Physaria kingii subsp.*bernardina* (*Lesquerella k.* subsp. *b.*)
(San Bernardino Mountains bladderpod)

5-Year Review:
Summary and Evaluation

Photo by Mary Crawford/USFS

U.S. Fish and Wildlife Service
Carlsbad Fish and Wildlife Office
Carlsbad, California

August 2022

ACKNOWLEDGEMENT

This 5-year Status Review was prepared by Kaitlyn Howell during her 2021 Directorate Fellows Program fellowship at the Carlsbad Fish and Wildlife Office. To complete this assessment, Kaitlyn conducted a literature review, updated occurrence data, coordinated with the U.S. Fish and Wildlife Service staff and external partners, assessed current threats to the species, and identified priority research and conservation tasks.

5-YEAR REVIEW

Physaria kingii subsp. *bernardina (Lesquerella k.* subsp. *b.)* (San Bernardino Mountains bladderpod)

GENERAL INFORMATION

Species: *Physaria kingii* subsp. *bernardina* (*Lesquerella k.* subsp. *b.*), San Bernardino Mountains bladderpod, a plant species
Date listed under the Endangered Species Act: August 24, 1994
Federal Register citation: USFWS 1994 (59 FR 43652)
Classification: Endangered
Recovery Plan: USFWS 1997, Draft, San Bernardino Mountains carbonate endemic plants Recovery Plan
Recovery Priority Number: 9C
Critical Habitat Designation: USFWS 2002 (67 FR 78569)

BACKGROUND

Under the Endangered Species Act of 1973, as amended (Act; 16 U.S.C. 1531 *et seq*.), the U.S. Fish and Wildlife Service's (USFWS), referred to as "we" in this document, maintain lists of endangered and threatened wildlife and plant species (referred to as the List) in the Code of Federal Regulations (CFR) at 50 CFR 17.11 (for wildlife) and 17.12 (for plants). Section 4(c)(2)(A) of the Act requires us to review each listed species' status at least once every 5 years.

Most recent status review: USFWS 2009. *Physaria kingii* subsp. *bernardina* (San Bernardino Mountains bladderpod); 5-year Review: Summary and Evaluation. Carlsbad Fish and Wildlife Office, Department of the Interior. 19 pp.

We initiated a status review for *Physaria kingii* subsp. *bernardina* in 2008. The review was finalized on August 13, 2009, and recommended no change in listing status.

Federal Register notice announcing this status review: On May 20, 2021, we published a Federal Register notice announcing initiation of the 5-year review of this species, and the opening of a 60-day comment period to receive information (USFWS 2021, pp. 27462–27464). We received no information about *Physaria kingii* subsp. *bernardina*.

Species overview and habitat: *Physaria kingii* subsp. *bernardina* (PHKIBE) is a short-lived perennial plant in the mustard family (*Brassicaceae*). This species is endemic to the San Bernardino Mountains, where it grows on carbonate soils in pinyon-juniper woodland and white fir forest (USFWS 1994, p. 43654). We designated critical habitat for this species in 2002 (USFWS 2002, entire).

ASSESSMENT

Information acquired since the last status review

This 5-year review was conducted by the USFWS Carlsbad Fish and Wildlife Office. Data for this review were solicited from the public and interested parties through a Federal Register notice announcing this review on May 20, 2021 (USFWS 2021, pp. 27462–27464). We also contacted Federal partners (the U.S. Forest Service) to request any data or information we should consider in our review. Additionally, we conducted a literature search and a review of information in our files.

SUMMARY OF NEW INFORMATION SINCE 2009

Distribution and Occurrence Status

Since 2009, no studies have examined PHKIBE life history, biology, or genetics. No occurrence[1] table was included in the previous review, but PHKIBE was known to occur from two areas on either side of Big Bear Valley. We have new information about these occurrences from site visits since 2009, including:

1. In 2010, the California Department of Fish and Wildlife (CDFW) collected seed for PHKIBE at California Natural Diversity Database (CNDDB) Element Occurrences (EOs) 1 and 4 (CDFW 2012, unpaginated). PHKIBE was found at both locations.

2. In 2011, California Botanic Garden (formerly Rancho Santa Ana Botanic Garden) completed a floristic survey of the Upper Santa Ana River watershed on the San Bernardino National Forest (SBNF). The effort included surveying for special status plant taxa (Fraga *et al.* 2011, p. 19). PHKIBE was found on carbonate outcrops near Coon Creek (Fraga *et al.* 2011, p. 34).

3. In 2015, the U.S. Forest Service (USFS) conducted emergency consultation on eight threatened or endangered species and critical habitat that may have been affected by the Lake Fire or associated response activities (USFS 2015, pp. 2–3). PHKIBE was found during site visits in the Coon Creek area (USFS 2015, pp. 84–90). Impacts to individual plants from fire suppression activities may have occurred, but no critical habitat was affected (see Fire Suppression Activities below).

There are three new occurrences not previously considered in the 2009 review. These new occurrences do not represent a significant range extension for PHKIBE. They are:

1. EO 9 was reported by Stoughton and Ashbaker in 2010 (CDFW 2021).

[1] The California Natural Diversity Database (CNDDB) is an inventory of the status and locations of rare plants and animals in California. The CNDDB assigns "Element Occurrence" (EO) numbers to unique locations of rare taxa. In this document, we use the term "occurrence" to refer to EOs delineated by the CNDDB, or locations not in the CNDDB that are greater than 0.25 miles (0.40 kilometers) apart.

2. Two occurrences were reported by the U.S. Forest Service (USFS) but have not been reported in the CNDDB. The first was observed during a biological assessment for the Lake Fire in 2015 (USFS 2015). This occurrence is approximately 2 miles (mi) [3.22 kilometers (km)] northeast of EO 9, and therefore represents a new EO. The second occurrence was reported in 2019 by USFS and is located approximately 0.67 mi (1.08 km) west of EO 1 and should also be considered a new EO.

We have also updated several occurrences based on new information from State and Federal partners. Changes in occurrence status since 2009 are:

1. Three EOs (CNDDB EO 3,7, and 8) were determined to be erroneous. The location of EO 3 was incorrectly recorded and is likely included in EO 1 (Eliason 2021, pers. comm.). EO 7 was erroneously mapped near the city of Sugarloaf. The herbarium record for EO 7 places it in EO 1 (CCH2 2021). EO 8 was determined to be erroneous because there is no reliable location information for this record (Eliason 2021, pers. comm.).

2. Two EOs (CNDDB EO 5 and 6) were considered extant in 2009. EO 5 has not been seen since 2008 despite suitable habitat, and EO 6 has not been seen since 2004. We now consider them presumed extant since they have not been observed in more than 10 years.

In summary, since the 2009 review we have received new information about PHKIBE occurrences from site visits. We recorded three new occurrences and updated five occurrence statuses. Based on information from the 2009 review and new information, there are currently seven occurrences of PHKIBE (Figure 1, Table 1). We determined that two occurrences are presumed extant and five occurrences are extant.

Threats

Our 2009 5-year review discussed Factor A threats (present or threatened destruction, modification, or curtailment of habitat or range) to PHKIBE from: (1) unauthorized off-highway vehicle (OHV) use; (2) urban development; (3) mining; and (4) fire suppression activity (USFWS 2009, pp. 6–7). The review discussed Factor D threats (inadequacy of existing regulatory mechanisms) and Factor E threats (other natural or manmade factors affecting a species' continued existence) from stochastic extinction and climate change.

This section summarizes new information about threats to PHKIBE since 2009. We have new information about the threats of fire suppression activities and climate change. Below, we also discuss biological opinions (USFWS 2015, entire; 2019, entire) issued to the USFS, which addresses potential effects on PHKIBE.

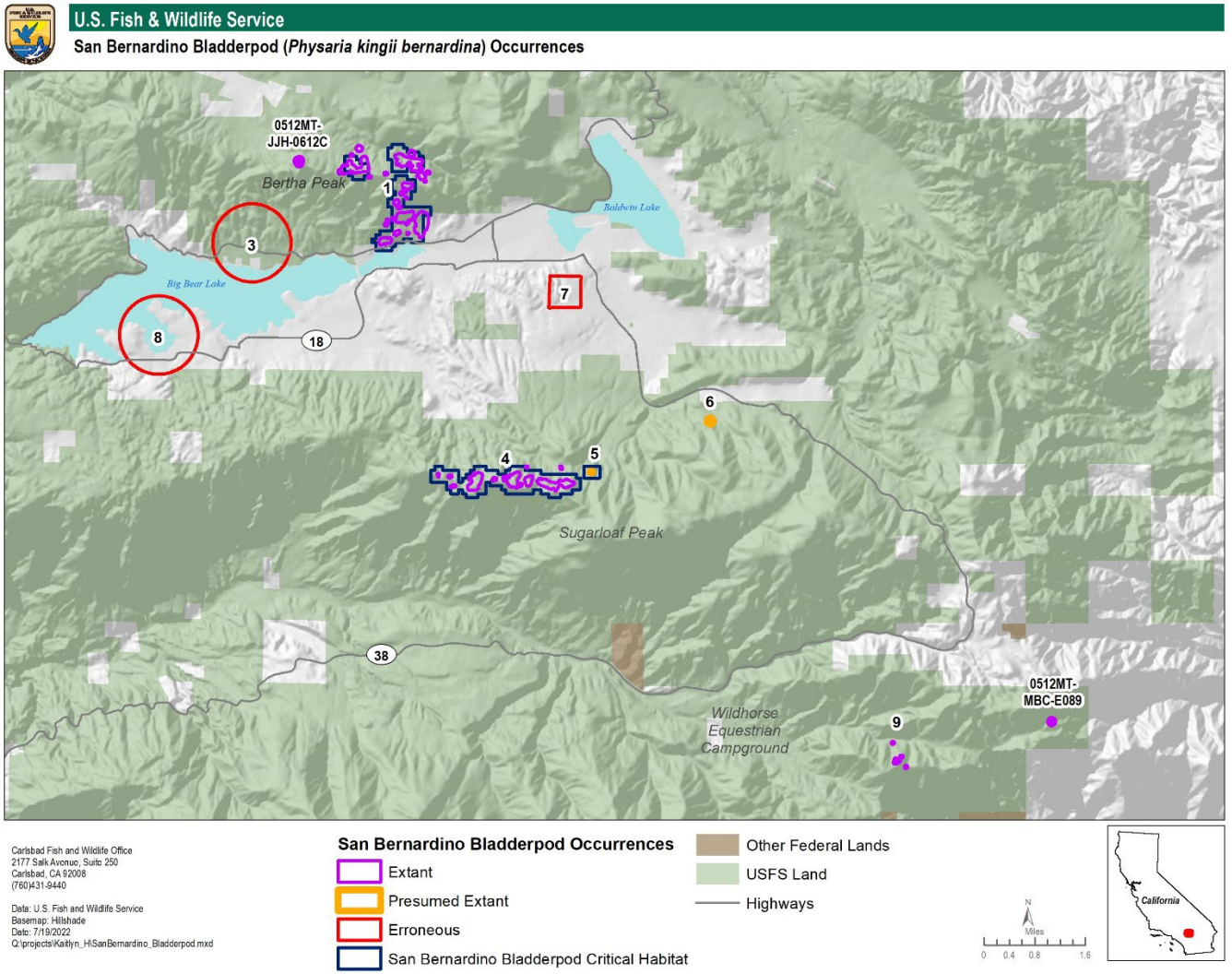

Figure 1. Map of San Bernardino National Forest indicating PHKIBE occurrences documented by CNDDB and USFS. Individual numbers indicate CNDDB EOs. The numbers and letters in series indicate the two USFS ID codes for occurrences not currently in CNDDB.

Table 1. PHKIBE occurrence table showing 2021 occurrence status and changes since listing and 2009 5-year review. "Number of USFS occurrences" refers to the number of individual Forest Service occurrences that make up the CNDDB EO.

2021 Location Name	CNDDB EO Number or USFS ID code	Number of USFS Occurrences	Status at listing[1]	2009 Status	2021 status	Owner	Conservation Status[2]	Counts	Threats	Change summary since 2009	References
Bertha Ridge	EO 1	40	Extant	Extant	Extant	USFS, Private	Conserved	26,358 (1980), 6,300 plus (1988), PARTS OF EO: 375 (2008), 71 (2009), 700 (2010), 100 (2011), seen (2012), 1 (2015), 2187 (2019)	Mining, OHV use, dumping, road/trail maintenance, dumping, wood cutting	Parts of EO visited in 2010, 2011, 2012, 2015, 2019. Some plants extirpated in SW, SE ends of site. Includes former EO 2 and should also include EO 3 and 7.	Eliason 2021, pers. comm., CDFW 2021, entire
Bertha Ridge	0512MT-JJH-0612C	1	n/a	n/a	Extant	USFS	Conserved	300 (2019)	n/a	First observed in 2019, based on USFS occurrence 0512MT-JJH-0612C. EO is not currently in CNDDB database.	USFS 2021, unpubl. data
Sugarloaf Ridge	EO 4	23	Extant	Extant	Extant	USFS	Conserved	10,000 (1991), approximately 15,000 TO 20,000 (2004), PORTIONS OF SITE: 3 (2006), seen (2008), 800 (2009), 300 (2010), 100 (2012), 477 (2014)	OHV use, trampling, heavy ski activity, hiker trail, proposed mountain bike trail	Portions of site sampled in 2010, 2012, 2014.	CDFW 2021, entire
Sugarloaf Ridge	EO 5	1	n/a	Extant	Presumed extant	USFS	Conserved	n/a	n/a	Last seen in 2008, not found in 2014 site visit despite suitable habitat.	CDFW 2021, entire

2021 Location Name	CNDDB EO Number or USFS ID code	Number of USFS Occurrences	Status at listing[1]	2009 Status	2021 status	Owner	Conservation Status[2]	Counts	Threats	Change summary since 2009	References
Sugarloaf Ridge	EO 6	1	n/a	Extant	Presumed extant	USFS	Conserved	n/a	n/a	No site visits since 2004.	CDFW 2021, entire
n/a	EO 3	n/a	n/a	n/a	Erroneous	n/a	n/a	n/a	n/a	n/a	Eliason 2021, pers. comm., CDFW 2021, entire
n/a	EO 7	n/a	n/a	n/a	Erroneous	n/a	n/a	n/a	n/a	n/a	CDFW 2021, entire, CCH2 2021, entire
n/a	EO 8	n/a	n/a	n/a	Erroneous	n/a	n/a	n/a	n/a	n/a	CDFW 2021, entire
Coon Creek Campground area, west	EO 9	7	n/a	n/a	Extant	USFS	Conserved	15 (2010), 1 (2011), 13 (2014), 17 (2015)	Foot traffic, recreational use (non-OHV); fire, fire-related activity	First observed in 2010.	CDFW 2021, entire
Coon Creek Campground area, east	0512MT-MBC-E089	1	n/a	n/a	Extant	USFS	Conserved	18 (2015)	Fire, fire-related activity	First observed in 2015, based on USFS occurrence 0512MT-MBC-E089. EO is not currently in CNDDB database.	USFS 2021, unpubl. data

[1] Extant status indicates the occurrence has been observed within the last 10 years. Presumed extant occurrences have not been observed for over 10 years, but suitable habitat is present. Erroneous occurrences were recorded in an incorrect location or some other aspect is erroneous.
[2] For the purposes of this document, the definition of "conserved" includes land unlikely to be developed such as those managed by USFS.
n/a – Not applicable.

Fire Suppression Activities

In the 2009 5-year review, we discussed fire suppression activities and effects to PHKIBE (USFWS 2009, p. 7). This section discusses fire suppression activities since 2009.

The Lake Fire burned approximately 31,359 acres of the San Bernardino Mountains in 2015 (USFS 2015, p. 2). The Forest Service initiated emergency section 7 consultation with us, and prepared a Biological Assessment (USFS 2015, entire). The fire burned primarily south and east of State Highway 38 in the San Gorgonio Wilderness. Two PHKIBE occupied areas were burned or affected by suppression activities. The areas burned or affected by associated suppression activities were:

1. Coon Creek West (CNDDB EO 9). This area did not burn, but suppression activities created a foot trail that was approximately 4 feet (ft) [1.22 meters (m)] from an individual PHKIBE (USFS 2015, pp. 84–86). Some soil was disturbed but there was minor impact to the habitat.

2. Coon Creek East (USFS site 0512MT–MBC–E089). This area was at the edge of the fire perimeter exposing it to ash and some trees in the immediate vicinity were burned (USFS 2015, p. 89). Trails and hand lines were created causing soil disturbance, vegetation damage, and trash to be present in the area.

USFS determined that Lake Fire suppression activities may have adversely affected individual plants but did not affect any designated critical habitat (USFS 2015, p. 93).

Climate Change

Climate change refers to a shift in the mean or variability in measures of climate (e.g., precipitation or temperature) that persists for an extended period of time, typically a decade or more, due to natural variability, human activity, or both (IPCC 2013, p. 1450). In our 2009 5-year review, we considered climate change as a threat to PHKIBE. Since then, downscaled projections under multiple future climate scenarios have become available for California, including across the range of PHKIBE in the San Bernardino Mountains.

Temperature changes

The San Bernardino Mountains have experienced a warming trend from 1951 to 2006 (PRISM Group 2007, pp. 2–10; Hall *et al.* 2018, p. 9). Cal-Adapt models project that annual average maximum and minimum temperatures will continue to increase in the 21st century (Table 2). Specifically, annual average maximum temperatures are projected to increase by 5.9 degrees Fahrenheit (F) (3.3 degrees Celsius) under Representative Concentration Pathway (RCP) 4.5, and by 8.7 degrees F (4.8 degrees Celsius) under RCP 8.5 between 2070 and 2099 (CEC 2021, unpaginated). The frequency, duration, and intensity of heat waves is also expected to increase (Hall *et al.* 2018, p. 12; Kalansky *et al.* 2018, p. 21).

Table 2. Projected annual average maximum and minimum temperatures for the range of PHKIBE in the San Bernardino Mountains. The values are the average of projections from four priority models (MIROC5, CanESM2, HadGEM2-ES, and ENRM-CM5) during the mid-century (2040–2069) and end-of-century time period (2070–2099). Data from Cal-Adapt (CEC 2021, unpaginated).

Year Range	RCP 4.5 projected annual average maximum temperature (degrees F ± standard deviation)	RCP 4.5 projected annual average minimum temperature (degrees F ± standard deviation)	RCP 8.5 projected annual average maximum temperature (degrees F ± standard deviation)	RCP 8.5 projected annual average minimum temperature (degrees F ± standard deviation)
Historical (1950-2005)	63.8 ± 1.2	34.4 ± 1.3	63.8 ± 1.2	34.4 ± 1.3
Mid-century (2040-2069)	68.4 ± 1.3	38.8 ± 1.0	69.9 ± 1.3	40.2 ± 1.4
End of century (2070-2099)	69.7 ± 1.1	39.9 ± 1.0	72.5 ± 1.5	43.5 ± 1.7

Precipitation changes

Climate change has already altered, and will continue to alter, the water cycle. Changes in the water cycle include: (1) changes in precipitation patterns and intensity; (2) changes in the incidence of drought; (3) widespread melting of snow and ice; (4) increasing evaporation; and (5) changes in soil moisture and runoff (USGCRP 2009, p. 41).

Precipitation in southern California is highly variable from year to year (Hall *et al.* 2018, p. 12; Kalansky *et al.* 2018, p. 24). Models of future precipitation generally project small mean changes relative to historical variability, and the overall direction of future precipitation is unclear (Hall *et al.* 2018, p. 13). Models do project increases in extreme precipitation frequency and intensity (Polade *et al.* 2017, p. 7; Swain *et al.* 2018, p. 428), including increases in the frequency of atmospheric-river storms, which deliver intense precipitation and can cause severe flooding (Dettinger 2011, p. 519). However, droughts are also projected to become more frequent and intense and will be exacerbated by higher temperatures (Kalansky *et al.* 2018, p. 25).

In Big Bear Valley (San Bernardino Mountains), average annual precipitation ranges from about 18 to 35 inches. Due to a rain shadow effect, precipitation generally decreases from west to east across the valley (USGS 2012, p. 4). Therefore, the effects of changing precipitation amount and timing will also likely differ at a relatively small scale in the San Bernardino Mountains.

Snowpack changes

Warming trends have already driven declines in mountain snowpack across the western United States (Mote *et al.* 2018, p. 4). Snowpack is affected by temperature and precipitation. In a warmer climate, a higher proportion of precipitation is expected to fall as rain rather than snow, snowpack is expected to melt earlier and more quickly, and snow lines are expected to rise (Viers *et al.* 2013; Dettinger *et al.* 2018, p. 21).

Sun *et al.* (2016) used downscaled general circulation models under two scenarios to predict future snowfall and snowpack in the southern California mountains. Their models included the San Bernardino, San Jacinto, and Los Angeles County Mountains. They projected that under RCP 8.5, midcentury mean snowfall would be 30 percent lower than baseline snowfall, and that snowfall loss would be greatest at lower and mid-elevations (Sun *et al.* 2016, pp. 106–107). Projections of the timing of snow-free date (i.e., how much earlier snow melts compared to baseline) differed depending on the model used, but on average the snow-free date occurred 16 days earlier (Sun *et al.* 2016, p. 108).

In addition to the projections of Sun *et al.* (2016, entire), projected changes in snow water equivalence (the amount of water contained in snowpack) are available from Cal-Adapt. For the range of PHKIBE in the San Bernardino Mountains, Cal-Adapt models project reductions in snow water equivalence in the 21st century compared with the observed historical baseline (CEC 2021, unpaginated; Table 3).

Table 3. Projected February snow water equivalence (SWE) for the range of PHKIBE in the San Bernardino Mountains. The values are the average of projections from four priority models (MIROC5, CanESM2, HadGEM2-ES, and ENRM-CM5) during the mid-century (2040–2069) and end-of-century time period (2070–2099). Data from Cal-Adapt (CEC 2021, unpaginated).

Year range	RCP 4.5 (inches ± standard deviation) projected February SWE	RCP 8.5 (inches ± standard deviation) projected February SWE
1950–2005 (observed)	2.03 ± 2.54	2.03 ± 2.54
2040–2069	1.12 ± 1.72	1.00 ± 1.87
2070–2099	0.85 ± 1.47	0.43 ± 0.80

It is currently unclear how important snowpack may be for PHKIBE compared to other climate variables (e.g., temperature and precipitation). Snowpack likely varies by occurrence. For example, PHKIBE occurrences on Sugarloaf Ridge may receive more snowpack than other locations due to elevation and latitude (USGS 2012, pp. 4, 45). Therefore, effects of snowpack changes may vary on a small scale across the range of PHKIBE.

Climate change summary and conclusion

For this 5-year review, we discussed projections from Sun *et al.* (2016, entire), reports from California's Fourth Climate Change Assessment (Hall *et al.* 2018, entire; Kalansky *et al.* 2018, entire; Pierce *et al.* 2018, entire), and data from Cal-Adapt (CEC 2021). These models provide projections of future temperature, precipitation, and snowpack in the southern California mountains under two emissions scenarios (RCP 4.5 and 8.5).

In the 2009 review, we discussed potential effects of climate change on montane species but did not have enough information to make specific predictions about effects to PHKIBE (USFWS 2009, pp. 11–12). Since then, new climate projections have become available for the range of PHKIBE, but we do not have specific information about how those changes will affect the species. However, the projected abiotic pressures resulting from climate change—increased

temperatures and changes in precipitation and snowpack—could alter PHKIBE habitat, particularly through altered soil moisture. Changes in precipitation amount and timing could impact individual PHKIBE at all life stages by reducing the amount of water available for germination, growth, and reproduction. Increasing temperatures combined with greater precipitation extremes could cause drier conditions, potentially decreasing PHKIBE population resiliency.

U.S. Forest Service Consultations

We issued a biological opinion in 2015 on proposed fuel reduction actions of the USFS in the Mountaintop Ranger District of the SBNF (USFWS 2015, entire). The SBNF proposed three fuels reductions projects within Big Bear Valley – the North Big Bear, Baldwin Lake, and Bluff Mesa projects. We determined that the proposed action was not likely to jeopardize the existence of PHKIBE nor negatively impact designated critical habitat (USFWS 2015, p. 40). We reached this conclusion because the USFS will implement avoidance and minimization measures, initial impacts from implementation of the project will be short in duration, design criteria and conservation measures will minimize the amount and intensity of treatments necessary to meet fuel objectives, and any unauthorized roads utilized for the project would be rehabilitated and blocked upon project completion.

In 2019, we issued a biological opinion for the ongoing activities affecting 12 mountain plant species on the SBNF, including PHKIBE (USFWS 2019, entire). We discussed the general effects of nine USFS management programs on listed species (USFWS 2019, pp. 18–26), and specific effects to PHKIBE (USFWS 2019, pp. 50–55).

We determined that the implementation of the USFS's Revised Land Resource Management Plan (Forest Plan, USFS 2006, entire) was not likely to jeopardize the continued existence of PHKIBE or result in destruction or adverse modification of critical habitat (USFS 2006, p. 55). We reached this conclusion because the USFS will minimize and avoid impacts from management programs (USFWS 2019, p. 55) through protective measures and management directions (USFWS 2019, pp. 9–12, Enclosure: Appendix A).

Summary of threats

Since the 2009 5-year review, we have received new information about ongoing threats to PHKIBE relating to (1) fire suppression activities and (2) climate change. This new information does not alter the conclusions of our 2009 5-year review.

CONCLUSION

In the 2009 review we recommended no status change for PHKIBE. Since 2009, we received new information on occurrences and threats to PHKIBE. We have recorded three new occurrences and updated the occurrence status of five occurrences. Based on the 2009 review and these updates, there are currently seven occurrences of PHKIBE; two are presumed extant and five are extant (Table 1).

The new recorded occurrences, updated occurrence status, and threats do not substantially alter the species status nor the results of the previous 5-factor analysis in the 2009 5-year review.

Therefore, we conclude that PHKIBE remains a federally listed endangered species and do not recommend a change in status at this time.

RECOMMENDATIONS FOR FUTURE ACTIONS

The recommended actions listed below are to be initiated over the next 5 years. Successful implementation of these actions will reduce threats to PHKIBE and provide information to better understand the biological and physical factors limiting population growth and distribution. We recognize that conservation of this taxon will require cooperation and coordination with partners to minimize impacts from current threats and aid future restoration efforts.

1. Study PHKIBE population genetics, including levels of genetic diversity and differentiation among and within occurrences. Determine levels of inbreeding, relatedness, and ploidy. This information will help us assess current levels of genetic diversity and gene flow and determine if genetic management is needed and assess appropriate seed sources for potential future reintroduction or augmentation activities.

2. Continue to collect additional seeds from PHKIBE occurrences to expand the conservation seed bank at the California Botanic Garden.

3. Continue working with the SBNF to monitor species occurrences and determine an appropriate monitoring frequency.

REFERENCES CITED

[CCH2] Consortium of California Herbaria 2. 2021. Detailed collection record information for catalog number UCR104655, collected by Wear and Moorhatch. Regents of the University of California. Website viewed June 2021. https://www.cch2.org/portal/collections/individual/index.php?occid=1469559&clid=0.

[CDFW] California Department of Fish and Wildlife. 2012. Seed collection and banking of 50 plant species of critical conservation concern, Phase 2, Final Performance Report. Endangered Species Act (Section 6) Grant-in-Aid Program; seed bank collection reports prepared by Michael Wall, Rancho Santa Ana Botanic Garden, State of California. 59 pp.

[CDFW] California Department of Fish and Wildlife. 2021. Occurrence report for San Bernardino bladderpod. California Natural Diversity Database, State of California. 10 pp.

[CEC] California Energy Commission. 2021. Cal-Adapt. California Energy Commission. Website viewed June 22, 2021. https://cal-adapt.org/.

Dettinger, M. 2011. Climate Change, Atmospheric Rivers, and Floods in California - A Multimodel Analysis of Storm Frequency and Magnitude Changes1. JAWRA Journal of the American Water Resources Association 47:514-523.

Dettinger, M., H. Alpert, J. Battles, J. Kusel, H. Safford, D. Fougeres, C. Knight, L. Miller, and S. Sawyer. 2018. Sierra Nevada Region Report. California's Fourth Climate Change Assessment, 94 pp.

Fraga, N.S., L. Gross, D. Bell, O. Mistretta, J. Wood, and T. Stoughton. 2011. The vascular flora of the Upper Santa Ana River watershed, San Bernardino Mountains, California. Crossosoma 37:9–111.

Hall, A., N. Berg, and K. Reich. 2018. Los Angeles region report. California's Fourth Climate Change Assessment. Publication number: SUM-CCCA4-2018-007, 97 pp.

[IPCC] Intergovernmental Panel on Climate Change. 2013. Climate change 2013: the physical science basis: Working Group I contribution to the Fifth assessment report of the Intergovernmental Panel on Climate Change [Stocker, T.F., D. Qin, G.-K. Plattner, M. Tignor, S.K. Allen, J. Boschung, A. Nauels, Y. Xia, V. Bex and P.M. Midgley (eds.)]. Cambridge University Press, 1535 pp.

Kalansky, J., D. Cayan, K. Barba, L. Walsh, K. Brouwer, and D. Boudreau. 2018. San Diego summary report. California's Fourth Climate Change Assessment. Publication number: SUM-CCCA4-2018-009, 114 pp.

Mote, P.W., S. Li, D.P. Lettenmaier, M. Xiao, and R. Engel. 2018. Dramatic declines in snowpack in the western US. Nature Partner Journals Climate and Atmospheric Science 1:1–6.

Pierce, D.W., J.F. Kalansky, and D.R. Cayan. 2018. Climate, drought, and sea level rise scenarios for California's Fourth Climate Change Assessment. California's Fourth Climate Change Assessment, California Energy Commission.

Polade, S.D., A. Gershunov, D.R. Cayan, M.D. Dettinger, and D.W. Pierce. 2017. Precipitation in a warming world: Assessing projected hydro-climate changes in California and other Mediterranean climate regions. Scientific Reports 7:10783-10.

PRISM Group. 2007. Climate Wizard, change in annual temperature 1951–2006. Website viewed November 22, 2013. http://www.climatewizard.org.

Sun, F., A. Hall, M. Schwartz, D.B. Walton, and N. Berg. 2016. Twenty-first-century snowfall and snowpack changes over the southern California mountains. Journal of Climate 29:91–110.

Swain, D.L., B. Langenbrunner, J.D. Neelin, and A. Hall. 2018. Increasing precipitation volatility in twenty-first-century California. Nature Climate Change 8:427-433.

[USFWS] U.S. Fish and Wildlife Service. 1994. Endangered and threatened wildlife and plants; five plants from the San Bernardino Mountains in southern California determined to be threatened or endangered. Federal Register 59:43652–43664.

[USFWS] U.S. Fish and Wildlife Service. 1997. San Bernardino Mountains Carbonate Plants Draft Recovery Plan. U.S. Fish and Wildlife Service, Portland, Oregon. 51 pp.

[USFWS] U.S. Fish and Wildlife Service. 2002. Endangered and threatened wildlife and plants; designation of critical habitat for five carbonate plants from the San Bernardino Mountains in southern California. Federal Register 67:78570–78610.

[USFWS] U.S. Fish and Wildlife Service. 2009. *Physaria (Lesquerella) kingii* subsp. *bernardina* (San Bernardino Mountains Bladderpod) 5-Year Review: Summary and Evaluation. Carlsbad Fish and Wildlife Field Office, Department of the Interior. 19 pp.

[USFWS] U.S. Fish and Wildlife Service. 2015. North Big Bear, Baldwin Lake, and Bluff Mesa Fuels Reduction Projects, Mountaintop Ranger District, San Bernardino National Forest, California. Carlsbad Fish and Wildlife Field Office, Department of the Interior. 109 pp.

[USFWS] U.S. Fish and Wildlife Service. 2019. Biological Opinion on the ongoing activities that affect twelve mountain plant species in the San Bernardino National Forest, California. Carlsbad Fish and Wildlife Office, Department of the Interior. 109 pp.

[USFWS] U.S. Fish and Wildlife Service. 2021. Endangered and Threatened Wildlife and Plants; Initiation of 5-Year Status Reviews of 76 Species in California and Nevada. Federal Register 86:27462–27464.

[USFS] U.S. Forest Service. 2006. Revised Land Management Plan, Final Environmental Impact Statement, and Record of Decision of Angeles, Cleveland, Los Padres, and San Bernardino National Forest. Pacific Southwest Region, Department of the Interior.

[USFS] U.S. Forest Service. 2015. Biological Assessment for the Lake Fire Incident for consultation under Section 7 of the Endangered Species Act on the effects of the emergency response and associated actions. Mountaintop and Front Country Ranger Districts, U.S. Department of Agriculture. 93 pp.

[USFS] U.S. Forest Service. 2021. Natural Resource Information System Data. San Bernardino National Forest, Mountaintop Ranger District, Department of Agriculture. Unpublished Data.

[USGS] U.S. Geological Survey. 2012. Geohydrology of Big Bear Valley, California: *Phase 1*—geologic framework, recharge, and preliminary assessment of the source and age of groundwater. Flint, L.E., and P. Martin, eds., with contributions by Brandt, J., A.H. Christensen, A.L. Flint, L.E. Flint, J.A. Hevesi, R. Jachens, J.T. Kulongoski, P. Martin, and M. Sneed. U.S. Department of the Interior. 130 pp.

[USGCRP] U.S. Global Change Research Program. 2009. Global climate change impacts in the United States, T.R. Karl, J.M. Melillo, and T.C. Peterson (eds.). Cambridge University Press, 196 pp.

Viers, J.H., S.E. Purdy, R.A. Peek, A. Fryjoff-Hung, N.R. Santos, J.V. Katz, J.D. Emmons, D.V. Dolan, and S.M. Yarnell. 2013. Montane meadows in the Sierra Nevada: changing hydroclimatic conditions and concepts for vulnerability assessment. University of California, Davis, Biomes and Ecosystems. 63 pp.

Personal communications

Eliason, S. 2021. Botanist, USFS, San Bernardino National Forest Mountaintop Ranger District. Email correspondence to Kaitlyn Howell, DFP Fellow, USFWS, Carlsbad Fish and Wildlife Office and Mary Crawford, Fish and Wildlife Biologist, USFWS, Carlsbad Fish and Wildlife Office. Subject: San Bernardino Mountains bladderpod occurrence location, San Bernardino County, California, USA.

FIELD OFFICE APPROVAL

Lead Field Supervisor, Fish and Wildlife Service

☒ Approve

SCOTT SOBIECH

Digitally signed by SCOTT SOBIECH
Date: 2022.08.30 09:05:08 -07'00'

Scott A. Sobiech
Field Supervisor