5-YEAR REVIEW

Thelypodium stenopetalum
(Slender-petaled mustard)

GENERAL INFORMATION

Species: *Thelypodium stenopetalum* (slender-petaled mustard), a plant species

Date listed under the Endangered Species Act: August 31, 1984

FR citation(s): USFWS 1984 (49 FR 34497–34500)

Classification: Endangered

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 (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 2011. *Thelypodium stenopetalum* (slender-petaled mustard); 5-year Review: Summary and Evaluation. Carlsbad Fish and Wildlife Office, Department of the Interior. 34 pp.

We initiated a status review for *Thelypodium stenopetalum* in 2009. The review was finalized on March 10, 2011 and recommended no change in status.

FR Notice citation announcing this status review: On January 27, 2020, 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 (85 FR 4692; USFWS 2020, pp. 4692–4694). We received no information about *Thelypodium stenopetalum*.

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 January 27, 2020 (USFWS 2020, pp. 4692–4693). We also contacted State and Federal partners and species experts 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 2011:

Biology and occurrence status

Since 2011, no studies have examined *Thelypodium stenopetalum* biology, life history, or genetics. We do have new information from 2015 to 2020 annual monitoring at the Baldwin Lake Ecological Reserve (Reserve), and from other site visits (Table 1; Figure 1). When discussing these visits, we reference the California Natural Diversity Database (CNDDB) Element Occurrence Number (EO) (CDFW 2020, entire).

Botanists from the California Department of Fish and Wildlife (CDFW) monitored *Thelypodium stenopetalum* at the Reserve (CNDDB EO 1) between 2015 and 2020 (Burton 2018, unpaginated; CDFW 2018, pp. 4–15; Burton 2019, unpaginated; Bjerke 2020, unpaginated), and the CDFW developed a monitoring plan and three management objectives for *T. stenopetalum* at the Reserve (CDFW 2018, entire). The management objectives are to: (1) maintain a population with both rosette and flowering individuals for 3 of 5 years between 2018 and 2022, (2) prevent disturbances at the Reserve, and (3) prevent nonnative plant species invasions from impacting *T. stenopetalum* (CDFW 2018, pp. 7–8). If future monitoring indicates that management objective 1 is not being met, CDFW would initiate reintroduction efforts. If off-highway vehicle use or other threats are identified in the future, the CDFW would repair fences or consider other management alternatives (CDFW 2018, p. 17).

At the Reserve, CDFW reported that:

1. No plants were counted in 2015 (a year with lower than average prior 2- and 3-year precipitation totals), and 51 plants were counted in 2017, a year when the 2-year precipitation total was above-average (CDFW 2018, pp. 11–12) (Figure 2; Table 2). [Previous research (Henderson 2003, pp. 28–29, 55–58) found that the annual number of *Thelypodium stenopetalum* plants was correlated with prior-year precipitation].

2. Over the 5-year monitoring period, the highest number of plants was observed in 2020, when CDFW botanists reported 188 plants (101 reproductive, 87 rosettes), with 4,725 buds, flowers, or fruits (Bjerke 2020, unpaginated). In 2020, the number of reproductive plants was greater than the number of prior-year (2019) rosettes, suggesting that some rosettes may have been present in 2019, but were not counted.

3. In 2020, aphids were present on at least 12 reproductive plants, but plants generally looked healthy (Bjerke 2020, unpaginated).

In 2011 and 2014, U.S. Forest Service (USFS) botanists visited *Thelypodium stenopetalum* occurrences at Eagle Point Lot K (CNDDB EO 2) (USFS 2020b). A total of 30 plants were found in 2011, and 1 plant was found in 2014 (Table 1).

Since 2011, *Thelypodium stenopetalum* has been reported west of CNDDB EO 6. Specifically, Tom Dodson and Associates reported that *Thelypodium stenopetalum* was present on a 3.17 acre (ac) [1.28 hectares (ha)] mitigation site near the Big Bear Area Regional Wastewater Agency administration building (BBCCSD 2016, p. 21).

In 2020, USFS botanists visited *Thelypodium stenopetalum*-occupied meadows. They reported 897 plants across the 5 meadows visited (USFS 2020a). At two occurrences, they collected seed for *ex situ* conservation, and at four occurrences, they collected tissue for future genetic analysis (USFS 2020a) (Table 1).

For this review, we revised the status of several *Thelypodium stenopetalum* occurrences since the 2011 5-year review, and we discuss an additional occurrence in North Baldwin Meadow that was not considered in the 2011 5-year review. Changes to occurrence status between 2011 and 2021 are:

1. We considered CNDDB EO 8 (Big Bear City Meadow Fragments; Figure 1) extirpated in 2011 (USFWS 2011, p. 32), but we consider it possibly extirpated in this review (Table 1), which is the current CNDDB status (CDFW 2020, p. 10). We made that change because the area has not been surveyed since 1983 (CDFW 2020, p. 10) and some habitat may still be intact. Additionally, a separate CNDDB EO that we considered in 2011 [former EO 9 (USFWS 2011, p. 32)] is now included in EO 8 (CDFW 2020, p. 10), so we removed EO 9 from our occurrence table (Table 1).

2. We considered CNDDB EO 5 (Shay Meadow; Figure 1) extirpated in 2011, but we consider it presumed extant in this review (Table 1), which is the current CNDDB status (CDFW 2020, p. 6). The occurrence was last observed in 1984 (CDFW 2020, p. 6). The area is partially developed, but habitat still exists within the CNDDB polygon. There has been no change in conservation status at this occurrence since 2011.

3. CNDDB EO 14 (north of EO 1 within North Baldwin Meadow, Figure 1) was not included in our occurrence table in the 2011 review. No plants were found in this area in 1980 surveys (Krantz Biological Services 1980, p. 26), and this occurrence is erroneous (Krantz 2021, pers. comm.). Although *Thelypodium stenopetalum* habitat exists in this area, no plants were found during surveys between 2015 and 2019 (Burton 2021, pers. comm.; Eliason 2021, pers. comm.).

In summary, monitoring at five *Thelypodium stenopetalum* occurrences since 2011 (Table 1) has provided some information about plant abundance. We have reassessed our 2011 occurrence status determinations and updated the status of three occurrences (Table 1), based on the date since last survey and information in the CNDDB.

Based on those updates, there are 10 occurrences of *Thelypodium stenopetalum*. Five are extant, two are presumed extant, one is possibly extirpated, and two are extirpated. One occurrence (CNDDB EO 14) is erroneous. We have no other new information that changes our understanding of *T. stenopetalum* biology or spatial distribution.

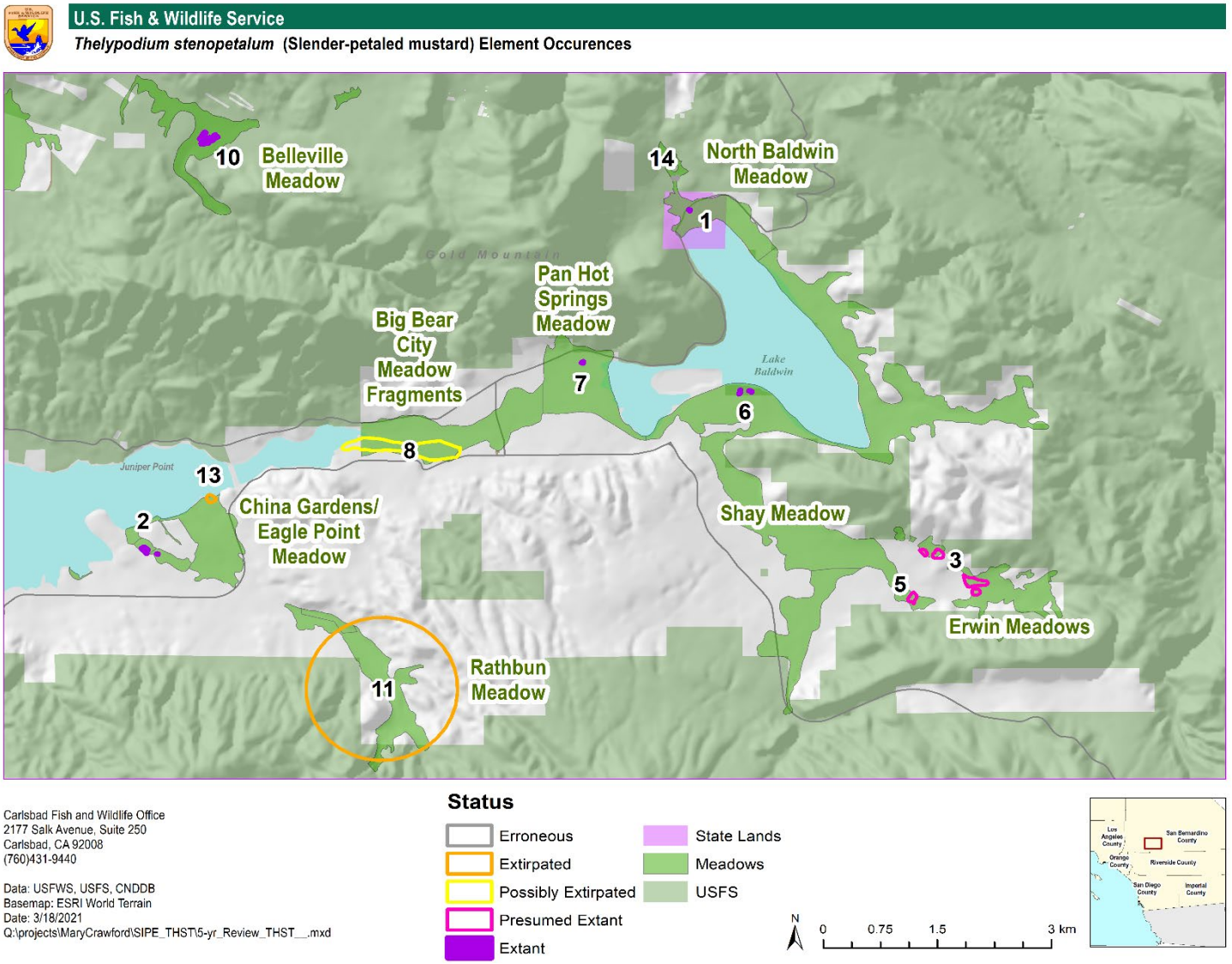

Figure 1. *Thelypodium stenopetalum* 2021 occurrence status, CNDDB EO number, and meadow name.

Table 1. Occurrence status for *Thelypodium stenopetalum*, including a summary of changes between 2011 and 2021.

CNDDB EO Number	Location	Meadow name	Owner	Extant at listing	2011 EO status	2021 EO status	Counts since 2011 [count, (count year)]	2011–2021 change summary
1	North shore of Baldwin Lake (Baldwin Lake Ecological Reserve)	North Baldwin Meadow	CDFW	Yes	Extant	Extant	0 (2015), 15 (2016), 51 (2017), 19 (2018), 241 (2019), 188 (2020)	There has been no change in EO or conservation status since 2011. CDFW has been monitoring the site since 2015.
14	North shore of Baldwin Lake	North Baldwin Meadow	USFS	NA	NA	Erroneous	NA	This occurrence is north of EO 1 within North Baldwin Meadow. It was not included in our occurrence table in the 2011 review. Although this occurrence is presumed extant in CNDDB, no plants were found at this location in the 1980s, (Krantz Biological Services 1980, p. 26), and the occurrence is erroneous (Krantz 2021, pers. comm.). No plants were found during 2015–2019 monitoring by CDFW (Burton 2021, pers. comm.), or in site checks by USFS (Eliason 2021, pers. comm.).
6	South shore of Baldwin Lake	Shay Meadow	USFS, Private	Yes	Extant	Extant	50 (2020)	There has been no change in EO or conservation status since 2011. The north part of this occurrence is on USFS land. The other parts of the occurrence are privately owned. Tom Dodson and Associates reported that *Thelypodium stenopetalum* was present on a 3.17 ac (1.28 ha) mitigation site near the Big Bear Area Regional Wastewater Agency administration building (BBCCSD 2016, p. 21).

CNDDB EO Number	Location	Meadow name	Owner	Extant at listing	2011 EO status	2021 EO status	Counts since 2011 [count, (count year)]	2011–2021 change summary
7	Pan Hot Springs (Southwest end of Baldwin Lake)	Pan Hot Springs Meadow	Big Bear City Community Services District, San Manuel Band of Serrano Mission Indians	Yes	Extant	Extant	338 (2019), 100 (2020)	The San Manuel Band of Serrano Mission Indians purchased part of the meadow in 2011. 10 ac (4.0 ha) of the Big Bear City Community Services District-owned meadow is under deed restriction, as mitigation for 1990 impacts to meadow habitat (BBCCSD 2008, p. 14).
2	East of Eagle Point	Eagle Point Meadow	Private	Yes	Extant	Extant	20 (2011), 1 (2014), 230 (2019), 80 (2020)	There has been no change in EO or conservation status since 2011. CNDDB and the 2011 5-year review stated that a conservation easement (held by the City of Big Bear Lake) is in place on this parcel, but we do not have records of that. In the Eagle Points Estates Declaration of Covenants, Conditions and Restrictions, there is a deed restriction over Lot K (the area occupied by *Thelypodium stenopetalum*) for the preservation of montane wet meadow habitat (Forest Properties 1992, p. 25).
8	Margin of Big Bear Lake at east end on south side, west of Big Bear City	Division Meadow, Big Bear City Meadow Fragments	Big Bear Airport District, Private, City of Big Bear Lake, Big Bear Municipal Water District	No	Extirpated	Possibly extirpated	NA	This area has multiple owners; there has been no change in conservation status since 2011. We considered this occurrence extirpated in 2011 (USFWS 2011, p. 32), but the area has not been surveyed since 1983 (CDFW 2020, p. 10) and some habitat may still be intact. This EO now includes former EO 9 (CDFW 2020, p. 10).

CNDDB EO Number	Location	Meadow name	Owner	Extant at listing	2011 EO status	2021 EO status	Counts since 2011 [count, (count year)]	2011–2021 change summary
11	Big Bear Valley Golf Course and Moonridge Meadows.	Rathburn Meadow	Private	No	Extirpated	Extirpated	NA	There has been no change in EO or conservation status since 2011.
13	Interlakken Shopping Center	China Gardens Meadow	Private	Yes	Extirpated	Extirpated	NA	This occurrence was considered extirpated in 2011 (Eliason 2010, pers. comm.). We do not have new information about EO or conservation status. This location was erroneously labeled as CNDDB EO 4 in our 2011 5-year review.
3	East end of Erwin Lake	Erwin Meadows	Private	Yes	Presumed extant	Presumed extant	NA	There has been no change in EO or conservation status since 2011. There is an open space easement over Parcel A, which encompasses parts of EO 3 and the Erwin Lake bottom (Kemper 1999, pp. 18, 20). There are also restrictions about operating motor vehicles (except for maintenance vehicles) on Parcel A (p. 20). All other parcels encompassing the occurrence are privately owned.
5	South west of Erwin Lake	Shay Meadow	Private	Yes	Extirpated	Presumed extant	NA	There are no records of this occurrence being extirpated. The occurrence was last observed in 1984, and is presumed extant in CNDDB (CDFW 2020, p. 6). The areas is partially developed, but habitat still exists within the CNDDB polygon, so this occurrence is presumed extant rather than extirpated. There has been no change in conservation status since 2011.
10	Belleville Meadow	Belleville Meadow	USFS	Yes	Extant	Extant	550 (2020)	There has been no change in EO or conservation status since 2011.

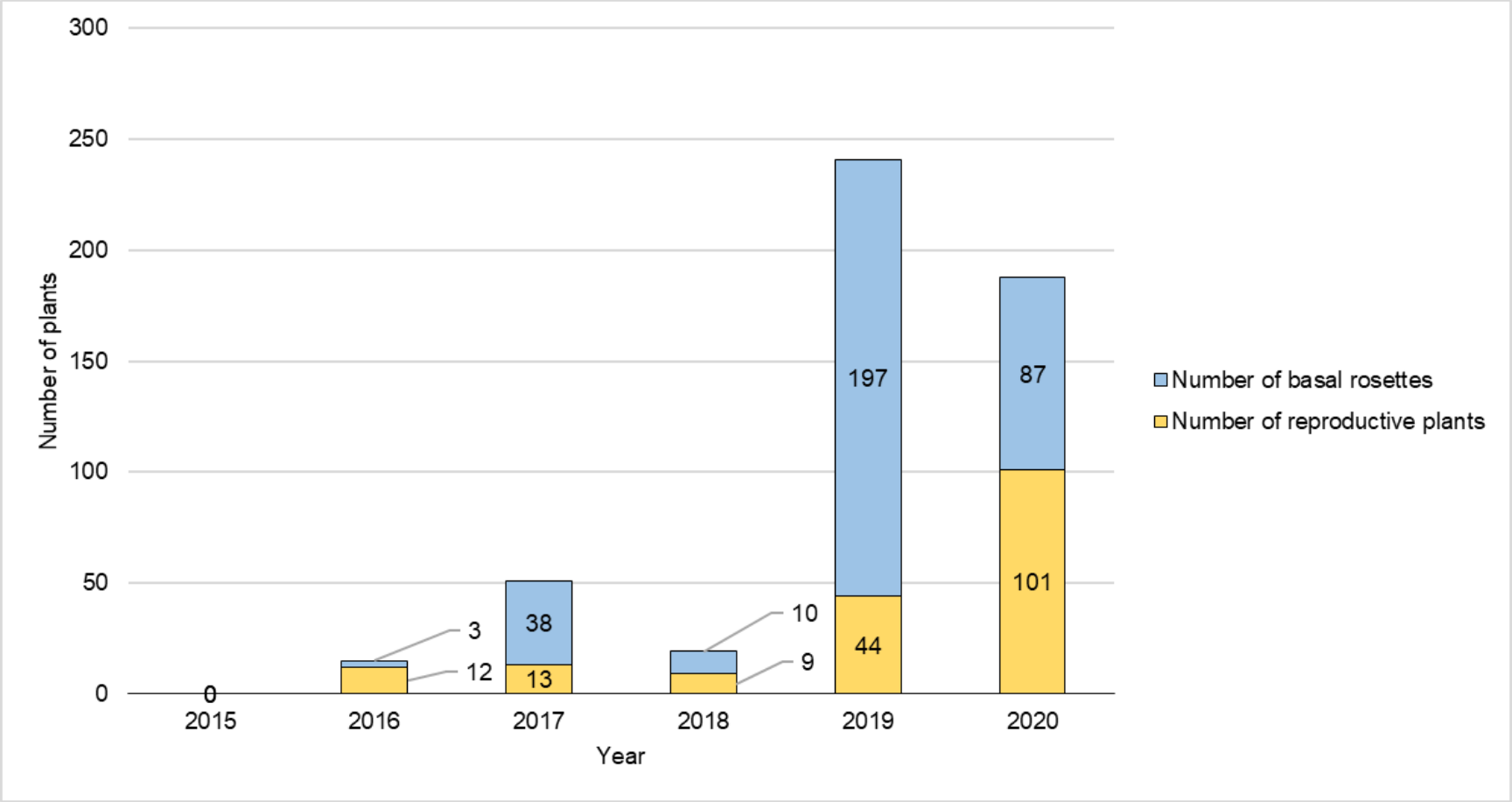

Figure 2. *Thelypodium stenopetalum* counts at Baldwin Lake Ecological Reserve. Unpublished data from Bjerke (2020).

Threats

Our 2011 5-year review discussed Factor A threats to *Thelypodium stenopetalum* from development, off-highway vehicles, alteration of hydrology, and nonnative invasive plants; Factor C threats from grazing; and Factor E threats from recreation activities, fire suppression, small population size, climate change, and drought.

This section summarizes new information about threats to *Thelypodium stenopetalum* from altered hydrology, nonnative plants, fire suppression, and climate change. We do not have new information about threats from development, off-highway vehicles, disease/predation, recreational activities, or small population size, so refer to the 2011 5-year review (USFWS 2011, pp. 10–13, 19–22) for discussion of those threats.

Altered hydrology

In 2011, we considered altered hydrology a threat to *Thelypodium stenopetalum* at five of six occurrences (USFWS 2011, p. 12). This section summarizes new information about hydrology in Big Bear Valley from a 2012 U.S. Geological Survey (USGS) report (USGS 2012, entire).

The Big Bear area (i.e., the Big Bear Lake and Baldwin Lake surface water drainage basins, encompassing Big Bear Valley and Baldwin Lake) relies on water supply from springs on the edge of the ground-water basin, and from wells drilled into the ground-water basin (USGS 2012, p. 105). Local water agencies have constructed new wells to help meet increased water demand (USGS 2012, p. 105).

The USGS (2012, pp. 15–22) used satellite-based remote-sensing techniques and well monitoring data to study land subsidence in the Baldwin Lake and Big Bear sub-basins. Between 1992 and 2005, they reported both land-surface subsidence and uplift for an area between Big Bear and Baldwin Lakes—encompassing Pan Hot Springs Meadow and Big Bear City meadow fragments—but it was unclear whether the amount of deformation in this area was elastic (recoverable) or inelastic (largely irreversible) (USGS 2012, pp. 15, 22). For the Sugarloaf area—encompassing parts of Erwin Meadow—USGS reported both subsidence and uplift between 1993 and 2005; the results suggested that deformations in this area were elastic (recoverable) (USGS 2012, p. 22).

In the 2011 5-year review (USFWS 2011, pp. 11–12), we discussed the effects of altered hydrology on *Thelypodium stenopetalum* plants and habitat. The 2012 USGS report provided new information about land subsidence or uplift near some *T. stenopetalum*-occupied meadows, but we do not have new information about altered hydrology at specific occurrences, or about impacts to the species. Therefore, the new information in the 2012 USGS report does not alter the conclusion of our 2011 5-factor threats analysis (USFWS 2011, p. 12; USGS 2012, entire).

Nonnative plants

At the last 5-year review in 2011, nonnative plants threatened 5 of 6 *Thelypodium stenopetalum* occurrences (USFWS 2011, p. 12). New information about this threat is available for the

T. stenopetalum occurrence at North Baldwin Meadow (CNDDB EO 1). Over 3 years of monitoring at this site, CDFW identified three non-native species: *Bromus tectorum* (cheatgrass), *Ranunculus testiculatus* (tubercled crowfoot), and *Lepidium perfoliatum* (clasping pepperweed). They recommended that nonnative plant invasions be further monitored, and that weed removal efforts be implemented (CDFW 2018, pp. 5, 16). We have no new information about nonnative species at other *T. stenopetalum* occurrences.

Fire suppression measures

In the 2011 5-year review, we discussed fuel zone maintenance and effects to *Thelypodium stenopetalum* plants (USFWS 2011, p. 20). This section describes fire suppression activities and coordination since 2011.

In 2015, the Lake Fire burned approximately 31,359 ac (12,691 ha) in the San Bernardino Mountains (USFS 2015, p. 2). The fire did not burn any areas occupied by *Thelypodium stenopetalum* (USFS 2015, p. 7). A retardant mixing site was set up at the Big Bear Area Regional Wastewater Agency sewage treatment plant, east of *Thelypodium stenopetalum* EO 6 (USFS 2015, p. 67). No effects to federally listed plants were expected from retardant mixing operations, and no Burned Area Emergency Response treatments were planned at the site (USFS 2015, p. 68).

In 2016, CDFW and USFWS staff and local stakeholders met with local fire officials to identify areas with state and federally listed plants, with a focus on Metcalf Meadow (Brandt 2016, pers. comm.; Brandt 2017, pers. comm.). During 2019 Eagle Point surveys, CDFW botanists communicated with a local resident, who informed surveyors that annual mowing—within about a 20 foot buffer of surrounding homes—occurs around the perimeter of the meadow (Burton 2019, unpaginated). We do not have reports of whether mowing has directly affected *Thelypodium stenopetalum* plants.

In 2017, the Holcomb Fire burned 1,503 ac (608 ha) in the San Bernardino Mountains northeast of Baldwin Lake (USFS 2017, p. 6). The fire did not burn any areas occupied by *Thelypodium stenopetalum* (USFS 2017, pp. 23–24). The USFS initiated emergency consultation with us for 11 species, including *T. stenopetalum* (USFS 2017, p. 3). The USFS determined that fire suppression activities did not affect federally listed meadow plants, and post-fire Burned Area Emergency Response (BAER) treatments (i.e., fencing) were expected to be beneficial (USFS 2017, p. 28). After the fire, CDFW biologists noted that a mud slide occurred on the north side of Highway 18 but did not affect areas occupied by *T. stenopetalum* (Burton 2019, unpaginated).

Climate change

The term “climate change” refers to a change in the mean or variability of one or more measures of climate (e.g., temperature or precipitation) that persists for an extended period, typically decades or longer, whether the change is due to natural variability, human activity, or both (IPCC 2013, p. 1450).

In 2011, we considered climate change (which may exacerbate altered hydrology) a rangewide threat to *Thelypodium stenopetalum* (USFWS 2011, p. 21).

Downscaled projections under several future climate scenarios are available for the southern California mountains, including across the range of *Thelypodium stenopetalum*.

Temperature changes

Southern California has already experienced a warming trend from 1951 to 2006 (Hall *et al.* 2018, p. 9). In the San Bernardino Mountains, Cal-Adapt models project increases in annual average maximum and minimum temperatures between a baseline time period (1961 to 1990) and an end of century period (2070 to 2090) (CEC 2019). Specifically, between 2070 and 2090, annual average maximum temperatures are projected to increase by 6.1 degrees Fahrenheit (°F) under Representative Concentration Pathway (RCP) 4.5, and by 8.9 °F under RCP 8.5 (CEC 2019). 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).

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 the 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 (Tank *et al.* 2009).

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, and snowpack is expected to melt earlier and more quickly (Viers *et al.* 2013, p. 9; Dettinger *et al.* 2018, p. 21). Snow lines are also expected to rise (Dettinger *et al.* 2018, p. 21).

Sun *et al.* (2016, p. 93) 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 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 *Thelypodium stenopetalum* in the San Bernardino Mountains, the Cal-Adapt models project reductions in snow water equivalence between a baseline time period (1961 to 1990) and an end of century period (2070 to 2090) (Table 2) (CEC 2019).

Table 2. Projected February Snow Water Equivalence for the range of *Thelypodium stenopetalum* in the San Bernardino Mountains.[1]

Year range	RCP 4.5 (inches ± standard deviation) projected February SWE	RCP 8.5 (inches ± standard deviation) projected February SWE
1950–2005 (observed)	2.12 ± 2.58	2.12 ± 2.58
2040–2069	1.13 ± 1.87	1.03 ± 1.94
2070–2099	0.87 ± 1.49	0.45 ± 0.82

[1] The values are the average of projections from four priority models (MIROC5, CanESM2, HadGEM2-ES, and ENRM-CM5) over a mid-century time period (2040–2069) and an end-of-century time period (2070–2099). Data from Cal-Adapt (CEC 2019).

Snowpack provides groundwater recharge and streamflow to montane meadows (Viers *et al.* 2013, p. 11), and both factors could be affected by earlier runoff and reductions in snowpack. Precipitation in the form of rain runs off much more quickly than snow, and these increased but intermittent stream flows could alter meadow channel morphology and affect streambank stability (Viers *et al.* 2013, p. 11).

Potential effects of climate change on *Thelypodium stenopetalum*

The effects of climate change on *Thelypodium stenopetalum* and its habitat have not been directly studied, and there is uncertainty in the predictions of downscaled climate models. However, the projected abiotic pressures resulting from climate change—increased temperature, changes in precipitation, and reduced snowpack and earlier runoff—could alter the hydrology of meadow habitat occupied by *T. stenopetalum*. Changing hydrology could cause shifts in plant communities (Debinski *et al.* 2010, pp. 1677–1679), and make meadows more vulnerable to other impacts.

In Big Bear Valley (San Bernardino Mountains), total precipitation decreases from west to east across the valley (USGS 2012, p. 4), and the percentage of total precipitation as snowfall also

varies depending on location within the valley (USGS 2012, p. 74). Therefore, the effects of future precipitation and snowpack changes will likely vary by meadow.

Changing precipitation type, amount, and timing could impact individual *Thelypodium stenopetalum* at all life stages by reducing the amount of water available for germination, growth, and reproduction. *T. stenopetalum* counts in a given year are positively correlated with cumulative precipitation over the previous 2 and 3 years (Henderson 2003, pp. 56–57). So, increasing precipitation extremes could increase the amount of variability in inter-annual *T. stenopetalum* abundance.

Climate change summary and conclusion

For this 5-year review, we have discussed projections from Sun *et al.* (2016, entire), reports from California's Fourth Climate Change Assessment (Hall *et al.* 2018, p. 9, 12–13; Kalansky *et al.* 2018, pp. 21, 24–25; Pierce *et al.* 2018, entire), and data from CalAdapt (CEC 2019). These new 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 2011 5-year review, we outlined how drier conditions could affect *Thelypodium stenopetalum* meadow habitat and individual plants (USFWS 2011, pp. 21–22). While we did not have enough information to make predictions about climate change effects to *T. stenopetalum*, we considered it likely that climate change would threaten the species (USFWS 2011, pp. 21–22).

Since 2011, new climate projections are available for the range of *Thelypodium stenopetalum*, but we do not have new information about the potential effects of those changes to the species (USFWS 2011, pp. 21–22). Increasing temperatures, combined with greater precipitation extremes and earlier runoff, could cause greater interannual variability in *T. stenopetalum* populations, potentially decreasing population resiliency. Climate change will likely alter the hydrology of montane meadows, but the new information does not alter the conclusion of our 2011 5-factor threats analysis.

Consultation on ongoing U.S. Forest Service activities

In 2019, we issued a biological opinion for the ongoing activities affecting 12 mountain plant species on the San Bernardino National Forest, including *Thelypodium stenopetalum* (USFWS 2019, entire). We discussed the general effects of nine Forest Service management programs on listed plants (USFWS 2019, pp. 18–26), and specific effects to *T. stenopetalum* (USFWS 2019, pp. 92–94).

We determined that the implementation of the U.S. Forest Service's Revised Land Resource Management Plan (Forest Plan; USFS 2006) was not likely to jeopardize the continued existence of *T. stenopetalum* (USFWS 2019, p. 95). We reached that conclusion because (1) the USFS has developed a Meadow Habitat Management Guide, which describes specific management strategies to promote recovery of montane meadow plants, and is consistent with the recovery plan for *Thelypodium stenopetalum*, and (2) the USFS will avoid and minimize impacts from management activities (USFWS 2019, p. 95). To avoid and minimize those impacts, the biological opinion

incorporated multiple protective measures (USFWS 2019, pp. 9–12), in addition to measures already being implemented by the USFS (USFWS 2019, Appendix A).

SUMMARY OF THREATS

Since the 2011 5-year review, we have received new information about ongoing threats at *Thelypodium stenopetalum* occurrences. The new information relates to the threats of (1) altered hydrology, (2) nonnative plants, (3) fire suppression measures, and (4) climate change. However, the new information does not alter the analysis or conclusions of our 2011 5-year review (USFWS 2011, pp. 10–24).

CONCLUSION:

In the 2011 5-year review, we recommended no status change for *Thelypodium stenopetalum.* Since 2011, we have received new survey and monitoring information for *T. stenopetalum*, and some new information about threats to *T. stenopetalum*. We have also updated the status of three occurrences. Based on those updates, there are 10 occurrences of *Thelypodium stenopetalum*. Five are extant, two are presumed extant, one is possibly extirpated, and two are extirpated.

The new information and updated occurrence status does not substantially alter the species' status or the results of our five-factor analysis in the 2011 5-year review. Therefore, we conclude that *Thelypodium stenopetalum* remains a federally endangered species.

RECOMMENDATIONS FOR FUTURE ACTIONS:

1. Collect additional seed from *Thelypodium stenopetalum* occurrences, to expand the *ex situ* conservation seed bank at California Botanic Garden (formerly Rancho Santa Ana Botanic Garden).

2. Study *Thelypodium stenopetalum* population genetics, including levels of genetic diversity and differentiation within and among occurrences, and levels of inbreeding, relatedness, and ploidy. This information will allow us to assess levels of current diversity and gene flow, assess whether genetic management is needed, and assess appropriate seed sources for potential future reintroduction or augmentation activities.

3. Conduct pollination studies to determine the mating system of *Thelypodium stenopetalum* (i.e., the level of self-compatibility, if any).

4. Develop a propagation protocol for *Thelypodium stenopetalum.*

5. Reach out to private landowners to identify opportunities for conservation on private lands. Work with private landowners, local governments, and conservation organizations to conserve and manage habitat.

6. Continue to monitor *Thelypodium stenopetalum* occurrences.

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