**Recovery Plan for Serpentine Soil Species of the San Francisco Bay Area**
[Click here to view document]

**Original Approved:** September 30, 1998
**Original Prepared by:** Diane R. Elam, David H. Wright, Bradley Goettle, U.S. Fish and Wildlife Service, and Sacramento Fish and Wildlife Office

**DRAFT AMENDMENT 1**

We have identified the best available information that indicates the need to amend recovery criteria for San Mateo thornmint (*Acanthomintha duttonii*, formerly *Acanthomintha obovata* ssp. *duttonii*), Tiburon mariposa lily (*Calochortus tiburonensis*), fountain thistle (*Cirsium fontinale* var. *fontinale*), Presidio clarkia (*Clarkia franciscana*), Pennell's bird's-beak (*Cordylanthus tenuis* ssp. *capillaris*), San Mateo woolly sunflower (*Eriophyllum latilobum*), and Tiburon jewelflower (*Streptanthus niger*) since the 1998 recovery plan was completed. In this proposed modification, we synthesize the adequacy of the existing recovery criteria, show amended recovery criteria, describe the rationale supporting the proposed recovery plan modification, and propose recovery actions. The proposed modification is shown as an addendum that supplements the recovery plan, superseding the following pages from Section II: p. 14 for San Mateo thornmint, p. 53 for fountain thistle, p. 64 for Presidio clarkia, p. 72 for Pennell's bird's-beak, pp. 92-93 for San Mateo woolly sunflower, and p. 128 for Tiburon jewelflower.[1] Also superseded is the overview of the recovery criteria for the aforementioned species presented in Table III-1 (Section III, pp. 10-19) of the recovery plan. The recovery plan does not specify recovery criteria for Tiburon mariposa lily, thus no information is superseded for this species.

**For**
**U.S. Fish and Wildlife Service**
**Pacific Southwest Region**
**Sacramento, CA**

**December 2018**

Approved: XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX

Regional Director, Pacific Southwest Region, Region 8,
U.S. Fish and Wildlife Service

Date: XXXXXXXXXXXXXXXX

[1] The superseded material includes only the specific recovery criteria described for these species. Recovery actions and/or other material on the specified pages are not superseded by this amendment.

## METHODOLOGY USED TO COMPLETE THE RECOVERY PLAN AMENDMENT

This amendment was prepared by the Sacramento Fish and Wildlife Office (SFWO) of the U.S. Fish and Wildlife Service (Service) and will be peer reviewed in accordance with the OMB Peer Review Bulletin following the publication of the Notice of Availability. We examined information from our files, the California Natural Diversity Database (CNDDB), scientific literature, and species experts. We developed amended recovery criteria by assessing threats to species using the Endangered Species Act's five listing-factors. Concepts from the Species Status Assessment (SSA) framework (Service, 2016) were used to augment this process. While a full SSA is beyond the scope of this recovery plan revision, the Service used the SSA framework to consider what species need to maintain viability by characterizing the status of the species in terms of its resiliency, representation, and redundancy (Wolf et al. 2015).

Resiliency describes the ability of populations to withstand stochastic disturbance. Resiliency is positively related to population size and growth rate. Further, it might be influenced by connectivity among populations. Generally, populations need abundant individuals within habitat patches of adequate area and quality in order to survive and reproduce in spite of disturbance.

Representation describes the ability of a species to adapt to changing environmental conditions over time. It is characterized by the breadth of genetic and environmental diversity within and among populations.

Redundancy describes the ability of a species to withstand catastrophic events. Generally, species that have adequate individuals within multiple populations minimize potential loss from catastrophic events. Redundancy is high when multiple, resilient populations are distributed within the species' ecological settings and across the species' range.

## ADEQUACY OF RECOVERY CRITERIA

Section 4(f)(1)(B)(ii) of the Endangered Species Act (Act) requires that each recovery plan shall incorporate, to the maximum extent practicable, "objective, measurable criteria which, when met, would result in a determination…that the species be removed from the list." Legal challenges to recovery plans [see Fund for Animals v. Babbitt, 903 F. Supp. 96 (D.D.C. 1995)] and a Government Accountability Audit (GAO 2006) also have affirmed the need to frame recovery criteria in terms of threats assessed under the five factors.

### Recovery Criteria

See an overview of the original version of criteria in Table III-1 (Section III, pp. 10-19) of the Recovery Plan for Serpentine Soil Species of the San Francisco Bay Area. [Click here to view document]

## Syntheses

### San Mateo thornmint (*Acanthomintha duttonii*)

Background and Status

San Mateo thornmint is a small annual plant in the mint family (Lamiaceae). This species is primarily self-pollinating and restricted to serpentine vertisol, a very uncommon type of serpentine soil with heavy-clay inclusions (McCarten 1993, Niederer et al. 2010). Historically, this species was sparsely distributed along the east side of the San Andreas Fault across a minimum range of 9.1 kilometers (5.7 miles)[2] in San Mateo County, California (Service 1985, CNDDB 2018). At the time of the approval of the recovery plan (Service 1998), there were two extant natural populations of San Mateo thornmint (Edgewood Park and Triangle), one introduced population (Pulgas Ridge; Pavlik and Espeland 1998), and three extirpated populations/colonies (Menlo Golf Club, Emerald Lake, and Upper Crystal Springs Reservoir). The Emerald Lake and Edgewood Park occurrences have since been merged into CNDDB occurrence #3 (CNDDB 2018). Following two additional extirpations (Triangle and Pulgas Ridge), the 2010 5-year review for San Mateo thornmint (Service 2010a) described a single extant population, occupying approximately 200 square meters (0.05 acre) of Edgewood Park (Niederer et al. 2010). Since 2010, four new San Mateo thornmint sites have been established, three at Edgewood Park (in additional to the natural site; Niederer and Weiss 2018) and one at Pulgas Ridge, property of the San Francisco Public Utilities Commission (SFPUC; C. Niederer, Creekside Science, pers. comm. 2018). The original introduced population at Pulgas Ridge may have failed because of insufficient seed application (Niederer et al. 2010). Meanwhile, the natural Edgewood Park colony has declined and its long-term viability seems unlikely (Niederer and Weiss 2018).

In 2008, the Creekside Center for Earth Observation initiated a San Mateo thornmint restoration project at Edgewood Park to achieve the following: habitat enhancement experiments, habitat suitability surveys for potential introductions, collection of and banking seeds, and initiation of a seed increase program. These goals were achieved within the first 2-3 years of the project and the results are summarized in the 2010 5-year review for San Mateo thornmint and detailed in Niederer et al. (2010). In 2010, a draft adaptive management plan for San Mateo thornmint (Niederer et al. 2010) was developed to provide guidance for future introductions and set objectives for management. The adaptive management plan suggests that San Mateo thornmint populations should maintain a minimum of 5,000 individuals to be considered self-sustaining. This figure is 2.5 times greater than the population target identified in the downlisting criteria of the 1998 recovery plan (i.e. 2,000 individuals). The management plan also advocates that the following objectives be used for current and newly established San Mateo thornmint sites: maintain occupancy at a minimum of 75 square meters (807 square feet), maintain bare ground at a minimum of 20% cover, and maintain nonnative plant and thatch at a combined maximum of 30% cover (Niederer et al. 2010).

[2] Distance measured as the shortest line distance between the edges of the CNDDB (2018) polygons for the Menlo Golf Club occurrence (#2) and the Upper Crystal Springs Reservoir occurrence (#4). The measurement was made using the distance tool in the Esri Base Map Application.

Threats

The status of threats to San Mateo thornmint has changed since the final listing rule (Service 1985) and additional threats have been realized since the 2010 5-year review. However, the greatest factor limiting recovery is still the rarity of serpentine vertisol habitat; the San Mateo thornmint "probably has the most restricted and limited serpentine habitat of all serpentine plant species in California" (McCarten, *in litt.* 1998:3). The few, and very small, patches of remaining serpentine vertisol will severely limit adequate redundancy of populations.

Some of the threats described in the final listing rule are no longer considered threats to San Mateo thornmint. The most serious, imminent threat at the time of the 1985 final listing rule, the proposed development of a golf course at Edgewood Park, is no longer a plausible threat (San Mateo County 1997). In 1981 and 1983, patches of soil containing San Mateo thornmint plants were mysteriously removed from Edgewood Park, indicating that there could be a threat of overutilization from collection (Service 1985). Because there have not been any signs of collection since 1983, the potential for overutilization is no longer believed to be a threat (Service 2010a).

Other threats described in the final listing rule and the 2010 5-year review, have been significantly lessened for extant San Mateo thornmint populations. However, they are still considered threats, especially for unoccupied serpentine vertisol that could be suitable for future introductions. Such threats include development, off-highway vehicle use, recreation activities, garbage dumping, and landslides.

The remainder of the previously described threats are still considered serious threats to current and future populations of San Mateo thornmint. Hydrology is considered an important component of San Mateo thornmint habitat requirements. Alterations in hydrology caused by developments are believed to have contributed to the Triangle extirpation and the ongoing decline of the natural Edgewood population (Niederer et al. 2010; C. Niederer, pers. comm. 2018). Hydrology can also be altered by local water use, erosion/landslides, land use, and climate change. Pesticide use could harm or extirpate populations. San Mateo thornmint is especially at risk from the aforementioned threats, and natural environmental fluctuations, because the following factors affect the species' representation and resiliency. Limits in population size, range, and genetic diversity can severely threaten the ability of San Mateo thornmint to survive and recover from catastrophic and/or stochastic events. Historical population representation has already been precluded by the extirpation of all but one population. Loss of genetic diversity, declining pollinator populations, and tendency for self-pollination, all increase extinction risk for San Mateo thornmint by reducing resiliency.

Additional threats to San Mateo thornmint have been identified since the 2010 5-year review. Germination trials at the UC Berkeley Botanical Garden, where San Mateo thornmint was successfully grown in different soil types, point to competition (from invasive nonnative plants and thatch) and moisture as the most important factors limiting wild San Mateo thornmint to serpentine vertisol (Niederer et al. 2010). Invasive grasses compete by depleting shallow soil moisture and creating dense thatch that smothers and suppresses seedling recruitment in native plants. Elevated atmospheric nitrogen deposition from increased air pollution exacerbates the invasive grass problem because additions of nitrogen to nutrient-deficient soils, like serpentine,

facilitate the invasion of weedy species (Weiss 2006). Nitrogen deposition in nitrogen-limited ecosystems may also affect mycorrhizal communities and increase plant susceptibility to other environmental stressors (summarized in Service 2010b).

Another serious threat that has arisen in recent years is dodder (*Cuscuta californica*). Dodder is a native parasitic plant that is parasitizing San Mateo thornmint, and other species, at Edgewood Park (Niederer and Weiss 2018).

Seed loss/mortality from falling into deep vertisol cracks (one year estimated to be 24% seed loss; Niederer and Weiss 2018) is likely a natural stressor for serpentine vertisol plants (Niederer et al. 2010, Pavlik and Espeland 1998). However, this reproductive loss may be exacerbated by other threatening conditions such as low production years, drought (more cracking), and heavy rain (more surface seeds wash into cracks and/or into unsuitable habitat). Seed loss may also increase with erosion, altered hydrology, and the effects of climate change (e.g. weather events, seed bank response to temperature and moisture changes). Significant seed loss could also play a role in creating negative feedback loops in declining populations, which would accelerate population declines, extirpations, and losses in genetic diversity.

**Tiburon mariposa lily (*Calochortus tiburonensis*)**

Background and Status

The Tiburon mariposa lily is a bulbous perennial in the lily family (Liliaceae). The species has been known to occur only in the open, rocky, serpentine-derived soils at the Ring Mountain Preserve on the Tiburon Peninsula in southern Marin County, California. The population is divided into nine colonies that inhabit areas that range in size from 0.1 hectare (0.25 acre) to 13 hectares (32 acres). The density of plants within each of these nine areas is variable (LSA Associates, Inc. 2008; Service 2011b). The Ring Mountain Preserve is currently owned and managed by Marin County Parks and Open Space. It is implementing the approved 2007 Ring Mountain Preserve Sensitive Resources Monitoring and Enhancement Strategy (LSA Associates, Inc. 2007), which includes the management of nonnative plants and monitoring of permanent plots established within each of the nine Tiburon mariposa lily colonies located on the preserve (LSA Associates, Inc. 2007; Service 2011b).

The status of the Tiburon mariposa lily has not changed substantially since it was listed in 1995 and the population has remained relatively stable (Service 2011b; Swope, Mills College, pers. comm. 2018). The species is known to have low rates of transition from one life history stage to another, a low reproductive rate, and a low mortality rate (Fiedler 1987; Fiedler *et al*. 1998; S. Swope, pers. comm. 2018). The low reproductive rate is due to the small proportion of individuals that actually flower annually, the small proportion of those that actually set seed, and low germination rates (Fiedler 1987; Fiedler et al. 1998; S. Swope, pers. comm. 2018).

The level of genetic diversity within the Tiburon mariposa lily population found at Ring Mountain Preserve is unknown, although genetic studies are currently being conducted (S. Swope, pers. comm. 2018). The patches of serpentine soil found at Ring Mountain Preserve can vary widely in soil chemistry and each colony has strong local adaptation to the particular soil chemistry found within the serpentine soil patch in which it occurs (S. Swope, pers. comm.

2018). Therefore, although the species is only known to occur at the Ring Mountain Preserve, the species expresses ecological variation among the nine colonies found at this one location.

Typically, a species needs multiple resilient populations throughout its range to provide for redundancy. However, the Tiburon mariposa lily has only ever had one population located at the Ring Mountain Preserve. Although this population is comprised of distinct colonies that are locally adapted to the soil chemistry of the particular serpentine soil patch in which they occur, this does not increase the species redundancy because all individuals occur within a 40-acre area at one location and the entire population would be at risk if a catastrophic event should occur.

Threats

Threats noted in the final listing rule (Service 1995) and during the 2011 5-year status review (Service 2011b) are still acting on the species and there have been no additional threats described.

**Fountain thistle (*Cirsium fontinale* var. *fontinale*)**

Background and Status

The fountain thistle is a perennial herb in the aster family (Asteraceae) that is restricted to moist serpentine seeps or streams found in grassland or chaparral habitats in San Mateo County. When the species was listed, it was only known to occur at three locations within 6 miles of each other (Service 1998, 2010a). The northern-most population found at Crystal Springs Reservoir is still extant; however, the Edgewood Park and Triangle populations described in the final listing rule (Service 1995) are now considered extirpated (Service 2010a). As described in the last 5-year review (Service 2010a), after the species was listed two new populations were discovered in Redwood City, one in Stulsaft Park and the other just east of Woodside Glens. With the discovery of these two new populations, all extant fountain thistle populations currently occur within an approximate 14.5-kilometer (9.0-mile) range (Niederer and Elliott 2012).

The population found at Crystal Springs Reservoir was once comprised of approximately ten to twelve subpopulations, although currently there are only eight that are supporting fountain thistle (Service 2011a; SFPUC, pers. comm. 2018). A majority of the subpopulations are found on land owned and managed by the SFPUC; however, two subpopulations (one extant and one extirpated) are located on land that is owned and managed by the California Department of Transportation (CalTrans) (Service 2011a; CNDDB 2018). Stulsaft Park is owned and managed by the City of Redwood City and the Woodside Glens population occurs on private land, although a portion of this population also occurs on CalTrans land (Niederer and Elliott 2012; CNDDB 2018). Edgewood Park is owned and managed by San Mateo County, and the Triangle location is owned and managed by CalTrans (CNDDB 2018). Management plans for the populations found at Crystal Springs Reservoir, the Triangle, and Stulsaft Park are currently being implemented or developed (Service 2010a).

Although the fountain thistle has limited dispersal capabilities due to its seed morphology and possibly due to the lack of a seed dispersing agent (see below), it is known to respond well to invasive species removal and recruit new individuals in areas where it already occurs (SFPUC, pers. comm. 2018; Niederer and Elliott 2011). Invasive species removal produced “significant passive fountain thistle recruitment” at both Stulsaft Park and the CalTrans portion of Woodside

Glens (Niederer and Elliott 2012). Prior to invasive plant removal at a portion of Stulsaft Park, the species was known to occur within an area measuring 82 square meters at an average density of 6.85 individuals per square meter. After the removal of giant reed (*Arundo donax*), the area occupied by fountain thistle increased to 131 square meters with an average density of 8.34 individuals per square meter (Niederer and Elliot 2012). In addition, many of the Crystal Springs Reservoir subpopulations found on SFPUC land have increased, both in size and in number of individuals, after invasive plant removal (SFPUC, pers. comm. 2018).

The species shows a wide variation in habitat and plant associates present at each known location. The population at Crystal Springs Reservoir primarily occurs within grassland and chaparral seeps, and the species at this location is often associated with tufted hair grass (*Deschampsia caespitosa*). The Woodside Glens population occurs in serpentine grassland within an open canopy of Monterey and stone pines, while the Stulsaft Park population occurs in more shaded areas containing oak/bay/coffeeberry woodland (Service 2010a). The species has lost some representation over time due to the extirpation of two previously occupied locations.

The fountain thistle does express some redundancy by having three extant populations distributed throughout a 9-mile-long range in San Mateo County (Niederer and Elliott 2011). In addition, the largest population at Crystal Springs Reservoir shows additional resiliency within the population because it is currently comprised of eight separate subpopulations (Service 2011a; SFPUC, pers. comm. 2018). However, due to the recent extirpation of two populations and the extirpation of two to four subpopulations within the Crystal Springs population, the fountain thistle has lost redundancy over time.

Threats

Threats noted in the final listing rule (Service 1995) and during the last 5-year status review (Service 2010a) continue to act on the fountain thistle. A threat that has not been previously described is the invasion of nonnative Argentine ants (*Linepithema humile*) and their impact on seed dispersal. Fountain thistle seeds contain a fat- and protein-rich protrusion known as an elaiosome, which native ants are known to eat. Dispersal occurs when a native ant either drops the seed while carrying it to their nest for later consumption or by eating the elaiosome and leaving the rest of the seed buried, which can then germinate when conditions are appropriate (Pemberton and Irving 1990; Christian 2001). Conversely, Argentine ants are known to consume the elaiosomes and leave the rest of the seed exposed under the parent plant, leaving it vulnerable to predation, disease, fire, and increased competition due to being in close proximity to its parent plant (Christian 2001). Since Argentine ants are known to displace native ants in areas they have invaded (Holway et al. 2002), and Argentine ants have been documented throughout the range of the fountain thistle (Niederer and Elliott 2011), it is likely the dispersal of fountain thistle at each known location has declined.

**Presidio clarkia (*Clarkia franciscana*)**

Background and Status

Presidio clarkia is a small annual plant in the evening primrose family (Onagraceae). This species is restricted to serpentine soils in grassland and coastal scrub communities. It is known to occur in only two locales, the Presidio in San Francisco County and Oakland Hills in Alameda County, California. Since the approval of the 1998 recovery plan, new locations for Presidio clarkia within these two locales have been either introduced or discovered. The 2010 5-year review for Presidio clarkia (Service 2010b) summarizes the introduction along the Pacific coast at the Presidio ("Coastal Bluffs" site) and the discovery of four additional sites in Oakland Hills (for seven total Oakland Hills sites). Since the 2010 5-year review, Presidio clarkia was also reintroduced at the historical "West Crissy Bluffs" site (also referred to as "McDowell Avenue," CNDDB occurrence #3) at the Presidio (Chassé and Forrestel 2014). The CNDDB (2018) reflects all known Presidio clarkia sites in Oakland Hills (CNDDB occurrence #4), but has not been updated for the Coastal and West Crissy bluffs introductions at the Presidio.

Ongoing habitat restoration and enhancement at the Presidio and Redwood Regional Park have increased local distributions and abundances of Presidio clarkia at these managed sites (EBRPD 2018; L. Stringer, Presidio Trust, pers. comm. 2018; L. Naumovich, Golden Hour Restoration Institute, pers. comm. 2018; GGNRA, unpubl. data 2018). Inspiration Point (Presidio; CNDDB occurrence #2) and Redwood Regional Park (Oakland Hills) continue to be the largest and most productive Presidio clarkia sites. The average population estimates for a 1.0-hectare (2.5-acre) plot at Inspiration Point is 58,904 individuals (2006-2018; GGNRA, unpubl. data 2018) and for a 3.0-hectare (7.4-acre) plot at Redwood Regional Park is 59,758 individuals (2008-2011, 2014-2015, and 2017; Naumovich 2018). Since monitoring began, abundances at the other Presidio clarkia sites did not exceed 2,000 individuals[3] until 2018. The 2018 censuses recorded 2,924 and 3,223 individuals at the Presidio's West Crissy Bluffs and WWII Memorial sites, respectively (GGNRA, unpubl. data 2018). Despite the recent increase in numbers, the likelihood that the West Crissy Bluffs site (or the Coastal Bluffs site) will continue to support Presidio clarkia is in question (M. Chassé, National Park Service, pers. comm. 2018).

All of the seven Oakland Hills sites are likely the remaining portions of a single population that was fragmented by residential development (CDFG 1997, Service 2010b). Six of the Oakland Hills sites contain only small patches of serpentine that are surrounded by residences, roads, and a tennis club. These sites, held by the City of Oakland or private landowners, are rarely monitored. Thus, the status of Presidio clarkia in these patches is currently unknown. Prior to 2010, these six Oakland Hills sites had abundances that ranged from 20 to over 1000 plants (summarized in Service 2010b).

Threats

Threats to Presidio clarkia have not substantially changed since the final listing rule (Service 1995) or the 2010 5-year review. The greatest threats to Presidio clarkia continue to be limited availability and fragmentation of suitable habitat, residential development, and competition from

[3] The number 2,000 is a benchmark number because it was identified in the former downlisting criteria as the minimum number of individuals required in each population for Presidio clarkia to be considered for downlisting (Service 1998).

various plant species. Presidio clarkia, throughout its limited range, is threatened with competition from nonnative invasive grasses, native shrubs, nonnative trees, and native trees planted outside of their natural range. Invasive grasses compete by depleting shallow soil moisture and creating dense thatch that smothers and suppresses seedling recruitment in native plants. Elevated atmospheric nitrogen deposition from increased air pollution exacerbates the invasive grass problem because additions of nitrogen to nutrient-deficient soils, like serpentine, facilitate the invasion of weedy species (Weiss 2006). Nitrogen deposition in nitrogen-limited ecosystems may also affect mycorrhizal communities and increase plant susceptibility to other environmental stressors (summarized in Service 2010b). Shrubs and trees compete by shading annual grassland plants. Trees also bury the nutrient-poor serpentine soil with a thick layer of organic material, which encourages further invasion of non-serpentine species.

The six small Oakland Hills sites remain unprotected and are especially vulnerable to erosion, roadside maintenance for fire management, competing plant species, and residential development. Presidio clarkia has likely persisted in some of these habitat fragments because the steep terrain is unconducive for development and landscaping. Thus, the terrain is also erosive and Presidio clarkia plants and seeds are subject to being washed into roads and disposed of. The habitat fragments that are not too steep and erosive are frequently mowed prior to seed set (R. Kanz, conservationist and Oakland resident, pers. comm. 2018; Service 2010b). Unlike the protected sites, the Oakland Hills fragments are not managed to reduce nonnative plant competition and trees are typically favored in residential areas. Plans for a residential development on the Crestmont Drive site are in process, though it is uncertain when the development will be constructed. The City of Oakland has not yet approved the lot divisions for the development because the requirements for a rare plant conservation easement have not all been fulfilled (M. Grefsrud, CDFW, pers. comm. 2018).

At the Presidio in San Francisco County, Presidio clarkia at the West Crissy Bluffs site are threatened by the site's small size, high disturbance rate, and position just below a road. Declining numbers of Presidio clarkia at the Coastal Bluffs introduction site could be due to inadequate seed input (only one year of seeding), or because the coastal climate and habitat are not suitable for Presidio clarkia (M. Chassé, pers. comm. 2018).

Other relevant threats described in the final listing rule and the 2010 5-year review include altered hydrology, small populations, loss of pollinators, loss of genetic diversity, and climate change. Also previously described, are threats that are currently considered only minor threats to extant Presidio clarkia populations. However, these are still considered threats, especially for unoccupied serpentine that could be suitable for future introductions. Such threats include recreational developments, pedestrian and mountain bicycle traffic, road construction, off-highway vehicle use, and garbage dumping.

The 2010 5-year review described overpopulation of gophers as a potential threat to Presidio clarkia at Redwood Regional Park. However, gopher disturbance is believed to benefit Presidio clarkia populations and its description as a threat in the 2010 5-year review may have been a misinterpretation (Creekside Science 2013; D. Defreese, East Bay Regional Park District, pers. comm. 2018; L. Naumovich, pers. comm. 2018; C. Niederer, Creekside Science, *in litt.* 2018a; S.

Weiss, Creekside Science, *in litt.* 2018a). The Service has not identified any additional threats that were not included in the final listing rule or 2010 5-year review.

**Pennell's bird's-beak (*Cordylanthus tenuis* ssp. *capillaris*)**

Background and Status

Pennell's bird's-beak is an herbaceous annual of the broomrape family (Orobanchaceae) (Olmstead et al. 2001). This species is known only from records in the Outer North Coast Ranges floristic province of Sonoma County, California (Chuang and Heckard 1986, Hickman 1993, CNDDB 2018). The known historical range of Pennell's bird's-beak is only a few square miles (Kruckeberg 1984), and is consistently associated with closed-cone coniferous forests and chaparral on serpentine soils (Chuang and Heckard 1986, Hickman 1993).

Like others of the genus, Pennell's bird's-beak is hemiparasitic; although it contains chlorophyll, it collects water, nitrogen, carbon, and other minerals from at least one host plant (Marvier and Smith 1997). Bird's-beak species establish root connections with host plants in the environment by means of haustoria (structures that grow into or around other structures to absorb water and/or nutrients; Chuang and Heckard 1971). Through culture experiments, Chuang and Heckard (1971) concluded that Baker's Manzanita (*Arctostaphylos bakeri* ssp. *bakeri*) was likely the host plant for Pennell's bird's-beak. However, studies report some hemiparasitic plants rely on multiple hosts throughout their life cycle (Marvier and Smith 1997), and a study by Heckard (1977) identified Sargent's cypress (*Cupressus sargentii*) as another possible host. This suggests that in the case of Pennell's bird's-beak, various hosts may provide resources throughout the dry season. Using community structure[4] to determine proper habitat for Pennell's bird's-beak might be an appropriate way to determine habitat suitability throughout its range.

Members of the bird's-beak group require bees for effective pollination (Chuang and Heckard 1986). It is likely that species in this genus are self-incompatible (Chuang and Heckard 1986), meaning reproduction probably only happens through sexual means (Chuang and Heckard 1986). Most species of bird's-beak flower during the hottest time of the year: from mid-July through September (Chuang and Heckard 1986). Flowering late in the season might allow bird's-beak more access to pollinators by reducing competition with other flowering plants (Chuang and Heckard 1986).

Botanists describe the dense populations of Pennell's bird's-beak to be in open, sunny areas (McCarten 1987). The plant is found consistently in full sunlight, suggesting some form of disturbance, such as fire, local flooding, or artificial clearing, is necessary to maintain high population levels (G. Cooley, CDFW, *in litt*. 2018). Research is needed to determine if this species is limited only by light, or if there is a specific host-plant, which requires different habitat (McCarten 1987; G. Cooley, *in litt*. 2018).

At the time of listing in 1995, Pennell's bird's-beak was known from two main locations in Sonoma County; one along Bohemian Highway and the second within and around the Harrison

[4] Where Baker's manzanita and sergeant cypress exist together on serpentine soils in Sonoma County (Service 1998).

Grade Ecological Reserve (HGER) owned and operated by the California Department of Wildlife (CDFW; Service, 1995). Presently, Pennell's bird's-beak is thought to occur in four separate locations (CNDDB 2018). The CNDDB lists occurrence #1 as mainly within HGER. Two occurrences (#2 and #4), designated in 2012, are within what is now the Bohemia Ecological Preserve (BEP) operated by the non-profit organization LandPaths (Erin Mullen *in litt.* 2018). There is currently a conservation easement on the property, owned by a non-profit organization, Sonoma Land Trust (Erin Mullen *in litt*. 2018). Lastly, CNDDB occurrence #3 is believed to be located on the privately owned Twin Valley Ranch near Porter Creek, about 11 kilometers (6.8 miles) northeast of CNDDB occurrence #2. This site has not been surveyed in the past 20 years; while the current status of the population remains unknown, it is thought to be extant.

Anecdotal reports suggest many Pennell's bird's-beak populations exist on private property outside of the before mentioned occurrences, which have not been surveyed by botanists (G. Cooley, CDFW, pers. comm. 2018). For example, additional populations are likely located next to HGER on private land. However, permission to survey this site has been consistently refused (Service 1995; G. Cooley, pers. comm. 2018). Observations from biologists at the HGER suggest there are currently Pennell's bird's-beak growing on private property outside the reserve boundaries (J. Bjerke, CDFW, *in litt*. 2018a). The full extent of these populations remains unknown.

Pennell's bird's-beak population numbers vary annually at the two main locations where they are observed (BEP and HGER; G. Cooley, pers. comm. 2018). In the late 1970's, small populations containing only a few individuals were seen at both sites. By 1981, botanists estimated there to be over 10,000 individuals at each location (Service, 1998a). In the summer of 2018, both sites contained dense populations of several thousand individuals each (E. Bainbridge, Service, pers. obs. 2018). Observations indicate there has been a general increasing population trend over the past 5 years at BEP (E. Mullen, pers. comm. 2018), as well as the HGER (G. Cooley, pers. comm. 2018).

Threats

The most significant threat to Pennell's bird's-beak is loss and degradation of habitat. In general, serpentine habitat available to Pennell's bird's-beak is patchy and discontinuous, possibly limiting gene flow. Roads and other infrastructure associated with development can be and have been placed on sites occupied by Pennell's bird's-beak, further fragmenting habitat. In recent years, residential and vineyard developments have become an increasing threat to serpentine habitat. Anecdotal reports suggest that most Pennell's bird's-beak populations exist on private property, where no formal botanical surveys have been conducted (G. Cooley, pers. comm. 2018).

Serpentine soils are likely unsuitable for cultivation, due to high calcium-magnesium ratios in the soil (Kruckeberg 1984; Service 1998; G. Cooley, *in litt*. 2018). However, serpentine sites been used in the past for dumping, or construction of roads to access other remote areas for cultivation. Therefore, land conversion to vineyards, a common practice in Sonoma County, still poses a threat. In recent years, *cannabis* cultivation and drying has taken place on lands occupied by the species, causing trampling and possible habitat impairment (J. Bjerke, *in litt.* 2018b). The

original listing rule (Service 1995) listed dumping in serpentine habitat as a threat. Activities from viticulture and unregulated *cannabis* cultivation remain a threat to Serpentine habitats.

Due to the calcium-magnesium ratios, few nonnative plants grow well on serpentine soils (Kruckeberg 1984; G. Cooley, pers. comm. 2018). However, barbed goatgrass (*Aegilops truncialis*) is tolerant of serpentine soils, potentially allowing for succession of other species (G. Cooley, pers. comm. 2018). Native forest trees such as California bay (*Umbellularia californica*) and Douglas fir (*Pseudotsuga menziesii*) are also somewhat tolerant of serpentine soil, and colonize (invade) serpentine habitat, shading areas that would otherwise be suitable to Pennell's bird's-beak (G. Cooley, *in litt*. 2018).

*Phytophthora* is a fungal pathogen known to infect the roots of manzanitas, and other plant species in California (Garbelotto 2001). While Pennell's bird's-beak's main host is unknown, it is likely it uses Baker's Manzanita to some extent (Chuang and Heckard 1986). Due to the hemiparasitic nature of Pennell's bird's-beak, diseases to potential host-species might pose a future threat (Service 2011d). In the event that *Phytophthora* infects colonies of Baker's manzanita, it could also affect the long-term persistence of Pennell's bird's-beak (Service 2011d).

In 2012, LandPaths purchased 550 acres of habitat under a conservation easement operated by Sonoma Land Trust, now known as the BEP. LandPaths does allow limited recreation in the form of guided tours and camping trips. While this recreation does pose a small threat to Pennell's bird's-beak, it is not likely to pose significant risks to the species. Studies and observations suggest small amounts disturbance might actually improve new colony establishment for Pennell's bird's-beak (Wilson et al. 2014; Cooley, pers. comm. 2018).

The continuing threats to the Pennell's Bird's Beak include invasive competition, damage from unregulated human land-use, human population size, habitat connectivity, loss of pollinators, and climate change.

**San Mateo woolly sunflower (*Eriophyllum latilobum*)**

Background and Status

San Mateo woolly sunflower is a perennial herb in the composite family (Asteraceae). It is believed to have originated as a hybrid between yellow yarrow (*Eriophyllum confertiflorum* var. *confertiflorum*) and common woolly sunflower (*Eriophyllum lanatum* var. *arachnoideum*) (Constance 1937, Mooring 1994). This species grows in San Mateo County, California, along San Mateo Creek and Lower Crystal Springs Reservoir. It favors shady spots along road cuts and steep slopes with coast live oak (*Quercus agrifolia*) (CNDDB 2018; SFPUC, unpubl. maps 2018). The final listing rule for San Mateo woolly sunflower described the species as growing on "serpentine-influenced soil in the coast live oak woodland community" (Service 1995). However, current species experts have not observed San Mateo woolly sunflower on serpentine soils (S. Foree, SFPUC, *in litt.* 2018b; J. Mooring, Santa Clara University, *in litt.* 2018a) and the species is commonly found on other soil types including Alambique-McGarvey Complex and Los Gatos (S. Foree, *in litt.* 2018b; SFPUC, unpubl. maps 2018).

At the time of the approval of the 1998 recovery plan, there was only one known occurrence of San Mateo woolly sunflower, which consisted of a few hundred plants along 4 kilometers (2.5 miles) of Crystal Springs Road (CNDDB occurrence #1; Service 1998). This occurrence is on private land and land over which the City of Hillsborough, the County of San Mateo, and the SFPUC have varying jurisdictions. The current known distribution of San Mateo woolly sunflower is entirely within the San Mateo Creek-Frontal San Francisco Bay Estuaries Watershed and extends approximately 8 kilometers (5 miles) from San Andreas Lake to Crystal Springs Road (CNDDB 2018). Since the approval of the 1998 recovery plan, three additional occurrences were discovered on SFPUC watershed land. The 2011 5-year review for San Mateo woolly sunflower (Service 2011c) referenced two of the new occurrences, San Mateo Road 2 (CNDDB occurrence #4) and Outgoing Road (not in CNDDB). In 2016, 66 plants were discovered west of the south end of San Andreas Lake, along Pilarcitos Road and Corol Reef Avenue (CNDDB occurrence #6; CNDDB 2018). In addition, approximately 150 plants were discovered in 2017 along the western bank of Lower Crystal Springs Reservoir (SFPUC, unpubl. maps 2018). The plants along the reservoir are an extension of the Outgoing Road occurrence.

There are reports of San Mateo woolly sunflower from farther south in San Mateo County. However, the identity of *Eriophyllum* species in these areas has been questioned. An *Eriophyllum* specimen collected in 1929 from CNDDB occurrence #2 (LA203607; designated as San Mateo woolly sunflower) was keyed to *Eriophyllum confertiflorum* by Barry Prigge in 1992 and by Thomas Huggins in 2018. However, both professionals doubted the keyed result and kept the specimen designation as San Mateo woolly sunflower (T. Huggins, Los Angeles Herbarium, *in litt.* 2018). A specimen collected from CNDDB occurrence #3 in 1962 (JEPS28876; also designated as San Mateo woolly sunflower) could be either San Mateo woolly sunflower or a different *Eriophyllum* hybrid (J. Mooring, *in litt.* 2018b; Strother and Baldwin, Jepson Herbaria, *in litt.* 2018). Similar is the case for a more recently discovered population (mentioned in the 2011 5-year review) on private property in the Tunitas Watershed (J. Mooring, *in litt.* 2018c). Thus, more research is required to determine whether these historical and/or extant *Eriophyllum* populations are truly San Mateo woolly sunflower.

Threats

Threats to San Mateo woolly sunflower have not substantially changed since the final listing rule (Service 1995) or the 2011 5-year review. The primary threats that were identified in the final listing rule were erosion and soil slippage, competition from nonnative plants, roadside maintenance, and the proposed construction of San Mateo Creek Trail along Crystal Springs Road (Service 1995). The San Mateo Creek Trail has not yet been built; however, it is still proposed in the most recent San Mateo County Trails Master Plan (MHA Environmental Consulting, Inc. 2001). Of just as much of a concern is the proposed development of the Meadowood Estates subdivision near Crystal Springs Road. At one point during the planning process for this development, 655 San Mateo woolly sunflower plants and nearly 500 trees were scheduled for removal from the property (S. Foree, *in litt.* 2018b). Not only would construction of the trail and/or subdivision threaten damage to San Mateo woolly sunflower colonies and habitat directly, the developments may also threaten San Mateo woolly sunflower persistence in surrounding areas by altering hydrology, accelerating erosion through increased pedestrian and bicycle traffic, increasing spread of invasive species, and exposing more areas to incompatible vegetation management practices.

The instability of this species' habitat (i.e. steep slopes and road cuts) exposes this plant to erosive events that can cause mortality and seed loss. On SFPUC watershed land, losses from soil slips have been greater than 100 plants at a single location (S. Foree, *in litt.* 2018a). The SFPUC has had success salvaging some of the losses by depositing the eroded soil and debris nearby in suitable habitat. However, eroded soil, plants, and seeds along roads outside of SFPUC watershed land, are removed and disposed of by road maintenance crews (S. Foree, *in litt.* 2018b).

Road maintenance activities (i.e. eroded soil removal, slope cutting and reshaping, herbicide application, and mowing) remain a significant threat to the San Mateo woolly sunflower. While considerable efforts have been made by SFPUC personnel to protect plants along roadsides by marking the plants and notifying road maintenance crews, these protections fall short when emergency maintenance is required. Furthermore, marking San Mateo woolly sunflower plants annually is time intensive and notifying the appropriate road maintenance personnel at the appropriate time can be difficult (S. Foree, *in litt.* 2018d). Although San Mateo County and the City of Hillsborough are aware of the Crystal Springs Road population, herbicide spraying (Town of Hillsborough 2014) and inappropriately-timed mowing (June-July; San Mateo County 2018) have occurred (T. Corelli, California Native Plant Society, pers. comm. 2007).

Nonnative, invasive species may outcompete San Mateo woolly sunflower, especially since the sunflower appears to be a poor competitor (S. Foree, SFPUC, pers. comm. 2018). Not previously identified in the final listing rule or 2011 5-year review, is the threat from invasive species that are native to the ecosystems inhabited by San Mateo woolly sunflower [primarily California blackberry (*Rubus ursinus*) and Pacific poison oak (*Toxicodendron diversilobum*); S. Foree, *in litt.* 2018a].

Other potential threats considered in the 1995 listing rule and/or the 2011 5-year review include few populations, small population size, low germination rates and seedling survival, seed predation, overutilization from collection, garbage and garden debris dumping, downhill seepage

of pesticides, and climate change. These threats require further investigation to determine how they influence San Mateo woolly sunflower survival and viability.

Threats identified since the 2011 5-year review (including the aforementioned Meadowood Estates development and competition from native plants) must also be considered. Various utilities have easements through the Crystal Springs Road population of San Mateo woolly sunflower. Utility projects and maintenance, such as upgrading water mains, may affect San Mateo woolly sunflowers that are in or near the utility rights of way (S. Foree, *in litt.* 2018a). Also requiring more research are the potential threats of fire suppression (H. Bartosh, Nomad Ecology, pers. comm. 2018), loss of pollinators, and sudden oak death (*Phytophthora ramorum*). Sudden oak death is a tree and woody-plant pathogen that is responsible for significant coast live oak mortality in California. On SFPUC watershed land, an infected coast live oak tree fell and buried a stand of San Mateo woolly sunflower (S. Foree, *in litt.* 2018c). Because the microhabitat underneath coast live oaks is so strongly associated with San Mateo woolly sunflower, sudden oak death may contribute to loss or degradation of San Mateo woolly sunflower habitat.

**Tiburon jewelflower (*Streptanthus niger*)**

Background and Status

The Tiburon jewelflower is an annual herb in the mustard family (Brassicaceae). The species is only known from two locations approximately 2 miles apart on the southern Tiburon Peninsula in Marin County, California, and it is unlikely the species ever occurred elsewhere (Morey and Hunter 1990). The largest population, in both the number of individuals and in geographic area, is located at the Old St. Hilary's Preserve at the tip of the Tiburon peninsula. This population currently contains approximately 3,000 individuals, but has shown population declines in five of the last six years monitored. Because this population is the largest and likely the most resilient, the long-term persistence of the species highly depends on this population (S. Swope, pers. comm. 2018). The second population occurs along the Middle Ridge of the peninsula and contains approximately 400-500 individuals in a small geographic area. This population is likely a remnant of a once larger population and is found either in serpentine openings within open grassland or in disturbed areas next to hiking trails. The Old St. Hilary's Church Preserve is partially protected by Marin County Parks and Open Space; however, a portion at the top of the hill is privately owned and is proposed for development (Service 2010c). The Middle Ridge location is owned by the Town of Tiburon and they have an Open Space Resource Management Plan, which includes the management of nonnative plants, monitoring passive recreational use, and minimizing impacts from passive recreational use through education and trail enhancements (LSA Associates, Inc. 2010).

There is also a population that was introduced to the Ring Mountain Preserve on the Tiburon Peninsula. This location has maintained a small population even during poor environmental conditions; however, this population may not be self-sufficient in the long-term (S. Swope, pers. comm. 2018). The introduced population at the Ring Mountain Preserve is owned by Marin County Parks and Open Space; however, since this population was a recent introduction, the species is not included in their management plan. The status of the Tiburon jewelflower has not changed substantially since the last 5-year status review, except for the introduction of the small population at the Ring Mountain Preserve (Service 2010c; S. Swope, pers. comm. 2018).

Recent genetic studies suggest the Middle Ridge population has lost a significant amount of genetic diversity over the last 50 years (S. Swope, pers. comm. 2018), so the species has lost representation over time. The population at Ring Mountain was a trial introduction to gauge the importance of the number of individuals within a population and genetic stability, and was also an attempt to generate novel genetic diversity (S. Swope, pers. comm. 2018). If this small, self-sustaining population is able to persist in the long-term and is successful in generating novel genetic diversity, the species' level of representation would increase.

The Tiburon jewelflower does not have much redundancy due to its limited range and the fact that the species is comprised of only two populations within 2-miles of each other. The number of individuals at either location can vary widely depending on environmental conditions and since the species occurs over a narrow range, the environmental conditions at any given time will be similar for both populations. If the introduced population at Ring Mountain Preserve is self-sustaining in the long-term, it will increase the species' redundancy by increasing its range-wide distribution.

Threats

Threats described at the time of listing and during the last status review continue to act on the species, and a full description of those threats can be found in the final listing rule (Service 1995) and in the 2010 5-year status review (Service 2010c). An additional threat that was not described in the last 5-year review is the loss of genetic diversity seen within the Middle Ridge population (S. Swope, pers. comm. 2018).

## AMENDED RECOVERY CRITERIA

Recovery criteria serve as objective, measurable guidelines to assist in determining when an endangered species has recovered to the point that it may be downlisted to threatened, or that the protections afforded by the Act are no longer necessary and the species may be delisted. Delisting is the removal of a species from the Federal Lists of Endangered and Threatened Wildlife and Plants. Downlisting is the reclassification of a species from an endangered species to a threatened species. The term "endangered species" means any species (species, sub-species, or distinct population segment) which is in danger of extinction throughout all or a significant portion of tis range. The term "threatened species" means any species that is likely to become an endangered species within the foreseeable future throughout all or a significant portion of its range.

Revisions to the Lists, including delisting or downlisting a species, must reflect determinations made in accordance with sections 4(a)(1) and 4(b) of the Act. Section 4(a)(1) requires that the Secretary determine whether a species is an endangered species or threatened species (or not) because of threats to the species. Section 4(b) of the Act requires that the determination be made "solely on the basis of the best scientific and commercial data available." Thus, while recovery plans provide important guidance to the Service, states, and other partners on methods of minimizing threats to listed species and measurable objectives against which to measure progress towards recovery, they are guidance and not regulatory documents.

Recovery criteria should help indicate when we would anticipate that an analysis of the species' status under section 4(a)(1) would result in a determination that the species is no longer an endangered species or threatened species. A decision to revise the status of or remove a species from the Federal Lists of Endangered and Threatened Wildlife and Plants, however, is ultimately based on an analysis of the best scientific and commercial data then available, regardless of whether that information differs from the recovery plan, which triggers rulemaking. When changing the status of a species, we first propose the action in the *Federal Register* to seek public comment and peer review, followed by a final decision announced in the *Federal Register*.

We provide delisting criteria for the Tiburon mariposa lily and provide both downlisting and delisting criteria for the San Mateo thornmint, fountain thistle, Presidio clarkia, Pennell's bird's-beak, San Mateo woolly sunflower, and Tiburon jewelflower. The following downlisting and delisting criteria will supersede those included in the Recovery Plan for Serpentine Soil Species of the San Francisco Bay Area (Service 1998):

## Downlisting Recovery Criteria

Revisions to the original criteria are shown in *italics*.

### San Mateo thornmint

The following downlisting criteria are adapted from Section II, p. 14 and Section III, p. 10 of the recovery plan. Revisions to the original criteria are shown in *italics*.

Factor A: Present or Threatened destruction, Modification, or Curtailment of Habitat or Range. Availability of serpentine vertisol habitat is the most limiting factor for San Mateo thornmint recovery. The current threats that may cause destruction, modification, or curtailment of habitat or range (occupied and/or unoccupied) include development, pesticide use, off-highway vehicle use, recreation activities, and garbage dumping. (Invasive nonnative grasses, soil nitrogen levels, altered hydrology, erosion/landslides, and climate change are addressed in Factor E.) To downlist San Mateo thornmint, threats to habitat or range must be reduced. This may be accomplished when the following criteria are met:

**A/1** *A minimum of* five populations[5,6] of San Mateo thornmint are fully protected and managed with the primary intention of preserving the populations in perpetuity. Each

[5] For this document, a population of San Mateo thornmint is defined as a group of individuals that is separated from other groups of San Mateo thornmint by at least 400 meters (0.25 mile). Because San Mateo thornmint have limited dispersal abilities and are primarily self-pollinated, groups that are separated by 400 meters will have very limited exchange of genes or alleles. A distance of 400 meters was also selected for consistency with the delineation of "occurrences" in the CNDDB.

[6] The former downlisting criteria specify "five populations (including the remaining two natural populations and the introduced population)" and "two additional populations." At the time of the 1998 recovery plan, the two natural populations were the natural Edgewood Park occurrence (CNDDB #3, as of 2018) and the Triangle occurrence (CNDDB #6). The "introduced population" referred to the Pulgas Ridge occurrence introduced by Pavlik and Espeland (1998; CNDDB #7). At the time of this amendment, two of the aforementioned populations have been extirpated and the third (Edgewood Park) may no longer be able to support a self-sustaining San Mateo thornmint

protected area should include occupied habitat with adjacent unoccupied habitat and a 150-meter (500-foot) buffer.

**A/2** Management plan(s), approved *by the Service*, are implemented for the populations described in **A/1** and any adjacent areas identified as essential to continued survival. *The plans must include provisions for standardized annual monitoring of populations.*

Factor B: Overutilization for Commercial, Recreational, Scientific, or Educational Purposes
The overutilization of San Mateo thornmint for commercial, recreational, scientific, or educational purposes is not believed to be a significant threat to the species at this time. Thus, no recovery criteria have been developed for this factor.

Factor C: Disease or Predation
To downlist San Mateo thornmint, threats from dodder must be reduced. Successful implementation of management plans (criterion **A/2**) is expected to reduce threats from dodder infestations.

Factor D: Inadequacy of Existing Regulatory Mechanisms
The inadequacy of existing regulatory mechanisms is not believed to be a significant threat to San Mateo thornmint. Thus, no recovery criteria have been developed for this factor.

Factor E: Other Natural or Manmade Factors Affecting Its Continued Existence
Other natural or manmade factors believed to affect the continued existence of San Mateo thornmint include invasive nonnative grasses, soil nitrogen levels, altered hydrology, erosion/landslides, few populations, small population size, low genetic diversity, seed loss/mortality, and climate change. To downlist San Mateo thornmint, Factor E threats must be reduced. This may be accomplished when the criteria under Factor A and the following criteria are met:

**E/1** Each population described in **A/1** contains a minimum of *5,000* (but preferably more)[7] *flowering individuals each year for a minimum of* 20 years.[8]

---

population (Niederer and Weiss 2018). Thus, the revised criteria specify, "a minimum of five populations of San Mateo thornmint."

[7] The original criterion read, "Until research shows otherwise, recovery should target securing populations containing a minimum of 2,000 plants each (but preferably more)." However, the best available information suggests that there should be a minimum of 5,000 individual San Mateo thornmint to maintain resiliency and protect the population from rapid extirpation. This increase in the minimum number of individuals is supported by expert recommendations (C. Niederer, *in litt.* 2018b; Niederer et al. 2010; S. Weiss, *in litt.* 2018b), species-specific risk factors [e.g. interannual population fluctuations, limited range, lack of seed bank response in extirpated areas (Niederer et al. 2010)], and population histories. In 1994, the natural Edgewood Park population had San Mateo thornmint densities up to 2,400 per square meter with an average density of 1,106 per square meter (Pavlik and Espeland 1998). San Mateo thornmint also has a history of extirpations, two of which occurred since the approval of the 1998 recovery plan. A higher population threshold will partially protect populations from undergoing rapid population declines before triggering management. The natural Edgewood Park colony (expected to be extirpated in the near future) was at a high of more than 53,000 in 1994; then fell to 20,280 in 1995; 6,885 in 1996; 5,289 in 1997; and 28 in 2017 (Pavlik and Espeland 1998, Niederer and Weiss 2018).

[8] A period of 20 years was identified as an appropriate period in the original recovery plan (Service 1998).

**E/2** Each population described in **A/1** *has numbers of flowering individuals that exhibit a* stable or increasing *trend* over a period of 20 years *that includes two normal precipitation cycles*[9] (or longer if suggested by the results of demographic monitoring).

**E/3** *Impacts from invasive species are managed so they do not pose a threat to the persistence of any of the San Mateo thornmint populations described in **A/1**.*

**E/4** Seeds, *representative of the breadth of the species' genetic diversity*, are stored in at least two Center for Plant Conservation certified facilities and reliable seed germination and propagation techniques are understood.[10] *Unless storage techniques and/or research show otherwise, stored seeds are replenished every 10 years*[11] *in order to ensure seed viability.*

**Fountain thistle**

The following downlisting criteria are adapted from Section II, p. 51-53 and Section III, p. 12 of the recovery plan. Revisions to the original criteria are shown in *italics.*

Factor A: Present or Threatened Destruction, Modification, or Curtailment of Habitat or Range
The main threat to the persistence of fountain thistle is habitat change and destruction. To downlist the species, threats to the species' habitat must be reduced. This reduction will be accomplished when the following have occurred:

**A/1** Occupied habitats *at Crystal Springs Reservoir, Stulsaft Park, and Woodside Glens,* and former known habitat *at the Triangle and Edgewood Park sites,* are fully protected and managed with the primary intention of preserving them in perpetuity. Each protected area includes occupied habitat with adjacent unoccupied habitat and a 150-meter (500- foot) buffer, where possible.[12] *Alternatively, currently unoccupied sites may be protected as a substitute for currently occupied sites (or sites containing former known habitat) if they are of equivalent habitat quality, are managed through a Service-approved management plan (see **A/2** below), and meet the occupancy criterion (see **E/1** below). Populations should be secured through voluntary land acquisitions, conservation easements, or other means.*

[9] A normal precipitation cycle is defined as a series of years that encompass average, above-average, and below-average rainfall conditions, starting and ending with average precipitation. Populations must demonstrate the ability to survive both precipitation extremes.
[10] Banked seeds may be used to establish new populations and/or as a supplementary seed source if a population is declining and needs to be artificially seeded. Having a supplementary source of seeds for each population increases species resiliency and redundancy.
[11] Circumstantial evidence at Edgewood Park indicates that in situ seeds can be viable for 8 years (Pavlik and Espeland 1998). In 2008, seeds collected between 1993 and 1996 (and stored at room temperature) were sown at UC Botanical Garden. Seeds from all years, except 1996, had high germination rates (53% average among all four years; Niederer et al. 2010; C. Niederer, *in litt.* 2018b). The Service recommends a seed renewal schedule of 10 years because long-term seed viability has not been scientifically tested and seed viability may vary among years.
[12] This criterion eliminates the threat of urban development in areas where the species currently occurs and in areas that contain the appropriate habitat but are currently unoccupied.

**A/2** Management plan(s), approved *by the Service*, are implemented for the populations located at Crystal Springs Reservoir, *Stulsaft Park, and Woodside Glens* and any adjacent occupied or unoccupied habitat identified as essential to continued survival. Management plans include survival of the species as an objective; provisions for standardized monitoring of populations every 3 years to determine demographic trends; *and strategies to control nonnative, invasive plant species*[13] *and Argentine ants.*[14] *Adequate funding is secured to implement the management plan(s) in perpetuity.*

Factor B: Overutilization for Commercial, Recreational, Scientific, or Educational Purposes
Overutilization for any purposes is not known to threaten the fountain thistle at this time. Thus, no recovery criteria have been developed for this factor.

Factor C: Disease or Predation
The implementation of population monitoring as described in **E/2** below is expected to help evaluate effects due to seed predation and any potential future diseases. Understanding how to germinate and propagate fountain thistle seeds as described in **E/3** below, will minimize effects due to seed predation by having the potential to artificially propagate the species for introduction in the event a population is declining due to seed loss.

Factor D: Inadequacy of Existing Regulatory Mechanisms
The inadequacy of existing regulatory mechanisms is not known to threaten the fountain thistle at this time. Thus, no recovery criteria have been developed for this factor.

Factor E: Other Natural or Manmade Factors Affecting Its Continued Existence
Measures described under Factor A are expected to aid in the amelioration of effects from nonnative plant and Argentine ant invasion, and from small population size. However, to downlist the species, threats from small population size must be further reduced and/or evaluated. This will be accomplished when the following have occurred:

**E/1** Unless research shows otherwise, populations under **A/1** contain a minimum of 2,000 reproductive, self-regenerating adults to produce a mixture of reproductive stages (seedlings, juveniles, adults) sufficient to ensure self-perpetuation. *The Crystal Springs Reservoir population contains a minimum of 20,000 reproductive, self-regenerating adults that are well distributed throughout each subpopulation.*[15] Each population *and subpopulation* contains reproductive, self-

[13] A management plan that includes measures to control nonnative invasive plants will aid in the amelioration of habitat loss from invasive plant encroachment. Fountain thistle is known to respond well to invasive plant removal.
[14] In order to encourage and/or increase the presence of native ant populations at fountain thistle locations, management plans should include measures to control Argentine ants. The presence of native ant populations at fountain thistle locations may increase seed dispersal.
[15] The population at Crystal Springs Reservoir was once comprised of approximately ten to twelve subpopulations (eight of which are extant) and is currently the most abundant population. During the 2017 census an estimated 33,150 individuals were counted in seven of the eight subpopulations (SFPUC, pers. comm. 2018). To increase the resiliency of the Crystal Springs population, individuals should be more widely distributed throughout the subpopulations in order to reduce the risk of population extirpation due to stochastic events. This will allow each

regenerating adults to produce a mixture of reproductive stages sufficient to ensure self-perpetuation.

**E/2** As described in **A/2**, standardized population monitoring *at Crystal Springs Reservoir, Stulsaft Park, Woodside Glens or any alternative site (see **A/1**)* shows stable or increasing populations with evidence of natural recruitment over a period of 20 years that includes two normal precipitation cycles[16] (or longer if suggested by the results of demographic monitoring). Because the species is a perennial, monitoring should include both flowering and vegetative individuals.

**E/3** Seeds are stored in at least two Center for Plant Conservation certified facilities and reliable seed germination and propagation techniques are understood.[17]

**Presidio clarkia**

The following downlisting criteria are adapted from Section II, p. 64 and Section III, p. 12 of the recovery plan. Revisions to the original criteria are shown in *italics*.

Factor A: Present or Threatened destruction, Modification, or Curtailment of Habitat or Range. The limited availability and fragmentation of suitable serpentine habitat is the most limiting factor for Presidio clarkia recovery. Current and potential threats that may cause destruction, modification, or curtailment of habitat or range (occupied and/or unoccupied) include residential and recreational development, roadside maintenance for fire management, pedestrian and mountain bicycle traffic, road construction, off-highway vehicle use, and garbage dumping. (Competition from various plant species, soil nitrogen levels, altered hydrology, erosion, and climate change are addressed in Factor E.) To downlist Presidio clarkia, threats to habitat or range must be reduced. This may be accomplished when the following criteria are met:

**A/1** *A minimum of* five populations[18] of Presidio clarkia, *which shall include Inspiration Point at the Presidio and Redwood Regional Park in Oakland Hills,*[19] are fully

---

population and subpopulation to attract sufficient pollinators (the more flowering individuals within a population, the more likely that population will attract sufficient pollinators) and to maintain a stable or increasing population.

[16] A normal precipitation cycle is defined as a series of years that encompass average, above-average, and below-average rainfall conditions, starting and ending with average precipitation. Populations must demonstrate the ability to survive both precipitation extremes.

[17] Banked seeds could be used as a supplementary seed source if a population is declining and needs to be artificially seeded. Having a supplementary source of seeds for each population will increase fountain thistle resiliency and redundancy.

[18] For this document, a population of Presidio clarkia is defined as a group of individuals that is separated from other groups of Presidio clarkia by at least 400 meters (0.25 mile). Because Presidio clarkia have limited dispersal abilities and are primarily self-pollinated, groups that are separated by 400 meters will have very limited exchange of genes or alleles. A distance of 400 meters was also selected for consistency with the delineation of "occurrences" in the CNDDB.

[19] The former downlisting criteria specify either "five known occurrences" or "all populations" of Presidio clarkia. At the time of the 1998 recovery plan, these occurrences/populations refer to the Inspiration Point, War Memorial, Redwood Regional Park, Crestmont Drive, and Old Redwood Road sites. Instead of the original terminology, the revised criteria specify, "a minimum of five occurrences, which shall include Inspiration Point at the Presidio and Redwood Regional Park in Oakland Hills" for the following reasons. The term, "five known occurrences," no longer applies to our current knowledge of Presidio clarkia distribution. The term, "all populations," is not used because the

protected and managed with the primary intention of preserving the populations in perpetuity. Each protected area includes occupied habitat and known former habitat along with adjacent unoccupied habitat and a 150-meter (500-foot) buffer.

**A/2** Management plan(s), approved *by the Service*, are implemented for the populations described in **A/1** and any occupied or unoccupied habitat identified as essential to survival. *The plans include provisions for standardized annual monitoring of populations.*

Factor B: Overutilization for Commercial, Recreational, Scientific, or Educational Purposes
The overutilization of Presidio clarkia for commercial, recreational, scientific, or educational purposes is not believed to be a significant threat to the species at this time. Thus, no recovery criteria have been developed for this factor.

Factor C: Disease or Predation
Neither disease nor predation is known to be a threat to Presidio clarkia. Thus, no recovery criteria have been developed for this factor.

Factor D: Inadequacy of Existing Regulatory Mechanisms
The inadequacy of existing regulatory mechanisms is not believed to be a significant threat to Presidio clarkia. Thus, no recovery criteria have been developed for this factor.

Factor E: Other Natural or Manmade Factors Affecting Its Continued Existence
Other natural or manmade factors believed to affect the continued existence of Presidio clarkia include competition from various plant species, soil nitrogen levels, altered hydrology, erosion, few populations, small population size, loss of pollinators, loss of genetic diversity, and climate change. To downlist Presidio clarkia, Factor E threats must be reduced. This may be accomplished when the criteria under Factor A and the following criteria are met:

**E/1** Each population described in **A/1** contains a minimum of 2,000 (but preferably more) *flowering individuals each year for a minimum of* 20 years.[20]

**E/2** Each population described in **A/1** *has numbers of flowering individuals that exhibit a* stable or increasing *trend* over a period of 20 years that includes *two* normal precipitation cycles[21] (or longer if suggested by the results of demographic monitoring).

**E/3** *Impacts from competing plant species are managed so they do not pose a threat to the persistence of any of the Presidio clarkia populations described in **A/1**.*

---

Service recognizes that there may be some extant sites/populations, for which meeting all of the downlisting criteria would not be feasible.

[20] The original criterion read, "Until research shows otherwise, recovery should target securing populations containing a minimum of 2,000 plants each (but preferably more)." A period of 20 years was identified as an appropriate period in the original recovery plan (Service 1998).

[21] A normal precipitation cycle is defined as a series of years that encompass average, above-average, and below-average rainfall conditions, starting and ending with average precipitation. Populations must demonstrate the ability to survive both precipitation extremes.

**E/4** Seeds, *representative of the breadth of the species' genetic diversity*, are stored in at least two Center for Plant Conservation certified facilities and reliable seed germination and propagation techniques are understood.[22] *Unless storage techniques and/or research show otherwise, stored seeds are replenished every 10 years*[23] *in order to ensure seed viability.*

**Pennell's bird's-beak**

The following downlisting criteria are adapted from Section II, p. 72 and Section III, p. 13 of the original recovery plan. Revisions to the original criteria are shown in *italics*.

Factor A: Present or Threatened destruction, Modification, or Curtailment of Habitat or Range. The main threat to the persistence of Pennell's bird's-beak is habitat change and destruction. To downlist the species, these threats must be reduced. This reduction will be accomplished when the following have occurred:

**A/1** *A minimum of five populations*[24] of Pennell's bird's-beak are fully protected and managed with the primary intention of preserving the populations in perpetuity. Each protected area should include occupied habitat with adjacent unoccupied habitat and a 150-meter (500-foot) buffer. Occupied habitat *is secured and voluntarily* protected in at least *five* sites (*or populations)*.

**A/2** All known populations, and any occupied or unoccupied habitat identified as essential to survival, *are voluntarily protected in perpetuity on parcels large enough to incorporate the spread and establishment of new colonies.*

**A/3** Management plan(s), approved *by the Service*, are implemented for the populations described in **A/1** and any occupied or unoccupied habitat identified as essential to survival. *The plans include provisions for standardized annual monitoring of populations.*

Factor B: Overutilization for Commercial, Recreational, Scientific, or Educational Purposes While Pennell's bird's-beak exists on lands used for recreational activities, these activities likely pose little or no threat to the species. Thus, no criteria have been developed for this factor.

[22] Banked seeds may be used to establish new populations and/or as a supplementary seed source if a population is declining and needs to be artificially seeded. Having a supplementary source of seeds for each population increases species resiliency and redundancy.

[23] There is circumstantial evidence that Presidio clarkia seeds in Redwood Regional Park "may be viable for up to 30 years" (Naumovich 2018). The Service recommends a more conservative seed renewal schedule of 10 years because long-term seed viability has not been scientifically tested and there are no data for viability of seeds from the Presidio populations.

[24] For this document, a population of Pennell's bird's-beak is defined as a group of individuals that is separated from other groups of Pennell's bird's-beak by at least 400 meters (0.25 mile). A distance of 400 meters was selected for consistency with the delineation of "occurrences" in the CNDDB.

Factor C: Disease or Predation

Disease and predation by mammals pose a small threat to Pennell's bird's-beak. In the state of California, pathogens such as *Phytophthora* sp. might affect the host species for Pennell's bird's-beak. While browsing of Pennell's bird's-beak by cattle and deer has been observed, the plant is not thought to be palatable to these mammals.

**C/1** *The spread of pathogenic species*[25] *that might be harmful to Pennell's bird's-beak habitat is controlled at or below a level at which a population viability analysis indicates it does not pose a threat to the persistence of Pennell's bird's-beak.*

Factor D: Inadequacy of Existing Regulatory Mechanisms

The inadequacy of existing regulatory mechanisms is not known to threaten Pennell's bird's-beak at this time. Thus, no recovery criteria have been developed for this factor.

Factor E: Other natural or Manmade Factors Affecting Its Continued Existence

Other natural or manmade factors believed to affect the continued existence of Pennell's bird's-beak include competition from nonnative plant species, low annual population numbers, loss of genetic diversity, and climate change. We could not develop criteria for every threat; the effects of some threats, such as climate change are not currently well understood.

**E/1** Until research shows otherwise, recovery *efforts will* target securing protected populations containing a minimum of 2,000 *individual* plants each, *but preferably many more*.[26]

**E/2** *Population trends at all sites are* stable or increasing over 20 years that include *two* normal precipitation cycles[27] (or longer if suggested by the results of demographic monitoring).

**E/3** *Impacts from plants that are nonnative to serpentine habitats have been managed at levels that do not pose a threat to the persistence of Pennell's bird's-beak.*

**E/4** Seeds *representative of the breadth of the species' genetic diversity* are stored in at least two Center for Plant Conservation certified facilities; seed germination, propagation, and out planting propagation techniques are understood.[28]

[25] The spread of *Phytophthora* in California poses a threat to several species of tree and shrubs, which could include one of Pennell's bird's-beak's host plants, the Baker's manzanita (Rizzo et al. 2002).

[26] Per guidelines in the 1998 recovery plan. Observation suggests healthy, resilient populations are much larger; at approximately 10,000 individuals, but this is yet to be confirmed by research.

[27] A normal precipitation cycle is defined as a series of years that encompass average, above average, and below-average rainfall conditions, starting and ending with average precipitation (Service, 1998).

[28] Banked seeds may be used to establish new populations and/or as a supplementary seed source if a population is declining and needs to be artificially seeded. Having a supplementary source of seeds for each population increases species resiliency and redundancy.

**San Mateo woolly sunflower**

The following downlisting criteria are adapted from Section II, pp. 92-93 and Section III, p. 14 of the recovery plan. Revisions to the original criteria are shown in *italics*.

Factor A: Present or Threatened destruction, Modification, or Curtailment of Habitat or Range. Current and potential threats that may cause destruction, modification, or curtailment of habitat or range (occupied and/or unoccupied) include residential and recreational development, roadside maintenance, utility maintenance and installations, garbage and garden debris dumping, downhill seepage of pesticides, and sudden oak death. (Competition from native and nonnative plants, erosion and soil slippage, fire suppression, and climate change are addressed in Factor E.) To downlist San Mateo woolly sunflower, threats to habitat or range must be reduced. This may be accomplished when the following criteria are met:

**A/1** *A minimum of five colonies*[29,30] of San Mateo woolly sunflower are fully protected and managed with the primary intention of preserving the occurrences in perpetuity. Each protected colony includes occupied habitat along with adjacent unoccupied habitat and a 150-meter (500-foot) buffer at the known site. *If genetic research confirms that additional historical and/or extant* Eriophyllum *populations in San Mateo County*[31] *were/are San Mateo woolly sunflower, these sites are also protected and managed as described above. If additional individuals, sub-populations, or populations are*

[29] For this document, a colony of San Mateo woolly sunflower is defined as a group of individuals that is separated from other groups of San Mateo woolly sunflower by approximately 650 meters (0.4 mile) or more. Because erosion and water flow are believed to be the primary mechanisms of dispersal, the approximate distance between separate colonies was estimated using a proxy, average capacity for dispersal. The average capacity for dispersal was determined with the following process:

(1) Identify the drainage pathways within the vicinities of the four known occurrences of San Mateo woolly sunflower.

(2) Use the distance tool in the Esri Base Map Application to measure straight-line distances from high points (i.e. peaks or ridgetops) to waterways (i.e. San Mateo Creek, San Andreas Lake, or Lower Crystal Springs Reservoir) for each drainage pathway.

(3) Average the distances for related drainage pathways (i.e. areas where there are multiple drainages from a single high point or where multiple high points spill into a single drainage) to avoid biasing areas with more complex topographical features.

(4) Average the pooled distances (i.e. distances of simple drainage pathways and average distances of complex drainage systems) for each of the four known occurrences. This pools the measurements a second time to avoid biasing occurrences with more measurements in step (5).

(5) Average the four averages from step (4) and round to the nearest 50 meters.

The average maximum dispersal distances for the four occurrences were 518, 557, 691, and 809 meters. Thus, the estimated average of the maximum dispersal distance among the four known occurrences of San Mateo woolly sunflower = 644 ≈ 650 meters

[30] The former downlisting criteria specify "the Crystal Springs Road population," which was the only known extant occurrence at the time of the approval of the 1998 recovery plan. The former downlisting criteria do not reflect our current knowledge of the distribution of San Mateo woolly sunflower. Thus, the amended criterion specifies a "minimum of five colonies," which reflects the four known extant occurrences [i.e. Crystal Springs Road (CNDDB occurrence #1), San Mateo Road 2 (CNDDB occurrence #4), Outgoing Road/Lower Crystal Springs Reservoir, and Pilarcitos Road/Corol Reef Avenue (CNDDB occurrence #6)], and the likely probability that there is at least one additional colony (see footnote **Error! Bookmark not defined.**).

[31] For example, CNDDB occurrence #2, CNDDB occurrence #3, and/or private property in the Tunitas Watershed (J. Mooring, *in litt.* 2018c).

*discovered on private lands,*[32] *they are secured through land acquisitions, conservation easements, or other means and protected as described above.*

**A/2** Management plan(s), approved *by the Service*, are implemented for the colonies described in **A/1** and any occupied or unoccupied habitat identified as essential to survival. *The plans include provisions for standardized annual monitoring of populations.*

**A/3** *Plants and seeds in colonies that would be destroyed by imminent developments and/or maintenance are salvaged to preserve unique genotypes and local adaptations.*

Factor B: Overutilization for Commercial, Recreational, Scientific, or Educational Purposes
The overutilization of San Mateo woolly sunflower from collection has been identified as a potential threat because of the plant's showy golden flowers and proximity to roads and a proposed recreation trail (Service 1995, Service 1998). However, overutilization for any purpose is not known to occur. Thus, no recovery criteria have been developed for this factor.

Factor C: Disease or Predation
Seed predation has been identified as a potential threat (Service 1995, Service 1998) because insect larvae have been observed in the seed heads of San Mateo woolly sunflower (McGuire and Morey 1992). However, the extent of predation is unknown. No recovery criteria have been developed for this factor.

Factor D: Inadequacy of Existing Regulatory Mechanisms
The inadequacy of existing regulatory mechanisms is not believed to be a significant threat to San Mateo woolly sunflower. Thus, no recovery criteria have been developed for this factor.

Factor E: Other Natural or Manmade Factors Affecting Its Continued Existence
Other natural or manmade factors believed to affect the continued existence of San Mateo woolly sunflower include competition from native and nonnative plants, erosion and soil slippage, few populations, small population size, low germination rates and seedling survival, fire suppression, loss of pollinators, and climate change. To downlist San Mateo woolly sunflower, Factor E threats must be reduced. This may be accomplished when the criteria under Factor A and the following criteria are met:

**E/1** Each colony described in **A/1** contains a minimum of *150* (but preferably more) [33] *flowering individuals each year for a minimum of* 20 years.[34]

[32] Experts suggest that there may be additional undocumented occurrences of San Mateo woolly sunflower on private property (H. Bartosh, pers. comm. 2018; J. Mooring, Santa Clara University, pers. comm. 2018).
[33] The original criterion read, "Until research shows otherwise, recovery should target securing populations containing a minimum of 2,000 plants each (but preferably more)." However, the best available information suggests that 2,000 plants may be an unnaturally large population for the known occurrences (CNDDB 2018). Species expert, S. Foree (*in litt.* 2018b), advised that populations of San Mateo woolly sunflower should maintain a minimum of 150 plants.
[34] A period of 20 years was identified as an appropriate period in the original recovery plan (Service 1998).

**E/2** Each colony described in **A/1** *has numbers of flowering individuals that exhibit a* stable or increasing *trend* over a period of 20 years that includes *two* normal precipitation cycles[35] (or longer if suggested by the results of demographic monitoring).

**E/3** *Impacts from competition with native and nonnative species are managed so they do not pose a threat to the persistence of any of the San Mateo woolly sunflower colonies described in **A/1**.*

**E/2** Seeds, *representative of the breadth of the species' genetic diversity*, are stored in at least two Center for Plant Conservation certified facilities and reliable seed germination and propagation techniques are understood.[36] *Unless storage techniques and/or research show otherwise, stored seeds are replenished every 5 years[37] in order to ensure seed viability.*

**E/3** *If genetic research confirms that CNDDB occurrences #2 and #3 contained populations of San Mateo woolly sunflower that have since been extirpated, these occurrences are reestablished using appropriate habitat restoration and plant propagation techniques. These additional occurrences are important due to the limited nature of the appropriate soil type.*

**Tiburon jewelflower**

The following downlisting criteria are adapted from Section II, p. 126–128 and Section III, p. 16 of the recovery plan. Revisions to the original criteria are shown in *italics*.

Factor A: Present or Threatened Destruction, Modification, or Curtailment of Habitat or Range
The main threat to the persistence of Tiburon jewelflower is habitat change and destruction. To downlist the species, threats to the species' habitat must be reduced. This reduction will be accomplished when the following have occurred:

**A/1** Occupied habitat at the Old St. Hilary's Preserve and Middle Ridge site is fully protected and managed with the primary intention of preserving the populations in perpetuity.[38] In addition, secure and protect adjacent unoccupied habitat and a

[35] A normal precipitation cycle is defined as a series of years that encompass average, above-average, and below-average rainfall conditions, starting and ending with average precipitation. Populations must demonstrate the ability to survive both precipitation extremes.
[36] Banked seeds may be used to establish new populations and/or as a supplementary seed source if a population is declining and needs to be artificially seeded. Having a supplementary source of seeds for each population increases species resiliency and redundancy.
[37] Studies by species expert, J. Mooring, have indicated that San Mateo woolly sunflower germination rates can be very low (*in litt.* 2018a). Constance (1937) reported that Rydberg's type specimen and Elmer's 4397 collection of San Mateo woolly sunflower had sterile achenes. However, seeds collected in 2009 had a germination rate of 28% (3 weeks on agar) after collection and a germination rate of 48% (5 weeks on agar) after 5 years of storage (Rancho Santa Ana Botanic Garden 2018). Until additional germination trials indicate otherwise, the Service recommends a seed renewal schedule of 5 years.
[38] Old St. Hilary's Preserve is the site with the largest historical and currently extant population. The Middle Ridge site is the only other location that is known to have supported Tiburon jewelflower historically.

150-meter (500- foot) buffer around protected occupied habitat, *where possible*.[39] *If additional individuals or populations are discovered on private lands that are not part of the Old St. Hilary's Preserve or protected land at Middle Ridge, they are secured through voluntary land acquisitions, conservation easements, or other means.*[40]

**A/2** Management plan(s), approved *by the Service, are developed and* implemented for *populations at Old St. Hilary's Preserve and Middle Ridge, and any other location(s) where the species may be discovered (see **A/1**).* Management plans will include survival of the species as an objective and will include any adjacent occupied or unoccupied habitat identified as essential to survival. The plans include provisions for annual standardized monitoring of each population to determine demographic trends *and actions to control invasive plant species*.[41] *Adequate funding must be dedicated in order to implement the management plan in perpetuity.*

Factor B: Overutilization for Commercial, Recreational, Scientific, or Educational Purposes
Overutilization for any purposes is not known to threaten the Tiburon jewelflower at this time. Thus, no recovery criteria have been developed for this factor.

Factor C: Disease or Predation
Neither disease nor predation is known to threaten the Tiburon jewelflower at this time. Thus, no recovery criteria have been developed for this factor.

Factor D: Inadequacy of Existing Regulatory Mechanisms
The inadequacy of existing regulatory mechanisms is not known to threaten the Tiburon jewelflower at this time. Thus, no recovery criteria have been developed for this factor.

Factor E: Other Natural or Manmade Factors Affecting Its Continued Existence
Measures described under Factor A above are expected to help aid in the amelioration of effects due to nonnative plant invasion, recreational uses, and small population size. However, to downlist the species, threats due to small population size must be further reduced and/or evaluated. This reduction and evaluation will be accomplished when the following have occurred:

**E/1** *As described in **A/2***, standardized population monitoring *at Old St. Hilary's Preserve, Middle Ridge and any other location(s) where the species may be discovered (see **A/1**)* shows stable or increasing populations over a period of 20 years that include *two*

[39] Eliminates the threat from urban development at the Old St. Hilary's Preserve and along Middle Ridge.
[40] Newly discovered individuals or populations on private lands would likely contribute to representation through novel genetic diversity and would increase redundancy by increasing the range-wide distribution of the Tiburon jewelflower.
[41] A management plan that includes measures to control nonnative invasive plants will aid in the amelioration of habitat loss due to invasive plant encroachment.

normal precipitation cycles[42] (or longer if suggested by the results of demographic monitoring). *If monitoring shows any population is declining, determine the cause of decline and reverse the trend.*

**E/2** Unless research shows otherwise, *the St. Hilary's Preserve and any other population that may be discovered (see **A/1**) contain at least 3,000[43] flowering individuals, and the Middle Ridge population* contain *at least* 2,000[44] *flowering individuals. This will allow each population to maintain its breadth of genetic diversity and adaptive potential over the long-term,[45] attract sufficient pollinators,[46] and maintain a stable or increasing population.*

**E/3** Seeds stored in at least two Center for Plant Conservation certified facilities[47] and reliable seed germination and propagation techniques are understood.[48]

## Delisting Recovery Criteria

All delisting criteria are new. Delisting criteria include meeting all the downlisting criteria for that particular species.

### San Mateo thornmint

Factor A: Present or Threatened Destruction, Modification, or Curtailment of Habitat or Range
Availability of serpentine vertisol habitat is the most limiting factor for San Mateo thornmint recovery. The current threats that may cause destruction, modification, or curtailment of habitat or range (occupied and/or unoccupied) include development, pesticide use, off-highway vehicle use, recreation activities, and garbage dumping. (Invasive nonnative grasses, soil nitrogen levels, altered hydrology, erosion/landslides, and climate change are addressed in Factor E.) To delist San Mateo thornmint, threats to habitat or range must be reduced until they no longer contribute to extinction risk. This may be accomplished when the following criteria are met:

[42] A normal precipitation cycle is defined as a series of years that encompass average, above-average, and below-average rainfall conditions, starting and ending with average precipitation. The populations must demonstrate the ability to survive both precipitation extremes.
[43] This is the current population size at the Old St. Hilary's Preserve. Since this population has lost little genetic diversity over the last 50 years, we are considering this the threshold population size needed to maintain the species' adaptive potential into the future.
[44] This location has less available habitat for the species and the population had approximately 2,000 individuals during favorable growing conditions in 2009 (Service 2010c).
[45] The population at Middle Ridge has lost a significant amount of genetic diversity over the last 50 years; however, the Old St. Hilary's Preserve has maintained its genetic diversity over this time period.
[46] The more flowering individuals within a population, the more likely that population will attract sufficient pollinators.
[47] Banked seeds could be used as a supplementary seed source if any of the populations need to be artificially seeded in the event the population is declining.
[48] If any of the current Tiburon jewelflower populations begin to experience a seriously decline, the species could be artificially propagated in a controlled setting for future introduction. Artificial propagation will also help facilitate introduction into new locations.

**A/1** A minimum of ten self-sustaining populations[49] of San Mateo thornmint are established on suitable habitat within or near the plant's known historical range, and are fully protected and managed with the primary intention of preserving the populations in perpetuity. Each protected area includes occupied habitat with adjacent unoccupied habitat and a 150-meter (500-foot) buffer, where possible. Additional populations should be protected if indicated by modeling or research.

**A/2** All lands upslope from the populations described in **A/1** are protected from incompatible uses.[50]

**A/3** The populations described in **A/1** each contain a minimum of 100 square meters (1076 square feet)[51] that are occupied by San Mateo thornmint.[52]

Factor B: Overutilization for Commercial, Recreational, Scientific, or Educational Purposes
The overutilization of San Mateo thornmint for commercial, recreational, scientific, or educational purposes is not believed to be a significant threat to the species at this time. Thus, no recovery criteria have been developed for this factor.

Factor C: Disease or Predation
To delist San Mateo thornmint, threats from dodder must be controlled or eliminated. Successful implementation of management plans (criterion **A/4**) is expected to reduce threats from dodder infestations. In addition, the following criteria must also be met:

**C/1** Negative effects from dodder infestations to the populations described in **A/1** are absent or below a level at which a population viability analysis indicates that dodder is negatively affecting long-term persistence.

**C/2** Long-term management of dodder is both practically and financially sustainable. Financial resources for control of present and potential future dodder infestations are secured.

[49] Unless threat-inclusive modeling indicates otherwise, a minimum of ten self-sustaining populations are required for adequate redundancy and distribution of risk. This minimum number of populations is supported by expert recommendations (C. Niederer, *in litt.* 2018b; S. Weiss, *in litt.* 2018b). Greater numbers of populations are required when populations are near together and occupy very small areas.
[50] Changes/alterations to the landscape and its uses can influence downslope hydrology, fertilizer and pesticide levels, soil chemistry, invasive species, erosion, and/or other stressors. The road and residential development that are upslope from the natural Edgewood Park population are believed to have altered the habitat conditions (Service 2010a) such that the site may no longer be able to support a self-sustaining population (Niederer and Weiss 2018).
[51] Although still small, an occupied area of 100 square meters can support well over 6,700 individuals and spreads out risk (i.e. vulnerability of a population that only occupies a few square meters) to a degree allowed by limited habitat availability. Densely clustered populations appear to be natural for San Mateo thornmint but occupied spatial area must be adequate to support a minimum of 6,700 individuals during low-density years caused by natural population fluctuations. Species expert, C. Niederer (*in litt.* 2018b), also advocates that populations occupy a minimum of 100 square meters to be considered for delisting.
[52] If the habitat is only 100 square meters, every square meter must be occupied to meet this criterion.

Factor D: Inadequacy of Existing Regulatory Mechanisms

The inadequacy of existing regulatory mechanisms is not believed to be a significant threat to San Mateo thornmint. Thus, no recovery criteria have been developed for this factor.

Factor E: Other Natural or Manmade Factors Affecting Its Continued Existence

Other natural or manmade factors believed to affect the continued existence of San Mateo thornmint include invasive nonnative grasses, soil nitrogen levels, altered hydrology, erosion/landslides, few populations, small population size, low genetic diversity, seed loss/mortality, and climate change. To delist San Mateo thornmint, Factor E threats must be reduced until they no longer contribute to extinction risk. This may be accomplished when the criteria under Factor A and the following criteria are met:

**E/1** For a minimum of 20 consecutive years[53] that include two normal precipitation cycles,[54] each of the populations described in **A/1** exhibits a stable or increasing population trend with a rolling average of at least 50,000 flowering individuals.[55] During low-density years (presumably from natural population fluctuations), the populations described in **A/1** must contain a minimum of 6,700 flowering individuals[56] and densities do not fall below 160 per square meter for two or more consecutive years.[57]

---

[53] A period of 20 years was identified as an appropriate period in the original recovery plan (Service 1998).

[54] A normal precipitation cycle is defined as a series of years that encompass average, above-average, and below-average rainfall conditions, starting and ending with average precipitation. Populations must demonstrate the ability to survive both precipitation extremes.

[55] Population monitoring for San Mateo thornmint began only after the species was imperiled and all populations had been negatively impacted by human activities (Sommers 1984). However, the most persistent natural population fragment (Edgewood Park) did appear to have a boom and bust cycle within eight consecutive years of monitoring during the 1990s. Although occupied area was small (between 19 and 84 square meters), average densities of reproductive individuals per square meter from 1990 to 1997 were 689, 230, 302, 794, 1106, 390, 89, and 63, respectively (Pavlik and Espeland 1998). The service recommends that healthy, self-sustaining populations of San Mateo thornmint should have average densities similar to the average density of the Edgewood Park colony between 1990 and 1996 (514 flowering individuals per square meter). The year 1997 is excluded because the population fell to 5,289 individuals and has not recovered since. With an average target density of 514 per square meter, a population occupying 100 square meters (criterion **A/3**) should, on average, support approximately 50,000 individuals (514*100 square meters = 51,400 ≈ 50,000).

[56] San Mateo thornmint naturally grow in dense clusters. Average density in the Edgewood Park population from 1990 through 1996 was 514 individuals per square meter (Pavlik and Espeland 1998). In the 2010 draft adaptive management plan for San Mateo thornmint (Niederer et al. 2010), species experts set annual objectives to maintain populations of at least 5,000 individuals that occupy at least 75 square meters (average density = 5,000/75 = 67 individuals per square meter). To be considered for delisting, San Mateo thornmint populations must maintain occupancy of at least 100 square meters (criterion **A/3**). Considering the population and life histories discussed in Footnotes 7 and 55, densities of only 50 individuals per square meter (5,000/100 square meters = 50) may be too low, even during natural population fluctuations. To maintain the target density calculated from the minimum goals described in the 2010 draft adaptive management plan (5,000/75 = 67 individuals per square meter), the Service recommends that populations occupying 100 square meters contain no fewer than 6,700 flowering individuals (67*100 square meters = 6,700) for a minimum of 20 years.

[57] While low-density years are anticipated, low densities for two or more consecutive years may indicate that a population lacks resiliency and/or is in danger of extirpation. Until more data are collected on natural population cycles in San Mateo thornmint, the Service recommends that 160 flowering individuals per square meter be used as a multi-year density threshold. This threshold was chosen because, based on the best historical data available (Pavlik and Espeland 1998), 160 is midway between the lowest known density after which the population rebounded (230

**E/3** The populations described in **A/1** occupy habitats that sustain a minimum cover of 20% bare ground and a maximum cover of 30% nonnatives (live and thatch).[58]

**E/4** Long-term management to maintain the conditions described in criterion **E/3** is both practically and financially sustainable. Active management is not required more frequently than once every 5 years.[59] Financial resources for long-term habitat management are secured.

**Tiburon mariposa lily**

Factor A: Present or Threatened Destruction, Modification, or Curtailment of Habitat or Range
The main threat to the persistence of Tiburon mariposa lily is habitat change and destruction. To delist the species, threats to the species' limited habitat must be reduced. This reduction will be accomplished when the following have occurred:

**A/1** One population (comprised of nine colonies) of Tiburon mariposa lily at Ring Mountain Preserve is fully protected and managed with the primary intention of preserving the population/colonies in perpetuity. Each protected area includes occupied habitat with adjacent unoccupied habitat and a 150-meter (500-foot) buffer, where possible.[60] If additional individuals, colonies, or populations are discovered outside of the Ring Mountain Preserve, they are secured through voluntary land acquisition, conservation easements, or other means.[61]

**A/2** Management plans, approved by the Service, are developed and implemented for the population at Ring Mountain Preserve and any other location(s) where the species may be discovered (see **A/1**). Management plans include survival of the species as an objective and include any adjacent occupied or unoccupied habitat identified as essential to continued survival. The plan also includes provisions for annual standardized monitoring of each colony to determine demographic trends and strategies to control nonnative, invasive plant species.[62] Adequate funding must be dedicated in order to implement the management plan in perpetuity.

---

per square meter in 1991) and the next lowest density after which the population did not recover (89 per square meter in 1996).

[58] Based on habitat treatment experiments, species experts (Niederer et al. 2010) determined that these habitat parameters are readily achievable. While detailed habitat parameters for historical San Mateo thornmint populations are unknown, personal observations (by Toni Corelli, Ken Himes, and Stuart Weiss) from when populations were more abundant align with the habitat characteristics of 20% bare ground and less than 30% nonnative/thatch cover (personal observations, as cited in Niederer et al. 2010).

[59] The Service believes this criterion is achievable because serpentine prairie rehabilitation that does not require frequent management has been successful at the Presidio in San Francisco County, California (L. Stringer, pers. comm. 2018).

[60] Eliminates the threat of urban development at the Ring Mountain Preserve.

[61] Newly discovered individuals, colonies, or populations would likely contribute to representation through novel genetic diversity and would increase redundancy by increasing the range-wide distribution of the Tiburon mariposa lily.

[62] A management plan that includes measures to control nonnative invasive plants will aid in the amelioration of habitat loss due to invasive plant encroachment.

Factor B: Overutilization for Commercial, Recreational, Scientific, or Educational Purposes
Overutilization for any purposes is not known to threaten the Tiburon mariposa lily at this time. Thus, no recovery criteria have been developed for this factor.

Factor C: Disease or Predation
The implementation of population monitoring as described in **E/1** below is expected to help evaluate effects due to herbivory and any potential future diseases. Stored seeds, as described in **E/3** below, could be used as a supplementary seed source if a population is declining due to increased herbivory and needs to be artificially seeded.

Factor D: Inadequacy of Existing Regulatory Mechanisms
The inadequacy of existing regulatory mechanisms is not known to threaten the Tiburon mariposa lily at this time. Thus, no recovery criteria have been developed for this factor.

Factor E: Other Natural or Manmade Factors Affecting Its Continued Existence
The implementation of measures described under Factor A is expected to help reduce effects from nonnative plant invasion. The following criteria will help evaluate population trends and will aid in minimizing effects due to small population size.

**E/1** As described in **A/2**, standardized colony monitoring at the Ring Mountain Preserve and any other location(s) where the species may be discovered (see **A/1**) shows stable or increasing trends over a period of 20 years that includes two normal precipitation cycles[63] (or longer if suggested by the results of demographic monitoring). If monitoring shows any colony is declining, determine the cause of decline and reverse the trend. Because the species is a perennial, monitoring should include both flowering and vegetative individuals.

**E/2** All protected colonies described in **A/1** contain at least 1,000 individuals in order to maintain adaptive potential over the long-term,[64] attract sufficient pollinators,[65] and maintain stable or increasing populations. Each colony contains

[63] A normal precipitation cycle is defined as a series of years that encompass average, above-average, and below-average rainfall conditions, starting and ending with average precipitation. The populations must demonstrate the ability to survive both precipitation extremes.
[64] Brook et al. (2002) used demographic data from Fiedler (1987) to model extinction risk and the impact of inbreeding for Tiburon mariposa lily at three different initial population sizes. At all three population sizes, inbreeding depression reduced the median time to extinction (MTE). Larger initial population sizes increased MTE, with an initial population of 1,000 having a MTE of 540 years when inbreeding depression is included. The modeled probability of extinction, mean final population size, and percentage of heterozygosity remaining for an initial population size of 1,000 with inbreeding over 100 years is 0.044, 1,185 individuals, and 0.975, respectively. As initial population size decreased, the probability of extinction increased and the percentage of heterozygosity remaining decreased. Since the Tiburon mariposa lily is confined to serpentine outcrops at the Ring Mountain Preserve, and each colony has strong local adaption to the specific soil chemistry of the patch of serpentine outcrop in which it occurs (S. Swope, pers. comm. 2018), each Tiburon mariposa lily colony should contain at least 1,000 individuals (Brook et al. 2002) in order to maintain its evolutionary potential and range-wide representation in perpetuity (Frankham et al. 2014) and give the species the best chance to adapt to future changing conditions.
[65] The more flowering individuals within a colony, the more likely that colony will attract sufficient pollinators. Increased pollination may increase seed production.

reproductive, self-regenerating adults to produce a mixture of reproductive stages sufficient to ensure self-perpetuation.

**E/3** Seeds from each population stored in at least two Center for Plant Conservation certified facilities[66] and reliable seed germination and propagation techniques are understood.[67]

**Fountain thistle**

Factor A: Present or Threatened Destruction, Modification, or Curtailment of Habitat or Range
The main threat to the persistence of fountain thistle is habitat change and destruction. To delist the species, threats to the species habitat must be further reduced, the species needs to have five populations distributed across the known range, and two additional subpopulations need to be reintroduced to the Crystal Springs Reservoir location so the entire population contains at least ten subpopulations.

**A/1** Populations and subpopulations are reestablished at recently extirpated locations[68] or equivalent sites. Reintroduced populations and subpopulations are maintained over a 20-year period that includes two normal precipitation cycles[69] (or longer if suggested by the results of demographic monitoring). If habitat at any of the extirpated locations is no longer suitable for the species, alternative sites that are within the species' historical range, and contain the appropriate habitat and associates, may be approved by the Service.[70]

**A/2** Management plans, approved by the Service, are developed and implemented for any reintroduced populations from **A/1.** Management plans include survival of the species as an objective and will include any adjacent occupied or unoccupied habitat identified as essential to survival. The plans include provisions for standardized monitoring of populations every 3 years to determine demographic trends and strategies to control Argentine ants.[71] Adequate funding is secured in perpetuity for implementation of management plans.

---

[66] The Tiburon mariposa lily is known to have a low reproductive rate, primarily driven by the small number of individuals that actually set seed in any given year. Banked seeds could be used as a supplementary seed source if the population needs to be artificially seeded in the event the population is declining. This criterion will also minimize the threat of seed loss due to herbivory. Having a supplementary source of seeds will increase Tiburon mariposa lily resiliency.

[67] If the Tiburon mariposa lily population begins to experience a seriously decline, the species could be artificially propagated in a controlled setting for future introduction.

[68] Triangle and Edgewood Park and at least two subpopulations at Crystal Springs.

[69] A normal precipitation cycle is defined as a series of years that encompass average, above-average, and below-average rainfall conditions, starting and ending with average precipitation. The populations must demonstrate the ability to survive both precipitation extremes.

[70] The successful reintroduction of populations that are currently extirpated will increase the species ability to withstand catastrophic events and will increase fountain thistle redundancy by increasing the current range-wide distribution of the species.

[71] A management plan that includes measures to control Argentine ants will aid in the reduction of this threat at any reintroduction site.

**A/3** Occupied habitats at sites where populations have been reintroduced under **A/1** are fully protected and managed with the primary intention of preserving the population/colonies in perpetuity. Each protected area includes occupied habitat with adjacent unoccupied habitat and a 150-meter (500- foot) buffer, where possible.[72] Habitat containing reintroduced populations is secured through voluntary land acquisitions, conservation easements, or other means.

Factor B: Overutilization for Commercial, Recreational, Scientific, or Educational Purposes
Overutilization for any purposes is not known to threaten the fountain thistle at this time. Thus, no recovery criteria have been developed for this factor.

Factor C: Disease or Predation
The implementation of population monitoring as described in **E/2** below is expected to help evaluate effects due to seed predation and any potential future diseases.

Factor D: Inadequacy of Existing Regulatory Mechanisms
The inadequacy of existing regulatory mechanisms is not known to threaten the fountain thistle at this time. Thus, no recovery criteria have been developed for this factor.

Factor E: Other Natural or Manmade Factors Affecting Its Continued Existence
Measures described under Factor A are expected to aid in the amelioration of effects from nonnative plant and Argentine ant invasion, and from small population size. However, to delist the species, threats from small population size must be further reduced and/or evaluated. This reduction and evaluation will be accomplished when the following have occurred:

**E/1** Unless research shows otherwise, populations under **A/1** contain a minimum of 2,000 reproductive, self-regenerating adults to produce a mixture of reproductive stages (seedlings, juveniles, adults) sufficient to ensure self-perpetuation. The Crystal Springs population contains a minimum of 30,000 reproductive, self-regenerating adults that are well distributed throughout each subpopulation.[73] Each population and subpopulation contain reproductive, self-regenerating adults to produce a mixture of reproductive stages sufficient to ensure self-perpetuation.

**E/2** Population monitoring of reintroduced populations under **A/1** detects evidence of natural recruitment and population trends that are stable or increasing over a 20-year monitoring period that include two normal precipitation cycles (or longer if suggested by the results of demographic monitoring). The other three extant populations are stable or increasing after downlisting.

---

[72] Eliminates the threat of urban development at any location where the species is reintroduced.

[73] The population at Crystal Springs Reservoir is comprised of numerous subpopulations and the entire population contains the largest proportion of the overall fountain thistle population. This population has supported more than 30,000 individuals in the past; however, almost all of these individuals were located within one subpopulation. To increase the resiliency of the Crystal Springs population, individuals should be more widely distributed throughout the subpopulations in order to reduce the risk of population extirpation due to stochastic events. This will allow each population and subpopulation to attract sufficient pollinators (the more flowering individuals within a population, the more likely that population will attract sufficient pollinators) and to maintain a stable or increasing census size.

**E/3** Seeds from each reintroduced population under **A/1**, once established, stored in at least two Center for Plant Conservation certified facilities.[74]

**Presidio clarkia**

Factor A: Present or Threatened Destruction, Modification, or Curtailment of Habitat or Range
The limited availability and fragmentation of suitable serpentine habitat is the most limiting factor for Presidio clarkia recovery. Current and potential threats that may cause destruction, modification, or curtailment of habitat or range (occupied and/or unoccupied) include residential and recreational development, roadside maintenance for fire management, pedestrian and mountain bicycle traffic, road construction, off-highway vehicle use, and garbage dumping. (Competition from various plant species, soil nitrogen levels, altered hydrology, erosion, and climate change are addressed in Factor E.) To delist Presidio clarkia, threats to habitat or range must be reduced until they no longer contribute to extinction risk. This reduction may be accomplished when the following criteria are met:

**A/1** A minimum of ten[75] self-sustaining populations of Presidio clarkia are established on suitable habitat within or near the plant's known historical range, and are fully protected and managed with the primary intention of preserving the populations in perpetuity. Each protected area includes occupied habitat with adjacent unoccupied habitat and a 150-meter (500-foot) buffer, where possible. Additional populations are protected if indicated by modeling or research.

**A/2** All lands upslope from the populations described in **A/1** are protected from incompatible uses.[76]

**A/3** Each of at least six of the populations described in **A/1** are contained in a protected area comprised of at least 12 hectares (30 acres)[77] of rehabilitated serpentine grassland.

Factor B: Overutilization for Commercial, Recreational, Scientific, or Educational Purposes
The overutilization of Presidio clarkia for commercial, recreational, scientific, or educational purposes is not believed to be a significant threat to the species at this time. Thus, no recovery criteria have been developed for this factor.

[74] Banked seeds from an established reintroduced population could be used as a supplementary seed source if the population experiences a decline and needs to be artificially seeded. Having a supplementary source of seeds for each reintroduced population will increase fountain thistle resiliency.
[75] Unless threat-inclusive modeling indicates otherwise, a minimum of ten self-sustaining populations are required for adequate redundancy and distribution of risk. Greater numbers of populations are required when populations are near together and occupy very small areas. A minimum of ten populations is also supported by expert recommendation (L. Naumovich, Golden Hour Restoration Institute, *in litt.* 2018).
[76] Changes/alterations to the landscape and its uses can influence downslope hydrology, fertilizer and pesticide levels, soil chemistry, invasive species, erosion, and/or other stressors. The West Crissy Bluffs site at the Presidio is possibly impacted by the presence of a road upslope of the occurrence (M. Chassé, pers. comm. 2018).
[77] To support self-sustaining populations, protected areas must be large and diverse enough to resist frequent invasions of nonnative plant species and ensure that there are microclimate refugia for Presidio clarkia to survive through a shifting climate. An area of at least 12 hectares is supported by expert knowledge (L. Stringer, Presidio Trust, *in litt.* 2018).

Factor C: Disease or Predation

Neither disease nor predation is known to be a threat to Presidio clarkia. Thus, no recovery criteria have been developed for this factor.

Factor D: Inadequacy of Existing Regulatory Mechanisms

The inadequacy of existing regulatory mechanisms is not believed to be a significant threat to Presidio clarkia. Thus, no recovery criteria have been developed for this factor.

Factor E: Other Natural or Manmade Factors Affecting Its Continued Existence

Other natural or manmade factors believed to affect the continued existence of Presidio clarkia include competition from various plant species, soil nitrogen levels, altered hydrology, erosion, few populations, small population size, loss of pollinators, loss of genetic diversity, and climate change. To delist Presidio clarkia, Factor E threats must be reduced until they no longer contribute to extinction risk. This may be accomplished when the criteria under Factor A and the following criteria are met:

**E/1** For a minimum of 20 consecutive years[78] that include two normal precipitation cycles,[79] each population described in **A/1** exhibits a stable or increasing population trend with a minimum of 2,000 flowering individuals[80] each year.

**E/2** For a minimum of 20 consecutive years[81] that include two normal precipitation cycles,[82] each of the six populations described in **A/3** contains a minimum of 28,000 flowering individuals[83] each year with a rolling 20-year average of at least 140,000 flowering individuals.[84]

---

[78] A period of 20 years was identified as an appropriate period in the original recovery plan (Service 1998).

[79] A normal precipitation cycle is defined as a series of years that encompass average, above-average, and below-average rainfall conditions, starting and ending with average precipitation. Populations must demonstrate the ability to survive both precipitation extremes.

[80] Resilient Presidio clarkia populations should, on average, support many more than 2,000 flowering individuals. However, during low-density years (presumably from natural population fluctuations), populations may decrease to as little as 20% of the population average (Inspiration Point; GGNRA, unpubl. data 2018). The Service and species expert, L. Naumovich (*in litt.* 2018), recommends that any population of Presidio clarkia should maintain numbers at or above 2,000 individuals to ensure adequate resiliency.

[81] A period of 20 years was identified as an appropriate period in the original recovery plan (Service 1998).

[82] A normal precipitation cycle is defined as a series of years that encompass average, above-average, and below-average rainfall conditions, starting and ending with average precipitation. Populations must demonstrate the ability to survive both precipitation extremes.

[83] During low-density years (presumably from natural population fluctuations), populations may decrease to as little as 20% of the population average (Inspiration Point; GGNRA, unpubl. data 2018). Decreasing by more than 80% may indicate that a population is irreparably declining or imperiled.

[84] Inspiration Point at the Presidio, which contains a 6-hectare (15-acre) remnant of serpentine grassland, was used to calculate a target average population of 140,000 flowering individuals. Inspiration Point population history (as opposed to that of Redwood Regional Park) was used because of its more-complete population data and, thus far, more-successful native prairie restoration. The average estimated population of Presidio clarkia at Inspiration Point from 2006 to 2018 is approximately 70,000 (rounded up from 68,002 because the population estimates for 2013-2018 are expected to be higher than recorded because data were missing; GGNRA, unpubl. data 2018). Thus, extrapolated to a 12-hectare (30-acre) area, the average population would be 140,000 (70,000*2 per 6*2 hectares = 140,000 per 12 hectares).

**E/3** The populations described in **A/1** adequately represent the genetic diversity present in the range of the species. At least two of the six populations described in **A/3** represent the genetic diversity of Presidio clarkia at the Presidio and another two of six populations represent the genetic diversity in Oakland Hills.

**E/5** The populations described in **A/1** occupy serpentine grasslands with negligible nonnative plant cover and with species-appropriate disturbance regimes such as grazing and/or burrowing mammal populations. Impacts from competing plant species are managed so they do not pose a threat to the persistence of Presidio clarkia in any of the populations described in **A/1**.

**E/6** Long-term management of Presidio clarkia habitat is both practically and financially sustainable. Active management is not required more frequently than once every 5 years.[85] Financial resources for long-term habitat management are secured.

**Pennell's bird's-beak**

Factor A: Present or Threatened destruction, Modification, or Curtailment of Habitat or Range
The main threat to the persistence of Pennell's bird's-beak is habitat change and destruction. To delist Pennell's bird's-beak, threats to the species habitat must be reduced. This reduction will be accomplished when the following have occurred:

**A/1** Areas of occupied habitat are secured or established and voluntarily protected in perpetuity for at least ten known sites large enough to incorporate the seasonal and spatial variation of new colonies.[86,87] Protected areas are at least 12 hectares (30 acres), unless future research indicates otherwise.[88]

**A/2** The breadth of current genetic variation is represented at protected sites.

**A/3** No damage is recorded over the course of 20 years due to trampling or vandalism.

Factor B: Overutilization for Commercial, Recreational, Scientific, or Educational Purposes
Threats from overutilization for commercial, recreational, scientific, or education purposes are not known to be a threat to the species at this time. Thus, no recovery criteria have been developed for this factor.

[85] The Service believes this criterion is achievable because serpentine prairie rehabilitation that does not require frequent management has been successful at Inspiration Point at the Presidio (L. Stringer, pers. comm. 2018).
[86] New colonies of Pennell's bird's-beak are thought to be somewhat dependent on disturbance (G. Cooley, *in litt.* 2018; Chuang and Heckard 1986). Areas set aside for the conservation of this species must be large enough to accommodate the natural cycle of disturbance and colonization.
[87] Anecdotal evidence from experts suggests that most Pennell's bird's-beak populations exist on private property where suitable habitat conditions exist (G. Cooley, pers. comm. 2018).
[88] Pennell's bird's-beak has been able to persist at the 13.5-hectare (33-acre) Harrison Grade Ecological Reserve. To our knowledge, this site is large enough to allow the persistence of Pennell's bird's-beak.

Factor C: Disease or Predation
See downlisting criteria.

Factor D: Inadequacy of existing Regulatory Mechanisms
The inadequacy of existing regulatory mechanisms is not known to threaten Pennell's bird's beak at this time. Thus, no recovery criteria have been developed for this factor.

Factor E: Other Natural or Manmade Factors Affecting Its Continued Existence
Other natural or manmade factors believed to affect the continued existence of Pennell's bird's-beak include competition from nonnative plant species, low population numbers, loss of genetic diversity, and climate change. We could not develop criteria for every threat; the effects of some threats, such as climate change, are not currently well understood.

**E/1** Plants that are nonnative to serpentine habitats are monitored and controlled at a level that allows for the increase, establishment, and persistence of Pennell's bird's-beak in protected areas on suitable habitat.

**San Mateo woolly sunflower**

Factor A: Present or Threatened Destruction, Modification, or Curtailment of Habitat or Range
Current and potential threats that may cause destruction, modification, or curtailment of habitat or range (occupied and/or unoccupied) include residential and recreational development, roadside maintenance, utility maintenance and installations, garbage and garden debris dumping, downhill seepage of pesticides, and sudden oak death. (Competition from native and nonnative plants, erosion and soil slippage, fire suppression, and climate change are addressed in Factor E.) To delist San Mateo woolly sunflower, threats to habitat or range must be reduced until they no longer contribute to extinction risk. This may be accomplished when the following criteria are met:

**A/1** A minimum of 20 self-sustaining colonies[89] of San Mateo woolly sunflower are established on suitable habitat within or near the plant's known historical range, and are fully protected and managed with the primary intention of preserving the populations in perpetuity. Each protected area includes occupied habitat with adjacent unoccupied habitat and a 150-meter (500-foot) buffer, where possible. If historical and/or extant *Eriophyllum* colonies (outside of the San Mateo Creek Watershed) are determined to be San Mateo woolly sunflower, a minimum of 40 self-sustaining colonies[90] are protected and managed as described above. Additional colonies are protected if indicated by modeling or research.

[89] Unless threat-inclusive modeling indicates otherwise, a minimum of 20 self-sustaining colonies are required for adequate redundancy and distribution of risk. Greater numbers of colonies are necessary because groups of this species have few individuals, occupy small areas, and are in close proximity to each other. This minimum number of colonies is supported by expert recommendation (S. Foree, *in litt.* 2018b).

[90] If the historical and/or present range San Mateo woolly sunflower extends beyond the San Mateo Creek Watershed, our understanding of this species' status and diversity would change. A larger range and greater diversity would improve this species' probability of long-term persistence. However, more colonies dispersed over a larger area would be necessary to preserve the benefits of a larger range and greater diversity.

**A/2** All lands upslope from the colonies described in **A/1** are protected from incompatible uses.[91]

**A/3** Potential negative effects to San Mateo woolly sunflower habitat from sudden oak death infestations are absent or below a level that threatens colony health and/or persistence.

Factor B: Overutilization for Commercial, Recreational, Scientific, or Educational Purposes
The overutilization of San Mateo woolly sunflower from collection has been identified as a potential threat because of the plant's showy golden flowers and proximity to roads and a proposed recreation trail (Service 1995, Service 1998). However, overutilization for any purpose is not known to occur. Thus, no recovery criteria have been developed for this factor.

Factor C: Disease or Predation
Seed predation has been identified as a potential threat (Service 1995, Service 1998) because insect larvae have been observed in the seed heads of San Mateo woolly sunflower (McGuire and Morey 1992). However, the extent of predation is unknown. No recovery criteria have been developed for this factor.

Factor D: Inadequacy of Existing Regulatory Mechanisms
The inadequacy of existing regulatory mechanisms is not believed to be a significant threat to San Mateo woolly sunflower. Thus, no recovery criteria have been developed for this factor.

Factor E: Other Natural or Manmade Factors Affecting Its Continued Existence
Other natural or manmade factors believed to affect the continued existence of San Mateo woolly sunflower include competition from native and nonnative plants, erosion and soil slippage, few populations, small population size, low germination rates and seedling survival, fire suppression, loss of pollinators, and climate change. To delist San Mateo woolly sunflower, Factor E threats must be reduced until they no longer contribute to extinction risk. This may be accomplished when the criteria under Factor A and the following criteria are met:

**E/1** For a minimum of 20 consecutive years[92] that include two normal precipitation cycles,[93] each colony described in **A/1** exhibits a stable or increasing population trend with a rolling average of at least 300 flowering individuals. During low

[91] Changes/alterations to the landscape and its uses can influence downslope hydrology, fertilizer and pesticide levels, soil chemistry, invasive species, erosion, and/or other stressors. San Mateo woolly sunflower often occurs on steep slopes that are especially vulnerable to hydrological changes and erosion. Incompatible uses include use of pesticides, dumping of garbage/garden debris, and changes to the landscape and/or hydrology that may increase the likelihood of slope erosion and/or soil slips.
[92] A period of 20 years was identified as an appropriate period in the original recovery plan (Service 1998).
[93] A normal precipitation cycle is defined as a series of years that encompass average, above-average, and below-average rainfall conditions, starting and ending with average precipitation. Populations must demonstrate the ability to survive both precipitation extremes.

density years (presumably from natural population fluctuations), each colony described in **A/1** contains a minimum of 150 flowering individuals.[94]

**E/4** Impacts from competition with native and nonnative species are managed so they do not pose a threat to the persistence of any of the San Mateo woolly sunflower colonies described in **A/1**.

**E/5** Long-term management of San Mateo woolly sunflower habitat is both practically and financially sustainable. Financial resources for long-term habitat management are secured.

**Tiburon jewelflower**

Factor A: Present or Threatened Destruction, Modification, or Curtailment of Habitat or Range
The main threat to the persistence of Tiburon jewelflower is habitat change and destruction. To delist the species, threats to the species habitat must be eliminated and at least one population must be successfully introduced into a suitable location. This will be accomplished when the following have occurred:

**A/1** A minimum of one new population is established in an area on the Tiburon peninsula that contains suitable protected habitat and appropriate plant associates.[95] Each introduced population is maintained over a 20-year period that includes two normal precipitation cycles[96] (or longer if suggested by the results of demographic monitoring).

**A/2** Service-approved management plan(s) are developed and implemented for the introduced population(s) from **A/1**. Management plan(s) include survival of the species as an objective and include any adjacent occupied or unoccupied habitat identified as essential to survival. The plans include provisions for annual standardized monitoring to determine demographic trends and control invasive

[94] San Mateo woolly sunflower primarily grows in small clusters of individuals along roads and banks. To maintain a low risk of colony extirpation, each colony should contain numerous clusters and the average number of individuals in a colony must be great enough to withstand infrequent road/utility maintenance, sudden oak death, and erosion events. San Mateo woolly sunflower colonies exhibit natural population fluctuations, thus a colony with an average population of 300 individuals will frequently contain fewer than 300 individuals. However, colonies that do not maintain a minimum of 150 flowering individuals each year could be irreparably declining or imperiled. The average and minimum population size for each colony is supported by expert recommendation (S. Foree, *in litt.* 2018b).

[95] The introduced population could be the small population that has already been introduced to the Ring Mountain Preserve. This population has been self-sustaining even during poor environmental conditions, suggesting the species would be successful if introduced to the appropriate areas. The successful introduction of an additional population will increase the species ability to withstand catastrophic events and contribute to redundancy by increasing the range-wide distribution of the Tiburon jewelflower.

[96] A normal precipitation cycle is defined as a series of years that encompass average, above-average, and below-average rainfall conditions, starting and ending with average precipitation. The populations must demonstrate the ability to survive both precipitation extremes.

species.[97] Adequate funding is dedicated to implement the management plan in perpetuity.

**A/3** The population(s) described in **A/1** is secured and protected, along with adjacent unoccupied habitat and a 150-meter (500- foot) buffer, where possible.[98] The introduced population(s) is secured through voluntary land acquisitions, conservation easements, or other means.

Factor B: Overutilization for Commercial, Recreational, Scientific, or Educational Purposes
Overutilization for any purposes is not known to threaten the Tiburon jewelflower at this time. Thus, no recovery criteria have been developed for this factor.

Factor C: Disease or Predation
Disease or predation are not known to threaten the Tiburon jewelflower at this time. Thus, no recovery criteria have been developed for this factor.

Factor D: Inadequacy of Existing Regulatory Mechanisms
The inadequacy of existing regulatory mechanisms is not known to threaten the Tiburon jewelflower at this time. Thus, no recovery criteria have been developed for this factor.

Factor E: Other Natural or Manmade Factors Affecting Its Continued Existence
Measures described under Factor A above are expected to help reduce and/or evaluate any effects due to nonnative plant invasion, recreational uses, and small population size. However, to delist the species, threats due to small population size must be further evaluated and reduced. This will be accomplished when the following have occurred:

**E/1** Unless research shows otherwise, the introduced population described in **A/1** contains at least 3,000 plants.[99] This will allow the introduced population to maintain its breadth of genetic diversity and adaptive potential over the long-term,[100] attract sufficient pollinators,[101] and to maintain a stable or increasing population.

**E/2** Population monitoring of introduced populations under **A/1** shows evidence of natural recruitment and contain a stable or increasing population over a 20-year

[97] A management plan that includes measures to control nonnative invasive plants will aid in the amelioration of this threat.
[98] Eliminates the threat of urban development at the location where the species is introduced.
[99] This is the current population size at the Old St. Hilary's Preserve. Since this population has lost little genetic diversity over the last 50 years, we are considering this the threshold population size needed to maintain the species' adaptive potential into the future.
[100] The population at Middle Ridge has lost a significant amount of genetic diversity over the last 50 years; however, the Old St. Hilary's Preserve has maintained its genetic diversity over this time period. Therefore, we are using the population size at the Old St. Hilary's Preserve as the threshold population size to maintain the species adaptive potential into the future.
[101] The more flowering individuals within a population, the more likely that population will attract sufficient pollinators.

monitoring period that include two normal precipitation cycles[102] (or longer if suggested by the results of demographic monitoring). The other populations are stable or increasing after downlisting.

All classification decisions consider the following five factors: (1) present or threatened destruction, modification, or curtailment of the species' habitat or range; (2) overutilization for commercial, recreational scientific or educational purposes; (3) disease or predation; (4) inadequate existing regulatory mechanisms in place outside the ESA (taking into account the efforts by states and other organizations to protect the species or habitat); and (5) other natural or manmade factors affecting its continued existence. When delisting or downlisting a species, we first propose the action in the *Federal Register* and seek public comment and peer review. Our final decision is announced in the *Federal Register*.

**Rationale for Recovery Criteria**

We have amended recovery criteria for San Mateo thornmint, Tiburon mariposa lily, fountain thistle, Presidio clarkia, Pennell's bird's-beak, San Mateo woolly sunflower, and Tiburon jewelflower to include delisting criteria that incorporate the biodiversity principles of resiliency, redundancy, and representation (Service 2016) and threats addressed under the five factors. The amended criteria were developed based on the Service's current understanding of the species needs and requirements. This understanding includes information gathered since the original recovery plan was published, such as more recent information about population status and trends, along with an updated understanding of the threats acting on the species, as summarized in the syntheses above. The criteria presented are based on the reduction of threats to the species, and they include a temporal aspect to ensure that the species are resilient to expected variation within a reasonable time period.

## ADDITIONAL SITE SPECIFIC RECOVERY ACTIONS

The actions identified below are those that, based on the best available science, are necessary to bring about the recovery of all listed species in this amendment and ensure their long-term conservation. However, these actions are subject to modification as might be indicated by new findings, changes in species status, and the completion of other recovery actions. The most stepped down (detailed) actions have been assigned a priority for implementation, according to our determination of what is most important for the recovery of these species based on life history, ecology, and threats.

[102] A normal precipitation cycle is defined as a series of years that encompass average, above-average, and below-average rainfall conditions, starting and ending with average precipitation. The populations must demonstrate the ability to survive both precipitation extremes.

Key to Terms and Acronyms Used in the Recovery Action Narrative and Implementation Schedule:

Priority numbers are defined per Service policy (Service 1983) as:

**Priority 1:** An action that must be taken to prevent extinction or to prevent a species from declining irreversibly.

**Priority 2:** An action that must be taken to prevent a significant decline of the species population/habitat quality or some other significant negative impact short of extinction.

**Priority 3:** All other actions necessary to provide for full recovery of the species.

The following Recovery Actions Narrative provides detail of the actions necessary to achieve full recovery. The priority assigned to each action is specified within parentheses at the end of the description.

The numeric recovery priority system follows that of all Service recovery plans. Because situations change over time, priority numbers must be considered in the context of past and potential future actions at all sites. Therefore, the priority numbers assigned are intended to guide, not to constrain, the allocation of limited conservation resources.

**San Mateo thornmint**

1. Protect San Mateo thornmint habitat and establish new populations.

    1.1. Identify serpentine vertisol and protect potential introduction sites. (**Priority 1**)

    1.2. Develop, or continue the existing, seed increase program. (**Priority 1**)

    1.3. Establish, by seeding, new populations within or near the species' known historical range. Seeding should take place in suitable habitats that also exhibit a range of natural environmental conditions. Numerous sites should be seeded to achieve adequate success rates and determine the range of habitat conditions under which successful establishment can be achieved. (**Priority 1**)

2. Research San Mateo thornmint life history and conservation strategies.

    2.1. Research and develop methods of dodder control that are effective and efficient for San Mateo thornmint populations. (**Priority 2**)

    2.2. Research optimal habitat characteristics, mechanisms of dispersal, and potential impacts from climate change. (**Priority 2**)

    2.3. Study the demography, reproductive biology, and genetic structure of populations. (**Priority 3**)

3. Monitor and manage San Mateo thornmint populations.

    3.1. Implement site-specific management plans for San Mateo thornmint and other native serpentine species. Manage habitat in occupied areas and in surrounding areas that affect, or could affect, conditions in occupied areas (e.g. weedy species invade from adjacent areas). Best habitat management practices may include complete eradication of nonnative species and restoration of native serpentine plant communities. (**Priority 1**)

    3.2. Implement a standardized annual monitoring program with the power to detect population trends. (**Priority 2**)

    3.3. Store seeds in at least two Center for Plant Conservation certified facilities. Unless storage techniques and/or research show otherwise, replenish seed stock every 10 years to ensure seed viability. (**Priority 2**)

    3.4. Establish a Service-approved monitoring plan to cover a minimum of 5 years post-delisting. The plan will be ready for implementation at the time of delisting to ensure the ongoing conservation of the species and the continued effectiveness of management actions. Adequate funding must be dedicated in order to implement the delisting management plan. (**Priority 3**)

**Tiburon mariposa lily**

1. Store seeds in at least two Center for Plant Conservation certified facilities. Unless storage techniques and/or research show otherwise, replenish seed stock every 10 years to ensure seed viability. (**Priority 2**)

2. Establish a Service-approved monitoring plan to cover a minimum of 5 years post-delisting of Tiburon mariposa lily. The plan will be ready for implementation at the time of delisting to ensure the ongoing conservation of the species and the continued effectiveness of management actions. Adequate funding must be dedicated in order to implement the delisting management plan. (**Priority 3**)

**Fountain thistle**

1. Store seeds in at least two Center for Plant Conservation certified facilities. Unless storage techniques and/or research show otherwise, replenish seed stock every 10 years to ensure seed viability. (**Priority 2**)

2. Establish a Service-approved monitoring plan to cover a minimum of 5 years post-delisting of fountain thistle. The plan will be ready for implementation at the time of delisting to ensure the ongoing conservation of the species and the continued effectiveness of management actions. Adequate funding must be dedicated in order to implement the delisting management plan. (**Priority 3**)

**Presidio clarkia**

1. Protect Presidio clarkia sites and establish additional populations.

    1.1. Identify and protect potential introduction sites. (**Priority 1**)

    1.2. Develop and implement a seed increase or collection program that represents the breadth of genetic diversity in the species. (**Priority 1**)

    1.3. Establish, by seeding, new populations within or near the species' known historical range. Seeding should take place in suitable habitats that also exhibit a range of natural environmental conditions. Numerous introductions maybe necessary to achieve adequate success rates and determine the range of habitat conditions under which successful establishment can be achieved. (**Priority 1**)

    1.4. Secure populations through land acquisitions, conservation easements, or other means. (**Priority 1**)

    1.5. Work with the City of Oakland and private landowners to maintain Presidio clarkia sites for the long-term survival of the species on their lands. Collaboratively determine the best management practices to accomplish both landowner objectives and conservation goals. Educate local roadside maintenance crews and landscapers. (**Priority 1**)

2. Research Presidio clarkia life history and conservation strategies.

    2.1. Conduct genetic research on existing populations to determine the species' genetic structure and diversity. (**Priority 2**)

    2.2. Research optimal habitat characteristics, mechanisms of dispersal, pollination biology, seed viability of populations from both the Presidio and Oakland Hills, and potential impacts from climate change. (**Priority 2**)

    2.3. Study the demography and reproductive biology of populations. (**Priority 3**)

3. Monitor and manage Presidio clarkia populations.

    3.1. Implement site-specific management plans for Presidio clarkia and other native serpentine species. Manage habitat in occupied areas and in surrounding areas that affect, or could affect, conditions in occupied areas (e.g. weedy species invade from adjacent areas). Best habitat management practices may include complete eradication of nonnative species and restoration of native serpentine plant communities. (**Priority 1**)

    3.2. Implement a standardized annual monitoring program with the power to detect population trends. (**Priority 2**)

3.3. Store seeds in at least two Center for Plant Conservation certified facilities. Unless storage techniques and/or research show otherwise, replenish seed stock every 10 years to ensure seed viability. (**Priority 2**)

3.4. Establish a Service-approved monitoring plan to cover a minimum of 5 years post-delisting. The plan will be ready for implementation at the time of delisting to ensure the ongoing conservation of the species and the continued effectiveness of management actions. Adequate funding must be dedicated in order to implement the delisting management plan. (**Priority 3**)

**Pennell's bird's-beak**

1. Establish or protect additional populations of Pennell's bird's-beak.

   1.1 Conduct botanical field surveys to discover additional populations. (**Priority 1**)

   1.2 Protect additional populations through voluntary conservation agreements or land acquisitions. (**Priority 1**)

   1.3 Collect and introduce Pennell's bird's-beak seeds in areas of appropriate habitat on protected lands. (**Priority 1**)

   1.4 Survey reintroduction sites annually to determine abundance and extent. (**Priority 2**)

2. Conduct research to increase understanding of Pennell's bird's-beak life history and annual establishment.

   2.1 Conduct research to determine the full range (area and extent) of the species. (**Priority 3**)

   2.2 Conduct demographic surveys and long-term monitoring that includes, but is not limited to, habitat surveys, genetic research, host-parasite dynamics, and annual establishment. (**Priority 1**)

   2.3 Investigate and monitor potential management methods to maximize population success. Adapt and modify management as necessary. (**Priority 2**)

3. Conduct genetic research to determine if genetically distinct populations exist outside of protected areas. (**Priority 3**)

4. Monitor and manage Pennell's bird's-beak populations on protected lands.

   4.1 At locations where the plant is protected, establish management plans to ensure the quality of existing habitat is maintained and/or degraded habitat is restored. (**Priority 2**)

4.2 Conduct regular patrols to deter illegal dumping in habitat. If needed, mitigate the effects of illegal dumping on habitat. (**Priority 3**)

4.3 Store seeds in at least two Center for Plant Conservation certified facilities. Unless storage techniques and/or research show otherwise, replenish seed stock every 10 years to ensure seed viability. (**Priority 2**)

4.4 Establish a Service-approved monitoring plan to cover a minimum of 5 years post-delisting. The plan will be ready for implementation at the time of delisting to ensure the ongoing conservation of the species and the continued effectiveness of management actions. Adequate funding must be dedicated in order to implement the delisting management plan. (**Priority 3**)

**San Mateo woolly sunflower**

1. Protect San Mateo woolly sunflower colonies and identify or establish additional colonies.

   1.1. Ensure that all road and utility maintenance personnel are aware of San Mateo woolly sunflower along Crystal Springs Road and mark colonies with permanent signs/markers. Implement other protection measures as needed. (**Priority 1**)

   1.2. Secure colonies through land acquisitions, conservation easements, or other means. (**Priority 1**)

   1.3. Identify and protect potential introduction sites. (**Priority 1**)

   1.4. Search for additional colonies on private and city land. Secure additional colonies through land acquisitions, conservation easements, or other means. (**Priority 2**)

   1.5. Implement a seed increase and/or propagation program that may be used to establish new colonies and supplement existing colonies when necessary. (**Priority 2**)

   1.6. Establish new colonies, to the extent described in the recovery criteria, within or near the species' known historical range. Colonies should be established in suitable habitats that exhibit a range of natural environmental conditions. Numerous introductions maybe necessary to achieve adequate success rates and determine the range of habitat conditions under which successful establishment can be achieved. (**Priority 2**)

2. Research San Mateo woolly sunflower life history and conservation strategies.

   2.1. Conduct genetic research on existing colonies to determine the species' genetic structure and genetic diversity. (**Priority 1**)

2.2. Study the historical and extant *Eriophyllum* occurrences that have been classified as San Mateo woolly sunflower to determine accurate species identities. Delineate the actual and historical range of San Mateo woolly sunflower. (**Priority 1**)

2.3. Research and develop reliable seed germination and propagation techniques. (**Priority 1**)

2.4. Determine the most effective and efficient habitat management practices to enhance colony health and reduce impacts from competing species and erosion. Experimentally test fire disturbance[103] as a management tool. (**Priority 1**)

2.5. Research optimal habitat characteristics, factors influencing seed germination, mechanisms of dispersal, impacts of seed predation, and potential impacts from climate change. (**Priority 2**)

2.6. Study the demography (including seedling survivorship), reproductive biology, and phenotypic plasticity (the capacity for marked variation in observable structural and functional properties of an organism because of environmental influences during development) of colonies. (**Priority 3**)

3. Monitor and manage San Mateo woolly sunflower colonies.

3.1. Implement site-specific management plans. Manage habitat in occupied areas and in surrounding areas that affect, or could affect, conditions in occupied areas (e.g. weedy species invade from adjacent areas). Best habitat management and restoration practices may include complete eradication of nonnative species, planting coast live oak trees, and/or treating sudden oak death infestations. (**Priority 1**)

3.2. Implement a standardized annual monitoring program with the power to detect population trends. (**Priority 2**)

3.3. Store seeds in at least two Center for Plant Conservation certified facilities. Unless storage techniques and/or research show otherwise, replenish seed stock every 5 years to ensure seed viability. (**Priority 2**)

3.4. Establish a Service-approved monitoring plan to cover a minimum of 5 years post-delisting. The plan will be ready for implementation at the time of delisting to ensure the ongoing conservation of the species and the continued effectiveness of management actions. Adequate funding must be dedicated in order to implement the delisting management plan. (**Priority 3**)

[103] Species expert, H. Bartosh, suggests that San Mateo woolly sunflower is fire-adapted, like its congener, common woolly sunflower (*Eriophyllum lanatum*). San Mateo woolly sunflower may be associated with road cuts because the disturbed ground in road cuts is similar to the effects of fire disturbance (H. Bartosh, pers. comm. 2018).

**Tiburon jewelflower**

1. Introduce and maintain one new Tiburon jewelflower population in an area on the Tiburon peninsula that contains suitable protected habitat and the appropriate plant associates. (**Priority 1**)

2. Work with Marin County Parks and Open Space to update their current management plan to include the Tiburon jewelflower. Institute a species-specific management plan to ensure a self-sustaining population over the long-term. (**Priority 1**)

3. Store seeds in at least two Center for Plant Conservation certified facilities. Unless storage techniques and/or research show otherwise, replenish seed stock every 10 years to ensure seed viability. (**Priority 2**)

4. Establish a Service-approved monitoring plan to cover a minimum of 5 years post-delisting of Tiburon jewelflower. The plan will be ready for implementation at the time of delisting to ensure the ongoing conservation of the species and the continued effectiveness of management actions. Adequate funding must be dedicated in order to implement the delisting management plan. (**Priority 3**)

## LITERATURE CITED


Brook, B.W., D.W. Tonkyn, J.J. O'Grady, and R. Frankham. 2002. Contribution of inbreeding to extinction risk in threatened species. Conservation Ecology 6:16.

Chassé, M.R. and A. Forrestel. 2014. 2011-2013 Monitoring Report for Federally Listed Plants within the Golden Gate National Recreation Area. April 2014. Report prepared for the Division of Natural Resource Management and Science, Golden Gate National Recreation Area, National Park Service, San Francisco, California, and the U.S. Fish and Wildlife Service, Sacramento Fish and Wildlife Office, Endangered Species Division, Sacramento, California. 38 pp.

Christian, C.E. 2001. Consequences of a biological invasion reveal the importance of mutualism for plant communities. Nature 413:635-639.

Chuang, T.I., and L.R. Heckard. 1971. Observations on root-parasitism in *Cordylanthus* (Scrophulariaceae). American Journal of Botany 58:218-228.

Chuang, T.I., and L.R. Heckard. 1986. Systematics and evolution of *Cordylanthus* (Scrophulariaceae-Pedicularieae). Systemic Botany Monographs. Volume 10.

(CDFG) California Department of Fish and Game. 1997. Recovery workshop summary, northern Bay Area serpentine plants. Plant Conservation Program, California Department of Fish and Game, Sacramento, California. 9 pp.

(CNDDB) California Natural Diversity Data Base. 2018. RareFind 5 [Internet]. Occurrence reports for *Acanthomintha duttonii* (Accessed August 15, 2018), *Cirsium fontinale* var. *fontinale* (Accessed July 16, 2018), *Clarkia franciscana* (Accessed August 15, 2018), *Cordylanthus tenuis* ssp. *capillaris* (Accessed August 3, 2018), and *Eriophyllum latilobum* (Accessed August 15, 2018). California Department of Fish and Wildlife, California.

Constance, L. 1937. A systematic study of the genus *Eriophyllum* Lag. University of California Publications in Botany 18:69–136.

Creekside Science. 2013. Serpentine Prairie Restoration Project, Redwood Regional Park: 2008-2013 (Executive Summary). Available online at http://www.ebparks.org/civicax/filebank/blobdload.aspx?BlobID=23697. Accessed July 27, 2018.

Fiedler, P.L. 1987. Life history and population dynamics of rare and common mariposa lilies (*Calochortus* Pursh: Liliaceae). Journal of Ecology 75:977-995.

Fiedler, P.L., B.E. Knapp, and N. Fredricks. 1998. Rare plant demography: lessons from the mariposa lilies (*Calochortus*: Liliaceae) In P.L. Fiedler and P.M. Kareiva, eds. Conservation biology: for the coming decade. Second edition. Springer, New York, New York. 533 pp.

Frankham, R., C.J.A. Bradshaw, and B.W. Brook. 2014. Genetics in conservation management: revised recommendations for the 50/500 rules, Red List criteria and population viability analysis. Biological Conservation 170:56-63.

Fund for Animals v. Babbitt, 903 F. Supp. 96. 1995. US District Court for the District of Columbia. September 29, 1995.

Garbelotto, M.M., P. Svihra, and D.M. Rizzo. 2001. New pests and diseases: sudden oak death syndrome fells 3 oak species. California Agriculture 55:9-19.

(GGNRA) Golden Gate National Recreation Area. 2018. Unpublished data, Presidio clarkia counts/estimates, 1990-2018. Submitted by Michael Chassé to Stephanie Prevost of the U.S. Fish and Wildlife Service on July 17, 2018.

Heckard, L.R. 1977. California native plant status report: *Cordylanthus tenuis* ssp. *capillaris*. California Native Plant Society, Sacramento, California.

Hickman, J.C. 1993. The Jepson manual. University of California Press, Berkley, California. 1,424 pp.

Holway, D.A., L. Lach, A.V. Suarez, N.D. Tsutsui, and T.J. Case. 2002. The causes and consequences of ant invasions. Annual Review of Ecological Systems 23: 181-233.

Kruckeberg, A.R. 1984. California serpentines: flora, vegetation, geology, soils, and management problems. University of California Press, Berkeley, California. 180 pp.

LSA Associates, Inc. 2007. Ring Mountain Preserve Sensitive Resource Monitoring and Enhancement Strategy. Prepared by LSA Associates, Inc., Point Richmond, California for the County of Marin, Department of Parks and Open Space. 45 pp.

_____. 2008. Ring Mountain Monitoring Report, Tiburon Paintbrush and Tiburon Mariposa Lily, 2007 and 2008. Prepared by LSA Associates, Inc., Point Richmond, California for the County of Marin, Department of Parks and Open Space. 22 pp.

_____. 2010. Open Space Resource Management Plan, Town of Tiburon, Marin County, California. Prepared by LSA Associates, Inc., Point Richmond, California for the Town of Tiburon. 22 pp. Prepared by LSA Associates, Inc., Point Richmond, California for the County of Marin, Department of Parks and Open Space. 96 pp.

Marvier, M.A., and D.L. Smith. 1997. Conservation implications of host use for rare parasitic plants. Conservation Biology 11:839-848.

McCarten, N.F. 1987. Ecology of the serpentine vegetation in the San Francisco Bay region. In T.S. Elias, ed. Conservation and management of rare and endangered plants. California Native Plant Society. pp. 335-340.

_____. 1993. Serpentines of the San Francisco Bay region; vegetation, floristics, distribution, and soils. November 23, 1986. Revised July 8, 1993. Report submitted to the Endangered Plant Program, California Department of Fish and Game, Sacramento, California. 118 pp.

McGuire, T. and S. Morey. 1992. Report to the Fish and Game Commission on the status of San Mateo woolly sunflower (*Eriophyllum latilobum*). Natural Heritage Division Status Report 92-1. California Department of Fish and Game. 27 pp.

MHA Environmental Consulting, Inc. 2001. San Mateo County 2001 Trails Plan, San Mateo County, California. Prepared by MHA Environmental Consulting, Inc. for San Mateo County Parks and Recreation Commission, Environmental Service Agency, Parks and Recreation Division. Available online at https://parks.smcgov.org/sites/parks.smcgov.org/files/documents/files/Trails%20Master%20Plan.pdf. Accessed August 16, 2018.

Mooring, J. 1994. A cytogenetic study of *Eriophyllum confertiflorum* (Compositae, Helenieae). American Journal of Botany 81:919-926.

Morey, S.C., and J.C. Hunter. 1990. A management strategy for the recovery of Tiburon jewelflower (*Streptanthus niger*). Endangered Plan Program, Natural Heritage Division, California Department of Fish and Game, Sacramento, California. 17 pp.

Naumovich, L. 2018. Serpentine Prairie Restoration Project, Redwood Regional Park, 2017 Annual Report. Golden Hour Restoration Institute, Berkeley, California. Report submitted to the East Bay Regional Park District. 33 pp.

Niederer, C. and C. Elliott. 2011. Fountain Thistle (*Cirsium fontinale* var. *fontinale*) Restoration Project (FWS Agreement Number 81420-A-J514). 22 pp.

_____. 2012. Fountain Thistle (*Cirsium fontinale* var. *fontinale*) Restoration Project Final Report (FWS Agreement Number 81420-A-J514). 20 pp.

Niederer, C., S. Weiss, and H. Forbes. 2010. San Mateo Thornmint (*Acanthomintha duttonii*) Restoration Project at Edgewood County Park and Natural Preserve, Year 2, Quarter 4, Status Report and Draft Adaptive Management Plan, April 13, 2010. Report submitted to the U.S. Fish and Wildlife Service. 95 pp.

Niederer, C. and S. Weiss. 2018. San Mateo Thornmint (*Acanthomintha duttonii*) Restoration Project, Status Report, January 2018. Report submitted to the U.S. Fish and Wildlife Service. 31 pp.

Olmstead, R.G., C.W. dePamphilis, A.D. Wolfe, N.D. Young, W.J. Elisons, and P.A. Reeves. 2001. Disintegration of the Scrophulariaceae. American Journal of Botany 88:348-361.

Pavlik, B. and E. Espeland. 1998. Demography of natural and reintroduced populations of *Acanthomintha duttonii*, an endangered serpentine annual in northern California. Madroño 45:31-39.

Pemberton, R.W. and D.W. Irving. 1990. Elaiosomes on weed seeds and the potential for myrmecochory in naturalized plants. Weed Science 38:615-619.

Rancho Santa Ana Botanic Garden. 2018. Spreadsheet containing results of germination trials. Rancho Santa Ana Botanic Garden, Claremont, California. Available online at https://www.rsabg.org/conservation/seed-conservation. Accessed September 5, 2018.

Rizzo, D. M., M. Garbelotto, J. M. Davidson, G. W. Slaughter, S. T. Koike. 2002. *Phytophthora ramorum* and Sudden Oak Death in California: I. Host Relationships. USDA Forest Service General Technical Report.

San Mateo County. 1997. Edgewood Park & Natural Preserve Master Plan. Adopted May 1997. Environmental Services Agency, Parks and Recreation Division, San Mateo County, California. 229 pp.

_____. 2018. Vegetation Management. County of San Mateo Public Works. Webpage. Available online at https://publicworks.smcgov.org/vegetation-management. Accessed August 17, 2018.

[Service] U.S. Fish and Wildlife Service. 1985. Endangered and threatened wildlife and plants; determination of endangered status for *Acanthomintha obovata* ssp. *duttonii* (San Mateo thornmint). Final rule. Federal Register 50:37858-37863.

_____. 1995. Endangered and threatened wildlife and plants; determination of endangered status for ten plants and threatened status for two plants from serpentine habitats in the San Francisco Bay Region of California. Final rule. Federal Register 60:6671-6685.

_____. 1998. Recovery Plan for Serpentine Soil Species of the San Francisco Bay Area. Region 1, Portland, Oregon. 442 pp.

_____. 2010a. *Acanthomintha obovata* ssp. *duttonii* (San Mateo thornmint), *Cirsium fontinale* ssp. *fontinale* (fountain thistle), *Pentachaeta bellidiflora* (white-rayed pentachaeta) 5-Year Review: Summary and Evaluation. U.S. Fish and Wildlife Service, Sacramento, California. 35 pp.

_____. 2010b. *Clarkia franciscana* (Presidio clarkia) 5-Year Review: Summary and Evaluation. U.S. Fish and Wildlife Service, Sacramento, California. 70 pp.

_____. 2010c. *Streptanthus niger* (Tiburon jewelflower) 5-Year Review: Summary and Evaluation. U.S. Fish and Wildlife Service, Sacramento, California. 19 pp.

_____. 2011a. Biological Opinion on the San Francisco Public Utilities Commission (SFPUC) Lower Crystal Springs Dam Improvements Project, San Mateo County, California (Corps files number 30317S). U.S. Fish and Wildlife Service, Sacramento, California. 87 pp.

_____. 2011b. *Calochortus tiburonensis* (Tiburon mariposa lily) 5-Year Review: Summary and Evaluation. U.S. Fish and Wildlife Service, Sacramento, California. 13 pp.

_____. 2011c. *Eriophyllum latilobum* (San Mateo woolly sunflower) 5-Year Review: Summary and Evaluation. Sacramento Fish and Wildlife Office. 16 pp.

_____. 2011d. *Cordylanthus tenuis* ssp. *capillaris* (Pennell's bird's-beak) 5-Year Review: Summary and Evaluation. Sacramento Fish and Wildlife Office. 22 pp.

_____. 2016. USFWS Species Status Assessment Framework: an integrated analytical framework for conservation. Version 3.4 dated August 2016.

(SFPUC) San Francisco Public Utilities Commission. 2018. Unpublished maps. Submitted by Sonya Foree to Stephanie Prevost of the U.S. Fish and Wildlife Service. 4 pp.

Sommers, S.C. 1984. Comments on *Acanthomintha obovata duttonii*, a proposed endangered species. Report submitted to the U.S. Fish and Wildlife Service, November 13, 1984. 38 pp.

Town of Hillsborough. 2014. 2013-2014 Chemical weed abatement project, various locations in Hillsborough, California, 94010. Addendum No. 1, issued on May 15, 2014. Available online at https://www.hillsborough.net/DocumentCenter/View/1086/Addendum-1_13-14-Chemical-Weed-Abatement?bidId=. Accessed August 17, 2018. 7 pp.

(GAO) Government Accountability Office. 2006. Endangered Species: Time and Costs Required to Recover Species Are Largely Unknown (Publication No. GAO-20548).

Weiss, S. B. 2006. Impacts of nitrogen deposition on California ecosystems and biodiversity. California Energy Commission, PIER Energy-Related Environmental Research. CEC-500-2005-165.

Wilson, B.L, R.E. Brainerd, and N. Otting. 2014. Identification and taxonomic status of *Cordylanthus tenuis* subsp. *pallescens* (Orobanchaceae). Madroño 61:64-76.

Wolf, S., B. Hartl, C. Carroll, M. C. Neel, and D. Greenwald. 2015. Beyond PVA: why recovery under the Endangered Species Act is more than population viability. BioScience 65:200-207.

*In Litteris*

Bainbridge, Elizabeth. 2018. Biologist, U.S. Fish and Wildlife Service. Notes from August 15, 2018, site visit to Bohemia Ecological Preserve with Gene Cooley (CDFW) and Erin Mullen (LandPaths).

Bjerke, Jeb. 2018a. California Department of Fish and Wildlife. Electronic mail correspondence to Elizabeth Bainbridge, Sacramento Fish and Wildlife Office, June 20, 2018. Subject: Pennell's bird's-beak.

_____, J. 2018b. California Department of Fish and Wildlife. Electronic mail correspondence to Elizabeth Bainbridge of the Sacramento Fish and Wildlife Office, July 16, 2018. Subject: Cannabis drying at Harrison Grade Ecological Reserve.

Cooley, Gene. 2018b. Biologist, California Department of Fish and Wildlife. Electronic mail correspondence to Elizabeth Bainbridge of the Sacramento Fish and Wildlife office dated July 14, 2018. Subject: things to think about on tomorrow's Pennell's bird's-beak field trip to better understand the bird's-beak habitat and status.

Foree, Sonya. 2018a. Biologist, Natural Resources and Lands Management Division, San Francisco Public Utilities Commission, San Francisco, California. Electronic mail message to Stephanie Prevost of the U.S. Fish and Wildlife Service dated July 19, 2018. Subject: San Mateo woolly sunflower.

_____. 2018b. Biologist, Natural Resources and Lands Management Division, San Francisco Public Utilities Commission, San Francisco, California. Electronic mail message attachment to Stephanie Prevost of the U.S. Fish and Wildlife Service dated August 23, 2018. Subject: Expert Knowledge Request for San Mateo woolly sunflower.

_____. 2018c. Biologist, Natural Resources and Lands Management Division, San Francisco Public Utilities Commission, San Francisco, California. Electronic mail message to Stephanie Prevost of the U.S. Fish and Wildlife Service dated August 24, 2018. Subject: Expert Knowledge Request for San Mateo woolly sunflower.

_____. 2018d. Biologist, Natural Resources and Lands Management Division, San Francisco Public Utilities Commission, San Francisco, California. Electronic mail message to Stephanie Prevost of the U.S. Fish and Wildlife Service dated September 20, 2018. Subject: Please review Personal Communication references for accuracy.

Huggins, Thomas. 2018. Collections Manager, University of California, Los Angeles Herbarium, Los Angeles, California. Electronic mail message to Stephanie Prevost of the U.S. Fish and Wildlife Service dated August 15, 2018. Subject: Specimen LA203607 *Eriophyllum latilobum*.

Mooring, John. 2018a. Professor Emeritus, Santa Clara University, Santa Clara, California. Electronic mail message to Stephanie Prevost of the U.S. Fish and Wildlife Service dated August 15, 2018. Subject: *Eriophyllum latilobum* [Expert Knowledge Request].

_____. 2018b. Professor Emeritus, Santa Clara University, Santa Clara, California. Electronic mail message to Stephanie Prevost of the U.S. Fish and Wildlife Service dated August 17, 2018. Subject: E-loan [Hesse specimen identity, JEPS28876].

_____. 2018c. Professor Emeritus, Santa Clara University, Santa Clara, California. Electronic mail message to Stephanie Prevost of the U.S. Fish and Wildlife Service dated August 23, 2018. Subject: *Eriophyllum latilobum*.

Mullen, Erin. 2018. LandPaths. Electronic mail correspondence to Elizabeth Bainbridge of the Sacramento Fish and Wildlife Office dated July 2018. Subject: Pennell's bird's-beak.

Naumovich, Lech. 2018. Executive Director, Golden Hour Restoration Institute, Berkeley, California. Electronic mail message to Stephanie Prevost of the U.S. Fish and Wildlife Service dated August 27, 2018. Subject: Expert Knowledge Request for Presidio clarkia.

Niederer, Christal. 2018a. Senior Biologist, Creekside Science, Menlo Park, California. Electronic mail message to Stephanie Prevost of the U.S. Fish and Wildlife Service dated July 6, 2018. Subject: Gophers as a threat to Presidio clarkia.

_____. 2018b. Senior Biologist, Creekside Science, Menlo Park, California. Electronic mail message to Stephanie Prevost of the U.S. Fish and Wildlife Service dated August 8, 2018. Subject: Expert Knowledge Request for San Mateo thornmint.

Stringer, Lewis. 2018. Associate Director of Natural Resources, Presidio Trust, San Francisco, California. Electronic mail message to Stephanie Prevost of the U.S. Fish and Wildlife Service dated August 27, 2018. Subject: Expert Knowledge Request for Presidio clarkia.

Strother, John and Bruce Baldwin. 2018. Electronic mail message from Kim Kersh of the University of California and Jepson Herbaria to Stephanie Prevost of the U.S. Fish and Wildlife Service dated August 14, 2018. Subject: *Eriophyllum* specimen.

Weiss, Stuart. 2018a. Chief Scientist, Creekside Science, Menlo Park, California. Electronic mail message to Stephanie Prevost of the U.S. Fish and Wildlife Service dated July 3, 2018. Subject: Gophers as a threat to Presidio clarkia.

_____. 2018b. Chief Scientist, Creekside Science, Menlo Park, California. Electronic mail message to Stephanie Prevost of the U.S. Fish and Wildlife Service dated September 4, 2018. Subject: Ephemeral thornmint populations.

Personal Communications

Bartosh, Heath. 2018. Senior Botanist and Rare Plant Specialist, Nomad Ecology, Martinez, California. Telephone conversation with Stephanie Prevost of the Sacramento Fish and Wildlife Office, July 18, 2018. Subject: San Mateo woolly sunflower.

Chassé, Michael. 2018. Natural Resource Management Specialist, Golden Gate National Recreation Area, National Park Service, San Francisco, California. Telephone conversation with Stephanie Prevost of the Sacramento Fish and Wildlife Office, July 18, 2018. Subject: Presidio clarkia.

Cooley, Gene. 2018. California Department of Fish and Wildlife. Conversation with Elizabeth Bainbridge of the Sacramento Fish and Wildlife Office, and Erin Mullen (LandPaths), August 15, 2018. Subject: Occurrences of Pennell's bird's-beak at Bohemia Ecological Preserve.

Corelli, Toni. 2007. California Native Plant Society, Santa Clara Valley Chapter. Telephone conversation with Betty Warne of the Sacramento Fish and Wildlife Office, September 7, 2007. Subject: Information on Marin dwarf flax, San Mateo woolly sunflower, white-rayed pentachaeta, fountain thistle, and San Mateo thornmint for Recovery Data Call.

Defreese, Denise. 2018. Wildland Vegetation Program Manager, East Bay Regional Park District, Oakland, California. Conversation with Stephanie Prevost of the Sacramento Fish and Wildlife Office, July 11, 2018. Subject: Presidio clarkia.

Foree, Sonya. 2018. Biologist, Natural Resources and Lands Management Division, San Francisco Public Utilities Commission, San Francisco, California. Conversation with Stephanie Prevost of the Sacramento Fish and Wildlife Office, June 28, 2018. Subject: San Mateo woolly sunflower.

Grefsrud, Marcia. 2018. Environmental Scientist, California Department of Fish and Wildlife, Bay Delta Region, Fairfield, California. Conversation with Stephanie Prevost of the Sacramento Fish and Wildlife Office, July 19, 2018. Subject: Presidio clarkia and Crestmont Drive development.

Kanz, Ralph. 2018. Conservationist and Oakland, California, resident. Conversation with Stephanie Prevost of the Sacramento Fish and Wildlife Office, August 1, 2018. Subject: Presidio clarkia Oakland sites.

Mooring, John. 2018. Professor Emeritus, Santa Clara University, Santa Clara, California. Telephone conversation with Stephanie Prevost of the Sacramento Fish and Wildlife Office, August 1, 2018. Subject: San Mateo woolly sunflower.

Mullen, Erin. 2018. LandPaths. Personal Conversation with Elizabeth Bainbridge of the Sacramento Fish and Wildlife Office, and Gene Cooley of the California Department of Fish and Wildlife, August 15, 2018. Subject: Occurrences of Pennell's bird's-beak at Bohemia Ecological Preserve.

Naumovich, Lech. 2018. Executive Director, Golden Hour Restoration Institute, Berkeley, California. Telephone conversation with Stephanie Prevost of the Sacramento Fish and Wildlife Office, July 13, 2018. Subject: Presidio clarkia.

Niederer, Christal. 2018. Senior Biologist, Creekside Science, Menlo Park, California. Conversation with Stephanie Prevost of the Sacramento Fish and Wildlife Office, June 28, 2018. Subject: San Mateo thornmint.

(SFPUC) San Francisco Public Utilities Commission. 2018. Scott Simono and Jessica Appel, Biologists, SPFUC. Site visit with and personal correspondence provided to Amber Aguilera, Sacramento Fish and Wildlife Office, on August 2, 2018. Subject: fountain thistle.

Stringer, Lewis. 2018. Associate Director of Natural Resources, Presidio Trust, San Francisco, California. Conversation with Stephanie Prevost of the Sacramento Fish and Wildlife Office, July 11, 2018. Subject: Presidio clarkia.

Swope, Sarah. 2018. Assistant Professor of Biology and Botanic Garden Director, Mills College, Oakland, California. Telephone conversation with Amber Aguilera of the Sacramento Fish and Wildlife Office, July 27, 2018. Subject: Status updates and overviews of biology and ecology for Tiburon mariposa lily and for Tiburon jewelflower.