Monardella viminea (M. linoides subsp. *v.*)
(Willowy Monardella)

5-Year Review:
Summary and Evaluation

Photo: USFWS, Public Domain

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

August 2022

5-YEAR REVIEW

***Monardella viminea* (*M. linoides* subsp. *v.*)**
(willowy monardella)

GENERAL INFORMATION

Species: *Monardella viminea* [*M. linoides* subsp. *v.* (Willowy monardella)], a plant species
Date listed under the Endangered Species Act: October 13, 1998
Federal Register citation: USFWS 1998 (63 FR 54938)
Classification: Endangered
Recovery Plan: There is no recovery plan for this species.
Recovery Priority Number: 8
Critical Habitat Designation: USFWS 2012b (77 FR 13394).

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 2012a. 5-year review short form summary *Monardella viminea* [*M. linoides* subsp. *v.* (Willowy monardella)]. Prepared by the Carlsbad Fish and Wildlife Office, Carlsbad, California. 9 pp.

We initiated the previous status review for *Monardella viminea* on April 27, 2012. The review was finalized on August 3, 2012 and recommended no change in 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).

Species Overview and Habitat: *Monardella viminea* (willowy monardella) is a strongly aromatic, herbaceous perennial in the *Lamiaceae* (mint) family. The species occurs in coastal sage scrub and riparian scrub in sandy bottoms and on banks of ephemeral washes in canyons where surface water flows for usually less than 48 hours after a rain event (Sheid 1985, p. 3; Elvin and Sanders 2003, p. 430; Kelly and Burrascano 2006, p. 51). It is a geographically narrow endemic restricted to three watersheds in San Diego County, California with most of the populations occurring on Marine Corps Air Station (MCAS) Miramar. The leaves are linear to lance shaped. When in bloom, the dense flowers are pale white to rose colored and subtended by greenish white, rose-tipped bracts. The stems are waxy, green, and hairy; a characteristic distinguishing it from other species of the same genus.

Monardella viminea was previously recognized and listed as *Monardella linoides* ssp. *viminea.* In 2003, Elvin and Sanders proposed a taxonomic split of this entity into two distinct species. Upon recognition of this taxonomic change and species split, the range of the listed entity was

reduced, and the southernmost occurrences were reclassified as *Monardella stoneana*. For more details regarding the taxonomic classification of *Monardella linoides* ssp. *viminea* as a distinct species (*M. viminea*) and reclassifying a portion of *Monardella linoides* ssp. *viminea* as a separate species (*M. stoneana*), and the consequences of recognizing this split, please refer to the revised final listing and revised critical habitat rule published in the Federal Register on March 6, 2012 (USFWS 2012b, pp. 13394–13447).

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). We also contacted the United States Geological Survey (USGS), Department of Defense (DoD), the City of San Diego, 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 2012

Biology and Distribution

Genetics

Milano and Vandergast (2018, entire) sampled 158 individuals from 12 occurrences throughout the species range to assess the genetic diversity and structure of *Monardella viminea*. Population structure analysis found no evidence of distinct genetic clusters or isolation by distance (Milano and Vandergast 2018, p. 37). There was little indication of diversity loss or increased inbreeding, and genetic redundancy was consistent across occurrences (Milano and Vandergast 2018, p. 42). This indicates the population is maintaining gene flow, thus supporting the adaptive capacity of the species.

Monitoring and Surveys

To update *Monardella viminea* occurrence[1] status, we reviewed Element Occurrence (EO) data from the California Natural Diversity Database (CNDDB), monitoring data from the San Diego Management and Monitoring Program (SDMMP) annual monitoring on Management Strategic Planning Area (MSPA) lands, and from regular monitoring conducted on MCAS Miramar.

To describe the location of *Monardella viminea* plants we reference the CNDDB EO ("occurrence"). Following the CNDDB definition of an EO, two occurrences are unique if the distance between their closest parts is less than or equal to 0.25 miles without regard to whether individuals interbreed (CNDDB 2020, p. 10). This is consistent with terminology we used in

[1] The California Natural Diversity Database is an inventory of the status and locations of rare plants and animals in California. The CNDDB 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 CNDDB, or locations not in the CNDDB that are greater than 0.25 miles (0.40 kilometers) apart.

previous documents and provides clarity in referencing clumps of plants in canyons that may be referred to by multiple or changing names.

For this review, we considered an occurrence extant if *Monardella viminea* was observed within the last 10 years. If the species had not been observed for over 10 years but suitable habitat is present, we considered it presumed extant. If *M. viminea* had not been observed for over 20 years and the habitat is degraded or partially developed, we considered the occurrence possibly extirpated.

Based on new information we updated the *Monardella viminea* occurrence table and added additional occurrences that were not considered in the 2012 5-year review (Table 1). Changes to occurrence status between 2012 and 2022 are:

1. CNDDB EO 2 was not included in the 2012 occurrence table. We considered it extant in 2008 (USFWS 2008, p. 4). The species was observed by a USFWS biologist in 2022, so we consider this occurrence extant. (CDFW 2021, p. 3; Gower 2022, pers. comm.).

2. Two EOs (CNDDB EO 5 and 6) were not included in the 2012 occurrence table and are now considered extirpated due to development and the lack of suitable habitat.

3. Two EOs (CNDDB EO 14 and 15) were considered extirpated in 2012 but are now considered extant. In 2017 and 2020, census and monitoring reports from MCAS Miramar reported *Monardella viminea* in each location (Vernadero 2018, p. 22; 2021, p. 22).

4. Former CNDDB EO 13 is now part of CNDDB EO 12 (CDFW 2021, p. 12).

5. Ten EOs (CNDDB EO 32, 33, 34, 35, 36, 37, 38, 39, 40, and 41) are new since our last 5-year review. Five EOs (32, 33, 35, 36, and 41) are considered extant, two EOs (34 and 40) are considered presumed extant, and two EOs (37 and 38) are considered possibly extirpated, and one EO is considered extirpated (EO 39).

In summary, monitoring for *Monardella viminea* has occurred at 20 occurrences since 2012 (Table 1), providing new information about the species presence and abundance. We reassessed our previous occurrence status determinations and updated the status of four occurrences. Additionally, information was added for 3 EOs omitted from the previous 5-year review, 1 was merged with another EO, and 10 are new occurrences reported since 2012. Based on those updates, there are now 30 occurrences of *M. viminea* (Figure 1; Table 1) of which 16 are extant, 2 are presumed extant, 2 are possibly extirpated, and 10 are extirpated.

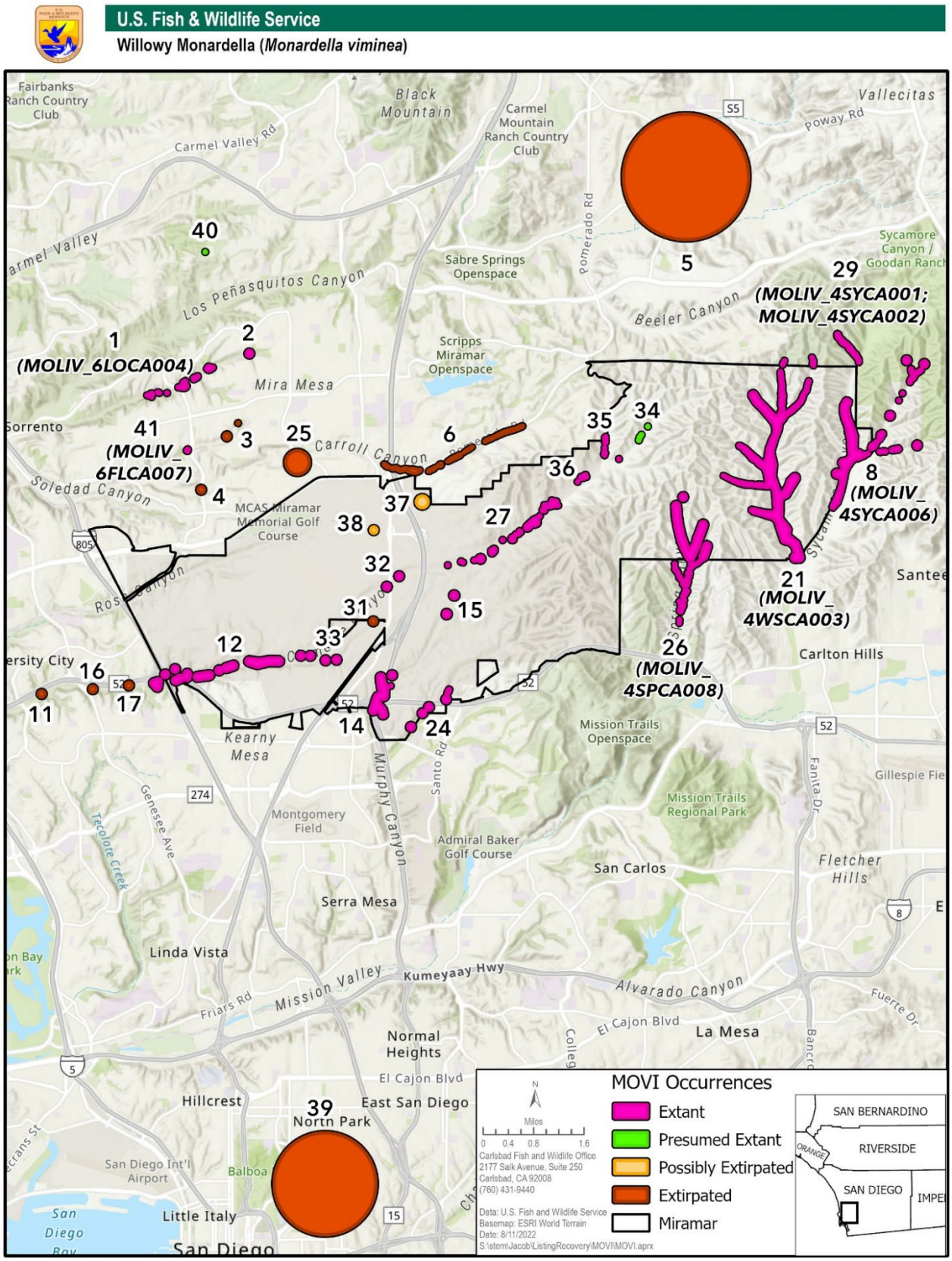

Figure 1. Distribution of *Monardella viminea* (willowy monardella) occurrences; showing occurrence status, CNDDB EO number, and SDMMP Occurrence ID (if applicable).

Table 1. Occurrence table for *Monardella viminea*, including a summary of changes between 2012 and 2022.

Canyon Name	2022 CNDDB EO Number	SDMMP Occurrence ID	Status at Listing (1998)	Status at Last Review (2012)	2022 Status	Landowner	EO Visits Since 2012 [Year (count)]	2012–2022 Change Summary	References
Lopez Canyon	1	MOLIV_6LOCA004	Extant	Extant	Extant	City	SDMMP surveys: 2014 (10) 2015 (13) 2016 (11) 2017 (9) 2018 (9) 2019 (5)	No change	CBI and AECOM 2021a, p. 336; CDFW 2021, pp. 1–2
Cuervo (Lopez) Canyon	2			Not included in 2012 5YR	Extant	City	Incidental observation by USFWS biologist	This occurrence was not included in the 2012 5-year review occurrence table. We considered it extant in 2008. The species was observed in 2022, so we consider this occurrence extant.	CDFW 2021, p. 3; Gower 2022, pers. comm.
Cemetery Canyon	3		Extant	Extirpated	Extirpated	City	N/A	No change	CDFW 2021, p. 4
Carroll Canyon Drainage	4		Extant	Extirpated	Extirpated	Private	N/A	No change	CDFW 2021, p. 5
McCoon's Ranch	5				Extirpated	Private	N/A	This occurrence was not included in the 2012 5-year review occurrence table. We consider it extirpated due to the lack of suitable habitat present.	CDFW 2021, p. 6
Kearney Mesa/ Carroll Canyon	6			Not included in 2012 5YR	Extirpated	DoD (Miramar), City, Private	N/A	This occurrence was not included in the 2012 5-year review occurrence table. It was considered extirpated in 2008 and we consider it extirpated due to the lack of suitable habitat and high amounts of development in the area.	CDFW 2021, pp. 7–8

Canyon Name	2022 CNDDB EO Number	SDMMP Occurrence ID	Status at Listing (1998)	Status at Last Review (2012)	2022 Status	Landowner	EO Visits Since 2012 [Year (count)]	2012–2022 Change Summary	References
Sycamore Canyon (includes EO 9 and 10)	8	MOLIV_4SYCA006	Extant	Extant	Extant	DoD (Miramar), SD County, Private	MCAS Miramar Surveys: 2012 (198) 2017 (118) 2020 (107) SDMMP surveys: 2015 (441) 2016 (238) 2017 (283) 2018 (283) 2019 (364)	This occurrence is now included in the SDMMP Rare plant monitoring and management plan. There is no change in occurrence status.	Tetra Tech 2013, pp. 16–17; Vernadero 2018, pp. 26, 29; CBI and AECOM 2021a, p. 336; CDFW 2021, pp. 9–10; Vernadero 2021, pp. 19, 26
San Clemente Canyon	11		Extant	Extirpated	Extirpated	City	N/A	No change	CDFW 2021, p. 11
San Clemente Canyon/ Miramar (includes EO 19)	12		Extant	Extant	Extant	DoD (Miramar), City	MCAS Miramar surveys: 2012 (0) 2017 (seen) 2020 (seen)	No change	Tetra Tech 2013, pp. 16–17; Vernadero 2018, pp. 24, 29; CDFW 2021, pp. 12–13; Vernadero 2021, pp. 19, 24
Murphy Canyon	14		Extant	Extirpated	Extant	DoD (Miramar), CALTRANS	MCAS Miramar surveys: 2012 (1) 2017 (1) 2020 (1)	This occurrence was considered extirpated in the 2012 5-year review. We now consider it extant due to the observation of one clump in 2017 and 2020 MCAS Miramar surveys. This occurrence continues to be threatened by erosion and most of the occurrence has been extirpated due to highway construction.	Tetra Tech 2013 pp. 16–17; Vernadero 2018, pp. 22, 29; CDFW 2021, p. 14; Vernadero 2021, pp. 19, 22
Murphy Canyon/ Rifle Range (includes EO 30)	15		Extant	Extirpated	Extant	DoD (Miramar)	MCAS Miramar Surveys: 2012 (0) 2017 (1) 2020 (1)	This occurrence was considered extirpated in the 2012 5-year review. We now consider it extant due to the observation of one clump in 2017 and 2020 MCAS Miramar surveys. This occurrence continues to be threatened by nonnatives and rifle range expansion.	Tetra Tech 2013, pp. 16–17; Vernadero 2018, pp. 22, 29; CDFW 2021, p. 15; Vernadero 2021, pp. 19, 22
San Clemente Park	16		Extant	Extirpated	Extirpated	City	N/A	No change	CDFW 2021, p. 16

Canyon Name	2022 CNDDB EO Number	SDMMP Occurrence ID	Status at Listing (1998)	Status at Last Review (2012)	2022 Status	Landowner	EO Visits Since 2012 [Year (count)]	2012–2022 Change Summary	References
San Clemente Park/ Genesee Ave	17		Extant	Extirpated	Extirpated	City	N/A	No change	CDFW 2021, p. 17
West Sycamore Canyon	21	MOLIV_4WSCA003	Extant	Extant	Extant	DoD (Miramar), City	MCAS Surveys: 2013 (353) 2017 (250) 2020 (212); SDMMP Surveys: 2016 (27) 2018 (10) 2019 (9)	No change	Tetra Tech 2013, pp. 16–17; Vernadero 2018, pp. 27, 29; CBI and AECOM 2021a, p. 336; CDFW 2021, p. 18–19; Vernadero 2021, pp. 19, 27
Elanus Canyon/ Miramar South	24		Extant	Extant	Extant	DoD (Miramar), City	MCAS Miramar surveys: 2012 (11) 2017 (10) 2020 (9)	No change	Tetra Tech 2013, pp. 16–17; Vernadero 2018, pp. 21, 29; CDFW 2021, p. 20; Vernadero 2021, pp. 19, 21
Carroll Canyon/ Kearney Mesa	25		Extant	Extirpated	Extirpated	Private	N/A	No change	CDFW 2021, p. 21
Spring Canyon	26	MOLIV_4SPCA008	Extant	Extant	Extant	DoD (Miramar), City, Private	MCAS Miramar surveys: 2012 (232) 2017 (192) 2020 (183); SDMMP annual monitoring: 2015 (31) 2016 (46) 2017 (42) 2018 (29) 2019 (28)	No change	Tetra Tech 2013, pp. 16–17; Vernadero 2018, pp. 25, 29; CBI and AECOM 2021a, p. 336; CDFW 2021, p. 22–23; Vernadero 2021, pp. 19, 25

Canyon Name	2022 CNDDB EO Number	SDMMP Occurrence ID	Status at Listing (1998)	Status at Last Review (2012)	2022 Status	Landowner	EO Visits Since 2012 [Year (count)]	2012–2022 Change Summary	References
San Clemente Canyon/ East I-15	27		Extant	Extant	Extant	DoD (Miramar)	MCAS Miramar surveys: 2012 (seen) 2017 (seen) 2020 (seen)	No change	Tetra Tech 2013, pp. 16–17; Vernadero 2018, pp. 23, 29; CDFW 2021, p. 24; Vernadero 2021, pp. 19, 23
Sycamore Canyon/ Goodan Ranch	29	MOLIV_4SYCA001; MOLIV_4SYCA002	Extant	Extant	Extant	City, Private	SDMMP annual surveys: MOLIV_4SYCA001: 2014 (85) 2015 (90) 2016 (57) 2017 (44) 2018 (52) 2019 (34); MOLIV_4SYCA002: 2016 (0) 2018 (10) 2019 (9)	No change	CBI and AECOM 2021a, p. 336; CDFW 2021, p. 25–26
MCB Miramar	31		Extant	Extirpated	Extirpated	DoD (Miramar)	MCAS Miramar surveys: 2013 (0) 2017 (0) 2020 (0)	No change	Tetra Tech 2013, pp. 16–17; Vernadero 2018, p. 24, 29; CDFW 2021, p. 27; Vernadero 2021, p. 19, 24
San Clemente Canyon/ Kearney Villa Road	32		Unknown	Unknown	Extant	DoD (Miramar)	MCAS Miramar surveys: 2012 (2) 2017 (2) 2020 (2)	This occurrence was not included in the 2012 5-year review occurrence table. We consider this occurrence to be extant.	Tetra Tech 2013, pp. 16–17; Vernadero 2018, pp. 24, 29; CDFW 2021, p. 28; Vernadero 2021, pp. 19, 24

Canyon Name	2022 CNDDB EO Number	SDMMP Occurrence ID	Status at Listing (1998)	Status at Last Review (2012)	2022 Status	Landowner	EO Visits Since 2012 [Year (count)]	2012–2022 Change Summary	References
San Clemente Canyon/ HWY 163	33		Unknown	Unknown	Extant	DoD (Miramar)	MCAS Miramar surveys: 2012 (seen) 2017 (seen) 2020 (seen)	This occurrence was not included in the 2012 5-year review occurrence table. We consider this occurrence to be extant.	Tetra Tech 2013, pp. 16–17; Vernadero 2018, pp. 24, 29; CDFW 2021, p. 29; Vernadero 2021, pp. 19, 24
Upper San Clemente Canyon/ Center Fork	34		Unknown	Unknown	Presumed Extant	DoD (Miramar)	MCAS Miramar surveys: 2012 (seen) 2017 (0) 2020 (0)	This occurrence was not included in the 2012 5-year review occurrence table. We consider this occurrence to be presumed extant. Though surveys were conducted in 2017 and 2020, MOVI has not been reported from this location since 2012. Though the species has not been observed in over 10 years, we consider it presumed extant because there is suitable habitat present to support the species.	Tetra Tech 2013, pp. 16–17; Vernadero 2018, pp. 23, 29; CDFW 2021, p. 30; Vernadero 2021, pp. 19, 23
Upper San Clemente Canyon/ Western Fork	35		Unknown	Unknown	Extant	DoD (Miramar)	MCAS Miramar surveys: 2012 (seen) 2017 (seen) 2020 (seen)	This occurrence was not included in the 2012 5-year review occurrence table. We consider this occurrence to be extant.	Tetra Tech 2013, pp. 16–17; Vernadero 2018, pp. 23, 29; CDFW 2021, p. 31; Vernadero 2021, pp. 19, 23
San Clemente Canyon/ Rue Biarritz	36		Unknown	Unknown	Extant	DoD (Miramar)	MCAS Miramar surveys: 2012 (seen) 2017 (seen) 2020 (seen)	This occurrence was not included in the 2012 5-year review occurrence table. We consider this occurrence to be extant.	Tetra Tech 2013, pp. 16–17; Vernadero 2018, pp. 23, 29; CDFW 2021, p. 32; Vernadero 2021, pp. 19, 23

Canyon Name	2022 CNDDB EO Number	SDMMP Occurrence ID	Status at Listing (1998)	Status at Last Review (2012)	2022 Status	Landowner	EO Visits Since 2012 [Year (count)]	2012–2022 Change Summary	References
Carroll Canyon/ Rose Canyon	37		Unknown	Unknown	Possibly Extirpated	DoD (Miramar)	MCAS Miramar surveys: 2012 (0) 2017 (0) 2020 (0)	This occurrence was not included in the 2012 5-year review occurrence table. We consider this occurrence to be possibly extirpated because *Monardella viminea* has not been observed for over 20 years. The last observation consisted of two clumps found during the 2002 surveys. According to MCAS Miramar biologists, it is highly unlikely that *Monardella viminea* will be observed in this canyon in the future due to overall lack of recruitment at MCAS Miramar (Vernadero 2021, p. 53).	Tetra Tech 2013, pp. 16–17; Vernadero 2018, pp. 29; CDFW 2021, p. 33; Vernadero 2021, pp. 5, 19, 53
Rose Canyon	38		Unknown	Unknown	Possibly Extirpated	DoD (Miramar)	MCAS Miramar surveys: 2012 (0) 2017 (0) 2020 (0)	This occurrence was not included in the 2012 5-year review occurrence table. We consider this occurrence to be possibly extirpated because *Monardella viminea* has not been observed for over 20 years. The last observation consisted of two clumps found during the 2002 surveys. According to MCAS Miramar biologists, it is highly unlikely that *Monardella viminea* will be observed in this canyon in the future due to overall lack of recruitment at MCAS Miramar (Vernadero 2021, p. 53).	Tetra Tech 2013, pp. 16–17; CDFW 2021, p. 34; Vernadero 2021, pp. 5, 19, 53
Switzers Canyon	39		Unknown	Unknown	Extirpated	City	N/A	This occurrence was not included in the 2012 5-year review occurrence table. We consider this occurrence to be extirpated because of habitat degradation and development.	CDFW 2021, p. 35
Deer Canyon/ Pensaquitos Canyon	40		Unknown	Unknown	Presumed extant	County, USFWS, State	N/A	This occurrence was not included in the 2012 5-year review occurrence table. We consider this occurrence to be presumed extant because it has not been surveyed and suitable habitat is present.	CDFW 2021, p. 36
Cemetery Canyon/ Camino Santa Fe Bridge	41	MOLIV_6FLCA007	Unknown	Unknown	Extant	City	SDMMP Annual Monitoring surveys: 2015 (86) 2016 (45) 2017 (62) 2018 (73) 2019 (66)	This occurrence was not included in the 2012 5-year review occurrence table. We consider this occurrence to be extant.	CBI and AECOM 2021a, p. 336; CDFW 2021, p. 37

Threats

In the 2012 revised final listing and critical habitat rule, we discussed Factor A threats (present or threatened destruction, modification, or curtailment of habitat or range) to *Monardella viminea* from urbanization and development, altered hydrology, fire and type conversion; and Factor E threats (other natural or manmade factors affecting a species' continued existence) from trampling, nonnative plant species, small population size and restricted range, fire, and climate change (USFWS 2012b, pp. 13398–13406).

This section summarizes new information about threats to *Monardella viminea* since 2012. We have new information about the threats of urbanization and development, altered hydrology, nonnative plant species, and climate change.

Urbanization and development

Urbanization and development were recognized as threats to *Monardella viminea* in the listing rule and the 2012 revised final listing and critical habitat rule (USFWS 1998, p. 54946; 2012b, pp. 13398–13399). While most occurrences of *M. viminea* are found on land conserved or owned by MCAS Miramar, and the City or County of San Diego, development continues to be a threat at four occurrence (EOs 8, 12, 14, and 24) and was a contributing factor to extirpation at seven occurrences historically (EOs 3, 4, 5, 6, 11, 25, and 39). Since the last 5-year review, EOs 5, 6, and 39, which were not discussed in the previous 5-year, are considered extirpated due to development (Table 1). Additionally, *M. viminea* occurrences remain indirectly threatened from surrounding urbanization due to higher levels of impervious surface areas that increase dry season runoff (AECOM 2022, p. 3). This increased runoff converts ephemeral drainages to a permanently wet state, promoting conversion to riparian habitat (AECOM 2022, p. 3).

Altered Hydrology

Altered hydrology was discussed as a significant threat to habitats that support *Monardella viminea* at listing and in the 2012 revised final listing and critical habitat rule (USFWS 1998, p. 54950; 2012b, p. 13399). Natural hydrological systems are required by *M. Viminea* to maintain and deposit material for secondary benches and streambeds on which the species grows (Sheid 1985, pp. 30–31, 34–35). Furthermore, a natural hydrological regime helps reduce competition from woody riparian species and nonnative grasses through scouring and erosion events; however, excessive scouring and erosion can reduce growth or damage *M. viminea* (Vernadero 2021, p. 53). Hydrological changes may occur within watersheds due to upstream urban development and precipitation changes that affect daily median and minimum discharges, dry season runoff, and flood magnitudes (White and Greer 2006, pp. 133–136).

In the 2012 analysis, EOs 3, 4, and 11 were listed as extirpated due to altered hydrological patterns. Altered hydrology has continued to threaten *Monardella viminea* habitat throughout its range. Since the last review, altered hydrology has been identified as a threat during monitoring conducted by SDMMP on MSPA lands at EOs 1 (MOLIV_6LOCA004), 8 (MOLIV_4SYCA006), 21 (MOLIV_4WSCA003), and 29 (MOLIV_4SYCA001; MOLIV_4SYCA002) (CBI and AECOM 2021a, pp. 345–346). Loss or damage of *M. viminea* clumps was documented on MCAS Miramar following large scouring events during the 2015–2016 and 2016–2017 growing

seasons (Vernadero 2021, pp. 53, 57). Additionally, some plants located in San Clemente Canyon (EO 35) were washed away after heavy rains in the past several years (Gordon 2022, pers. comm.). In summary, 10 occurrences are potentially impacted by the threat of altered hydrology (CDFW 2021).

Nonnative Plant Species

Nonnative plants were identified as a threat to *Monardella viminea* in the listing rule and in subsequent 5-year reviews (USFWS 1998, p. 54950; 2008, pp. 11–12; 2012b, p. 13404). This threat is ongoing, and nonnatives are listed as a threat at 11 out of 30 occurrences (CDFW 2021, pp. 1, 4–5, 9, 11–12, 15, 18, 22, 25, 37).

Nonnative plants are present throughout all canyons on MCAS Miramar where *M. viminea* occurs. During the 2020 surveys, Vernadero (2021, pp. 32–34) observed nonnative plant cover in all but two monitoring plots. In some plots, nonnatives were the dominant plant species cover (Vernadero 2021, p. 32). In review comparing plot photographs captured in 2012 to photos captured in 2017 and 2020, surveyors noted the most distinguishable pattern was the increase in nonnative species (Vernadero 2021, p. 52). In monitoring completed off the MCAS Miramar base, SDMMP noted nonnatives as a medium (threat occurs in 10 to 50 percent of area within maximum extent) or high (threat occurs in 50 to 100 percent of area within maximum extent) level threat in 5 out 7 occurrences monitored in 2019 (CBI and AECOM 2021a, pp. 343–346).

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). Downscaled projections under several future climate scenarios are available for the range of *Monardella viminea*.

Temperature Changes

Southern California has already experienced a warming trend from 1951 to 2006 (Hall *et al.* 2018, p. 9). In San Diego County, Cal-Adapt models project increases in annual average maximum and minimum temperatures between a baseline period (1961 to 1990) and an end of century period (2070 to 2099) (CEC 2022, p. 2–4). Specifically, between 2070 and 2099, annual average maximum temperatures are projected to increase by 5.0 degrees Fahrenheit (°F) under Representative Concentration Pathway (RCP) 4.5, and by 8.2 °F under RCP 8.5 (CEC 2022, p. 3). 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). As a result, the average annual precipitation will likely not change significantly between baseline observations (1961–1990) and the end of century period (2070–2099); however, precipitation will likely occur during more intense storms and over a shorter rain season. Furthermore, dry years will be more likely to occur consecutively, increasing drought risk (CEC 2022, p. 5).

Potential Effects of Climate Change on *Monardella viminea*

The effects of climate change on *Monardella viminea* 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 drought—could alter the hydrology of the habitat occupied by *M. viminea*. As discussed in the Altered Hydrology section above, *M. viminea* is dependent on a natural hydrological regime to maintain appropriate habitat and decrease competition (for a more in-depth discussion on the effects of altered hydrology, please refer to the 5-factor analysis in the 2012 revised final listing and critical habitat rule (USFWS 2012b, entire). Additionally, more frequent extreme precipitation events may result in increased scouring events that can wash away individual *M. viminea* plants.

A study on species vulnerability to climate change was conducted using 156 rare plants recognized by the California Native Plant Society and CNDDB (Anacker *et al.* 2013, entire). While this study did not specifically include *Monardella viminea*, two *Monardella* taxa were included (*M. hypoleuca* ssp. *Lanata* and *M. stebbinsii*). Both taxa modeled responses to climate change vulnerability and ranged from moderately vulnerable to extremely vulnerable (Anacker *et al.* 2013, p. 209). Of the factors tested, most showed no significant relationship to climate change vulnerability rank except for temperature and precipitation; suggesting temperature and precipitation changes within a species range are the primary drivers of a species vulnerability (Anacker *et al.* 2013, p. 201).

At MCAS Miramar, Kassebaum (2015, p. 20) implemented a habitat enhancement project to compare the effects of supplemental watering on garden specimens of *Monardella viminea* to naturally occurring populations experiencing drought conditions. While not a formal study, Kassebaum noted lower flowering during drought years in the wild populations compared to plants that received supplemental watering, suggesting prolonged drought and increased temperatures may negatively affect *M. viminea* reproduction (Kassebaum 2015, pp. 20–21).

Climate Change Summary and Conclusion

For this 5-year review, we discussed reports from California's Fourth Climate Change Assessment (Hall *et al.* 2018, pp.9, 12–13; Kalansky *et al.* 2018, pp. 21, 24–25; Pierce *et al*. 2018, entire) and data from Cal-Adapt (CEC 2022, entire). These new models provide projections of future temperature and precipitation in San Diego County under two emissions scenarios (RCP 4.5 and 8.5).

In the 2012 revised final listing and critical habitat rule, we outlined how drier conditions associated with climate change could affect *Monardella viminea* habitat and individual plants (USFWS 2012b, pp. 13405–13406). However, we did not have enough information specific enough to make accurate predictions about the potential effects of those changes to the species (USFWS 2012b, p. 13406). Since 2012, new climate projections are available for the range of *M. viminea* and while we do not have new information specific to the species, observations of *M. viminea* and studies on related taxa (Anacker *et al.* 2013, entire) suggest climate change is a threat to the species throughout the range. Increasing temperatures, combined with greater precipitation extremes and longer drought periods, could cause drier conditions in *M. viminea* habitat, increasing stress on individual plants and potentially decreasing population resiliency. Drier conditions may promote an increase in fire frequency; as fire frequency increases, the habitat in which *M. viminea* grows may become more vulnerable to other threats such as erosion and invasive species. Additionally, with more intense precipitation extremes, *M. viminea* occurrences may face increased threats from scouring events that result in individual plants being washed away.

Summary of Threats

Since the 2012 5-year review, we received new information about ongoing threats at *Monardella viminea* occurrences. The new information relates to the threats of (1) urbanization and development, (2) altered hydrology, (3) nonnative plants, and (4) climate change. The new information does not alter the five-factor analysis or conclusions of our 2012 5-year review.

CONSERVATION EFFORTS

In 2021, SDMMP completed a plan that provides a framework to manage rare plants on conserved lands in San Diego County, including *Monardella viminea* (CBI and AECOM 2021a, pp. 331–371). The Plan identifies best management practices to restore *M. viminea* habitat and occurrences, makes recommendations for reintroduction, introduction, and translocation, and identifies additional research needs for occurrences on MSPA lands (CBI and AECOM 2021a, pp. 358–371).

In addition to the rare plant management framework, SDMMP also developed guidelines for seed collection, banking, and bulking for seven Management Strategic Plan (MSP) priority plants, including *Monardella viminea* (CBI and AECOM 2021b, pp. 160–171). The plan "provides a strategic approach to managing seed resources" by identifying and prioritizing plants needing seed conservation, identifying effective seed management and funding actions, and providing land mangers information for managing seed resources (CBI and AECOM 2021b, p. 8).

CONCLUSION

In the 2012 5-year review, we recommended no status change for *Monardella viminea*. Since 2012, we received new monitoring and survey information for *M. viminea*, and some new information about threats to *M. viminea*. Based on the new information, we updated the status of 4 occurrences considered in previous reviews and added occurrence information for 10 occurrences not considered in previous reviews. There are now 30 occurrences of *M. viminea* (Table 1); 16 are extant, 2 are presumed extant, 2 are possibly extirpated, and 10 are extirpated.

The new information and updated occurrence statuses does not substantially alter the species' status or the results of our five-factor analysis in the 2012 5-year review. Therefore, we conclude that *Monardella viminea* remains a federally endangered species.

RECOMMENDATIONS FOR FUTURE ACTIONS

The recommended actions listed below are to be initiated over the next 5–10 years. Successful implementation of these actions will reduce threats to *Monardella viminea* 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. Continue to monitor known *M. viminea* occurrences to update occurrence status, size, and threats. That information can be used to identify high-priority occurrences for management or areas for restoration. Work with landowners to implement management strategies as identified in the MSP Framework Rare Plant Management Plan (see CBI and AECOM 2021a, pp. 354–369).

2. Determine habitat characteristics that support *M. viminea* growth, survival, and reproduction. Identify areas of potential supportive habitat for reintroduction.

3. Enhance habitat where *M. viminea* occur, through nonnative plant control, flood control, and anti-erosion measures where necessary. Test available herbicides to learn their effect on *M. viminea* and determine whether it could be used to control nonnative grasses and forbs without negatively affecting *M. viminea*.

4. Identify suitable introduction/reintroduction sites to expand current distribution of *M. viminea* in areas where suitable habitat is present. Conduct habitat restoration to support pollinators, if necessary.

5. Research effects of drought and high temperatures on *M. viminea* recruitment and survivorship.

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Lead Field Supervisor, Fish and Wildlife Service

☒ Approve

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