

Fremontodendron mexicanum
(Mexican flannelbush)

**5-Year Review:
Summary and Evaluation**



Photos by Mary Crawford/USFWS 2022

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

August 2022

5-YEAR REVIEW

Fremontodendron mexicanum (Mexican flannelbush)

GENERAL INFORMATION

Species: *Fremontodendron mexicanum* (Mexican flannelbush), a plant species

Date listed under the Endangered Species Act: October 13, 1998

Federal Register citation: Service 1998 (63 FR 54956)

Classification: Endangered

Recovery Plan: There is no recovery plan for this species

Recovery Priority Number: 8

Critical Habitat Designation: Service 2007 (72 FR 54984)

Status in Mexico: In danger of extinction (SEMARNAT 2010, p. 64)

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 (Service), referred to as “we” in this document, maintains 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: Service 2009. *Fremontodendron mexicanum* 5-year review: summary and evaluation. Prepared by the Carlsbad Fish and Wildlife Office, Carlsbad, California. 25 pp. + appendices.

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 from the public (Service 2021, pp. 27462–27464). We received and incorporated data from the San Diego Management and Monitoring Program (SDMMP).

Species Overview and Habitat: *Fremontodendron mexicanum* is a small tree in the mallow family (*Malvaceae*). Plants have large, orange to yellow flowers and can grow up to 19 feet (ft) [6 meters (m)] high. This species is endemic to southern California and northwestern Baja California, Mexico, where it grows in drainages within closed-cone coniferous forest and southern mixed chaparral.

ASSESSMENT

Information acquired since the last status review

This 5-year review was conducted by the Service’s 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. We also contacted species experts and partners with the Bureau of Land Management and the U.S. Geological Survey to request any new information

we could consider in our review. Additionally, we conducted a literature search and a review of information in our files.

SUMMARY OF NEW INFORMATION SINCE 2009

Occurrence status

To update *Fremontodendron mexicanum* occurrence¹ status, we reviewed Element Occurrence (EO) data from the California Natural Diversity Database (CNDDDB), monitoring data from the SDMMP, herbaria records from the Consortium of California Herbaria (CCH2) and the San Diego Natural History Museum's Flora of Baja California, and survey information from Baja California (Campos *et al.* 2019, entire).

For this review, we used the following definitions of occurrence status:

1. We considered an occurrence extant if *Fremontodendron mexicanum* had been observed at the occurrence within the last 20 years.
2. We considered an occurrence presumed extant if the species had not been observed in the last 20 years, but suitable habitat was present.
3. We considered an occurrence possibly extirpated if the species had not been observed for over 20 years, and if the habitat was degraded or partially developed.
4. We considered an occurrence extirpated if the species had not been observed for greater than 20 years and the habitat was completely developed.

Our 2009 5-year review identified 15 site-native occurrences of *Fremontodendron mexicanum*. Four were extant, eight were extirpated, and three had unknown status.

Our 2022 5-year review of new information finds that there are 13 site-native occurrences of *Fremontodendron mexicanum*. Although two new occurrences have been found in Baja California, database edits and other new information have reduced the number of occurrences since our 2009 5-year review. Across this species' range, five *F. mexicanum* occurrences are extant, one is presumed extant, two are possibly extirpated, and five are extirpated. Additionally, *F. mexicanum* is present at two reintroduction sites in San Diego County, but we do not include these sites in our occurrence count because plant count is very low and there is no evidence of recruitment.

In the 2009 5-year review, we included a table of *Fremontodendron mexicanum* collections that were likely from cultivated sources (Service 2009, p. 28). These collections were from San Diego, Orange, Los Angeles, Monterey, and Santa Clara Counties (Service 2009, p. 28). However, references describe *F. mexicanum* as limited to southern San Diego County and northern Baja California (Wolf 1942, entire; Harvey 1943, p. 110; Munz 1974, p. 843).

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

Beginning in the late 19th century, *Fremontodendron mexicanum* was grown and distributed through the nursery trade (Wolf 1942, entire). Additionally, hybrid cultivars between *F. mexicanum* and *Fremontodendron californicum* (California flannelbush) have been widely grown and distributed (Kelman 1991, p. 19; O'Brien n.d., unpubl. data, pp. 169–170; O'Brien 1992, entire), collections outside of San Diego County could be hybrid cultivars or the listed entity (CCH2 2021, entire).

For this review, we consider 20 locations of *Fremontodendron mexicanum* to be possibly or likely cultivated (Appendix A), either because (1) the location was outside of San Diego County or Baja California, (2) collection data indicated that the location was possibly cultivated, (3) collection data indicated that the specimen may be a hybrid cultivar, or (4) other collection information (such as the presence of a single individual or location within an urban area) suggested a possibly cultivated location. Plants at these locations could have genetic value, but more study would be needed to characterize the genetic composition of likely cultivated versus site-native locations (Ismail *et al.* 2021, p. 6).

Changes to occurrence status in San Diego County, United States

The changes to *Fremontodendron mexicanum* occurrence status in San Diego County between 2009 and 2022 are because:

1. In 2009, we listed EO 2 (Mearns 3825), Woodwardia Canyon and Little Cedar Canyon as separate occurrences (Service 2009, p. 26). Since then, the CNDDDB has assigned EO 2 to the Little Cedar Canyon and Woodwardia occurrences, and the Mearns 1894 collection is also attributed to EO 2. Therefore, three locations from our 2009 5-year review have been combined into EO 2.
2. In 2009, we listed EO 6 and SD 7223 (an 1878 Sanford collection) as separate locations (Service 2009, p. 26). However, the CNDDDB attributes SD7223 to EO 6 (CDFW 2021, p. 5). Therefore, the two locations from our 2009 5-year review have been combined into EO 6 for this occurrence. In 2009, the status of EO 6 was unknown and the status of SD7223 was extirpated, but CNDDDB considered this EO to be presumed extant. Since the occurrence has not been relocated since 1878 (Reiser 2001, p. 122) but suitable habitat may be present, we consider this location possibly extirpated rather than extirpated.
3. In 2009, the status of EO 7 was unknown, but CNDDDB considers this EO to be presumed extant. Since the occurrence has not been observed since 1981 but suitable habitat may be present, we consider this EO presumed extant rather than unknown. The area was searched in 2006 and no plants were found (CDFW 2021, p. 6).
4. In 2009, a herbarium specimen 15 miles from San Diego (CAS3234) was listed in the occurrence table, but this specimen is not in CNDDDB or the California Academy of Sciences Herbaria (Magnaghi 2022, pers. comm.). Because it is possibly erroneous, we do not include it for this review.
5. We have added two reintroduction sites to the occurrence table: Wild Man Canyon and Mother Miguel Saddle, both on the San Diego National Wildlife Refuge (SDNWR).

However, we do not include these reintroduction sites in the total count of occurrences, because only two plants remain at each site, and there have been no signs of recruitment at either site.

In total, there are six occurrences of *Fremontodendron mexicanum* in San Diego County. Two occurrences are extant, one is presumed extant, two are possibly extirpated, and one is extirpated ([Table 1](#)). Additionally, there are two reintroduction sites at the SDNWR.

Changes to occurrence status in Baja California, Mexico

Since 2009, we also received new information about *Fremontodendron mexicanum* in Baja California:

1. In 2016, J. Riley documented a location of *F. mexicanum* at Cerro Grande. This resulted in one new extant occurrence of the species.
2. In 2018 and 2019, Campos and others visited four locations of *F. mexicanum* in Baja California (Campos *et al.* 2019, pp. 22–24), including the Cerro Grande population documented by Riley. They confirmed that three locations are extirpated (Campos *et al.* 2019, pp. 22–24) ([Table 1](#)). At the Cerro Grande population, Campos *et al.* (2019, p. 22) observed seedling germination and plants resprouting after a recent fire.
3. In 2019, Santore and Rockefeller documented a location of *F. mexicanum* east of Ejido Benito Juarez. This resulted in one new extant occurrence of the species (Santore and Rockefeller 2020, pers. comm.).

In total, there are three extant occurrences of *Fremontodendron mexicanum* in Baja California: (1) Cerro Grande, documented in 2016; (2) east of Ejido Benito Juarez, documented in 2019, and (3) Arroyo Hediondo, which we discussed in the 2009 5-year review. Additionally, 4 occurrences are extirpated ([Table 1](#), [Table 2](#)).

Biology

Seed germination

Austin (2014, pp. 32–33) found that heat treatment positively affected *Fremontodendron mexicanum* seed germination. Heating seeds at 212 degrees Fahrenheit (100 degrees Celsius) for 5 minutes resulted in significantly greater seed germination (Austin 2014, pp. 32–33).

Pollination

Austin (2014, p. 22) found that European honeybees (*Apis mellifera*) were the predominant floral visitors to *Fremontodendron mexicanum* in Cedar Canyon (241 of 282 floral visits, 88.5 percent). Other floral visitors were native Hymenoptera, hummingbirds, and a fly (Austin 2014, p. 22). European honeybees appear to be relatively effective pollinators of *F. mexicanum* (Austin 2014, p. 35).

To assess whether *Fremontodendron mexicanum* could self-pollinate, Austin (2014, p. 14) excluded pollinators from 10 Mexican flannelbush flowers on five plants. During the 3-week pollination study, plants that received pollen from a neighboring plant developed fruits, but no self-pollinated flowers developed fruits (Austin 2014, p. 26).

Table 1. Summary of rangewide occurrence status in 2009 and 2022 for site-native occurrences or reintroduction sites. As described above, since 2010, three occurrences have been attributed to other EOs by the CNDDDB. The two reintroduction sites on the SDNWR are extant, but we do not include them in the occurrence count. The table does not include the possibly erroneous occurrence in San Diego County (CAS3234).

Occurrence status	Number of occurrences in 2009 United States	Number of occurrences in 2009 Mexico	Number of occurrences in 2022 United States	Number of occurrences in 2022 Mexico
Extant	3	1	2	3
Presumed extant	NA	NA	1	NA
Possibly extirpated	NA	NA	2	NA
Extirpated	4	4	1	4
Unknown	3	NA	NA	NA
Total number of site-native occurrences	10	5	6	7
Total number of reintroduction sites	NA	NA	2	NA

NA = Not Applicable

Seed production and dispersal

Austin (2014, p. 27) noted elaiosomes on 97 percent of *Fremontodendron mexicanum* seeds. Elaiosomes are fleshy, lipid-rich structures attractive to ant species (Edwards *et al.* 2006, p. 688). The presence of elaiosomes suggests that *F. mexicanum* seeds may be dispersed by ants, although no ant interactions with *F. mexicanum* seed were observed during the study (Austin 2014, p. 36).

Reintroduction activities

In 2009, we discussed a project to create new occurrences of *Fremontodendron mexicanum* by introducing plants onto the SDNWR (Service 2009, p. 9).

For the introduction to northeast Mother Miguel Mountain, 141 plants were planted in two locations on the SDNWR. Fifty-nine plants were planted northeast of Mother Miguel Mountain, and 82 plants were planted in Wild Man Canyon (Martin 2011, entire).

Planted *Fremontodendron mexicanum* were watered during the 2011 growing season, but below-average rainfall between 2012 and 2016 likely contributed to high mortality of planted *F. mexicanum* on the Refuge (Martin 2017, entire). At the Wild Man Canyon reintroduction site, erosion and trampling from unauthorized trail use killed additional plants (Martin 2017, entire). As of 2016, two *F. mexicanum* were present at Wild Man Canyon and two were present at Mother Miguel Saddle, and no recruitment has been reported at these locations since they were outplanted (Martin 2017, entire; SDMMP 2020, entire).

Summary

Due to reintroduction activities on the SDNWR and discoveries of new occurrences in Mexico, we are aware of four more locations of *Fremontodendron mexicanum* in 2022 compared with 2009: two reintroduction sites on the SDNWR, and two new locations in Baja California. However, due to database edits by the CNDDDB, three occurrences that we considered separately in 2009 have now been attributed to other CNDDDB EOs. Finally, one location considered in 2009 is possibly erroneous, so we do not include it in the occurrence count. Overall, there are 13 site-native occurrences of *F. mexicanum* and 2 reintroduction sites, a reduction of one occurrence since 2009.

Austin (2014, pp. 22, 26–27, 32–33) studied the reproductive ecology of *Fremontodendron mexicanum* and found that: (1) heat treatment positively affected *F. mexicanum* seed germination, (2) European honeybees were the main floral visitors, (3) bagged flowers did not develop seed, suggesting that this species may not be able to self-pollinate, and (4) seeds may be ant dispersed because they have eliasomes.

Threats

In the 2009 5-year review, we discussed eight threats to *Fremontodendron mexicanum*. We discussed Factor A threats (the present or threatened destruction, modification, or curtailment of habitat or range) to this species from nonnative invasive plants and border control activities (Service 2009, pp. 10–11). We discussed Factor E threats (other natural or manmade factors affecting a species' continued existence) from small population size, altered fire regime, and climate change (Service 2009, pp. 16–18).

For this review, we have new information about all eight threats discussed in the 2009 5-year review. Additionally, we have new information about three disturbances that were not discussed in the 2009 5-year review: trail use, agriculture, and mining.

Nonnative invasive plants

In the 2009 5-year review, we discussed tamarisk (*Tamarix*, a nonnative invasive shrub) as a threat to *Fremontodendron mexicanum* in Cedar Canyon (Service 2009, p. 10). We considered tamarisk to be a moderate threat to *F. mexicanum*.

Since 2009, we received new information about this threat from SDMMP monitoring. Nonnative plants are present at EOs 1 and 2 and at the two reintroduction sites on the SDNWR ([Table 3](#)). Nonnative plants are generally present at less than 10 percent within the maximum extent, but at the two reintroduction sites they occur at 50 percent or more of the maximum extent ([Table 3](#)).

Table 2. Occurrence table for site-native or reintroduced occurrences of *Fremontodendron mexicanum* in the United States and Mexico.

State /Country or County	Location name	CNDDDB EO number	FWS 2009 status	FWS 2022 status	SDMMP ID	Ownership /conservation status	2009–2022 change and threats summary	References
San Diego County	Cedar Canyon, Otay Mountain	1	Extant	Extant	FRME2_3CEC_A001	BLM, Private/partially conserved	No change in EO or conservation status. SDMMP monitoring noted nonnative forbs and grasses on site, and that erosion may be affecting some plants. Tamarisk is present at low levels in the canyon.	CDFW 2021, pp. 1–2; SDMMP 2020, entire
San Diego County	Little Cedar Canyon and Woodwardia Canyon, Otay Mountain	2	Extant	Extant	FRME2_3LCC_A002	BLM, Otay Ranch Preserve Owner/Manager /Conserved	No change in EO or conservation status. We considered Little Cedar Canyon and Woodwardia Canyon separately in 2010, but the CNDDDB has combined these records into EO 2. The 1894 Mearns record is attributed here in CNDDDB. Nonnative plants are a threat at this occurrence according to SDMMP data.	CDFW 2021, pp. 3–4; SDMMP 2020, entire
San Diego County	2.25 miles north of Jamul Valley	6	Unknown	Possibly extirpated	NA	Private, County of San Diego, City of Chula Vista, State/partially conserved	The location of this 1878 record by Sanford is unknown, but because suitable habitat may be present, we changed the occurrence status from “Extirpated” to “Possibly extirpated”. No threats information is available.	CDFW 2021, p. 5; Service 2009, p. 26; Reiser 2001, p. 122
San Diego County	Unnamed canyon on the west flank of Otay Mountain	7	Unknown	Presumed extant	NA	BLM/ Conserved	No new information about EO or conservation status. No threats information is available.	CDFW 2021, p. 6
San Diego County	Point Loma	NA	Extirpated	Possibly extirpated	NA	Unknown	This EO was deleted from CNDDDB because the CNDDDB determined that the occurrence seemed very likely cultivated. We continue to consider it a native occurrence. No threats information is available.	CDFW 2013, entire
San Diego County	Mother Miguel Saddle, Northeast Mother Miguel Mountain	NA	NA	Extant (reintroduction)	FRME2_3MO_MI005	Service /Conserved	Reintroduction efforts were discussed in the 2009 5-year review, but this site was not included in the occurrence table. 59 plants were originally planted here and 2 remain. Nonnative plants are a threat at this occurrence according to SDMMP data.	SDMMP 2020, entire; Martin 2011, entire; Martin 2017, entire

State /Country or County	Location name	CNDDB EO number	FWS 2009 status	FWS 2022 status	SDMM P ID	Ownership /conservation status	2009–2022 change and threats summary	References
San Diego County	Wild Man Canyon, Mother Miguel Mountain	NA	NA	Extant (reintroduction)	FRME2_3WIM_C004	Service /Conserved	Reintroduction efforts were discussed in the 2009 5-year review, but this site was not included in the occurrence table. 82 plants were originally planted here and 2 remain. User-created trails up Mother Miguel Mountain caused trampling, and some plants were lost to erosion. The re-aligned trail is directly adjacent to this occurrence. Nonnative plants are also a threat at this occurrence according to SDMMP data.	SDMMP 2020, entire; Martin 2017, entire; Service 2019, p. 6
San Diego County	Border Field Monument	NA	Extirpated	Extirpated	NA	State/ Conserved	No new information about EO or conservation status. No threats information is available.	Reiser 2001, p. 122
Baja California, Mexico	East of Ejido Benito Juarez	NA	NA	Extant	NA	NA	New occurrence reported since 2009. Over 100 plants were observed at the top of the wash. A marijuana growing operation was present at this location in 2019.	Santore and Rockefeller 2020, pers. comm., entire
Baja California, Mexico	Arroyo Hediondo	NA	Extant	Extant	NA	NA	No new information about EO or conservation status. Four plants were observed during a 2006 visit by Snapp-Cook and Harper. A small dam for livestock had been built upstream, but it was unclear how this would affect the canyon hydrology or the <i>Fremontodendron mexicanum</i> . No new threats information is available.	Snapp-Cook 2006, unpubl. data, pp. 3–4
Baja California, Mexico	Cerro Grande, 15 km south of Tecate	NA	NA	Extant	NA	NA	This population was documented by Riley in 2016. During site visits in 2019, germination and resprouting individuals were observed, and ecological data, vouchers, leaf tissue samples, and seed were collected. Campos <i>et al.</i> (2019, p. 22) noted signs of recent fire at this population, but the population looked healthy.	Campos <i>et al.</i> 2019, p. 22; SDNHM 2021, entire
Baja California, Mexico	Cariso Creek	NA	Extirpated	Extirpated	NA	NA	No new information about EO or conservation status. No threats information is available.	SDNHM 2021, entire

State /Country or County	Location name	CNDDDB EO number	FWS 2009 status	FWS 2022 status	SDMM P ID	Ownership /conservation status	2009–2022 change and threats summary	References
Baja California, Mexico	Arroyo Seco vicinity (north of San Quintin)	NA	Extirpated	Extirpated	NA	NA	No change in EO status. There is no collection information to support this location. The Wiggins collections in 1931 (San Antonio Canyon) are approximately 45 miles north of San Quintin.	Wiggins 1980, p. 815
Baja California, Mexico	Los Malcriados (along Arroyo La Grulla, approximately 9 miles south of Maneadero in Ensenada)	NA	Extirpated	Extirpated	NA	NA	No change in EO status. We have new information from Campos et al. 2019.	Campos <i>et al.</i> 2019, p. 22; SDNHM 2021, entire
Baja California, Mexico	Canyon of San Antonio Del Mar and Johnson's Ranch	NA	Extirpated	Extirpated	NA	NA	No change in EO status. We have new information from Campos et al. 2019.	Campos <i>et al.</i> 2019, p. 22; SDNHM 2021, entire

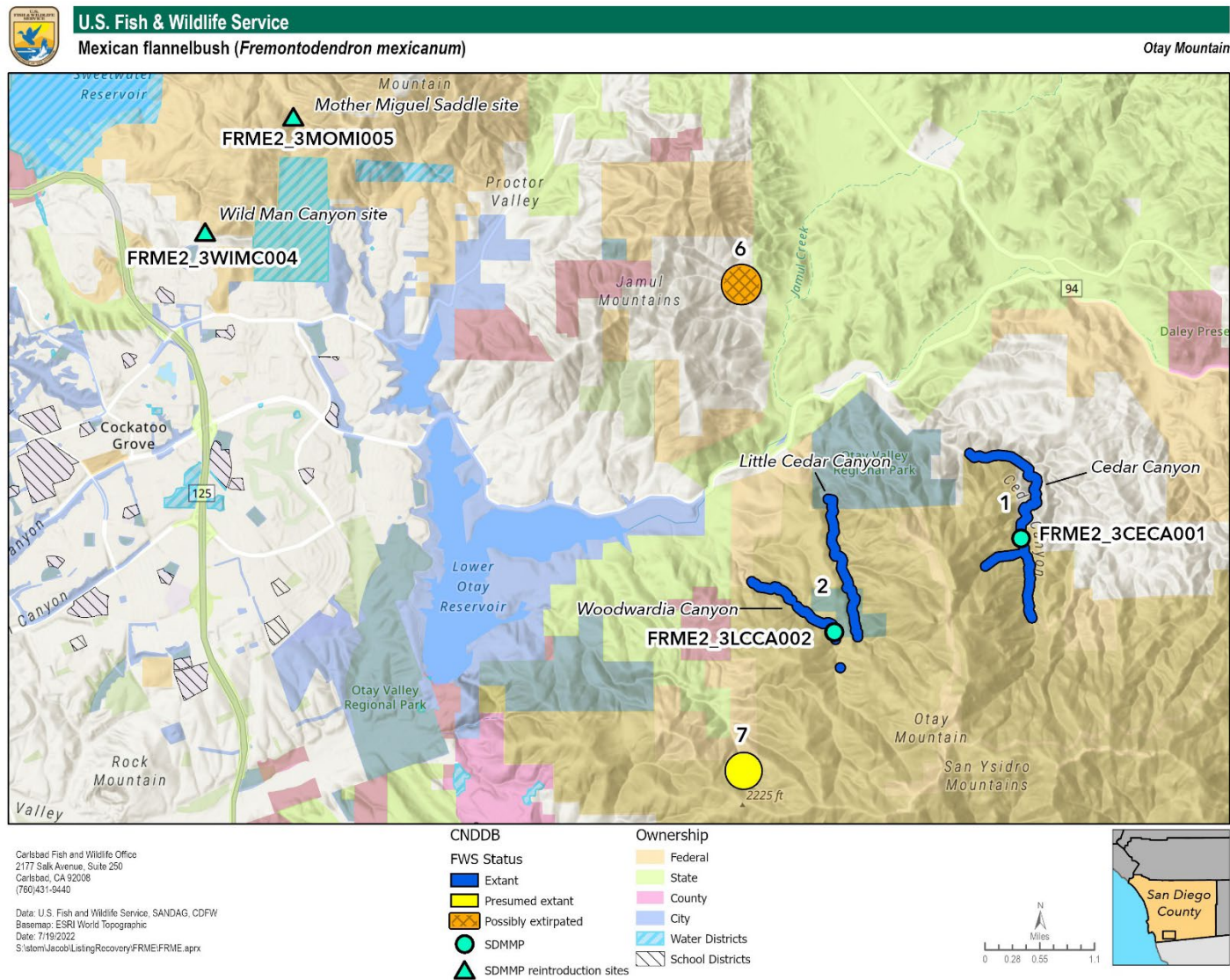
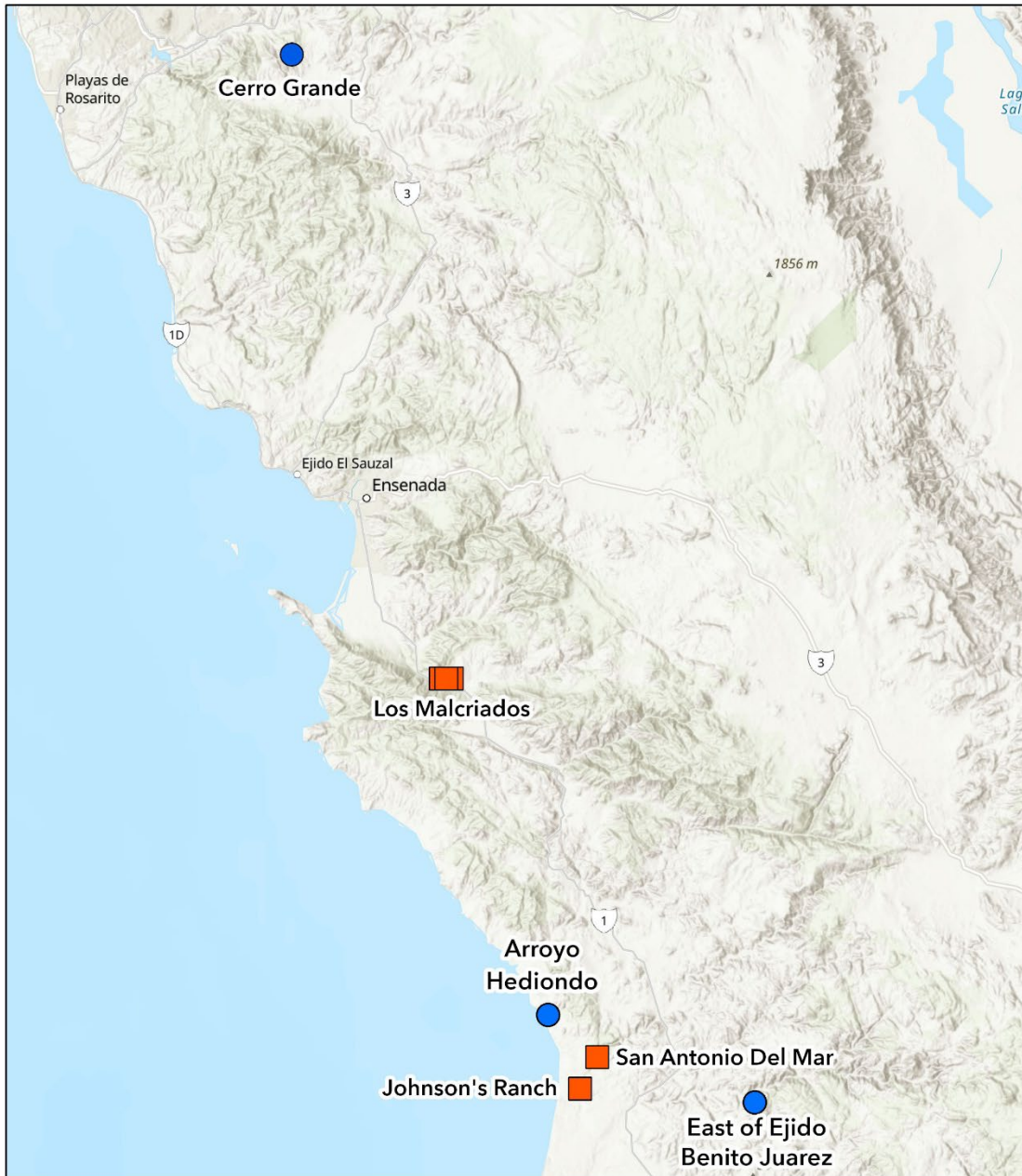


Figure 1. *Fremontodendron mexicanum* occurrences in San Diego County, showing occurrence status, CNDDB EO, the SDMMP ID, and land ownership.



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Data: U.S. Fish and Wildlife Service, Baja Flora
Basemap: ESRI World Terrain
Date: 7/19/2022
System: Jacob/ListingRecovery/FRME/FRME.aprx

- Extant
- Extirpated

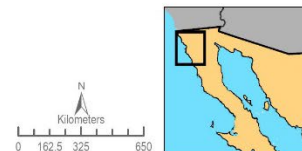


Figure 2. *Fremontodendron mexicanum* locations in Baja California, Mexico, with status and location name.

Table 3. Summary of invasive plant presence at SDMMP monitoring points of *Fremontodendron mexicanum*.

Location name	CNDDDB EO number	SDMMP Occurrence ID	Sample point number	Year	Nonnative forbs ¹	Nonnative grasses	Nonnative woody plants
Cedar Canyon, Otay Mountain	1	FRME2_3CECA001	1	2017	3	3	2
Little Cedar Canyon	2	FRME2_3LCCA002	1	2017	3	4	3
Little Cedar Canyon	2	FRME2_3LCCA002	2	2017	1	3	1
Mother Miguel Saddle	NA	FRME2_3MOMI005	1	2016	6	7	1
Wild Man Canyon	NA	FRME2_3WIMC004	1	2017	3	5	1

¹ Disturbance category for each threat. The disturbance category is the percent of the maximum occurrence extent (occupied area) disturbed by each threat: 1 = 0 percent in maximum extent or adjacent 33 ft (10 m) buffer; 2 = 0 percent in maximum extent but threat detected in surrounding 33 ft (10 m) buffer; 3 = greater than 0 to less than 10 percent of maximum extent; 4 = 10 to less than 25 percent of maximum extent; 5 = 25 to less than 50 percent of maximum extent; 6 = 50 to less than 75 percent of maximum extent; and 7 = greater than or equal to 75 percent of maximum extent.

Border control activities

In the 2009 5-year review, we discussed border control activities and potential effects to *Fremontodendron mexicanum* from road construction and vehicle use. However, we were not aware of any direct impacts to *F. mexicanum* (Service 2009, p. 11).

There have been no impacts to *Fremontodendron mexicanum* from border control activities since the 2009 5-year review. In 2015, we concurred with U.S. Customs and Border Protection that proposed road maintenance along a portion of the Mother Grundy Truck Trail and the 5150 Road would have no effect on *F. mexicanum* (Service 2015, p. 1).

Small population size

Small population size was a threat to *Fremontodendron mexicanum* at listing because the estimated number of individuals was less than 100 (Service 1998, p. 54962). In the 2009 5-year review, we determined that there were approximately 6,000 *F. mexicanum* plants in three canyons in San Diego County (Service 2009, p. 7). Because more plants were known in 2009, we were less concerned about genetic effects of small population size (Service 2009, p. 16). However, in 2009 we did not have information about population genetic structure or breeding system.

The 2014 pollination study by Austin provided new information about *Fremontodendron mexicanum* breeding system. Austin (2014, p. 26) found that *F. mexicanum* plants developed

fruits when they received pollen from a neighboring plant, but no self-pollinated flowers developed fruits.

Self-compatible plant species can produce seed when fertilized with their own pollen, while self-incompatible (i.e., obligate outcrossing) plant species need pollen from unrelated plants in order to reproduce. Some plants have mixed or “intermediate” mating systems; for example, they may outcross but are also self-compatible (Charlesworth 2006, p. R729). Obligate outcrossing plants may have a genetically-determined self-incompatibility system to prevent self-fertilization (Hiscock and Tabah 2003, p. 1037), or self-fertilization may be prevented by floral morphology (Charlesworth 2006, p. R730).

For *Fremontodendron mexicanum*, it is unclear whether the mechanism for self-incompatibility is genetically determined, or whether a larger study might find some level of self-pollination. Studies of genetic structure and levels of genetic diversity would allow us to better characterize the vulnerability of *F. mexicanum* to small population size and potential loss of diversity.

Altered fire regime, increased ignition sources

In the 2009 5-year review, we discussed how *Fremontodendron mexicanum* on Otay Mountain responded after a 2003 fire (Service 2009, p. 18). Plants may resprout after fire, and seeds may also germinate following fire (Service 2009, p. 18). Although plants responded vigorously after the 2003 fire on Otay Mountain, shorter fire return intervals could threaten *F. mexicanum* if plants do not have time to mature and set seed before the next fire (Service 2009, p. 18).

New information since 2009 has confirmed that seed germination and plant resprouting occur in response to heat. First, Austin (2014) found that heat treatments increased *Fremontodendron mexicanum* seed germination. Second, Campos *et al.* (2019) observed seedlings and resprouting plants after recent fire. We do not have information to suggest that shorter fire return intervals are currently a threat to *F. mexicanum*, although altered fire regimes could threaten *F. mexicanum* in the future.

Climate change

In 2009, climate models for the Northern Hemisphere projected warmer temperatures, more intense precipitation, and increased summer drying (Service 2009, p. 19). The impacts of climate change to *Fremontodendron mexicanum* individuals were unknown (Service 2009, pp. 19–20).

Since 2009, scientists have used downscaled climate models to project changes in temperature and precipitation in California under a range of future climate scenarios (Jennings *et al.* 2018, entire; Kalansky *et al.* 2018, entire; Pierce *et al.* 2018, entire) ([Table 4](#)). These models project that:

1. Temperature has increased throughout Southern California over the past century, and warming is expected to continue (Hall *et al.* 2018, pp. 10–11; Jennings *et al.* 2018, pp. 20–29).
2. Coastal areas are projected to experience relatively lower amounts of warming compared to inland regions, because the ocean provides a buffering effect (Hall *et al.* 2018, p. 10; Jennings *et al.* 2018, pp. 71, 77, 80).

Wet and dry precipitation extremes are projected to increase in the future, although models project small mean changes compared to historical variability (Hall *et al.* 2018, p. 13; Jennings *et al.* 2018, p. 46).

In response to climate change, plant species may persist in a modified climate, move to areas of more suitable climate, or go extinct (Theurillat and Guisan 2001, p. 78; Parmesan 2005, pp. 48–52). Hughes (2000, entire) identified four broad categories of climate change effects on species:

1. Physiological effects, caused by changes in precipitation, temperature, and atmospheric CO₂ concentration. In plants, those variables affect photosynthesis and respiration.
2. Effects on species distributions due to increased temperature. As the climate warms, species are expected to shift towards higher latitudes and elevations. In San Diego County, although models project cooler temperatures in coastal areas, habitat loss and fragmentation could limit potential coastward range shifts (Jennings *et al.* 2018, p. 14).
3. Phenological effects, including alteration of environmental cues, such as temperature and resource availability.
4. *In situ* adaptation, in which species evolve to adapt to changing conditions over time.

In general, the San Diego flora is more likely to experience range contractions rather than shifts or expansions, and increased nonnative plant spread into native plant communities is also likely (Jennings *et al.* 2018, pp. 16, 18). Plant species with longer life spans or long-lived seed could be less susceptible to climate variability (Jennings *et al.* 2018, p. 19). However, we do not have species-specific information or models about how *Fremontodendron mexicanum* could respond to projected temperature and precipitation changes.

Table 4. Projected annual average maximum temperatures for *Fremontodendron mexicanum* in San Diego County. The values are the average of projections from four priority models (MIROC5, CanESM2, HadGEM2-ES, and ENRM-CM5) during the mid-century (2035–2064) and end-of-century time period (2070–2099). Data from Cal-Adapt (CEC 2021, entire).

Year Range	RCP 4.5 projected annual average maximum temperature (30 year average and range, degrees F)	RCP 8.5 projected annual average maximum temperature (30 year average and range, degrees F)
Historical (1961–1990)	73.8 (range 71.3–76.8)	73.8 (range 71.3–76.8)
Mid-century (2035–2064)	77.8 (range 74.7–81.2)	78.7 (range 75.8–83.0)
End of century (2070–2099)	79.1 (range 76.0–82.8)	81.8 (range 77.9–86.3)

Trail use

We did not discuss disturbance from trail use at listing or in the 2009 5-year review. Unauthorized trail use has impacted plants at the Wild Man Canyon reintroduction site on the SDNWR.

Unauthorized trail use on Mother Miguel Mountain increased after the 2007 Harris Fire, and by 2015, user-created routes had caused loss of vegetation, soil disturbance, and erosional issues in the area (Service 2019, p. 3). Reintroduced *Fremontodendron mexicanum* at the Wild Man Canyon site were trampled or affected by erosion (Service 2019, pp. 6, 9). Between 2015 and 2019, the SDNWR planned and implemented a project to establish a sustainable trail and manage public use, resulting in a realigned trail, interpretative signage, and rehabilitation of the unauthorized route (Service 2019, pp. 8–18). The realigned trail is adjacent to the reintroduced *F. mexicanum* at Wild Man Canyon.

User-created trails are also present at the Little Cedar and Woodwardia Canyon occurrence (EO 2) (Crawford 2022, pers. obs.).

Agriculture

Agriculture is not a threat to *Fremontodendron mexicanum* in the United States but is the likely cause of extirpations in Mexico. Campos *et al.* (2019, p. 22) reported that agricultural fields were present at two historical *F. mexicanum* points along Arroyo La Grulla in Baja California, Mexico. At the San Antonio Canyon location, plants were likely killed by a cattle dam above the canyon (Campos *et al.* 2019, p. 22).

Mining

Mining is not a threat to *Fremontodendron mexicanum* in the United States but is a threat to the species in Mexico. Campos *et al.* (2019, p. 22) reported that an active gravel mine was present at one of the historical *F. mexicanum* points along Arroyo La Grulla in Baja California, Mexico.

Summary of threats

In 2009, we recommended that the status of Mexican flannelbush remain unchanged due to the lack of new information about population dynamics and occurrence status (Service 2009, p. 20).

Since the 2009 5-year review, we received new information about ongoing threats at *Fremontodendron mexicanum* occurrences ([Table 2](#), [Table 3](#)). For this review, we have new information about all eight threats discussed in the 2009 5-year review. Additionally, we have new information about three disturbances that were not discussed in the 2009 5-year review: trail use, agriculture, and mining.

Conclusion

In 2009, we recognized four extant *Fremontodendron mexicanum* occurrences (three in the United States and one in Mexico). Since then, we received new information about the status and threats of this species. We also received new information about three threats which were not discussed in the 2009 5-year review: trail use, agriculture, and mining. Trail use is present at occurrences in the U.S., and agriculture and mining are threats to *F. mexicanum* in Mexico.

Due to reintroduction activities on the SDNWR and discoveries of new occurrences in Mexico, we are aware of four more locations of *Fremontodendron mexicanum* in 2022 compared with 2009: two reintroduction sites and two new locations in Baja California. There are 13 site-native

occurrences of *F. mexicanum* across the species' range. Six occurrences are extant or presumed extant ([Table 1](#)).

In addition to the new occurrences and updated occurrence status, a study of *Fremontodendron mexicanum* reproductive ecology has provided new information about seed germination, pollination, and seed dispersal.

The updated occurrence status and other new information does not substantially alter the species' status or the results of our five-factor analysis in the 2009 5-year review. Therefore, we conclude that *Fremontodendron mexicanum* remains a federally endangered species.

RECOMMENDATIONS FOR FUTURE ACTIONS

We recommend that the following actions be completed over the next 5 years to manage threats to *Fremontodendron mexicanum* and aid in recovery efforts. We recognize that conservation of this species will require cooperation and coordination with partners.

1. Support partners to enhance habitat and manage nonnative plants at *F. mexicanum* occurrences.
2. Identify opportunities to work with private landowners to conserve *F. mexicanum*. Purchase private lands occupied by *F. mexicanum* from willing sellers.
3. Augment the *F. mexicanum* reintroduction sites on the SDNWR. Identify other potential reintroduction sites and work with interested landowners to establish additional locations of *F. mexicanum*.
4. Coordinate with the SDMMP on the development of a Rare Plant Management Plan for *F. mexicanum*, which includes species-specific best management practices and identifies research needs.
5. Work with partners in Mexico to identify additional survey areas and prioritize conservation actions.

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APPENDIX

Table A1. Likely or possibly cultivated locations of *Fremontodendron mexicanum*. The table does not include the erroneous location in Monterey County at Junipero Serra Peak (former EO 14) (CDFW 2005, entire). All collection information is from the Consortium of California Herbaria (CCH2 2021, entire).

Cultivation status	State/Country or County	Location name	Accession number (primary collector and year)
Likely cultivated	Los Angeles County	Altadena, dry mesa	Not in CCH2
Likely cultivated	Los Angeles County	Claremont Creek	SD93035 (Bertsh 1953)
Unknown, possibly cultivated	Los Angeles County	Cloverleaf Drive, Monrovia	UCR2932 (Oshima 1963)
Unknown, possibly cultivated	Los Angeles County	College Street and Foothill Blvd.	LOB106335 (Goudge 1975)
Cultivated	Los Angeles County	Los Angeles Pierce College, Woodland Hills	NA
Unknown, possibly cultivated	Los Angeles County	North of Highway 101	SFV108547 (Gasser 1956)
Likely cultivated	Los Angeles County	Pomona College	Not in CCH2
Likely cultivated	Los Angeles County	San Gabriel Canyon	Not in CCH2
Likely cultivated	Los Angeles County	Via Del Monte, Palos Verde	UCSB18828 (Keith 1963) ²
Likely cultivated	Los Angeles County	Whittier	Not in CCH2
Unknown, possibly cultivated	Orange County	Modjeska Canyon Road	LOB 106334 (Canington 1974)
Likely cultivated	Orange County	Santa Ana Botanical Gardens	LOB106340 (Durbin 1950)
Likely cultivated	Orange County	Tucker Wildlife Sanctuary	RSA659637 (Daubert 1991)
Likely cultivated	San Diego County	Agua Tibia Creek	SD136123 (Faulkner 1984)

² Reference: CDFW 2005

Cultivation status	State/Country or County	Location name	Accession number (primary collector and year)
Likely cultivated	San Diego County	Alpine	SD135330 (Gibson 1991)
Likely cultivated	San Diego County	Bonita	SD32168 (Harbison 1944)
Unknown, possibly cultivated	San Diego County	De Luz Murrieta Road	LOB106336 (Campbell 1975)
Likely cultivated	San Diego County	Florida Canyon	SDSU11262 (Hoyt 1989) ²
Unknown, possibly cultivated	San Diego County	Live Oak Canyon Road east of O'Neil Park	LOB10634 (Roddy 1972)
Likely cultivated	San Diego County	Mission Trails Park	SDSU11261 (Loughlin 1991)
Likely cultivated	San Diego County	North of Barret Lake	UCR130662, RSA628848 (Helmkamp 1999) ²
Likely cultivated	San Diego County	Presidio Hills Park	Not in CCH2
Likely cultivated	San Luis Obispo County	Cal Poly SLO, Poly Canyon Road	OBI111292 (Poplack 2014)
Unknown, possibly cultivated	San Luis Obispo County	Lopez Reservoir	OBI111293 (Hixon 2017)
Likely cultivated	San Luis Obispo County	Nipomo Hill	UCR132037 (Helemkamp 2003)
Likely cultivated	Santa Clara County	Embarcadero Road & El Camino Real	Not in CCH2

NA – Not applicable.

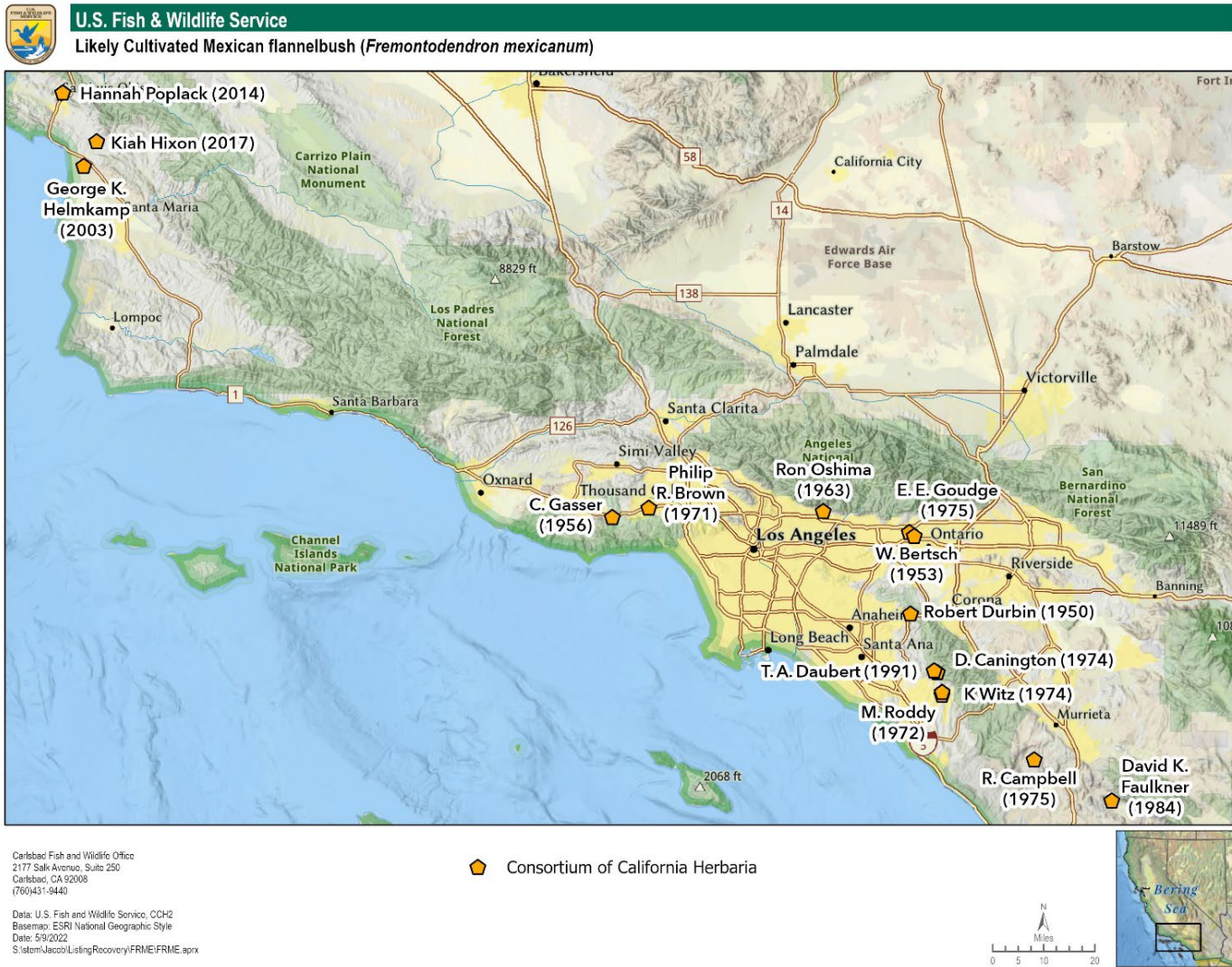


Figure A1. Likely or possibly cultivated locations of *Fremontodendron mexicanum* in San Luis Obispo, Los Angeles, Orange, and San Diego Counties.

FIELD OFFICE APPROVAL

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Approved

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