provide scientific evidence to substantiate a decline of the Joshua tree population. Instead, the petition predicts a future decline due to global climate change. Further, the proposed action conflicts with other public policy directives such as affordable housing mandates and wastewater discharge prohibitions. As you know, much of the western Joshua tree population resides on federally protected lands and state preserves, giving them the highest level of protection. Outside those jurisdictions, they are protected under state law through the California Desert Native Plants Act, which requires permitting for removal.
I urge you to consider the significant impacts this will have on rural desert communities and respectfully ask that you deny this petition.

Thank you,

Daniela Bellissimo

EXHIBIT 5

ASSOCIATION OF WESTERN EMPLOYERS

Original on file,
received June 11, 2020

June 11, 2020

Mr. Eric Sklar
President
California Fish and Wildlife Commission
P.O. Box 944209
Sacramento, CA 94244-2090

Re: Petition to List the Western Joshua Tree

Dear President Sklar,

I write in strong opposition to the petition submitted to list the western Joshua tree as a threatened species under the California Endangered Species Act. The Joshua tree already receives protections at the federal, state, and local levels and is prized locally and throughout the country for its beauty and as a symbol of a healthy desert. Adding redundant protections will place significant financial burden on private land owners, in the development of public facilities, affordable housing, and career building jobs all of which have been planned while successfully protecting the Joshua tree already.

Contributing to the very real and often severe challenges of lack of housing, homelessness, and real economic progress in the California desert's many rural, underserved communities serves no useful public policy goal and runs counter to many well established goals put forth with wide agreement from multiple Legislatures and Administrations.

Even more troubling is the fact that the petition submitted by the Center for Biological Diversity fails to provide scientific evidence to substantiate a decline of the Joshua tree population. Instead, the petition predicts a future decline due to global climate change. The proposed listing is nothing more than a solution in search of a problem. Much of the western Joshua tree population resides on federally protected lands and state preserves, giving them the highest level of protection. Outside those jurisdictions, they are protected under state law through the California Desert Native Plants Act, which requires permitting for removal.

On behalf of the thousands of career building jobs relying on the work of our Association and others, I urge you to not follow through on this listing request.

Thank you for your consideration.

Sincerely,

Assembly member Jeff Miller, retired (Riverside County)
Chair, Association of Western Employers

30211 Avenida Banderas #200 Rancho Santa Margarita, CA 92688
(949) 438-0448

EXHIBIT 6

NOSSAMAN LLP

ATTORNEYS AT LAW

18101 Von Karman Avenue
Suite 1800
Irvine, CA 92612
T 949.833.7800
F 949.833.7878

Paul S. Weiland
D 949.477.7644
pweiland@nossaman.com

Refer To File # 501803-0004

VIA EMAIL

June 10, 2020

Erik Sklar, President
California Fish and Game Commission
1416 9th Street, Suite 1320
Sacramento, CA 95814
fgc@fgc.ca.gov

Re: Petition to list the western Joshua tree as threatened or endangered under the California Endangered Species Act

Dear President Sklar:

This letter is prepared and submitted on behalf of QuadState Local Governments Authority ("QuadState").[1] We are writing to oppose a petition ("Petition") submitted by the Center for Biological Diversity ("Petitioner") to list the western Joshua tree (*Yucca brevifolia*)[2] as threatened as either a full species or as the subspecies (*Yucca brevifolia brevifolia*) under the California Endangered Species Act ("CESA"), Fish & G. Code ("Code"), § 2050 *et seq*. We understand that at its June 24-25, 2020 meeting, the California Fish and Game Commission ("Commission") will consider whether listing the western Joshua tree under CESA, as requested by the Petition, may be warranted. We request the Commission reject the Petition.

While QuadState is confident that CESA and its implementing regulations require rejection of the Petition, QuadState supports the Commission deferring any decision until the next Commission meeting in order to provide our County members and their constituents with a meaningful opportunity to participate in the listing process. We understand that Commission staff have also recommended the decision be deferred until the August 19-20, 2020 Commission meeting.[3] As you

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[1] QuadState is a joint exercise of powers authority established between eight counties and one city in four Western states. QuadState membership includes three desert counties in California—Imperial County, Inyo County, and San Bernadino County—in which the western Joshua tree may be found.

[2] Due to the species' treatment in the majority of existing scientific literature, the Petition primarily refers to Joshua tree as a single species rather than distinguishing between *Y. brevifolia* (the western Joshua tree) and *Y. jaegeriana* (the eastern Joshua tree); however, the Petition adopts the recent view that *Y. brevifolia* is distinct from *Y. jaegeriana* and requests listing of only *Y. brevifolia*. *See* Petition at 1, 4. In this letter, QuadState refers to the petitioned species as the western Joshua tree.

[3] *See* June 24-25, 2020 Commission Agenda *available* at: https://nrm.dfg.ca.gov/FileHandler.ashx?DocumentID=180395&inline.

are well aware, governments and their citizens are facing a raft of challenges at this moment in time largely as a consequence of the COVID-19 pandemic and its devastating societal impacts. These circumstances have made it difficult for our members to give the Petition and the Department of Fish and Wildlife's ("Department") March 11, 2020 Initial Evaluation of the Petition ("Department Evaluation") appropriate attention.

Deferral will also allow the County members and their constituents with an opportunity to confer with Commission staff and Department personnel regarding the potential to adopt a 2084 regulation in the event that the Commission determines, over our objections, that listing the western Joshua tree under CESA may be warranted. As we are in the midst of a recession of uncertain depth and length, and because all agree that the threat to the species is not by any stretch a near-term threat, a 2084 regulation could be invaluable as a tool to limit the economic consequences of candidacy while ensuring adequate protection for the species, should the Commission pursue that route.

As set forth in greater detail below, QuadState does not believe that the Petition demonstrates that the western Joshua tree meets the definition of a threatened species under CESA. Rather, the Petition relies substantially on effects to the species that may be caused by climate change that Petitioner admits may not be evident for 50 or more years into the future. Such a request is unprecedented. Neither CESA nor its implementing regulations contemplate listing species where the data do not indicate existing and demonstrable threats. To date, the Commission has not listed a species primarily on the basis of potential, future adverse effects of climate change and doing so would establish a precedent not rooted in principles of sound science.

QuadState urges the Commission not to simply accept Petitioner's assertions regarding threats to the western Joshua tree and its habitats; rather, QuadState requests the Commission fulfill its legal obligation to evaluate the information in the Petition and other available information and determine whether the Petition's claims are credible and provide a lawful basis for a candidacy determination.

1. LEGAL BACKGROUND

Section 2070 of the Code provides that the Commission "shall establish a list of endangered species and a list of threatened species." CESA defines a threatened species as:

> a native species or subspecies of a bird, mammal, fish, amphibian, reptile, or plant that, although not presently threatened with extinction, is likely to become an endangered species in the foreseeable future in the absence of the special protection and management efforts required by this chapter.

Fish & G. Code § 2067. The statute defines endangered species as a species:

> which is in serious danger of becoming extinct throughout all, or a significant portion, of its range due to one or more causes, including loss of habitat, change in habitat, overexploitation, predation, competition, or disease.

Id. at § 2062.

A. Petition requirements

Any person can submit a petition to list a species under CESA. In order for a petition to be accepted by the Commission, the Code requires the petition include sufficient scientific information that the petitioned action may be warranted. Fish & G. Code, § 2072.3. Specifically, the CESA requires that a petition include information regarding the "population trend, range, distribution, abundance, and life history of a species, the factors affecting the ability of the population to survive and reproduce, the degree and immediacy of the threat, the impact of existing management efforts, suggestions for future management, and the availability and sources of information," as well as the "kind of habitat necessary for species survival, a detailed distribution map, and any other factors that the petitioner deems relevant." *Id*.

Caselaw clarifies that a species does not qualify as a candidate for "endangered" or "threatened" classification if the petition does not provide sufficient information that would lead a reasonable person to conclude the petitioned action may be warranted. *Natural Resources Defense Council v. Fish & Game Com*., 28 Cal. App. 4th 1104, 1119 (1994) (citing Fish & G. Code, § 2074.2).

B. Obligations of California Department of Fish and Wildlife in evaluating petitions

Pursuant to section 2073.5 of the Code and Title 14 of the California Code of Regulations, the Department must address each of the following petition components when evaluating whether the petitioned action (here, listing the western Joshua tree as threatened) may be warranted:

1. Population trend;
2. Range;
3. Distribution;
4. Abundance;
5. Life history;
6. Kind of habitat necessary for survival;
7. Factors affecting the ability to survive and reproduce;
8. Degree and immediacy of threat;
9. Impact of existing management efforts;
10. Suggestions for future management;
11. Availability and sources of information; and
12. A detailed distribution map.

Cal. Code Regs., tit. 14, § 670.1(d)(1). As set forth below, QuadState believes neither the information presented by the Petition nor the information contained in the Department Evaluation are sufficient to indicate that listing the western Joshua tree may, in fact, be warranted.

2. NEITHER THE PETITION NOR THE DEPARTMENT EVALUATION ESTABLISH SUBSTANTIAL POSSIBILITY THAT LISTING THE WESTERN JOSHUA TREE MAY BE WARRANTED

As noted above, a threatened species under CESA is one that is not presently threatened with extinction, but is "likely to become an endangered species in the foreseeable future in the absence of the special protection and management efforts required by this chapter." Fish & G. Code § 2067. The Petition requests the western Joshua tree be listed as threatened under CESA. Thus, the question for the Commission is whether the species is likely to become in danger of extinction in the *foreseeable future* without *special protection and management* afforded by the Code. Below, we provide information establishing that the western Joshua tree does not meet the criteria for listing under the Code.

A. Western Joshua tree unlikely to become an endangered species in the foreseeable future

The Petition is clear that the western Joshua tree is not faced with "imminent risk of extinction," and, admits that "extirpation [of the species] is likely decades away[.]" Petition at 1, 48. While the Petition predicts that western Joshua trees will be "close to being functionally extinct" in California by "century's end" (that is, 80 years from now), the Petition also explains that "researchers have been raising the alarm about threats to Joshua trees for decades." *Id*. at 32. For example, a study cited by Petitioner from 1953 stated that "regardless of the present wide distribution and large concentration of yuccas, [the Joshua tree's] future appears very dim." *Id*. at 34. And yet, more than 70 years after that grim assessment, there has been no observable downward trend in the population of the Joshua tree, as stated in the Petition and reiterated in the Department Evaluation. *See* Petition at 19 ("no range-wide population trends have been documented"), at 20 ("Regardless of whether Joshua tree abundance is already declining, it is virtually certain that abundance will decline in the foreseeable future"), and at 9 ("The Petition does not present an estimate of western Joshua tree population size, nor does it provide evidence of a range-wide population trend…"); *see also* Department Evaluation at 2 ("Although a reliable estimate of western Joshua tree population size is not available, information available to the Department indicates that the Joshua tree is currently relatively abundant"). Indeed, the Petition itself notes that "while the threats facing *Y. brevifolia* in the coming decades are dire, unlike more narrowly-endemic species, the species has the benefit of being long-lived, with a relatively large current distribution, spread across the elevational and latitudinal gradients, much of which is in protected areas." Petition at 65.

Neither CESA nor its implementing regulations provide guidance on how the Commission should apply the "foreseeable future." Nevertheless, the Petition cites to a 2013 memorandum from the Director of the Department to the Executive Director of the Commission ("2013 Memorandum") concerning a petition to list the American pika on the basis of climate change-induced threats as precedent for the theory that the end of the 21st century may be an appropriate measure. Petition at 63; Memorandum from Charlton H. Bonham, Director of California Dep't of Fish and Wildlife to Sonke Mastrup, Exec. Director of Fish and Game Comm'n, (May 5, 2013) at 1 (emphasis added).

Petitioners fail to mention, however, that the Department ultimately recommended in the 2013 Memorandum that the Commission not list the American pika as a result of the potential threat of climate change. Instead, the Department noted in the 2013 Memorandum that "the best scientific information currently available indicates [the American pika] is not in serious danger in the ***next few decades*** of becoming extinct throughout all or a significant portion of the species' range in the state, nor by the end of the century should the existing climate change models and predicted trajectory of suitable pika habitat come to fruition." 2013 Memorandum at 1 (emphasis added).

Given that supposed extirpation of the Joshua tree is likely "decades" in the future and that there currently is no demonstrable downward trend in the species' abundance or range, QuadState fails to see how the Petition provides the best scientific evidence that the species is in danger of extinction in the foreseeable future.

B. Climate change modeling and relevant studies diverge on the effects of climate change on the Joshua tree

The Petition relies heavily on certain select studies to support the contention that extirpation of the western Joshua tree in California is a foregone conclusion due to the predicted effects of climate change. But multiple studies predict growth and expansion of the range of the tree as a result of a warming climate, while others predict a modest contraction of the tree's range, and still others predict total extirpation. This range of outcomes indicates uncertainty that increases as one looks further into the future.

For example, and as mentioned by Petitioners in a footnote, Notaro et al. (2012) predicted a "robust range expansion" of the species of nearly 150 percent as a result of climate change. Petition at 38, n. 38. Petitioners discount Notaro et al. because that study did not examine the species' response to climate change in California, but fail to mention other studies that also predict potential expansion of the species' range in California.

Archer et al. (2008) notes that "limited available data suggest increases in atmospheric [carbon dioxide] concentrations could promote Joshua Tree seedling survival, and could result in an increase of this native species' range." Steven R. Archer and Katharine I. Predick, *Climate Change and Ecosystems of the Southwestern United States*, Rangelands 30(3): 23-38 (June 2008). The same study further provides that:

> Although the deserts of southwestern North America have been the sites of many important ecological studies, there have been relatively few long-term monitoring studies that provide the opportunity to observe changes in ecosystem structure and function in response to climate change per se… Current observation systems are inadequate to separate the effects of changes in climate from the effects of other drivers…
>
> …

> In climate simulations for the Intergovernmental Panel on Climate Change emission scenarios, novel climates arise by 2100 AD. These future novel climates (warmer than any present climates, with spatially variable shifts in precipitation) increase the likelihood of species reshuffling into novel communities and other ecological surprises… Most ecological models are based upon modern observations, and so might fail to accurately predict ecological responses to future climates occurring in conjunction with elevated atmospheric CO2, nitrogen deposition, and nonnative species introductions.

Id. at 27-28.

Likewise, a study published in 2012 demonstrated that where there was a 3 degree Celsius increase in mean July maximum temperature, Joshua tree distribution within the Joshua Tree National Park ("JTNP") declined by a predicted 90 percent, but a suitable Joshua tree refugium remained in the park. Cameron W. Barrows, Michelle L. Murphy-Mariscal, *Modeling impacts of climate change on Joshua trees at their southern boundary: How scale impacts predictions*, Biological Conservation 152: 29-36 (2012). The study's authors noted that statistical analyses used in previous larger-scale climate modeling homogenized different local conditions and adaptations and, as a result, failed to accurately characterize "the unique niches of statistical outliers, individual populations at the periphery of a species' distribution." *Id*. at 30. To better understand Joshua trees' response to changing climactic conditions, the study's authors employed niche modeling, which considers habitat variables (e.g., climate and terrain) to assess the "complex interaction of factors" constraining species distribution. *Id*. Using this niche modeling, Barrows and Murphy-Mariscal explained that their results contrasted with those of two studies cited heavily by Petitioner: Dole e al. (2003) and Cole et al. (2011) (collectively "Dole and Cole"). While Dole and Cole constructed models wherein similar levels of climate change resulted in no suitable habitat for Joshua trees within the central or southern portions of their current distribution, Barrows and Murphy-Mariscal's results indicated suitable habitat would, indeed, remain. *Id*. at 34. Barrow and Murphy-Mariscal opined that the differences were due to scales of analyses used by Cole and Dole rather than differences in modeling or model assumptions. *Id*. Put simply, Barrows and Murphy-Marsical "were able to incorporate local adaptations as well as topographic-climate complexities, a perspective that would almost certainly be lost with the homogenizing of climate adaptations and landscape features inherent with larger scale analyses." *Id*. (citing Pennington et al. 2010). Importantly, and unlike Cole et al. (2011), Barrows and Murphy-Mariscal found no evidence of Joshua tree mortality within JTNP that was unrelated to fires, despite specifically searching for such causes. *Id*.

Finally, QuadState wishes to bring to the Commission's attention a paper presented at the 2018 Desert Symposium demonstrating that young *Y. jaegeriana* within the Cima Dome in the Mojave National Preserve (located in San Bernadino County, California) appear to survive and grow even through periods of long-term drought. *See* James W. Cornett, *Eastern Joshua tree (Yucca jaegeriana) growth rates and survivability on Cima Dome, Mojave National Preserve*, 2018 Desert Symposium (2018) ("The… study indicates young Joshua trees established near the species' elevational limit have the capacity to survive and continue to grow despite the long-term drought experienced during the… study"). While this paper was written based on a study of *Y. jaegeriana*, one could reasonably postulate that *Y. brevifolia* occurring at similar elevations elsewhere in California would respond in much the same fashion in response to climate change-induced drought and temperature increases as their eastern counterpart. At a minimum, this paper provides further support for QuadState's position that the potential impacts to Joshua tree as a result of climate change do not form a reasonable basis on which to list the Joshua tree or place the species on the list of CESA candidates.

The varying results of studies and models demonstrate that specific effects of climate change on the western Joshua tree are uncertain, and, therefore, the Commission should decline to find the species may warrant listing under CESA at this time.

C. Special protection and management unlikely to address primary alleged threat of climate change

Even assuming that the species is, in fact, in danger of extinction in the foreseeable future, the Petition still fails to meet the test for listing the western Joshua tree as threatened under CESA. As is described in greater detail below, because the primary threat identified by the Petition is that of climate change, there would not appear to be relevant special protection or management efforts that the Commission could put into place that would reverse the supposed trajectory of the species.

The Petition acknowledges its position that "[c]limate change represents the single greatest threat to the continued existence of the *Yucca brevifolia*." Petition at 31. Indeed, the Petition states that "***[e]ven under the most optimistic climate scenarios, western Joshua trees will be eliminated from significant portions of their range by the end of the century***…" *Id*. (emphasis added).

Consequently, the Petition explains that the "lack of effective regulatory mechanisms to address greenhouse pollution is largely determinative as to the question of whether *Y. brevifolia* qualifies for CESA protection." Petition at 50-51. And the first remedy suggested in the Petition for ameliorating threats to the species and to manage and recover the species is for the governor of the State of California to declare a "climate emergency and take[] all necessary action to set California on a path to full decarbonization of [the state's] economy by no later than 2045 (e.g., banning the sale of new fossil fuel vehicles by 2030 and requiring the generation of all electricity from carbon-free sources 2030)." *Id*. at 65. The Department Evaluation also acknowledges that the most important recovery actions for the species are those leading to rapid and steep greenhouse gas emission reductions to minimize climate change. Department Evaluation at 27.

QuadState notes that the Petition neither explains nor substantiates how state-level action to address climate change would lead to a reduction in greenhouse gas emissions at a level necessary to ameliorate threats of climate change on western Joshua trees located in the State of California. Moreover, the Code explicitly states that the relevant management actions and protections must be available under Chapter 1.5 of the Code itself.[4] Fish & G. Code at § 2067. These provisions relate

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[4] As noted above, the definition of a "threatened" species under CESA is a "native species or subspecies of a bird, mammal, fish, amphibian, reptile, or plant that…is likely to become an endangered species in the foreseeable future in the absence of the special protection and management efforts required by [Chapter 1.5 of the Code]." Fish & G. Code

to regulation of "take" of CESA-listed species and not to broad orders by the governor regulating GHG emissions.

Other protective or special management measures recommended by Petitioner include preparation of recovery plans, development of Natural Community Conservation Plans, acquisition of habitat to expand and connect existing state parks to protect Joshua trees, and development of fire protocols within the species range, among others. While these measures may be beneficial to the Joshua tree, the Petition states – and the Department Evaluation recognized – that threats to the Joshua tree due to habitat destruction, fire, and invasive species merely exacerbate the larger threat caused by climate change. *See* Department Evaluation at 2. As such, the measures recommended by Petitioner would not, without a reversal of the climate change trajectory, provide sufficient benefit to counter the purported threat to the species. If the climate change predictions espoused by the Petition prove true, the presence or absence of any protective measures would make no difference to the species' status. As noted above, the Petition admits that even under the best climate change scenario, the species will become close to functionally extinct. Petition at 32.

D. Joshua tree is adequately protected in the State of California

QuadState notes that the western Joshua tree already benefits from substantial on-the-ground conservation pursuant to federal, state, and local law, regulation, and policy, and believes that the Petition's claim that the western Joshua Tree is inadequately protected is wholly without merit. Petition at 48, 58.

For example, under the California Desert Protection Act of 1994 ("CDPA"), Congress expanded environmental protections to millions of acres of desert "wilderness" by establishing the Death Valley and Joshua Tree National Parks, and the Mojave National Preserve. Pub. L. No. 103-433, 108 Stat. 4471 (1994). Through the CDPA, Congress declared its policy that public lands in the California desert be included in the national park and national wilderness preservation systems in order to perpetuate the diverse ecosystems of the California desert in its natural state. *Id*. The CDPA withdrew designated areas from "all forms of entry, appropriation, or disposal under the public land laws" and effectively functions to preserve and protect the very habitat necessary for the Joshua tree's survival. *Id.;* 16 U.S.C. §§ 410aaa–42, 410aaa–47.

The Petition acknowledges that 96 percent of the western Joshua Tree population in the northern part of its range occurs on federal lands protected under the CDPA and other mechanisms and that ten percent of the species occurring in the northern part of its range occurs on National Park Service land which is "generally well-managed and should prevent significant habitat loss or degradation from activities such as [off-road vehicle] use, cattle grazing, road building, or other forms of development." Petition at 55. Nevertheless, Petitioners attempt to minimize the significance of this protection by noting without additional commentary the existence of a single grazing allotment (the 86,400-acre Hunter Mountain Allotment) within Death Valley National Park that supposedly

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§ 2067. The term "special protection and management efforts" is not further defined by the Code. Chapter 1.5 of the Code does not set forth any required special protection and management obligations relating to state-listed species outside of the application of prohibitions on import, export, and take established in § 2080 and activities relating thereto.

overlaps with the "range of *Y. breviolia*". *Id*. Petitioners cite the National Park Service's Death Valley National Park Wilderness and Backcountry Stewardship Plan and Environmental Assessment (2012) ("Park Service EA"). The Park Service EA, however, does not address whether the western Joshua tree occurs within the Hunter Mountain Allotment, and the Petition does not explore whether the current grazing allotment (which permits grazing of no more than 150 head of cattle between November 20 to June 30 of each year), in fact, negatively affects the species. *See* Park Service EA at 122.

At the state and local level, numerous laws and ordinances serve to provide significant additional protection for the western Joshua tree. For example, under the California Desert Native Plants Act, the western Joshua tree may not be harvested without a permit in Imperial, Inyo, Kern, Los Angeles, Mono, Riverside, San Bernardino, and San Diego Counties. Food & Agr. Code, §§ 80073(a), 80003. Local jurisdictions have adopted measures similar to those set forth in the California Desert Native Plants Act, including specific prohibitions on harvesting or removing Joshua trees. *See* San Bernadino County Code 88.01.060(c)(4). Chapter 14 of the City of Palmdale Municipal Code declares as its policy that "appropriate action must be taken in order to protect and preserve desert vegetation, ***and particularly Joshua trees***, so as to retain the unique natural desert aesthetics on some areas of this City[.]" Palmdale, Cal., Ordinance Ch. 14.04, § 14.04.010 (1992) (emphasis added).

QuadState fails to see how preservation and protection of such significant portions of a species' current habitat in addition to strong state and local laws and ordinances prohibiting removal of the species could lead a reasonable person to conclude such species is inadequately protected under existing regulatory mechanisms.

3. DEPARTMENT EVALUATION FAILS TO NOTE THE FACT THAT THE PETITION IS INCOMPLETE

QuadState notes that the Department appears to have completely ignored the requirement of the California Code of Regulations that a petition to list a species under CESA provide information concerning the species population trends and abundance. Despite acknowledging that the "Petition does not present an estimate of western Joshua tree population size, nor does it provide evidence of a rangewide population trend," the Department nevertheless found that the Petition presented sufficient information on population trend and range. Department Evaluation at 2, 9.

Indeed, the Petition explicitly states that "[d]ue to the [Joshua tree's] patchy distribution within its range, highly variable population density…and lack of range-wide population surveys, a reliable estimate of Joshua tree population size is not available." Petition at 19. Moreover, the Petition notes that "impacts such as adult mortality and consequent population declines and range reductions may have a lag time before the presence is felt on the landscape." *Id*. at 20.

QuadState fails to understand how a Petition's provision of no data can result in a Department finding that sufficient data was provided.

4. STANDARD FOR LISTING UNDER CESA CANNOT BE BASED ON FUTURE DECLINE ALONE

The Petition includes dire warnings concerning the threat climate change poses to the western Joshua tree; however, the Petition also acknowledges that "[s]ince the end of the Pleistocene, the Joshua tree's distribution has been remarkably stable throughout the Holocene into the present day." Petition at 16-17. Despite the continued persistence of the species for tens of thousands of years, the Petition nevertheless predicts that the species will be extirpated at least from the JTNP by 2071 to 2099. *Id.* at 37. Among the studies relied upon by the Petition for this prediction is Cole et al. 2011. *Id.* at 68. However, it is notable that Cole et al. 2011 explains that the warming climate that occurred at the end of the Pleistocene and marking the beginning of the Holocene was the "most recent warming event of similar magnitude to that predicted for the near future." Cole et al. 2011 at 139. While that study indicated the species did not migrate as one might have expected, the species nevertheless has continued to persist, demonstrating its remarkable resilience.

Common logic would tell us that a species should not be listed on the sole basis that it may experience a future decline in range or distribution, particularly where no studies have demonstrated a downward population trend or reduction in abundance at a population level. Indeed, to date, the Commission has declined to list any species solely (or primarily) on the basis of future threats due to climate change. Doing so would open Pandora's box, allowing for the listing of innumerable plants and animal species that are not currently in danger of extinction nor likely to become so in the coming decades. QuadState believes a listing – or even a placement of a species – based on supposed future threats would be inconsistent with the Code.

QuadState suggests that the approach the Department adopted with respect to the American pika, mentioned briefly above and cited by the Petition, was precisely right. There, the Department did not recommend listing the species under CESA on the basis of future threats caused by climate change. Instead, the Department noted its belief that continued study and monitoring of the American pika would be "imperative" for the agency over the "next few decades" in order to "better assess the foreseeable future and the need for protections under CESA." 2013 Memorandum at 2.

This wait and watch closely approach suggested by the Department in connection with the status of the American pika under state law was prudent, thoughtful, and warranted. The Commission should decline to find the Petition warranted at this time and should, instead, adopt an approach wherein the species' trends and trajectory are closely monitored. The Commission may elect to initiate the CESA listing process at a later date due to the provision of new information and, of course, interested persons may submit new petitions to list at any time, which would trigger the petition review process.

5. CONCLUSION

In light of the foregoing, QuadState urges the Commission not to simply accept Petitioner's assertions regarding threats to the western Joshua tree and its habitats; rather, QuadState requests the Commission fulfill its legal obligation to evaluate the information in the Petition and other available information and determine whether the Petition's claims are accurate and credible.

Natural Resources Defense Council v. Fish & Game Com., 28 Cal. App. 4th 1104, 1119, 1125. The "may be warranted" finding described in Fish & Game Code § 2074.2 requires a determination that there is a "substantial possibility" that the petitioned action is warranted. *Id*. Based on the information provided in the Petition, there can be no rational determination of a substantial possibility that listing the western Joshua tree would be warranted at this time.

Very truly yours,

Paul S. Weiland
Nossaman LLP

cc: Charlton Bonham, Director, California Department of Fish and Wildlife
Gerald Hillier, Executive Director, QuadState Local Governments Authority

EXHIBIT 7

GRANITE™

June 11, 2020

Original on file,
received June 11, 2020

Mr. Eric Sklar
President
California Fish and Wildlife Commission
P.O. Box 944209
1416 Ninth Street, Suite 1320
Sacramento, CA 94244-2090

Also emailed to fgc@fgc.ca.gov

Re: Petition to List the Western Joshua Tree; June 24-25 Hearing; Agenda item #27

Dear President Sklar,

Granite Construction Company is writing in strong opposition to the petition submitted by the Center for Biological Diversity to list the western Joshua tree as a threatened species under the California Endangered Species Act. The Joshua tree already receives protections at the federal, state, and local levels. Listing the tree would add redundant protections that place a significant financial burden on private landowners while doing little to address the long-term threat to the species.

The California desert is comprised of rural, underserved communities that face economic challenges unlike other areas of our state. Listing the Joshua tree would effectively halt future development at a time when California is grappling with housing shortages and rising homelessness.

Even more troubling is the fact that the petition submitted by the Center for Biological Diversity fails to provide scientific evidence to substantiate a decline of the Joshua tree population. Instead, the petition predicts a future decline due to global climate change. The proposed listing is nothing more than a solution in search of a problem. Much of the western Joshua tree population resides on federally protected lands and state preserves, giving them the highest level of protection. As an example, Joshua Tree National Park's contains 792,623 acres (over 1,200 sq. miles) of habitat for the Joshua tree where it already has the ultimate protection. The Mojave National Monument is over 1.6 million acres and the National Park Service describes the desert solitude there as containing a "large Joshua tree forest". Outside of those jurisdictions, they are also already protected under state law through the California Desert Native Plants Act, which requires permitting for removal or transplant.

Granite Construction Co is the largest transportation infrastructure contractor in California with more than 2,800 employees in the state. Based in Watsonville, California and founded in 1922, the work that Granite performs is considered an essential public service, from making aggregate (sand and gravel), to producing asphalt and concrete paving materials, to rebuilding our roads, streets and bridges for state and local entities. The production of aggregate, asphalt and concrete requires years of planning, engineering, environmental review and permitting – all an expensive and risky venture process for private companies that invest in this state. Active aggregate production facilities that have been permitted under environmental review and mitigation under the authority of the California Endangered Species Act (CEQA) result in appropriate mitigation measures arising from guidelines such as the California Desert Native Plants Act. For operational aggregate and production facilities in the California desert, changing the mitigation measures for previously approved facilities will result in increased costs, uncertainty, and a reduction in the ability to produce and utilize such aggregate reserves. This means lower employment, more costly public and private construction, and less efficiency in spending the valuable SB1funding approved by the legislature and Governor, and subsequently upheld by an overwhelming margin by the voters. Given that these active facilities are operational, have previously undergone science-based impact analysis, and are operating under CEQA-approved mitigation measures for many species including the western Joshua tree, Granite urges the Commission to recognize these types of facilities and exempt or grandfather them from the effects of a candidate listing review that is not science-based.

I urge you to consider the significant impacts this potential listing will have on the employees and businesses in the rural desert communities and respectfully ask that you deny this petition.

Thank you,

Jim Radich
Senior Vice President
California Operating Group

MONTEREY BAY AREA OFFICE
580 West Beach Street, Watsonville CA 95076 • Phone (831) 763-6100 • Fax (831) 763-6121

EXHIBIT 8

555 12th Street, Suite 1500
Oakland, California 94607
tel (510) 808-2000
fax (510) 444-1108
www.meyersnave.com

Shaye Diveley
Attorney at Law
sdiveley@meyersnave.com

meyers | nave

June 11, 2020

Eric Sklar, President
California Fish and Game Commission
P.O. Box 944209
Sacramento, CA 94244-2090
fgc@fgc.ca.gov

Re: Petition to List the Western Joshua Tree (*Yucca brevifolia*) as Threatened Under the California Endangered Species Act

Dear President Sklar and Commission Members:

The County of San Bernardino (County) and Town of Yucca Valley (Town) jointly submit this letter in response to the Center for Biological Diversity's Petition (Petition) for the listing of the western Joshua tree (*Yucca brevifolia*) as a threatened or endangered species under the California Endangered Species Act (CESA). The County and Town strongly oppose the Petition and the listing of the western Joshua tree under CESA.

The Fish and Game Commission (Commission) is scheduled to consider as Item 27 at its June 24-25, 2020, meeting (1) the Petition; (2) the Department of Fish and Wildlife's (Department) "Report to the Fish and Game Commission: 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" (Report); and (3) public comments. The posted agenda indicates that staff has recommended the Commission's consideration of the Petition be continued to the August 19-20, 2020 meeting based on input from stakeholders, among others. As key stakeholders, the County and Town are grateful for the additional time to address the important issues raised by the Petition and to work with the Department with respect to the proposed listing.

The County and Town submit these joint comments now to further the anticipated dialogue and to highlight three vital concerns to the Commission that justify denial of the Petition. First, the California Desert Native Plants Act, the California Environmental Quality Act (CEQA) and numerous local ordinances already provide strong and comprehensive protections to preserve western Joshua tree populations and their habitat. Indeed, the County and Town both have specific provisions preventing improper removal of the western Joshua tree and actively enforce these measures to ensure the protection of this iconic species. Second, the Petition fails to provide sufficient data of actual impacts to the western Joshua tree to warrant listing at this time.

Existing management efforts have been successful, as demonstrated by the current population trend, range, distribution and abundance of the western Joshua tree. Although climate change may pose certain threats to this species (along with nearly every other species), at present nearly all of the threats identified in the Petition are based on widely variable modeling assumptions. Third, granting candidate status to the western Joshua tree would interfere with existing regulations and thwart critically needed housing, infrastructure and other projects. This is a huge and undue burden on the desert communities, particularly given the speculative grounds for the Petition.

For these reasons, as discussed in more detail below and in the enclosed Technical Memorandum from Heritage Environmental Consultants, the Petition does not meet the criteria for listing the western Joshua tree as a threatened species pursuant to Fish and Game Code section 2072.3 and California Code of Regulations, Title 14, section 670.1. These concerns are not exclusive, and the County and Town will be supplementing this letter with additional comments and supporting materials in advance of the August meeting.

Current Law Already Provides Strong and Comprehensive Protections for the Western Joshua Tree and Grounds for Denying the Petition

The western Joshua tree is an iconic species of the California desert and deserving of strong regulation to protect its continued survival. These protections are already in place and, contrary to the assertions in the Petition, these protections are effective in reducing impacts to western Joshua trees throughout their range in California. Thus, these protections serve as grounds for denying the Petition.

Federal

At the federal level, the California Desert Protection Act (16 U.S.C. § 410) established the Death Valley and Joshua Tree National Parks and the Mojave National Preserve in the California desert, protecting a vast range of western Joshua tree. In addition, there are approximately 69 wilderness areas within the U.S. Bureau of Land Management lands in the California Desert Conservation Area. The federal government recognized the protections these vast areas afford the species when it declined to list the western Joshua tree under the federal Endangered Species Act last year (a proceeding more fully discussed below).

State

The California Desert Native Plants Act (Cal. Food & Agric. Code, § 80001 *et seq.*) (DNP Act) was enacted in 1981 expressly to protect California desert native plants, including the western Joshua tree, in the Counties of Imperial, Inyo, Kern, Los Angeles, Mono, Riverside, San Bernardino, and San Diego, from unlawful harvesting on both public and privately owned lands. Under the DNP Act, the harvest, transport, sale, or possession of western the Joshua tree is prohibited unless a person has a valid permit that strictly regulates the grounds and procedures for any removal. The DNP Act has been enforced for nearly 40 years to ensure that no western Joshua trees are removed or damaged unless as permitted by the applicable county.

County

The County's Desert Native Plant Protection Ordinance (San Bernardino County Code (County Code) § 88.01.050) (Ordinance) implements the DNP Act. The Ordinance provides regulations for the removal or harvesting of specified desert native plants in order to preserve and protect the plants and to provide for the conservation and wise use of desert resources. The Ordinance requires a permit for the removal of all Joshua trees, regardless of trunk or stem size. In addition, permit conditions for Joshua trees must include provisions for transplanting wherever feasible. (County Code § 88.01.050(f)(3)(A).) Additional protections are in place to require transplanting for specimen trees, which have a circumference greater than 50 inches or height taller than 15 feet. Violation of this section constitutes a misdemeanor punishable by a fine of up to $1,000, up to six months of jail time, and a replacement program for disturbed Joshua trees that were illegally removed. (County Code § 88.01.050(j).) The provisions are intended to augment and coordinate with the DNP Act and the efforts of the State Department of Food and Agriculture to implement and enforce the DNP Act.

Town and Other Municipalities

The western Joshua tree also already enjoys substantial protection within the Town of Yucca Valley. Under section 9.10.040 of the Town's Municipal Code, the Joshua tree is listed as a "regulated desert native plant." For all commercial development projects within the Town, an applicant must submit a native landscaping documentation package that identifies the regulated native plants within the development area, documents their size, height, health, and proposed placement or disposition of the plant. "All regulated desert native plants identified … as likely to survive transplanting shall be made available for adoption or shall be transplanted on site as part of the project's landscaping plan. All native plant permit applications shall illustrate <u>maximum utilization of regulated desert native plants in the project's landscaping plan</u>." (Municipal Code section 9.10.040 [emphasis added].) Moreover, the Town's Municipal Code requires that all Joshua trees that are likely to survive transplanting procedures, and which are not incorporated into the project's landscaping plan, must be made available for adoption. (Id.) Therefore, the Town already endeavors to ensure that the Joshua tree is protected during commercial development.

The Town regulation is just one of the many local protections for the western Joshua tree. For example, the Cities of Hesperia (Hesperia Municipal Code Ch. 16.24 "Protected Plants"), Palmdale (Palmdale Municipal Code Ch. 14.04 "Joshua Tree and Native Desert Vegetation Preservation"), and Victorville (Victorville Municipal Code Ch. 13.33 "Preservation and Removal of Joshua Trees") all have similar ordinances intended to protect or avoid impacts to western Joshua trees. The County and Town will endeavor to provide a more comprehensive survey of local regulations for the August 19-20, 2020, meeting.

For Projects By or Under Permit at All Governmental Agencies within the State – CEQA

Because of the heightened protection of western Joshua trees by local ordinance, projects that may affect the western Joshua tree are also scrutinized under the California Environmental Quality Act (Public Resources Code § 21000 et seq.) (CEQA) and its implementing guidelines to ensure mitigation for any impacts. In addition, the Petition omits that Joshua trees are listed as a "sensitive natural community" within the California Natural Diversity Database (CNDDB). As a result, projects under CEQA are often required to inventory all accessible Joshua trees within the proposed project disturbance areas and have a qualified botanist identify those likely to survive transplantation. Suitable trees are relocated prior to grading to off-site reclamation or restoration areas, and maintained to ensure successful transplantation. Alternatively, project applicants are often required to permanently conserve land (on or off the project site) that comprises suitable Joshua tree habitat as mitigation for the clearance of any Joshua trees on their site.

In addition, the Petition falsely states that local agencies can circumvent impacts to Joshua trees merely by adopting a statement of overriding considerations. One of the most well-settled principles of CEQA is that all feasible mitigation measures must be implemented. Measures to avoid impacts to biological resources, such as transplanting, permanently conserving habitat, or replanting fresh saplings, are all measures that have been deemed feasible under California law and therefore must be incorporated into environmental analysis, when applicable under CEQA.

In sum, the State, the County, the Town and other local jurisdictions have adopted policies that protect Joshua trees from unregulated removal and habitat loss in the urbanizing areas within the species' current habitat range. The existence of these policies, and the listing of Joshua trees within the CNDDB, both trigger substantive requirements under CEQA to conserve habitat and otherwise mitigate impacts to Joshua trees by new development. The County and Town intend to submit additional information prior to the August meeting to demonstrate that these robust protections fully enforce and provide the necessary protections to the western Joshua tree, so that listing under the CESA is not warranted.

The Petition's Claims that the Western Joshua Tree's Survival is Uniquely Threatened and Can Be Preserved by the Listing Under CESA Are Unsupported

The County and Town further want to direct the Commission's attention to the unsupported nature of the Petition. Under CESA, the decision to list a species as threatened or endangered must be based upon the best available scientific information. (Fish & Game Code § 2070.) A petition for listing a species as threatened must provide sufficient scientific information under CESA regulations regarding the population trend, abundance, degree and immediacy of the threat, impact of existing management efforts, and suggestions for future management. (Fish and Game Code, § 2072.3; 14 Cal. Code Reg. § 670.1(d)(1).)

The best available scientific information does not warrant a finding that the survival of the western Joshua tree is threatened at this time. The Petition cites several studies that model the future impact of global climate change on the western Joshua tree. The County and Town have serious concerns, however, that the Petition relies too heavily on the modeling of future climate change impacts as a basis for listing the western Joshua tree as threatened, given that the U.S. Fish & Wildlife Service (USFWS) concluded that there has been no major reduction in Joshua tree populations during the last 40 years, and the existing potential habitat for the western Joshua tree currently exceeds 5 million acres.[1] The Petition also fails to adequately and accurately account for the strong protections already in place (as discussed above) to relocate, replant or replace any trees impacted by new development, therefore these local programs will assist in ensuring the survival of western Joshua trees in lower elevations.

The enclosed Technical Memorandum on Scientific basis for listing the western Joshua tree (*Yucca brevifolia*) as threatened under the California Endangered Species Act, dated June 10, 2020, from Heritage Environmental Consultants (Technical Memo) raises significant questions regarding the Petition's overall premise that climate change will cause extirpation of the species. The Technical Memo notes that all of the major studies cited by the Petition were based on data from Joshua Tree National Park, which the Petition acknowledges to be the southernmost range of the species. The Technical Memo further notes that results from Joshua Tree National Park may not accurately represent population trends farther north in the species' range. The report specifically questions whether the Petition's conclusions regarding impacts from greater wildfires, climate change, and encroaching development hold true in its northern range. More data is therefore needed to confirm whether northern populations will be affected by predation, invasive grasses and other species, wildfires and climate change in the same manner as those populations located within Joshua Tree National Park.

The Petition argues that modeling of future climate change scenarios indicates that the western Joshua tree will face more difficult challenges to its survival than other species. At this time, however, it is wholly premature to list the Western Joshua tree as threatened where the rationale for listing is based entirely on future modeling (not present activity), and where measures are in place to protect the western Joshua tree in areas where the hypothetical threats identified in the future modeling, i.e., lower elevations and urbanizing areas, are the greatest.

Furthermore, the long-range modeling of potential impacts from climate change do not provide a reasonable basis for listing the western Joshua tree as threatened because current populations have remained stable and recruitment continues throughout most of its habitat. The Petition noted that a 2018 study published by the USFWS[2] provides "the most complete synthesis of range data" for the western Joshua tree. By the Petition's own admission, the USFWS Assessment therefore provides the best available science on the western Joshua tree's population trend and abundance. The Petition and USFWS Assessment noted, however, that "a reliable estimate of Joshua tree population size is not available," due largely to patchy distribution of the species within its range, highly variable population density (4 to 840 trees per acre) and a lack of

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[1]Summary of Findings https://www.regulations.gov/document?D=FWS-R8-ES-2016-0088-0028

[2] U.S. Fish and Wildlife Service. 2018. Joshua Tree Species Status Assessment. Dated July 20, 2018. 113 pp. + Appendices A–C (USFWS Assessment).

range-wide population surveys. (Petition, p. 19.) Nevertheless, the Petition and the USFWS Assessment found more than 3.2 million acres of potential habitat in the area identified as YUBR South, and almost 2 million acres of potential habitat in the area identified as YUBR North, for a total of more than 5 million acres of potential habitat for the western Joshua tree. (Petition, pp. 18-19.)

Despite its reliance on the USFWS Assessment, the Petition fails to mention the key finding in that report: threats to individual Joshua trees are not likely influencing population resiliency on a population or species scale since there is no evidence to indicate any recent population size reductions or range contractions over the past 40 years, based on distribution mapping and limited demographic studies that indicate recruitment is occurring. (USFWS Assessment, pp. 1-2, 61, 65.) Rather, the Petition seeks to distinguish the threats analysis in the USFWS Assessment by asserting, without any justification or support, that "political influence" factored into its ultimate conclusions. (Petition, p. 4, fn. 3.)

The underlying premise of the Petition is that: "Regardless of whether Joshua tree abundance is already declining, it is virtually certain that abundance will decline in the foreseeable future… [due to] the impacts of climate change, fire, habitat loss and other sources of mortality." (Petition, p. 18.) This is akin to saying that there is no evidence today, but someday there will be proof. Spokespersons for the Center for Biological Diversity also admitted as much when they stated to news outlets that "the idea is to get ahead of the curve…. The Joshua tree, because it has protected public land and a whole lot of other private land, it provides an opportunity to collectively figure out how to get adaptation right… as our climate warms."[3] The USFWS Assessment, however, contradicts the Petition's first assumption that western Joshua tree populations are currently in decline. The Petition's remaining rationale for listing the western Joshua tree relies on modeling of future climate change scenarios through the end of the 21st century. This is not the standard under CESA, which requires a documented immediacy of the threat to the species. Although the County appreciates the significant work that the academic community has produced to evaluate the viability of the western Joshua tree, such work at this time remains highly speculative given the massive complexities in the intersection of climate change, species migration and other interrelationships, such as the western Joshua tree's symbiotic relationship with its pollinating moth.

The County and Town do not dispute that climate change may affect the ability of many plant species, including California desert species like the western Joshua tree, to adapt and survive. However, as explained in the enclosed Technical Memo, the Petition does not provide adequate analysis of how this global concern would be unique to the western Joshua tree, would directly affect the tree's migration and other resiliency factors, and would be redressed through management and listing as threatened under CESA. For similar reasons, the Commission denied

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[3] Brendan Cummings, senior counsel and conservation director for the Center for Biological Diversity https://www.desertsun.com/story/news/environment/2019/10/15/conservationists-seek-protect-california-joshua-trees-climate-change/3990631002/

listing the American pika as a threatened species, a decision that was upheld by the courts despite several lawsuits by the Center for Biological Diversity.[4]

Based on its current population and range, the local measures to protect, relocate and replant the western Joshua tree, and its wide range of habitat zones, additional studies are needed to validate the accuracy of models that are predicting significant habitat loss for the western Joshua tree. That the models run for 80 years through 2100 further suggests that additional studies can be reasonably performed without any immediate threat to the survival of the species. These additional studies may ultimately show that the modeling is correct, however, the County and Town will bear a heavy burden if western Joshua tree is regulated under CESA, and such burden is not appropriate if it is not actually needed to protect the western Joshua tree's survival. These factors make it too speculative to warrant consideration of the western Joshua tree as a candidate at this time.

The Commission Should Ensure that any Action on the Proposed Listing Does Not Interfere with the Existing Regulatory Regime for Protection of the Western Joshua Tree

The County and Town again express appreciation for the staff's recommendation that the consideration of the Petition be continued to the August meeting. In addition to facilitating a complete substantive analysis, this continuance is critical to ensure that if the Commission considers granting candidate status to the western Joshua tree, measures can be put into place to avoid interference with the existing regulation protecting the species and confirm that essential infrastructure, affordable housing and other important development projects can proceed.

It cannot be overstated how listing the western Joshua tree under CESA would have drastic and detrimental effect on the County, Town and other desert communities. As has been expressed by numerous letters already submitted to the Commission, the western Joshua tree is widespread and its presence is addressed in nearly every development project in the area. Usurping the long-standing protections in place under the California Desert Protection Act and the local ordinances by granting candidate status to the western Joshua tree would cause havoc to the existing regulatory regime and prevent the development of critically needed projects.

For example, the Town is presently in the middle of a two-phase waste water treatment plant project that involves the construction of a treatment plant, infrastructure throughout the Town, and individual connections to approximately 6,000 homes and businesses. This significant project is in response to a related discharge prohibition imposed upon the Town by other state agencies. In some instances, Joshua trees must be removed in order to install the collection systems and related private property connections. The placement of added restrictions on the

[4] See *Ctr. for Biological Diversity v. California Fish & Game Comm* (2011) 195 Cal. App. 4th 128, 124 Cal. Rptr. 3d 467; CDFW denied petition for listing American pika; court rejected attorneys' fee claim where petition was again denied after court ordered reconsideration.

removal of the Joshua Tree would hinder this project by causing delays and increasing costs to the Town and individual residents and business owners who are responsible for constructing the new connections to their homes and businesses. In this time of economic hardship and uncertainty, these additional costs could significantly affect residents and businesses within the Town. Listing the Joshua Tree as a candidate species would also impact development projects that have already been approved by the Town, including Yucca Plaza (a 23,056 square foot multi-tenant commercial shopping center) and Princeton Equine (an equine veterinary clinic).

Additionally, listing the western Joshua tree as a candidate species could severely hinder future development. The County's rural desert areas have many small projects that would have incidental *de minimis* impacts on the western Joshua tree's survival; imposing the incidental take process on such projects would seriously deter and likely stop many of these small projects, typically single homes or home additions. For the Town, various developers are in development review for the construction of affordable housing. Placing additional hurdles on development, where the margins for a developer are already razor thin, could force these developers to look elsewhere and deprive the Town of much needed affordable housing, as identified in the Town's Regional Housing Needs Assessment. Similarly, other projects, including a campground that would service the Joshua Tree National Park, a housing subdivision, and a carwash, are in the pre-application phase. Listing the western Joshua tree as a candidate species could result in many of these projects being postponed or abandoned entirely.

These projects (and others like it) need to be allowed to proceed without additional requirements that may be imposed if the western Joshua tree is granted candidate status, and the County and Town intend to propose regulations to ensure those protections under California Fish and Game Code section 2084. The regulatory burden for local agencies to comply with the CESA is especially unjustified given that the potential threats to the western Joshua tree from global climate change or other factors are unsupported or, at most, not imminent.

* * * * * *

The County and Town thanks the Commission for considering these preliminary comments and look forward to working with the Department on these issues over the next several months.

Sincerely,

Meyers Nave Riback Silver & Wilson

Shaye Diveley
Special Counsel
County of San Bernardino

Burke, Williams & Sorensen, LLP

Thomas D. Jex
Town Attorney
Town of Yucca Valley

Enclosures: Heritage Environmental Consultants, Technical Memorandum on Scientific basis for listing the western Joshua tree (*Yucca brevifolia*) as threatened under the California Endangered Species Act, June 10, 20203537965.6

Technical Memorandum

Prepared For: County of San Bernardino

Prepared By: Heritage Environmental Consultants

Subject: Scientific basis for listing the western Joshua tree (*Yucca brevifolia*) as threatened under the California Endangered Species Act

Date: June 10, 2020

Background

On October 15, 2019, the Center for Biological Diversity (CBD) submitted a petition to the California Fish and Game Commission to list the western Joshua tree (*Yucca brevifolia* [YUBR]) as threatened under the California Endangered Species Act (CESA) (CBD 2019). In February 2020, the California Department of Fish and Wildlife (CDFW) completed a review of the petition, as well as other scientific information available to CDFW. In its review, CDFW determined that "the petition provides sufficient scientific information to indicate that the petitioned action may be warranted" and recommended that the commission "accept the petition for further consideration under CESA" (CDFW 2020a). In the event that the commission accepts the petition, YUBR would become a candidate for listing as threatened under CESA.

Petition Review

Heritage Environmental Consultants was asked to review existing information and provide expert opinion regarding the scientific basis for listing YUBR as threatened under the CESA. The following review is based primarily on the petition itself (CBD 2019) and CDFW's subsequent review of the petition (CDFW 2020a) because of the limited time available for a more in-depth review of the supporting literature for these two documents. As such, this review accepts in a general sense that both CBD and CDFW have reviewed the existing literature and represent it accurately in their respective documents. The following sections provide review comments following the same outline as CBD's petition.

Life History

Most aspects of the life history of YUBR have been well-researched and are generally accepted. The current taxonomy of *Y. brevifolia* as a distinct species from *Y. jaegeriana* has been accepted. The previous taxonomy, with two subspecies (*Y. brevifolia brevifolia*) and (*Y. brevifolia jaegeriana*), would also provide a suitable basis for listing of either one or both subspecies under the CESA, if the current taxonomy were to be rejected.

Flowering, seed production, dispersal, predation, germination, and growth are generally understood, although several points are worth noting, as follows.

Seed production is an episodic event, correlated with increased precipitation. Sufficient moisture is also required for survival of young YUBR. In a desert environment, conditions for recruitment of YUBR seedlings may only occur “a few times in a century” (Esque and others 2015, in CBD 2019) and no seed production or seedling survival can be expected in drought years.

Individual YUBR cannot be aged in the same way as true trees because they lack annual growth rings. In previous studies, growth (size) has been used as a surrogate for age, on the assumption that larger trees must be older. At the level of this review, it is unclear how well previous studies have been able to correlate size with age, or if any studies have been conducted for sufficient time to even demonstrate a statistically significant correlation.

Considering that seedling recruitment is a rare event, and that age structure in the existing population is uncertain, it is questionable whether a demographic shift (reduced frequency of younger YUBR) has actually occurred, or if the observed reduction of younger plants is an artifact of the infrequent nature of recruitment events. That is, has it just been a long time since the last recruitment event, such that no younger plants are present? In asking this question, it is important to acknowledge the role of climate change, which may have reduced the probability of recruitment events by increasing temperature and the incidence of drought.

Current and Historical Distribution

The current range of YUBR is essentially the same as its historical distribution (post-European contact), demonstrating that human actions have not affected its distribution at present. Some studies (for example, Cole et al. 2011, in CBD 2019) reported model results that indicate future reductions in the southern portion of the range. This same model showed a substantial northward expansion of suitable habitat, albeit without consideration of the dispersal ability of YUBR, which appears to be relatively slow.

It has been suggested that the species is divided into two populations; however, the separation between these populations is a relatively short distance (“a small gap”, CBD 2019, page 64) that appears similar to within-population gaps. Habitat differences have been suggested between the two populations, with more creosote bush in the south, and more pinyon pine, juniper, and sagebrush in the north. No evidence was provided to show that this gradient causes any sort of separation between the two purported populations, other than being a convenient correlation. Other differences between populations, in terms of temperature and precipitation, show substantial overlap and are not likely to be statistically valid.

Abundance and Population Trends

The petition stated that “a reliable estimate of Joshua tree population size is not available” and that “no range-wide population trends have been documented” (CBD 2019, page 19). In the absence of any estimate of population size or trend, and for a species that is relatively abundant and widespread, it is not clear how it is “likely to become an endangered species in the foreseeable future in the absence of the special protection and management efforts" (California Fish and Game Code Section 2067, in part).

Nevertheless, the petition provided information from several studies at Joshua Tree National Park (JTNP) that showed recruitment is limited and mortality is increasing, as well as a correlation between higher temperatures and lower density, and contraction of the species' range at lower elevations. CBD (2019) asserted that these results all point to a population in decline. It is important to note that the studies referenced by CBD were all conducted at JTNP, which is located at the extreme southern edge of the species current and historical range, at the transition between the Mojave Desert to the north and the hotter Sonoran Desert to the south. It seems possible that study results from JTNP may not accurately represent population trends farther north in the species' range.

CDFW (2020a) cited two studies at Edwards Air Force Base, near the center of the range of YUBR, that appeared to show stable or increasing populations, although at least one of these studies was not without some uncertainty. CDFW (2020a, page 13) stated that "the range, distribution, and density information available to the Department indicates that the abundance of western Joshua tree is currently relatively high". In the absence of robust range-wide abundance and population trend data, or at least additional samples from other locations within the species' range, it is uncertain what the actual abundance and population trends are for YUBR.

Factors Affecting Ability to Survive and Reproduce

The petition suggested that factors including predation, invasive species, wildfires, climate change, and habitat loss to development "collectively threaten the continued viability of the species" (CBD 2019, page 20). This is a bold statement considering the lack of population abundance and trend data, much less the level of demographic data needed to truly assess long-term viability. Regardless, the threats listed in the petition were generally reasonable, with a few exceptions noted here.

JTNP has hosted several large wildfires in recent years. The petition used this fact to suggest that fire risk has increased across the range of YUBR; however, it is not clear that this is the case, or if the recent large fires at JTNP represent a more local anomaly. Recent studies (for example, Brooks and others 2018, in CBD 2019, page 28) found that "although fire occurrence across large parts of the warm deserts may be relatively low, they can be much higher and pose significant land management challenges in localized areas."

It appears that most of the recent studies on the effects of fire on YUBR were carried out at JTNP and showed a significant reduction in the local population in burned areas (CBD 2019). However, CDFW (2020a) cited a study at Edwards Air Force Base (located in the center of the species range) that showed a stable long-term local population following wildfire. This result reinforces the idea that studies in a small area on the edge of the species' range (JTNP) may not be applicable across its entire range.

There is no doubt that human-caused climate change is an ongoing process that may increase temperatures within the range of YUBR. Existing studies suggest that precipitation may increase in the area, but that it will also become more variable, meaning long periods of drought can be expected. "Climate change represents the single greatest threat to the continued existence of *Yucca brevifolia*" (CBD 2019, page 32). The question is, how will YUBR as a species be affected, given the uncertainty among different climate model scenarios? And perhaps more importantly, how does listing YUBR as threatened under the CESA improve the situation, given that climate change is best addressed at the regional and global levels?

In answer to the first question, the petition (CBD 2019, pages 34 to 45) reviewed a number of studies that examined the effects of climate change on YUBR at several scales. The most detailed of these studies, and the ones most relied on by the petition to demonstrate ongoing and future effects of climate change on the species, were focused on JTNP. As noted above, it is unclear if results obtained at JTNP are applicable across the range of the species.

Habitat loss to development is another likely threat to YUBR; however, the extent of this threat is uncertain. The petition stated (CBD 2019, page 46) that an estimated 41.6% of suitable habitat for YUBR in the south population area would be lost to development by 2095, based on an Environmental Protection Agency model (cited to USFWS 2018 in CBD 2019, page 46). The parameters and assumptions of this model were not examined, but this result seems speculative. It appears that the model predicted that almost all private lands in the western Mojave Desert would be developed. Given the desert climate, lack of water, distance from the greater Los Angeles area (as a source of jobs), and perhaps other factors, this projection needs to be strongly questioned.

Inadequacy of Existing Regulatory Mechanisms

While existing regulatory mechanisms that protect YUBR as a species may be limited at the state and federal levels, it is unclear how a CESA listing would lead to substantial changes in the current situation. For example, the petition acknowledged climate change as the greatest risk and that "ultimately the species cannot be saved absent global action to reduce such emissions" (CBD 2019, page 48). A CESA listing of YUBR would have little or no bearing on efforts to reduce carbon emissions at a global scale. Similarly, the CESA has no legal standing on federal lands, which make up 48% of the south population area and 96% of the north population area. In practice, state-listed species are sometimes considered during project analysis under the National Environmental Policy Act (NEPA); however, there is no requirement for such consideration.

The petition suggested that CESA listing would bring focus to preservation of YUBR and its habitat for projects analyzed pursuant to the California Environmental Quality Act (CEQA). While listing may increase findings of significance on the basis of effects to YUBR, this may not necessarily equate to a reduction of effects to YUBR because agencies can still approve projects that may have a significant effect, as acknowledged in the petition (CBD 2019, page 55).

The petition gives relatively little space to local ordinances, although it does list Hesperia, Palmdale, Victorville, Yucca Valley, and Los Angeles and San Bernardino Counties as local jurisdictions that have plant protection ordinances or similar measures (CBD 2019, page 53). At the level of this review, these ordinances were not reviewed to determine if they "nominally protect" YUBR, or if in fact they provide substantial protections within the limits of local control over private land use.

Recommended Management and Recovery Actions

The list of recommended management and recovery actions (CBD 2019, page 65), while ambitious, is notable in that only one (a recovery plan) is directly related to CESA listing. The remainder could easily be enacted independently, although a CESA listing may provide focus for YUBR and spur such actions. CDFW (2020a, page 27) noted that "some of the suggestions are not within the Department's jurisdiction."

Conclusions

The ultimate question to be answered by this review is whether the existing scientific information in CBD's petition and the CDFW's review of that petition demonstrates that the YUBR, "…although not presently threatened with extinction, is <u>likely</u> to become an endangered species in the <u>foreseeable future</u> in the absence of the <u>special protection and management efforts</u>…" (California Fish and Game Code Section 2067, in part, emphasis added).

It appears that CDFW has previously defined "foreseeable future" to include the contemplated timeline in the petition, which examines climate change modeling through the end of the 21st century (CBD 2019, page 63). In this case, the prolonged timeline further complicates some of the questionable assumptions raised above, which further increases the substantial uncertainty as to the actual effects of some threats to YUBR, including wildfire, climate change, and human development, particularly at the farther reaches of the foreseeable future. It may be that these threats, while seemingly real at present, would not reach the level of actually threatening YUBR for an uncertain and perhaps lengthy period of time, if at all.

Other entities have examined the rarity and threats to YUBR and found that it is not at sufficiently high risk at this time to warrant special status. At the federal level, the U. S. Fish and Wildlife Service (USFWS) determined that listing the Joshua tree as threatened or endangered under the federal Endangered Species Act (ESA) was not warranted on August 15, 2019. The California Native Plant Society (CNPS) Inventory of Rare and Endangered Plants of California, which is considered a definitive source on the rarity of plants in the state, lists the Joshua tree as "Considered But Rejected" because it is "too common" (CNPS 2020).

The conclusion to the petition makes sweeping statements about the listing of YUBR as a symbolic action, as "an emblem of our society's failure to address the climate crisis" (CBD 2019, page 66). It should be noted that symbolism is not one of the criteria used to consider listings under the CESA. Nor is symbolism a noteworthy scientific principle. A symbolic listing of YUBR would likely divert staff time and funding to special protection and management actions. There are 286 taxa of federally- and/or state-listed plants in the state of California, including 100 taxa that are only listed by the state (CDFW 2020b). In addition, there are 168 taxa of federally- and/or state-listed wildlife in the state of California, including 39 taxa that are only listed by the state (CDFW 2019). The great majority of these taxa are rarer, and more likely to be threatened with extinction, than YUBR. Yet, a listing of YUBR would likely draw some staff resources and funding away from these other species, increasing their risk of extinction. While admittedly the CESA contains no provision for weighing risk of extinction of other species in a listing decision, it is worth asking if a symbolic listing is worth that risk.

References

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EXHIBIT 9

Steve Harris
[redacted]

June 12, 2020

Mr. Eric Sklar, President
California Fish and Game Commission
P.O. Box 944209
1416 Ninth Street, Ste. 1320
Sacramento, CA 94244-2090

Sent via U. S. Mail
And by Email to Melissa Miller-Henson@fgc.ca.gov

Re: Opposition to Petition of Center for Biological Diversity to declare Western Joshua Tree an Endangered Species; Report to Fish and Game Commission "*Evaluation of a Petition from The Center for Biological Diversity to List Western Joshua Tree as Threatened Under the Endangered Species Act" - February 2020*
278 Acres in Kern County, California; Parcel No. 244-040-14 and Parcel No. 244-040-15; Boron, California; Britton Associates, LLC

Dear Mr. Sklar:

I am writing to you on behalf of my family members who, together with me, form Britton Associates, LLC, the owner of 278 acres in Boron, California. We are writing to strongly protest and oppose the Petition submitted by the Center for Biological Diversity to list the Western Joshua Tree as a threatened species under the California Endangered Species Act. I have had the opportunity to review the above-listed 41-page Report and I would like to make you aware of several things in it that I think are weaknesses and probably militate against using it as a basis to institute such a sweeping action.

Probably the first and best place to start is the report's executive summary. On its Page 2, it states this:

"The Petition does not present an estimate of western Joshua tree population size, nor does it provide evidence of a range-wide population trend; nevertheless, the Petition does provide information showing that some populations of western Joshua tree[s] are declining, particularly within Joshua Tree National Park. Although a reliable estimate of western Joshua tree population size is not available, information available to the Department indicates that western Joshua tree is currently relatively abundant."

(Report to the Fish and Game Commission of February 2020, Page 2, Paragraph 2)

While we know and understand the emotional importance of the Joshua Tree to the identity of the State of California, this statement alone makes it clear that this isn't a species that is dying out and it's not one that really is threatened, whether in the colloquial sense or in the scientific or legal sense, either.

Much is made in Pages 2 through 7 of the Report to indicate that a very low threshold or standard is required for the Commission to entertain a Petition. Rather than go through each of the precedents, I can properly conclude that the Commission is clearly invested with discretion and authority to look at common sense facts and trends rather than simply adopt wholesale the report's findings; they are based on the opinions and conclusions of an entity of an entity whose mission, as it puts it, is "saving life on earth". (Biological Diversity.org; home page)

The Report continues on its Page 8 reflecting that the deterioration of the current Western Joshua Tree population trend is primarily the result of a massive fire:

"The Petition cites a study by DeFalco et al. (2010) that examined the mortality of western Joshua tree[s] across several study sites five years after a fire in Joshua Tree National Park burned nearly 5700 hectares (22 square miles (mi2)) in May 1999. The study found that approximately 80 percent of western Joshua trees that were burned by the fire died by 2004, and approximately 26 percent of the unburned trees died as well, with drought a likely contributing factor."

This passage alone introduces a factor that clearly had little to do with a declining population for environmental reasons. A massive wild fire, whether the cause of climate change, arson or other reasons, is an unforeseen circumstance that cannot be planned for in the context of insulating any species from extinction, threatened or otherwise. It is a catastrophic event.

Interestingly, the Report reaches a conclusion on its Page 13 as to abundance:

"The discussion of western Joshua tree's "Current and Historical Distribution" on pages 16 through 19 of the Petition includes information demonstrating that western Joshua tree[s] currently has a relatively widespread distribution in southern California. The Petition

acknowledges that a reliable estimate of western Joshua tree population size is not available."

Notwithstanding that factual statement, the Report indicates that:

"...information available to the Department indicates that the abundance of western Joshua tree[s] is currently relatively high. *The Petition provides sufficient information on the abundance of western Joshua tree[s] for the Department to make the recommendation in Section IV of this Petition Evaluation."*

(Report, Pages 13 and 14)

Findings that Joshua trees are abundant, that a fire geographically wiped out a number of them in a relatively small and narrow region and that there is no reliable information as to their total population seems antithetical to a decision that the Joshua tree is an endangered species. Certainly, given these weaknesses, along with the admission that the pollination of the Joshua tree through asexual reproduction, flowering, pollination, seed production and other methods are not deteriorating or apparently reduced to a level that the existence of the tree as a species is now threatened.

I don't want this entire letter to simply be a critique and analysis of the Report; I bring it up only because it seems weak on its face even to me, a lay person. If you look at the entire Report, in essence, its sole reason for existence is the threat of climate change. The body of law that the Petitioners are relying on, the California Endangered Species Act (CESA) most likely never contemplated its own expansion to take in the prediction of a future decline due to global climate change. Certainly, this would open a Pandora's box for species protections and most likely would do hard and serious damage to local governments and economies. Our land is in a rural and underserved community with little housing and proximity to the main east-west highway (CA 58) connecting US 395 (north-south) and CA 14, the Palmdale Freeway. The Mojave Air and Space Port is located in this region as is Edwards Air Force Base. Other uses, such as vehicle testing and proving grounds, exist here as well. In point of fact, we store over 100,000 tons of mined clay on our property, too.

Our family has owned this property since the 1930s and operated a clay mine on it until the 1960s.

With the Mojave Space Port, Edwards AFB and other federal lands (including one directly adjacent to us) there is little opportunity for new housing or economic development if this petition were granted. California is grappling with housing shortages and rising homelessness, caused in part by a lack of necessary housing in more populated areas.

In just my doing some basic research, I have learned that just last year, the John D. Dingell, Jr. Conservation, Management and Recreation Act placed into protected status hundreds of thousands of acres of federal lands on which Joshua trees grow. Three years prior to that, nearly two million acres of desert lands containing Joshua tree habitat were placed into protection through the use of the Antiquities Act. It would be hard to find a single species benefitting more from these land preservation efforts than the Joshua tree. The Joshua tree is also protected under State law through the California Desert Native Plants Act, which requires permitting for removal. Clearly, the overwhelming majority of Joshua trees exist on land already protected by the State and federal governments.

Our family has significant longevity in owning and maintaining this property. For us, such a decision would not only render it valueless but essentially useless, too. To take such a drastic and massive decision based solely upon climate change without any objective evidence (I have looked at the Report and I just don't see any), wanders quite closely to a taking without compensation. That isn't good for us and it isn't good for the State, either. There needs to be a common sense fact-based process and findings that in fact show that the species is very nearly extinct. The Report hasn't presented that and, since the Report relies on the Petition, it must not have, either.

For all of these reasons, my family and I urge you to deny the Petition in its entirety. Rural desert communities will suffer enormous impacts if it is granted and I just do not see a logical basis for that.

Yours truly,

Steve Harris
For Britton Associates, LLC, Owners

tc

EXHIBIT 10

Buchalter

18400 Von Karman Avenue
Suite 800
Irvine, CA 92612
949.760.1121 Phone
949.720.0182 Fax

File Number: H5318-0002
949.224.6439 Direct
dwance@buchalter.com

June 19, 2020

VIA U.S. MAIL AND VIA E-MAIL (FGC@FGC.CA.GOV)

Eric Sklar, President
California Fish and Game Commission
PO Box 944209
Sacramento, CA 94244-2090

Re: Petition to list the western Joshua tree as threatened or endangered under the California Endangered Species Act

Dear President Sklar:

This letter is prepared and submitted on behalf of Hesperia Venture I, LLC and Terra Verde Group, LLC ("HVI/TVG") to respond to the Petition submitted, under the California Endangered Species Act (California Fish & Game Code ("Code") § 2050 et seq.) ("CESA"), by the Center for Biological Diversity ("Petitioner") requesting the California Fish and Game Commission ("Commission") to take any one of three actions: (1) list the western Joshua tree (Yucca brevifolia) as threatened; (2) list a subspecies of the western Joshua tree (Yucca brevifolia brevifolia) as threatened; or (3) list as ecologically significant units ("ESUs") either or both the North or South population clusters of the western Joshua tree (Yucca brevifolia) species.

We understand that the Commission's staff will recommend at the June 24-25, 2020 meeting that the Commission continue review of the Petition until the August 19-20, 2020 Commission meeting. We support this recommendation for the reasons stated by staff as well as the challenges created by the COVID-19 pandemic, which is affecting the public's thorough review and analysis of the Petition and the Petition evaluation report ("Report") to the Commission by the Department of Fish and Wildlife ("Department"), as well as the public's participation in the hearing process.

If the Commission chooses to proceed with the hearing on the Petition, we request the Commission reject the Petition. Under CESA and its implementing regulations, the Petition is inadequate to warrant listing of the western Joshua tree or the other actions requested by Petitioner. Various stakeholders in their submitted comments to the Commission have outlined many of the Petition's deficiencies. In addition, we have concerns that granting the Petition will also have a detrimental impact on the availability of affordable housing needed within southern California. These concerns derive from the potential financial consequences of listing the western Joshua tree to a recently approved Tapestry project of HVI/TVG's in the City of Hesperia. The Tapestry project is intended to address the significant housing shortage that currently exists in California by providing an affordable option for homebuyers that is not available in the Southern California market. The Tapestry project, from the beginning, was designed to bring essential affordable housing stock to market while addressing the local environmental concerns.

Unlike most new housing projects, Tapestry was designed from the outset to be the most environmentally sensitive project in the state. All homes and commercial buildings will be required to use solar energy to the maximum extent possible. Even public buildings, such as schools, will be required to implement the solar energy directive. Tapestry is also making the most efficient use of our precious water resources. All homes and commercial buildings will have dual plumbing so that all irrigation needs can be met with non-potable water. Parks, schools, parkways, etc. will all use non-potable water for irrigation purposes. Tapestry will require building to CalGreen standards and will implement recycling to the maximum extent possible.

All environmental and conservation measures for Tapestry will be implemented to address important issues affecting the quality of life in California, including measures to protect Joshua trees. The City of Hesperia required several mitigation measures to protect Joshua trees for Tapestry, including protocols for transplanting, incorporating or managing Joshua trees as part of the project. In accordance with the City of Hesperia's Protected Plant Policy (City of Hesperia 2009), Tapestry will prepare a transplant plan, which will describe the salvage procedures for Joshua trees prior to construction. It is anticipated that a portion of the salvaged Joshua trees will be incorporated into Tapestry's landscaping. The remaining Joshua trees will be available for public adoption. Further, Tapestry is creating a Habitat Management Plan for the conservation easement and open space portions of the project. Joshua trees are present in the northern and central portions of Tapestry's conservation easement and open space areas that altogether encompass 3,533 acres of the project, which will be managed in perpetuity.

The listing of western Joshua trees would significantly increase costs to develop any housing within southern California, thereby decreasing the availability of affordable housing. These costs and impacts are unwarranted at this time based on the evidence presented by Petitioners for a possible impact to the western Joshua tree, which is based on possible detrimental impacts to the western Joshua tree. The plain rationale of Petitioner for the listing boils down to the contention that climate change will occur and detrimental impacts will likely occur to the western Joshua tree. Petitioner presents no concrete evidence of the extent of the detrimental impacts to the western Joshua tree, its habitat, or its range. In fact, the Petition at page 19 states that "no range-wide population trends have been documented." The simplicity of Petitioner's contention would justify listing almost all plants and animals within California as threatened, even if those plants and animals, like the western Joshua tree, are currently abundant and range stable.

The stability and abundance of the western Joshua tree is noted within several sources before the Commission. First, the Department states in its Report on the Petition that "information available to the Department indicates that the abundance of western Joshua tree is currently relatively high" (CDFW 2020, page 2). Second, USFWS compiled a Joshua Tree Species Status Assessment (USFWS 2018), which on page 2 states :

> "Currently, populations of both Joshua tree species have large distributions, ecological diversity, and a large amount of intact habitat. Therefore, we consider that Joshua tree populations now have: (1) a high capacity to withstand or recover from stochastic disturbance events (resilience); and (2) both species likely can recover from catastrophic events (redundancy) and (3) adapt to changing conditions (representation)."

Third, Petitioner's own reference materials, regarding the current distribution of Joshua tree, Sweet et. al 2019, page 2, states that:

> "Joshua Tree National Park straddles the lower elevation Colorado and higher elevation Mojave Deserts in southern California. Evidence from paleo-biological records indicates that Joshua trees, among many species, have shifted their distribution since the Pleistocene, when they were more broadly distributed in the southwestern United States (Smith et al. 2011). Today, Joshua trees occur in a jagged continuous band across the western Mojave Desert and in fragmented populations to the north and east (Cole et al. 2011); the occurrence of Joshua trees within JTNP defines the current southern extent of the Mojave Desert before it transitions into the Colorado Desert within the park. While the ecotone between these deserts has shifted during glacial and inter-glacial cycles, as a whole, it is believed to have been quite stable since the end of the Pleistocene (Holmgren et al. 2010)."

Regardless of the conclusions of abundance of trees and range, Petitioner maintains that the Commission must take one or more of the actions noted above for the western Joshua tree. The

Commission has a duty to follow the CESA and its implementing regulations and deny all of Petitioner's requested actions, since none are warranted based upon the current Petition and its wholly lacking evidence. For the Commission to do otherwise would cause great harm to the rule of law at the expense of affordable housing desperately needed for Californians.

Very truly yours,

BUCHALTER
A Professional Corporation

Douglas E. Wance

DEW:gt

EXHIBIT 11

July 23, 2020

Original on file,
received July 23, 2020

California Fish and Game Commission
P.O. Box 944209
Sacramento, CA 94244

Re: Petition to List the Western Joshua Tree as a Threatened Species – OPPOSE

Dear President Sklar and Commission Members:

On behalf of the above business organizations in the Inland Empire, we write in opposition to the petition submitted by the Center for Biological Diversity to list the western Joshua tree as threatened under the California Endangered Species Act (CESA). If this proposal is approved, it would set a dangerous precedent that would subject any tree or animal that is not endangered to protection under CESA because they could be impacted by climate change.

Much of the western Joshua tree population resides on federally protected lands and state preserves, giving them the highest level of protection. Outside those jurisdictions, they are protected under state law through the California Desert Native Plants Act, which requires permitting for removal. The Center for Biological Diversity filed a petition with the California Department of Fish and Wildlife to increase existing protections by listing the tree as threatened despite their own acknowledgment that the species is currently not in decline. Rather, the petition argues that the species may be threatened in the future by global climate change, a threat that will not be mitigated through increased regulations on local property owners. Additionally, the Petition does not present an estimate of western Joshua tree population size, nor does it provide evidence of a range-wide population trend. Despite all of this information staff from the Department of Fish and Wildlife determined the Petition provides sufficient scientific information to indicate that the petitioned action may be warranted for western Joshua tree.

The state of California has never protected a species primarily on the threat of climate change. The imposition of the CESA will create unnecessary impediments, as well as greatly increased costs, to the delivery of much-needed infrastructure improvements throughout the Inland Empire region. In many cases, these limitations upon infrastructure development will prevent the agencies from delivering much needed housing development, transportation network capacity enhancements and job creation through commercial development opportunities. Placing significant constrains and financial burdens on infrastructure development will not address the theoretical decline in the species as outlined in the Petition. The Commission must recognize when conflicting state public policies create an untenable framework for communities and local governments to navigate.

For the reasons stated above and others, we urge you to reject the Petition. If you have any questions or would like to discuss our position in greater detail, please contact Luis Portillo at 909-944-2201 or by email at lportillo@ieep.com. Thank you.

Sincerely,

Janice Moore
Apple Valley Chamber of Commerce

Bette Rader
Beaumont Chamber of Commerce

Zeb Welborn
Chino Valley Chamber of Commerce

Bobby Spiegel
Corona Chamber of Commerce

Gloria Martinez
Fontana Chamber of Commerce

Joshua Bonner
Greater Coachella Valley Chamber of Commerce

Peggi Hazlett
Greater Ontario Business Council

Cyndi Lemke
Hemet San Jacinto Chamber of Commerce

Shannon Shannon
Hesperia Chamber of Commerce

Andrea De Leon
Highland Chamber of Commerce

Paul Granillo
Inland Empire Economic Partnership

Oscar Valdepeña
Moreno Valley Chamber of Commerce

Patrick Ellis
Murrieta/Wildomar Chamber of Commerce

Jennifer Walker
Perris Valley Chamber of Commerce

Monique Manzanares
Pomona Chamber of Commerce

Robert Hufnagel
Rancho Cucamonga Chamber of Commerce

John Mills
Redlands Chamber of Commerce

Emily Falappino
Temecula Valley Chamber of Commerce

Peggy Robertson
Upland Chamber of Commerce

Mark Creffield
Victor Valley Chamber of Commerce

EXHIBIT 12

Original on file,
received August 5, 2020

August 5, 2020

Mr. Eric Sklar
President
California Fish and Game Commission
1416 9th Street, Suite 1320
Sacramento, CA 95814

Re: California Fish and Game Commission Meeting - August 19-20, 2020
Agenda Item 25: Petition to list the Western Joshua Tree as Threatened pursuant to the California Endangered Species Act

Dear President Sklar:

Our organizations endorse the attached comments from Briscoe, Ivester & Bazel on behalf of the California Building Industry Association, California Alliance for Jobs, California Business Properties Association, California Farm Bureau Federation, California Construction and Industrial Materials Association, California Manufacturers and Technology Association, California Cattlemen's Association, Joshua Tree Gateway Association of Realtors, and Southwest Riverside County Association of Realtors regarding Item #25 on the August 19-20, 2020, California Fish and Game Commission meeting agenda – Western Joshua Tree. As noticed on the Commission's August 19-20, 2020 agenda, the Commission will consider and potentially act on the Petition to determine whether the petitioned action may be warranted.

As discussed in the attached document, our organizations are concerned by the clear absence of "sufficient information" in the Petition, as prescribed in Fish and Game Code section 2072.3, regarding the "abundance" and "population trend" of the western Joshua tree to indicate that listing the species may be warranted. For example, the Petition fails to offer any estimate of the abundance of the western Joshua tree, so there is no showing for the Department or Commission to even evaluate with respect to this statutorily required factor.

We are concerned that should the Commission determine that the petitioned action may be warranted – even in light of the fact that there is zero information in the petition regarding "abundance" and "population trend" – that it will provide a justification for future petitioners to dispense with any pretense of addressing the abundance and population trend of a species (or, indeed, any other statutorily required factor impacting species survival). This is not a question regarding whether the petitioned action may be warranted, but rather whether there is sufficient information regarding each of the statutorily required categories upon which the Commission can base its findings.

Based on the issues raised in the attached document as well as other concerns raised by other commenters objecting to the Petition, we urge the Commission to find that the Petition does not contain sufficient information regarding abundance and population trend to indicate that listing the western Joshua tree may be warranted, and reject the Petition.

Sincerely,

Tyler Munzing
American Council of Engineering Companies, California

Peter Tateishi
Associated General Contractors of California

Michael Quigley
California Alliance for Jobs

Michael Miiller
California Association of Winegrape Growers

Nick Cammarota
California Building Industry Association

Rex S. Hime
California Business Properties Association

Kirk Wilbur
California Cattlemen's Association

Frank T. Sheets, III
California Cement Manufacturers Environmental Coalition

Valerie Nera
California Chamber of Commerce

Sunshine Saldivar
California Farm Bureau Federation

Rich Gordon
California Forestry Association

Lance Hastings
California Manufacturers and Technology Association

Adam Harper
California Construction and Industrial Materials Association

Dan Macon
California Wool Growers Association

Jody Rich-Ramirez
Joshua Tree Gateway Association of REALTORS®

James Camp
National Association of Industrial and Office Properties – California Chapters

Gene Wunderlich
Southwest Riverside County Association of Realtors®

Gail Delihant
Western Growers Association

cc: Commission Vice President Samantha Murray
Commissioner Jacque Hostler-Carmesin
Commissioner Russell Burns
Commissioner Peter S. Silva
Executive Director Melissa Miller-Henson, California Fish and Game Commission
Director Charlton Bonham, California Department of Fish and Wildlife

EXHIBIT 13

BRISCOE IVESTER & BAZEL LLP
235 MONTGOMERY STREET
SUITE 935
SAN FRANCISCO, CALIFORNIA 94104
(415) 402-2700
FAX (415) 398-5630

David M. Ivester
(415) 402-2702
divester@briscoelaw.net

August 5, 2020

By Email
California Fish and Game Commission
1416 Ninth Street, Suite 1320
Sacramento, CA 95814

Re: Petition to List Western Joshua Tree

Dear Members of the Commission:

Introduction

I write on behalf of the California Building Industry Association, California Alliance for Jobs, California Business Properties Association, California Farm Bureau Federation, California Construction and Industrial Materials Association, California Manufacturers and Technology Association, California Cattlemen's Association, Joshua Tree Gateway Association of Realtors, and Southwest Riverside County Association of Realtors to call to the Commission's attention deficiencies in the Petition, dated October 15, 2019, by the Center for Biological Diversity (CBD) to list the western Joshua tree as threatened under the California Endangered Species Act (CESA). The Petition plainly fails to provide "sufficient information," as prescribed in Fish and Game Code section 2072.3, regarding the "abundance" and "population trend" of the western Joshua tree to indicate that listing the species may be warranted. Abundance and population trend, naturally, are two of the most obvious and important factors in determining whether a species warrants listing, yet CBD acknowledges that its Petition does not provide either an estimate of western Joshua tree abundance or evidence of a rangewide population trend. Nor does CBD explain why it failed to obtain or provide any such information. If a petition as deficient as this one is deemed acceptable, one is hard put to imagine why the Legislature bothered to require petitions to include such information or direct the Commission to assess the "abundance" and "population trend" of a species when deciding whether to accept a petition for further consideration. (Fish & Game Code §§ 2072.3, 2074.2.) The Commission should reject the Petition in keeping with section 2074.2.

Legal Background

The Commission is authorized to list certain species as threatened or endangered under CESA. The Act allows an interested person to petition the Commission to list a species (Fish & Game Code § 2071) and establishes a process for the Commission's consideration of such a petition. After referring a petition to the Department of Fish and Wildlife to evaluate whether the petition contains sufficient information to indicate that the petitioned action may be warranted and receiving the Department's evaluation report and recommendations, the Commission must hold a public hearing and then determine whether the petition contains "sufficient information" to indicate that the petitioned action "may be warranted." (Fish & Game Code §§ 2073, 2073.5, 2074.2.) If the Commission determines that the petition does not provide sufficient information, it must reject the petition (*Id.* § 2074.2(e)(1)), and that ends the process. If the Commission determines that the petition does provide sufficient information, it must accept it for consideration. (*Id.* § 2074.2(e)(2).) If the petition is accepted, the species becomes a "candidate" for listing (*id.*) and is treated under CESA much the same as a listed species (*id.* § 2085). The Department must then review the status of the species and, within 12 months, submit to the Commission a report indicating whether the listing is warranted. (*Id.* § 2074.6.) After receiving the Department's report, the Commission must hold a public hearing and then determine whether the petitioned action "is warranted." (*Id.* § 2075.)

The Legislature prescribed the necessary contents of a petition:

> To be accepted, a petition shall, at a minimum, include sufficient scientific information that a petitioned action may be warranted. Petitions shall include information regarding the population trend, range, distribution, abundance, and life history of a species, the factors affecting the ability of the population to survive and reproduce, the degree and immediacy of the threat, the impact of existing management efforts, suggestions for future management, and the availability and sources of information. The petition shall also include information regarding the kind of habitat necessary for species survival, a detailed distribution map, and any other factors that the petitioner deems relevant.

(*Id.* § 2072.3.)

The California Court of Appeal has elaborated on the standard to be applied by the Commission in finding facts and exercising its discretion regarding accepting or rejecting a petition:

> "[T]he term 'sufficient information' in section 2074.2 means that amount of information, when considered with the Department's written report and the comments received, that would lead a reasonable person to conclude the petitioned action may be warranted." The phrase "may be warranted" "is appropriately characterized as a 'substantial possibility that listing could occur.'" (*Natural Resources Defense Council, supra*, at p. 1125.) "Substantial possibility," in turn, means something more than the one-sided "reasonable possibility" test for an environmental impact report [under the California Environmental Quality Act] but does not require that listing be more likely than not [akin to the "reasonably probable" standard required for preliminary injunctions].

(*Center for Biological Diversity v. Fish & Game Com.* (2008) 166 Cal.App.4th 597, 609-610.)

Petition

As noted above, section 2072.3 provides that to be accepted, a petition to list a species must, at a minimum, include sufficient scientific information that the listing may be warranted and must include information regarding, among other things, the "population trend" and "abundance" of the species.

CBD's discussion of both population trend and abundance, comprising but one page of its petition, may readily be summarized. CBD first admits:

> Due to the species' patchy distribution within its range, highly variable population density (4 to 840 trees per acre) and lack of range-wide population surveys, a reliable estimate of Joshua tree population size is not available (USFWS 2018). Similarly, no range-wide population trends have been documented.

(Petition, p. 19.) It then points to some recent studies and speculates about population decline:

> However, recent studies carried out in portions of the species' range indicate that density is negatively correlated with increasing temperature, the species range is contracting at lower elevations, recruitment is limited, and mortality is increasing, all of which would likely reflect a population already starting to decline.

(*Id.*) After briefly describing four studies, none of which speak of the rangewide abundance or population trend of the western Joshua tree, CBD concludes:

> Regardless of whether Joshua tree abundance is already declining, it is virtually certain that abundance will decline in the foreseeable future. The impacts of climate change, fire, habitat loss and other sources of mortality are discussed further [elsewhere in the Petition].

(*Id.*, p. 20.)

Department's Evaluation Report

The Department's discussion of both population trend and abundance in its Evaluation Report, dated February 2020, is similarly brief.

With respect to population trend, the Department observes:

> The Petition acknowledges that a reliable estimate of western Joshua tree population size is not available and that no range-wide population trends have been documented. The Petition therefore relies on studies indicating that western Joshua tree density is negatively correlated with increasing temperature, the species range is contracting at lower elevations, recruitment is limited, and plant mortality is increasing.

(Evaluation Report, p. 8.) It then summarizes the four studies in a brief paragraph devoted to each. The Department also states that it received two other reports on western Joshua tree populations at Edwards Air Force Base:

> One of these reports describes a geographic information system (GIS) based analysis that was conducted to determine population trends for western Joshua tree at Edwards Air Force Base between 1992 and 2015 (USAF 2017a). The report suggests that western Joshua tree populations on the base were stable to increasing; however, the report describes several issues that increase the uncertainty of the results. The second report describes a GIS analysis, literature review, and field survey conducted of a 1999 fire area on Edwards Air Force Base to evaluate western Joshua tree survivorship and/or regeneration (USAF 2017a). The report used aerial photography taken in 1992 to count all identifiable western Joshua trees present in two areas prior to the 1999 fire and compared this information with the results of a 2017 field survey that identified all western Joshua trees in these same two areas. This report concludes that Joshua tree populations were stable in the sampled areas of the fire area from 1992 to 2017.

(*Id*., p. 9.)

The Department concludes:

> The Petition does not present an estimate of western Joshua tree population size, nor does it provide evidence of a range-wide population trend; nevertheless, the Petition does provide information showing that some populations of western Joshua tree are declining, particularly within Joshua Tree National Park. The Petition provides sufficient information on the population trend of western Joshua tree for the Department to make the recommendation [that the Commission accept the Petition for further consideration].

(*Id*.)

With respect to abundance, the Department observes that "[t]he Petition acknowledges that a reliable estimate of western Joshua tree population size is not available." (*Id*., p. 13.) The Department notes that the Petition states that "the western Joshua tree has a patchy distribution and a variable population density of 4 to 840 trees per acre" and "includes information demonstrating that western Joshua tree currently has a relatively widespread distribution in southern California." (*Id*.)

The Department describes, apart from the Petition, other relevant scientific information that it has indicating the relatively high abundance of western Joshua trees:

> [T]he Department possesses vegetation maps that cover a large portion of the California deserts where western Joshua tree occurs. It may be possible to use cover estimates from these maps as a rough proxy for western Joshua tree abundance;

> however, the Department does not possess this information for the entire western Joshua tree distribution in California. The range, distribution, and density information available to the Department indicates that the abundance of western Joshua tree is currently relatively high.

(*Id.*)

The Department concludes:

> The Petition acknowledges that a reliable estimate of western Joshua tree population size is not available; however, information available to the Department indicates that the abundance of western Joshua tree is currently relatively high. The Petition provides sufficient information on the abundance of western Joshua tree for the Department to make the recommendation [that the Commission accept the Petition for further consideration].

(*Id.*, pp. 13-14.)

Discussion

The Petition Does Not Contain Sufficient Information Regarding The Abundance Of Western Joshua Tree To Indicate That Its Listing May Be Warranted

For many reasons, the Petition falls far short of providing sufficient information regarding the abundance of the western Joshua tree to indicate that listing of the species may be warranted.

First and most obvious, the Petition does not provide an estimate of the abundance of the western Joshua tree. Indeed, CBD acknowledges as much. (Petition, p. 19.)

Second, while the Petition points to four studies of certain characteristics of the western Joshua tree, it does not even venture to assert what, if anything, these studies may reveal about the abundance of the western Joshua tree. Put bluntly, the Petition says nothing to indicate the current abundance of the western Joshua tree.

Third, the Department in any event observes that available evidence belies any implicit suggestion that the abundance of the western Joshua tree is anything but robust. Noting that it "possesses vegetation maps that cover a large portion of the California deserts where western Joshua tree occurs," the Department confirms that "[t]he range, distribution, and density information available to the Department indicates that the abundance of western Joshua tree is currently relatively high." (Evaluation Report, p. 13.)[1]

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[1] After acknowledging that the Petition does not estimate western Joshua tree abundance and offering its own assessment that its abundance is "relatively high," the Department nonetheless concludes that "[t]he Petition provides sufficient information on the abundance of western Joshua tree" for the Department to recommend accepting it. (Evaluation Report, pp. 13-14.) One might be forgiven for wondering how the Department could reach such a conclusion, since it appears contrary to the cited facts and the Department offers no explanation of how or

Fourth, while the Commission and the Court of Appeal have, *in appropriate circumstances*, allowed petitioners to get by without providing reliable information about a species' abundance and instead resort to reasonable inferences about abundance drawn from incomplete evidence, no such alternative approach is warranted here, nor is any such inference justified by the information in the petition. In *Center for Biological Diversity v. Fish & Game Com.* (2008) 166 Cal.App.4th 597, the court considered whether a petition to list the California tiger salamander (CTS) contained sufficient information to indicate its listing may be warranted. As the court observed, CTS spend most of their adult lives out of sight in underground burrows, and individual CTS emerge only infrequently, sporadically, and briefly to breed. (*Id.*, pp. 601-603.) In that case too limited scientific data was available on the abundance of the species, and there was no comprehensive, rangewide population estimate. (*Id.*, p. 602.) Owing to the difficulty of estimating total population size, the Department concluded that "absent long-term monitoring data produced by a scientifically designed study, attempting to estimate the total population size rangewide is not appropriate." (*Id.*, pp. 602-603.) CBD offered instead an estimate of the number of breeding females, 4,479, derived from statistical analysis (comprised largely of assumptions) regarding known breeding ponds. (*Id.*, p. 603.) Noting again the characteristics of CTS complicating estimating abundance, the court found CBD's estimate of breeding female salamanders plausible and found that it supported a prima facie showing that CTS may be threatened or endangered. (*Id.*, p. 611.)

Here, circumstances are anything but appropriate to accept the paltry information in the Petition. As noted above, CBD fails to offer *any* estimate of the abundance of the western Joshua tree, so there is no showing even to evaluate with respect to this statutorily required factor.

Even if CBD had ventured an estimate of abundance, there is no reason for it to suggest it could do so by resorting to some less reliable, indirect approach. Unlike the CTS, the western Joshua tree does not move and does not hide. Rather, it stands still and stands out prominently on the desert landscape, 24/7/365—just waiting to be observed and counted. CBD offers no excuse for its failure simply to look and count. Given the relative ease with which a reliable estimate of western Joshua tree abundance may be obtained, this is not an appropriate circumstance for a petition to fail to provide such an estimate.

Similarly, even if CBD had asserted that inferences might be drawn from the studies it cited to derive an estimate of western Joshua tree abundance, no such inference is appropriate here. As the court explained in *Center for Biological Diversity v. Fish & Game Com.* (2008) 166 Cal.App.4th 597, when presented with information supporting a prima facie showing, a reasonable person would conclude there is a substantial possibility that listing could occur, "unless the countervailing information and logic, persuasively, wholly undercut some important component of that prima facie showing." (*Id.*, p. 612.) The court then considered the absence of an estimate of CTS abundance

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why it concluded otherwise. California courts have long called on agencies to "set forth findings to bridge the analytic gap between the raw evidence and ultimate decision or order." (*Topanga Assn. for a Scenic Community v. County of Los Angeles* (1974) 11 Cal.3d 506, 515.) The Department has failed to do so here. With apologies to Ricky Ricardo, "Lucy, you got some 'splainin' to do."

and concluded "[t]he absence of historic population counts of the species, *given its reclusive characteristics*, does not greatly diminish the strength of the inferences of threat or endangerment that arise from the showing of habitat loss." (*Id.*, emphasis added.) Noting that the strength of inferences from circumstantial evidence varies, the court added:

> Pointing to an absence of evidence that could provide a stronger inference of population decline, alone, does nothing to diminish the evidence that was provided. That would only undermine the existing showing if the absent evidence was available but was suppressed because it was unfavorable.

(*Id.*, fn. 15.)

Here, unlike the CTS, the western Joshua tree is not reclusive nor hard to find; one need only look and count. CBD though averted its eyes from such evidence, failed to provide it to the Commission, and failed to provide any estimate of western Joshua tree abundance. Moreover, the Department independently concluded from information apart from the Petition that western Joshua tree abundance is "relatively high"—not a finding that, in and of itself, would suggest the species is threatened or endangered. Under these circumstances, any contrary inference CBD may wish to draw from its cited studies is wholly undercut.

The Petition Does Not Contain Sufficient Information Regarding The Population Trend Of Western Joshua Tree To Indicate That Its Listing May Be Warranted

CBD does not offer a separate discussion of population trend, and instead collapses its discussion of both abundance and population trend into a single page in the Petition. Glossing over these fundamental factors suggests that information regarding them would not advance a finding that listing the western Joshua tree may be warranted. Because CBD treated abundance and population trend together in its Petition, the reasons the Petition is deficient with respect to population trend track in many respects those discussed above with respect to abundance.

First, the Petition does not provide information of a rangewide population trend of the western Joshua tree. CBD acknowledges as much. (Petition, p. 19.)

Second, rather than attempt to demonstrate what, if anything, the four studies it cites may reveal about a rangewide population trend of the western Joshua tree, CBD punts. It instead asserts that "[r]egardless of whether Joshua tree abundance is already declining," it will decline in the future and impacts of climate change, fire, and habitat loss are discussed elsewhere in the Petition. (Petition, p. 20.)

Third, much as explained above with respect to abundance, while the Commission and the Court of Appeal have, in appropriate circumstances, allowed petitioners to get by without providing reliable information about a species' population trend and instead resort to reasonable inferences drawn from incomplete evidence, this is not such a circumstance. Even if CBD had ventured to assert a rangewide population trend, there is no reason for it to suggest it could do so by resorting to some less reliable, indirect approach like resorting to studies, such as it cites, regarding other aspects of the species.[2] The western Joshua tree does not move and does not hide. Moreover, it stands prominently on the desert landscape. One need only look to observe them on the landscape or on current and historical aerial photographs. CBD offers no excuse for its failure simply to look and count to ascertain a population trend. Given the relative ease with which a reliable population trend of the western Joshua tree could be derived, this is not an appropriate circumstance for a petition to fail to provide such fundamental, important information.

Moreover, even if one deemed resort to some alternative approach otherwise reasonable, no inference about population trend that might conceivably be drawn from the studies CBD cited is appropriate here, since CBD failed even to try to obtain the most obvious, definitive, and readily available evidence simply by looking and counting. Blinding itself to such evidence does not lend credence to whatever inference CBD might posit from the paltry information it offered.

Indeed, the U.S. Air Force provided two reports on western Joshua tree populations at Edwards Air Force Base to the Department that showed how such a direct assessment of population trend can and should be done. As described by the Department, two geographic information system (GIS) based analyses were conducted, drawing on aerial photography, literature review, and field surveys, to determine population trends, one from 1992 to 2015 and the other from 1992 to 2017. One concluded that the western Joshua tree population on the Base was "stable to increasing," and the other that the population in the study area of an earlier fire was "stable." (Evaluation Report, p. 7.)

Any inference about population trend that might be drawn from CBD's cited studies would be wholly undercut by CBD's failure to seek and obtain the best evidence readily available to it and by the forthright observe-and-count studies that show populations in sampled areas to be stable and even increasing.

Conclusion

CBD's Petition fails to provide even the most basic information about two critical factors in determining whether a species' listing may be warranted: information about its "abundance" and "population trend." CBD indeed seems to dismiss these statutory requirements of a petition as all but unnecessary. It describes a few studies of various aspects of the western Joshua tree apparently as eyewash, but fails even to assert, much less explain, what, if anything, these studies might show about the species' rangewide abundance or population trend. Rather, CBD summarily dispenses with these statutory requirements by turning instead to argue only that "[r]egardless of whether Joshua tree abundance is already declining," it will decline in the future. (Petition, p. 20.)

The Legislature though presumably included "abundance" and "population trend" among the factors that must be addressed in petitions for good reason. It presumably had good reason as

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[2] The Department inexplicably seems to give more credence to the studies CBD cites than CBD even asserts, and concludes that the Petition provides sufficient information on population trend for it to recommend acceptance of the Petition. (Evaluation Report, p. 9.)

well to call on the Commission to consider these two factors in deciding whether a petition provides sufficient information to indicate a species' listing may be warranted.

Were CBD's Petition to be deemed adequate, and accepted for further consideration, the Legislature's requirements would be rendered a dead letter. Future petitioners may well dispense with any pretense of addressing the abundance and population trend of a species (and, indeed, perhaps other factors prescribed in section 2072.3), and instead hire experts simply to opine what the future may bring with climate change, fires, and all.

The Commission should adhere to the Legislature's requirements, find that the Petition does not contain sufficient information regarding abundance and population trend to indicate that listing the western Joshua tree may be warranted, and reject the Petition.

Very truly yours,

BRISCOE IVESTER & BAZEL LLP

David Ivester

David Ivester

DMI/mh

EXHIBIT 14

JMBM Jeffer Mangels Butler & Mitchell LLP

jmbm.com

Kerry Shapiro
415-984-9612
KShapiro@JMBM.com

Two Embarcadero Center, 5th Floor
San Francisco, California 94111-3813
(415) 398-8080 (415) 398-5584 Fax
www.jmbm.com

August 6, 2020

Eric Sklar, President
California Fish and Game Commission
1416 9th Street, 12th Floor
Sacramento, CA 95814
fgc@fgc.ca.gov

VIA EMAIL ONLY

Re: Petition to list western Joshua tree as threatened under California Endangered Species Act and 90-day evaluation

Dear President Sklar,

This letter is submitted on behalf of CEMEX Construction Materials Pacific, LLC ("CEMEX") in opposition to the petition ("Petition") submitted by the Center for Biological Diversity ("CBD") to list the western Joshua tree (*Yucca brevifolia*) as a threatened species under the California Endangered Species Act ("CESA"), Fish & Game Code §§ 2050 *et seq*. We request the California Fish and Game Commission ("Commission") reject the Petition.

The Petition is unwarranted and unprecedented in that:

(1) the Petition fails to demonstrate that the western Joshua tree meets the statutory definition of a "threatened" species;

(2) the Petition mischaracterizes existing regulatory programs to improperly suggest that CESA is the sole viable method of protecting western Joshua trees;

(3) the California Department of Fish and Wildlife ("Department") failed to independently analyze the Petition for adequacy; and

(4) the Department's recommendation to the Commission is wholly unsupported by the 90-day evaluation ("Evaluation").

Further, if the Petition were granted and the western Joshua tree were listed, it could significantly affect CEMEX's future operating plans at its existing mining and production sites, and potentially impose dramatically higher mitigation costs. The imposition of additional, Department-administered processes will be redundant of CEMEX's existing management obligations under local and state regulations, including (1) the California Native Plant Protection

Act ("CNPPA") (Fish and Game Code §§ 1900-1913), (2) the Desert Native Plant Act ("DNPA") (Food and Agriculture Code § 80001 *et seq*.), and (3) local ordinances implementing and supplementing the CNPPA and DNPA.

Yet these potential consequences are unnecessary. The Department should not have overlooked its legal duty to analyze the Petition and should not have arbitrarily accepted the claims made in the Petition. Although the standard for finding that listing "may be warranted" is not as stringent as the standard for listing a species following the Department's full status review, there must nevertheless be sufficient information in the Petition such that a reasonable person would conclude that listing may be warranted. As demonstrated below, the Petition does not contain sufficient information, and no reasonable person could find additional action on the Petition warranted.

I. Background on CEMEX's Operations Affected by Western Joshua Tree Listing

CEMEX is a construction materials manufacturing company specializing in the production of cement, aggregates, and ready-mixed concrete, employing nearly 2,000 people in California. With operations throughout California, CEMEX serves both public and private construction projects with the much-needed supply of these construction materials necessary to support essential infrastructure like roads, bridges, water conveyance and flood protection, housing, hospitals, and schools.

Further, the California Department of Conservation has identified substantial areas potentially impacted by this Petition as important sources of natural resources necessary to produce construction aggregates. For example, according to the Department of Conservation's 2017 Report,[1] the San Bernardino-Riverside Production-Consumption Region will need approximately 993 million tons of aggregate construction materials over the next 50 years. Moreover, the demand for cement has already outstripped the state's supply and must be regularly supplemented by imports year after year.

CEMEX owns, occupies, or has mineral rights to thousands of acres in the region potentially affected by the Petition and operates a cement manufacturing plant as well as various mining operations in that region. These facilities produce (1) limestone, the main constituent in cement and a critical input for the supply of cement from CEMEX's plant, (2) construction aggregate materials necessary for producing local and regional building materials such as concrete and asphalt, and (3) silica and alumina, required additives for the production of cement. These facilities have western Joshua trees on-site, although not within the footprint of existing operations.

Should the western Joshua tree be listed under CESA, the potentially duplicative mitigation requirements resulting therefrom could substantially impact project implementation and increase costs for CEMEX's ongoing mining operations. These increased costs will be borne by

[1] State Mineral and Geology Board Updated Designation Report No. 14 (March 2017).

CEMEX's customers, whether public or private, and thus ultimately borne by consumers and taxpayers. Importantly, CESA's duplicative mitigation measures and costs would not directly correlate to increased conservation benefits for the western Joshua tree because CEMEX is already required under existing management and protection mechanisms to relocate and re-establish any removed western Joshua trees.

II. <u>The Commission Should Reject CBD's Petition</u>

CESA defines a "threatened" species as "a native species or subspecies of a bird, mammal, fish, amphibian, reptile, or plant that, although not presently threatened with extinction, is likely to be become an endangered species in the foreseeable future in the absence of the special protection and management efforts required by this chapter." (Fish & G. Code § 2067.) And while anyone may submit a petition to list a species under CESA, to be accepted, a petition must include sufficient scientific information to indicate that the petitioned action may be warranted. (Fish & G. Code § 2072.3.)[2] A species will not qualify for candidate status if there is not sufficient information to lead a reasonable person to conclude that the petitioned action may be warranted. (*Nat. Resources Defense Council v. Fish & Game Com.* (1994) 28 Cal.App.4th 1104, 1119.)

In light of the foregoing, the Department and the Commission cannot arbitrarily and carelessly accept assertions regarding the status of the species and its habitat(s) in a listing petition. Both agencies have a legal duty to evaluate the information in the petition – and other readily available information – to determine whether a petition's claims are accurate and credible. (*Id.* at pp. 1119, 1125.) Further consideration of the petition "may be warranted" only if there is a "substantial possibility" that the petitioned-for action is warranted. (*Id.*)

Here, the Petition fails this test, and the Commission should reject it from further consideration. Specifically, no reasonable person could find that the petitioned-for action is warranted because:

(i) the Petition fails to demonstrate the western Joshua tree could be a "threatened" species, as defined by CESA;

(ii) the Petition fails to demonstrate CESA is the only existing management tool that can adequately protect the species;

(iii) the Department's Evaluation is significantly deficient because it failed to independently analyze the content of the Petition; and

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[2] A petition must contain sufficient information on: (i) population trend; (ii) range; (iii) distribution; (iv) abundance; (v) life history; (vi) kind of habitat necessary for survival; (vii) factors affecting the ability to survive and reproduce; (viii) degree and immediacy of threat; (ix) impact of existing management efforts; (x) suggestions for future management; (xi) availability and sources of information; and (xii) a detailed distribution map. (Fish & G. Code §§ 2072.3, 2073.5; 14 CCR § 670.1(d).)

(iv) the Department's recommendation is unsupported by the information and conclusions in the Evaluation.

These shortcomings are discussed in more detail below.

A. CBD's Petition Fails to Demonstrate the Western Joshua Tree Meets the Statutory Criteria to be Listed as "Threatened"

A "threatened" species is one which is likely to become endangered in the "foreseeable future." "Foreseeable future" is undefined by CESA and traditionally interpreted by the Department to align with the term's application under the Federal Endangered Species Act ("ESA").[3] In September 2019, the United States Fish and Wildlife Service ("USFWS") and National Marine Fisheries Service ("NMFS") promulgated regulations and defined "foreseeable future" as being only so far in the future as when the appropriate wildlife service can reasonably determine *both* future threats and a species' *likely* (*i.e.*, more likely than not) response to those threats. (50 CFR § 424.11(d) ("2019 Regulations").) Case law is also clear that the "foreseeable future" *must* be based on facts found within the administrative record. For example, prior to the 2019 Regulations, USFWS determined foreseeable future based on a "timeframe over which the best available scientific data allow[s] [USFWS] to reliably assess the effects of threats" on the species. (*In re Polar Bear Endangered Species Act Listing* 794 F.Supp.2d 65, 93 (D.D.C. 2011).) When analyzing whether it was appropriate to list the polar bear as threatened, USFWS found that the foreseeable future extended only so far as 45 years, during which time multiple factors – including biological and habitat factors – could be "confidently predict[ed]."[4] (*Id.*)

Here, the Petition urges the Commission to list the western Joshua tree as "threatened" because CBD "is virtually certain that abundance will decline in the foreseeable future," based on asserted threats of (1) climate change, (2) fire, (3) habitat loss, and (4) unspecified "other" threats. (Petition at p. 20.) Yet, CBD's assertions do not demonstrate that the western Joshua tree could meet the statutory definition of "threatened." There is no evidence that the western Joshua tree is racing toward the precipice of extinction. Rather, the Petition requests that the Commission look nearly <u>80 years</u> into the future based on wholly speculative threats. Such long range forecasting into the distant future would, if accepted, obliterate the concept of "foreseeable" future, and is not consistent with *either* existing regulatory requirements or the body of case law that require *both* impacts and responses to be reasonably predictable.

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[3] *See* Tara L. Mueller, Guide to Federal and California Endangered Species Law 90 (1994); *see also* Brad D. Kern, "Permitting the Take: An Analysis of Section 2081 of the California Endangered Species Act" 102 N.Y.U. Law Journal 74, 75-76.

[4] CBD was also a proponent of the polar bear listing and argued that USFWS should have considered the "foreseeable" future to extend to 2100 – approximately 90 years. The court was "perplexed" by CBD's argument for extending USFWS's "foreseeable future" analysis. (*In re Polar Bear Endangered Species Act Listing*, 794 F.Supp.2d at 93, fn. 34.)

Indeed, CBD asserts that the western Joshua tree has been under threat since the middle of the 20th century, claiming that researchers have been "raising the alarm" that "regardless of the present wide distribution and large concentration of yuccas, [the Joshua tree's] future appears dim." (Petition at p. 34.) 70 years later, the western Joshua tree's "wide distribution and large concentration" has not changed and there has been no observable downward trend in population; but CBD continues to paint an alarmist picture of the western Joshua tree.

To support its specious arguments, CBD relies on a limited number of studies that are generally confined to western Joshua tree's extreme southern range, and then extrapolates select findings from those limited studies to support alleged range-wide assumptions. For example, the Petition relies on a single 2010 study for the proposition that wildfire poses a significant threat to western Joshua trees based on post-fire survival rates. (Petition at p. 25.) However, that study was limited to a small portion of the species' range located in Joshua Tree National Park. CBD improperly infers, generalizes, and applies the study's conclusions to the entire range of the western Joshua tree, when in fact, multiple other studies provide contradictory evidence regarding fire risk. Indeed, studies from *other* areas of the western Joshua tree's range indicate (1) decreased fire frequency and (2) increased western Joshua tree recruitment *after* fires.[5]

The misapplication of limited data to support CBD's general conclusions is foundational to the Petition and thus fatally undermines the Petition. Simply, CBD relies on insufficient data and urges the Commission to rely on faulty future assumptions, ignore applicable legal standards, and list a species that does not – and could not – meet the legal definition of "threatened."

B. CBD's Petition Mischaracterizes Existing Regulatory Mechanisms and Improperly Suggests CESA Listing is the Sole Method of Adequately Protecting the Western Joshua Tree

Section 2072.3 of the Fish and Game Code[6] requires a petition to include specific information, including, "the impact of existing management efforts." CBD states, "No existing regulatory mechanism are [sic] currently in place at the international, national, state, or local level that adequately address the threats facing *Y. brevifolia*." (Petition at p. 48.) Although the Petition briefly discusses local plant protection ordinances in, "Hesperia, Palmdale, Victorville, Yucca Valley, and Los Angeles and San Bernardino counties" it dismisses these existing management mechanisms, stating that "none act as an actual bar to tree removal." (Petition at p. 53.)

This discussion fatally misconstrues both the existing local regulatory landscape *and* CESA's scope. The Petition's discussion presupposes that local regulatory mechanisms *must* bar any

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[5] M.L. Brooks & J.R. Matchett (2006) "Spatial and Temporal Patterns of Wildfire in the Mojave Desert, 1980-2004," 64 JOURNAL OF ARID ENVIRONMENTS 148 (concluding that observed wildfire frequency in the Mojave Desert decreased without demonstrated change in the amount of impacted area); U.S. Air Force, Joshua Tree Survivorship and/or Regeneration in Fire Area on Edwards Air Force Base." 412th Civil Engineering Group. Environmental Management Division. Edwards Air Force Base (2017) (concluding there was increased recruitment of western Joshua trees after fires).

[6] Hereinafter, all references to "Section" shall refer to the California Fish and Game Code.

removal of the western Joshua tree for such protections to be of any consequence. However, even CESA is not an absolute bar on Joshua tree removal – it prohibits "take" of a listed species absent an incidental take permit. (Cal. Fish & G. Code § 2081.) This exemption is similar to existing management mechanisms, which often require a permit prior to removing a western Joshua tree and mandates removed trees be "transplanted or stockpiled for future transplanting wherever possible." (*See e.g.*, Palmdale Municipal Code §§ 14.04.010-14.04-120; San Bernardino County Dev. Code § 88.01.050.)

This mischaracterization of existing local regulatory protections is fatal to the Petition. A CESA threatened listing is warranted when, among other things, it demonstrates that a species "is likely to become an endangered species . . . *in the absence of the special protection and management efforts* required by [CESA]." (Cal. Fish & G. Code § 2067.) Here, CESA's "special protection and management efforts" are duplicative of multiple existing regulations that already prohibit Joshua tree removal and require "removed" Joshua trees to be relocated. Thus, CESA will provide little, if any, additional protections to the western Joshua tree.

Presently, if CEMEX were to remove a western Joshua tree, it would be required to comply with existing regulations in place to protect the western Joshua tree.[7] For example, under certain county or municipal tree protection ordinances, CEMEX would be required to obtain tree removal permits, demonstrate such removal is necessary, and do everything it can to offset the tree removal, including replanting the trees. Accordingly, CESA protections would require CEMEX to undertake similar and potentially duplicative permitting and minimization measures, but with the Department acting as the overseeing body rather than the local county or municipal authority. Although the Petition fails to adequately discuss existing protections, an impartial review of those existing protections demonstrates that no further action on the Petition is warranted.

C. The Department Failed to Independently Analyze the Petition for Adequacy

Section 2073.5 requires the Department to "evaluate the petition on its face *and* in relation to other relevant information the department possesses or receives." (Cal. Fish & G. Code § 2073.5 (emphasis added).) Indeed, courts have reiterated the requirement that the Department's Evaluation adhere to a "sufficient information" standard – *i.e.*, is the information contained in the petition *actually* sufficient. (*Nat. Resources Defense Council v. Cal. Fish & Game Com.* (1994) 28 Cal.App.4th 1104, 1122 (emphasis added).)

First, in analyzing the information available to it, the Department actively ignores USFWS's 12-Month Evaluation of the Joshua tree and determination to *not* list the species under the Federal ESA. (*See* 84 FR 41694 (Aug. 15, 2019.) In that evaluation, USFWS determined, among other reasons, that the Joshua tree did not merit federal protection because (1) there was no significant population decline over the past 40 years and recruitment continues to occur across the species'

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[7] *See* Appendix A of the August 6, 2020 letter submitted by CalCIMA for a detailed summary of existing regulations.

range; (2) despite threats, including wildfire, invasive plants, effects of climate change, there was not a threat "of population-or-species level decline in the foreseeable future," and (3) significant portions of the species' habitat is protected lands that require additional environmental review and/or permitting before impacting the species. (*Ibid.*) The Department's failure to identify, acknowledge, or otherwise engage with the significant work of a fellow wildlife service is indicative of the Evaluation's deficiencies and a troubling sign of the Department's failure to undertake its legal duty to evaluate the Petition.

Second, despite the requirement to evaluate the Petition's information, the Department's Evaluation does not actually *analyze* the Petition so much as it simply re-states the information contained within the Petition absent any critical assessment. Indeed, multiple sections of the Department's Evaluation simply say, "The Petition cites" a chosen study, followed by a summary of said study that emulates the Petition's phrasing. More is needed from the Department than a recitation of the Petition. The table below demonstrates just how closely the Department's Evaluation mirrors the Petition when discussing invasive species:

Petition	**The Department's Evaluation**
"Invasive plant species are widely established in the Mojave Desert throughout the range of the *Yucca brevifolia*. And while invasive species represent a relatively small percentage of the flora, they represent a huge percentage of the biomass." (Petition at page 22.)	"Invasive plant species are widely established in the Mojave Desert throughout the range of the western Joshua tree, and represent a large percentage of biomass on the landscape." (Evaluation at page 16.)
"The abundance of diversity of alien species in the Mojave is positively correlated with disturbance, including livestock grazing, off-highway/off-road vehicle (OHV or ORV) use, fire, urbanization, roads, and agriculture." (*Ibid.*)	"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." (*Ibid.*)
"Invasive species are also aided by nitrogen deposition as a result of air pollution." (*Ibid.*)	"These invasive species are also aided by nitrogen deposition as a result of air pollution." (*Ibid.*)

Petition	The Department's Evaluation
"To the degree there is competition is [sic] would likely be most significant with emergent seedlings under nurse plants as this is the most vulnerable life stage of the Joshua tree. The much bigger issue is that these invasive plants have altered fire dynamics, leading to more frequent fires that are killing innumerable Joshua trees." (*Id.* at p. 23.)	"Although it is possible that invasive species may compete with emergent western Joshua tree seedlings, the biggest impact to the 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." (*Ibid.*)
"As discussed below, the altered fire regimes in the Mojave represent a significant threat to the Joshua tree at the individual and population level." (*Id.* at pp. 23-24.)	"The Petition describes this as a significant threat to western Joshua tree at the individual and population level." (*Ibid.*)

The Department's cursory analysis and summary of the Petition is inadequate to satisfy the requirements of Section 2073.5. Statutory language and case law plainly state that the Department is required to *analyze* the information in the Petition, not *summarize* the information in the Petition. The Department's failure to adequately analyze the Petition renders the Evaluation as nothing more than a governmental rubber stamp instead of a critical analysis – and the Commission cannot rely on it when determining the sufficiency of the Petition.

D. The Department's Recommendation that the Commission Accept the Petition is Inconsistent With and Unsupported by Its Own Purported Evaluation

The Department's Evaluation recommends to the Commission that it accept the Petition for further consideration. The Department makes this recommendation despite multiple conclusions throughout the Evaluation to the opposite effect that demonstrate there is insufficient evidence to support a listing.

The Department's conclusion, in whole, states,

> Pursuant to Section 2073.5 of the Fish and Game Code, the Department has evaluated the Petition on its face and in relation to other relevant information the Department possesses or received. In completing its Petition Evaluation, the Department has determined there is sufficient scientific information to indicate that the petitioned action for western Joshua tree may be warranted. Therefore, the Department recommends the Commission accept the Petition for further consideration under CESA."

(Evaluation at 29.) The Department's conclusion offers no summation and no details as to why it recommends further consideration of the Petition. This omission is striking given the sheer number of times in the Evaluation that the Department offered unsupported and contradictory conclusions, including:

- Population Trend

  "The petition **does not** present an estimate of western Joshua, nor does it provide evidence of a range-wide population trend; nevertheless the Petition does provide information showing that some populations of western Joshua tree are declining [at the extreme southern end of the species' range] . . . [t]he Petition provides sufficient information on the population trend . . . to make the recommendation in … this Petition Evaluation." (Evaluation at 9 (emphasis added).)

- Abundance

  "The Petition acknowledges that a reliable estimate of western Joshua tree **is not available**; however, information available to the Department indicates that the abundance of western Joshua tree is currently **relatively high**. The Petition provides sufficient information on the abundance of western Joshua tree for the Department to make the recommendation in … this Petition Evaluation." (Evaluation at 13-14 (emphasis added).)

- Degree and Immediacy of Threat

  "[T]he Petition **suggests** that western Joshua tree is already being affected by threats described in the Petition, and these threats are likely to intensify significantly by the end of the century. The Petition provides sufficient information on the degree and immediacy of threat to western Joshua tree for the Department to make the recommendation in … this Petition Evaluation." (Evaluation at 23 (emphasis added).)

- Suggestions for Future Management

  "The Petition provides several suggestions for future management of western Joshua tree, although some of the suggestions are **not within the Department's jurisdiction**. The Petition provides sufficient suggestions for future management of western Joshua tree for the Department to make the recommendation in … this Petition Evaluation." (Evaluation at 27 (emphasis added).)

The Department's conclusion that the Petition warrants further consideration, despite multiple admissions of the Petition's inadequacies and the Department's analysis of contradictory information, strains credulity to put it mildly. The Department's recommendation is wholly unsupported by information within the Department's own conclusions throughout the Evaluation.

III. Conclusion

Neither listing nor candidacy for the western Joshua tree is appropriate at this time. The species does not – and cannot – meet the definition of "threatened" under CESA. Furthermore, there are fatal deficiencies in *both* the Petition and the Evaluation that preclude further action. Should the Commission decide to accept the Petition for further consideration, its decision would violate the minimal standards CESA requires because the Petition is deficient on multiple fronts, including, most importantly, the failure to include sufficient scientific information. The Department's blind acceptance of the Petition, absent any independent review, undermines its recommendation to accept the Petition. Furthermore, the increased cost of anticipated mitigation were the species to be listed under CESA is expected to be significant – with little-to-no additional conservation benefits beyond those required by existing regulations.

Based on these factors, no reasonable person could find the western Joshua tree is likely to be listed. CEMEX thus urges the Commission to reject the Petition. Thank you.

Very truly yours,

KERRY SHAPIRO of
Jeffer Mangels Butler & Mitchell LLP

cc: Chuck Bonham, Director
Debbie Haldeman, CEMEX
Daniel Quinley, Esq.

EXHIBIT 15

COMMERCIAL REAL ESTATE SERVICES

Original on file, received August 6, 2020

CBRE

Mark McGaughey
First Vice President
Broker Lic. 00418549

CBRE, Inc.
Brokerage Services
Broker Lic. 00409987

234 S. Brand Boulevard
8th Floor
Glendale, CA 91204

+1 818 502 6785
+1 818 243 6069

mark.mcgaughey@cbre.com
www.cbre.com

August 6, 2020

Mr. Eric Sklar
President
California Fish and Wildlife Commission
P.O. Box 944209
Sacramento, CA 94244-2090

Re: Petition to List the Western Joshua Tree

Dear President Sklar,

I write in strong opposition to the petition submitted by the Center for Biological Diversity to list the western Joshua tree as a threatened species under the California Endangered Species Act. The Joshua tree already receives protections at the federal, state, and local levels. Listing the tree would add redundant protections that place a significant financial burden on private landowners while doing little to address the long-term threat to the species.

The California desert is comprised of rural, underserved communities that face economic challenges unlike other areas of our state. Listing the Joshua tree would effectively halt future development at a time when California is grappling with housing shortages and rising homelessness.

Even more troubling is the fact that the petition submitted by the Center for Biological Diversity fails to provide scientific evidence to substantiate a decline of the Joshua tree population. Instead, the petition predicts a future decline due to global climate change. The proposed listing is nothing more than a solution in search of a problem. Much of the western Joshua tree population resides on federally protected lands and state preserves, giving them the highest level of protection. Outside those jurisdictions, they are protected under state law through the California Desert Native Plants Act, which requires permitting for removal.

I urge you to consider the significant impacts this will have on rural desert communities and respectfully ask that you deny this petition.

Sincerely,

Mark McGaughey
First Vice President

c: Palmdale City Council
J.J. Murphy, Palmdale City Manager

EXHIBIT 16

CALCIMA

California Construction and Industrial Materials Association

August 6, 2020

Original on file,
received August 6, 2020

Eric Sklar
President
California Fish and Game Commission
P.O. Box 944209
Sacramento, CA 94244-2090
fgc@fgc.ca.gov

Re: Comments – Petition to list western Joshua tree (*Yucca brevifolia)* as a threatened species under the California Endangered Species Act

Dear Mr. Sklar,

California Construction and Industrial Materials Association ("CalCIMA") submits this letter opposing further action on the petition ("Petition") submitted by the Center for Biological Diversity ("CBD") to list the western Joshua tree as a threatened species under the California Endangered Species Act ("CESA") Fish & Game Code §§ 2050 *et seq.*. We respectfully request the California Fish and Game Commission ("Commission") reject the Petition for the enumerated reasons expressed in this letter, including: (i) the Petition's failure to include statutorily required scientific information regarding western Joshua tree population trends and abundance; (ii) the Petition's failure to demonstrate that neither threats such as climate change and habitat loss, nor the western Joshua tree's response to those threats, will occur within the "foreseeable future;" and (iii) the Petition's failure to include sufficient information regarding existing regulations.[1]

CalCIMA is a statewide trade association representing construction and industrial material producers operating in California. Our members supply the materials that build our state's infrastructure, including public roads, rail, and water projects; help build our homes, schools and hospitals; assist in growing crops and feeding livestock; and play a key role in manufacturing wallboard, roofing shingles, paint, low-energy light bulbs, and battery technology for electric cars and windmills. The continued availability of our members' materials are critical to ensuring California meets its renewable energy, affordable housing, and infrastructure goals. CalCIMA represents its member-producers on a statewide level on issues involving regulation, land use, and environmental protections, among other things. Because the proposed listing of the western Joshua tree fails to meet the basic listing criteria under the California Endangered Species Act ("CESA") and will have drastic impacts on CalCIMA's members, CalCIMA urges the listing be rejected from further consideration.

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[1] CalCIMA requests this letter be included in the administrative record for this Petition. Additionally, CalCIMA incorporates by reference herein the arguments and factual assertions contained in the various letters submitted to the Commission by individual members of CalCIMA opposing further action on the Petition, as well as the prior letter submitted by the California Cement Manufacturers Environmental Coalition (CCMEC) that includes CalCIMA, dated June 11, 2020.

CalCIMA
1029 J Street, Suite 420
Sacramento, CA 95814
Phone: 916 554-1000
Fax: 916 554-1042

Regional Office:
3890 Orange Street, #167
Riverside, CA 92501
Phone: 951 941-7981
Fax: 916 554-1042

www.calcima.org
www.distancematters.org

On November 12, 2019, the California Fish and Game Commission ("Commission") provided public notice that it received, on October 21, 2019, a petition ("Petition") from the Center for Biological Diversity ("CBD") to list the western Joshua tree (*Yucca brevifolia*) as threatened under CESA. Also in November 2019, the Commission provided the Petition to the California Department of Fish and Wildlife ("CDFW") for further evaluation. In February 2020, CDFW provided the 90-day "Evaluation of a Petition from the Center for Biological Diversity to List the Western Joshua Tree (*Yucca Brevifolia*) as Threatened Under the California Endangered Species Act" ("90-Day Evaluation"). CDFW's 90-Day Evaluation recommended "the Commission accept the Petition for further consideration under CESA" because the Petition contains sufficient scientific information indicating further listing of the western Joshua tree "may be warranted." (90-Day Evaluation at p. 29.)

EXECUTIVE SUMMARY

Neither CDFW's 90-Day Evaluation nor the Petition itself contain sufficient scientific information to support further consideration of the proposed listing, and no reasonable person could find the western Joshua tree should be listed as threatened. Accordingly, and as discussed in greater detail below, **CalCIMA urges the Commission to reject the Petition and not declare the western Joshua tree as a candidate species for the following reasons:**

1. The Petition does not include the statutorily required scientific information regarding western Joshua tree population trends and abundance;
2. The Petition does not demonstrate that either threats such as climate change and habitat loss, or the western Joshua tree's response to those threats, will occur within the "foreseeable future;" and
3. The Petition fails to include sufficient scientific information that demonstrates existing regulations are insufficient.

CalCIMA sincerely appreciates both the opportunity to provide comments to the Commission regarding the Petition and the Commission's careful consideration of the Petition's failure to meet the basic statutory requirements, especially given the unnecessary and substantial impacts accepting the Petition would have on CalCIMA and its members.

DISCUSSION

1. The Petition Fails to Include Sufficient Scientific Information Regarding Western Joshua Tree Population Trends and Abundance

The Commission must follow specific CESA statutory requirements and regulatory guidance when determining whether a petition is complete. Specifically,

> *[a]n incomplete petition shall be returned to the petitioner by the commission staff within 10 days of receipt. A petition shall be deemed incomplete if it is not submitted on [Form] FGC-670.1 (3/94) or fails to contain information in each of the required categories set forth in subsection (d)(1).*

(14 CCR § 670.1(b).)[2]

Furthermore, CDFW must independently assess whether the information contained in the petition is accurate and credible and cannot simply accept the petitioner's claims as sufficient to support further action. (*Natural Resources Defense Council v. Fish & Game Com.* (1994) 28 Cal.App.4th 1104, 1125.) Thus, regulations require *both* the Commission and CDFW to review the Petition for completeness and determine that the Petition contains information in each of the required categories set forth in statute and regulation, including population trends and abundance. (Fish & G. Code §§ 2072.3, 2073.5; 14 CCR §670.1(d).) The petitioned action may be warranted *only if* the Petition contains the required information.[3]

CDFW acknowledges in the 90-Day Evaluation that "The Petition does not present an estimate of western Joshua tree population size, nor does it provide evidence of a range-wide population trend" and that "a reliable estimate of western Joshua tree population size is not available." (90-Day Evaluation at p. 2.) CDFW further admits "Although a reliable estimate of western Joshua tree population size is not available, information available to the Department indicates that western Joshua tree is currently relatively abundant" (*Ibid.*)

The Petition acknowledges its own insufficiencies, stating,

> *"Due to the species' patchy distribution within its range, highly variable population density (4 to 840 trees per acre) and lack of range-wide population surveys, a reliable estimate of Joshua tree population size is not available (USFWS 2018). Similarly, no range-wide population trends have been documented."*

(Petition at p. 19.)

The Petition relies solely on "[a] series of small-scale studies in Joshua Tree National Park, at the *very edge of the species' range*, summarized in Cornett (2014)." (Petition at 20.) The Petition fails to demonstrate that these small-scale studies support a reasonable conclusion that western Joshua tree abundance is declining; that the studies are somehow more valid than other population studies that show stable western Joshua tree populations; or that decline is occurring uniformly across the species' range. Additionally, the Petition fails to discuss significantly larger and more recent studies undertaken at Edwards Air Force Base, located within the middle of the species' range, that describe *increasing*

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[2] Petition requirements are enumerated in California Fish & Game Code sections 2072.3, 2073.5, and regulations governing the administration of the requirements for listing, uplisting, downlisting, and delisting species are found in Title 14 of the California Code of Regulations section 670.1.

[3] The 90-Day Evaluation must evaluate whether a petition contains sufficient information on: (i) population trend; (ii) range; (iii) distribution; (iv) abundance; (v) life history; (vi) kind of habitat necessary for survival; (vii) factors affecting the ability to survive and reproduce; (viii) degree and immediacy of threat; (ix) impact of existing management efforts; (x) suggestions for future management; (xi) availability and sources of information; and (xii) a detailed distribution map. (Fish & G. Code §§ 2072.3, 2073.5; 14 CCR § 670.1(d).)

western Joshua tree populations.[4] Ignoring these less favorable (to its argument) and even contradictory studies, the Petition instead relies on conjecture and conclusory language and asserts, "[r]egardless of whether Joshua tree abundance is already declining, it is virtually certain that abundance will decline in the foreseeable future." (Petition at p.20). The term 'virtually' indicates a lack of evidence to support CBD's dire predictions and CBD's attempts to mischaracterize the state of scientific information and otherwise ignore required legal standards.

Despite CDFW's and CBD's recognition that the scientific evidence is lacking, and the Petition's failure to provide a balanced discussion of the science that is available, CDFW's 90-Day Evaluation concludes that the Petition is sufficient, *in violation of regulatory requirements*. In short, there is no legally supportable basis that allows CDFW to determine that the Petition contains sufficient information on either population trends or abundance.

CDFW and the Commission cannot disregard regulatory requirements and cannot lawfully allow, let alone recommend further consideration of the Petition. The Petition does not include sufficient scientific information regarding western Joshua tree population trends or abundance, and further action under CESA is not warranted.

2. The Petition Does Not Provide Sufficient Scientific Information to Demonstrate that the Western Joshua Tree is Likely to Become Endangered in the "Foreseeable Future" Due to Climate Change or Habitat Loss

A species may be listed as "threatened" only if it "is likely to become an endangered species in foreseeable future." (Cal Fish & G. Code § 2067.) As it relates to endangered species, "foreseeable future" is generally defined as the time period in which one "can reasonably determine *both* the future threats and the species' response to those threats are likely." (50 C.F.R. § 424.11(d); *see also Natural Resources Defense Council*, *supra*, 28 Cal.App.4th at 1124 (by definition, a species to be listed as threatened is "on the brink of survival" not simply subject to possible threats).) Thus, the western Joshua tree can only be listed as threatened if the Petition provides sufficient information regarding *both* threats *and* the species' response to such threats. Here, the Petition fails to demonstrate the western Joshua tree will likely become endangered in the "foreseeable future" and CBD does not provide sufficient information regarding *either* the future threats of climate change or habitat loss or the western Joshua tree's response to those threats.

First, the Petition fails to reconcile multiple, divergent climate models. The Petition admits that "While temperature projections for the Mojave are unidirectional . . . precipitation projections are complicated and divergent." (Petition at p. 33.) Furthermore, when describing the anticipated impacts of climate change on the western Joshua tree, the Petition describes a laundry-list of climate models

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[4] See U.S. Air Force, Joshua Tree Historical Status on Edwards AFB. 412th Civil Engineering Group. Environmental Management Division. Edwards Air Force Base (2017a); U.S. Air Force, Joshua Tree Survivorship and/or Regeneration in Fire Area on Edwards Air Force Base. 412th Civil Engineering Group. Environmental Management Division. Edwards Air Force Base (2017b).

(primarily conducted between 1998 and 2003) but does not address those models' scattershot findings. For example, the Petition describes one 2003 model and acknowledges that while "a considerable portion of the current range of *Y. brevifolia* will become climatically unfavorable . . . significant amounts of new habitat may become available." (Petition at p. 35.) Despite the models indicating that the models themselves and climate change impacts are unknown and may vary significantly, the Petition presents only the worst-case scenarios. Simply stating the worst case scenario is not sufficient to demonstrate that climate change presents a foreseeable threat to the western Joshua tree or that the species' response to climate change will result in a change in the species' status in the foreseeable future. The models CBD presents simply provide too many different potential outcomes, making it impossible to understand both the scope of potential future threats *and* the species' response thereto.

There have been nearly 40 years of dire predictions regarding the health of western Joshua tree populations; which have thus far been inaccurate. Nevertheless, the Petition requests the Commission look 80 years in the future without sufficient data. Simply put, the Petition offers conjecture regarding a hypothetical future fate of the western Joshua tree but does not sufficiently demonstrate that the western Joshua tree is likely to become endangered in the foreseeable future.

Second, the Petition argues the western Joshua tree is facing significant habitat loss due to urban development and infrastructure development (roads, highways, transmission lines, industrial facilities, and renewable energy projects). (Petition at pp. 46-47.) The Petition also argues that existing local and state regulations are insufficient to protect against habitat loss. The Petition insinuates that California state parks are the only adequate existing protection for western Joshua tree habitat and that state statutes, including the California Environmental Quality Act ("CEQA") and Desert Native Plant Act ("DNPA"), and local tree protection ordinances are insufficient because the regulations do not outright prohibit western Joshua tree removal or may be amended or rescinded. (Petition at pp. 52-53, 57-58.)

Despite the Petition's ready dismissal of existing regulatory mechanisms, the western Joshua tree is sufficiently protected by state and local regulations, as further discussed below. Removal of a western Joshua tree generally requires a permit from the local authority and requires the removed western Joshua tree to be replanted, rather than destroyed. (*See, e.g.,* San Bernardino County Code § 88.01.50; .Hesperia Municipal Code § 16.24; *see also* Appendix A for a list of existing regulatory programs and policies.) Additionally, a significant portion of the species' habitat is already subject to a level of protection by virtue of being located on Federally owned lands.[5] (Felicia Sirchia, Scott Hoffman, and Jennifer Wilkening, "Joshua Tree Species Status Assessment," U.S. Fish and Wildlife Service (July 20, 2018) at 2.)

The Petition's predictions of climate change and habitat loss, and its presumption that existing regulatory mechanisms are insufficient to prevent negative impacts to the western Joshua tree, do not demonstrate that the western Joshua tree is likely to become endangered in the foreseeable future, as

[5] There are two regions populated by western Joshua tree. The *Yucca brevifolia* ("YUBR") South population region is comprised of approximately 3,661,960 acres, of which 47 percent is federally owned. The North population region is comprised of approximately 1,977,837 acres, of which 96 percent is federally owned.

is required to list a species as threatened under CESA (Cal Fish & G. Code § 2067.) The Petition instead presents hypothetical threats – of inconsistent statutory application – and panders to misplaced fear of political discretion rather than demonstrating sufficient scientific information of actual threats to the species.

3. The Petition Does Not Include Sufficient Scientific Information Discussing Existing Management Efforts and Does Not Acknowledge that CESA Protections are Duplicative of Existing Management Efforts

The Petition misleadingly states, "No existing regulatory mechanism are [sic] currently in place at the international, national, state or local level that adequately address the threats facing *Y.* brevifolia" (Petition, p. 48). This statement is wholly inaccurate. Land throughout the YUBR South region is subject to a vast number of existing regulations and policies that protect western Joshua trees. The Petition does not meaningfully address these regulatory protections. Rather, the Petition's arguments reflect mere disagreement with how existing statutes are implemented. The Petition insinuates that the only effective species' protections are absolute prohibitions on "take." (Petition at p. 53.) However, even CESA does not prohibit take; it simply requires a permit to engage in take – a limitation similar to existing regulations.

The Petition's 'Inadequacy of Existing Regulatory Mechanisms' section also focuses on CBD's political convictions that the current Presidential administration's "harmful rollbacks of federal climate policy" (Petition, p. 49) should be redressed on the state level. The Petition provides no meaningful discussion of California's multiple existing climate change policies that protect our State's communities and natural environments. The Petition also fails to discuss the multiple local regulations that directly protect western Joshua trees. These regulations include:

- Eight municipalities, including towns, cities, and counties which protect western Joshua trees and require permits prior to disturbance or removal;
- Multiple designations of western Joshua trees as "ecologically significant" or requiring additional environmental review of impacts to western Joshua trees;
- State-level environmental review laws, including the California Environmental Quality Act ("CEQA") and Desert Native Plant Act ("DNPA"), which require environmental review and mitigation; and
- Multiple local "Climate Action Plans" that address climate change impacts on desert ecosystems.[6]

Taken together, these local and state regulatory requirements adequately protect the western Joshua tree and CESA's protection provisions will therefore be redundant. That is, "take" of western Joshua tree is already prohibited or otherwise regulated at the local and county level and projects that impact

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[6] A table summarizing local and state regulations that protect the western Joshua tree is attached as Appendix A to this letter.

western Joshua trees are required to obtain permits and mitigate for those impacts to western Joshua trees. CESA protections will not add a meaningful additional layer of protection, and, instead, will simply shift permitting requirements from the desert to Sacramento.

The volume and breadth of existing regulations adequately protect the western Joshua tree. Additional protection under CESA will be redundant and will not provide any additional protection. Imposing these duplicative and unnecessary restrictions would be especially inappropriate given the extensive and harmful impacts the listing process would have on numerous operations and projects of CalCIMA's members. CBD's failure to address existing protections is yet another example of how the Petition mischaracterizes the status of the western Joshua tree in order to try and force a listing decision lacking scientific merit.

CONCLUSION

CalCIMA thanks the Commission for considering these comments. We respectfully ask the Commission to reject the Petition and not declare the western Joshua tree to be a candidate species pursuant to being listed as threatened under CESA. Please contact Suzanne Seivright-Sutherland with any questions or concerns at (951) 941-7981 or at sseivright@calcima.org.

Sincerely,

Robert Dugan
President & CEO

cc: Charlton Bonham, Director, California Department of Fish and Wildlife
Kerry Shapiro, Esq., Jeffer Mangels Butler & Mitchell LLP
Dan L. Quinley, Esq., Jeffer Mangels Butler & Mitchell LLP

APPENDIX A: CHART OF EXISTING STATE AND LOCAL WESTERN JOSHUA TREE REGULATIONS

Authority	Description of management effort	Code/General Plan/Policy Links
	Local Management Efforts	
City of Adelanto	Permit required for removal - code requires compliance with requirements of San Bernardino for relocation of western Joshua trees.	Permit Application and Plant Protection Management Code
Town of Apple Valley	No existing western Joshua tree shall be disturbed, moved (transplanted or otherwise), removed or destroyed unless such disturbance, move, removal or destruction is first reviewed and approved by the Town of Apple Valley. Sets specific findings which need to be made in order to authorize removal.	Apple Valley Code 9.76.040 Joshua Trees
Town of Apple Valley	Climate Action Plan	https://www.applevalley.org/services/planning-division/climate-action-plan
City of Hesperia	Arborist/botanist developed plan and relocation / adoption program - includes single family residence provisions protecting healthy trees.	Protected Plant Policy
City of Hesperia	Climate Action Plan	http://www.cityofhesperia.us/DocumentCenter/View/1587/Climate-Action-Plan-7210?bidId=
City of Lancaster	Objective with six supporting policies to maintain important biologic systems specifically including western Joshua trees. Also required CEQA monitoring plan (BR-8) requires planning department in Grading Plans to provide protection for special status plants in western Joshua tree woodlands including translocation, weed control BMPs.	Link to General Plan(pg. 2-25) and CEQA Mitigation Monitoring Plan (pg. 12-10)
City of Palmdale	Requires site plans permits avoidance transplanting and as a last resort if other actions infeasible, mitigation required.	City code
City of Victorville	Makes it a misdemeanor to cut, damage, destroy, dig up, or harvest any western Joshua tree without the prior written consent of the director of parks and recreation or his designee	Victorville Code
City of Victorville	Climate Action Plan	https://www.victorvilleca.gov/government/city-departments/development/planning/land-use-plans
City of Yucca Valley	Requires Native Plant Permit for Removal - Includes relocation and transplanting options and adoption provision.	Native Plant Permit Policy
	County Management Efforts	
County of Los Angeles	Joshua Tree Woodlands Significant Ecological Area (SEA) Included on SEA protected tree list across multiple SEA's.	County Ordinance and SEA Planning Guide
County of Los Angeles	Community Climate Action Plan	http://planning.lacounty.gov/ccap/background
County of San Bernardino	Tree removal permit and plot plan map - approval by authority - extra protections for specimen tree's as defined and allows enforcement by CA department of forestry as applicable.	Title 8 Division 8 (88.01) County Ordinance
County of San Bernardino	83.10.080(c)(1) Regional Landscaping Standards - The County of San Bernardino's 'San Bernardino County Development Code (Development Code)' details policy regarding the protection of western Joshua trees inclusive of 'Regional Landscape Standards' that applies to all new and rehabilitated landscapes associated	

	with homeowner installed residential uses, and rehabilitated landscapes associated with any develop-installed residential uses. One of the aims of the 'Regional Landscape Standards' is to preserve existing natural vegetation. Specifically, section 83.10.080(c)(1) of the 'Regional Landscaping Standards' addresses western Joshua trees in the desert region prohibiting removal of western Joshua trees without a tree removal permit, and requires the western Joshua tree to be relocated on-site unless specific permission from the County of San Bernardino Land Use Services Department is obtained as detailed below.	
County of San Bernardino	88.01.050 Tree or Plant Removal Permits - Additionally, the County of San Bernardino addresses western Joshua trees via a 'Plant Protection and Management' policy within the Development Code to manage plant resources under private or public ownership inclusive of conserving the native plant life heritage for the benefit of all, including future generations. Section 88.01.050 'Tree or Plant Removal Permits' requires a permit to be required for the removal of a regulated tree or plant that is inclusive of western Joshua trees. The County of San Bernardino provides limited justification for removal of regulated plants in Section 88.01.050(f), and administers supplemental guidance specific to western Joshua trees in Section 88.01.050(f)(3) as detailed below.	
County of San Bernardino	88.01.060 Desert Native Plant Protection - Section 88.01.060 'Desert Native Plant Protection' regulates the removal or harvesting of specified desert native plants in order to preserve and protect the plants and to provide for the conservation and wise use of desert resources. This section is intended to augment and coordinate with the Desert Native Plants Act (Food and Agricultural Code Section 80001 et seq.) and the efforts of the State Department of Food and Agriculture to implement and enforce the Act.	
County of San Bernardino	County of San Bernardino Mining Permits / Reclamation Plans - The County of San Bernardino implements policies within their mining permit and reclamation plan procedures to protect western Joshua trees by providing that mineral extraction does not result in significant adverse environmental effects. Mining can be meet present needs without compromising needs of future generations with minimized environmental impacts associated with minerals extraction activities. The County of San Bernardino is focused on reducing environmental impacts and implements strategies for assessing the sustainability of mining operations inclusive of measuring, monitoring, and working to improve various performance metrics to minimize land disturbance, pollution reduction, and efficient reclamation activities. Posted below are example strategies that the County of San Bernardino implements within their 'Mine Permit Conditions'.	
County of San Bernardino	Greenhouse Gas Emissions Reduction Plan	http://www.sbcounty.gov/Uploads/lus/GreenhouseGas/FinalGHGFull.pdf
	State Management Efforts	
	California Environmental Quality Act ("CEQA") – Projects that face CEQA approvals must take special account of western Joshua trees because the species is listed as a "sensitive natural community" within the California Natural Diversity Database.	
	Surface Mining And Reclamation Act ("SMARA")	

	California Desert Native Plants Act (Cal. Food & Agric. Code § 80001 *et seq.*) Prohibits harvest, transport, sale, or possession absent of a permit.	
	Climate change initiatives...	
	Federal Management Efforts	
	Desert Renewable Energy Conservation Plan ("DRECP")	
	California Desert Protection Act (16 U.S.C. § 410)	

EXHIBIT 17

CALPORTLAND

KERN, INYO AND MONO COUNTIES BUILDING TRADES COUNCIL

Tehachapi Wind Wall, LLC

Lebata, Inc.

August 6, 2020

Mr. Eric Sklar, President and
Members of the Fish and Game Commission
P.O. Box 944209
Sacramento, CA 94244-2090

[*VIA EMAIL TO FGC@FGC.CA.GOV*]

RE: August 19-20 Meeting Agenda Item 25: Western Joshua tree listing petition

Dear President Sklar and Members of the Fish and Game Commission:

CalPortland Company ("CalPortland") submits this letter on its behalf and on behalf of a coalition of construction materials, housing, energy, and labor companies (for purposes of this letter, the "Coalition") and organizations concerning the pending petition to list the Western Joshua Tree (*Y. brevifolia* or "Joshua tree") as threatened under the California Endangered Species Act (Fish & G. Code § 2050 *et seq.* ["CESA"].)[1] For the reasons set out below, the Coalition urges the Commission to reject the Petition.

In order to be accepted by the Commission, CESA requires a listing petition to include certain scientific information, which when taken as a whole, must show that the "petitioned action may be warranted". (Fish & G. Code § 2072.3.) The Petition now before the Commission does not satisfy this standard. The Petition fails to include any scientific information at all regarding *Y. brevifolia*'s abundance and population trend, and other scientific information wholly undercuts the Petition's cited evidence regarding threats to the species and the degree and

[1] The Petition, which can be found online at https://nrm.dfg.ca.gov/FileHandler.ashx?DocumentID=175218&inline, is hereby incorporated by reference.

immediacy of those threats. Taken as a whole, the Petition does not establish that listing of Joshua trees may be warranted.

Beside the Petition's failure to satisfy CESA's requirements for acceptance by the Commission, the Commission's consideration of the Petition at all during the continuing and intensifying COVID-19 pandemic is problematic from public access and procedural due process standpoints. The Commission's acceptance of the Petition would immediately affect land use decisions across millions of acres, an area larger than some states. Impaired access to the Commission as a result of the pandemic means that stakeholders and the public will not be able to fully participate in a decision that could profoundly impair housing construction and economic development in communities where both are most needed. At the same time, the Petition acknowledges that immediate protection of *Y. brevifolia* is unnecessary – the species is "not currently" "in serious danger of becoming extinct throughout all, or a significant portion, of its range". (Petition, p. 48.) Such a danger "is likely decades away." (*Ibid*.)

The Coalition urges the Commission to reject the Petition for its failure to meet CESA's basic informational requirements. Alternatively, CalPortland asks the Commission to postpone its consideration of the Petition until such time that the public can fully participate in the Commission's decision.

This letter proceeds in four parts: Part 1 establishes the Coalition's vested interest in the Commission's action on this matter. Part 2 addresses serious procedural and due process problems in the Commission's consideration of this matter during the ongoing COVID-19 pandemic. Part 3 outlines CESA's criteria and evidentiary standards governing the Commission's consideration of a listing petition. Part 4 outlines the patent defects in the Petition that require the Commission, as a matter of law, to find "the petition does not provide sufficient information to indicate that the petitioned action may be warranted[.]" (Fish and G. Code § 2072.4(e)(1).)

Finally, this letter encloses and incorporates by reference WestLand Resources, Inc.'s *Assessment Of Petition To List The Western Joshua Tree (Yucca Brevifolia) As Threatened Under The California Endangered Species Act* (August 2020) ("WestLand Assessment"). The WestLand Assessment provides an expert critical analysis of evidence and arguments offered in the Petition, and identifies the Petition's critical scientific and evidentiary shortcomings.

1. <u>Coalition Members' Beneficial Interest</u>

Coalition members, which include those companies and organizations identified at the top of this letter, as well as other entities with similar interests, are landowners, essential businesses, employers, and community leaders within the Mojave Desert region and surrounding areas that would be impacted by the Commission's acceptance of the Petition. Coalition members provide essential construction materials, public infrastructure, housing, energy, and skilled labor, and their ability to carry out these critical functions would be impaired by acceptance of the Petition.

2. Procedural and Due Process Problems

The Commission Should Exercise Its "Sound Discretion" To Postpone Its Hearing On The Petition. Governor Newsom's Executive Order N-29-20 (March 17, 2020) imposes a temporary partial exception to Bagley-Keene Act requirements that "would prevent, hinder, or delay appropriate actions to *prevent and mitigate the effects of the COVID-19 pandemic*." (Executive Order N-25-20 [emphasis added].) Executive Order N-29-20 waives aspects of the Bagley-Keene Act that require state agencies to be physically present during a meeting or to make physical facilities available to members of the public for meetings addressing "actions to prevent and mitigate the effects of the COVID-19 pandemic."

The Executive Order makes these same partial waivers applicable to state agency meetings for all other purposes, subject, however, to the following mandate:

> All state and local bodies are urged to use *sound discretion* and to make reasonable efforts to *adhere as closely as reasonably possible to the provisions of the Bagley-Keene Act* and the Brown Act, and other applicable laws regulating the conduct of public meetings, *in order to maximize transparency and provide the public access to their meetings*.

(Executive Order N-29-20, ¶ 3 [emphasis added].) In other words, while agencies may proceed under the modified access rules established by the Executive Order, agencies are encouraged to exercise their "sound discretion" to do more than the minimum to "maximize transparency and provide the public access to their meetings." Compliance with this direction is not a "one size fits all" proposition. Some routine matters may be appropriate for consideration by electronic means, while other matters, including non-urgent matters and matters with significant geographic, social, and economic impacts, should be postponed to such a time that the public can be afforded full access to the Commission's meetings.

The Commission's consideration of the Petition is not an "appropriate action to prevent and mitigate the effects of the COVID-19 pandemic"; it is business as usual. The Commission's decision to consider the Petition by exclusively electronic means even while the current pandemic intensifies in California evidences no effort by the Commission to exercise "sound discretion" to "adhere as closely as reasonably possible to the provisions of the Bagley-Keene Act". Nor does the Commission's action show any effort to "maximize transparency and provide the public access to their meetings" as directed by Executive Order N-29-20 and consistent with the Commission's own Core Value of Transparency.

Virtual meeting technologies do not provide fair and equal access to all members of the public, but rather impose new challenges to public participation for those that do not have access to required technologies. Members of the public that wish to participate must do so by electronic or telephonic devices that they purchase or otherwise obtain themselves, which imposes a barrier to participation that has a known negative effect on participation by members of the public living in rural and low income areas, as are many of the communities that would impacted by the Commission's acceptance of the Petition. (See, e.g., Goss, Justin et al, Public Policy Institute of California, *California's Digital Divide* (March 2019) available at: https://www.ppic.org/publication/californias-digital-divide/.)

These electronic challenges are compounded by poor accessibility to key Department staff members, as detailed in CalPortland's June 11, 2020 letter to the Commission, as well as by staff's inability to timely respond to Public Records Act ("PRA") requests for documents relevant to this matter. Attorneys on behalf of CalPortland submitted two Public Records Act requests each to the Department and to the Commission on June 8. The requested records relate narrowly to documents concerning the Commission's Joshua tree listing process and the Department's evaluation of the Joshua tree listing process, among other documents.

Despite multiple follow-up communications with the Department and Commission's PRA coordinator and reviewing staff since June 8, the Department provided the required 10-day response indicating that it would provide certain records for only one of the two requests submitted on June 8. The Department failed to comply with the PRA's 10-day response requirement for the second records request. On July 22, accompanying a limited production of responsive documents, the Department transmitted a letter to CalPortland's attorneys stating as follows, in relevant part:

> Due to the COVID-19 emergency, most Department staff are working remotely and do not have access to all Department records. For this reason, our search for responsive records has been limited to those records Department staff can access remotely.

(Department Response to Public Records Act Request No. 20-06-212, July 22, 2020.)

The Commission, by comparison, failed to respond to both records requests within the 10-day initial response period, and did not respond in any fashion until July 21, when a Commission staff person communicated the following by email:

> We will be happy to complete the Public Records Request (PRA) for the Letters received for the Western Joshua tree petition. Please be aware that due to the volume of comments received (over 5,000), it will take several months to complete this project.

(Email from J. Greaves to M. Harrison, July 21, 2020.)

Apart from the Department's and Commission's violation of basic PRA response requirements, these communications show that the pandemic is impeding state government's ability to carry out normal operations, even those as fundamental as responding to requests for public records. The practical consequence of the Department and Commission's failure to respond and timely produce requested records is that CalPortland and other stakeholders are unable to review the complete administrative record before the Commission as is necessary to fully comment on the Petition.

Rather than proceed with consideration of the Petition while COVID-19 social distancing orders remain in effect, we urge the Commission to use its "sound discretion" to postpone consideration of the Petition until social distancing is no longer required in order to "maximize transparency and provide the public access to their meetings". (See Executive Order N-29-20, ¶ 3.) The Petition makes clear that such a delay will result in no harm to *Y. brevifolia*. As noted above, danger, if any, to Joshua trees "is likely decades away." (Petition, p. 48.)

The Fish and Game Code's timeframe for the Commission to hold a public hearing on a Petition is directory, not mandatory. Prevailing California law allows the Commission to postpone its consideration of the Petition without consequence. Fish and Game Code section 2074 provides that the Commission shall consider a petition "at its next available meeting" after the Department completes is evaluation of the petition, while section 2074.2(d) allows the Commission to continue the public hearing on a petition for an additional 90 days.

As a general rule, "requirements relating to the time within which an act must be done are directory rather than mandatory or jurisdictional, unless a contrary intent is clearly expressed." (*Edwards v. Steele* (1979) 25 Cal. 3d 406, 410 ["*Edwards*"]; *Briggs v. Brown* (2017) 3 Cal. 5th 808, 877.) In the absence of statutory provisions clearly expressing that intent, courts have routinely found deadlines or time limitations directory where no "consequence or penalty is provided for failure to do the act within the time commanded." (*Edwards*, at p. 410; *Kabran v. Sharpe Memorial Hospital* (2017) 2 Cal. 5th 330, 340.) Here, the Fish and Game Code intent that the timeframes set out in sections 2074 and 2074.2 are mandatory rather than directory. The Commission can postpone consideration of the Petition without consequence.

Finally, even if the Commission's timeframe to consider the Petition were mandatory, such deadlines never supersede the people's right to constitutional due process, and such deadlines may be adjusted as necessary to avoid infringement of constitutional protections, such as the right to due process. (See *Ursino v. Superior Court* (1974) 39 Cal.App.3d 611, 621-622.)

As stated above, the Petition makes clear that a delay – even a delay as long as may be necessary for the COVID-19 pandemic to subside – will result in no immediate harm to *Y. brevifolia*. The species is not in serious danger of becoming extinct; rather, such a danger "is likely decades away." (Petition, p. 48.) The Petition further acknowledges that *Y. brevifolia* has been remarkably stable for the past 11,000 years or more. (*Id*., at p. 17.) The circumstances do not demand immediate action by the Commission; to the contrary, the Executive Order, the continuing pandemic, "sound discretion," and basic principles of due process and public participation all militate toward postponement of this matter until the public can fully participate in the Commission's process.

3. CESA Criteria and Evidentiary Standard

Fish and Game Code section 2072.3 establishes the criteria a listing petition must meet in order "to be accepted" by the Commission. Specifically, a petition "shall" include "sufficient scientific information that a petitioned action may be warranted", as well as sufficient scientific information for each of the following categories:

(A) Population trend;
(B) Range;
(C) Distribution;
(D) Abundance;
(E) Life history;
(F) Kind of habitat necessary for survival;
(G) Factors affecting the ability to survive and reproduce;
(H) Degree and immediacy of threat;
(I) Impact of existing management efforts;
(J) Suggestions for future management;
(K) Availability and sources of information;
(L) A Detailed distribution map.

These criteria are mandatory (i.e., a petition "shall include"), not directory. (Fish & G. Code § 2072.3; Cal. Code Regs., tit. 14, § 670.1(d) [emphasis added].) "A petition will be rejected by the commission if it fails to include sufficient scientific information under the categories of Section 2072.3 of Fish and Game Code (subsections d(1)(A) through (L) above) that the petitioned action may be warranted." (Cal. Code Regs., tit. 14, § 670.1(e)(1) [emphasis added].)

In other words, CESA and implementing regulations bar the Commission from accepting a petition that (1) fails to include any information at all concerning any one of the above categories; or (2) fails to include "sufficient scientific information" concerning any one of the above categories. (Cal. Code Regs., tit. 14, § 670.1(e)(1).)

"Sufficient scientific information" is undefined in CESA, but the phrase "sufficient information" in the CESA listing context has been interpreted to mean "that amount of information, when considered with the Department's written report and the comments received, that would lead a reasonable person to conclude the petitioned action may be warranted." (*Center for Biological Diversity v. Fish & Game Com.* (2008) 166 Cal.App.4th 597, 609-610 ["*Center for Biological Diversity*"].) Evidence proffered with a petition is sufficient to meet the "may be warranted" standard "only if it is material to the criteria at issue, is credible, supports the petition, and, when weighed against the department's written report and any comments received, is strong enough to indicate" that the requested action may be justified. (*Central Coast Forest Assn. v. Fish & Game Com.* (2018) 18 Cal.App.5th 1191, 1204 ["*Central Coast Forest Assn.*"].)

Even where a petition includes otherwise "sufficient scientific information", that information may be rendered insufficient where "countervailing information and logic persuasively, wholly undercut some important component of that prima facie showing." (*Center for Biological Diversity v. Fish & Game Com*. (2008) 166 Cal.App.4th 597, 612.)

The Petition falls short of the above standards in the following ways:

- The Petition fails to provide any evidence whatsoever that the northern or southern populations of *Y. brevifolia* meet the Department's own definition of an Evolutionary Significant Unit ("ESU"). As a result, evidence offered by the Petition concerning factors affecting the species' ability to survive and reproduce (criterion "G" above) and concerning the degree and immediacy of the threat to the species (criterion "H" above) is scientifically insufficient when viewed range-wide.

- The Petition fails to provide any evidence whatsoever regarding *Y. brevifolia's* abundance and population trend (criteria "D" and "A" above), and fails to address evidence that wholly undercuts the Petition's claim that the species' population is declining range-wide;

- The Petition mischaracterizes the evidence regarding factors affecting *Y. brevifolia*'s ability to survive and reproduce (criterion "G" above);

- The Petition provides no evidence that either fire or climate change present an immediate range-wide threat to *Y. brevifolia* (criterion "H" above), and fails to address other evidence that wholly undercuts the Petition's claim that these factors are in fact a threat to the species.

- The Petition's primary suggestion for future management is infeasible and exceeds the Commission's and Department's authority under CESA (criterion "J" above).

Taken as a whole, the Petition fails to provide scientific information sufficient to "lead a reasonable person to conclude the petitioned action may be warranted." (*Center for Biological Diversity, supra,* 166 Cal.App.4th at pp. 609-610; *Central Coast Forest Assn., supra,* 18 Cal.App.5th at p. 1204.) We discuss these defects in detail below.

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4. The Petition Does Not Satisfy CESA Criteria For Acceptance By The Commission

The Petition Provides No Evidence That Northern or Southern *Y. Brevifolia* Populations Qualify As ESUs. The Petition asks the Commission to list the Joshua tree as a "species" or a "subspecies or variety" across the species' entire range, or as various, distinct ESUs. (Petition, pp. ii, 16, fn. 8.) The Petition, however, fails to provide any evidence whatsoever supporting its argument for recognizing *Y. brevifolia* ESUs.

By the Department's own adopted definition, a population may qualify as an ESU where it meets two criteria: (1) it must be reproductively isolated from other conspecific (i.e., same species) population units, and (2) it must represent an important component of the evolutionary legacy of the species. (See WestLand Assessment, p. 3.) The Petition provides no such evidence. To the contrary, studies cited for other purposes in the Petition show that it is likely that the Joshua tree northern and southern populations are not reproductively isolated, and that there is gene flow between the two populations. (*Id*., at pp. 3-5.)

The consequence of this is that the Petition presents "(1) a biased discussion of the population status and dynamics of Joshua trees across their range and (2) a biased conclusion of threats to Joshua trees." (WestLand Assessment, p. 5.) In other words, because the Joshua tree northern and southern populations are not ESUs, the Petition must address the species across the entire range, rather than one population or the other, in order to show that listing "may be warranted." (Fish & G. Code § 2072.3.)

The Petition wholly fails in this regard. Rather, the Petition supports its assertions by improperly extrapolating findings from a limited dataset developed from within a geographical fraction of *Y. brevifolia*'s range. As explained in the WestLand Assessment:

> While ecologists often extrapolate population dynamics by subsampling populations of the organism of interest, the statistical reliability of this subsampling depends on multiple procedural and ecological factors. . . . Critically, a failure to account for these factors when sampling or extrapolating data can lead to spurious conclusions that do not reflect the biological processes that are occurring.

(WestLand Assessment, p. 6.) The Petition fails to follow standard scientific practices necessary to properly extrapolate data. As a consequence, the studies cited in the Petition concerning factors affecting survival and reproduction, and degree and immediacy of the threat cannot and do not constitute scientifically sufficient evidence supporting the Petition's range-wide assertions regarding *Y. brevifolia*.

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The Petition Provides No Evidence Regarding *Y. Brevifolia's* Abundance or Population Trend. "Abundance" in the CESA context refers to the number of individuals of a taxon in a given area. "Population trend" relates to the directional change in abundance of a specific taxon in a given area through time. Data on abundance and population trend is essential to adjudging whether a particular species is "likely to become an endangered species in the foreseeable future in the absence of the special protection and management efforts" required by CESA. (Fish & G. Code § 2067.) On both required components, the Petition includes no information, much less scientifically sufficient information.

The Department's *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* (February 2020) ("Department Evaluation") openly acknowledges these two deficiencies: "[T]he Petition does not present an estimate of western Joshua tree population size, nor does it provide evidence of a range-wide population trend . . .." (Department Evaluation, p. 9 [emphasis added].) Instead, "the Petition includes information demonstrating that western Joshua tree currently has a relatively widespread distribution in southern California," and that "the abundance of western Joshua tree is currently relatively high." (Department Evaluation, p. 13.) The Petition also cites to studies indicating that Joshua trees have been stable in at least Joshua Tree National Park for more than 11,000 years. (Petition, p. 17; Department Evaluation, p. 10.) According to the Department, the only information presented in the Petition regarding abundance and population trend show that the petitioned action is not warranted. (See Fish & G. Code § 2072.3.)

The Department Evaluation, however, concludes without support that because "the Petition does provide information showing that some populations of western Joshua tree are declining, particularly within Joshua Tree National Park . . ., sufficient information on population trend, range . . . distribution was shown." (Department Evaluation, p. 2.) With all due respect to the Department, the identified *lack* of information does not transform into "sufficient information" because studies may have indicated a potential decline in Joshua Tree National Park—a tiny fraction of the "range and population" for which the Petition seeks listing.

Further, the Petition's "information showing that some populations of western Joshua tree are declining" does not constitute "sufficient scientific information." Studies cited in the Petition to support its argument that the Joshua tree population is declining (e.g., DeFalco et al. (2010), Harrower and Gilbert (2018)) are based on a few, discrete study plots within Joshua Tree National Park, which lies at the extreme southern end of the species' range. This evidence is not scientifically sufficient for two reasons: first, the Petition improperly extrapolates the data across the Joshua tree's entire range without satisfying any of the scientific and statistical criteria to do so. (WestLand Assessment, pp. 5-7.) In other words, study data from, as in one case, as little as a single hectare within Joshua Tree National Park do not accurately represent conditions across the Joshua tree's more than six million-acre range.

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Second, the Petition fails to address other studies that wholly contradict its cited studies. For example, USAF 2017a (cited in the Department Evaluation) shows that Joshua tree populations on Edwards Air Force Base are stable to increasing. (WestLand Assessment, p. 7.) The Edwards Air Force Base data, like the data presented in the Petition, are both part of the body of data regarding the Joshua tree species, but neither dataset by itself describes the entire species. (*Ibid*.)

At the same time, accurate information concerning *Y. brevifolia*'s abundance and population trend can be ascertained. *Y. brevifolia* is not like the elusive California Tiger Salamander, which lives most of its life underground. Instead, abundance and population trend data on *Y. brevifolia* could be gathered through straightforward and common scientific means that include representative sampling and statistically-valid data extrapolation.

The Department Evaluation, as noted, acknowledges that the Petition contains no information concerning *Y. brevifolia*'s abundance and population trend. The Petition is accordingly incomplete as a matter of law, and incomplete as a practical matter as well – without this data, it is impossible for the Commission to determine whether *Y. brevifolia* is "likely to become an endangered species in the foreseeable future in the absence of the special protection and management efforts" required by CESA. (Fish & G. Code § 2067.) The Commission must decline to accept the Petition without this data.

The Petition Contains Insufficient Scientific Information On Factors Affecting The Ability to Survive and Reproduce. The Petition relies heavily on a few studies to support its argument that threat factors are impeding recruitment, leading toward population decline and range reduction. (See Petition, p. 20.) The Petition's evidence offered in this regard does not constitute "sufficient scientific evidence" for two reasons.

First, the Petition again improperly extrapolates studies on recruitment at specific sites within Joshua Tree National Park across the species' entire six million-acre range. (WestLand Assessment, p. 9.) The consequences of improper data extrapolation are evident even among the studies cited by the Petition. While the Petition cites certain studies (Barrows and Murphy-Mariscal 2012, Sweet et al. 2019) for the proposition that recruitment "has already largely stopped" within Joshua Tree National Park, these same studies note continued recruitment elsewhere in Joshua Tree National Park. (*Ibid*.) Other long-term data from northern portions of the Joshua tree range show evidence of new plants between 1963 and 2001, which wholly undercuts the Petition's assertion that recruitment is declining range-wide. (*Ibid*.)

"Evidence" cited in the Petition drawn from limited study areas and improperly extrapolated across the entire *Y. brevifolia* range is simply not "sufficient scientific information." Recruitment may indeed be declining in the specific, limited geographic areas discussed in the Petition, but the Petition provides no evidence that such information accurately describes conditions anywhere else within the species' range. The Petition's claims in this regard are pure conjecture.

Second, the studies cited by the Petition to support its arguments concerning recruitment address only sexual reproduction, despite the fact that *Y. brevifolia* recruitment can occur through both sexual and asexual reproduction. (See Petition, p. 8; WestLand Assessment, pp. 9-10.) Thus, according to WestLand, "studies cited by the Petition may be systematically underestimating total recruitment (sexual and asexual) at the locations where asexual reproduction is more likely to occur – namely, lower elevations and post-fire habitat." (*Ibid*.) In other words, the evidence provided by the Petition concerning recruitment is fundamentally incomplete, and cannot constitute "sufficient scientific information."

The Petition's reliance on incomplete, geographically-limited data means that the Petition fails to provide "sufficient scientific information" regarding *Y. brevifolia*'s ability to survive and recruitment capacity. These failings also mean that the Petition provides no evidentiary basis for the Commission to conclude that *Y. brevifolia* recruitment is declining range-wide. To the contrary, as the U.S. Fish & Wildlife Service ("USFWS") recently found following extensive scientific review: "Threats to individual trees are not likely influencing population resiliency on a population or species scale since there is no evidence to indicate any recent population size reductions or range contractions and limited demographic studies indicate recruitment is occurring." (*Endangered and Threatened Wildlife and Plants; 12-Month Findings on Petitions to List Eight Species as Endangered or Threatened Species*, 84 Fed. Reg. 41694 (August 15, 2019) ["USFWS Findings"], p. 41697.)

The Petition Provides No Evidence To Support Its Claim That Climate Change And Fire Immediately Threaten *Y. Brevifolia* Range-Wide. The Petition claims that wildfire and climate change are the two most significant threats to *Y. brevifolia*'s continued viability. (Petition, p. 24 ["Wildfire is one of the greatest threats to the persistence of *Yucca brevifolia*"]; p. 32 ["Climate change represents the single greatest threat to the continued existence of *Yucca brevifolia*"].) A petition must provide sufficient scientific information concerning the degree and immediacy of threat to a species so that the Commission may evaluate whether the species "is likely to become an endangered species in the foreseeable future" and thus appropriate for listing. (Fish & G. Code § 2067.) The Petition, however, provides no evidence showing that either factor threatens *Y. brevifolia* range-wide, now or in the foreseeable future. Further, the Petition fails to address other evidence, particularly concerning fire, that appears to wholly undercut the evidence cited by the Petition.

With respect to wildfire, the Petition relies primarily on a single study, DeFalco et al. (2010), for the assertion that wildfire threatens individuals and recruitment throughout *Y. brevifolia*'s range. (WestLand Assessment, p. 10.) As with its arguments concerning abundance, population trend and recruitment, the Petition again improperly extracts data from a limited geographic area within Joshua Tree National Park to the entire Joshua tree range. The fundamental scientific and statistical defects in this approach are set out above. (*Id*., at p. 11.)

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The Petition further compounds its evidentiary missteps by mischaracterizing the findings of certain studies. As stated in the WestLand Assessment:

> The Petition cites scientific papers that undermine the Petition's argument that increasing wildfire frequency and intensity have considerable effects on the continued existence of Joshua trees. For example, the Petition cites Brooks and Matchett (2006) as evidence that an increase in fire size and frequency in the Mojave Desert will impact the ability of Joshua trees to survive and reproduce. However, Brooks and Matchett (2006) actually concluded the opposite: for the 15 years of data analyzed, there was a *decrease* in the observed frequency of fires and no clear trend in the amount of area burned.

(WestLand Assessment, p. 11 [emphasis in original].) The Petition cites other studies, including Esque et al. (2015) (Petition, p. 30) and Abella et al. (2009) (Petition, p. 31), as evidence that wildfire negatively impacts Joshua trees individuals and recruitment when, in fact, neither study analyzed fire impacts on Joshua trees. (*Ibid*.)

Finally, the Petition ignores other evidence, including USAF 2017b, as cited in the Department Evaluation, showing that the number of individual Joshua trees had actually increased post-fire. (See WestLand Assessment, p. 11.) While this data may be no more appropriate for range-wide extrapolation than the data cited in the Petition, this evidence wholly undercuts the Petition's claim that fire is unequivocally a significant threat to the species.

The Petition's analysis of climate change as a threat to *Y. brevifolia* is equally troubled. As stated in the WestLand Assessment:

> The Petition relies largely on three sources to argue that climate change constitutes a significant and immediate threat to the species: Cole et al. (2011), Barrows and Murphy-Mariscal (2012), and Sweet et al. (2019). The latter two studies are limited to modeling efforts in Joshua Tree National Park. The results of Cole et al. (2011) have been explicitly refuted by other researchers.

(WestLand Assessment, p. 12.) Data improperly extrapolated is scientifically invalid, as explained above. Studies of certain areas of Joshua Tree National Park cannot be extrapolated range wide because, among other reasons, fine scale topographic and climactic data are necessary to understand how a particular species will react to climate change, as acknowledged by Sweet et al. (2019), one of the studies cited by the Petition. (Id., at p. 13.) In other words, the effects of climate change do not present in the same way across the entire Joshua tree range, which varies widely in topography, elevation, temperature, and in other important metrics.

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As respects Cole et al. (2011), which the Petition cites extensively at pages 36-40, the study's models based on assumptions of climate predictions and other factors "have been explicitly rejected by recent genetic and distribution modeling efforts that were not cited by the Petition." (WestLand Assessment, p. 12.) In particular, Smith et al. (2011) documents evidence of population growth historically and argues that previous periods of climate change do not explain historical changes to Joshua tree population size, in conflict with Cole et al. (2011). (*Ibid*.)

The Petition does not address these evidentiary challenges directly, other than to acknowledge, as noted, that "extirpation is likely decades away." Even this prediction, however, rings hollow. As the Petition notes, the Joshua tree's imminent demise has been predicted since at least 1953. (See Petition, p. 24, citing to Webber (1953).) While the body of data regarding the species may have grown since that time, the data does not support a conclusion that the species is in decline, or, more specifically, climate change threatens *Y. brevifolia* range-wide.

The Commission has previously confronted and rejected listing in a similar context. Specifically, the Commission declined to list the American pika for the following reasons:

> Based on the criteria described above, the best scientific information currently available to the Department indicates the American pika is not in serious danger in the next few decades of becoming extinct throughout all or a significant portion of the species' range in California, nor by the end of the century should the existing climate change models and predicted trajectory of suitable pika habitat come to fruition. At the present time, the species is widespread through its known range in California and the scientific uncertainty associated with current modeling efforts do not establish with scientific certainty or otherwise provide a sufficient scientific basis for the Department to know categorically or to state the actual threat climate change ultimately poses to the species at this time or through the end of this century. Even the models currently available predict a reduction in pika habitat and therefore populations, distribution, and abundance, but not extinction.

(Department of Fish & Wildlife, *Report to the Fish and Game Commission, Status Review of the American Pika (Ochotona pinceps) In California*, February 25, 2013, pp. 55-56 ("Pika Status Review").)

This same rationale applies to *Yucca brevifolia*: the species is not in serious danger of extirpation in the next few decades; the species is widespread through its known range in California; and current climate models do not provide a sufficient scientific basis to know categorically or to state the actual threat climate change ultimately poses to the species at this time or through the end of this century.

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The Petition's Primary "Suggestion For Future Management" Is Infeasible. CESA requires a petition to include "suggestions for future management." (Fish & G. Code § 2072.3; Cal. Code Regs., tit. 14, § 670.1(d)(1)(J).) This phrase is not elsewhere defined in CESA, but a closely-related term, "special protection and management efforts", appears in CESA's definition of "threatened species", as follows:

> "Threatened species" means a native species or subspecies of a bird, mammal, fish, amphibian, reptile, or plant that, although not presently threatened with extinction, is likely to become an endangered species in the foreseeable future *in the absence of the special protection and management efforts required by this chapter*. Any animal determined by the commission as "rare" on or before January 1, 1985, is a "threatened species."

(Fish & G. Code § 2067 [emphasis added].) Given that a petition filed pursuant to section 2072.3 seeks to list a species as "threatened", it stands to reason that section 2072.3's requirement that such a petition include "suggestions for future management" is intended to facilitate the Commission's identification of "special protection and management efforts." Importantly, however, such "management efforts" must be those that are "required by this chapter", i.e., CESA. (*Ibid*.) Thus, any "suggestions for future management" identified in a petition must also fall within the requirements and authority of CESA. It stands equally to reason that any suggested measures must actually be feasible, or in other words, bear some possibility of occurring.

The Petition states that climate change "represents the single greatest threat to the continued existence of the *Yucca brevifolia*", and that "the lack of effective regulatory mechanisms to address greenhouse pollution is largely determinative as to the question of whether *Y. brevifolia* qualifies for CESA protection. (Petition, pp. 32, 50-51.) Because the Petition contends that climate change is the primary threat to the species, only actions that can reduce or eliminate the effects of climate change would be effective in preventing the asserted threat. (See Department Evaluation, p. 27 ["The Petition states that the most important recovery actions for western Joshua tree are those that lead to rapid and steep greenhouse gas emission reductions to minimize the additional warming that will occur in the climate system"].)

In this regard, the Petition offers the following management action:

> The governor declares a climate emergency and takes all necessary action to set California on a path to full decarbonization of our economy by no later than 2045 (e.g. banning the sale of new fossil fuel vehicles by 2030 and requiring the generation of all electricity from carbon-free sources by 2030).

(Petition, p. 65.) Even casual observers of California's long and difficult process toward regulating greenhouse gas emissions will understand that such a "declaration" by the governor is itself unlikely, but that the probability of such drastic regulatory measures being implemented by declaration is even less likely. This measure is infeasible on its face.

More fundamentally, however, this suggested measure lies well outside the Commission's and the Department's purview under CESA. The Department obliquely acknowledges this: "some of the [management] suggestions are not within the Department's jurisdiction." (Department Evaluation, p. 27.) The Petition's central management suggestion, in fact the only management suggestion oriented toward minimizing additional climate warming, is consequently neither feasible nor actionable or enforceable by the Commission or the Department. None of the Petition's other nine management suggestions entail measures to counteract climate change, and so the Petition functionally fails to satisfy CESA's requirement in this regard.

Conclusion and Recommendations

The Petition, as shown above, fails to provide any information whatsoever concerning *Y. brevifolia*'s abundance and population trend, even though such data is ascertainable. The Petition also fails to provide sufficient scientific information concerning factors affecting the species' ability to thrive and reproduce, and the degree and immediacy of the threat to the species. Finally, the Petition's management suggestion for the primary threat factor to the species is infeasible and unenforceable. Subsection (e)(1) of section 670.1 of Title 14 of the California Code of Regulations mandates that the Commission decline to accept the Petition.

As the Commission is well aware, a decision to not accept a petition is not a pronouncement that the species does not or will not require protection. To the contrary, a model for appropriate action can be found in the Commission's Pika Status Review, which states, in relevant part:

> It will be imperative for the Department and for the scientific community to study and monitor the distribution and abundance of the American pika over the next few decades, and as climate change models become more data driven, to be able to better assess the foreseeable future. Such monitoring will ultimately inform scientific understanding as to whether the American pika is trending toward serious danger of extinction or not.

(Pika Status Review, pp. 55-56.)

The Petition fails to show that the Joshua tree is likely to become "extinct" throughout its range in the "foreseeable future." Joshua trees have a life span of approximately 200 years. They are admittedly abundant. There is no evidence presented that their extinction in the foreseeable future is likely. It is clear from the data gaps in the Petition that the species merits further study. But the wisdom of further study is not the same as possessing sufficient scientific information currently to warrant listing.

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The Commission should also pay special attention to the vast geographic area that would be impacted by acceptance of the Petition, and the particularly challenging economic and social issues within these areas that would be compounded by the Commission's action. As other commenters will no doubt explain, acceptance of the Petition would result in real hardship to already-challenged communities. This fact provides all the more reason for the Commission to postpone consideration of the Petition until these communities can be fully heard.

For the reasons set out above, CalPortland respectfully requests that the Commission decline to accept the Petition at this time, and to instead encourage the scientific community to study and monitor *Yucca brevifolia* over the next few decades.

* * *

Very truly yours,

By

Robert M. Binam
Senior Vice President and General Counsel
CalPortland Company

cc: Building Industry Association of Southern California
California Building Industry Association
Coast Aggregates
Golden Queen Mining Company, LLC
Holliday Rock
Lebata, Inc.
State Building and Construction Trades Council of California
Tehachapi Wind Wall, LLC
Vulcan Materials Company
Mark Harrison, Esq., Harrison, Temblador, Hungerford & Johnson LLP

Encl: WestLand Resources, Inc., *Assessment Of Petition To List The Western Joshua Tree (Yucca Brevifolia) As Threatened Under The California Endangered Species Act* (August 2020)

ASSESSMENT OF PETITION TO LIST THE WESTERN JOSHUA TREE (*YUCCA BREVIFOLIA*) AS THREATENED UNDER THE CALIFORNIA ENDANGERED SPECIES ACT

Prepared for: CalPortland, Inc.

Prepared by: WestLand Resources, Inc.

Date: August 4, 2020

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APPENDICES

1. EXECUTIVE SUMMARY

On October 15, 2019, the Center for Biological Diversity (CBD or Petitioner) submitted a petition (the Petition) to the California Department of Fish and Wildlife Service (CDFW) to list the purported Western Joshua Tree (*Yucca brevifolia* or Joshua tree) as threatened under the California Endangered Species Act (CESA). WestLand Resources, Inc. (WestLand) has reviewed the Petition and available scientific information on *Y. brevifolia*. Our review of the Petition indicates that the evidence provided in the Petition is limited in its scope and does not meet the standards required by CESA. The evidence provided in the Petition is based primarily on studies conducted in Joshua Tree National Park, and these findings are improperly extrapolated to represent dynamics of *Y. brevifolia* across its range, including population trends, threat factors, and immediacy and degree of threats. The Petition, however, does not address this lack of evidence or provide a reasoned argument to justify that studies conducted in Joshua Tree National Park can properly be extrapolated to represent dynamics of Joshua tree across its range. Critically, the Petition does not appropriately address this lack of evidence or provide sufficient scientific information to inform the decision of whether the species warrants listing under CESA. Collectively, these issues demonstrate that the Petition does not provide sufficient scientific information to indicate that the listing of this species is warranted under CESA.

Specifically, the fundamental issues we identify in the Petition and discuss in greater detail below are:

- The Petition lacks sufficient scientific information to justify the conclusion that Joshua tree populations should be considered Evolutionary Significant Units (ESUs).
- The Petitioners extrapolate range-wide patterns from a small subset of the Joshua tree's range to support their conclusion regarding population trends, threat factors, and degree and immediacy of threats, without providing scientific evidence to justify that their extrapolation is statistically and biologically appropriate.
- The Petition does not contain sufficient scientific information on the population status of Joshua trees to support the Petitioner's claims.
- The Petition misinterprets the available data of potential threats to Joshua trees, and does not survey scientific evidence providing alternate findings regarding potential threats to Joshua trees.

In our discussion below we first address the Petitioner's arguments that there are two Joshua tree ESUs in California. We then discuss limitations of the available scientific data regarding the population dynamics of Joshua tree and the Petitioner's inappropriate extrapolation of those data from studies of limited geographic extent to the population of Joshua tree throughout its range in California. Understanding these fundamental questions is essential to the critical evaluation of the rest of the Petitioner's arguments regarding population trends and the potential threats to this species.

2. PETITION DOES NOT PROVIDE SUFFICIENT SCIENTIFIC INFORMATION TO SUPPORT DESIGNATION OF AN EVOLUTIONARILY SIGNIFICANT UNIT(S) FOR JOSHUA TREE

The Petition argues that *Y. brevifolia* is a listable taxonomic entity under CESA and should be considered for listing as threatened. The Petition also states that Joshua trees in the western Mojave Desert are subdivided into two populations, North and South, and declares that these populations can be considered ESUs for the purposes of listing under CESA (Petition, pg. 64). The CDFW's definition of an ESU requires sufficient scientific evidence to support listing under CESA. Specifically, to conclude that a species or subspecies includes ESUs, CDFW has adopted the definition proposed by the National Marine Fisheries Service for an ESU that a population must meet two criteria (CDFW 2015): (1) it must be reproductively isolated from other conspecific (i.e., same species) population units, and (2) it must represent an important component of the evolutionary legacy of the species (Waples 1991). However, scientific evidence supporting the Petitioner's argument that these two populations should collectively, or individually, be considered ESUs consistent with CDFW's adopted definition has not been provided. Rather, the Petitioners support their position with a simple declarative statement, relying upon USFWS' (2018) delineation of populations of *Y. brevifolia*, a small gap between the putative north and south populations of this taxon, and differences in the associated vegetation between populations as the sole evidence to conclude that CDFW should recognize these populations as ESUs.

Waples (1991) stresses the importance of genetic information, stating that "population characteristics that are important in an evolutionary sense must have a genetic basis." For example, in CDFW's status review of the fisher (*Pekania pennanti*) in California (CDFW 2015), CDFW relied upon mitochondrial genetic data and explicit empirical evidence and modeling of dispersal as justification to conclude that fishers in northern and southern California are "genetically distinct and were effectively isolated from each other." Yet, the Petition contains no genetic, dispersal, or other data to establish that the northern and southern populations are reproductively isolated or represent an important component in the evolutionary legacy of the species. Indeed, while the Petition relies upon USFWS' (2018) delineation of northern and southern population, USFWS makes no conclusion that these populations are ESUs. In fact, USFWS (2018) acknowledges that the structure of Joshua tree populations is unknown and that "more research is needed to better inform our understanding of where local populations occur on the landscape, how the local populations interact, and how this structure influence regional population demographics…" (pp. 18).

Critically, genetic studies cited in the Petition (that were not discussed in the context of ESU designation), show that it is likely that the purported northern and southern populations are not reproductively isolated. Per the map provided in the Petition (Petition, pp. 1), the proposed northern and southern populations of *Y. brevifolia* are separated by a "small gap" (Petition, pp. 64) measuring less than 10 miles (**Figure 1**; calculated from maps provided by Petition, pp. 1, and USFWS 2018). While the arguments made in the Petition focus on the dispersal rate of *Y. brevifolia* seeds transported by rodent species within their relatively small home ranges (Petition, pp. 11; Vander Wall et al. 2006, Waitman et al. 2012), USFWS (2018) documents *Y. brevifolia* fruits being consumed by cattle, mule deer, horses and burros (pp. 24; internal citations omitted). Ungulates have much larger range sizes than rodents and an ~10-mile gap would not be as great an impediment to seed dispersal for such species. Moreover, *Y. brevifolia* is pollinated by the yucca moth *Tegeticula antithetica* (Yoder et al. 2013), which may be capable of transporting pollen between populations. Thus, the scale of dispersal of both *Y. brevifolia*, its seed dispersers, and its pollinator *T. antithetica* must be understood to determine the realized spatial separation between populations and potential for reproductive isolation. An analysis cited in the Petition regarding *T. antithetica* genetic population structure across the range of *Y. brevifolia* suggests that its pollinator "disperses widely" (Yoder et al. 2013, pp. 1231), although the distance over which *T. antithetica* may transport pollen is not well-understood. Importantly, despite extensive sampling across the north and south populations of *Y. brevifolia,* Yoder et al. (2013) found little evidence for population genetic structure within the "pure" *Y. brevifolia* populations across its range. This suggests that there is gene flow between the north and south populations and thus that there is little evidence to support reproductive isolation. While Yoder et al. (2013) did find some evidence for greater genetic differences the farther away *Y. brevifolia* populations were from each other, this occurred at a far greater scale than the ~10-mile gap between the proposed northern and southern ESUs (Yoder et al. 2013). Indeed, disjunct populations *within* the proposed ESUs are separated by a greater spatial distance (e.g., ~11.4 miles; **Appendix A**) than the gap *between* the proposed North and South ESUs (~9 miles)[1], yet the Petitioner's do not acknowledge this discrepancy. Together, these data do not support the idea that the north and south populations of *Y. brevifolia* are reproductively isolated from one another, nor that the gap constitutes a major barrier to dispersal that could produce geographic isolation.

The arguments made in the Petition also rely upon purported differences in associated vegetation between the northern and southern populations to conclude they should be recognized as ESUs. Waples (1991) states that populations that occupy unique habitats may be an ESU. However, for this designation to be supported, there needs to be evidence that occupancy of different, unique habitat types is an indication of ecological and genetic differences between those populations. The Petition contains no evidence that the habitats occupied by the Petition's proposed northern and southern ESUs are unique to either region. To the contrary, the USFWS' Species Status Assessment for Joshua tree (USFWS 2018) shows that there is substantial overlap in the ecoregions present in the northern

[1] To calculate distances between populations within and between the proposed North and South ESUs, WestLand used the Generate Near Table (https://pro.arcgis.com/en/pro-app/tool-reference/analysis/generate-near-table.htm) in ArcgIS Pro 2.6. The 35 polygons of both the north and south populations (data from Cole et al. 2011, USFWS 2018) were digitized the analysis ran to generate a stand-alone table with the closest distance (meters) to the other 34 polygons (**Appendix A**). The distance from boundary to boundary, was used to derive measures of the maximum dispersal distance between adjacent populations.

and southern populations of *Y. brevifolia* (**Figure 1, Table 1**)[2]. Specifically, the proposed southern and northern ESUs overlap in the ecoregions present for approximately 75% of the range of *Y. brevifolia* (**Table 1**), indicating that the ecoregions within each proposed ESU are not unique to either. Considering (1) the generally similar habitats occupied by the northern and southern populations of *Y. brevifolia*, (2) an apparent lack of genetic differences between the two populations (described above), and (3) a lack of evidence to support isolation, the Petitioners have provided no compelling evidence that the north and south populations of *Y. brevifolia* occupy unique habitats that would confer some ecological or genetic distinctness on one population over the other that would warrant designation of an ESU.

The consequences of the Petition's unsupported conclusion that northern and southern populations of *Y. brevifolia* should be recognized as ESUs are (1) a biased discussion of the population status and dynamics of Joshua trees across their range and (2) a biased conclusion of threats to Joshua trees. Specifically, the lack of evidence supporting the conclusion that the north and south populations are ESUs makes the extrapolation of data from a small subset to the range of the species statistically and biologically inappropriate (see below). Illustration of the biases that resulted from the limited data presented in the petition are provided in the sections that follow.

3. THE PETITION PROVIDES NO INFORMATION ON THE RANGE-WIDE POPULATION STATUS OF JOSHUA TREES

A fundamental flaw in the Petition, that is particularly evident in the Petitioner's conclusions regarding the population status of Joshua trees, is the misapplication and inappropriate extrapolation of findings from a small portion of the range of *Y. brevifolia* to the species as a whole. Extrapolating range-wide population dynamics from a subset of non-random data can produce erroneous and biased conclusions. While ecologists often extrapolate population dynamics by subsampling populations of the organism of interest, the statistical reliability of this subsampling depends on multiple procedural

[2] *Y. brevifolia* is located almost exclusively in the Mojave Desert with a small portion of its northern population extending into the Great Basin Desert. Near the northeastern extent of the range of *Y. brevifolia* there is a hybrid zone where *Y. brevifolia* and *Y. jaegeriana* overlap and hybrids occur (USFWS 2018). The USFWS (2018) describes the ecoregion of the northern and southern populations where *Y. brevifolia* (see Figure 1). According to the EPA, ecoregions are identified by analyzing the biotic and abiotic composition of the area, including geology, landforms, soils, vegetation, climate, wildlife, and hydrology (epa.gov).

The southern population occurs mostly within the Western Mojave Basin ecoregion from Joshua Tree National Park north to Ridgecrest and Red Mountain. Level-four ecoregions common in the southern population area that support *Y. brevifolia* include Eastern Mojave Basin, Eastern Mojave Mountain Woodland and Shrubland, Western Mojave Basin, Western Mojave Low Ranges and Arid Footslopes and Western Mojave Mountain Woodland and Shrublands. Occupied habitats in this portion of *Y. brevifolia*'s range extend from approximately 750 to 2,200 meters in elevation (ca 2,400 to 7,200 feet) and rainfall ranges from 82.4mm (3.24in) to 738.1 mm (29.06in). Temperatures through the year in this area are also variable with mean winter minimum temperatures ranging from -5.7°C (22°F) to 4.8°C(41°F) to summer mean high temperatures of 23.4°C (74°F) to 37.2°C (99°F) (USFWS 2018).

The northern population of *Y. brevifolia* in California includes northern Mojave Desert, southern Great Basin Desert and transitional vegetation types between the Great Basin and Mojave Desert. Common level-four ecoregions in the northern part of the species range include, but are not limited to, Western Mojave Basin, Western Mojave Low Ranges and Arid Footslopes, Western Mojave Mountain Woodland and Shrublands, and Eastern Mojave Low Ranges and Arid Footslopes. Occupied habitats in this portion of *Y. brevifolia*'s range extend from approximately 1,500 to 2,200 meters in elevation (ca 4,900 to 7,200 feet) and rainfall ranges from 95.8mm (3.77in) to 429mm (16.89in). Temperatures through the year in this area are also variable with mean winter minimum temperatures ranging from -8.1°C (17°F) to 3.6°C(38°F) to summer mean high temperatures of 20.4°C (69°F) to 36.3°C (97°F) (USFWS 2018).

and ecological factors. As described by (Conn et al. 2015), these factors include how intensive the sampling effort is, the spatial proximity of the sampling area to the areas the data are extrapolated to, variability of the ecological process in question, and the similarity of explanatory covariates in the sampled area to the explanatory covariates across range of the organism of interest. Critically, a failure to account for these factors when sampling or extrapolating data can lead to spurious conclusions that do not reflect the biological processes that are occurring. Yet, the Petition does just that and does not take these considerations into account when extrapolating data from Joshua Tree National Park to infer the range-wide population status of Joshua trees.

First, Joshua Tree National Park is located at the extreme southern edge of the species' range and constitutes less than 5% of the total area known to be currently inhabited by *Y. brevifolia* (311,961 acres in Joshua Tree National Park, out of total 6,463,397 acres of Y. brevifolia range, calculated from data included in Cole et al. 2011, USFWS 2018). Therefore, sampling solely within Joshua Tree National Park does not represent intensive random sampling that can be reasonably expected to accurately reflect population trends, nor is it in close proximity to the rest of the range.

Second, the range of *Y. brevifolia* encompasses a wide diversity of habitat types, such that Joshua trees experience spatiotemporal variation in the conditions that promote reproduction, recruitment and survival. Thus, subsampling one region does not accurately represent conditions in other parts of the range, because this sampling does not capture the variation in Joshua tree density, climactic conditions, soil and vegetation characteristics that are known to occur throughout the range of the species (**Figure 1**; USFWS 2018, pp. 57-58; Esque et al. 2010) and are discussed throughout the Petition (e.g., the highly variable population density (pg. 19) and climactic conditions (pg. 18)). Joshua trees occupy a wide elevational (750 to 2220 meters) and geographical range extending from southeastern California to Nevada (Petition, pg. 16), encompassing a broad diversity of habitats with varying ecological communities (Turner and Brown 1982, USFWS 2018). Indeed, *Y. brevifolia* in Joshua Tree National Park are found in only two out of the 24 Level IV-ecoregions inhabited by *Y. brevifolia* across its range (**Figure 1**, **Table 1**). According to the EPA, ecoregions are identified by analyzing the biotic and abiotic composition of the area, including geology, landforms, soils, vegetation, climate, wildlife, and hydrology (epa.gov). For this reason, it is unlikely that Joshua Tree National Park is representative of the broad range of variation experienced by Joshua trees (see below). Moreover, *Y. brevifolia* demonstrate irregular sexual reproduction that is highly dependent on local conditions and asexual reproduction that can result from local factors that vary across the landscape (see below). Together, the statistical reliability for extrapolating data from a small, non-random subset of the *Y. brevifolia* range is poor and will likely fail to reflect population dynamics and status across the range of Joshua tree.

Despite the flaws inherent in extrapolating from a small, biased subset of data, the Petition does not provide scientific evidence or justification to support the extrapolation of data from Joshua Tree National Park across the range of *Y. brevifolia*. Indeed, both the Petition and CDFW's evaluation of the Petition acknowledge that there are no reliable estimates of species population size or documented range-wide population trends for *Y. brevifolia* (Petition, pp. 19). In fact, based on the best data available, CDFW has determined that Joshua trees are relatively abundant (CDFW 2020b). Yet, based on data from a few, discrete study plots on the extreme southern edge of the species boundary, the Petition concludes that, for the species as a whole, "recruitment is limited, and mortality is increasing, all of which would likely reflect a population already starting to decline" (Petition, pp. 19). This extrapolation from a limited study area at the edge of the species range to conclude that *Y. brevifolia* is experiencing a range-wide population decline, when other studies, e.g., USAF 2017a (cited in CDFW 2020), show that Joshua tree populations on Edwards AFB were stable to increasing, is a striking example of how insufficient scientific information can potentially lead to inappropriate conclusions. Moreover, the Petition misinterprets the available scientific data and does not include key data in its analysis of the population status of Joshua trees. We discuss these issues in the sections below.

3.1 THE INFORMATION PROVIDED BY THE PETITION REGARDING THE ABUNDANCE AND POPULATION TRENDS OF JOSHUA TREES IS MISLEADING

In the discussion of abundance and population trends, the Petition cites three studies to support its contention that Joshua tree populations are declining: DeFalco et al. (2010), Harrower and Gilbert (2018), and Cornett (2014)[3]. All three studies were limited to Joshua Tree National Park. Critically, the Petition's extrapolation of data from these three studies across the species' entire range is scientifically inappropriate for the reasons set out above. As survival and reproduction of *Y. brevifolia* varies based on local conditions (e.g., due to elevation and temperature; Harrower and Gilbert 2018, St. Clair and Hoines 2018), Joshua Tree National Park is unlikely to be representative of range-wide patterns in Joshua tree abundance and population trends due to variation in elevation, climactic, soil type, temperature ranges, rainfall amounts, and vegetation characteristics. This point is highlighted by the fact that Joshua Tree National Park only contains a small subset of the Level IV ecoregions that are encompassed by the range of *Y. brevifolia* (USFWS 2018, pp. 19). Specifically, the ecoregions present in Joshua Tree National Park only account for approximately 12% of the land occupied by *Y. brevifolia* (**Table 1**), and the ecoregions present in Joshua Tree National Park are not the dominant ecoregion types found throughout the range of Joshua trees (**Figure 1**). Thus, population trends documented solely within Joshua Tree National Park are unlikely to provide an accurate representation of the abundance and population trends of *Y. brevifolia* across their range.

The Petition cites three studies conducted within Joshua Tree National Park to support the conclusion that Joshua tree populations are declining. To understand how fire influenced Joshua tree populations, DeFalco et al. (2010) selected 10 study sites, five each in burned and unburned areas of Joshua Tree National Park sampled from 1999-2005. Within each burned and unburned area, DeFalco et al. (2010) randomly selected four to five 300-600 meter transects for a total of 46 transects within Joshua Tree

[3] The Petition also cites St. Clair and Hoines (2018) as evidence that Joshua tree density is negatively correlated with increasing temperature, but this study was performed across Joshua tree species, such that the relevance of any findings to *Y. brevifolia* is limited and there appears to have been no attempt to randomly sample locations. No information was provided about how sites were selected except "site selection in our study maximized coverage across Joshua tree's range…" (St. Clair and Hoines 2018, pp. 3).

National Park. Harrower and Gilbert (2018) evaluated Joshua tree demographic parameters at 11 sites across the 1,200 meter elevational distribution of the species in Joshua Tree National Park (two sites were included just outside of the park's boundaries) in 2016 and 2017. Finally, Cornett (2014) studied Joshua trees at a single one-hectare study plot in Joshua Tree National Park from 1990-2013 and discusses studies conducted at two additional one-hectare study plots within Joshua Tree National Park.

The findings of these studies are limited in their explanatory power for range-wide population dynamics of *Y. brevifolia*, as the results do not appear to capture the environmental variation of occupied habitat throughout the range of the species (see above; **Figure 1**). For example, the single, one-hectare study site investigated by Cornett (2014) renders it impossible for researchers to understand how representative these results are for Joshua trees outside of the single study site. Harrower and Gilbert (2018), Cornett (2014) and DeFalco et al. (2010) are case studies, that, if combined with other studies conducted throughout the range of the species, would contribute to a range-wide understanding of *Y. brevifolia* population dynamics. Alone however, these studies do not and cannot provide evidence of a range-wide population decline, as claimed in the Petition. Indeed, a cursory review of the available scientific literature cited by USFWS (2018) indicates that the densities of Joshua trees are increasing in other portions of its range (e.g., Webb et al. 2003; USAF 2017a as Cited in CDFW 2020). In short, the Petition cites as evidence studies conducted only in a small portion of the species range, the results of which cannot provide inference beyond the specific sites sampled. As such, rather than providing sufficient evidence documenting population declines, the Petition bases its conclusions on data that is insufficient to inform species-wide inferences of population status.[4]

[4] For species such as the Joshua tree that occur across broad geographic distributions, study designs should include several elements to make reliable inference about population abundance, trends, and other population parameters such as recruitment. We suggest several possible actions by which strong inference into Joshua tree population abundance and trends can be gained. First, range-wide stratified random samples are required to be certain that the population estimate is "weighted" based on relevant ecological factors that influence the species' distribution (Edwards 1998, Thompson 2012). Range-wide stratification of the occupied habitat should be based on important ecological features, including soil type, lithology, vegetation type, and climactic zone (Vojta et al. 2013). This measure is particularly necessary, as Joshua Tree National Park only contains two of the ecoregions inhabited by Joshua trees, and these two ecoregions do not represent the dominant type found throughout their range. Due to this variation in ecoregions across the range of *Y. brevifolia*, stratified samples throughout the range are required to gain strong inference into population trends. Second, the spatial extent of sampling (e.g., the number of study sites where individuals are sampled) should be sufficient to estimate summaries (abundance or density) of interest and measures of uncertainty (e.g., 95% confidence intervals) and to examine how covariates of interest may be associated with these summaries (Williams et al. 2002). Multiple plots should be sampled (sub-samples) in order to characterize variation within and across study sites (Hurlbert 1984). Finally, given the broad spatial distribution of the Joshua tree, and the longevity of individuals, a power analysis should be conducted to estimate the spatial extent and temporal duration of the sampling period required to estimate parameters of interest at desired levels of confidence (Steidl et al. 1997).

3.2 THE INFORMATION PROVIDED IN THE PETITION REGARDING THE RECRUITMENT OF JOSHUA TREES IS MISLEADING

Joshua tree recruitment is one of the key population parameters that the Petition focuses on in its discussion of the factors affecting the ability for Joshua trees to survive and reproduce. The Petition contends that recruitment is currently being substantially impacted by threats to Joshua trees and that this lack of recruitment will lead toward population declines and range reductions (Petition, pp. 20).

The Petition, however, inappropriately extrapolates patterns of recruitment occurring at specific sites within Joshua Tree National Park to represent recruitment rates across the range of *Y. brevifolia*. This extrapolation is inappropriate for two reasons. First, reproduction and recruitment of juveniles into the population is contingent on local microhabitat and ecological contexts (Reynolds et al. 2012) that can be highly variable both within and across habitat types (e.g., Borchert and DeFalco 2016, pp. 833, Webb et al. 2003). Even within Joshua Tree National Park, which according to the Petition has "limited" recruitment that has "largely stopped", studies cited by the Petition noted recruitment across the park (Barrows and Murphy-Mariscal 2012, pp. 34, Sweet et al. 2019, pp. 7). Long-term data from the northern portions of the *Y. brevifolia* range show evidence of new plants between 1963 - 2001, which does not support range-wide reductions in recruitment (Webb et al. 2003).

Second, the Petition cites studies that do not comprehensively measure recruitment. As discussed by the Petition (pp. 8), recruitment can occur into *Y. brevifolia* populations through both sexual and asexual reproduction (Gucker 2006), such that some populations are "largely if not entirely clonal" (Petition, pp. 8). However, the studies cited by the Petition do not inventory asexual reproduction (Barrows and Murphy-Mariscal 2012, pp. 31, Harrower and Gilbert 2018, pp. 4, Sweet et al. 2019, pp. 4). This bias limits the predictive power of data from Joshua Tree National Park to infer recruitment in other parts of the range, as patterns of sexual and asexual reproduction will differ across habitats occupied by *Y. brevifolia* due to variation in the conditions that promote each type of reproduction.[5]

Specifically, there is some evidence that asexual reproduction is more common at elevational extremes (Harrower and Gilbert 2018, pp. 7,12), that it may occur in response to fire (DeFalco et al. 2010, pp. 244, Loik et al.2000, pp. 82, Webber 1953) and, in some cases, herbivory (Esque et al. 2015, pp. 87). Thus, the studies cited by the Petition may be systematically underestimating total recruitment (sexual and asexual) at the locations where asexual reproduction is more likely to occur – namely, lower elevations and post-fire habitat. In the absence of a comprehensive investigation of sexual and asexual recruitment, it is not possible to state whether recruitment is limited at lower elevations, or whether that result follows from a selective appraisal of only one of the reproductive strategies available to *Y.*

[5] To better understand recruitment across the range of *Y. brevifolia*, we propose several actions. Joshua trees are long-lived species with irregular sexual reproduction. Population age-structures can be elucidated by measuring the height of Joshua trees (a common means by which to estimate age) within random stratified plots across the range of *Y. brevifolia*. Sensitivity and power analyses can be used to determine how large a sample, and how many years of sampling, are required to estimate population trends with a sufficient level of confidence. Moreover, a life stage analysis can provide inference into the mortality of each life stage of *Y. brevifolia*, how these patterns vary across the range, and how mortality of different life stages may impact population dynamics in the future.

brevifolia. Indeed, asexual reproduction is critical to population dynamics in other clonal tree species like quaking aspen, where asexual reproduction is common following fire and herbivory (Kulakowski et al. 2013, Mock et al. 2008). Mock et al. (2008) states that "the relative frequency of sexual vs. asexual reproduction determines long-term dominance and persistence of clonal plants at the landscape scale" (pp. 4827) and notes that "the proportion of these reproductive strategies varies across the species' range" (pp. 4828; internal citation omitted). Thus, it is inappropriate to exclude measures of asexual reproduction, as it may systemically bias measures of recruitment in particular kinds of habitats and for those long-lived species that are subject to "irregular" sexual reproduction, such as *Y. brevifolia* (Esque et al. 2010, pp. 11).

4. THE PETITION MISINTERPRETS THE AVAILABLE SCIENTIFIC DATA REGARDING THE DEGREE AND IMMEDIACY OF POTENTIAL THREATS TO JOSHUA TREES

The Petitioner's inappropriate extrapolation of data from a non-random subset to the entire *Y. brevifolia* range is also pervasive in the Petitioner's conclusions regarding the potential threats to Joshua trees. The Petition concludes that the degree and immediacy of threats to the species is such that immediate listing under CESA is required. The Petition attempts to justify this conclusion by relying heavily on the putative impacts from fire and climate change. However, the spatial bias and inappropriate extrapolation that is prevalent throughout the Petition results in a misinterpretation of the available data. Moreover, the Petition incorrectly cites numerous studies that do not support the conclusion that fire and climate change are significant threats to Joshua trees.

4.1 THE PETITION PROVIDES NO EVIDENCE THAT FIRE IS A RANGE-WIDE THREAT TO JOSHUA TREES

The Petition cites various studies to show that fire represents a considerable threat to Joshua trees. However, several of these citations are either misinterpreted by the Petition or do not support the Petition's claims.

The Petition relies heavily on DeFalco et al. (2010) to assert that fires have had a demonstrative effect on Joshua trees and threatens individuals throughout the species' range. DeFalco et al. (2010), however, provides data from a single fire complex in Joshua Tree National Park with apparently limited variability in fire intensity (i.e., "all burned sites were nearly denuded of shrub and perennial grass cover, and…lacked the safe sites beneath nurse plants"). As such, the results of DeFalco et al. (2010) have limited utility for predicting how fire will affect Joshua trees across its range; the results of a fire at a single location cannot be extrapolated across highly variable vegetative, soil, and climactic conditions such as those experienced by *Y. brevifolia* across its range. Sweet et al. (2019), another study upon which the Petition relies, provides caution against oversimplification of the effects of fire on Joshua trees noting that burn area polygons do not reflect the variability in fire dynamics. Despite several sample sites within burn area polygons, Sweet et al. (2019) did not observe evidence of fire on sample sites in Joshua Tree National Park (with a single exception where a light burn occurred within a sample site). Consequently, taking into account fire intensity is particularly important when drawing conclusions on the effects of fire on Joshua trees at Joshua Tree National Park or predicted refugia within the park, and even more so when extrapolating results to the range of the species. In point of fact, second-hand review of research cited by USFWS (2018) conducted in other parts of the *Y. brevifolia* range provide contrary results, showing that the number of individual *Y. brevifolia* plants had increased post-fire (USAF 2017b, pp. 1-3 as cited in CDFW 2020). The Petition fails to acknowledge this direct evidence of the importance of capturing the variation in conditions when drawing broad conclusions about the effects of fire on Joshua trees.

The Petition cites scientific papers that undermine the Petition's argument that increasing wildfire frequency and intensity have considerable effects on the continued existence of Joshua trees. For example, the Petition cites Brooks and Matchett (2006) as evidence that an increase in fire size and frequency in the Mojave Desert will impact the ability of Joshua trees to survive and reproduce. However, Brooks and Matchett (2006) actually concluded the opposite: for the 15 years of data analyzed, there was a *decrease* in the observed frequency of fires and no clear trend in the amount of area burned.

The Petition also cites scientific studies as evidence of the effects of fire on Joshua trees that do not measure or report results regarding the effects of fire on *Y. brevifolia*. For example, the Petition cites Esque et al. (2015) and implies that they provide evidence of significant impacts of fire frequency and intensity on Joshua trees (Petition, pg. 30). Esque et al. (2015) does not report or analyze impacts of fire on Joshua trees, instead, this study tracks the survival of a cohort of young plants with a focus on herbivory. The potential effects of fire are briefly mentioned in the discussion, but this study does not include any data on fire. The Petition cites Abella et al. (2009) as evidence that Joshua tree woodlands are not adapted to fire and recover slowly (Petition, pg. 31) and that "Joshua trees have low post-fire survival, are slow to repopulate burned areas, and successful recruitment from resprouting requires sufficient precipitation in the years following fire (Petition, pg. 24). Yet, Abella et al. (2009) neither measures the effects of fire on Joshua trees nor reports any data whatsoever on Joshua trees. Instead, Abella et al. (2009) examined plant communities, soils and seed banks several years after a fire had taken place in the Mojave Desert, with no mention of *Y. brevifolia* outside of a brief statement in the introduction.

4.2 THE PETITION DOES NOT PROVIDE A COMPREHENSIVE REVIEW OF THE THREATS OF CLIMATE CHANGE TO JOSHUA TREES

The issues of inappropriate extrapolation of results to the species as a whole and the general lack of critical review of the available scientific literature are also prevalent in the Petition's analysis of the threats of climate change on Joshua trees. The Petition relies largely on three sources to argue that climate change constitutes a significant and immediate threat to the species: Cole et al. (2011), Barrows and Murphy-Mariscal (2012), and Sweet et al. (2019). The latter two studies are limited to modeling efforts in Joshua Tree National Park. The results of Cole et al. (2011) have been explicitly refuted by other researchers. We discuss each of these below.

The Petition relies heavily on Cole et al. (2011) to conclude that no suitable habitat for Joshua trees will exist by the end of the century. Cole et al. (2011) models predicted Joshua tree habitat into the future by combining assumptions of climate predictions, the current distribution of the species, the assumed response of Joshua trees to climate warming in the paleontological past, and the extinction of mega-faunal seed dispersers that limit dispersal. In particular, the predictions of Cole et al. (2011) assume that Joshua trees underwent a range contraction in response to warming conditions in the past and that future expansions in their range will be extremely limited due to reduced dispersal capability, as the megafauna that once acted as seed dispersers are now extinct. These assumptions have been explicitly rejected by recent genetic and distribution modeling efforts that were not cited by the Petition. Specifically, Smith et al. (2011) did not find evidence that Joshua trees have undergone substantial declines in its historical range based on genetic data and distribution modeling. They also found no evidence that dispersal rates have changed dramatically due to extinction of megafauna. In fact, Smith et al. (2011) found evidence of population growth historically in Joshua trees, although not in the recent past, and argues that previous climate change does not explain historical changes to population size. Regardless, Smith et al. (2011) explicitly question the assumptions of Cole et al. (2011) and cast doubt upon the assumptions and predictions of Cole et al. (2011) relied upon so heavily by the Petition. Yet, the Petition does not acknowledge or discuss the findings of Smith et al. (2011).

The Petition relies upon other modeling efforts that predict the locations of future suitable habitat conditions for Joshua tree within Joshua Tree National Park: Barrows and Murphy-Mariscal (2012) and Sweet et al. (2019). Both reports predict reductions in suitable habitat across the park. To project population changes that could result from climate change, baseline distributions and trends of *Y. brevifolia* must be generated and then these baseline measures are used to project into the future, based on the assumptions incorporated into climate models. The lack of data that initially used to calibrate such climate models are critically important, because a lack of representative data will bias the conclusions of the projections. Sweet et al. (2019) and Barrows and Murphy-Mariscal (2012), however, are limited to Joshua Tree National Park, and cannot be appropriately extrapolated past the boundaries of the park for two main reasons. First, there is insufficient range-wide distribution data for *Y. brevifolia*. The outcomes of predictive models depend on the parameters and assumptions they are founded on. By supplying such models with a non-random subset of data that does not represent the overall population, the likelihood that model parameters will not reflect current reality of range-wide *Y. brevifolia* distribution is high and makes it very probable that future distribution projections will be skewed. Indeed, there is some evidence that pairing an underestimate of current distributions with a climate scenario that predicts conditions will be less favorable to Joshua trees, as was done by Sweet et al. (2019), will likely lead to a drastic underestimate of future Joshua tree distributions at the landscape scale (Smith et al. 2011).

Second, where species are distributed on the landscape depends on a complex suite of factors, including factors external to the organism - such as abiotic and biotic conditions - and factors internal to the individual – such as physiological tolerance. As explicitly recognized and discussed by Sweet et al. (2019), fine scale topographic and climactic data are necessary to understand how a particular species will react to climate change. The studies cited by the petition use a correlative approach that links *Y. brevifolia* distribution data to climactic and soil characteristics, and use these to project how *Y. brevifolia* will respond to future conditions (Barrows and Murphy-Mariscal 2012, Cole et al. 2011, Sweet et al. 2019). While this correlative approach can provide meaningful insight, it does not consider the physiological tolerances of *Y. brevifolia*, nor how changes in biotic communities may influence *Y. brevifolia* populations. This is an important distinction, as Pearson and Dawson (2003) state, "the species distributions as they appear today may not be in equilibrium with the current climate, nor indeed are they necessarily determined primarily by climate." Moreover, the reality of how climate change will affect ecological systems is complex and the reliability of models to estimate these effects depend on how representative the population data are over time and space. If non-random samples are taken, and if the number of samples and years of observation are limited in scope and duration, then resulting estimates are likely to be biased. Importantly, the direction of potential bias is also unknown. As such, the extrapolation of results from a limited area to the entire range of *Y. brevifolia* is biologically and statistically inappropriate for determining the range-wide effects of climate change.

5. CONCLUSION

A critical review of the Petition indicates that there is not sufficient scientific evidence to provide strong inference into either range-wide population trends or the threats that may be affecting Joshua trees. Critically, the Petition does not appropriately address this lack of evidence or provide sufficient scientific information to inform the decision of whether the species warrants listing under CESA. First, the Petition suggests that North and South *Y. brevifolia* populations are ESUs but provides no supporting evidence under the criteria required by CFDW. Second, the Petition improperly extrapolates data from Joshua Tree National Park, comprising less than 5% of the total population range, as representative of range-wide processes. This extrapolation is likely to produce spurious conclusions, as Joshua trees occur in many different habitat types across their range that may influence local survival and reproduction. For example, contrary to the overarching claim made in the Petition that populations are declining based upon patterns observed in Joshua Tree National Park, the Petition does not review the evidence that Joshua tree populations are increasing in other parts of their range. Third, the potential threats to the species are mischaracterized in the Petition and are not supported by the references cited by the Petition. The Petition also does not fully survey the literature on potential threats to *Y. brevifolia*, as studies not cited by the Petition directly contradict the conclusions therein (e.g., the potential effects of climate change based on models). Together, these issues demonstrate that the Petition does not provide sufficient scientific information to indicate that the listing of this species under CESA is warranted.

Table 1. Ecoregions occupied by Joshua tree (*Yucca brevifolia*) across range

Ecoregions shared between YUBR North and South	YUBR North	YUBR South	YUBR within JTNP	Total of Each Ecoregion Type	Percentage of YUBR Total Range
14a Eastern Mojave Basins	177,486	161,793	49,799	339,279	6.02%
14b Eastern Mojave Low Ranges and Arid Footslopes	243,139	91,484	163,617	334,623	5.93%
14f Mojave Playas	315	61,428		61,743	1.09%
14j Western Mojave Basins	120,368	2,045,394		2,165,762	38.40%
14k Western Mojave Low Ranges and Arid Footslopes	434,802	557,426		992,227	17.59%
5i Eastern Sierra Great Basin Slopes	1,912	97,773		99,685	1.77%
5j Eastern Sierra Mojavean Slopes	9,851	202,977		212,829	3.77%
Total shared Ecoregions between YUBR North and South (acres)	**987,874**	**3,218,275**		**4,206,149**	**74.57%**

Ecoregions unique to YUBR North or South	YUBR North	YUBR South	YUBR within JTNP	Total of Each Ecoregion Type	Percentage of YUBR Total Range
13ac Upper Owens Valley	46,631			46,631	0.83%
13h Lahontan and Tonopah Playas	2,439			2,439	0.04%
13u Tonopah Basin	598,194			598,194	10.61%
13v Tonopah Sagebrush Foothills	304,124			304,124	5.39%
13w Tonopah Uplands	47,055			47,055	0.83%
13x Sierra Nevada-Influenced Ranges	23,934			23,934	0.42%
13y Sierra Nevada-Influenced High Elevation Mountains	127			127	0.00%
14g Amargosa Desert	37,168			37,168	0.66%
14h Death Valley/Mojave Central Trough	2,608			2,608	0.05%
14l Western Mojave Mountain Woodland and Shrubland	40,766			40,766	0.72%
14o Mojave Sand Dunes	22			22	0.00%
14n Mojave Lava Fields		806		806	0.01%
5o Tehachapi Mountains		59,118		59,118	1.05%
8c Arid Montane Slopes		199,157		199,157	3.53%
8e Southern California Lower Montane Shrub and Woodland		8,320		8,320	0.15%
8f Southern California Montane Conifer Forest		6,094		6,094	0.11%
8g Northern Transverse Range		57,716		57,716	1.02%
Total Ecoregions unique to YUBR North or South (acres)	**1,103,069**	**331,211**	**0**	**1,434,280**	**25.43%**
Grand Total (acres)	**2,090,943**	**3,549,487**	**213,416**	**5,640,429**	

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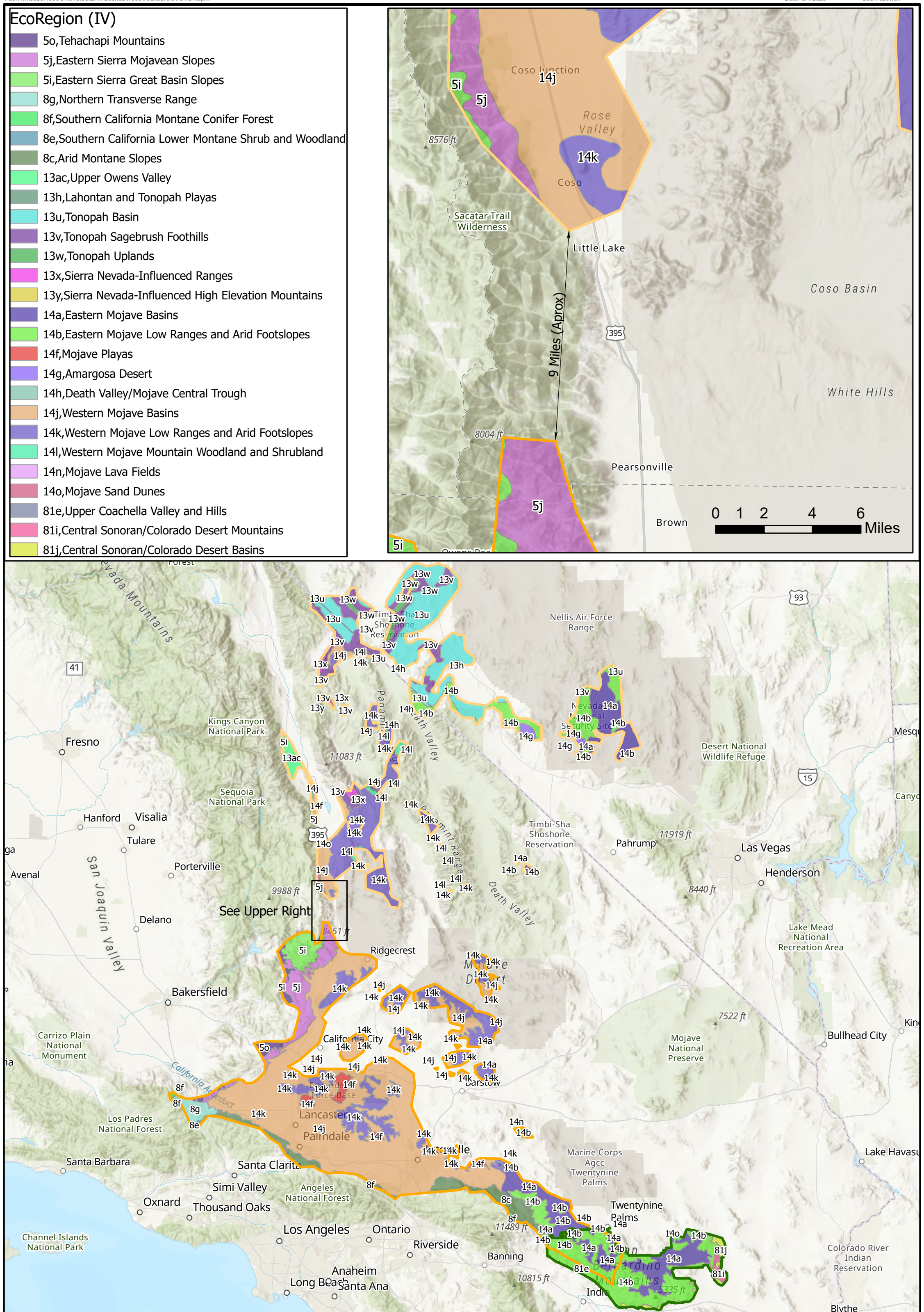
FIGURES



Data Sources: EPA (http://www.epa.gov/wed/pages/ecoregions.htm)
NPS (https://services1.arcgis.com/fBc8EJBxQRMcHlei/arcgis/rest/services/NPS_Park_Boundaries/FeatureServer)
UFWS (Digitized from PDF Report Sirchia et al 2018)
Image Source: ArcGIS Online World Topographic Map

Legend

Joshua Tree National Park

Population

YUBR North

YUBR South

N 0 15 30 Miles; 0 30 60 Kilometers

WestLand Resources

Assessment of Petition to List the Western Joshua Tree as Threatened under the California Endangered Species Act

Joshua tree (*Yucca brevifolia* or YUBR) range and ecoregions

Figure 1

APPENDIX A

Population polygons of Joshua tree (*Yucca brevifolia*) across range

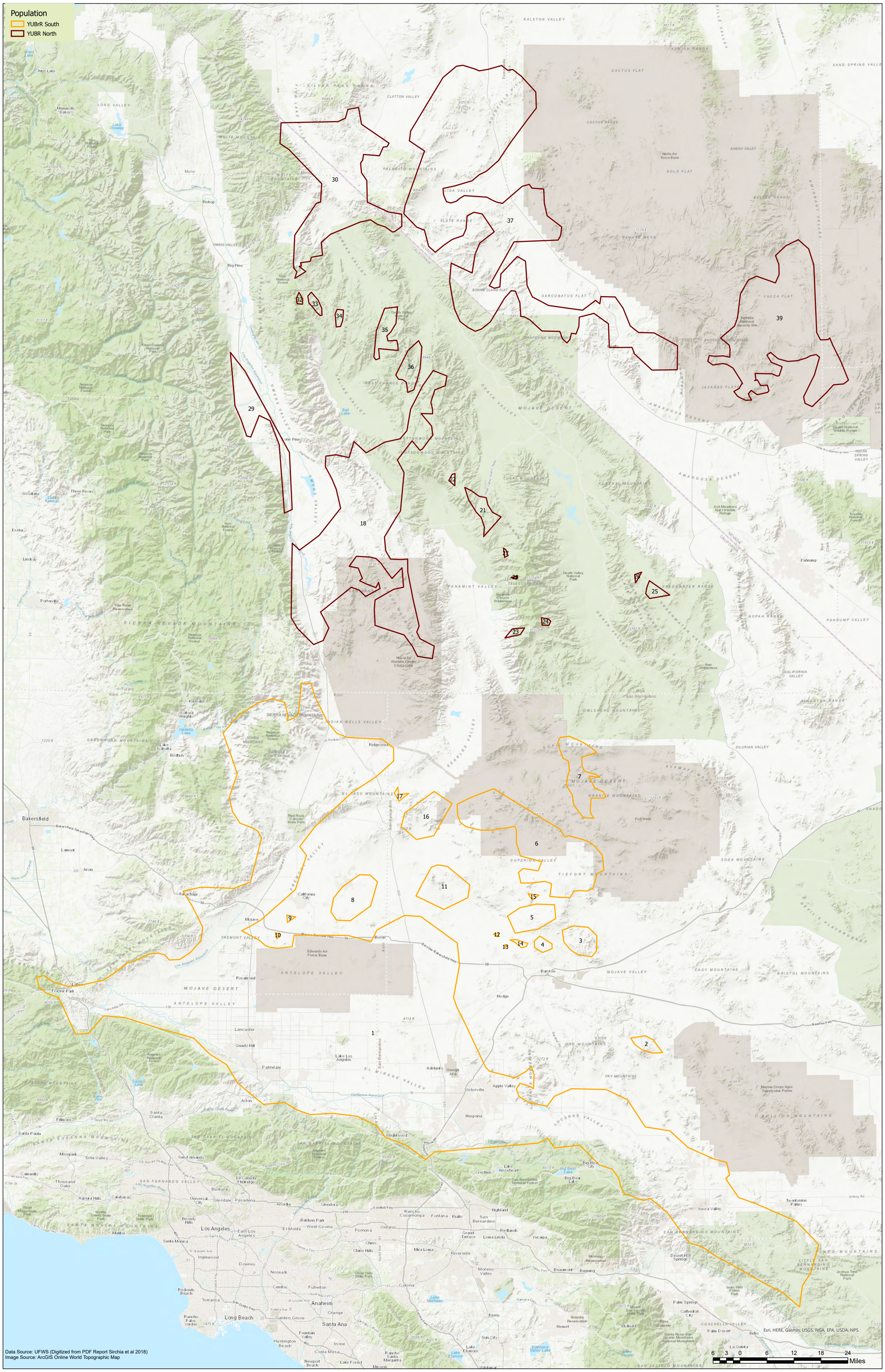

Population
YUBrR South
YUBR North
Data Source: UFWS (Digitized from PDF Report Sirchia et al 2018)
Image Source: ArcGIS Online World Topographic Map
Miles

EXHIBIT 18

ANTELOPE VALLEY HISPANIC CHAMBER OF COMMERCE

FOUNDED 1997

819 EAST AVENUE Q 9 PALMDALE CA, 93550 • 661-538-0607

WWW.AVHISPANICCHAMBER.ORG / AVHISPANICCHAMBER@GMAIL.COM

Original on file,
received August 6, 2020

August 6, 2020

Mr. Eric Sklar
President
California Fish and Wildlife Commission
P.O. Box 944209
Sacramento, CA 94244-2090

Re: Petition to List the Western Joshua Tree

Dear President Sklar,

I write in strong opposition to the petition submitted by the Center for Biological Diversity to list the western Joshua tree as a threatened species under the California Endangered Species Act. The Joshua tree already receives protections at the federal, state, and local levels. Listing the tree would add redundant protections that place a significant financial burden on private landowners while doing little to address the long-term threat to the species.

The California desert is comprised of rural, underserved communities that face economic challenges unlike other areas of our state. Listing the Joshua tree would effectively halt future development at a time when California is grappling with housing shortages and rising homelessness.

Even more troubling is the fact that the petition submitted by the Center for Biological Diversity fails to provide scientific evidence to substantiate a decline of the Joshua tree population. Instead, the petition predicts a future decline due to global climate change. The proposed listing is nothing more than a solution in search of a problem. Much of the western Joshua tree population resides on federally protected lands and state preserves, giving them the highest level of protection. Outside those jurisdictions, they are protected under state law through the California Desert Native Plants Act, which requires permitting for removal.

I urge you to consider the significant impacts this will have on rural desert communities and respectfully ask that you deny this petition.

Sincerely,

Sylvia S. Duarte
President, AV Hispanic Chamber of Commerce

c: Palmdale City Council
J.J. Murphy, Palmdale City Manager

EXHIBIT 19

Original on file,
received August 6, 2020

CUSHMAN & WAKEFIELD | PACIFIC COMMERCIAL REALTY ADVISORS

Vincent M. Roche
Executive Director/Principal
Lic. #01155079
5060 California Avenue, Suite 1000
Bakersfield, CA 93309
Direct +1 661 633 3817
Fax +1 661 633 3801
Vincent.Roche@paccra.com
www.paccra.com

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California Fish and Wildlife Commission
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I urge you to consider the significant impacts this will have on rural desert communities and respectfully ask that you deny this petition.

Sincerely,

Vincent M. Roche
Executive Director/Principal

c: Palmdale City Council
J.J. Murphy, Palmdale City Manager

EXHIBIT 20

Western Joshua Tree

(***Yucca brevifolia***)

Fish and Game Commission Meeting
August 19-20, 2020
Jeb McKay Bjerke
Native Plant Program

1

Presentation Overview

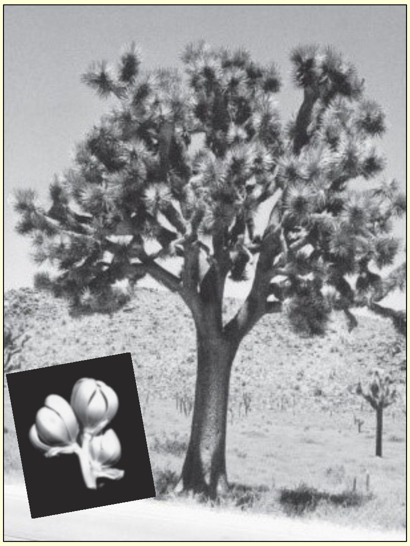
Purpose: Summarize Western Joshua Tree Petition Evaluation Report

1. Brief Species Overview
2. Information in the Petition and in the Department's Possession
3. Department Recommendation

2

2

Western Joshua Tree
Yucca brevifolia or
Yucca brevifolia var. *brevifolia*



Eastern Joshua Tree
Yucca jaegerana or
Yucca brevifolia var. *jaegerana*

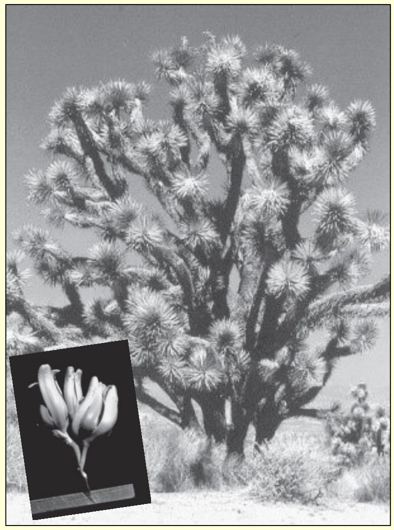


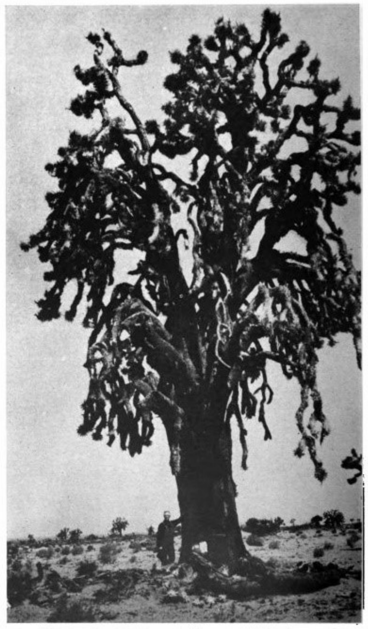
Photo Source: Lenz, L.W. 2007. Reassessment of *Yucca brevifolia* and recognition of *Y. jaegeriana* as a distinct species. Aliso: A Journal of Systematic and Evolutionary Botany 24(1):97–104. (cited in petition)

3

3

4

Agriculture Monograph 17, U. S. Department of Agriculture PLATE 15



Yucca brevifolia Engelm.: 15 miles east of Lancaster, Calif. An exceptionally fine plant. Photographed by Ernest Braunton, July 9, 1925.

5

5

6

Information In Petition

- ✓ Population Trend
- ✓ Geographic Range
- ✓ Distribution
- ✓ Abundance
- ✓ Life History
- ✓ Habitat Necessary for Survival
- ✓ Factors Affecting Survival & Reproduction
- ✓ Degree and Immediacy of Threat
- ✓ Impact of Existing Management Efforts
- ✓ Suggestions for Future Management
- ✓ Detailed Distribution Map
- ✓ Sources & Availability of Information

7

7

Other Relevant Information the Department Possessed or Received

Vegetation maps possessed by the Department

Reports from Edwards Air Force Base:

- population trend from 1992-2015
- survivorship and/or regeneration within a fire area

Comments and information from a landowner

8

8

Abundance and Population Trend

(Information from Petition)

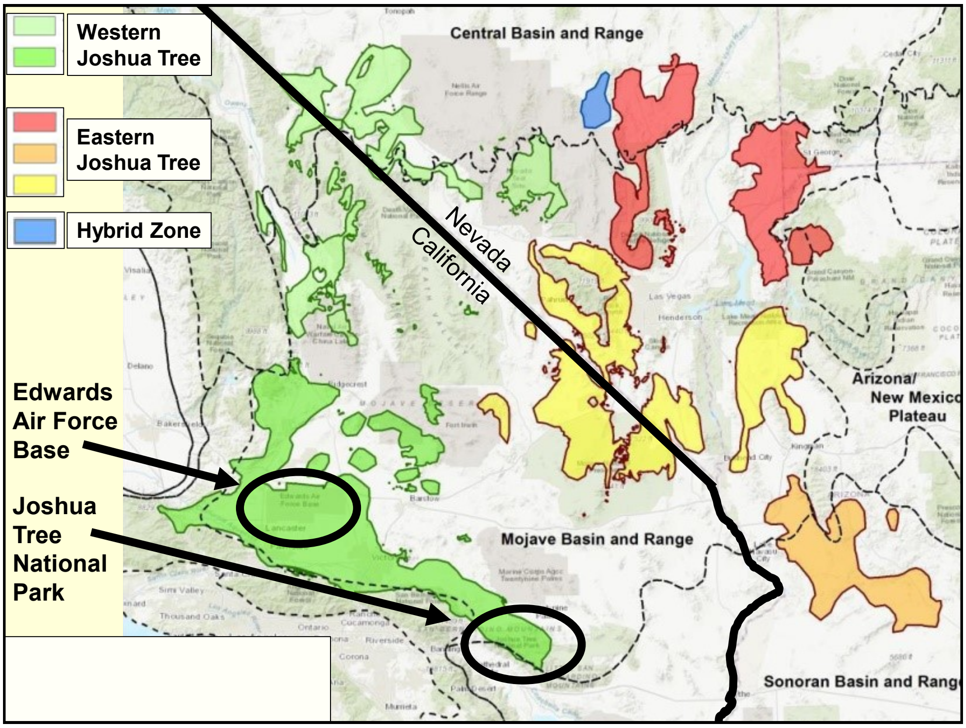
- No population size estimates
- No evidence of a range-wide population trend
- Some populations declining, particularly within Joshua Tree National Park

Abundance and Population Trend

(Additional Information in Department Possession)

- Currently relatively abundant
- Populations at Edwards Air Force Base appeared stable to increasing from 1992 to 2015

Source: U.S. Air Force. 2017. Joshua Tree Historical Status on Edwards AFB. 412th Civil Engineering Group. Environmental Management Division. Edwards Air Force Base



11

Life History

(Information from Petition)

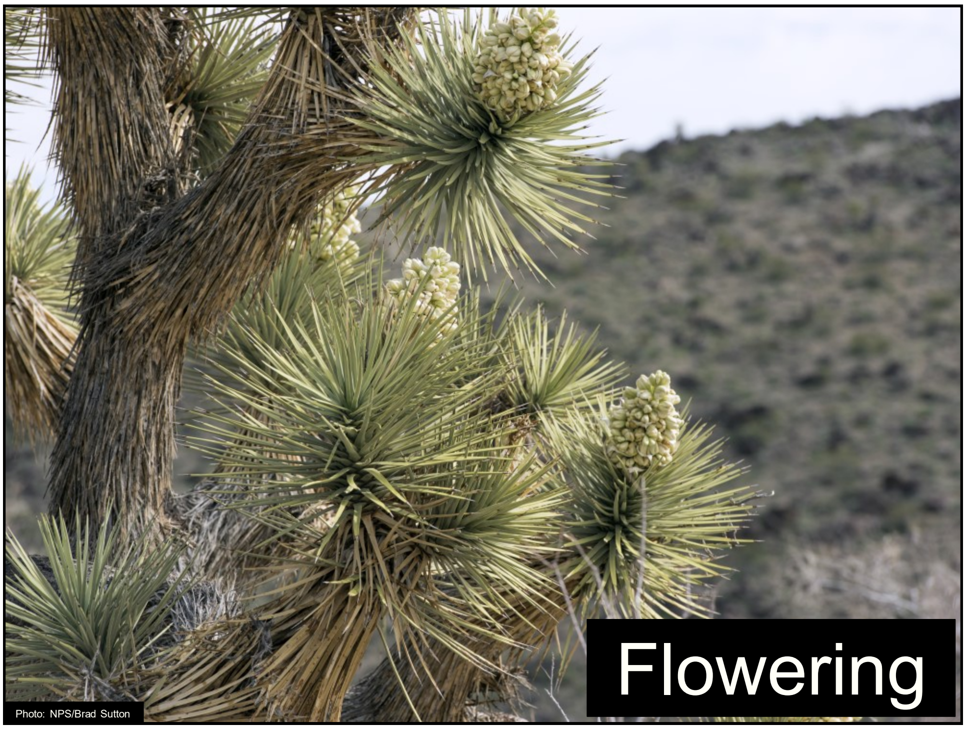
- Sexual or asexual reproduction
- Episodic and rare flowering
- Obligate pollination mutualism
- Seed production
- Germination and growth

12

12


Asexual Reproduction
Photo: Jeb Bjerke

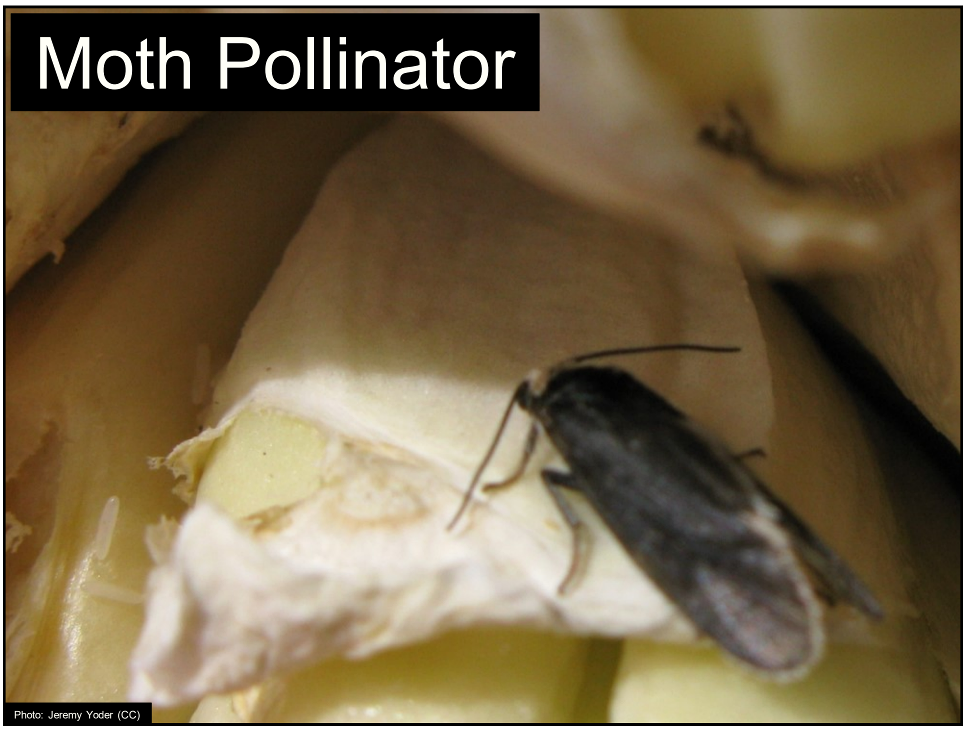
13


Flowering
Photo: NPS/Brad Sutton

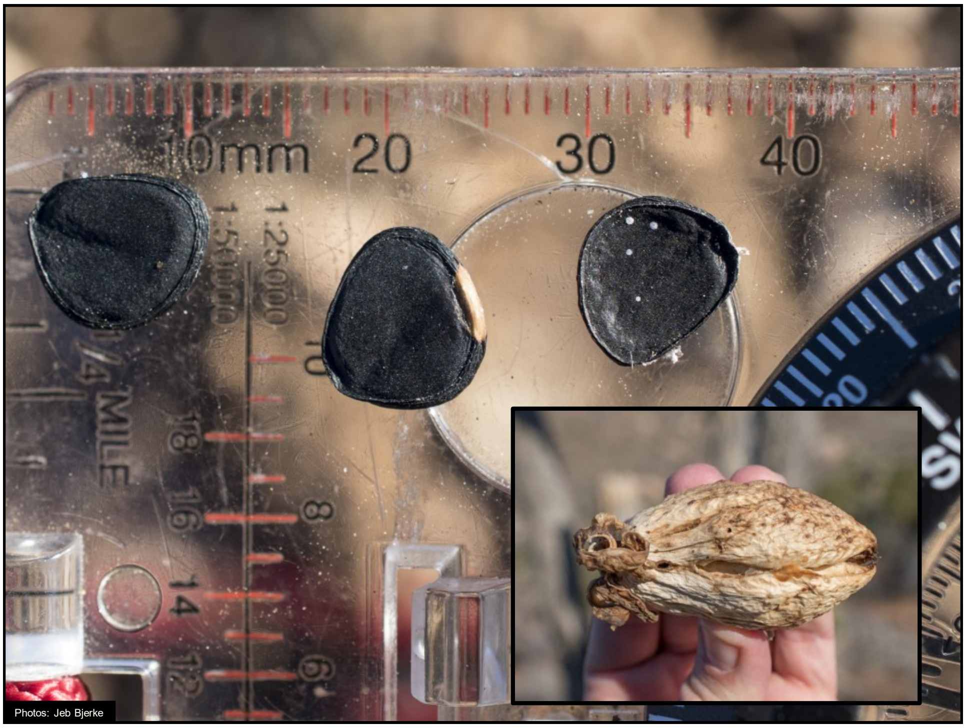
14


Photo: NPS/Robb Hannawacker

15


Moth Pollinator
Photo: Jeremy Yoder (CC)

16


10mm 20 30 40
1:25000
1:50000
1/4 MILE
Photos: Jeb Bjerke

17


Recruitment
18
Photo: NPS/Brad Sutton

18

AR 265

Habitat

(Information from Petition)

- Hot, dry sites on flats, mesas, bajadas, and gentle slopes
- Various soils
- Temperature and precipitation important
- Needs obligate pollinators, rodents, and plants to shelter emerging seedlings

19

19

20

Factors Affecting Survival & Reproduction

(Information from Petition)

- climate change
- habitat loss to human development
- invasive species
- wildfires
- predation

21

21

Factors Affecting Survival & Reproduction

(Information from Petition)

- Climate change represents the single greatest threat
- Six published models predict contractions at the western edge of its range
- Climate change contributes to other threats.

22

Models of Future Joshua Tree Distribution

Author (year)	Modeled Area	Data/Methods	Scenario	Results
Thompson et al. (1998)	Rangewide	15 km grid, temperature & precipitation, Little (1971,1976) range map	Doubled CO_2	**8-fold increase in range to north and east, range retraction in California**
Shafer et al. (2001)	Rangewide	25 km grid, 3 climate variables, Little (1971,1976) range map	2090-2099	**Increase in range to north and east, severe range retraction in California**
Dole et al. (2003)	Rangewide	10 km grid, temperature & precipitation data, Benson and Darrow (1981) range map	Doubled CO_2	**Increase in range to north and east, both contraction and expansion of range in California**
Cole et al. (2011)	Rangewide	Sophisticated model using presence/absence points from several sources, with statistical testing of the model, migration rates included, range retraction ~11,700 years ago examined	2070-2099	**Increase in range to north and east, very severe range retraction in California**
Barrows and Murphy-Mariscal (2012)	Joshua Tree National Park	Sophisticated fine-scale model using adult and juvenile presence points, adults and juveniles mapped separately to check for warming that has already occurred	+1°, +2° and +3° C warming	**Decrease but not elimination from Joshua Tree National Park (<10% remains under +3° C warming). Juvenile range already reduced ~75% from adult range**
Sweet et al. (2019)	Joshua Tree National Park	Sophisticated fine-scale model, Maxent, expanded presence point data from Barrows and Murphy-Mariscal (2012), field verification of model results at 14 macroplots	2070-2099	**Very severe range retraction in Joshua Tree National Park: almost complete elimination under current CO_2 trajectory**

23

24


Invasive Grasses
Photo: NPS/Robb Hannawacker

25


Fire
Photo: NPS

26

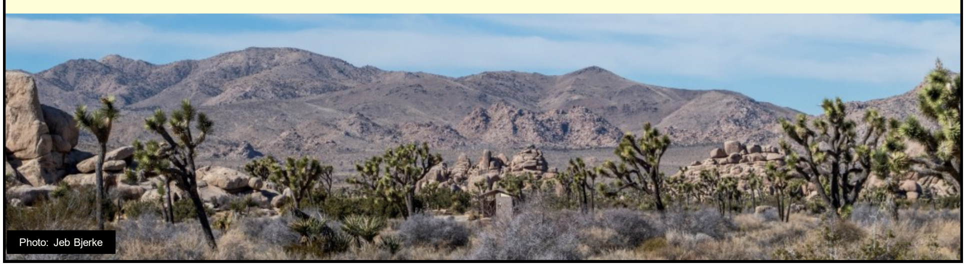
AR 269

27

Impact of Existing Management

(Information from Petition)

- Inadequate regulatory mechanisms for:
  - CO_2 emissions
  - invasive species and fire
  - habitat loss and degradation



28

Sources & Availability of Information

(Information from Petition)

100+ scientific papers and other sources

Photo: NPS/Brad Sutton

29

29

Information In Petition

- ✓ Population Trend
- ✓ Geographic Range
- ✓ Distribution
- ✓ Abundance
- ✓ Life History
- ✓ Habitat Necessary for Survival
- ✓ Factors Affecting Survival & Reproduction
- ✓ Degree and Immediacy of Threat
- ✓ Impact of Existing Management Efforts
- ✓ Suggestions for Future Management
- ✓ Detailed Distribution Map
- ✓ Sources & Availability of Information

Other Relevant Information the Department Possessed or Received

30

30

Department Recommendation

The Department recommends that the Commission find there is sufficient information to indicate that the petitioned action may be warranted, and the petition should be accepted and considered.

31

31

SUMMARY

- Information from Petition and other sources
- Climate change listed as greatest threat: 6 models project California range reduction
- Human development, invasive species and altered fire regime are additional threats
- Petition states existing regulatory mechanisms are inadequate
- Recommendation: there is sufficient information to indicate that the petitioned action may be warranted

32

32

Questions ◈ Thank You

Jeb McKay Bjerke
Senior Environmental Scientist (Specialist)
(916) 651-6594
Jeb.Bjerke@wildlife.ca.gov

33

33

EXHIBIT 21

CALIFORNIA FISH & GAME COMMISSION

AUGUST 20, 2020 HEARING

Available at:

https://cal-span.org/unipage/?site=cal-span&owner=CFG&date=2020-08-20.

[Digital copy submitted to the Court with along with the courtesy copy of the Petition]

EXHIBIT 22

CALIFORNIA FISH & GAME COMMISSION

SEPTEMBER 22, 2020 HEARING

Available at:

https://cal-span.org/unipage/?site=cal-span&owner=CFG&date=2020-09-22

[Digital copy submitted to the Court with along with the courtesy copy of the Petition]

EXHIBIT 23

GAVIN NEWSOM, GOVERNOR OFFICE OF ADMINISTRATIVE LAW

California Regulatory Notice Register

REGISTER 2020, NUMBER 41-Z PUBLISHED WEEKLY BY THE OFFICE OF ADMINISTRATIVE LAW OCTOBER 9, 2020

PROPOSED ACTION ON REGULATIONS

GENERAL PUBLIC INTEREST

(Continued on next page)

Time-Dated Material

PROPOSITION 65

RULEMAKING PETITIONS DECISION

SUMMARY OF REGULATORY ACTIONS

The *California Regulatory Notice Register* is an official state publication of the Office of Administrative Law containing notices of proposed regulatory actions by state regulatory agencies to adopt, amend or repeal regulations contained in the California Code of Regulations. The effective period of a notice of proposed regulatory action by a state agency in the *California Regulatory Notice Register* shall not exceed one year [Government Code § 11346.4(b)]. It is suggested, therefore, that issues of the *California Regulatory Notice Register* be retained for a minimum of 18 months.

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subdivision (d). If CDFW determines the project is complete, the District will not be required to obtain an incidental take permit under Fish and Game Code section 2081 subdivision (b) or a Lake or Streambed Alteration Agreement under Fish and Game Code section 1605 for the proposed project.

In accordance with Fish and Game Code section 1653 subdivision (e), if CDFW determines during the review, based on substantial evidence, that the request is not complete, Trout Unlimited, Inc. will have the opportunity to submit under Fish and Game Code section 1652.

FISH AND GAME COMMISSION

NOTICE OF FINDINGS
Western Joshua Tree
(*Yucca brevifolia*)

NOTICE IS HEREBY GIVEN that, pursuant to the provisions of Section 2074.2 of the Fish and Game Code, the California Fish and Game Commission (Commission), at its September 22, 2020 meeting, accepted for consideration the petition submitted to list the western Joshua tree (*Yucca brevifolia*) as threatened or endangered under the California Endangered Species Act.

Pursuant to subdivision (e)(2) of Section 2074.2 of the Fish and Game Code, the Commission determined that the amount of information contained in the petition, when considered in light of the California Department of Fish and Wildlife's (Department) written evaluation report, the comments received, and the remainder of the administrative record, would lead a reasonable person to conclude there is a substantial possibility the requested listing could occur.

Based on that finding and the acceptance of the petition, the Commission is also providing notice that the western Joshua tree is a candidate species as defined by Section 2068 of the Fish and Game Code.

Within one year of the date of publication of this notice of findings, the Department shall submit a written report, pursuant to Section 2074.6 of the Fish and Game Code, indicating whether the petitioned action is warranted. Copies of the petition, as well as minutes of the September 22, 2020 Commission meeting, are on file and available for public review from Melissa Miller–Henson, Executive Director, California Fish and Game Commission, 1416 Ninth Street, Suite 1320, Sacramento, California 95814, phone (916) 653–4899.

Written comments or data related to the petitioned action should be directed to the California Department of Fish and Wildlife, P.O. Box 944209, Sacramento, CA 94244–2090, Attn: Jeb Bjerke or email nativeplants@wildlife.ca.gov (include "Western Joshua Tree) in the subject line. Submission of information via email is preferred.

PROPOSITION 65

OFFICE OF ENVIRONMENTAL HEALTH HAZARD ASSESSMENT

SAFE DRINKING WATER AND TOXIC ENFORCEMENT ACT OF 1986

NOTICE OF INTENT TO LIST CHEMICALS BY THE LABOR CODE MECHANISM: MOLYBDENUM TRIOXIDE INDIUM TIN OXIDE

The California Environmental Protection Agency's Office of Environmental Health Hazard Assessment (OEHHA) intends to list the following chemicals as known to the state to cause cancer under the Safe Drinking Water and Toxic Enforcement Act of 1986 (Proposition 65[1]): molybdenum trioxide (CAS No. 1313–27–5) and indium tin oxide (CAS No. 50926–11–9). This action is being proposed pursuant to the "Labor Code" listing mechanism[2]. OEHHA has determined that each of these substances meets the criteria for listing by this mechanism.

Background on listing by the Labor Code mechanism: Health and Safety Code section 25249.8(a) incorporates California Labor Code section 6382(b)(1) into Proposition 65. The law requires that certain substances identified by the International Agency for Research on Cancer (IARC) be listed as known to cause cancer under Proposition 65. Labor Code section 6382(b)(1) refers to substances identified as human or animal carcinogens by IARC. OEHHA has adopted regulations concerning these listings in Title 27, Cal. Code of Regs., section 25904. As the lead agency for the implementation of Proposition 65, OEHHA evaluates whether a chemical's listing is required.

OEHHA's determination: *Molybdenum trioxide* and *indium tin oxide* meet the requirements for listing as known to the state to cause cancer for purposes of Proposition 65.

IARC has published on its website "IARC Monographs on the Evaluation of Carcinogenic Risks to Humans, Volume 118. Welding, *Molybdenum Trioxide*, and *Indium Tin Oxide*." (IARC 2018). IARC concludes that molybdenum trioxide and indium tin

[1] Health and Safety Code section 25249.5 et seq.
[2] Health and Safety Code section 25249.8(a) and Title 27, Cal. Code of Regs., section 25904.

EXHIBIT 24

American Journal of Botany 97(2): 243–250. 2010.

Desert wildfire and severe drought diminish survivorship of the long-lived Joshua tree (*Yucca brevifolia*; Agavaceae)[1]

Lesley A. DeFalco[2,4], Todd C. Esque[2], Sara J. Scoles-Sciulla[2], and Jane Rodgers[3]

[2]U.S. Geological Survey, Western Ecological Research Center, 160 N. Stephanie Street, Henderson, Nevada 89074 USA; and
[3]U.S. National Park Service, Grand Canyon National Park, 823 San Francisco Street, Suite F, Flagstaff, Arizona 86001 USA

Extreme climate events are transforming plant communities in the desert Southwest of the United States. Abundant precipitation in 1998 associated with El Niño Southern Oscillation (ENSO) stimulated exceptional alien annual plant production in the Mojave Desert that fueled wildfires in 1999. Exacerbated by protracted drought, 80% of the burned *Yucca brevifolia*, a long-lived arborescent monocot, and 26% of unburned plants died at Joshua Tree National Park by 2004. Many burned plants <1 m tall died immediately, and survival of all but the tallest, oldest plants declined to the same low level by 2004. Postfire sprouting prolonged survival, but only at the wetter, high-elevation sites. During succeeding dry years, herbaceous plants were scarce, and individuals of *Thomomys bottae* (pocket gopher) gnawed the periderm and hollowed stems of *Y. brevifolia* causing many of them to topple. *Thomomys bottae* damage reduced plant survivorship at low-elevation, unburned sites and diminished survival of burned plants in all but the driest site, which already had low survival. Accentuated ENSO episodes and more frequent wildfires are expected for the desert Southwest and will likely shift *Y. brevifolia* population structure toward tall, old adults with fewer opportunities for plant recruitment, thus imperiling the persistence of this unique plant community.

Key words: Agavaceae; climate change; El Niño Southern Oscillation; herbivory; invasive alien annuals; Mojave Desert; pocket gophers; *Thomomys bottae*; *Yucca brevifolia*.

Pronounced El Niño Southern Oscillation (ENSO) episodes in western North America have drawn recent attention to the role of extreme climate events in shaping arid plant communities. Rapid growth and abundant biomass of Eurasian annual grasses including *Bromus tectorum*, *B. madritensis* subsp. *rubens*, and *Schismus* spp. are associated with heavy winter and spring precipitation that typically falls during El Niño phases in North American warm deserts (Hunter, 1991; Esque and Schwalbe, 2002; Salo, 2002; Brooks and Matchett, 2006). Shoots of these alien annual grasses senesce and persist during the succeeding dry La Niña phases and provide the continuity between sparsely distributed shrubs for sustaining wildfire. Few native perennials in Mojave Desert shrublands resprout in response to scorching or burning of aboveground tissues, and survival is typically low (O'Leary and Minnich, 1981; Brown and Minnich, 1986; Loik et al., 2000a). The accentuated amplitude of ENSO events in recent decades (Allan and Soden, 2008) and the rapid transition from wet to dry years during El Niño and La Niña phases has enhanced the frequency and size of wildfires in the American Southwest (Swetnam and Betancourt, 1990, 1998; Littell et al., 2009). Despite the prominent impacts to desert shrublands, the long-term consequences of wildfire on stand-level structure of desert plants in combination with greater prevalence of predicted climate extremes are unknown for the North American desert region.

The ENSO cycle not only predisposes the Southwest desert region to wildfires, but also to extreme drought events that may have a profound impact on population structure and community dynamics of long-lived desert plant species. Droughts lasting several years can selectively remove the most common perennial species from desert plant communities (Webb et al., 2003; Hereford et al., 2006; Miriti et al., 2007). Many of these perennial plants influence the availability of food, cover, and structure for a variety of small desert animals; therefore, attrition of selective sizes of these perennial plants may have cascading effects on desert plant stand structure and their associated animal communities (Brown et al., 1997). As food resources decline, shifts in diet, and intensified use of limited available resources may result in further declines of adult perennial plants and hinder seedling establishment, but this dynamic has not been well documented for desert regions.

Yucca brevifolia Engelm. (Joshua tree) is a slow-growing, long-lived endemic of the Mojave Desert (Comanor and Clark, 2000; Gilliland et al., 2006) and can vigorously resprout after disturbances such as wildfire (Webber, 1953; Vogl, 1968; Conrad, 1987; Loik et al., 2000a; USDA, 2002). Although the long-term effects of wildfire on population structure of *Y. brevifolia* are unknown, recent studies indicate that a large proportion of *Y. brevifolia* populations die after fire, yet resprouting may be a

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[4] Author for correspondence (e-mail: Lesley_DeFalco@usgs.gov)

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more rapid means of establishing reproductive adults than postfire recruitment (Minnich, 1995; Loik et al., 2000a). Fueled by a continuous stand of annual plants resulting from above-average rainfall in 1998, the Juniper Fire Complex spread across nearly 5700 ha in Joshua Tree National Park in May 1999. This wildfire provided an opportunity to examine the long-term effects of alien-grass-fueled fires on *Y. brevifolia* ecology and population dynamics. In this study, we monitored attrition of *Y. brevifolia* during the 5 yr following this moderate-intensity fire and examined how climate variability interacts with sprouting and herbivory to impact short-term survival of this desert icon.

MATERIALS AND METHODS

Site selection—Ten months after the fire, study sites were randomly selected within burned and adjacent unburned areas in Joshua Tree National Park using a Geographic Information System (Fig. 1). We selected burned and unburned areas at five sites with similar slopes, exposures, and soils, but they differed in elevation. Adjacent burned and unburned areas were typically separated by a road such that the fire was stopped arbitrarily and not by biological or edaphic factors. We characterized the temporal and spatial patterns in precipitation for each site using the PRISM Climate Mapping Program (PRISM Group, Oregon State University, http://www.prismclimate.org, created 24 September 2008).

Sampling design—We randomly selected four to five 300–600-m point-centered quarter line transects within paired burned and unburned areas at the five sites for a total of 46 transects (Brower et al., 1998). Each transect had sampling points at 100 m intervals so that *Y. brevifolia* plants selected for the study did not overlap between adjacent points. At each sampling point, the closest *Y. brevifolia* within each of four quadrants (NE, SE, SW, and NW) was marked with a numbered aluminum tag attached to the trunk at a height of 1 m. For plants <1 m tall, we attached tags with wire wrapped loosely around the stem. When the closest plant in a quadrant was dead, it was tagged and measured, but the next-closest live plant in that quadrant was also marked so we would have a robust sample size to monitor the effects of fire after the initial loss of plants. In addition, if the plant selected in a burned quadrant was <1 m tall, the second-closest live plant in that quadrant was also marked in anticipation of greater attrition in this smaller size class. These additional tagged plants were important for long-term monitoring of the population because nearly 40% of burned plants <1 m tall appeared dead at the initial sampling date. We assumed all scorched plants selected and tagged on burned plots were alive at the time of the fire; plants presumed to be dead before the fire burned completely so that only their ash silhouettes remained on the ground surface.

Assessment of survival for* Y. brevifolia *that sprouted or sustained herbivore damage—For each tagged *Y. brevifolia*, we first determined whether the plant was alive or dead. A plant was considered dead when no green leaf blades were found on any leaf axil and green sprouts were absent from the stem and the root crown. Two to three observers visually estimated and averaged among them the scorch damage for *Y. brevifolia* plants in burned areas as a percentage of total aboveground plant surface area blackened by the fire. For burned and unburned plants, height was measured from ground level using a telescoping fiberglass rod graduated in cm. Live and dead root and stem sprouts were counted separately, and damage by herbivores was noted. Tissue damage by *Thomomys bottae* (pocket gopher) predominated, although damage by other herbivores (e.g., lagomorphidae or sciuridae) was also noted. *Thomomys bottae* damage was easily identified when subterranean burrows extended into the inner portions of *Y. brevifolia* stems and soil was backfilled into scarred parts of the plant. This tissue damage often weakened the *Y. brevifolia* stem resulting in the plant toppling to the ground.

Data analysis—We used the LIFEREG procedure in SAS (SAS Institute, SAS version 9.1.3. Cary, North Carolina, USA) to compare the declining survivor functions (Allison, 1995), which characterized the probability of survival during the 5 yr following the fire. Before we conducted each survival analysis, we used LIFEREG to select the appropriate model fit among the exponential, Weibull, gamma, log-normal, and log-logistic distributions based on log-likelihood. Then we tested the differences in survivor functions using Wald's χ^2. We first compared survivor functions between burned and unburned plants (Burn), among sites (Site), and among the different sizes of *Y. brevifolia* (Height) as well as the two-way interactions. Survivor functions for plants with different degrees of scorching (Scorch) were also compared for burned plants only. We then compared survivor functions between *Y. brevifolia* with and without sprouts (Sprout), among sites, and the two-way interaction in separate burned and unburned analyses. Finally, we compared survivor functions between *Y. brevifolia* with and without *T. bottae* damage (Damage), among sites, and the interaction to examine the influence of herbivory on survival in the separate burned and unburned areas.

RESULTS

Study sites—The Mile Marker 21, Cap Rock, and Lost Horse sites occur at lower elevation and generally received less precipitation than the Upper and Lower Covington Flats sites during the study (Fig. 2). Above-average precipitation occurred at all sites in September 1997 and the following February and May 1998. The subsequent dry period that lasted from September 1998 through March 1999 produced conditions that led to the Juniper Fire Complex in May 1999. Below-average rainfall generally prevailed the succeeding 19 mo except for heavy summer monsoon activity in July 1999 and August 2000 and average precipitation that fell in February 2000 at high-elevation sites. Average precipitation returned to high-elevation sites and partially to low-elevation sites in January and February 2001 but was immediately followed by a protracted drought period that lasted through January 2003. Precipitation during the remainder of the study period generally rebounded to average levels with pulses and deficits occurring during summer monsoonal periods and winter months, respectively.

***Survival of burned* Y. brevifolia**—Survival of burned *Y. brevifolia* at the lowest elevation site, Mile Marker 21, declined at a greater rate relative to unburned controls than burned plants at high-elevation sites (Burn × Site, $\chi^2 = 20.1$, $p < 0.01$). By the spring 2004 census, the average survival for burned plants was 20% compared with 74% for unburned plants (Burn, $\chi^2 = 349.7$, $p < 0.01$). Plants that sustained more than 30% scorch damage had lower than 30% survival by 2004 (Scorch, $\chi^2 = 77.1$, $p < 0.01$; Fig. 3). Survivor functions for the different scorch damage classes did not differ among sites (Scorch × Site, $\chi^2 = 37.0$, $p = 0.56$).

Survival of the larger unburned plants declined more slowly than smaller plants during the 5-yr study, but immediate declines in survival were striking for all sizes of burned *Y. brevifolia* (Burn × Height, $\chi^2 = 8.7$, $p = 0.07$; Fig. 4). In unburned areas, slow declines in the smallest *Y. brevifolia* were detected by the 2001 census following two consecutive dry years. Declining survival of the intermediate (1 m to <3 m) and tallest (3 m and greater) unburned plants was detected at 4 and 5 years, respectively. In contrast, survival of small burned *Y. brevifolia* dropped the first year after the fire and steadily declined during each census. Survival for all sizes of burned *Y. brevifolia* declined uniformly to the lowest survival probability of approximately 20% after 5 yr except for the tallest plants that declined to 30%.

***Survival of sprouting* Y. brevifolia**—Most *Y. brevifolia* did not produce sprouts (Table 1), but of those that did, more were burned (33%) than unburned (15%). Unburned plants at the high-elevation Upper Covington Flat site maintained high survival regardless of whether they sprouted; at the lower elevation Lost Horse and Cap Rock sites, unburned plants with

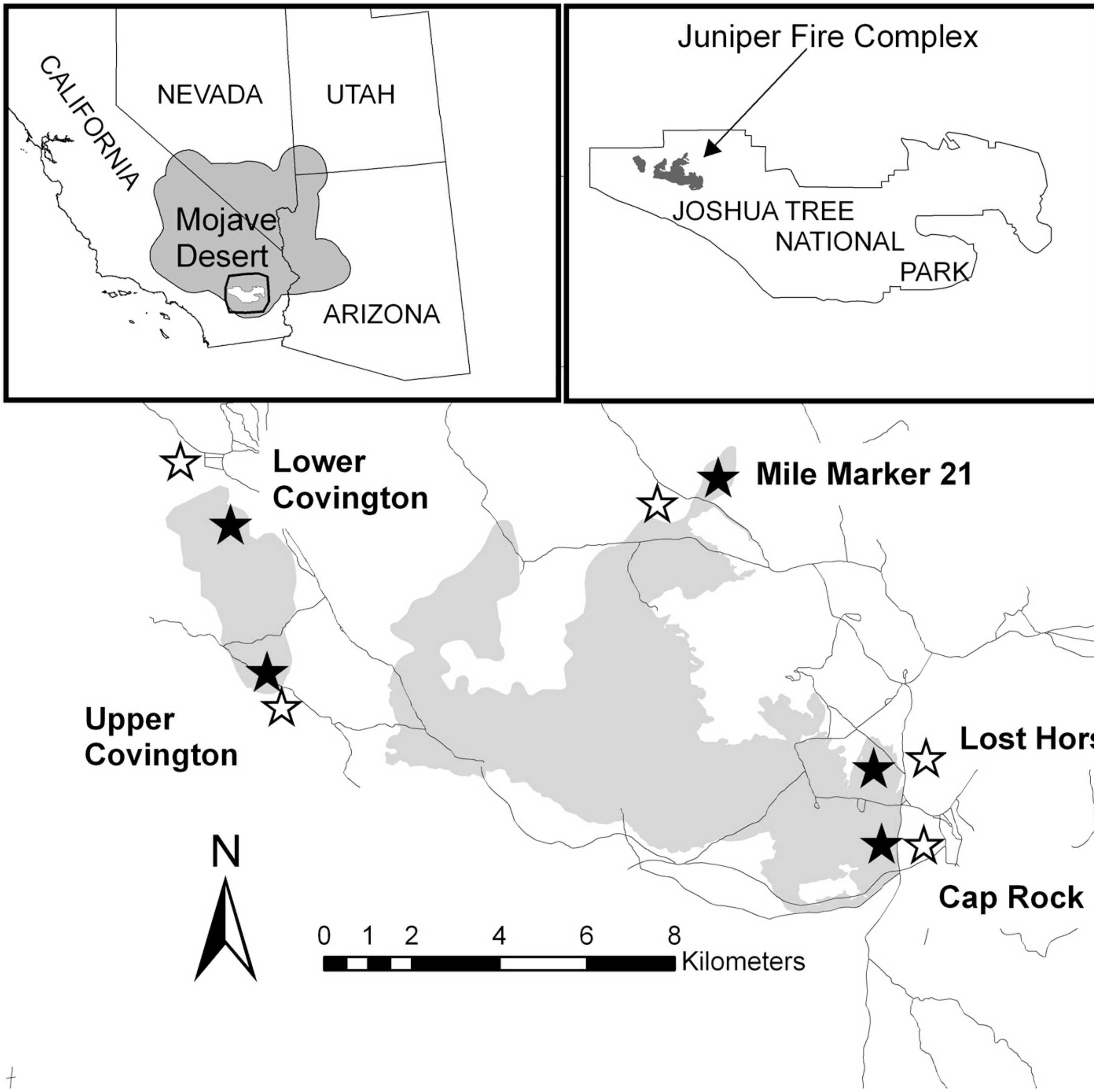

Fig. 1. Five study areas within the Juniper Fire Complex at Joshua Tree National Park, California. Each site contains replicated transects within adjacent burned (black stars) and unburned areas (clear stars).

sprouts had higher survival after 5 yr than those without sprouts (Sprout × Site, $\chi^2 = 16.4$, $p < 0.01$, Fig. 5A). Surprisingly, survival of unburned *Y. brevifolia* that sprouted at the Lower Covington Flat and Mile Marker 21 sites declined more dramatically than plants without sprouts (Fig. 5A). Alternatively, sprouting generally prolonged survival for burned *Y. brevifolia* (Sprout, $\chi^2 = 2265.1$, $p < 0.01$, Fig. 5B). While the survival of *Y. brevifolia* that sprouted in burned areas of the Upper and Lower Covington Flats sites declined much more slowly than those without sprouts, *Y. brevifolia* survival at the lower elevation sites converged at the same low level by year 5 (Sprout × Site, $\chi^2 = 107.6$, $p < 0.01$).

***Survival of* Y. brevifolia *damaged by* T. bottae**—Damage to the stems of *Y. brevifolia* was the most dramatic form of herbivory observed, although damage to periderm on the lower stems of *Y. brevifolia* by *Lepus californicus* (jackrabbit) and *Neotoma* spp. (woodrat) was also confirmed from tooth patterns. The majority of *Y. brevifolia* did not have *T. bottae* damage in unburned (86%) and burned areas (72%). In addition, damage to *Y. brevifolia* occurred predominantly at the low-elevation sites and was virtually absent from Lower and Upper Covington Flats (Table 1). Damaged *Y. brevifolia* plants in these unburned, low-elevation sites had slightly lower survival

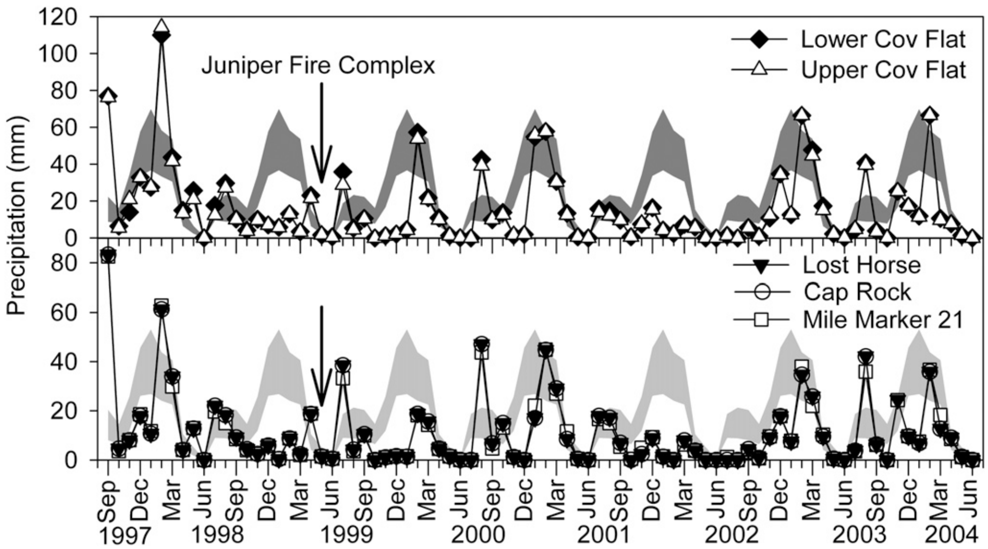

Fig. 2. Monthly precipitation for higher-elevation Lower Covington (1502 m a.s.l.) and Upper Covington (1307 m) sites (upper panel), and lower-elevation Lost Horse (1286 m), Cap Rock (1286 m), and Mile Marker 21 (1232 m) study sites (lower panel) at Joshua Tree National Park. The 95% confidence interval around the 1935–1995 seasonal averages for upper elevation (dark gray shading) and lower elevation (light gray shading) were derived from the Lower Covington Flat and Mile Marker 21 sites, respectively. Arrow denotes occurrence of May 1999 Juniper Fire Complex. Elevation and monthly precipitation were derived from the PRISM Climate Mapping Program, Oregon State University (http://www.prismclimate.org).

than undamaged plants (Damage, $\chi^2 = 3.1$, $p = 0.07$, Fig. 6A). In the burned areas, survival declined rapidly for animal-damaged *Y. brevifolia* at low-elevation Cap Rock and Lost Horse sites but was similar between damaged and undamaged plants at Mile Marker 21 where survival for these plants declined early to the same low level (Damage × Site, $\chi^2 = 11.3$, $p = 0.01$, Fig. 6B).

DISCUSSION

***Low survival of burned* Y. brevifolia**—Five years after the Juniper Fire Complex of May 1999, approximately 80% of burned *Y. brevifolia* died compared with 26% in adjacent unburned sites. This high postfire mortality of *Y. brevifolia* is consistent with other studies including 90% mortality six years after a 1978 fire in Lower Covington Flat at Joshua Tree National Park (Allison, 1984) and 64–95% mortality at sites censused 1 to 47 yr after fires in Mojave and Sonoran deserts of California (Minnich, 1995). Declining survival during the first year is attributed to immediate losses of small *Y. brevifolia* (<1 m tall) whose active meristems close to the ground are vulnerable to extreme fire temperatures and flames that consume whole plants (Brooks, 2002; Esque, 2004). As they age and grow taller, *Y. brevifolia* shed leaves from the trunk and are less likely to burn, unlike younger plants whose aging leaves are still attached and provide ladder fuel (T. C. Esque, personal observation). Thus, taller plants likely sustained less proportional burn injury to the outer periderm tissue during the fire, and steep declines in this size class occurred only after the consecutive dry periods that began in the autumn months during 1999 and 2000. Furthermore, the slower decline in survival for burned *Y. brevifolia* at the more mesic, high-elevation sites underscores the importance of postfire climate conditions on defining the demographic structure of recovering *Y. brevifolia* populations.

Low survival of* Y. brevifolia *exacerbated by drought—Mortality of more than one-quarter of the unburned *Y. brevifolia* during the 5-yr duration of this study demonstrates how even in the absence of wildfire, drought is changing the demography of long-lived species within the desert Southwest. Survival of unburned *Y. brevifolia* <1 m tall diverged from other size classes in 2001 after 2 yr of low autumn through spring precipitation. Deficits of precipitation that continued into 2003 reduced survival of plants in the middle size classes (1 m to <3 m tall) as well as the largest plants by 2004; thus, even the oldest adult *Y. brevifolia* were susceptible to prolonged drought.

The recent drought that persisted for several years throughout western North America (Cook et al., 2004) caused widespread mortality of other desert species including *Ambrosia dumosa*, *Sphaeralcea ambigua*, and *Eriogonum fasciculatum* in the Colorado Desert (Miriti et al., 2007); *A. dumosa* and *Larrea tridentata* in the eastern Mojave Desert (Hamerlynck and McAuliffe,

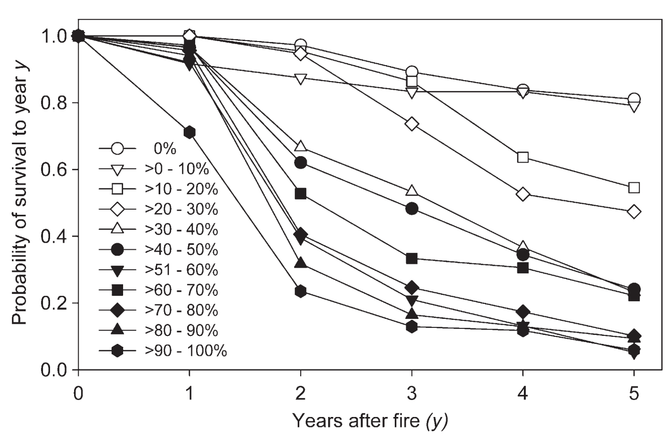

Fig. 3. Estimated survivorship functions for burned *Yucca brevifolia* that sustained different percentages of scorching of aboveground tissue at Joshua Tree National Park 5 yr after the Juniper Fire (year 0 = May 1999). Analysis included 559 *Y. brevifolia*.

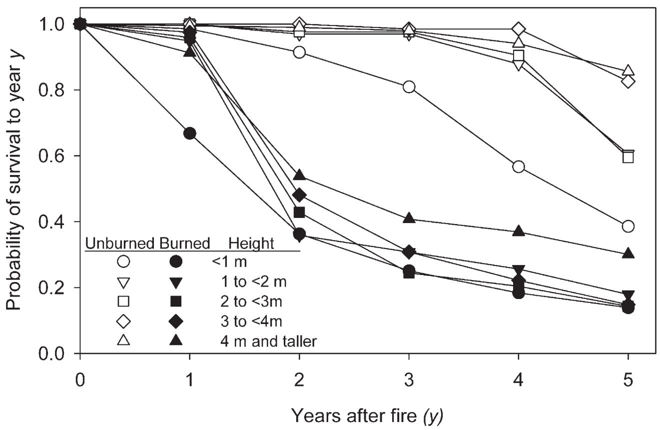

Fig. 4. Estimated survivorship functions for unburned (open symbols) and burned (black symbols) *Yucca brevifolia* at Joshua Tree National Park 5 yr following the Juniper Fire (year 0 = May 1999). Analysis included 1154 *Y. brevifolia*.

2008); and *Cercidium microphyllum*, *A. dumosa*, *L. tridentata*, *Encelia farinosa*, and *Krameria grayi* in the northern Sonoran Desert (Bowers and Turner, 2001; Bowers, 2005). Indeed, episodic mortality during past decades and centuries indicates that extremes in precipitation have altered plant composition and stand age structure in North American warm deserts (Turner, 1990; Pierson and Turner, 1998; Hereford et al., 2006). However, predicted changes in the regional climate present novel threats to these desert plant communities. We expect that the greater frequency and amplitude of the rapid switches between El Niño wet phases that promote alien annual plant production followed by dry La Niña phases (McCabe et al., 2004; IPCC, 2007; Seager et al., 2007; Allan and Soden, 2008) will continue to promote desert wildfires that injure and kill all size classes of *Y. brevifolia*. Future ENSO periods will likely favor a demographic shift toward taller, older *Y. brevifolia* populations. These shifts in stand structure due to drought- and fire-induced losses of smaller *Y. brevifolia* may prevail over plant responses that enhance survival such as freezing tolerance that facilitates plant migration as atmospheric CO_2 concentrations increase (Huxman et al., 1998; Loik et al., 2000b; Dole et al., 2003). Furthermore, given that the recruitment of *Y. brevifolia* seedlings is phenomenologically linked to the canopies of perennial shrubs and grasses during high precipitation years (Brittingham and Walker, 2000), greater frequency of recruitment failure on postfire landscapes will be detrimental to aging *Y. brevifolia* populations in the future.

***Herbivore-induced losses of* Y. brevifolia**—The loss of *Y. brevifolia* was not only amplified by the lack of precipitation following the wildfire but also by herbivores that damaged burned plants. Herbaceous annual plants were scarce during the growing season following the 1999 fire, and many perennials were dormant due to low autumn through spring precipitation that triggers germination and breaks leaf dormancy (Went, 1948; Beatley, 1974). Widespread incidence of tissue damage by *T. bottae* in burned areas implies that the roots and periderm of *Y. brevifolia* that did not die immediately in the fire offered an alternative succulent food source in denuded areas where shrubs and grasses were incinerated. We did not monitor densities of *T. bottae* among the sites during this study, so we cannot eliminate the possibility that higher densities of *T. bottae* that may have occurred at low-elevation, burned sites were responsible for greater *Y. brevifolia* mortality. Similar to our results, the shift from wet to dry ENSO periods has caused herbivore-mediated plant mortality in other systems: bromeliads were eaten by frugivorous collared peccaries during fruit shortages on Barro Colorado Island, Panama (Ticktin, 2003), bush lupines in coastal California were eaten by herbivorous moths after nematode predation on moths declined (Preisser and Strong, 2004), and mesquite tree establishment in north central Chile was hindered by prevalence of exotic herbivores (Holmgren et al., 2006). Thus, *Y. brevifolia* mortality as a consequence of a switch in *T. bottae* diet driven by a shortage of herbaceous plants in 2000 is a compelling hypothesis that requires further investigation.

Sprouting in* Y. brevifolia *does not always ensure survival—In our study, 33% of *Y. brevifolia* that were censused in burned areas sprouted from the root crown or stem after the fire compared with 15% in unburned areas. One year after a 1978 fire in Covington Flats, Allison (1984) found 25% of the *Y. brevifolia* sprouting from the root crown, and Loik et al. (2000a) observed 30% of plants sprouting from the root crown or the stem one year after a 1995 fire in Lower Covington Flats. In unburned areas, survival of *Y. brevifolia* was enhanced by sprouting at the low-elevation sites, Cap Rock and Lost Horse, while survival of the higher-elevation Upper Covington Flat site remained high regardless of sprouting. Sprouting, in response to the combination of shallow soils or substrate instability and low-level disturbances such as high winds, has been demonstrated to extend the life span of individuals of other species (Del Tredici, 2001). Accordingly, we considered that *Y. brevifolia* that sprout after burn injury are able to quickly re-establish as reproductive adults and thereby circumvent the challenges of plant establishment during seed dispersal, seed

Table 1. Number of *Yucca brevifolia* with and without new leaf sprouts and with and without *Thomomys bottae* damage during the study. Percentage of population by site and burn area are shown in parentheses. Some *Y. brevifolia* could not be found for assessment of sprouts in some years; thus, table values reflect only the *Y. brevifolia* that could be definitely assessed out of the total number of plants in the study (i.e., 14% of unburned and 2% burned *Y. brevifolia* could not be found in all years for assessment of sprouts and were omitted for the sprout analysis).

	Unburned		Burn		Unburned		Burn	
Site	No sprouts	Sprouts	No sprouts	Sprouts	No damage	Damage	No damage	Damage
Mile Marker 21	64 (51)	13 (10)	106 (81)	19 (15)	90 (72)	35 (28)	75 (57)	56 (43)
Cap Rock	99 (80)	19 (15)	90 (67)	43 (32)	107 (86)	17 (14)	91 (67)	44 (33)
Lost Horse	105 (88)	12 (10)	79 (58)	55 (40)	96 (80)	24 (20)	80 (58)	57 (42)
Upper Cov Flat	65 (67)	25 (26)	55 (64)	28 (33)	97 (100)	0 (0)	86 (100)	0 (0)
Lower Cov Flat	59 (66)	16 (18)	59 (54)	50 (46)	90 (100)	0 (0)	96 (88)	13 (12)
Total	392 (71)	85 (15)	389 (65)	195 (33)	480 (86)	76 (14)	428 (72)	170 (28)

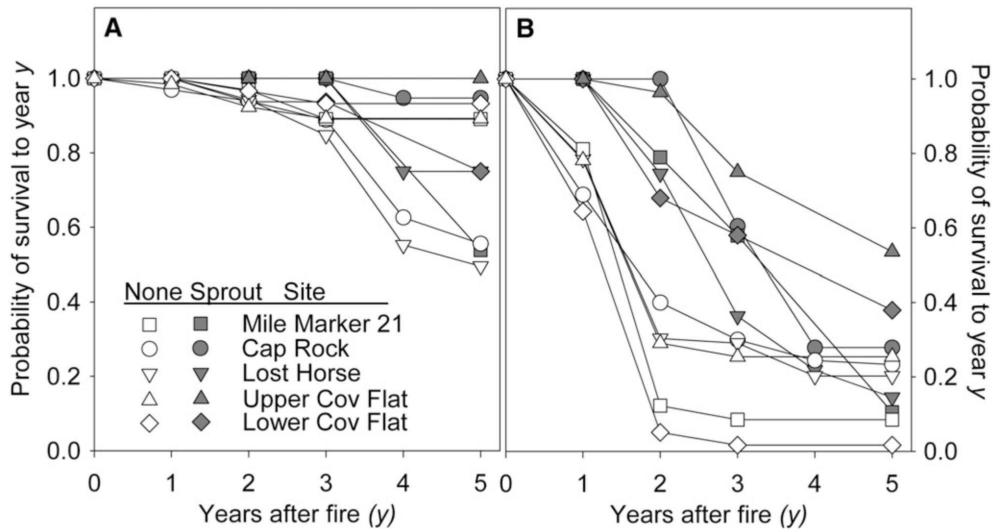

Fig. 5. Estimated survivorship functions for (A) unburned and (B) burned *Yucca brevifolia* without sprouts (open symbols) and with sprouts (gray symbols) among five sites at Joshua Tree National Park 5 yr after the Juniper Fire (year 0 = May 1999). Analysis included 584 burned and 477 unburned *Y. brevifoli*a.

germination, and development toward reproductive size in a variable environment.

Fire-adapted plants in systems where high intensity fires are frequent can remobilize carbohydrates stored in belowground structures so that plants can sprout from the root crown (Bond and Midgley, 2001). *Yucca brevifolia* is shallow-rooted with little or no developed taproot system (Rundel and Gibson, 1996) so after burn injury, the belowground resources of *Y. brevifolia* may be insufficient or energetically too costly to mobilize for new sprouts. Alternatively, stem sprouting after injury can occur by remobilizing carbohydrates stored in the aboveground tissues as observed in subtropical coastal sand dune trees (Nzunda et al., 2008). Results from a study in Lost Horse Valley at Joshua Tree National Park (Smith et al., 1983) imply that carbon gain during January through May can provide a surplus of resources after the annual cost of leaf production, root and shoot growth, and maintenance respiration is considered, potentially leaving any surplus storage that could be used for sprouting. In our study, larger plants generally sustained less proportional surface burning than smaller plants; therefore, we speculate that the larger plants in general had greater reserves available for sprouting, which prolonged survival. Webber (1953) suggested that *Y. brevifolia* is highly adapted to fire, and in addition with others (Loik et al., 2000a), speculated that *Y. brevifolia* sprouting is a successful means of repopulating disturbed sites. Our data indicate that *Y. brevifolia* sprouting can provide some advantage to survival only when precipitation is sufficient (e.g., at higher-elevation sites or during wet

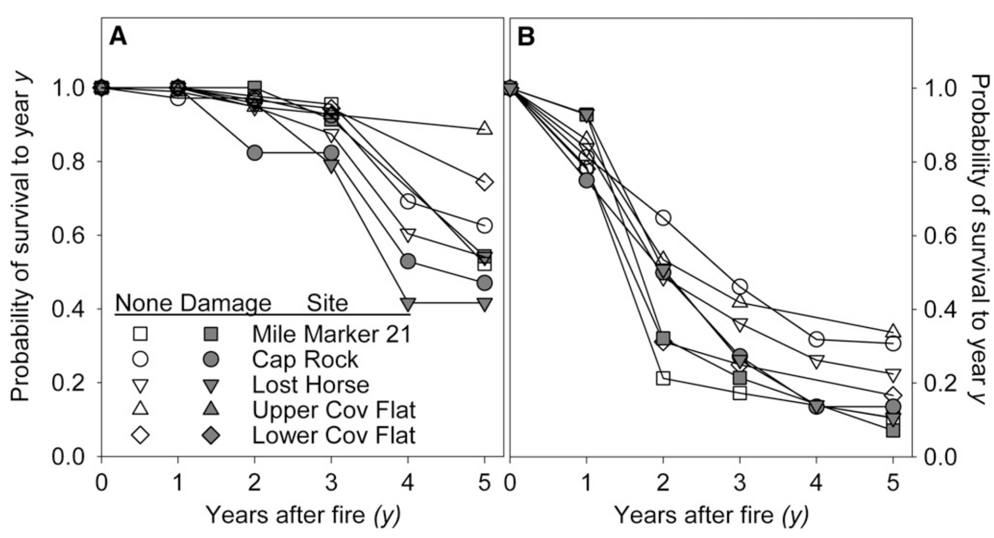

Fig. 6. Estimated survivorship functions for (A) unburned and (B) burned *Yucca brevifolia* without damage (open symbols) and with damage (gray symbols) by *Thomomys bottae* among five sites within Joshua Tree National Park 5 yr after the Juniper Fire (year 0 = May 1999). Functions for damaged *Y. brevifolia* were not analyzed for Upper and Lower Covington Flat sites due to lack of or too few plants that were damaged by *T. bottae.* Analysis included 512 burned (excludes Upper Covington) and 369 unburned *Y. brevifoli*a (excludes Upper and Lower Covington Flats).

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years). Thus, sprouting of *Y. brevifolia* in the Mojave Desert presents an uncertain recovery strategy in postfire landscapes, especially in the face of herbivory and recurring low-precipitation years, and merits further long-term research attention.

The recruitment of *Y. brevifolia* is a slow process even without the impediments introduced by accelerated fire-return intervals. At 13 burned sites in Joshua Tree National Park, few arboreal species recolonized even 47 yr after a single fire (Minnich, 1995). *Yucca brevifolia* re-established so slowly in comparison to other perennial species on plowed fields that after 70 yr there were virtually no arboreal species on disturbed sites (Carpenter et al., 1986). A 20-yr study of *Y. brevifolia* on three 0.1-ha plots in southern California found only two seedlings, both of which died within a year (Comanor and Clark, 2000), though sample sizes were small for drawing demographic conclusions. After the 1999 fire in Joshua Tree National Park, burned sites were nearly denuded of shrub and perennial grass cover, and this postfire landscape lacked the safe sites beneath nurse plants necessary for *Y. brevifolia* seedlings to establish (Brittingham and Walker, 2000; Loik et al., 2000a). Mortality of seed-producing adults over expansive areas and loss of suitable establishment sites are important limitations to *Y. brevifolia*'s recolonization after fires.

Alien annual grasses introduce a complication in the slowly recovering landscape of the Mojave Desert because in addition to causing fires, they compete with native species for water and nutrients (Brooks, 2000; DeFalco et al., 2003, 2007). These annual grasses are ubiquitous in the Mojave Desert, and production is intimately tied to above-average autumn and winter precipitation during wet El Niño phases. The success of alien annual grasses in postfire habitats prolongs the period during which recolonizing *Y. brevifolia* are susceptible to fire (D'Antonio and Vitousek, 1992). The larger the burned area, the more difficult it will be for native plants to recolonize their original range (Carpenter et al., 1986; Vitousek et al., 1997), especially for species such as *Y. brevifolia* that require animal dispersal (Vander Wall et al., 2006; Waitman, 2009). Continued monitoring of long-lived plant species such as the iconic *Y. brevifolia* will provide insights into how population- and community-level dynamics will respond to a future changing climate and determine how scientists and managers can plan for and possibly mitigate such changes.

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EXHIBIT 25

Raising Questions in the Central Mojave Desert

Robert E. Reynolds, editor

California State University Desert Studies Center
2013 Desert Symposium

April 2013

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Front cover: Mule Canyon

Back cover: Folded sediments in Big Borate Canyon

Title page: Mule team hauling borax ore in Mule Canyon

Population dynamics of the Joshua tree (*Yucca brevifolia*): twenty-three-year analysis, Queen Valley, Joshua Tree National Park

James W. Cornett
JWC Ecological Consultants, P.O. Box 846, Palm Springs, California 92263, jwcornett@aol.com

One of the most recognizable desert plants is the Joshua tree, *Yucca brevifolia*. Large size, dagger-like leaves and endlessly varying silhouettes make the Joshua tree visually unique. It is the only native tree found on Mojave Desert flatlands, the ecologically dominant component in many regions and one of seven plant species for which an American national park has been named. It has become the symbol of the California deserts (Cornett, 1999). For these reasons populations of *Y. brevifolia* were monitored for more than twenty years at ten, one-hectare study sites located in California, Nevada, Utah and Arizona. This paper describes the results of twenty-three years of monitoring one Joshua tree population located in Queen Valley, Joshua Tree National Park, California.

The Queen Valley study site was located on an alluvial plain surrounded by low hills and mountains. Drainage occurred to the northwest, into nearby Lost Horse Valley. Soil was a mix of sand and silt. Site elevation was 1,362 meters above sea level. At the inception of the study *Y. brevifolia* was considered to be dominant and likely accounted for the greatest biomass of any plant species. Listed in estimated decreasing order of ground cover were the following perennial plant taxa found within the site boundaries: *Hilaria rigida, Ephedra aspera*, *Coleogyne ramosissima, Yucca brevifolia, Eriogonum fasciculatum, Stipa speciosa, Ambrosia salsola, Sporobolus contractus, Atriplex canescens, Tetradymia stenolepis*, *Lycium cooperi, Yucca schidigera, Cylindropuntia echinocarpa, Opuntia basilaris and Echinocereus mojavensis.* Taxonomic nomenclature follows *The Jepson Manual* (Baldwin et al., 2012).

A wildfire passed through the project site on July 1, 2006, consuming most perennial plant species including many Joshua trees. In January of 2013, nearly seven years later, *Yucca brevifolia* accounted for the most ground coverage followed by *Ambrosia salsola*, *Atriplex canescens* and perennial bunch grass species.

From 1990 through 2013 Joshua trees within the Queen Valley study site were monitored in most years with regard to dimensions, vigor and reproductive status. Forty-four living trees were present in 1990 representing both mature and immature individuals. Based upon leaf cluster status, 26 of the 44 trees were considered to be enlarging, 12 were stable, and 6 were declining. By 2013 *Y. brevifolia* numbers had declined to 12, an approximately 73% decrease. Of the 12 living trees remaining on-site in 2013, 5 were considered enlarging, 4 were stable and 3 were declining.

The Geo Fire of 2006 was responsible for the destruction of numerous Joshua trees. However, tree numbers and vigor were already in decline in March of 2006 when the annual analysis was conducted. From December 1990 to March of 2006 tree numbers had declined from 44 to 36, an approximate decrease of 18%. Of those 36 trees 16 were considered to be enlarging, 15 were stable and 5 were declining.

This data indicates the population of *Yucca brevifolia* within the Queen Valley study site was declining in both numbers and vigor from 1990 to 2013. The Geo Fire intensified the rate of decline. The results compliment a twenty-year analysis of a Joshua tree population at Upper Covington Flat in the western portion of Joshua Tree National Park (Cornett, 2009). The population on the Upper Covington Flat site declined by a similar pre-fire percentage, 16%, in twenty years. Taken together these results may indicate a gradual decline in Joshua tree numbers and vigor within Joshua Tree National Park. Changes in climate associated with global warming may explain declines in Joshua tree populations at these two study sites (Cole et al., 2011).

I thank the Garden Club of the Desert and Joshua Tree National Park Association for providing financial support for this research.

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EXHIBIT 26

Not a drop left to drink

Robert E. Reynolds, editor

California State University Desert Studies Center
2014 Desert Symposium
April 2014

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Front cover: snow geese at Sonny Bono National Wildlife Refuge, Salton Sea

Back cover: terns at Corvina Beach, Salton Sea

Title page: Ship Mountains from Fenner Valley

Population dynamics of the Joshua tree (*Yucca brevifolia*): twenty-three-year analysis, Lost Horse Valley, Joshua Tree National Park

James W. Cornett

JWC Ecological Consultants, P.O. Box 846, Palm Springs, California 92263, jwcornett@aol.com

ABSTRACT: From 1990 through 2013, Joshua tree (*Yucca brevifolia*) numbers declined within a one-hectare study site in Lost Horse Valley, Joshua Tree National Park. This decline along with declines at two additional sites and projected long-term increases in temperature and drought frequency indicate this species may be extirpated from the Park as early as the 22nd century.

Introduction

One of the most distinctive plants in the southwest is the Joshua tree, *Yucca brevifolia*. Large size, dagger-like leaves and endlessly varying form give it a distinctive appearance and have made it a symbol of the Mojave Desert (Bakker, 1971; Foster, 1987; Jaeger, 1950). The Joshua tree is the only native tree found on Mojave Desert flatlands and provides important habitat for many animals, particularly birds (Miller and Stebbins, 1964). In three units of the national park system—Joshua Tree, Mojave, and Death Valley—the trees are locally common and form what have been referred to as woodlands (Munz, 1974) or forests (Jaeger, 1957). As a subject of research, the Joshua tree's large size and distinctive appearance provide a unique opportunity to accurately assess population dynamics and evaluate them in terms of long-term environmental changes. This paper describes the results of twenty-three years of monitoring a one-hectare Joshua tree study site in Lost Horse Valley, Joshua Tree National Park, California.

Study site

Lost Horse Valley is located near the geographical center of Joshua tree distribution in Joshua Tree National Park (Figure 2). In November 1990 a one-hectare study site was established within an area of relatively high *Yucca brevifolia* density where both mature and immature trees were present. The site lies on an alluvial plain at an elevation of 1,330 meters above sea level (33°58.403′N, 116°10.049′W). Low hills and mountains surround Lost Horse Valley with drainage to the north through Quail Wash.

Within site boundaries soil is a mix of sand and silt. Perennial plant species, listed in decreasing order of ground cover, were *Hilaria rigida, Stipa speciosa*, *Yucca brevifolia, Ephedra aspera, Coleogyne ramosissima, Eriogonum fasciculatum, Ambrosia salsola, Sporobolus contractus, Lycium cooperi, Atriplex canescens, Tetradymia stenolepis, Senna armata, Cylindropuntia echinocarpa, Echi-*

Joshua trees in Lost Horse Valley, Joshua Tree National Park.

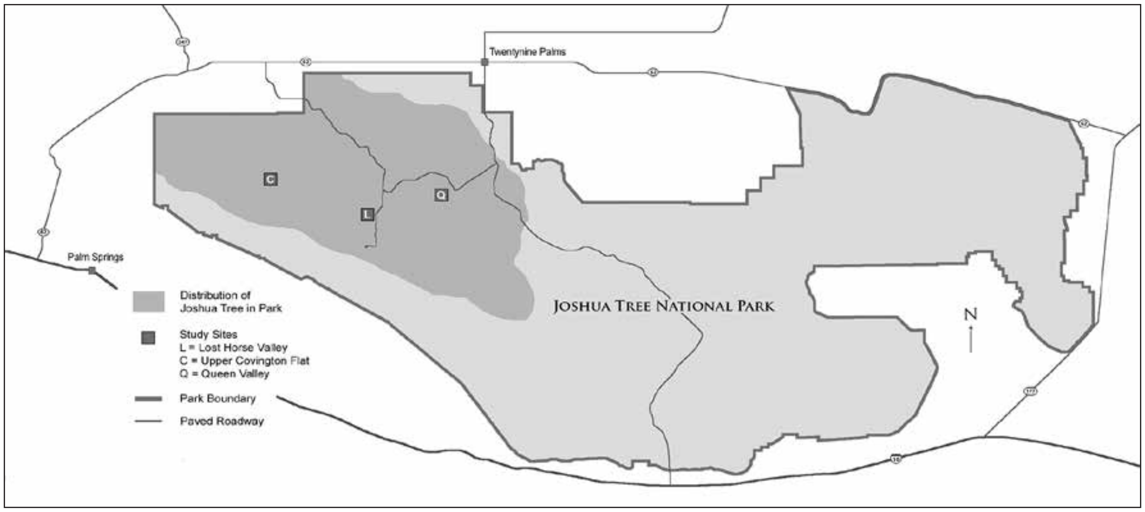

Figure 2. Location of Lost Horse Valley, Queen Valley and Upper Covington Flat study sites in Joshua Tree National Park.

nocereus mojavensis, Cylindropuntia ramosissima and *Opuntia basilaris*. Taxonomic nomenclature is taken from *The Jepson Manual* (Baldwin et al., 2012).

Reliable air temperature data was available for Lost Horse Valley beginning in 1993 (Western Regional Climate Center, 2014). From 1993 through 2013, December was the coldest month with a mean minimum temperature of -0.3°C. Temperature often dropped below freezing in December and January. The coldest temperature recorded was -12.2°C on 17 January 1997. July was the hottest month with an average daily maximum temperature of 33.7°C. The highest temperature recorded was 41.7°C on 18 July 2005. Reliable precipitation data was available from 1995 through 2013 (Western Regional Climate Center, 2014). Average annual precipitation during this period was 12.93 cm. The least amount of precipitation fell in 2002 when only 2.26 cm was recorded for the entire year. The highest annual precipitation, 38.38 cm, was recorded in 2005.

Cattle were introduced into Lost Horse Valley in the mid-1870s (Greene, 1983). Commercial grazing continued intermittently through World War II, but by 1950 all grazing permits were inactive or had been rescinded. Grazing cattle have been absent from Lost Horse Valley and Joshua Tree National Park since that time.

Methods

From 1990 through 2013, individual Joshua trees within the Lost Horse Valley study site were monitored annually with regard to dimensions, vigor and reproductive status. Individual trees were identified with numbered aluminum tags loosely wired around trunks at the inception of the study. Site visits occurred in late winter and spring when Joshua tree would be blooming. Mature trees were defined as those in bloom during the annual site visit or which possessed an expired inflorescence from a previous year's bloom. (All or part of an expired inflorescence typically remains attached to a tree for a decade or more.) Immature trees were those which had not yet blossomed. A tree with one or more green terminal leaf rosettes was considered a living tree. An erect tree with no green leaf rosettes was considered dead unless it possessed one or more crown or rhizome clonal sprouts which possessed a green leaf rosette.

Results

Seventy living trees were present in 1990, representing 44 mature (approximately 63% of total) and 26 immature individuals (37%). By 2013 *Y. brevifolia* numbers had declined to 47 individuals, an approximately 33% decrease. Of the 46 remaining trees, 43 were mature trees (approximately 93% of total) and 3 were immature trees (7%). No new, young Joshua trees appeared during the study period.

This data indicates the number of *Yucca brevifolia* within the Lost Horse Valley study site had declined in numbers from 1990 through 2013. The decline was greatest among immature trees (93%). Immature were inevitably smaller and with less extensive roots systems and less moisture and nutrient reserves than mature trees.

Discussion

The results in Lost Horse Valley parallel those found at two other study sites in Joshua Tree National Park (Figure 2). A second site at Upper Covington Flat showed a 16% decline in Joshua tree numbers from 1988 through 2008 (Cornett, 2009). A third site in Queen Valley showed a wildfire-assisted 73% decrease from 1990 through 2013 (Cornett, 2013). Taken together the three sites represent a broad geographical sampling within Joshua Tree National Park. The declines at all three sites, along with mortality of selected large trees (Cornett, 2006) would seem to indicate *Yucca brevifolia* numbers are declining throughout the Park.

The high percentage of immature tree death, lack of seedling establishment and absence of other detectable causes suggest recurring droughts combined with warmer temperatures over the past twenty-three years are the most likely causes of declining Joshua tree numbers. From 1988 through 2012 the desert regions of southeastern California experienced a 16% decrease in precipitation compared with the previous twenty-five year period (1963 through 1987). Perhaps more importantly, severe drought years, when annual precipitation was less than half the long-term average, occurred only twice in the previous twenty-five years but six times between 1988 through 2012 (National Climatic Data Center, 2013). The severity of drought was exacerbated by a rise in annual temperature of approximately 2 degrees C beginning in the late 1970s. Long-term climatic predictions indicate these conditions are likely to continue (Seager et al. 2007; Solomon et al. 2007) and, if the present rate of decline continues, the extinction of *Yucca brevifolia* in Joshua Tree National Park could occur as early as the twenty-second century.

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The Garden Club of the Desert and Joshua Tree National Park Association provided financial support for this research. Cameron Barrows reviewed the entire manuscript and made many helpful suggestions. Joe Zarki provided information on the history of cattle grazing in Joshua Tree National Park. Terry Cornett reviewed the manuscript for clarity and consistency and made many helpful suggestions. I thank each of these organizations and individuals for their assistance and support.

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EXHIBIT 27

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Ecosphere

Context-dependent mutualisms in the Joshua tree–yucca moth system shift along a climate gradient

Jennifer Harrower† and Gregory S. Gilbert

Department of Environmental Studies, University of California Santa Cruz, 1156 High Street, Santa Cruz, California 95064 USA

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Abstract. Changing climate patterns can affect the geographic distribution of species through effects on species interactions. Iconic Joshua trees are limited to a narrow range of climate conditions, and climate change is expected to shift suitable habitat to higher elevations and latitudes than their current geographic distribution. As such, the survival of the species requires colonization of new habitats. However, Joshua trees form an obligate mutualistic relationship with yucca moths that pollinate the flowers but whose offspring then consume a portion of the developing seeds. It is not known whether the yucca moths will move in synchrony with Joshua trees, or how changing environmental conditions may affect the net benefits and costs of the yucca moth–Joshua tree interaction. To evaluate the spectrum of conditional outcomes of the interaction, we examined a range of performance measures and abiotic factors across the elevation range that spans the distribution of Joshua trees in Joshua Tree National Park. We found a strong concordance between tree size, moth and tree abundance, and reproductive success, with peak performance of both partners at intermediate elevation. Within sites, larger trees produced more flowers, attracted more pollinators, and had greater seed set. We found that the conditional outcomes of the interaction varied predictably along the gradient: Seed set, as well as seed predation, was greatest at intermediate elevations where trees and pollinators were both at high abundance. At range margins, the proportion of infertile seeds increased, possibly because low pollinator abundance led to pollen limitation. The reproductive success of Joshua trees is tightly linked to pollinator abundance, and the conditional outcomes (magnitude of the fitness benefit) of the mutualism change depending on where it occurs on the elevation gradient.

Key words: climate gradient; context dependency; Joshua tree; mutualism; species interaction; *Tegeticula synthetica; Yucca brevifolia;* yucca moth.

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† **E-mail:** jharrower@ucsc.edu

Introduction

The outcome of mutualistic species interactions can set geographical ranges (Afkhami et al. 2014) and influence population dynamics (Holland et al. 2002). Changes in abiotic conditions can affect the outcome of an interaction through direct effects on each interacting species as well as by modulation of the interaction itself. Abiotic changes can enhance a mutualism, convert it to antagonism, disrupt it, or force migration of one or both species (Bronstein 1994, Warren and Bradford 2014, Rafferty et al. 2015).

Rapid anthropogenic climate change is one of the biggest threats to ecosystems, visible as disruption of species' phenology (Field et al. 2014, Melillo et al. 2014), the decoupling of trophic relationships (Van der Putten et al. 2010), asynchronous species range shifts (Chen et al. 2011), and differential outcomes of symbiotic interactions (Tylianakis et al. 2008, Hegland et al. 2009, CaraDonna et al. 2017). We have already witnessed shifts in species ranges to higher elevations and

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toward the poles (Parmesan and Yohe 2003, Poloczanska et al. 2013, Mason et al. 2015). Numerous forecasts suggest future changes in climate conditions will continue to shift species distributions and change the direction and magnitude of the outcomes of key species interactions (Burkle et al. 2013, Chamberlain et al. 2014, Schmidt et al. 2016).

Species ranges are determined simultaneously by abiotic factors such as temperature, moisture, and nutrients and by positive and negative species interactions (Bronstein 1994, Afkhami et al. 2014, Louthan et al. 2015, Tylianakis and Morris 2017).

To understand limits and uncover opportunities to manage the outcomes of mutualistic interactions under future climate scenarios, we need to know how these interactions determine range limits, and how the effect varies across environmental gradients. Elevation gradients function as natural experimental systems through systematic variation in abiotic and biotic factors and provide opportunities to gain needed insight into the context dependence of mutualisms (Sundqvist et al. 2013, Rasmann et al. 2014). Changes in weather patterns or in soil temperature, moisture, and nutrients can impact the outcomes of species interactions (Forrest 2015, McQuillan and Rice 2015, Rafferty et al. 2015). Evaluating local variation in demographically important outcomes of species interactions along geographical gradients may help to predict whether a species distribution range will decline, be stable, or expand in the face of climate change.

The iconic Joshua tree (*Yucca brevifolia*; Agavaceae) is a monocotyledonous tree distributed throughout the Mojave Desert of North America. Joshua trees produce bisexual flowers that occur in dense panicles, flowering once yearly between February and April, and can reproduce sexually or via clonal growth from sprouts from the root system (Fig. 1). Pollinated exclusively and obligately by yucca moths (*Tegeticula synthetica* and *Tegeticula antithetica*; Prodoxidae), the female oviposits her eggs into the Joshua tree floral ovary and then actively pollinates the flower using specialized tentacles (Trelease 1893, Pellmyr 2003). The yucca moth is the tree's only pollinator and her growing larvae consume a fraction of the fertilized seeds; this results in a tight codependence between the species for survival (Pellmyr and Huth 1994). Bogus yucca moths (*Prodoxus weethumpi* and *Prodoxus sordidus*; Prodoxidae) are the sister genus of *Tegeticula* (Darwell et al. 2018) and will parasitize this system by ovipositing eggs into plant tissue and forming galls in the fruits and stalks (respectively) without providing a pollination service (Pellmyr et al. 2006).

Obligate mutualisms like the Joshua tree–yucca moth interaction are acutely sensitive to changes in climate. The interacting partners may respond differently, creating an asynchrony in species phenology that can lead to population decline and local extinction (Pellmyr and Huth 1994, Geib and Galen 2012, Rafferty et al. 2015). Environmental changes that shift the outcome to fewer viable seeds or greater seed predation could be detrimental to both species. However, the climate envelope within which this mutualism currently exists is narrow, and climate change effects in the Mojave Desert are expected to limit this envelope to only the highest elevations in Joshua Tree National Park (JTNP) within 90 yr, greatly reducing habitat with suitable climate and potentially extirpating the species from its namesake park (Dole et al. 2003, Cole et al. 2011, Barrows and Murphy-Mariscal 2012). Abiotic changes will likely affect Joshua trees, their pollinators, and/or the interaction between them (Fig. 1). We do not know how either the Joshua tree or the yucca moths respond directly to the expected changes to climate conditions, or how the interaction may be affected.

A key step toward anticipating how the Joshua tree–yucca moth mutualism may respond to environmental change is to examine how each organism varies across its geographic range, and how the outcomes of those interactions vary along that range. These mutualisms can be considered context-dependent when either the sign (−, 0, +) or the magnitude (strong to weak) of the interaction changes (Chamberlain et al. 2014). It is unknown whether the performance of Joshua trees and their moths have independent optima and minima at the same environmental conditions, or whether the geographic distribution of the mutualism is primarily determined by abiotic effects on just one of the partners and the other partner just follows along.

Here, we examine how the abundance of each species varies by elevation and quantify how the outcome of the Joshua tree–yucca moth interaction shifts depending on the context of where it occurs. We then develop and test a conceptual model that characterizes the drivers and structure of this context-dependent pollination mutualism (Fig. 2). This descriptive framework provides a

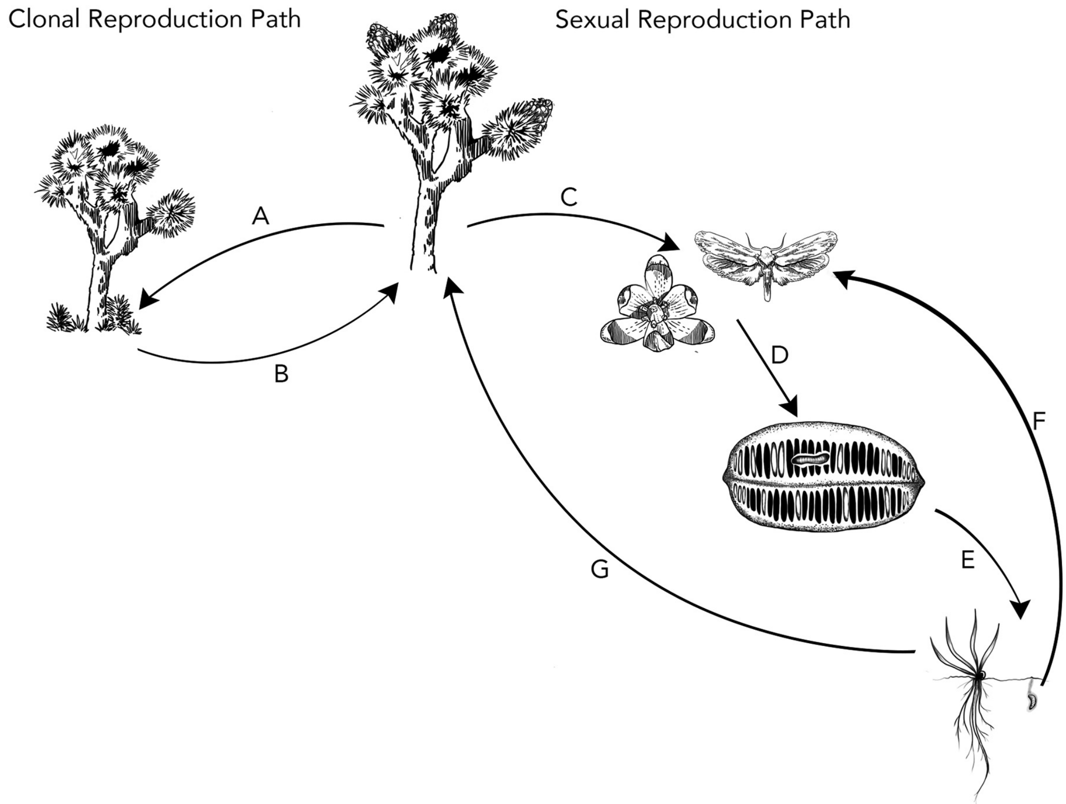

Fig. 1. The clonal reproductive path and the sexual reproductive path in Joshua tree reproduction. In the clonal path, (A) the Joshua tree creates a juvenile clone via underground ramets. This juvenile may grow into an adult (B) and then follow the clonal, sexual, or both reproductive paths. In sexual reproduction, the adult tree flowers and a moth emerges from a cocoon to pollinate and oviposit eggs in Joshua tree flower (C). The flower forms a seedpod containing both fertile and infertile seeds. Developing moth larvae consume a fraction of the fertile seeds (D), exit the pod, and form a cocoon in the soil (E). Larva pupates for at least a year and emerges from soil as adult moths during the next flowering cycle of Joshua trees (F). Seeds land in hospitable area and grow into a new Joshua tree for the cycle to begin again (G).

structured approach for thinking about the factors contributing to mutualism outcomes in the Joshua tree–yucca moth system and aims to provide a tool to describe processes and context-dependent outcomes along an abiotic gradient.

In this study, we sampled the abundance of Joshua trees and their moth pollinators across an elevation gradient to determine what impact species density and/or location has on the outcomes of this species interaction and the resulting Joshua tree fitness. Specifically, we ask: (1) How do processes that are demographically important for Joshua trees change along an elevation gradient across the tree range in Joshua Tree National Park? (2) Does the abundance of yucca moth pollinators of Joshua trees vary predictably across the Joshua tree range in JTNP? (3) To what degree is the reproductive success of Joshua trees explained by pollinator abundance vs. environmental conditions? (4) Do the outcomes of the Joshua tree–yucca moth mutualism vary predictably along an elevation gradient?

Materials and Methods

Study sites

The study was conducted between spring 2016 and summer 2017 across a 1200-m elevation gradient (ranging from 1004 to 2212 m) in JTNP, in southwestern California, USA (located at 33.8734° N, 115.9010° W), with two additional sites located northwest of JTNP to include the northernmost

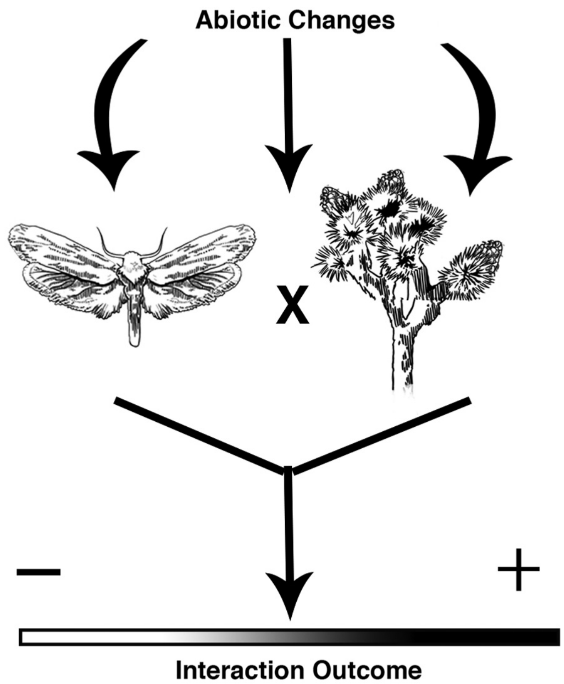

Fig. 2. Conceptual model of the hypothesized factors influencing plant fitness in the Joshua tree/yucca moth symbiotic relationship across an elevation gradient in Joshua Tree National Park. Top black arrows represent three specific hypotheses tested; abiotic factors can influence the moth directly, the Joshua tree directly, or influence the interaction between them through sign (−, 0, +) or magnitude (strong to weak). A resulting positive interaction outcome refers to positive fitness effects for the moth and tree (more moths and/or seeds), while a negative interaction outcome refers to hypothetical negative fitness effects (less moths and/or seeds).

point of the local Joshua tree distribution (Appendix S1: Fig. S1). Biogeographically, JTNP is situated at the transition zone between the Mojave and Colorado deserts. We selected 11 sampling sites from a continuous Joshua tree population that ranged from the southernmost point of the global Joshua tree distribution to the northern end of its continuous local range. These sites encompass four broad eco-regional vegetation types: Sonoran–Colorado Desert scrub, Mojave–Sonoran creosote bush scrubland, Mojave mid-elevation desert, and pinyon–juniper woodland (Sawyer et al. 2009). We obtained climate and soil moisture data for sites from 7 HOBO Pro V2 datalogger weather stations (Onset Computer, Cape Cod, Massachusetts, USA). Although the sites experience a similar cismontane influence along the western margin, they experience different climate conditions on average and vary across the gradient from very hot and dry at the lowest elevation to seasonal freezing temperatures at the highest elevation (Table 1).

Joshua tree demography

To determine whether Joshua tree demographic parameters change across an elevation gradient in JTNP, we sampled two 20 × 200-m belt transects randomly positioned and separated by 50 m, and running from southeast to northwest at each of the 11 sites (Appendix S1: Fig. S1). Since Joshua trees are monocots and do not produce annual growth rings, we measured the height of each tree using a digital clinometer (Haglöf HEC2, Madison, Mississippi, USA) and counted the number of branches and flower panicles. All juveniles (<0.5 m tall) were considered to be clonal if they occurred next to another tree and if rhizomes connected to the tree were found by digging underground; otherwise seedlings were considered to be the products of sexual reproduction. Any dead trees were counted separately from live trees.

Soil sampling

At each of the eleven sites, three soil cores (5 cm diameter and 15 cm length) were collected along each of the two transects and then bulked (six cores per site). Soil texture is sandy loam at all sites with varying amounts of rock and gravel. Soil was dried, ground, and analyzed for total carbon and total nitrogen following the combustion method (AOAC 1997), pH (in H_2O), total extractable ammonium and nitrate content by flow injection analyzer method (Keeney and Nelson 1982, Hofer 2003), extractable phosphorus using the Olsen method (Olsen 1982), and percentage soil moisture following the gravimetric method (Black 1965) at the UC Davis Analytical Lab (http://anlab.ucdavis.edu; Table 1).

Moth sampling

To determine whether the abundance of moth pollinators varies predictably over the distribution of Joshua trees along an elevation gradient, we used moth traps (clear plastic acetate painted with tangle-trap [Contech, Victoria, British Columbia,

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Table 1. Characteristics of the eleven sites along an elevation gradient in JTNP.

	Site										
Variable	1	2	3	4	5	6	7	8	9	10	11
Latitude °N	34.24	34.11	33.55	34.13	34.47	33.58	33.59	33.55	34.14	34.14	34.14
Longitude °W	116.1	116.0	116.3	116.1	116.2	116.1	116.7	116.1	116.2	116.4	116.4
Elevation (m)	1004	1049	1114	1240	1290	1331	1402	1494	1625	2076	2212
Summer Tav (°C)	30.2	29.3	–	–	27.3	–	24.4	23.1	–	–	19.9
Summer RH (%)	32.1	34.9	–	–	34.7	–	46.1	45.6	–	–	42.2
Num of trees	7	26	14	48	34	42	39	61	35	38	4
Summer ppt (m)	0.01	0.23	–	–	0.12	–	0.25	0.01	–	–	0.003
Soil H_2O (m^3/m^3)	0.01	0.02	–	–	0.05	–	0.11	0.05	–	–	0.14
C (total) (%)	3.03	0.19	0.20	0.31	0.21	0.96	0.34	0.25	0.29	0.47	0.52
NH_4-N (ppm)	1.89	1.44	1.17	1.43	1.20	1.86	1.61	1.06	1.59	1.93	1.51
NO_3-N (ppm)	5.53	2.03	3.06	4.26	2.19	39.1	2.41	2.19	4.02	4.42	1.90
Olsen-P (ppm)	10.9	6.30	8.00	9.10	5.40	19.3	11.4	7.50	12.9	22.7	14.9
K (ppm)	339	203	251	174	116	263	231	79.0	277	476	135
Na (ppm)	7	5	5	6	6	6	4	5	4	7	14
Ca (meg/100 g)	27.2	3.16	2.63	3.2	3.03	7.41	3.75	4.58	2.85	3.56	7.47
Mg (meg/100 g)	1.44	0.93	1.05	0.81	0.86	1.09	0.91	1.12	0.82	1.66	2.27
CEC (meg/100 g)	29.5	4.62	4.34	4.49	4.22	9.20	5.26	5.93	4.39	6.47	10.2
OM (%)	2.87	0.45	0.42	0.40	0.40	1.72	0.58	0.62	0.81	1.01	1.28
pH	8.06	8.09	8.00	7.90	7.92	7.28	7.65	7.41	7.32	7.26	6.63

Notes: Tav, average temperature; RH, relative humidity; ppt, precipitation; C, carbon; NH_4-N, ammonium; NO_3-N, nitrate; P, phosphorus; K, potassium; Na, sodium; Ca, calcium; Mg, magnesium; CEC, cation exchange capacity; OM, organic matter; pH, potential of hydrogen; JTNP, Joshua Tree National Park. Entries containing "–" indicate that no climate data was collected in those locations.

USA] and secured to unopened blooms at the peduncle; Smith et al. 2009) to sample flower panicle visitation across the 11 sites. The traps were randomly attached to three flower panicles per tree, three trees per site, or to the maximum number of blooms available at that location. The traps remained in place for 28 d to be exposed during peak pollinator emergence, and then they were removed and the captured moths were morphotyped to species by comparison to the collection at the Essig Museum of Entomology (https://essig.berkeley.edu).

Seed collection

To determine whether seed production varies with elevation, tree size, or pollinator abundance, we collected a maximum of six pods per tree, six trees per site from each transect. If a tree had fewer than six pods, the total number available was collected and then we moved to the next tree, attempting to collect at least 36 pods per site. The total number of all pods available in each transect was recorded. For each site, the collected pods were weighed and measured, split open, and all seeds were counted, noting the number of fertile and infertile seeds in each.

Data analysis

We conducted simple linear regressions to evaluate the relationships between tree, site, and pollinator characteristics and compared different combinations of interactions both within and across sites. We then used generalized additive models (GAM) because we expected a non-linear and potentially idiosyncratic relationship between plant and pollinator numbers across elevation as well as between tree performance characteristics and elevation. Generalized additive models are nonparametric extensions of linear models that allow the expected response to vary smoothly with a set of predictor variables (Yee and Mitchell 1991). We also used multiple regression to identify the most important combinations of characteristics for explaining moth abundance and seed set. This was done with stepwise regression to identify a model that parsimoniously explained the variability in the response variable for each combination of variables. We used the following criteria to select the best model: (1) The model had the lowest Akaike information criterion value, (2) the model explained the most variability in the response variable, (3) individual variables in the model were significant at $\alpha = 0.10$ or better,

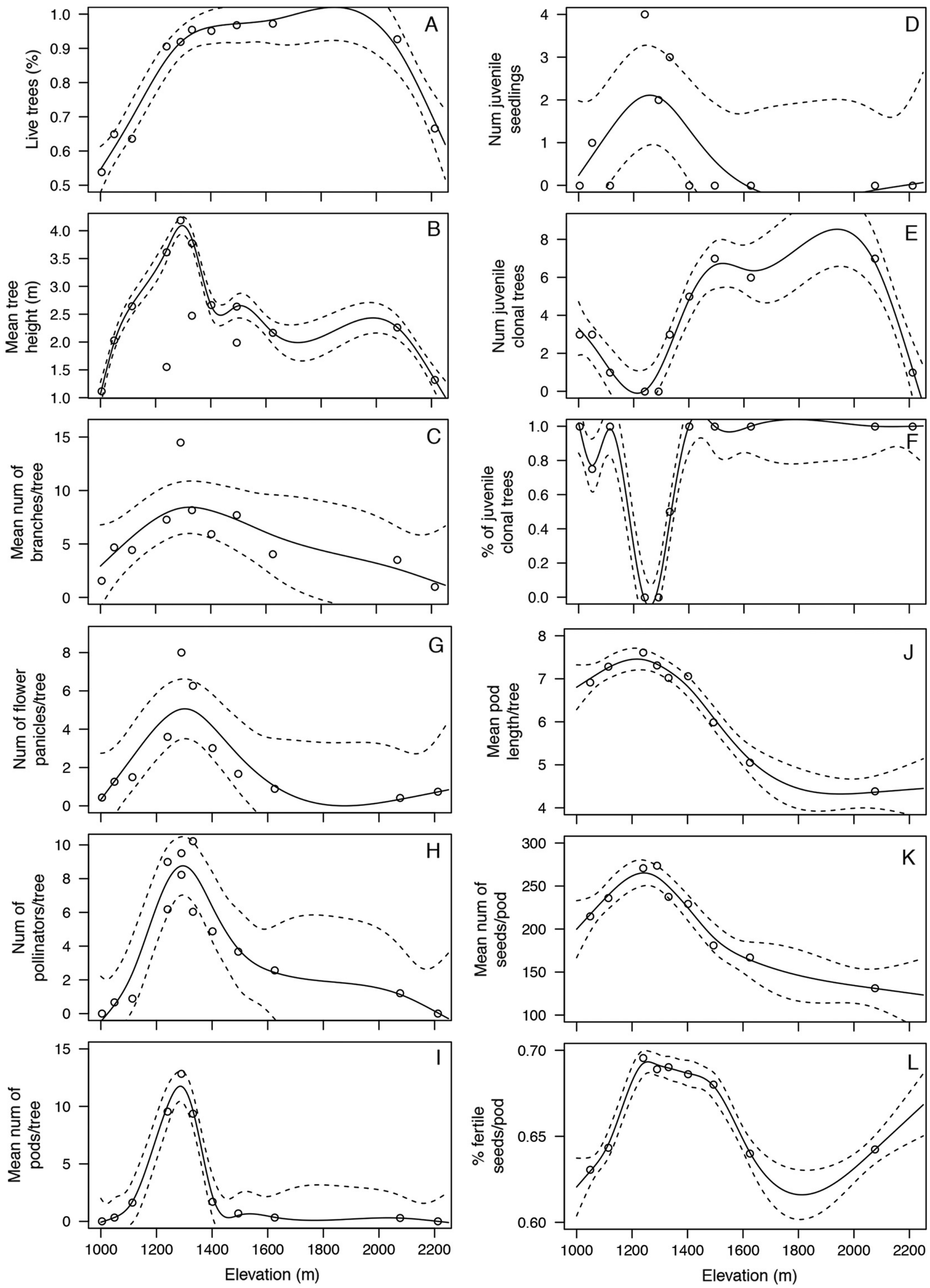

Fig. 3. Joshua tree performance measured as a function of elevation. Solid lines represent the fitted values from

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(Fig. 3. *Continued*)
a generalized additive model that estimates the form of a relationship between 12 performance measures and elevation. Dotted lines represent 95% confidence intervals. Top left panel (A–C) reflects measures of tree growth characteristics. Top right panel (D–F) includes measures of juvenile tree performance. Bottom left (G–I) reflects measures of tree reproductive potential. Bottom right (J–L) shows pod characteristics.

and (4) variables had low multicollinearity (Burnham and Anderson 2003). When all four criteria were not met, we selected the best model possible from the remaining criteria.

To determine the conditional variance of the outcomes of the pollination mutualism, we counted the number of fertile seeds (seeds are black), infertile seeds (seeds are small and white), and eaten seeds (seeds with visible predation damage) across the elevation gradient. As the positive outcome for the tree is the number of fertile seeds, and the positive outcome for the moth is proportional to the number of consumed seeds, we used a GAM to examine the ratio of fertile seeds to eaten seeds to determine how the mutualism outcomes shift. All calculations were performed using the R language for statistical computing (The R Development Core Team 2017).

Results

Weather conditions and soil properties along the elevation gradient

Average summer temperature per site declined steadily along the elevation gradient with the warmest site at a daily average of 30.2°C and the coolest at 19.9°C (r^2 = 0.9; Table 1). Relative humidity generally increased with elevation (r^2 = 0.636), as did the soil moisture at 10 cm (r^2 = 0.8), increasing from 0.005 to 0.14 m^3/m^3. Soil nutrients did not follow any noticeable trend with elevation, although pH declined from 8.06 to 6.63 with increasing elevation (r^2 = 0.827).

Demography and reproduction across the elevation gradient

Joshua trees are distributed across a 1200-m elevational range in JTNP, peaking at intermediate elevations (Table 1). The number of dead Joshua trees peaks at both the lowest (1004 m) and highest (2212 m) elevations across the range (Fig. 3). At the lowest and highest elevations in the range, there were no seedlings that were the product of sexual reproduction. Trees were small and few, and with few flowers, and we encountered no moths, seedpods, or seedlings at those sites, so reproduction was limited to clonal spread. Generalized additive models highlight a marked peak at around 1250 m where the trees were numerous and large and produced many flowers; this peak coincided with a high abundance of moths, as well as high production of pods, seeds, fertile seeds, and seedlings that grew from seeds (Fig. 3).

In the GAMs, the effect of elevation was highly significant for 12 of the 14 evaluated response variables, all except tree branches (P = 0.109) and number of seedlings (P = 0.282). The deviance explained by the models varied from 57.8% for the number of seedlings to 99% for the percent of eaten seeds (Table 2).

Joshua tree performance across the elevation gradient

Within each site (Fig. 4), as well as for all sites combined (r^2 = 0.787, P = 0.0003), larger Joshua trees produced more flower panicles. This reflects the developmental relationship between branch nodes and inflorescence production. While there was a positive relationship between tree size and the percent of fertile seeds per pod across sites (r^2 = 0.67, P = 0.007), there was no consistent relationship between tree size and fertile seeds within sites (Fig. 4). Likewise, there was no relationship between tree size and the pod length within sites, suggesting that seed production was not a simple function of plant vigor (Fig. 4).

Joshua tree and yucca moth interaction across the elevation gradient

The number of pods produced was significantly positively correlated with the mean pollinator density per trap (r^2 = 0.87, $P \leq 0.026$); similarly, the percent fertile seeds per pod (r^2 = 0.8, $P \leq 0.0012$) and total number of seeds per pod (r^2 = 0.43, $P \leq 0.056$) were correlated with pollinator abundance, suggesting that areas with more moths will have greater sexual

Table 2. Statistics associated with the generalized additive modeling for the 14 different response variables as a function of elevation.

Species variables	D (%)	r^2	c_r	edf	f	P
Number of living trees/8000 m^2	96.9	0.941	0.8263	4.801	28.21	7.2×10^{-5}
Mean tree height	99.7	0.982	2.5855	8.589	62.25	0.006
Mean number of branches/tree	63.1	0.477	5.7150	2.954	2.686	0.109
Number of seedlings/site	57.8	0.353	0.9091	3.481	1.557	0.282
Number of juvenile clones/site	96.9	0.919	3.2727	6.21	15.92	0.01
% Juvenile clonal trees/site	99.5	0.96	0.7500	8.77	27.52	0.104
Mean number of flowers panicles/tree	76.5	0.619	2.5289	3.85	3.615	0.073
Mean number of pollinators/tree	93.4	0.847	3.7543	5.694	8.813	0.022
Mean number of pods/tree	99.2	0.958	3.3458	8.117	26.21	0.044
Mean pod length/tree	98.6	0.972	6.5133	3.973	58.32	1.6×10^{-5}
Mean number seeds/pod	97.4	0.944	215.70	4.269	26.71	0.003
% Fertile seeds/pod	99.6	0.976	0.6664	6.631	44.03	0.062
% Infertile seeds/pod	99	0.999	0.2299	7.811	693.3	0.032
% Eaten seeds/pod	99	0.999	0.104	7.999	6840	2×10^{-5}

Notes: D, deviance explained; r^2, the coefficient of determination; $c_{r,}$ intercept of the model in the response scale; edf, estimated degrees of freedom; f, f ratio statistic; P, calculated probability.

reproduction of Joshua trees. There was no correlation between pod length and the number of moths (r^2 = 0.26, $P \leq 0.16$).

Moth abundance was significantly correlated with tree size (r^2 = 0.826, $P \leq 0.0001$), tree abundance, and number of flower panicles per tree (r^2 = 0.764, $P \leq 0.0004$). Bigger trees had significantly more flower panicles (r^2 = 0.787, $P \leq 0.0002$). Moth abundance increased with the local abundance of trees but dropped off abruptly at the site with the most trees (61 trees/800 m^2; Fig. 5). This site (1494 m) had a high number of trees; however, many of those trees were clumped in clonal reproduction groups. With all sites combined, there was a strong correlation between number of moths and total flower panicle numbers per site (r^2 = 0.914, $P \leq 4.3 \times 10^{-6}$); however, within sites, only those sites in the middle of the elevation range showed a positive correlation with more moths associated with more flowers on individual trees (Fig. 6).

Combinations of factors explain fertile seeds and moth abundance across sites

While different factors were the best predictors of fertile seeds or of moth abundance in pairwise correlations, when taken together, certain combinations of factors resulted in the strongest explanatory models. The best multivariate model to explain percent fertile seeds included elevation, the total number of flower panicles, and the number of trees (r^2 = 0.85, P = 0.0176). Moth abundance was best explained by the total number of flower panicles, the number of trees, and the number of pods (r^2 = 0.9468, $P = 2.292 \times 10^{-5}$). The predictor variable tree height did not appear in any of the final models, probably because tree height and panicle number are strongly colinear and functionally linked. Together these models indicate that reproductive success of both Joshua trees and the yucca moths are greatest where the Joshua trees are abundant and vigorous.

Conditional variance of the mutualism across elevation

Across the elevation gradient, the number of fertile seeds varied with respect to the number of eaten seeds (Fig. 7; r^2 = 0.98, P = 0.007). There were more fertile seeds per pod than the eaten seeds per pod at each of the elevation extremes. Conversely, the trees had a higher percentage of infertile seeds at either end of the elevation range compared to the seed pods occurring in the middle of the range (Fig. 7), yet seed predation increased as an inverse of the production of infertile seeds (r^2 = 0.918; $P = 4.7 \times 10^{-5}$).

Discussion

Effect of elevation on tree demography and reproduction

Our results showed that tree death was greatest at the lowest elevations, with tree abundance and

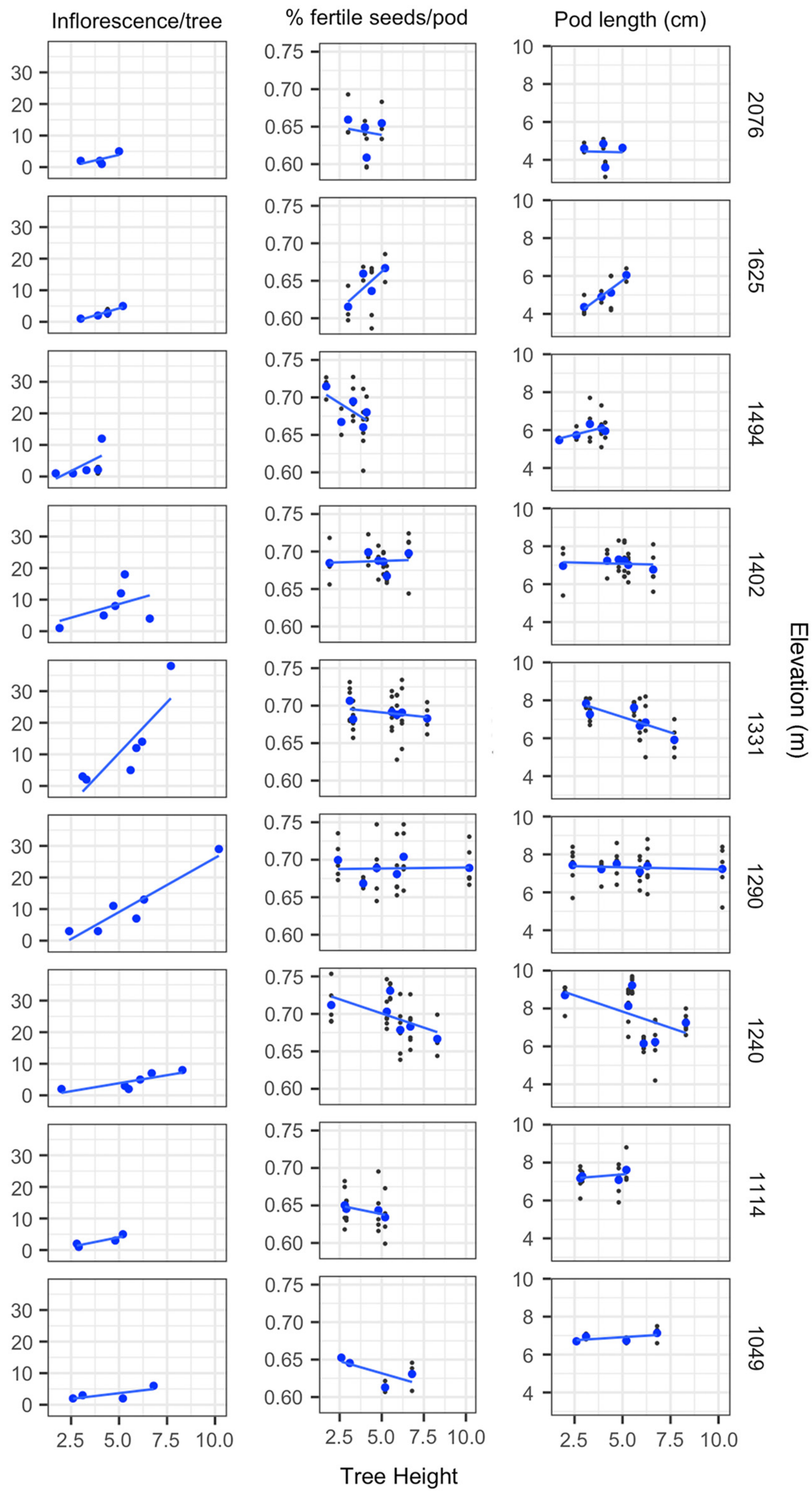

Fig. 4. Flower panicles per tree, percent fertile seeds per pod, and pod length, as a function of tree height, across the elevation gradient. There was no sexual reproduction at either the low (1004 m) or high (2212 m) elevation extremes.

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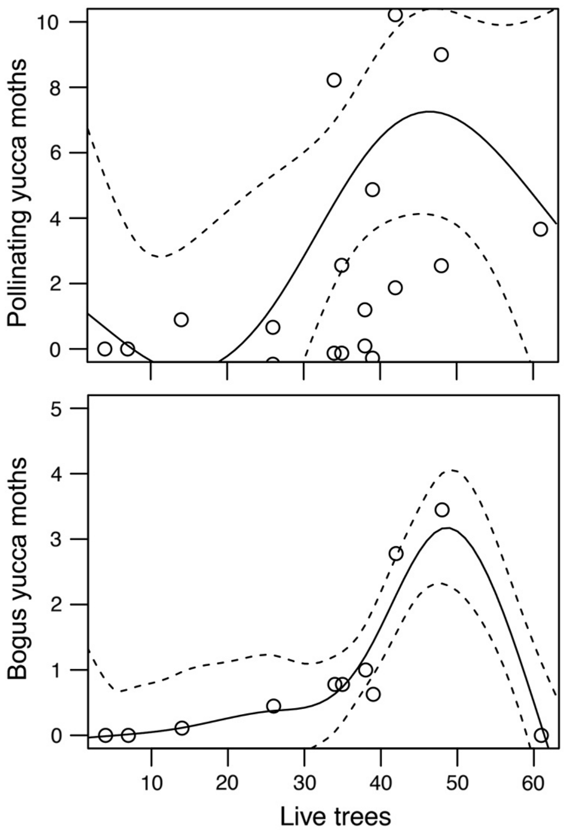

Fig. 5. Both pollinating yucca moth (*Tegeticula*) and bogus yucca moth (*Prodoxus*) abundance increase with density of live Joshua trees. At the highest tree density, moth abundance was low despite high tree abundance; this was the highest elevation site at 2212 m (site 11), which had no successful sexual reproduction.

performance peaking at intermediate elevation. The ratio of dead to living trees was greater at the lower elevations where the sites are warmer and drier than sites at higher elevation. These sites fall in a transitional ecotone between the Colorado and Mojave Desert where plant communities change significantly in response to local climate (Barrows et al. 2014). Vegetation in transition zones such as these is predicted to be particularly sensitive to changes in climate (Ackerly et al. 2010). Patterns of size and reproduction across the elevation gradient were consistent with expectations from the models (Cole et al. 2011, Barrows and Murphy-Mariscal 2012) with Joshua trees dying and not reproducing at lower elevations. These results also agree with a recent demographic analysis of Joshua trees that found a negative relationship between warming temperatures and stand density, potentially constraining tree establishment (Clair and Hoines 2018).

Elevation in JTNP is a surrogate for strong gradients in precipitation, temperature, soil type, and pH. Desert precipitation is low, so local differences in precipitation strongly affect the spatial and temporal patterns of desert biodiversity (MacMahon 1979, Barrows and Murphy-Mariscal 2012). Soil moisture was very low at the lower, warmer elevations and may have contributed to Joshua tree death. Our results agree with model predictions (Cole et al. 2011, Barrows and Murphy-Mariscal 2012) and suggest that the range of Joshua trees is contracting at the lower elevations where there was no seedling recruitment and high tree mortality. As the hot, dry conditions extend upward, future generations of trees may only thrive at cooler, higher elevations.

We also found that a high proportion of trees were dying at the highest elevations, where there are strong winds and freezing temperatures. However, the high mortality at the highest site may be an artifact of small sample size; there were only four trees present at the upper range limit. Expected warming may make higher elevations more hospitable to Joshua trees in the future, but there is very limited land area at such high elevations in JTNP and those locations are also areas of high fire threat within the park (DeFalco et al. 2010).

At elevation extremes, Joshua tree reproduction is almost exclusively clonal. This agrees with studies which found that Joshua tree clonality increases with elevation (Simpson 1977, Rowlands 1978), 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 (Reynolds et al. 2012). 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. This could be tested with experimental outplanting of seeds.

Most species ranges occur along environmental gradients of variable habitat quality, with reduced fitness at range limits (Eckert 2002, Sagarin and Gaines 2002, Sexton et al. 2009). Clonal reproduction may allow plants to better

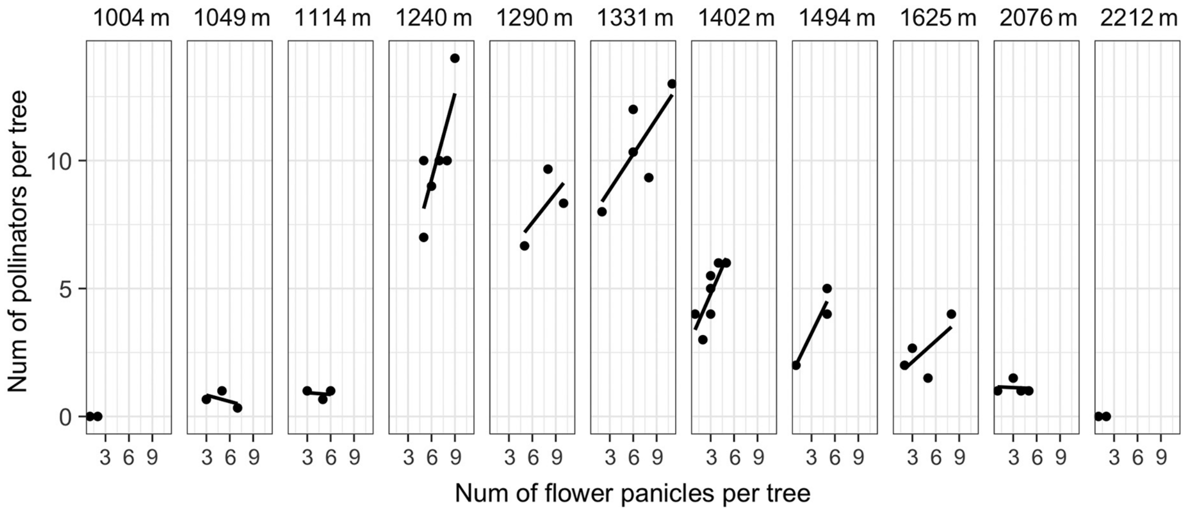

Fig. 6. Linear analysis within site for each of the eleven sites of the number of pollinators vs. the number of flower panicles per tree. Pollinator number per tree increases with the number of flower panicles on that tree, except at elevation extremes.

forage for nutrients and water at the range margins; clonality may be due to an absence of pollinators and failed sexual reproduction; and clonality may dominate where environmental conditions are difficult for seedling establishment (Barrett 2015). A contracting range edge is typically a product of declining fitness and local extinction (Jump et al. 2009). If trailing edge populations of (mostly clonal) Joshua trees are also those in the population that are best adapted to deal with the highest local temperatures, a lack of sexual outcrossing with populations at higher elevations could threaten overall species persistence due to reduced fitness of seedlings as the climate warms (Dlugosch and Hays 2008, Dlugosch and Parker 2008). Clones have reduced reproductive fitness, which could increase susceptibility to local extinction of the trees (Hampe and Petit 2005). The lack of pollinators, seed set, and seedlings at higher elevations suggests that Joshua trees are not currently expanding their range upslope; however, this trend would be better established by examining tree demography across several years. Common garden experiments with genotypes from different elevations, planted at different elevations, could uncover any local adaptation to higher temperatures.

We found considerable Joshua tree seedling recruitment at intermediate elevations, peaking around 1300 m, near the lower part of their range. This area of high seedling recruitment is also where the trees were biggest, produced the most flowers, pods, and seeds, and had the biggest branches. Other studies have found that Joshua tree seeds germinate best following a heat treatment and that seedlings grow best following a cold treatment; however, these impacts are bounded by temperature extremes (Went 1948). This suggests that the 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.

The relationship between moth abundance and tree abundance

Populations of both trees and moths were most vigorous near the middle of their elevation range. In many ecosystems, the number of individuals within a species is lower and performance is suboptimal toward their range edges (Eckhart et al. 2011). In JTNP, populations of both trees and moths peaked at approximately the same elevation, as did all measures of tree vigor. This may be either because the two species coincide in their environmental preferences, or because the mobile moths are able to congregate where robust tree hosts produce many flowers.

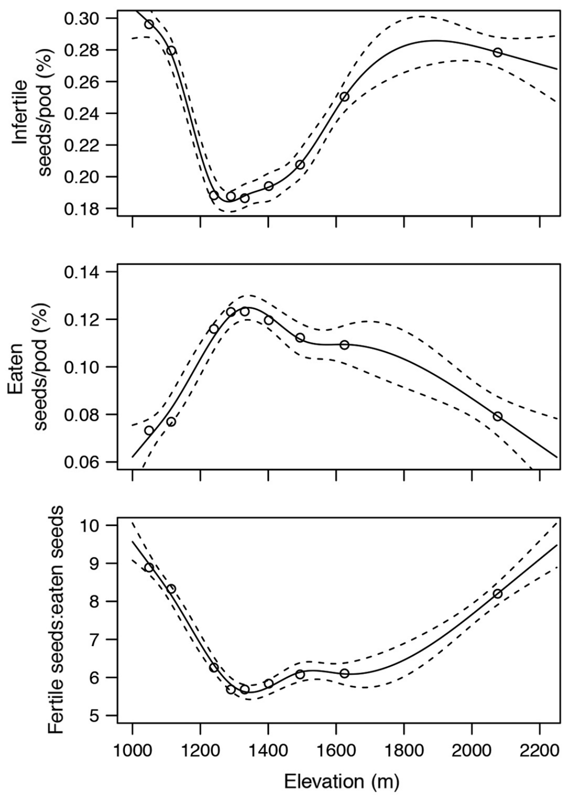

Fig. 7. The percent infertile seeds per pod, percent eaten seeds per pod across an elevation gradient, and the conditional variation of the ratio of the percent of fertile seeds and percent eaten seeds across the elevation gradient. There were no seeds produced at the extreme elevations of 1004 and 2212 m. Solid line shows a fit from a generalized additive model; dotted lines represent a 95% confidence interval.

Large trees may derive more resources from their environment, allowing them to potentially support a larger population of organisms that depend on them for survival (Greene and Johnson 1994). Except at extreme elevations, bigger Joshua trees, which had more flowers, hosted more pollinators (Fig. 6). They did not, however, produce more seeds (Fig. 4). This suggests that there are site-level characteristics across the elevation gradient, other than moth abundance, that contribute to tree reproductive success.

The number of flowers is linked to tree size both across and within sites. This relationship makes sense developmentally because after flowering, a Joshua tree produces a branch from the flower node; more branches can then support more flower panicles in flowering years (Rowlands 1978).

We found that the density of both pollinating moths and bogus yucca moths generally increases with the densities of live trees just as pollinator moths do. Curiously, there was a low abundance of both moth species at the sites (elevation 1500–1600 m) with the highest density of trees. These higher elevation sites were dominated by trees reproducing asexually. It is not clear whether moths are unable to thrive at these higher elevations or if the low numbers of flowers meant that location was unable to attract or support the moths. In either case, the low moth numbers mean low seed set for the trees. This elevation range, from 1500 to 1600 m, where trees thrive but moths do not, may be an important transition zone for future work on the details of the Joshua tree–yucca moth climate mismatch.

While tree density does not appear to drive moth abundance directly, we found a very strong relationship between moth and flower numbers. Yucca moths are directly dependent on flowers and use their resulting fruit as nurseries for their larva (Pellmyr 2003). Areas where the moth populations exceed the ability of plants to produce seed could lead to a loss of the next generation for both trees and moths, as one way the mutualism is kept in check is through abscission of flowers carrying excessive egg loads (Pellmyr and Huth 1994). However, we only found a relationship between moth and flower numbers within sites at middle elevations from 1240 to 1625. At extreme elevations, having more flowers did not correspond to higher moth numbers, which may indicate that in those areas, moth numbers are limited by site-specific conditions other than the number of flowers. For some insects that use fruit as a larval nursery, temperature can impact larval development (Krishnan et al. 2014). Temperature fluctuations may impact other stages of plant and animal life cycles in addition to flowering and pollinator emergence (Forrest 2015); yucca moths continue a portion of their life cycle underground and may be limited by temperature changes that they encounter in the soil at extreme elevation.

The relationship between moth abundance and seed production

We found that seed production was strongly dependent on moth numbers. The areas with no moths failed to produce any seeds, even though there were flowering Joshua trees present. 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. These results are consistent with findings of pollen-limited seed set in other yucca–yucca moth systems (Aker and Udovic 1981, Aker 1982, Addicott 1985, James et al. 1994). The decreased moth numbers and seed set at Joshua tree range margins suggest that these pollinators may play a key role in setting range limits.

Pod size, however, was not correlated with moth numbers. In many systems, fruit production can be resource limited and is linked to factors such as plant size or availability of key resources (Stephenson 1981, Fenner 2012). This is also found in other species of yucca where variance in fruit production was explained by geographic region as opposed to pollinator visitation (Udovic 1981). In Joshua trees, while the total number of fertile seeds may be dependent on the availability of pollinators, the size of the pods and seeds was smaller at range margins (Fig. 3), suggesting resource limitation. This appears to be more dependent on where the tree is growing and the resources it has available than tree size or pollinator number, because pod size does not vary consistently with changes in moth number or tree size. Small seed size could also contribute to the low seedling numbers toward range margins but was not examined here. These results suggest that both pollinator abundance and tree access to resources are key for producing large seed pods with high numbers of fertile seeds.

Trees growing at the elevation extremes of the range produced a higher percentage of infertile seeds than did trees at the middle elevations. Inside of the pods, developing moth larvae consume seeds by moving down a chamber within a locule until they encounter an infertile seed, at which point they exit the pod by chewing out through the side and drop to the ground to burrow and pupate (Ziv and Bronstein 1996). Thus, having some number of infertile seeds spaced among the fertile seeds can actually improve overall seed survival.

Moth density is linked with pod number and to the percent of fertile seeds across the sites but is weakly related to the total number of seeds per pod or pod length. One explanation could be that moth numbers remain low until around 1250 m elevation whereas total seed production (both fertile and infertile seeds) climbs before that. The flowers receive enough pollen to make infertile seeds but fertile seed set is low, either due to pollen quality or low abundance of pollen. Joshua trees may be producing large pods due to abundant available resources (soil, water and light). At either elevation extreme, the pods have a much higher percentage of infertile seeds. A lack of available pollinators could result in large pods with more infertile seeds due to the low number of pollination events, suggesting that reproduction is pollen limited in these locations. This would occur if the environmental envelope of the moth's range does not extend as far as the Joshua tree's range, so that the number of pollinators is lower toward the range edges, resulting in lower numbers of fertile seeds and higher infertile seeds. This idea is consistent with other studies of systems involving specialized pollinators (Wilcock and Neiland 2002, Trunschke et al. 2017).

Summarizing the outcomes of the mutualism across the elevation gradient

Our results suggest that the outcome of the Joshua tree–yucca moth mutualism varies with respect to its location on the elevation gradient, in agreement with other research that demonstrates context dependency in mutualistic interactions (Bronstein 1994, Chamberlain et al. 2014, Cass et al. 2016, Ji and Bever 2016, Tylianakis and Morris 2017). 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 (Fig. 2). 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.

As this study only considers a single elevational transect with one study site per elevation, other variables such as genetic similarity and weather patterns could co-vary with elevation, presenting a limitation inherent in the study design. However, the measures of growth and reproduction (except for flowers and moths) are integrated across many years at those sites, and while there will undoubtedly be temporal variation, these flower and fruit observations are consistent with those expected from the integrated data, thus supporting a temporal variability argument.

With species distribution information, we can focus on the key variables and conditions that influence population numbers and promote favorable mutualistic outcomes, as well as quantify the outcome of the association in different locations and the potential for species to track the changing climate. Future work with species distribution modeling that predicts how moths may respond to the changing climate could help us gauge if Joshua trees and their pollinators might overlap under future climate scenarios and how the local conditions may affect the outcomes of their mutualism.

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Supporting Information

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