Managed rare plant populations extant; introduction efforts somewhat successful; USFWS Recovery Criteria generally in progress or completed. Data gaps warrant moderate confidence in findings and fail to support trend analysis.

4.6 Rare Plants

4.6.1 Why Focal Resource Was Assessed

Description

The California Floristic Province, considered a global biodiversity hotspot, hosts more endemic plant taxa (2,125 taxa) and more identifiable subspecies than any comparable area in the continental United States (Mittermeier 1998, Calsbeek et al. 2003). The unique geological history and globally-rare Mediterranean climate have allowed for the diversification of a unique assemblage of plant species (Médail and Pierre Quézel 1999, Calsbeek et al. 2003). California, and the San Francisco Bay Area in particular, are also under major development pressure to support a growing population (Lewis and Neiman 2002). Habitat fragmentation, alteration, and loss are major contributors to the extinction of rare plant species (Matthies et al 2004). Collaboration between the California Native Plant Society, California Department of Fish and Wildlife, US Fish and Wildlife, and land managers, such as the National Park Service, has been essential to the protection and enhancement of existing rare plant species in California (Falk and Holsinger 1991). The conservation of public lands by the National Park Service, including the Golden Gate National Recreation Area (GOGA), allows for the protections and management ofs landscapes with associated rare flora.

Eight rare plant taxa found within GOGA-managed lands were selected for a review of status and distribution: Franciscan manzanita (*Arctostaphylos franciscana*), Presidio manzanita (*Arctostaphylos montana* ssp. *ravenii*), marsh sandwort (*Arenaria paludicola*), Tiburon paintbrush (*Castilleja affinis* ssp. *neglecta*), Presidio clarkia (*Clarkia franciscana*), Marin dwarf flax (*Hesperolinon congestum*), San Francisco lessingia (*Lessingia germanorum*), and Hickman's cinquefoil (*Potentilla hickmanii*). Additional rare plant taxa were selected for a more general geospatial analysis of habitat and distribution.

Critical questions

This chapter addresses the following questions regarding the status, trends, distribution, and potential habitat of the plant taxa identified as ‘of interest’ by GOGA.

1. What is the current status and distribution of threatened and endangered species of interest within GOGA?
2. What are significant stressors for threatened and endangered species of interest within GOGA?

3. Has climate influenced population trends for three federally listed annual plant species: Presidio clarkia (*Clarkia franciscana*), Marin dwarf flax (*Hesperolinon congestum*), or San Francisco lessingia (*Lessingia germanorum*)?
4. What areas within GOGA have high numbers of threatened, endangered and rare plant species of interest?
5. Where, within GOGA, is potential habitat for threatened and endangered plants?

Critical Questions 1, 2, and 3 are addressed in a literature review on a per-species basis in Section 4.6.3. Summary maps in Section 4.6.4 address Critical Questions 4 and 5.

4.6.2 How Focal Resource Was Assessed

Measures

The measures used to determine the condition of rare plant taxa of interest mirror the critical questions. A literature review addressed the current status, distribution, and stressors for each of the of the four plant taxa of interest. The following indicators and measures were created in collaboration with NPS staff to capture the condition of rare plant species of interest on PRNS lands.

Indicator of Condition	Specific Measure	Condition Categories	Confidence Categories
How many of the natural populations observed since GOGA management began are still extant?	Proportion of natural populations with > 0 individuals in 2012 and 2013. Populations not monitored in 2012, 2013, and 2014 will not be counted toward score.	Green: 66-100% natural populations with > 0 individuals in 2012 and 2013	High: All populations were monitored annually with consistent methodology since discovery
		Yellow: 33-66%	Medium: 50-99% populations monitored as above, or consistent monitoring plans have been adopted in recent years
		Red: 0-33%	Low: 0-50% populations monitored as above, or methods unknown
Have introduction efforts been successful?	Proportion of successful introductions into new sites. This does not include natural populations. Lack of introduction efforts is not counted toward score.	Green: 66-100% of introduced populations extant	High: All populations monitored annually with consistent methodology since discovery
		Yellow: 33-66%	Medium: 50-99% populations monitored as above, or consistent monitoring plans have been adopted in recent years
		Red: 0-33%	Low: 0-50% populations monitored as above or methods unknown

Have the USFWS Recovery Plan goals been fulfilled for populations within GOGA lands?	Proportion of interim and long-term goals realized, partially-met or in progress. Goals carried out by other entities will not be counted toward score.	Green: 66-100% of recovery criteria met, in progress or partially met	High: Score based on 2013 or more recent USFWS 5-year Report and 2013 or more recent NPS report to USFWS
		Yellow: 33-66%	Medium: Score based on 2012 or earlier USFWS 5-year Report and 2013 or more recent NPS report to USFWS
		Red: 0-33%	Low: USFWS 5-year Report and/or 2013 NPS report not available

Data Sources and Methods

Literature Review

Evaluation of the condition of special status plants began with development of the list of taxa of interest. This analysis is limited to taxa identified by GOGA as 'of interest', which includes Franciscan manzanita (*Arctostaphylos franciscana*), Presidio manzanita (*Arctostaphylos montana* ssp. *ravenii*), marsh sandwort (*Arenaria paludicola*), Tiburon paintbrush (*Castilleja affinis* ssp. *neglecta*), Presidio clarkia (*Clarkia franciscana*), Marin dwarf flax (*Hesperolinon congestum*), San Francisco lessingia (*Lessingia germanorum*), and Hickman's cinquefoil (*Potentilla hickmanii*). None of these plants were included in the GOGA Rare Plant Model Report (URS 2005). All of the plant species of interest meet at least one of the following criteria:

- Listed as endangered or threatened under the federal or California state Endangered Species Acts; and/or
- Listed by the California Native Plant Society (CNPS) as rare, threatened, or endangered in California and Elsewhere (Rank 1B).

CNPS designations and descriptions of general plant characteristics were obtained from the California Native Plant Society's Inventory of Rare and Endangered Plants (CNPS 2014). This inventory provides updated federal and state designations as well as CNPS ranking status.

Data Analysis of Climate Effects on Three Rare Plant Population Sizes

The effect of climate variables on long-term population estimates were analyzed for three rare annual plant species: Presidio clarkia (*Clarkia franciscana*), Marin dwarf flax (*Hesperolinon congestum*), and San Francisco lessingia (*Lessingia germanorum*). One population was analyzed for each of the three rare plant species of interest. In the case of Marin dwarf flax, two related populations were analyzed as one population with the sum of the two survey values. Each population was analyzed independently. Sampling methodology was consistent over survey dates for a given population (Chassée and Forrestel 2014). Climate data was taken from the National Oceanic and Atmospheric Administration's Global Historical Climatology Network

(NOAA 2015). Monthly summarized climate data from 1994 to 2014 were used from the San Francisco Downtown land-based weather station (located at 37.76667, -122.43333). Climate variables included monthly total precipitation, monthly mean maximum temperature, monthly mean minimum temperature, extreme minimum temperature per month, and extreme maximum temperature per month.

Population data for the Presidio clarkia and San Francisco lessingia fit within a normal distribution, as inspected in histograms and confirmed by applying a Shapiro-Wilks test for normality. Original Marin dwarf flax population values were non-normal due to a right skew; however, a square-root transformation normalized the values visually and were confirmed to be normal with the Shapiro-Wilks test. Five models were proposed based on potential biological significance. The number of parameters included in each model was limited by the limited sample size, particularly for Marin dwarf flax and San Francisco lessingia. The limited sample sizes reduced the degrees of freedom in the analysis of multiple parameters.

The four models were: 1) seasonal precipitation totals; 2) monthly spring mean minimum temperature; 3) monthly spring minimum temperature extreme; 4) monthly spring mean maximum temperature; and 5) monthly spring maximum temperature extreme. The seasonal precipitation totals model had four parameters: total spring precipitation (April, May, June); total summer precipitation (July, August, September); total fall precipitation (October, November, December); and total winter precipitation (January, February, March). The monthly spring temperature models include parameters from February, March, April, and May. The model with best fit to data was selected for each of the species by comparing the Akaike Information Criterion (AIC) values for each model. The parameters within the model with the lowest AIC value, and thus best model fit, was then tested for significance.

Distribution and Density Mapping

Data sources used to determine the spatial distribution of species of interest within GOGA was limited to NPS survey data. Rare plant survey protocols are described in Chassé and Forrestel 2014. Vegetation community data was created by URS in 2009 for the Fire Management Plan. The vegetation community data were used to characterize the habitat types for species of interest.

Rare plant density was calculated by summarizing abundance data (number of rare plants) and representing the density within a consistent area (hectare). The point density surface of number of individual species was calculated by buffering each species occurrence, summarizing by species, and identifying unique polygons. GIS metadata associated with final geospatial products contain a detailed methodology.

Reference Conditions/Values

Reference conditions for the rare plants described in the literature review portion of this chapter are based on historical distribution records, as summarized in the USFWS Recovery Plans, which are based on any verifiable documentation, including: botanical collections, the California Natural Diversity Database and notes taken by botanists at the time. Given that this assessment is largely based on USFWS documentation paired with NPS updated information, this historical distribution is the most widely accepted reference condition available. Many of the species were

Comment [1]: I think it would be good to also include annual precip (July of the previous year hrough June of the census year). This could replace one of he less meaningful parameters such as summer precip. I would also like to add a 5 h model that combines precip and spring temp. perhaps total precip + mar, april and may avg temp could be the parameters?

Comment [2]: This is some hing we will likely want to explore further. Can you please share your spreadsheets and R files for his analysis?

Comment [3]: Fire Plan was 2005. I think hey created some of their own veg. communities based on veg. map

Comment [4]: I'm not familiar with this dataset. The only veg community mapping I'm aware of is the parkwide veg map which was completed in 2001 using 1994 aerial imagery.

Comment [5]: URS only did mapping of new lands in San Mateo that weren't in the parkwide veg map.

not well documented historically and are thus difficult to compare to current distribution or potentially occupied habitat.

4.6.3 Status, Distribution, and Stressors for Species of Interest

4.6.3.1 Franciscan manzanita *(Arctostaphylos franciscana)* Condition Assessment

Franciscan manzanita (*Arctostaphylos franciscana*) is a perennial evergreen shrub found in maritime chaparral~~coastal scrub~~, mostly~~often~~ on serpentinite substrate. This California endemic shrub blooms from February to April and occurs at 60 to 300 m of elevation. This manzanita is currently listed as federally endangered and is also listed by the California Native Plant Society (CNPS) as Rare Plant Rank 1B.1, which is defined as 'seriously endangered in California'. This species was presumed extinct in the wild~~considered extirpated~~ since 1947 until rediscovered in 2009. Currently, there is only one known wild extant individual. ~~There are currently 4 known historic occurrences. Only one of the four occurrences is presently extant. The three other occurrences are~~is considered extirpated (CNPS 2014).

Comment [6]: All but one historic location occurred on serpentinite substrate. The substrate underlying the Mount Davidson occurrence may have been ei her serpentinite or greenstone.

Comment [7]: I found this confusing and redundant with the next section, so I deleted it.

Condition and Trend

The Franciscan Manzanita was known from three San Francisco locations prior to 1947: the former Masonic Cemetery, former Laurel Hill Cemetery (both in the Richmond district), and Mount Davidson (in south-central San Francisco). Additional unconfirmed historical sightings may have occurred near Laguna and Haight Streets (USFWS 2003; Chassé 2013). No naturally occurring individuals of Franciscan Manzanita had been reported between 1947 and 2009, although no systematic surveys were known during that period (Chasse and Forrestel 2014). In 2009, a single wild individual was found in a construction area near Doyle Drive, and was trans~~re~~planted outside of the construction footprint in 2010 (USFWS 2013). This plant is unique in that its current known population consists of one trans~~re~~planted genetic individual (with multiple clonal transplants) in GOGA property, and a few individuals raised in botanical gardens (USFWS 2013; Figure 4.6.3.1.1). The genetic individual from Doyle Drive was confirmed to be Franciscan manzanita by Vasey and Parker (2010), who also determined that the individual had been crossed with *A. uva-ursi* at some point in the genetic lineage. Sixty-eight clones from the wild individual were planted within proposed USFWS critical habitat in 2013 (Chasse and Forrestel 2014).

Comment [8]: The Franciscan manzanita was observed to occur at Masonic Cemetery by manzanita expert James Roof in the late 1930's but no confirmed voucher exists from that loca ion.

Work to conserve the Franciscan manzanita and its genetic makeup was outlined in the 2009 Conservation Plan (USFWS 2013). Actions to protect the manzanita include: transplanting the wild individual; distributing cuttings of the wild individual to various botanical nurseries; developing a seed germination protocol at Golden Gate National Parks Conservancy Nursery; conducting a pollinator study of the wild individual; and removing voles from the transplanted location (USFWS 2013).

Stressors

Franciscan manzanita is highly limited in its potential recover due to dramatic loss of maritime chaparral on serpentine or greenstone outcrops within the San Francisco peninsula (USFWS 2003). Urban development and habitat loss due to competition with non-native species are cited as the main factors cited by Chasse et al~~se and Forrestel~~ (2009~~ and 2011~~).

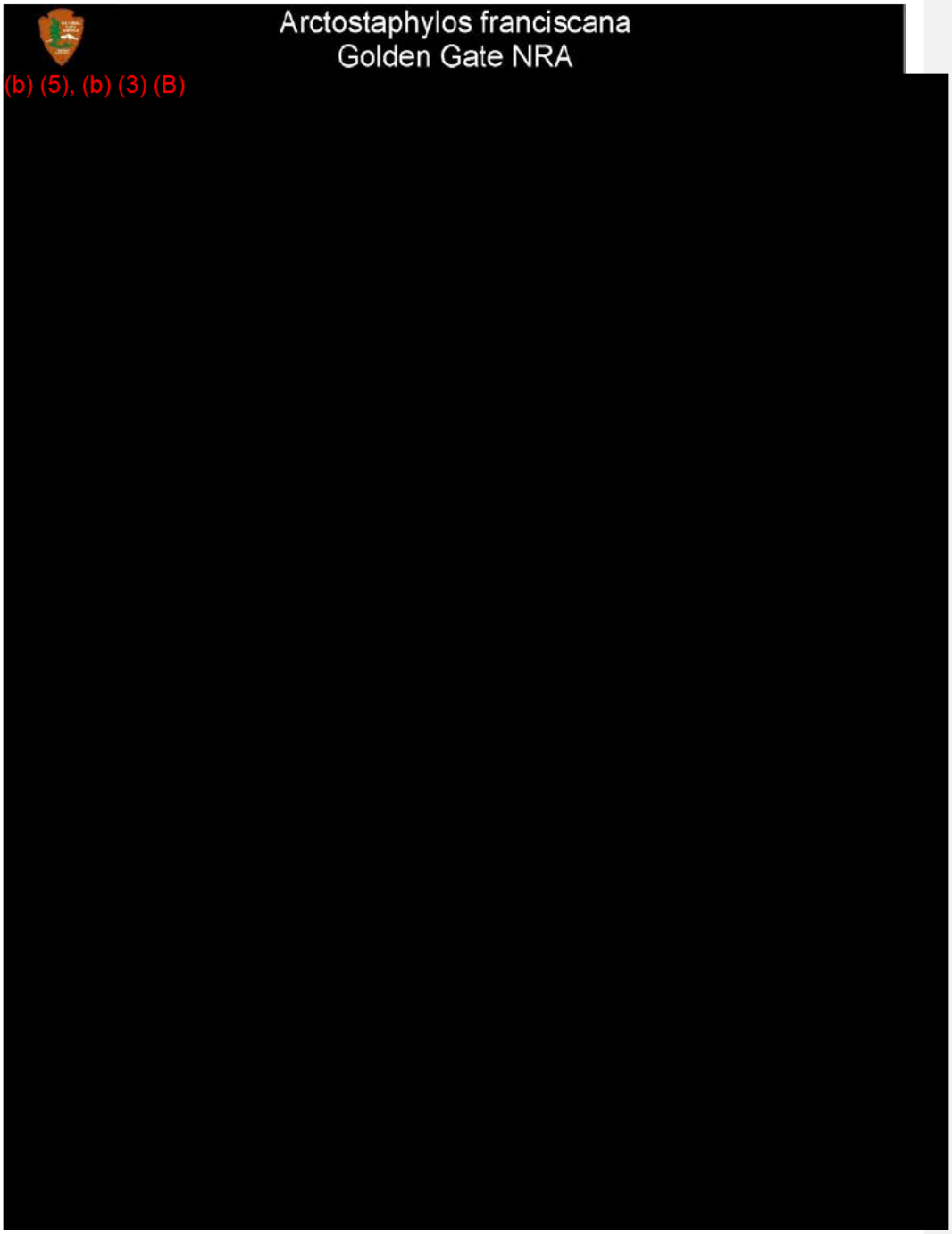
Pests and Pathogens

Potential threats to Franciscan manzanita include fungal pathogens. Twig blight, a fungal infection generally caused by *Botryosphaeria* species in *Arctostaphylos*, was observed on the wild plants during the winter of 2009-2010 but subsided during the summer months (USFWS 2013). Twig blight is of greater concern during wet years (USFWS 2003). Phytophthoera pathogens also impact *Arctostaphylos* species~~may also impact the plant, but have not yet been observed on the remaining wild individual (Chasse and Forrestel 2014)~~. *Phytophthora ramorum*, the pathogen that causes sudden oak death, is known to cause foliar blight in other Arctostaphylos species and has recently been identified as the cause of severe dieback and mortality of another rare Arctostaphylos, A. virgata.. *P. cinnamomi* is threatening *A. pallida* (pallid manzanita) in the East San Francisco Bay as well as A. myrtifolia (Ione manzanita) in the Sierra foothills and is of concern for Franciscan manzanita (USFWS 2013). All tests for this water-borne mold have returned as negative for the transplanted individual.

Voles and other small mammals have been attributed with branch dieback and browsing (Chasse et al 2011 and 2014). The native orange tortrix moth (*Argyrotaenia franciscana*), a leaf roller moth, severely infested the transreplanted individual, but is not known to cause mortality (USFWS 2013).

Arctostaphylos franciscana
Golden Gate NRA

(b) (5), (b) (3) (B)



Anthropogenic Disturbance

The proximity of GOGA and the Franciscan manzanita clones to dense urban development increases the risk of human damage, both intentionally and unintentionally. Nitrogen deposition from automobiles and industrial processes can create a favorable environment for competitive non-native species by altering the soil chemistry of remaining suitable serpentine habitat (USFWS 2013). Publicity surrounding the rediscovery of Franciscan manzanita may have generated public interest in collecting clippings of the planted individuals. Although the location of the individuals is not known, all GOGA lands are publicly accessible and adjacent to a large urban population. However, the transreplanted individual is within a larger restoration area protected by post and cable fencing from high use areas (USFWS 2013). Vandals have damaged various trees and shrubs on GOGA property; similar damage could incidentally include manzanita populations (Chasse and Forrestel 2014). Soil compaction from trampling by surveyors could reduce water infiltration, reduce soil oxygen levels and damage mycorrhizal fungi in seedling roots (Waltert et al. 2002).

Drought and ***Climate Change***

The managing partner, Presidio Trust, determined that water stress was the primary cause of significant branch dieback on the transplanted individual in 2013. The water stress was speculatively attributed to multiple combined factors, including recent reduced annual rainfall. The Trust natural resource staff conduct ongoing monitoring of soil moisture at the transplanted individual, where low soil moisture readings serve as a trigger for irrigation. Precipitation and temperature are expected to change with future climate change, which could exacerbate the current water stress issue. A U.S. Geological Survey study showed potential for "an increase in average maximum summer air temperatures at Golden Gate National Recreation Area… and a reduction statewide in fog frequency (Madej et al. 2010, p 24; Johnstone and Dawson, 2010, p. 4535)" (as cited in USFWS 2013). In addition to serpentine habitats, cool temperatures and summer fog are primary habitat requirements for Franciscan manzanita (USFWS 2013). The remaining suitable habitat for Franciscan manzanita is fragmented and limited by development and agency control (USFWS 2013). Various projected climate change scenarios could provide ideal conditions for fungal pathogens.

Comment [9]: Michael, can you add more detail here about what happened with the drought stress including ongoing monitoring and watering?

Genetic Bottleneck and Propagation Challenges

"Reduced genetic variation may result in the plant's offspring not being able to adapt to changes in habitat such as decrease in fog and increase in temperature or loss of pollinators" (USFWS 2013). As an obligate seeding plant, Franciscan manzanita may require specific pollinators for seed production. The single wild individual may also be sensitive to environmental changes or stochastic events (USFWS 2013). Multiple genotypes exist in multiple botanical gardens and may be used to increase the genetic variability of propagated (Gluesenkamp et al 2010). However, caution must be used to avoid contaminating the Franciscan manzanita gene pool with hybrid genotypes (USFWS 2013).

The alteration of fire interval in the general area of Franciscan manzanita may decrease the survival of the wild individual and planted seedlings (USFWS 2013). As an obligate seeding

species; A. franciscana requires fire to stimulate seed germination. In the highly urban environment of San Francisco, wildfire-induced germination is extremely unlikely. Laskowski et al. found that a pretreatment of a ratio of 1:50 smoke water in distilled water improved germination of a related *Arctostaphylos* species, which may be applied in Franciscan manzanita propagation (2014).

Level of confidence in assessment

The Final Designation of Critical Habitat for Franciscan Manzanita from 2013 undertook a comprehensive review of the status and threats to the species (USFWS 2013). Considerable planning, monitoring and management efforts toward the conservation of the Franciscan manzanita have been undertaken by the USFWS, Presidio Trust, GOGA, San Francisco State University, Golden Gate National Parks Conservancy, CDFW and the City and County of San Francisco. The frequent rate of monitoring and documentation regarding the current threat and trends of the wild individual and clonal population lead to a high level of confidence in determining the status of the Franciscan manzanita. All of the discussion in this report has been based on the comprehensive recent reviews completed by the USFWS and GOGA, as well as a few pertinent scientific research efforts.

Gaps in understanding

Due to the highly managed status of this species, it will be important to continue to monitor the clonal plantings, the mother plant, and any potential negative effects of those monitoring and management actions. Potential unanticipated effects of increased human visitation to the Franciscan manzanita populations could include: soil compaction, introduction of weeds or pathogens, and increased public visibility.

Propagation and establishment of new clonal populations has been initiated, but the methodology could be improved with further study. There is little current knowledge regarding the pollination requirements of Franciscan manzanita in terms of self-pollination, dependence on pollinators and presence of potential pollinators (USFWS 2013). Current research on the ideal conditions for Franciscan manzanita propagation are underway and will inform future propagation efforts.

Appropriate placement of new populations is challenged by the limited study of now extirpated wild populations. All known habitat characteristics are based on the highly disturbed original location of the one wild individual, and on herbarium data from 1889 to the 1940s (USFWS 2013). Future planting efforts will have to incorporate climate change predictions into locating successful new planting areas.

Condition Summary

Indicator of Condition	Specific Measure	Condition Status	Rationale
How many of the natural populations observed since GOGA management began are still extant?	Proportion of natural populations with > 0 individuals in 2012 and 2013. Populations not monitored in 2012, 2013, and 2014 will not be counted toward score.		Consistently monitored natural population consists of one extant mother plant.
Have introduction efforts been successful?	Proportion of successful introductions into new sites. This does not include natural		Of the 58 clones planted on the (b) (5), (b) (3) (B) in 2013, 47 (81%) were alive in October 2013. No genetic diversity is

	populations. Lack of introduction efforts is not counted toward score.		represented in the clonal populations.
Have the USFWS Recovery Plan goals been fulfilled for populations within GOGA lands?	Proportion of interim and long-term goals realized, partially-met or in progress. Goals carried out by other entities will not be counted toward score.		A Recovery Plan is under development but has not been published.

The entire known population of Franciscan manzanita consists of one wild individual receiving careful monitoring and maintenance~~.~~ ~~:~~ clonal plantings (81% survival rate in 2013)~~.~~ ~~:~~ and botanical garden specimens (Chasse and Forrestel 2014). Multi-agency coordination will be required to plant, monitor, and maintain new populations created from clonal cuttings ~~from the mother plant~~ until the populations are considered self-sustaining (USFWS 2013). The success of new clonal populations depends on identifying areas with required habitat elements, including climate, soil type, lack of pathogens, and presence of pollinators and soil mycorrhiza (USFWS 2013). In the absence of major management inputs, the extremely limited genetic diversity and lack of self-propagation of this species is likely to limit the success of the Franciscan manzanita in a future of climate change, urban pressures and competition from non-native and native plants.

Comment [10]: Michael, do you want to add some references to your thesis here or elsewhere? That should be referenced in this sec ion for sure.

4.6.3.2 Presidio Manzanita (*Arctostaphylos montana* ssp. *ravenii*) Condition Assessment

Presidio manzanita (*Arctostaphylos montana* ssp. *ravenii*), also known as Raven's manzanita, is a perennial evergreen shrub found in maritime~~coastal scrub,~~ chaparral~~,~~ and coastal prairie, often on serpentinite substrate. This California endemic shrub blooms from February to March and occurs at 45 to 215 m of elevation. This manzanita is currently listed as federally endangered and California endangered, and is also listed by the California Native Plant Society (CNPS) as Rare Plant Rank 1B.1, which is defined as 'seriously endangered in California'(CNPS 2014). This species is known from only one native occurrence at the Presidio in San Francisco, consisting of a cluster of plants that all belong to a single clone. There have been significant revisions to the taxonomy of this species and the related Franciscan manzanita (*Arctostaphylos franciscana*) since description (USFWS 2003).

Condition and Trend

The historical distribution of the Presidio manzanita is difficult to assess because the species was not recognized as a distinct taxon until recently, well after the extirpation of the original suspected occurrences. Now-extirpated locations that may have hosted Presidio manzanita are limited to the San Francisco peninsula, including: former Laurel Hill Cemetery, the former Masonic Cemetery, Mount Davidson, Mount Tamalpais, and the Protestant Orphan Asylum (Chassé 2013). These occurrences coincide with references to related species, and it is unknown how widespread the Presidio manzanita was historically (USFWS 2012a).

Comment [11]: At least one voucher from Laurel Hill Cemetery has been confirmed to have contained branches of both Franciscan and Raven's manzanita; so Laurel Hill is a confirmed site for both species. The voucher from Masonic is considered to be Raven's Manzanita; no confirmed vouchers exist for Franciscan Manzanita at Masonic but observa ions have been noted in the literature.

A single wild individual Presidio manzanita plant was rediscovered in 1952 and has been used for clonal propagation in surrounding habitat. Only one other location, (b) (5), (b) (3) had successful plant establishment after planting in 1987 (Figure 4.6.3.2.1). Both populations are

Comment [12]: Clonal plan ings (b) (5), Point did not persist. Plantings persisted at hree fragmented loca ions (b) (5) (b) (5), (b) (3) (B)

monitored annually for growth and branch dieback, although monitoring individuals is challenging due to intermingling of clonal plants (Chasse and Forrestel 2014). No natural seedling establishment has occurred since the individual was discovered (USFWS 2003).

Stressors

Plant interactions

Indirect effects from nearby trees can include altered wind patterns, decreased solar radiation and altered soil hydrology. These trees could be limiting the expansion of Presidio manzanita into potentially suitable habitat (USFWS 2012a). Branch dieback is attributed to in-growth and encroachment of associated native species, as well as the non-native species *Oxalis pes-caprae* (Bermuda buttercup) (Chasse and Forrestel 2014). Competitive plants may alter nutrient and water availability on the generally harsh serpentine soils (Parker and Frey 2010). Non-native species may also alter the symbiotic mycorrhizal community to benefit invasion into the Presidio manzanita habitat (Parker and Frey 2010). Leaves from the native plant, soap root (*Chlorogallum pomeridianum* var. *divaricatam*), shade the clonal plantings and cause leaf dieback (Parker and Frey 2010). Native plants, such as *Grindelia hirsutula* ssp. *maritima* (gumweed), *Baccharis pilularis* (coyote brush), and *Ceanothus thyrsiflorus* (blue blossom) are also encroaching on the clonal planting (Chasse et al 2014).

Anthropogenic Effects

Irrigation drift from nearby lawn may alter the natural soil moisture regime for mother and clonal plantings (Chasse and Forrestel 2014). No clipping or vandalism has been observed of the mother plant or clonal plantings as the plant's location has been kept from the public (USFWS 2012a). Other potential effects include accidental damage due to indirect or direct effects of road maintenance or vegetation management activities (USFWS 2003).

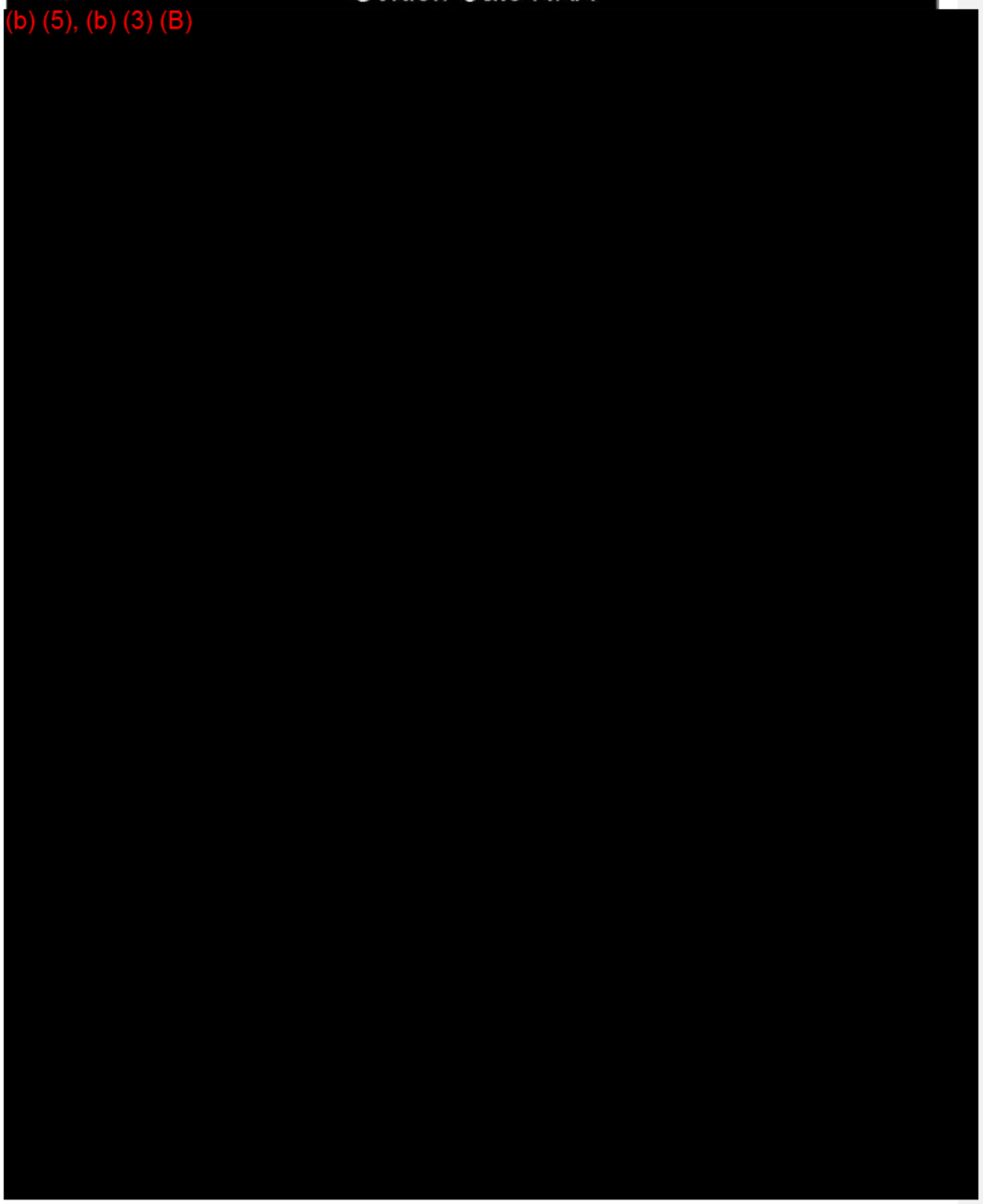
Pests and Pathogens

A significant infestation of tussock moth caterpillars (Lymantriidae family) partially defoliated multiple clonal plants in 1999. No subsequent infestations were as severe as the initial outbreak and none were observed in 2011 or noted in 2014 (USFWS 2012a). Leaf rollers infested the Presidio manzanita population in 2010, but have not been observed since (USFWS 2012a). Twig blight has also caused leaf dieback of the mother and daughter clones during years with frequent late rains (USFWS 2012a). *Phytophthora cinnamomi*, a soil borne water mold, has caused the decline of other rare *Arctostaphylos* species. If introduced to the mother or clonal plants, it would permanently contaminate soil and seedbank as well as cause the decline or death of adjacent individuals (USFWS 2012a).

Comment [13]: The phytophthora section should be consistent for both manzanita sec ions

Arctostaphylos montana ssp. ravenii
Golden Gate NRA

(b) (5), (b) (3) (B)



Wildlife Interactions

Native insect loss throughout San Francisco could limit the pollination of Presidio manzanita. However, studies of pollinator populations visiting the area of mother and clonal plants indicates that there has been an increase in overall pollinator visitation and diversity from 2004 to 2008 (Vanden Berg et al. 2010 and Wood et al. 2005). Gambel (2012) showed that *Bombus melanopygus* and *B. vosnesenskii* queens were the most frequent pollinators to both Presidio and Franciscan manzanita species, which could indicate species cross-pollination. Although Presidio manzanita can self-pollinate, this results in a decrease in genetic diversity in the following generations (Allendorf and Luikart, 2007).

Arctostaphylos fruits are primarily dispersed by mammals, and can be deposited in scat or harvested and stored by rodents (Parker 2010). Loss of native wildlife and small mammal eradication programs on adjacent properties could limit natural dispersal of Presidio manzanita fruit (USFWS 2012a).

Genetic Bottleneck and Small Population Size

The UC Berkeley Botanic Garden and Presidio Native Plant Nursery have unsuccessfully attempted propagating Presidio manzanita seeds from self-pollinated fruits. "Clonal plantings of Franciscan manzanita have been planted within pollinator distance of Presidio manzanita clones to provide the possibility of gene flow between the two taxa" (Chasse and Forrestel 2014). Other clonal populations are known from botanical gardens and at least one commercial nursery. This lack of genetic variability may limit the species ability to adapt to climate change or other environmental changes. The limited distribution and size of Presidio manzanita populations also increases the species' vulnerability to stochastic events, such as fire, storm, drought, or other perturbations (USFWS 2012a).

Climate Change

Precipitation and temperature are expected to change with future climate change, which could exacerbate current water stress. Drought conditions, increased winter flooding, or loss of summer fog could adversely affect the existing population and/or render currently suitable habitat unsuitable for Presidio manzanita (USFWS 2013).

Level of confidence in assessment

The condition and trend of the Presidio manzanita summarized in this report have been based primarily on conclusions found in the most recent GOGA monitoring report (Chasse and Forrestel 2014) and USFWS 5-year Review (USFWS 2012a). USFWS reports are comprehensive reviews of the species and supersede conclusion made in this document. Additional reports were incorporated as needed to fully depict the status of Presidio manzanita. Any discoveries of independent wild populations of Presidio manzanita could greatly improve and/or alter the conclusions made in this report, as all information is gleaned from historical botanical literature, and observations of the one wild plant and clonal propagates.

Gaps in understanding

The wild individual plant has set seed but no natural successful seedling generation has been observed since its discovery in 1952 (USFWS 2012a). Parker and Frey conclude that the Presidio manzanita is an obligate seeder that requires fire or disturbance to germinate seeds (2010). The urban environment and limited number of unique genetic individuals restricts experimental studies involving fires, but further research in fire surrogates may increase the seeding potential of this species.

Further pollination studies could examine the timeline of flower pollination in relation to climate variables, the level of direct and indirect pollination by invertebrates, and the pollinator relationship between Presidio and Franciscan manzanita species (Gambel 2012).

Genetic analyses have explored the relationship of this species to related *Arctostaphylos* species (Parker and Frey 2010, Boykin et al. 2005, Wahlert et al. 2009). Further research into the genetic makeup of Presidio manzanita could inform potential cross-pollination with botanical garden genotypes to increase the genetic diversity of future generations. Studies of fruit set, seed viability, and self-pollination viability of related *Arctostaphylos* taxa are recommended by the interim recovery guidelines in the 5-year Review (USFWS 2012a).

Condition Summary

Indicator of Condition	Specific Measure	Condition Status	Rationale
How many of the natural populations observed since GOGA management began are still extant?	Proportion of extant natural populations with > 0 individuals in 2012 and 2013.		Only one well-monitored natural individual plant exists.
Have introduction efforts been successful?	Proportion of successful introductions into new sites.		One planting effort had 17 successful clones near the 'mother' plant at (b) (5), (b) (b) (5), Two planting efforts failed at (b) (5), (b) and Inspiration Point in 1987 and 1988. Clonal plantings have not been attempted at other Presidio sites. Monitoring protocol unknown for failed introductions.
Have the USFWS Recovery Plan goals been fulfilled for populations within GOGA lands?	Proportion of interim and long-term goals realized or in progress. Goals carried out by other entities will not be counted toward score.		According to the 5 year review (USFWS 2012a), three of seven interim goals have been partially met or were in progress (habitat and population stabilization, establishing daughter clones, and population and clone size increases). Three were met, at least partially, by other entities (plant propagation, populations outside Presidio, and taxonomy and reproduction studies). One has not been met (sexually reproduction population). Of long-term criteria, two have

			not been met (spontaneous reproduction of Presidio population, establishment of new populations) and one is coordinated by another entity (permanent cultivated plants).

The Presidio manzanita is limited to a single clonal population in the San Francisco Presidio, established from one wild individual rediscovered in 1952. Extirpated occurrences were observed historically from other locations on the San Francisco peninsula (USFWS 2012a). According to the most recent USFWS 5-year Review (2012a), full recovery of Presidio manzanita is not expected and may not be possible in the foreseeable future. Interim and long-term recovery criteria include establishment of new clonal and sexual populations, and increases in existing populations of Presidio manzanita in the Presidio and elsewhere. Although the National Park Service and Presidio Trust have exhibited considerable effort in managing the existing and new populations of Presidio manzanita, the species remains endangered due to its limited population size, lack of genetic variation, competition from native and non-native plants, lack of successful reproduction, and vulnerability to potential climate impacts (USFWS 2012a).

4.6.3.3 Marsh sandwort (*Arenaria paludicola*) Condition Assessment

Marsh sandwort (*Arenaria paludicola*) is a perennial stoloniferous herb in the Caryophyllaceae (pink) family. It is found in marshes and swamps (freshwater or brackish), often on sandy openings. This herb, found in California and Washington, blooms from May to August and occurs at 3 to 170 m of elevation. This sandwort is currently listed as federally endangered and California endangered, and is also listed by the California Native Plant Society (CNPS) as Rare Plant Rank 1B.1, which is defined as 'seriously endangered in California'. This species was known from only two natural occurrences in San Luis Obispo. There are currently 15 known occurrences. Only two of the fifteen occurrences are presently extant. Ten of the other occurrences were recorded over 20 years ago, and have been classified as extirpated by the CNPS (CNPS 2014).

Condition and Trend

The historical range of marsh sandwort included coastal areas extending ~~A small number of h~~Historical ~~botanical collections of~~ly, ~~marsh sandwort were taken~~was ~~infrequently collected~~ from coastal southern and central California to~~and~~ Washington (USFWS 1998). In California, historical populations are known from five areas: in the vicinity of (b) (5), (b) (5), (b) (3) in the Presidio of San Francisco, Scotts Valley in Santa Cruz, Guadalupe-Nipomo Dunes in San Luis Obispo County, the Los Angeles basin, and along the Santa Ana River in the vicinity of San Bernardino. Of these, the Presidio (b) (5), (b) (3) location overlaps with current GOGA lands. The sandwort was last observed in 1899 in what was referred to as the "Presidio Swamp" (Brandegee 1892), but was extirpated by the filling of marsh lands along the Presidio's northern shore ~~and the creation~~expansion (b) (5), (b) (3) (USFWS 1998). In 2011, this species was introduced to the Marin Headlands through the joint efforts of ~~Population establishment efforts in the Marin Headlands were initiated by~~ ~~UC Santa Cruz and~~ the US Fish and Wildlife Service, UC Santa Cruz and GOGA ~~in 2011~~ (Chasse and Forrestel 2014; Figure 4.6.3.3.1). Planted individuals are monitored for size and health of the plants, which have grown together (Chasse and Forrestel 2014). Initial survivorship ranged from 25 to 65% depending on site location, site preparation

Comment [14]: Michael, does this sound right? Wasn't there a (b) (5), specimen?

and plant propagation (Parker 2012 in Chasse and Forrestel 2014). The most recent documented survival rates from March 2013, were 39% and 64% at the two planted sites in the Marin Headlands (Chasse and Forrestel 2014).

Stressors

Anthropogenic Influence

Other populations that occur outside of protected lands are more vulnerable to habitat loss and development threats, including indirect effects such as degradation or alteration of water chemistry or quality. The GOGA populations are protected from development and other similar pressures. ~~There is a greatly diminished possibility that these planted populations and their respective watersheds could be degraded or altered. The planting area and surrounding watersheds are protected, but also occur near popular public access points.~~ Although the planted populations are not immediately accessible, trampling by humans or pets could be a threat if the populations expand (Chasse and Forrestel 2014).

Plant and Wildlife Interactions

Competition with native coastal plants and non-native grasses for water, nutrients, light, and space could limit the viability of the marsh sandwort (USFWS 1998). At one of the two main GOGA populations, both native (Vicia gigantea) and non-native (Delairea odorata) are outcompeting marsh sandwort and require active management to protect the sandwort. Without active management, this population will likely be extirpated. Herbivory of flowers could reduce the potential for the population to expand (USFWS 2008). All plant interactions may not be negative: Bontrager et al. discovered that the relationship of marsh sandwort to neighboring plants of other species is dependent on microhabitat variability (Bontrager et al. 2014).

Physical Factors

Natural or human-enhanced sedimentation into wetland habitat could alter the water table regime and degrade habitat for marsh sandwort (USFWS 1998). Marsh sandwort individuals were able to withstand varying salinity levels in a greenhouse setting (Bontrager et al 2014), this may improve the species resilience to changing water chemistry.

Reduced Gene Pool and Population Size

Small populations can have significantly lower germination rates than larger populations of the same species due to high levels of homozygosity, where the offspring receives two copies of the same gene from both parents (Menges 1991). The two wild populations, Oso Flaco and Black Lake Canyon, were found to be genetically distinct, with further genetic segregation between potentially clonal groups in Oso Flaco Lake (Mazer et al. 2000). This level of genetic divergence may call for maintaining distinct clonal lineages in future recovery efforts (USFWS 2008). Unpredicted random events that damage one or more of these populations is more significant due to the small size and isolation of the reintroduced populations (USFWS 1998).

Comment [15]: Do any of the remaining populations occur outside of protected lands? There are just a few wild individuals left and I would imagine they are on protected lands.

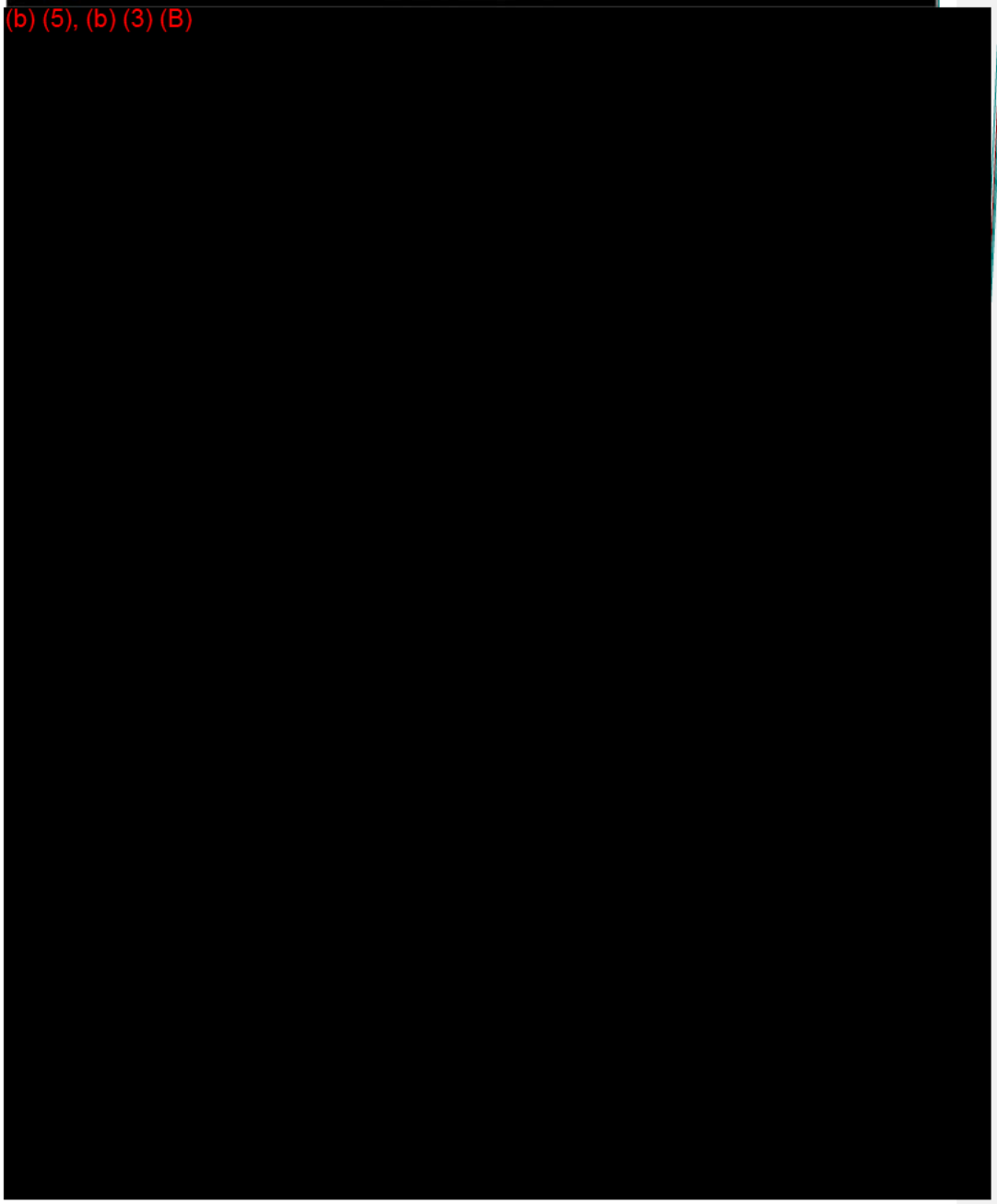
Comment [16]: this is important and should also be noted in the conclusion

Comment [17]: It would be good to add information about pollinators here -- are they potentially limiting for this species????

Comment [18]: Not clear what this is referring to. Add more info.

Arenaria paludicola
Golden Gate NRA

(b) (5), (b) (3) (B)



Comment [19]: This map is incomplete; the largest and healthiest reintroduced population is missing.

Comment [20]: _Marked as resolved_

Comment [21]: _Re-opened_

Comment [22]: Michael - I think they need to recreate this map - not sure what you mean when you say this is resolved...

Climate Change

Changing climate conditions could render the chosen reintroduction sites unsuitable to future marsh sandwort populations. Drought, in combination with groundwater pumping and aquifer recharging with pesticide and fertilizer, altered the water table in natural habitat of marsh sandwort (USFWS 1998). Although the human influence is reduced in GOGA property, water tables could diminish in climate scenarios with frequent drought. The limited gene pool from the natural population could reduce the species' viability in a changing climate (USFWS 2008).

Level of confidence in assessment

The condition and trend of the marsh sandwort summarized in this report have been based primarily on conclusions found in the most recent GOGA monitoring report (Chasse and Forrestel 2014), USFWS 5-year Review (USFWS 2008), and the USFWS Recovery Plan (USFWS 1998). The USFWS reports are comprehensive reviews of the species and supersede conclusions made in this document. The 2011 population planted within GOGA lands was not described in the 2008 5-year Review or the 1998 Recovery Plan. However, the USFWS is due to produce another 5-year Review for the species that will contain up to date information regarding the status and trend of marsh sandwort in all wild and introduced populations. Additional reports and studies were incorporated as needed to fully depict the status of marsh sandwort.

Gaps in understanding

General declines in wild population numbers in Oso Flaco Lake and Black Lake Canyon are not fully understood. Anthropogenic biostimulation and alteration of hydrologic regimes may have played an important role in making previously suitable habitat unsuitable (USFWS 2008). The failure of these populations to maintain self-sustaining populations would inform management of planted populations.

Historic occurrences identified in herbaria specimens contain limited information on habitat requirements of marsh sandwort when collected (USFWS 2008). Studies of the genetic variation of marsh sandwort across its known range would inform the recovery strategy for the species (USFWS 2008). The Recovery Plan recommends non-destructive research into the following areas: genetic intra- and inter-population relationships; the tolerance of the species to withstand the effects of human, physical, or biological variables on survivorship of the species; and main factors in population growth (USFWS 1998).

Condition Summary

Indicator of Condition	Specific Measure	Condition Status	Rationale
How many of the natural populations observed since GOGA management began are still extant?	Proportion of natural populations with > 0 individuals in 2012 and 2013. Populations not monitored in 2012, 2013, and 2014 will not be counted toward score.		The populations within GOGA lands were introduced. There are no known natural population within GOGA lands.

Have introduction efforts been successful?	Proportion of successful introductions into new sites. This does not include natural populations. Lack of introduction efforts is not counted toward score.		710 individuals were introduced to 2 sites and 4 microsites in 2011. The two main sites had a survivorship rate of 39% and 64%. Monitoring was adapted to accommodate growth of population.
Have the USFWS Recovery Plan goals been fulfilled for populations within GOGA lands?	Proportion of interim and long-term goals realized		GOGA manages a successful introduction of marsh sandwort, as recommended by the USFWS. Four of 6 recommendations are fulfilled or in process (protect and enhance habitat, monitor population and habitat, establish new populations, evaluate progress), and two are partially fulfilled or conducted by other parties (conduct research, augment existing populations).

The most recent USFWS 5-year Review of marsh sandwort concluded that the species had a low potential of recovery due to lack of understanding of threats and limiting factors, necessity of intensive management and unknown probability of the species success (USFWS 2008). Establishing new populations in the historic range of marsh sandwort was recommended in the recovery actions of the 5-year Review and the preliminary downlisting criteria in the Recovery Plan (USFWS 2008 and 1998). The two populations planted within the Marin Headlands in 2011 have not been evaluated by any published USFWS review. Initial monitoring indicates that after initial loss of individuals observed in 2012 (25-35% at Miwok site and 45-65% at Rodeo site), 2013 monitoring showed an increase over the previous year: 39 and 64%, respectively (Chasse and Forrestel 2014).

4.6.3.4 Tiburon paintbrush (*Castilleja affinis* ssp. *neglecta*) Condition Assessment

Tiburon paintbrush (*Castilleja affinis* ssp. *neglecta*) is a hemiparasitic perennial herb found associated with various host plants on north to west facing slopes in serpentine bunchgrass and valley and foothill grassland (USFWS 1998, CNPS 2014, USFWS 2012b). GOGA staff have only found Tiburon Indian paintbrush populations in patches of Nicasio ceanothus (*Ceanothus decornutus;* Chasse and Forrestel 2014). This California endemic herb blooms from April to June and occurs at 60 to 400 m of elevation. It is currently listed as federally endangered and California threatened, and is also listed by the California Native Plant Society (CNPS) as Rare Plant Rank 1B.2, which is defined as 'fairly endangered in California'. There are currently a total of 9 known occurrences. Seven of the nine occurrences are presently extant. The two other occurrences were recorded over 20 years ago, and are considered extirpated (CNPS 2014).

Comment [23]: Please note where hese are

Condition and Trend

The Tiburon paintbrush is limited to Marin, Napa and Santa Clara counties (USFWS 2012b). The Nicasio Ridge population occurs on GOGA land (managed by Point Reyes National Seashore) and on the adjacent private property, which includes the majority of individuals. (Chasse and Forrestel 2014; Figure 4.6.3.4.1). All populations noted in the USFWS 5-year Review have shown high fluctuations in numbers of individuals (USFWS 2012b). However, the results from the Nicasio Ridge population monitoring have shown overall consistent gains in individuals since monitoring began in 2003 (Chasse and Forrestel 2014). Two additional outlier patches near the main Nicasio Ridge population were recorded in 2012: Outlier Patch 1 showed a decrease the second monitoring year, while Outlier Patch 2 showed an increase (Chasse and Forrestel 2014). Historically, the paintbrush was noted in five places in Marin County (three on the Tiburon Peninsula), one in Napa County near American Canyon, and one in Santa Clara County (USFWS 2012b). An additional occurrence was noted at Stinson Beach in Marin county, but this was last observed in 1965 (USFWS 2012b).

Comment [24]: This should be moved to he previous paragraph

Stressors

Anthropogenic influence

Tiburon paintbrush individuals within GOGA are not subject to development pressures present in other occurrence areas (USFWS 1998). However, incidental foot traffic or pet activity could pose a threat to the GOGA individuals (Hunter 1989). The proximity to developed areas increases the likelihood of fire or vandalism of plants (USFWS 2012b).

Plant Interactions

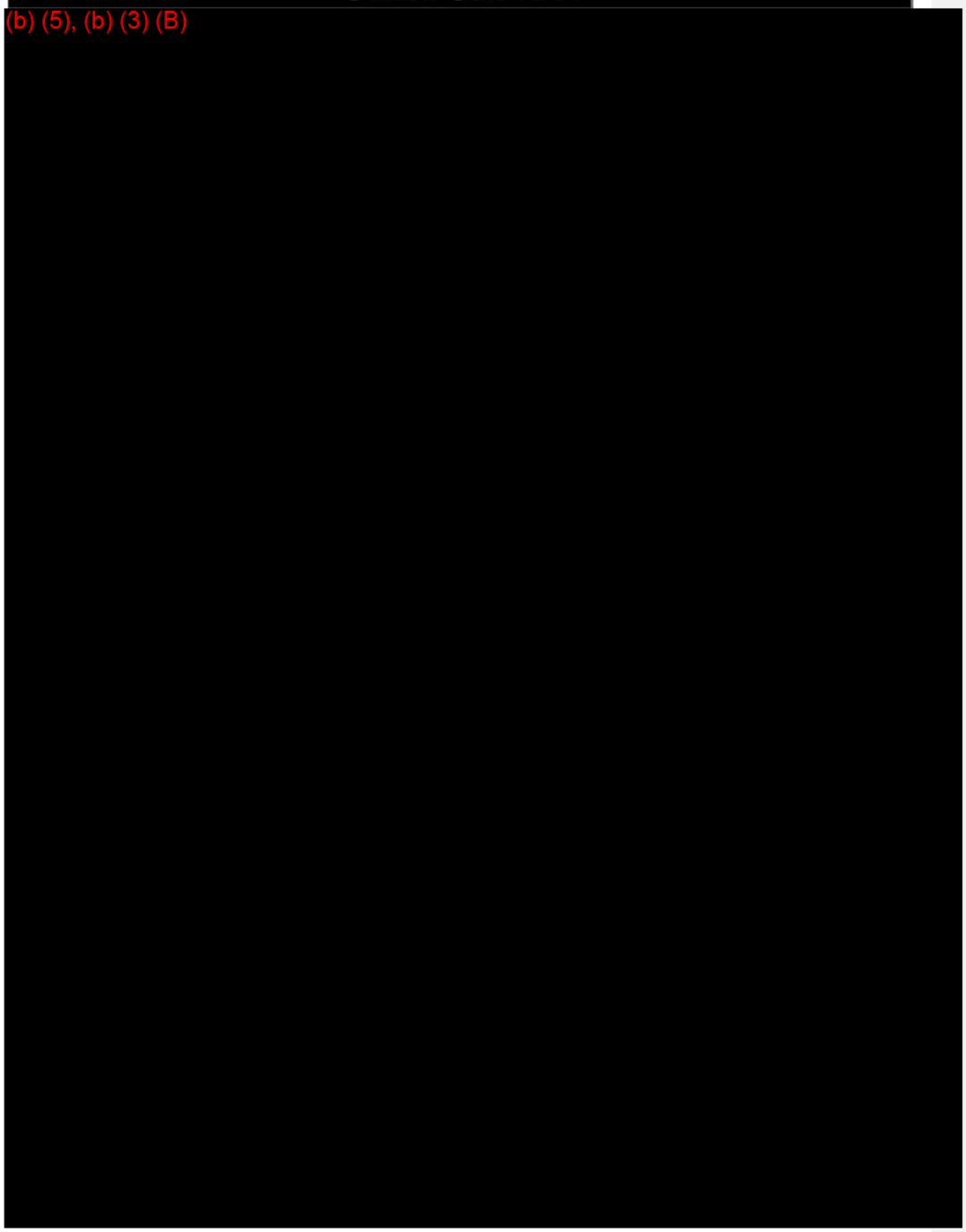
Invasion of non-native species into naturally nutrient-poor serpentine habitats may be facilitated by nitrogen deposition from vehicular traffic and industrial output prevalent in the Bay Area (Weiss 1999). Invasion by non-natives, such as distaff thistle (*Carthamus* sp.) and tocalote (*Centaurea melitensis*), could threaten Tiburon paintbrush populations (Chasse and Forrestel 2014). Point Reyes National Seashore has been working to remove tocolote near the Nicasio Ridge occurrence (USFWS 2012b).

Animal Interactions

Herbivory by native small and large mammals of Tiburon paintbrush plants could pose a threat to individuals (USFWS 2012b). Feral pig (*Sus scrofa*) rooting was considered a threat to Santa Clara occurrence (County of Santa Clara et al. 2010). Cattle grazing is considered instrumental in reducing non-native grass species in Santa Clara County (County of Santa Clara et al. 2010). Grazing effects have not been evaluated for the Nicasio Ridge population. GOGA staff anecdotally note that paintbrush populations may be limited to chaparral areas due to grazing pressures in grasslands (Chasse and Forrestel 2014).

Castilleja affinis ssp. neglecta
Golden Gate NRA

(b) (5), (b) (3) (B)



Climate Change

Due to its limited distribution and dependence on serpentine habitats, Tiburon paintbrush populations may be limited in naturally relocating to more suitable habitats in an era of climate change. Furthermore, the lack of genetic diversity due to small populations also decreases the populations' survival in changing climatic conditions (USFWS 2012b).

Level of confidence in assessment

The condition and trend of the Tiburon paintbrush summarized in this report have been based primarily on conclusions found in the most recent GOGA monitoring report (Chasse and Forrestel 2014), USFWS 5-year Review (USFWS 2012b), and the USFWS Recovery Plan for Serpentine Soil Species of the San Francisco Bay Area (USFWS 1998). The USFWS reports are comprehensive reviews of the species and supersede conclusions made in this document. Additional reports and studies were incorporated as needed to fully depict the status of Tiburon paintbrush.

Gaps in understanding

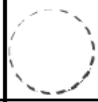
The USFWS 5-year Review noted a second occurrence of 50 individuals was surveyed once in 1991 within GOGA, but this occurrence was not described in the GOGA Rare Plant Report (USFWS 2012b, Chasse and Forrestel 2014).

The role of grazing is not fully understood or quantified. Experimental manipulation of grazing, fire, and propagation were identified in the recovery strategies of the Rare Plant Report (Chasse and Forrestel 2014) with an unknown status. The 1998 USFWS Recovery Plan suggested the use of burn boxes as a way to integrate small-scale burning onto the landscape, with reduced risk of unintended adverse effects to the population. If the adjacent land owner is willing, GOGA could take advantage of the opportunity for natural studies examining the distribution of paintbrush individuals within the two properties of different land management strategies.

The Recovery Plan also recommends demography, genetic, pollination, and taxonomic studies of Tiburon paintbrush (USFWS 1998). A 1968 study of *Castilleja* chromosome numbers and polyploidy conducted by Heckard (as cited in USFWS 2012b) found that inbreeding was possible between species with various ploidy levels. No additional studies, genetic or otherwise, had been conducted specific to Tiburon paintbrush by the 5-year Review (USFWS 2012b).

Condition Summary

Indicator of Condition	Specific Measure	Condition Status	Rationale
How many of the natural populations observed since GOGA	Proportion of natural populations with > 0 individuals in 2012 and 2013.		GOGA annual monitoring of the population has been consistent since first monitored in 2003 (Chasse and Forrestel 2014). Two outlier patches have been observed since

management began are still extant?			2012 and show fluctuations in populations size.
Are introduction efforts successful?	Proportion of successful expansions and/or introductions into new sites		No planted populations have been attempted at GOGA
Have the USFWS Recovery Plan goals been fulfilled for populations within GOGA lands?	Proportion of interim and long-term goals realized, partially-met or in progress. Goals carried out by other entities will not be counted toward score.		Of the four recovery criteria reviewed in the USFWS 5 year status report, two are completed or in progress for the GOGA population (habitat secure, 20 year monitoring) one has not been met (management plan creation), and one is coordinated by other entities (seed storage). Downlisting criteria are not calculated for this indicator as all downlisting criteria overlap recovery goals.

The GOGA Tiburon paintbrush population has increased steadily and substantially since monitoring efforts noted in 2003. Initial population numbers were limited to 4 individuals in 2003 and 2004, but have since reached over 140 individuals in 2013. The 2012 and 2013 numbers include two additional outlier patches in the vicinity of the original main patch (Chasse and Forrestel 2014). However, these numbers are far below the 2,000 individuals per recovering population recommended in the Recovery Plan (USFWS 1998). This population is protected and annually monitored by NPS staff. Carefully-applied research could target the benefits or drawbacks of management-related disturbance agents such as grazing and fire, as well as demographic, taxonomic and pollinator studies (USFWS 2012b).

4.6.3.5 Presidio clarkia (*Clarkia franciscana*) Condition Assessment

Presidio clarkia (*Clarkia franciscana*) is an annual herb found in coastal shrub and grasslands in valleys and on foothills, often on serpentinite substrate. This California endemic herb blooms from May to July and occurs at 25 to 335 m of elevation. It is currently listed as federally endangered and California endangered, and is also listed by the California Native Plant Society (CNPS) as Rare Plant Rank 1B.1, which is defined as 'seriously endangered in California'. This species is currently known from a total of 4 occurrences. Only three of the four occurrences are presently extant. The other occurrence was recorded over 20 years ago, and has been classified as extirpated by the CNPS (CNPS 2014).

Comment [25]: Where are the 3 known occurrences?

Condition and Trend

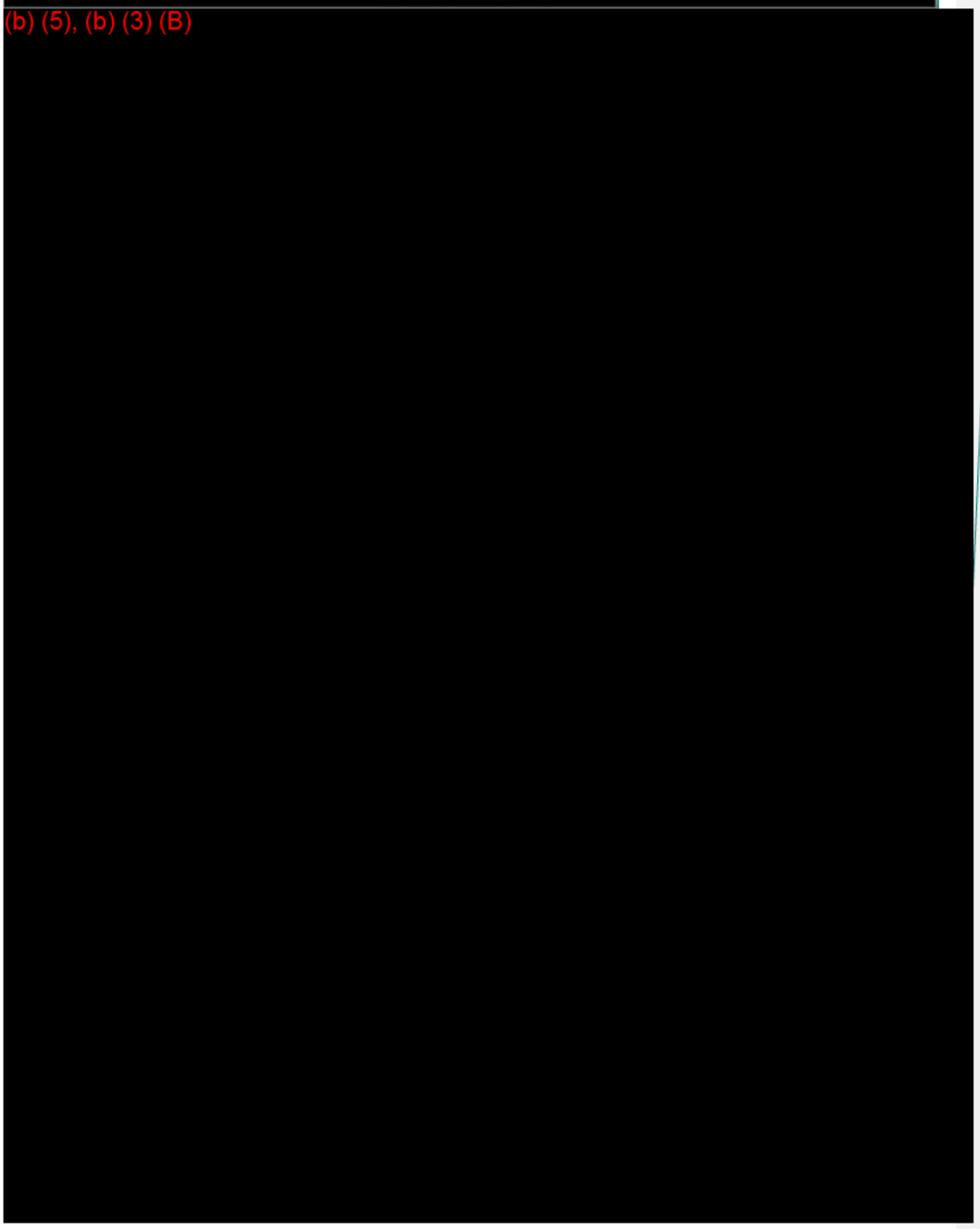
Historically, the Presidio population, discovered in 1958, was the only known population of Presidio clarkia (USFWS 2012). This population includes the occurrences at (b) (5), (b) (3) and the (b) (5), (b) (3) (B) (Figure 4.6.3.5.1). Another population was discovered in the Oakland Hills at Redwood Regional Park in 1980 (USFWS 2010). One natural occurrence within GOGA property occurs on (b) (5), (b) (3) (B) . Three introduced populations include the (b) (5), (b) (3) (B) (b) (5), (2011; Chasse and Forrestel 2014). Seeding efforts at a (b) (5), (b) (5), (b) site in (b) (3)

2008 that showed approximately a 33% success rate in 2009 (USFWS 2010). The 2008 and 2011 seeding

Comment [26]: Difficult to follow. Please rephrase.

Clarkia franciscana
Golden Gate NRA

(b) (5), (b) (3) (B)



Comment [27]: Michael can you confirm that he maps throughout show only extant occurrences; not extinct occurrences or failed reintroductions?

efforts are both described as the (b) (5), (b) (3) (B) location.

The 2013 (b) (5), (b) (3) (B) population was estimated to include between~~greater than~~ 39,448 to 52,752 individuals~~, as estimated in a macroplot that includes a portion of the population~~ (Chasse and Forrestel 2014). The (b) (5), (b) (3) (B) site consisted of approximately 48 individuals in 2013; and the (b) (5), (b) (3) (B) population was not surveyed in 2013 (Chasse and Forrestel 2014). Major variation in population size has been observed in both the (b) (5), (b) (3) (approximately 1,000 to 110,000 individuals between 2005-2013) and (b) (5), (b) (3) (approximately 4 to 973 individuals between 1998-2013) sites. In the (b) (5), (b) (3) population, the lowest number of individuals occurred in 2008 (approximately 10,000) and 2012 (20,000); in the (b) (5), (b) population, lowest numbers were in 2008 (4), 2009 (29) and 2013 (48). These low abundance years generally co-occur with drought or recovery from drought years (USFWS 2010).

Population estimates of the (b) (5), (b) (3) population were analyzed for relationship to specific climate factors for this report. Of five models tested, the model with the best fit and lowest AIC value was the Spring Mean Minimum Temperature model. The parameters within this model were tested for significance (see Table 4.6.3.5.1 below). Of all the parameters, the effect of March Mean Minimum Temperature (MMNT) on the Presdio clarkia (b) (5), (b) (3) population size was nearly statistically significant (p-value = 0.0985). The positive effect that the March MMNT has on population values indicates that warmer March temperatures may predict or facilitate larger clarkia population sizes. Presidio clarkia generally would be at a vegetative or early blooming development stage in March (CNPS 2014). Colder mean March temperatures could be indicative of frost damage to developing clarkia, which would reduce overall individuals observed in peak spring surveys.

However, the dataset is spatially limited to one site, which limits any potential interpretation of data to the (b) (5), (b) (3) population. A future study incorporating population data from other sites with different climate variables would bolster the findings of this analysis. This study also did not test all potential climate factors or combinations in order to avoid multiple testing, which would negate the significance of any findings.

Table 4.6.3.5.1. Summary Statistics of Spring Mean Minimum Temperature for Presidio Clarkia

Coefficients	Estimate	Std. Error	t value	Pr(>|t|)
Intercept	-153636.9	197364.7	-0.778	0.4798
February MMNT*	-496.2	1479	-0.336	0.7541
March MMNT	2863.5	1334.7	2.145	0.0985
April MMNT	3111.5	2258.9	1.377	0.2404
May MMNT	-2892	2148.3	-1.346	0.2495

* MMNT= Mean Minimum Temperature

Stressors

Plant Interactions

Comment [28]: Please include a table showing the AIC values for each model compared for his specise anothe other species with trend analysis too.

Comment [29]: Was precip tested? If it wasn't significant, it would be good to include some conjecture as to why not esp considering he sentence at teh end of the last paragraph.

Comment [30]: Michael, does the Presidio get frost? is this statement reasonable?

Comment [31]: Include results for precip models too event if not sig

Non-native and native herbaceous plants, including weedy natives such as Himalayan blackberry (*Rubus ursinus*), blue blossom (*Ceanothus thyrsiflorus*), and poison-oak (*Toxicodendron diversilobum*) may outcompete Presidio clarkia for suitable microhabitat (Chasse and Forrestel 2014). Shading, litter accumulation, and increased soil moisture from native and introduced shrubs and trees could reduce habitat suitability for Presidio clarkia. Invasive plant species are controlled and removed by the Presidio Trust (Chasse and Forrestel 2014). Non-native trees have been removed from the (b) (5), (b) (3) (B) sites. Although this has improved the habitat for Presidio clarkia, although residual effects from litter accumulation may alter the soil properties (USFWS 2010).

Anthropogenic Interactions

Many of the negative anthropogenic disturbances cited in the Recovery Plan have been eliminated by efforts of GOGA and the Presidio Trust. These managing entities have made efforts to fence populations, remove trees, and reduce the cover of non-native plants (USFWS 2010). Road maintenance and poorly-timed mowing no longer threaten extensions of the population (USFWS 2010). Trail erosion, storm drain runoff and other hydrologic issues were concerns cited in the 5-year Review (USFWS 2010). Nitrogen deposition from industrial and automobile combustion can alter the chemical makeup of serpentine habitats to favor non-native plant invasion (USFWS 2010).

Niederer, Weiss and Stringer studied the potential benefits of anthropogenic disturbance and reintroduction of historically excluded natural disturbance to Presidio clarkia populations (2014). This study consisted of blocks with or without Presidio clarkia seed that each received one of the following treatments: “fall burning, fall flaming, fall mowing with thatch reduction, fall scraping, fall tarping, spring burning, and spring mowing with and without thatch reduction” (Niederer et al 2014). Application of scraping, flaming or tarping in late fall, after annual grass germination, proved to be the most effective at reducing annual grass germination and thatch. Fall scraping and flaming also showed increased numbers of Presidio clarkia in unseeded plots if seeds were initially present (Niederer et al 2014).

Habitat Restriction

Population expansion is limited by the lack of preserved areas that contain the required serpentine habitat preferred by the Presidio clarkia. Three additional areas were repatriated with Presidio Clarkia and are monitored every other year (Chasse and Forrestel 2014). Soil depth and solar insolation were not considered major limiting factors in Presidio clarkia distribution at Inspiration Point (USFWS 2010). However, Presidio clarkia was not found directly under tree canopies (Weiss and Neiderer 2009).

Genetic Bottleneck

Presidio clarkia habitat has been lost to development, and remaining populations are fragmented by roads and other development. Isolated populations with limited genetic variability are more subject to genetic drift and stochastic events, such as erosion, climate, fire, or disease (USFWS 2010). Early genetic work on Presidio clarkia concluded that the species self-pollinates and is monomorphic in most of its populations, but has enzymatic variation in lieu of genetic variation (Gottlieb and Edwards 1992). Gene flow of the generally self-pollinating species could be

facilitated by pollinators that increase the genetic variability of isolated populations (Gottleib 1974, USFWS 2010).

Climate Change

Presidio clarkia was observed to be intolerant to variations in microclimate conditions at the (b) (5), site. The limited distribution and climatic variation intolerance of Presidio clarkia could leave the isolated populations vulnerable to climatic variations. As shown in monitoring data, drought years have shown the lowest population sizes observed (Chasse and Forrestel 2014, USFWS 2010), which could indicate declining populations in a drier climate regime.

Level of confidence in assessment

The condition and trend of the Presidio clarkia summarized in this report have been based primarily on conclusions found in the most recent GOGA monitoring report (Chasse and Forrestel 2014), USFWS 5-year Review (USFWS 2010), and the USFWS Recovery Plan for Serpentine Soil Species of the San Francisco Bay Area (USFWS 1998). The USFWS reports are comprehensive reviews of the species and supersede conclusions made in this document. Multiple species-specific studies have been conducted to inform management of protected Presidio clarkia populations, most notably the work of Neiderer and Weiss (2009 and 2014). Additional reports and studies were incorporated as needed to fully depict the status of Presidio clarkia.

Gaps in understanding

The Recovery Plan recommends surveying historic locations for present individuals or potential suitable habitat for repatriation. One such area, the (b) (5), (b) (3) (B) was seeded with Presidio clarkia in 2011 (Chasse and Forrestel 2014). The 2014 Rare Plant report recommends increasing efforts to monitor introduced populations (Chasse and Forrestel 2014), and to begin monitoring the seeded population on the (b) (5), (b) (3) (B)

The dramatic fluctuations in population size are not fully understood and may be due to a combination of climate variables and management activities (USFWS 2010). The recently planted and infrequently monitored (b) populations are located within a more coastal habitat than the more interior (b) (5), (b) (3) (B) sites. The (b) site is subject to wind, increased precipitation and increased fog conditions (USFWS 2010). These coastal conditions were cited as less than ideal and potentially a major driver in determining the lower abundance of the (b) (5), (b) (3) (B) site (Chasse and Forrestel 2009, as cited in USFWS 2010).

Condition Summary

Indicator of Condition	Specific Measure	Condition Status	Rationale
How many of the natural populations observed since GOGA management began are still extant?	Population trend is increasing or stable		Consistent monitoring of the main macroplot at (b) (5), (b) have shown high levels of variation in population size.

Are introduction efforts successful?	Proportion of successful introductions into new sites. This does not include natural populations. Lack of introduction efforts is not counted toward score.		Three populations have been introduced GOGA lands. Two sites initiated in 2011 have not been monitored yet, and one population was extant in recent surveys.
Have the USFWS Recovery Plan goals been fulfilled for populations within GOGA lands?	Proportion of interim and long-term goals realized		For the populations within GOGA management areas, three delisting criteria are met or partially fulfilled (protection of populations, minimum population size and population stability), and two are fulfilled by other entities (research and seed storage).

The Presidio populations of Presidio clarkia are managed and monitored by the Presidio Trust and the National Park Service. Both the natural (b) (5), (b) (3) population and the monitored introduced (b) (5), (b) (3) (B) population have shown great variation in population size since monitoring began (Chasse and Forrestel 2014). Results from applied management studies (Neiderer and Weiss 2009, Neiderer et al 2014) can be carefully incorporated into future management of Presidio clarkia to increase population sizes and resilience.

4.6.3.7 Marin dwarf flax (*Hesperolinon congestum*) Condition Assessment

Marin dwarf flax (*Hesperolinon congestum*) is an annual herb found with bunchgrasses, chaparral, and dry grasslands in valleys and foothills, mostly on serpentinite substrate (USFWS 2011). Recent classification work has placed Marin dwarf flax within the Hesperevaco sparsiflorae-Hemizonion congestae alliance, which is described as a serpentine annual grassland in sunny open areas with oceanic influence (Rodriguez-Rojo 2001). This California endemic herb blooms from April to July and occurs at 5 to 370 m of elevation. It is listed as federally threatened and state threatened, and is also listed by the California Native Plant Society (CNPS) as Rare Plant Rank 1B.1, which is defined as 'seriously endangered in California'. There are currently 26 known occurrences. Twenty-three of the occurrences are presently extant. The three other occurrences have been classified as extirpated or possibly extirpated by the CNPS (CNPS 2014), two of which occurred in San Francisco and were extirpated by urban development prior to listing (USFWS 2014).

Comment [32]: Where are the extant populations?

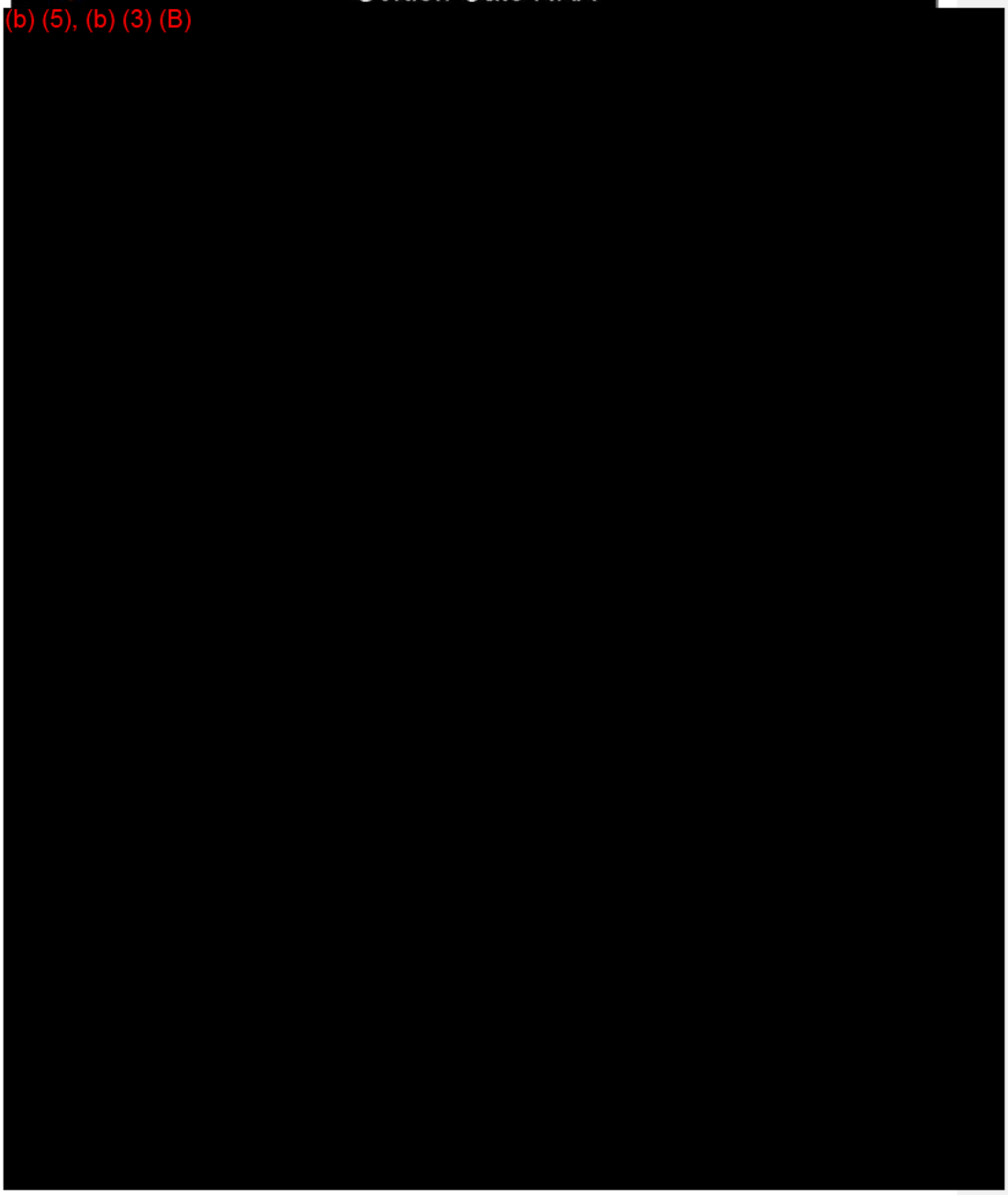
Condition and Trend

Marin dwarf flax is limited to San Francisco, San Mateo and Marin Counties in California. GOGA boundaries encompass populations at~~in~~ (b) (5), (b) (Marin; managed by Point Reyes National Seashore), within the (b) (5), (b) (3) (B) management unit (San Mateo; managed by the SFPUC), near the (San Francisco) and an unsuccessful introduced population at (b) (5), (b) (3) (San Francisco) (Figure 4.6.3.7.1; Chasse and Forrestel 2014). Populations vary in number and in spatial distribution and extent between years (USFWS 2011). The overall Presidio population was considered unstable in the 2011, due to "relatively 20-fold increases and declines over the 1995-2010 survey period" (USFWS 2011). Initial seeding of Marin stock was

Comment [33]: This sentence doesn't make sense as written and needs to be expanded upon

Hesperolinon congestum
Golden Gate NRA

(b) (5), (b) (3) (B)



successful in 2000 but was removed in 2008 due to concerns about the genetic source of the seeds (Chasse and Forrestel 2014). A new seeding effort was attempted in 2010 with Presidio seed stock, but few individuals have ~~not~~ successfully established from that effort (Chasse and Forrestel 2014). The historical range of Marin dwarf flax has not been established. However, it is likely that it included all current extant populations, and all populations listed in the original 1995 report, in which 14 populations were listed but only 12 were discussed (USFWS 2011). The dwarf flax also probably inhabited areas of San Francisco and San Mateo counties that are now urban development but were at one point serpentine habitat (USFWS 2011).

Comment [34]: A total of 13 individuals were observed at (b) (5), (b) in May of 2015.

Comment [35]: Voucher specimens of Marin dwarf flax were collected from both Laurel Hill and Masonic cemeteries.

For this report, population estimates of two populations of Marin dwarf flax populations, Yerba Buena and Raven's Manzanita, were combined before being analyzed together for relationship to specific climate factors. Of five models tested, the model with the best fit and lowest AIC value was the Spring Extreme Minimum Temperature model. The parameters within this model were then tested for significance (see Table 4.6.3.7.1 below). Of all the parameters, the effect of February and March Extreme Minimum Temperature (EMNT) parameters on the Marin dwarf flax population size were statistically significant (p-value < 0.05). The positive effect that the February EMNT has on population values indicates that warmer February temperatures might predict or facilitate larger Marin dwarf flax population sizes. Marin dwarf flax generally would have germinated and be at a vegetative development stage in February. Any extremely cold February temperatures could be indicative of frost damage to developing individuals, which would reduce overall individuals observed in peak bloom surveys. The March EMNT had an opposite effect on population values: increasing EMNT values correlated with decreasing population numbers. This could be a case where the EMNT values are collinear with precipitation factors, where increased temperatures correlate with decreased precipitation rates. This analysis is unable to interpret the biological significance of the EMNT values in relation to population numbers.

Overall, the dataset is spatially limited to one site, which limits any potential interpretation of data to the GOGA-managed population. A future study incorporating population data from other sites with different climate variables would bolster the findings of this analysis. This study also did not test all potential climate factors or combinations in order to avoid multiple testing, which would negate the significance of any findings.

Comment [36]: See notes in Clarkia section

Table 4.6.3.7.1. Summary Statistics of Spring Extreme Minimum Temp. for Marin Dwarf Flax

Coefficients	Estimate	Std. Error	t value	Pr(>|t|)
Intercept	179928.6	148614.2	1.211	0.2926
February EMNT*	2500.5	880.2	2.841	0.0468
March EMNT	-5761.7	1531.6	-3.762	0.0197
April EMNT	5160.5	2635.6	1.958	0.1218
May EMNT	-2469.1	1644.9	-1.501	0.2077

* EMNT= Extreme Minimum Temperature

Stressors

Plant Interaction

Both non-native and native plant populations may threaten the populations of Marin dwarf flax by competition for resources. Several Monterey cypress trees (*Cupressus macrocarpa*) adjacent to a Marin dwarf flax population were removed prior to the 1998 Recovery Plan (USFWS 1998). Chasse and Forrestel (2014) identified yellow star-thistle (*Centaurea solstitialis*), windmill pink (*Silene gallica*), fennel (*Foeniculum vulgare*), Italian thistle (*Carduus pycnocephalus*), and non-native grasses~~teasel (*Dipsacus fullonum*)~~ as species of particular competition concern. Invasion by non-native species into low-nutrient soil areas may be fostered by nitrogen deposition from industrial and motor vehicle combustion (USFWS 2011). Areas with increased nitrogen deposition and subsequent increases in non-native vegetation biomass can be restored with grazing, mowing, weeding, and selective herbicide (USFWS 2011).

Comment [37]: Teasel may have been listed by mistake in our rare plant report; it is not one of the invasives of concern for Marin dwarf flax.

Wildlife Interaction

Gopher activity may disturb soil associated with Marin dwarf flax populations. Effects from cattle grazing are unknown but of research interest (Chasse and Forrestel 2014).

Anthropogenic Disturbance

Casual recreational use and unleashed dogs were considered a threat to Marin dwarf flax during the initial listing, but the population has since been fenced. Although not managed by GOGA, the SFPUC populations may be affected by trail development, increased visitor access, and improvements to Crystal Springs Reservoir (USFWS 2011). Salvage of Marin dwarf flax is not considered a viable avoidance measure as recommended by the Native Plant Protection Act, as transplants often fail at the reintroduction site (USFWS 2011).

Climate Change

Although the specific effects of climate change on a population-size scale are not well defined, alterations of the current climate regime could render current habitat unsuitable (USFWS 2011). Harrison et al. identified Marin dwarf flax as a rare species that has persisted despite historical climate change due to its occurrence in areas with more benign climates and within larger areas with the required special habitat features (2008). These findings indicate that these species could persist through regional climate change in certain habitats.

Level of confidence in assessment

The condition and trend of the Marin dwarf flax summarized in this report have been based primarily on conclusions found in the most recent GOGA monitoring report (Chasse and Forrestel 2014), USFWS 5-year Review (USFWS 2011), and the USFWS Recovery Plan for Serpentine Soil Species of the San Francisco Bay Area (USFWS 1998). The USFWS reports are comprehensive reviews of the species and supersede conclusions made in this document. Additional reports and studies were incorporated as needed to fully depict the status of Marin dwarf flax.

Gaps in understanding

The 5-year Review describes a discrepancy between the CNDDB and original populations in the 1995 listing (USFWS 2011). Only extant populations recognized by GOGA Rare Plant Report are considered in this document. Lack of surveys with consistent monitoring methodology

precluded the USFWS from making conclusions on many of the Marin dwarf flax populations (USFWS 2011).

Although grazing, mowing, herbicides, weeding and fire have been suggested as management options to reduce increased competition from non-native species in nutrient-poor soil types, these management options have not been specifically tested on improving Marin dwarf flax populations (USFWS 2011). Research needs of Marin dwarf flax demography include soil seed bank, pollination and reproductive strategy studies (USFWS 2011). Surveys of potentially suitable habitat would increase presence/absence data, increase potential for re-introduction efforts, and help direct conservation planning.

Condition Summary

Indicator of Condition	Specific Measure	Condition Status	Rationale
How many of the natural populations observed since GOGA management began are still extant?	Proportion of natural populations with > 0 individuals in 2012 and 2013. Populations not monitored in 2012, 2013, and 2014 will not be counted toward score.		The (b) (5), population is not consistently monitored. The two populations at the (b) (5), (b) (3) (B) have shown great variation over sampling years. All are extant.
Have introduction efforts been successful?	Proportion of successful expansions and/or introductions into new sites		In 2000, the reintroduction of the dwarf flax was attempted at (b) (5), (b) but the plants were removed in 2008 under advisement because of the possibility of their genetic difference from other populations. A seeding operation was attempted at the Presidio in 2011 but has had limited success (less than 15 individuals after 4 years)~~was unsuccessful~~.
Have the USFWS Recovery Plan goals been fulfilled for populations within GOGA lands?	Proportion of interim and long-term goals realized		Three recovery criteria were established for the dwarf flax. Within GOGA-managed lands, one is fulfilled (land protection), and two are partially fulfilled (management plan and stable monitored population)

Great levels of variability in population numbers occur in all monitored populations of Marin dwarf flax, and are generally attributed to variation in annual precipitation (USFWS 2011). The Presidio population was considered unstable in the 5-year Review; all other GOGA-related populations were not monitored often enough to conclude population trends (USFWS 2011).

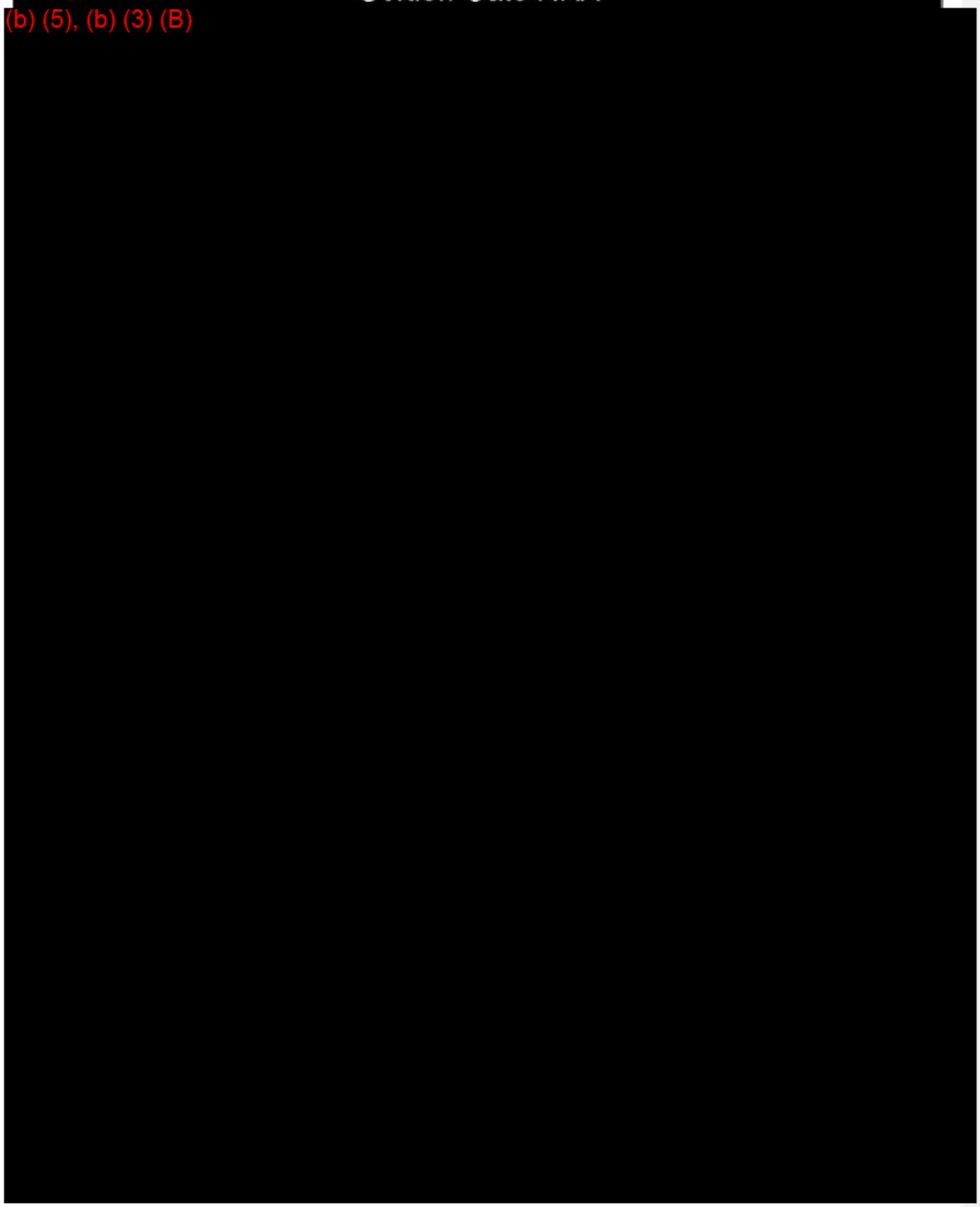
4.6.3.8 San Francisco lessingia (*Lessingia germanorum*) Condition Assessment

San Francisco lessingia (*Lessingia germanorum*) is an annual herb found on remnant dunes of coastal scrub. This California endemic herb blooms from June to November and occurs at 25 to 110 m of elevation. It is currently listed as federally endangered and California endangered, and is also listed by the California Native Plant Society (CNPS) as Rare Plant Rank 1B.1, which is defined as 'seriously endangered in California'. This species is known from only four native

occurrences at (b) (5), (b) in San Francisco and one on (b) (5), (b) (3) (B) (Figure 4.6.3.8.1; CNPS 2014).

Lessingia germanorum
Golden Gate NRA

(b) (5), (b) (3) (B)



Condition and Trend

This species is found only in the San Francisco Presidio and near San Bruno Mountain in San Mateo Counties of California. Its historic range included all suitable central dune scrub habitat throughout the San Francisco peninsula (USFWS 2012c). GOGA manages multiple populations within the Presidio Recovery Unit of San Francisco: (b) (5), (b) (3) (B) (Chasse and Forrestel 2014). Historically, the species occurred throughout the San Francisco peninsula in central dune scrub habitats, but it is now restricted to the (b) (5), (b) (3) (B) and (b) (5), Park in Daly City (USFWS 2012c). The Daly City population occurs near t(b) (5), (b) (3) (B) (b) (5), on privately-owned land (USFWS 2012c). (b) (3)

Overall population numbers had increased from 1994 to 2011, and were likely maintained by acts of stewardship: weeding, protection and seeding (USFWS 2012c). Of the five populations managed by GOGA, the US Fish and Wildlife Service recognizes population sizes will fluctuate, but should not decline below these minimum recommended population sizes: (b) (5), (b) (50,000), (b) (5), (b) (3) (1,000), (b) (5), (5,000), (b) (5), (5,000), and (b) (5), (b) (5,000) (USFWS 2003). However, the report also states that "fixed population size targets have limited applicability for San Francisco lessingia" (USFWS 2003).

The 2014 USFWS Rare Plant Report (Chasse and Forrestel 2014) summarizes the population statistics of the Presidio populations:

- "The core population of L. germanorum at the (b) (5), (b) macroplot is below the recovery threshold of 50,000 individuals. The 80% confidence level for the 2013 population estimate within the macroplot at (b) (5), (b) (3) (B) is between 18,940 and 25,925.
- The (b) (5), (b) (3) population is over twice the recovery threshold of 5,000 individuals with 10,546 individuals.
- The (b) (5), (b) (3) (B) population (combined total of (b) (5), (b) and (b) (5), (b) (3) (B) Site) is above the recovery threshold of 5,000 individuals.
- The (b) (5), (b) (3) (B) population (combined total of (b) (5), (b) (3) (B) (b) , and (b) (5), (b) (3) (B) areas) is above the recovery threshold of 5,000 individuals.
- The (b) (5), (b) (3) (B) population, with 268 individuals, is below the recovery threshold of 5,000 individuals.
- A previously introduced population of L. germanorum at the (b) (5), (b) (3) (B) has not persisted.
- New subpopulations of L. germanorum have been established in the (b) (5), (b) (3) area and currently number 2,041 individuals."

More specific habitat goals were expressed in the most recent 5-year Review, including non-native plant cover, bare ground cover, and substrate conditions (USFWS 2012c). These habitat characteristics were not monitored quantitatively and are not considered in this report.

Population estimates of the (b) (5), (b) San Francisco lessingia was analyzed for any relationship with specific climate factors. Of five models tested, the model with the best fit and lowest AIC value was the Spring Mean Maximum Temperature model. The parameters within

this model were then tested for significance (see Table 4.6.3.8.3 below). Of all the parameters, the effect of March and May Mean Maximum Temperature (MMXT) parameters on the Lobos Dunes San Francisco lessingia population numbers were statistically significant (p-value < 0.05). San Francisco lessingia is a late season annual that generally blooms in July to November (CNPS 2014). The positive effect that the both the March and May MMXT had on population values indicates that warmer March and May temperatures might predict or facilitate larger lessingia population sizes. Generally cold temperatures could be indicative of frost damage to developing individuals, which would reduce overall individuals observed in peak spring surveys. The effect of the March and May MMXT are generally small, even if they are significant.

Overall, the dataset is spatially limited to one site, which limits any potential interpretation of data to the (b) (5), (b) populations. A future study incorporating population data from other sites with different climate variables would bolster the findings of this analysis. This study also did not test all potential climate factors or combinations in order to avoid multiple testing, which would negate the significance of any findings.

Table 4.6.3.8.3. Summary Statistics of Spring Mean Maximum Temperature for San Francisco Lessingia

Coefficients	Estimate	Std. Error	t value	Pr(>|t|)
(Intercept)	27.9369	40.4799	0.69	0.5006
February MMXT	-0.1394	0.2255	-0.618	0.5457
March MMXT	0.4705	0.1907	2.467	0.0261
April MMXT	0.1003	0.2184	0.459	0.6527
May MMXT	-0.4308	0.1787	-2.411	0.0292

* MMXT= Mean Maximum Temperature

Stressors

Plant Interactions

The artificial lack of disturbance of dunes has caused gradual shrub encroachment (e.g. *Lupinus chamissonis*) into the remnant coastal dune system, which can cause succession to stable shrub habitat (Chasse and Forrestel 2014). Development and vegetation change have altered natural processes that would allow dune habitat to persist by blocking wind patterns, stabilizing sandy slopes and fragmenting dunes (USFWS 2003). Non-native grasses, such as *Bromus diandrus, Briza maxima, Avena fatua, and Lagurus ovatus*, may also outcompete San Francisco lessingia for resources. Non-native grasses and forbs are currently managed by GOGA in order to maintain and improve habitat quality. Topsoil inversion, where soil from >0.75 m deep replaces the topsoil of dunes, could be an effective tool in reducing invasive herbaceous cover recruitment (Chasse and Forrestel 2014).

Non-native historical forests alter the ecology of historic dune habitat by increasing litter, stabilizing sandy soil, reducing wind effect and increasing soil moisture (USFWS 2003). The 2003 Recovery Plan (USFWS 2003) long-term recovery criteria include desired structural habitat features, which include restoration of dune fields with active wind disturbance and reduced shrub and non-native plant cover (USFWS 2012c).

Anthropogenic Disturbance

Pedestrian, pet, and horse trampling can directly destroy individuals and/or degrade habitat quality by introducing non-native competitive species (USFWS 2012c). Habitat fragmentation due to urban development limits the species capacity for dispersal and extent of potential habitat. Further development and introduction of competitive landscape plants may occur under management of Presidio lands by the Presidio Trust. The Presidio Trust is also allowed to dispose of Presidio lands to non-federal ownership in order to meet financial success criteria, which would reduce the protection of federal listing (USFWS 2003). Existing populations that expand into unprotected landscaped or historic forest areas can be impacted by visitor use and park operations (Chasse and Forrestel 2014). Existing habitat has been expanded by three large-scale dune restoration projects near the (b) (5), (b) (3) and (b) (5), (b) (3) (B) (Chasse and Forrestel 2014).

Genetic Bottleneck

The San Bruno and Presidio populations of San Francisco lessingia are as genetically distinct from each other as each genotype is from other species of the genus, although the two populations are morphologically identical. San Francisco lessingia is generally self-incompatible, requiring pollination for successful reproduction. Subpopulations limited in extent are vulnerable to stochastic events such as erosion, landslides and loss of pollinators (USFWS 2012c).

Climate Change

Predictions of climate change at a small-scale are variable and not suitable for management decisions at this time. However, even slight alterations in climate regime could render currently suitable habitat within GOGA managed lands to be unsuitable in the future. Populations are currently limited by natural and anthropogenic barriers to dispersal, and would be vulnerable to climatic shifts (USFWS 2012c).

Level of confidence in assessment

The condition and trend of the San Francisco lessingia summarized in this report have been based primarily on conclusions found in the most recent GOGA monitoring report (Chasse and Forrestel 2014), USFWS 5-year Review (USFWS 2012c), and the USFWS Recovery Plan for Coastal Plants of the Northern San Francisco Peninsula (USFWS 2003). The USFWS reports are comprehensive reviews of the species and supersede conclusions made in this document. Additional reports and studies were incorporated as needed to fully depict the status of San Francisco lessingia.

Gaps in understanding

Habitat conditions of existing populations should be monitored in order to assess whether success criteria for recovery has been achieved. Species-specific research of current pollinator status in current and planned reintroduction sites could improve management of San Francisco lessingia populations (USFWS 2012c).

Condition Summary

Indicator of Condition	Specific Measure	Condition Status	Rationale
How many of the natural populations observed since GOGA management began are still extant?	Proportion of natural populations with > 0 individuals in 2012 and 2013. Populations not monitored in 2012, 2013, and 2014 will not be counted toward score.		Of the four GOGA populations, two are above their respective recovery threshold population sizes. These thresholds are specific to each site, and were set by the USFWS. All natural populations are extant.
Are introduction efforts successful?	Proportion of successful introductions into new sites. This does not include natural populations. Lack of introduction efforts is not counted toward score.		(b) (5), (b) (3) (B) has been successful, but a (b) (5), introduction effort was unsuccessful. Monitoring protocol unknown for unsuccessful introduced population
Have the USFWS Recovery Plan goals been fulfilled for populations within GOGA lands?	Proportion of interim and long-term goals realized		Recovery criteria are set out by recovery unit. The GOGA lands fall within the Presidio Recovery Unit. The Interim Recovery Criteria have been met for four of five areas within the Presidio Recovery Unit (USFWS 2012). None of the three sites within the Presidio Recovery Unit have met the specifics of the long term recovery criteria.

Comment [38]: Seeds of Lessingia germanorum were introduced accidentally to (b) (5), during direct seeding of other native annual species; his occurrence was censused each year until it was no longer extant.

GOGA and the Presidio Trust monitor and manage all extant populations of San Francisco lessingia excluding one Daly City occurrence (USFWS 2012c). Of the managed populations, three populations ((b) (5), (b) (3) (B) and (b) (5), (b)) are above target population levels from the initial Recovery Plan, two populations ((b) (5), (b) and (b) (5), (b) (3) are below target population levels and one introduced population ((b) (b) has not persisted (Chasse and Forrestel 2014). Two new subpopulations, totaling over 2,000 individuals, were established in (b) (5), (b) (3) (B) (Chasse and Forrestel 2014). All of the Presidio populations have been bolstered by habitat restoration and regular maintenance activities (USFWS 2012c).

Comment [39]: Didn't we collect seeds from he Daly City popula ion?

Comment [40]: Michele Laskowski tried without success to get permission from the landowners before she left. Landowner never responded.

4.6.3.9 Hickman's cinquefoil (*Potentilla hickmanii*) Condition Assessment

Hickman's cinquefoil (*Potentilla hickmanii*) is a perennial herb found in variety of habitats, including coastal bluff scrub, closed-cone coniferous forest, vernally mesic meadows and seeps, and freshwater marshes and swamps. This California endemic herb blooms from February ~~April~~ to August and occurs at 10 to 149 m of elevation. This cinquefoil is currently listed as federally endangered and California endangered, and is also listed by the California Native Plant Society (CNPS) as Rare Plant Rank 1B.1, which is defined as 'seriously endangered in California'. There are currently 5 total known occurrences. Only two remnant populations and one

Comment [41]: Add coastal terrace prairie. (Within he GGNRA, this is the only habitat type hey occupy.)

Comment [42]: this year hey bloomed February-July

introduced population~~three of the five occurrences~~ are presently extant (CNPS 2014). USFWS has attempted multiple reintroductions at sites in Monterey County with very limited success.

Condition and Trend

Hickman's cinquefoil was originally described by Alice Eastwood in 1902 on the Monterey Peninsula (USFWS 2009). The species was collected in 1905 by Katherine Brandegee from Moss Beach in San Mateo County, and in a nearby location in 1933 (USFWS 2009). Later collections came from the Monterey Peninsula during the 1930s, but specific details about locations is lacking. The species is considered extirpated from both of these sites, due to development and other changes in land use (USFWS 2009). One stable population of Hickman's cinquefoil, first found in 2005, occurs at Rancho Corral de Tierra, a GOGA parcel north of the city of Montara (Figure 4.6.3.9.1). In 2011, ~~T~~the parcel was ~~recently~~ acquired by GOGA from the Peninsula Open Space Trust. The GOGA population has been monitored in 2008, 2013, and 2015 and appears to be relatively stable. In large patches (greater than 20) there are representatives from a variety of size classes. Patches with smaller numbers of individuals appear to be waning, with fewer young plants per adult. GOGA has focused on controlling invasive species threatening the larger isolated patches and has determined that seed collection and outplanting is not necessary to preserve this species at this site at this time. ~~GOGA has not actively planted this species and the population appears stable~~ (M. Chasse and S. Bennett, personal communication, 2015). At the time of the 5-year Review, this species was known from two remnant native populations: one occurs near Pebble Beach in Monterey County with fewer than 20 individuals, and the second occurs near the town of Montara with 3000 individuals (USFWS 2009). A 2015 census indicated a total of 5274 individuals, though this increase probably reflects a more detailed counting technique than used in previous years and not an actual increase in the number of individuals (S. Bennett personal communication 2015) . ~~Hickman's cinquefoil was not monitored by GOGA, and was not reported in the 2011-2013 Monitoring Report for Federally Listed Plants within the Golden Gate National Recreation Area (Chasse and Forrestel 2014)~~.

Comment [43]: (deleted east)

Comment [44]: Rephrase; should simply say hat data wasn't included; it was monitored.

Stressors

Plant Interactions

Hickman's cinquefoil is very low growing and dies back annually, making it vulnerable to encroachment of a variety of plants--particularly fast growing and thatch producing plants. Artificially increased year-round water availability at the Pebble Beach population has caused an increase in competitive invasive species, such as Harding grass (*Phalaris aquaticus*), velvet grass (*Holcus lanatus*) and tall fescue (*Festuca arundinacea*), that favor the increase in water availability (USFWS 2004). ~~Though preliminary un~~~~Shading caused by Monterey pine trees could threaten the Montara population (USFWS 2009).~~ The GOGA population is currently threatened by annual invasive grasses, perennial invasive grasses, and encroachment by conifers and native shrubs. These non-native invasive threats are being actively managed by NPS staff to preserve the isolated patches, with hopes of converting non-native grasslands between isolated patches of potentilla into a native coastal prairie to encourage genetic flow between patches. Based on analysis of historical aerial photography starting in 1943, the populations that appear very small and isolated today were actually connected by grasslands (probably due to agricultural disturbance of scrub to promote farming and/or pasture land) in the 1940s.

Management activities changed since that time and the encroachment of native scrub has severely isolated several populations, and in those smaller patches, abundance appears to be decreasing since 2008 surveys. Future management efforts may require the removal of scrub and riparian vegetation to reconnect satellite populations to encourage genetic flow and resilience. ~~reduce invasive species in adjacent areas~~ (S. Bennett, personal communication 2~~, February 19, 2~~015).

Animal Interactions

The Pebble Beach ~~and Montara~~ populations have been predated by various herbivores, including mule deer (*Odocoileus hemonius*), gophers (*Thomomys* sp.), mice (various species), voles (*Microtus* spp.), snails (various species), and slugs (various species) (USFWS 2009). ~~Gopher herbivory may also positively affect the populations by reducing invasive plant cover (USFWS 2004).~~ The GOGA population has been negatively impacted by gopher/burrowing mammal activity, which appear to destroy the roots of the plants. The impact appears minimal in the larger patches. ~~Small isolated patches of potentilla at~~The GOGA population~~C~~attle grazing has been observed as both beneficial, reducing the cover of competitive species, and harmful, by trampling or predation, to Hickman's cinquefoil populations (USFWS 2009). The role of pollinators for this species is not currently completely understood. The GOGA population seems to support a variety of insect orders who are potential pollinators, but throughout the rest of its range, insect visitations (and natural seed production) appear uncommon.

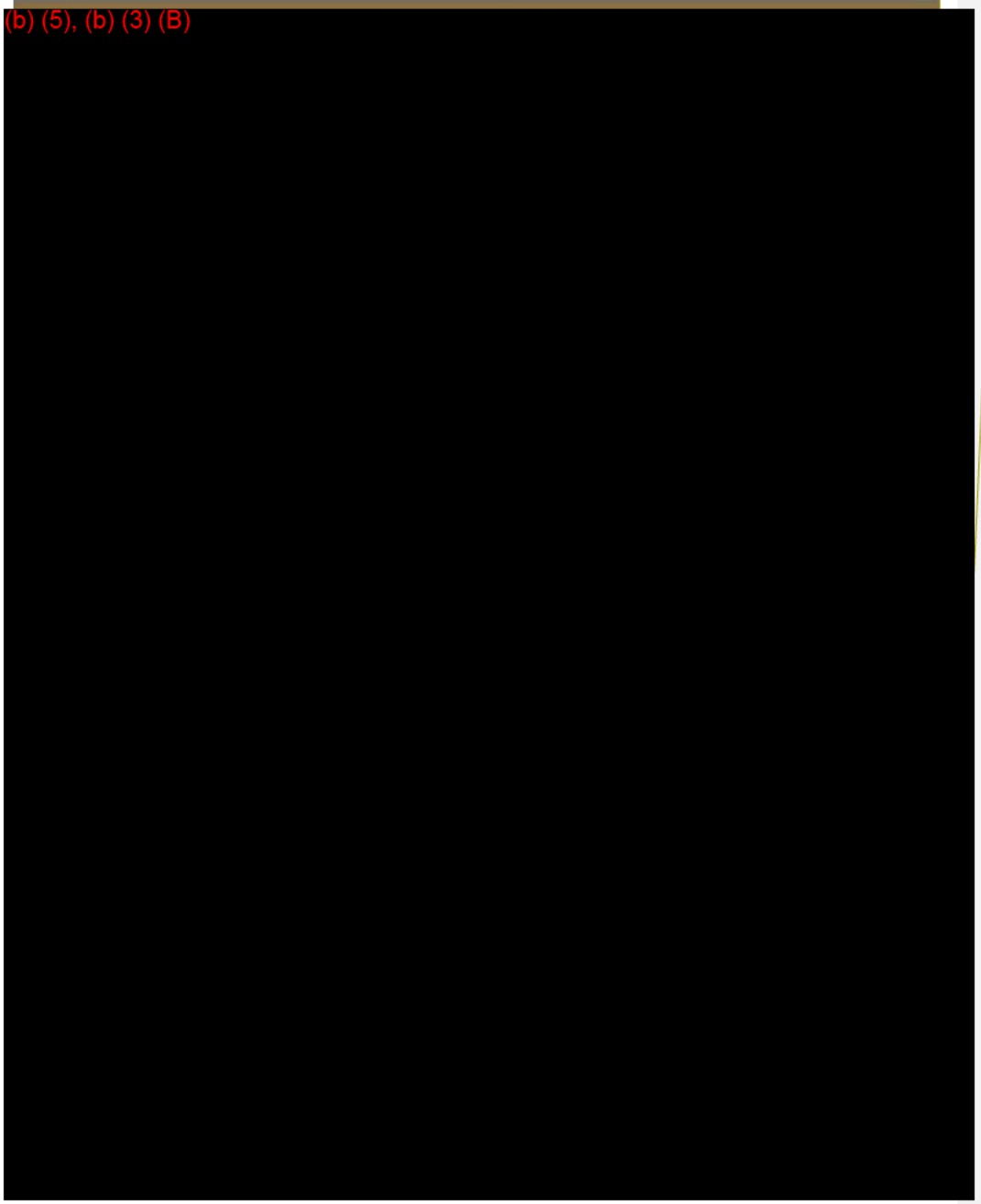
Anthropogenic Disturbance

~~Mowing and heavy recreational use surrounding the fenced Pebble Beach population may be reducing the potential for the population to expand.~~ The population at Pebble Beach currently sits in a former horseshoe ring and picnic area, and since that population has been fenced off, numbers appear to be reducing. The GOGA population is distributed along hillsides--with densest populations supporting a variety of size classes occurring on or within 10 feet of trails, typically along hill crests where soil is thinnest. Based on the observed distribution, GOGA staff has suggested that foot traffic may either exclude the invasion of non-native grasses or scarify seeds and encourage germination for this species, though the coexistence of trails and remnant potentilla plants may be due to other abiotic factors. This question warrants further study. Other activities, such as the redirection of water flow towards the plant has negatively impacted the Pebble Beach population. (S. Bennett personal communication, 2015)

Comment [45]: not sure if you want to add sources, but we just had this looked at by a student researcher and can share the report with you

Potentilla hickmanii
Golden Gate NRA

(b) (5), (b) (3) (B)



Comment [46]: we have better data now. Not sure the source of this data, but even the 2008 data includes one patch occurs on the other green parcel displayed in this map.

Genetic Bottleneck

Significant habitat reduction by development and its secondary impacts have reduced the populations from estimated previous population levels. Such small populations have increased homozygosity and can have reduced germination rates as compared to healthy populations of the same species (USFWS 2009). The two small populations are also susceptible to stochastic events that could remove or significantly decrease the population. One instance occurred when a severe storm deposited beach cobble and significantly reduced the Pebble Beach population (USFWS 2009). Comparison of reproductive success as measured by size class distribution among patches suggests that the threat of genetic homozygosity is exacerbated when patches become isolated by grassland conversion and numbers reach fewer than 20 individuals in a patch (S. Bennett personal communication 2015.

Level of confidence in assessment

The condition and trend of the Hickman's cinquefoil summarized in this report have been based primarily on conclusions found in the most recent USFWS 5-year Review (USFWS 2009), ~~and~~ the USFWS Recovery Plan for Five Plants from Monterey County, California (USFWS 2005), and personal communication with NPS staff. The USFWS reports are comprehensive reviews of the species and supersede conclusions made in this document. No data on Hickman's cinquefoil were included in the 2011-2013 Rare Plant Report compiled by GOGA (Chasse and Forrestel 2014). Michael Chasse provided basic information on the GOGA Hickman's cinquefoil occurrence in (b) (5), (b) (3) (B) (2015) and Susie Bennett provided information during final review stages. The condition and trend (b) (5), (b) (3) (B) population are not well documented at the time of the analysis.~~is time.~~

Gaps in understanding

~~No data was available for this report on the Hickman's cinquefoil population at Rancho Corral~~Arroyo de Tierra population. ~~This parcel was recently acquired by GOGA and census data has not yet been conducted. It is highly recommended that a consistent monitoring plan be created and executed in order to better understand this population.~~At the time of data compilation for this report, spatial and census information about the GOGA population was not provided due to the recent addition of this site into the park and the on-going development of a monitoring protocol. Since that time, a monitoring technique has been developed and will be repeated annually to allow for adaptive management of this species. To assist with species conservation throughout the potentilla's range, managers recommend identifying pollinators at GOGA. Additionally, the relationship between scrub encroachment and patch size should be monitored and mediated if deemed necessary.

Comment [47]: Susie, please revise this

Condition Summary

Indicator of Condition	Specific Measure	Condition Status	Rationale

How many of the natural populations observed since GOGA management began are still extant?	Proportion of natural populations with > 0 individuals in 2012 and 2013. Populations not monitored in 2012, 2013, and 2014 will not be counted toward score.		The existing population is extant, and is being actively managed. ~~However, this is based on email correspondence without supporting data~~ (Chasse and Bennett pers. com. 2015).
Are introduction efforts successful?	Proportion of successful expansions and/or introductions into new sites		No introduced populations within GOGA-managed lands were noted (Chasse and Forrestel 2014).
Have the USFWS Recovery Plan goals been fulfilled for populations within GOGA lands?	Proportion of interim and long-term goals realized		Of the five criteria for downlisting, the GOGA population has met two criteria (viable population, management of encroaching vegetation), and the status of the other three remains unknown (long-term management funding, monitoring, and seed bank storage)

As a whole, ~~T~~the (b) (5), (b) (3) (B) population of Hickman's cinquefoil is considered stable by GOGA staff (M. Chasse, personal communication, February 19, 2015). However, this population was not described~~recognized~~ in the most recent USFWS 5-year Review (2009) or Recovery Plan (2005). ~~No data were presented on this species in terms of its population size, location or stressors or other observations. This occurrence would benefit from an increase in documentation of existing or planned monitoring efforts~~.

Comment [48]: is this paragraph necessary?

4.6.4 Density and Distribution of Rare Plants in GOGA Lands

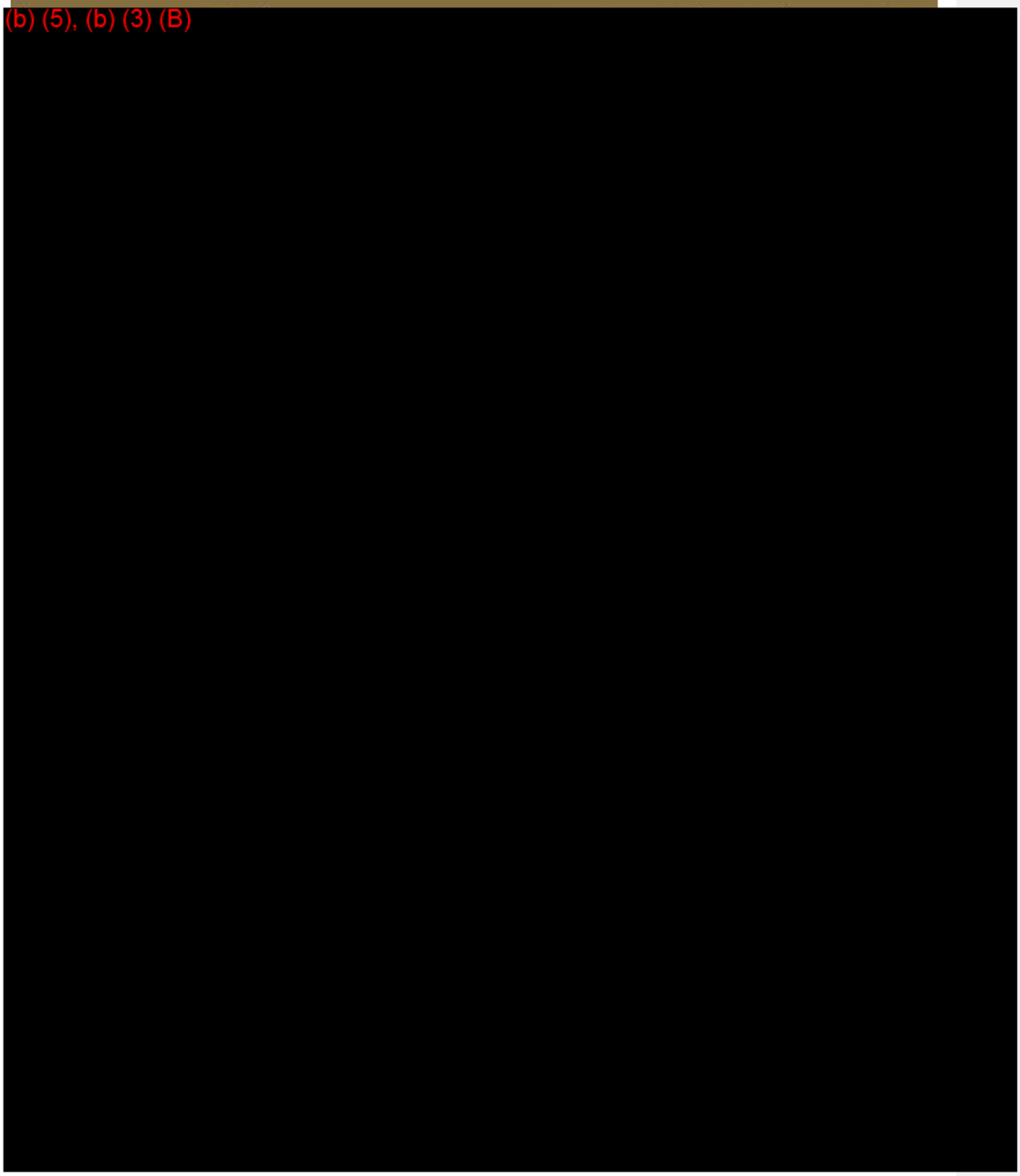
Critical Question 4 was addressed by mapping the density of rare plants per hectare within GOGA-managed lands (Figures 4.6.4.1, 4.6.4,2 and 4.6.4,3). This mapping effort includes threatened, endangered, and rare plant species of interest to GOGA management, not just the species of interest discussed above. The maps and associated spatial data will support management decisions regarding known rare plant occurrences.

Comment [49]: add the # of species included in this mapping

Critical Question 5 was addressed by mapping known occurrences of threatened and endangered plants within vegetation types that occur in GOGA-managed lands (Figures 4.6.4.4, 4.6.4.5 and 4.6.4.6). Precise locations of known rare plant populations can serve as indicators of habitat preferences or requirements. Those preferences can then be used to identify other potential habitats for survey or rare plant introduction efforts. The maps and supporting spatial data will support GOGA rare plant management, habitat restoration, and inform future survey efforts.

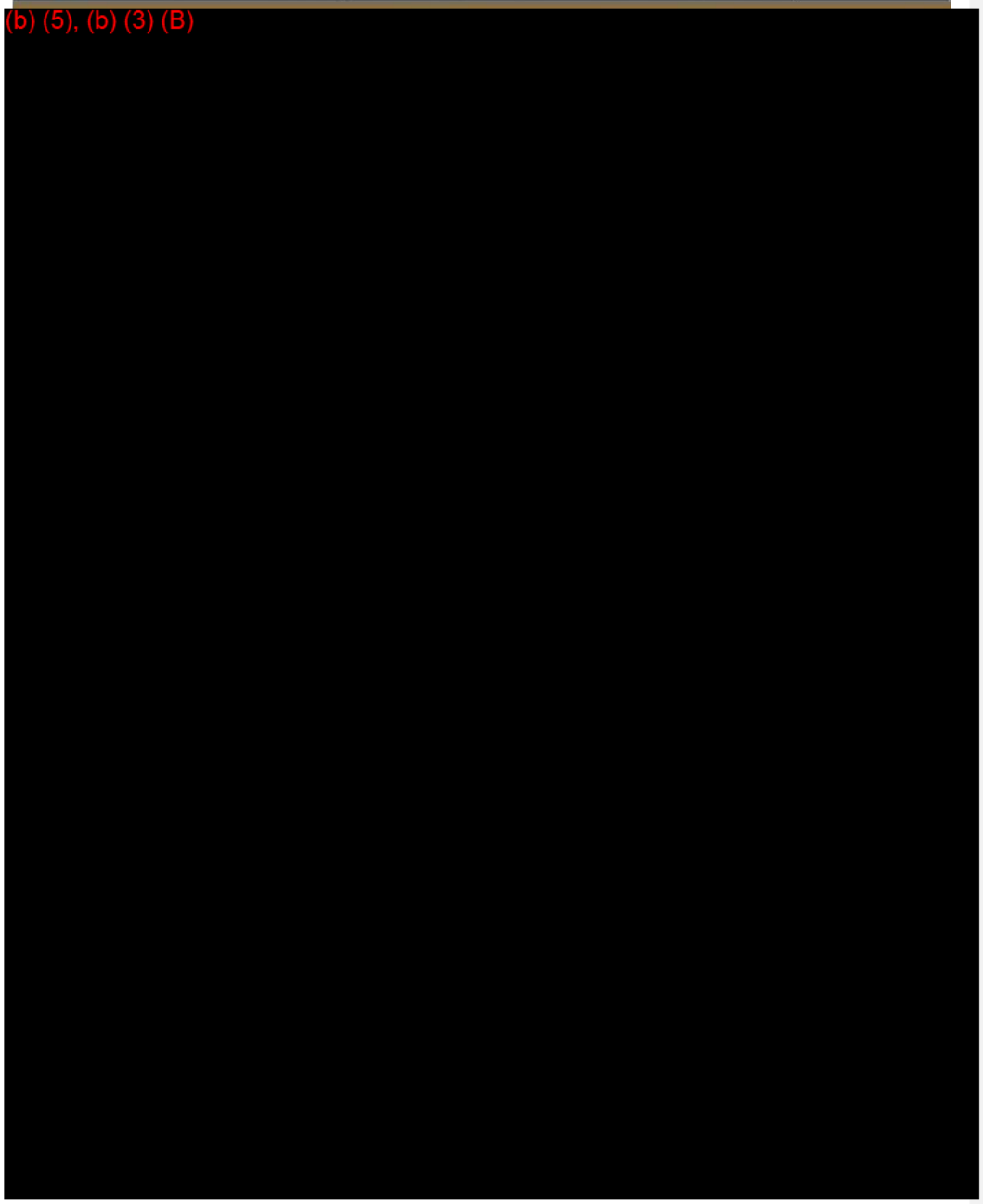
Rare Plant Density (individuals/hectare)
GOGA-Managed Land in Marin County

(b) (5), (b) (3) (B)



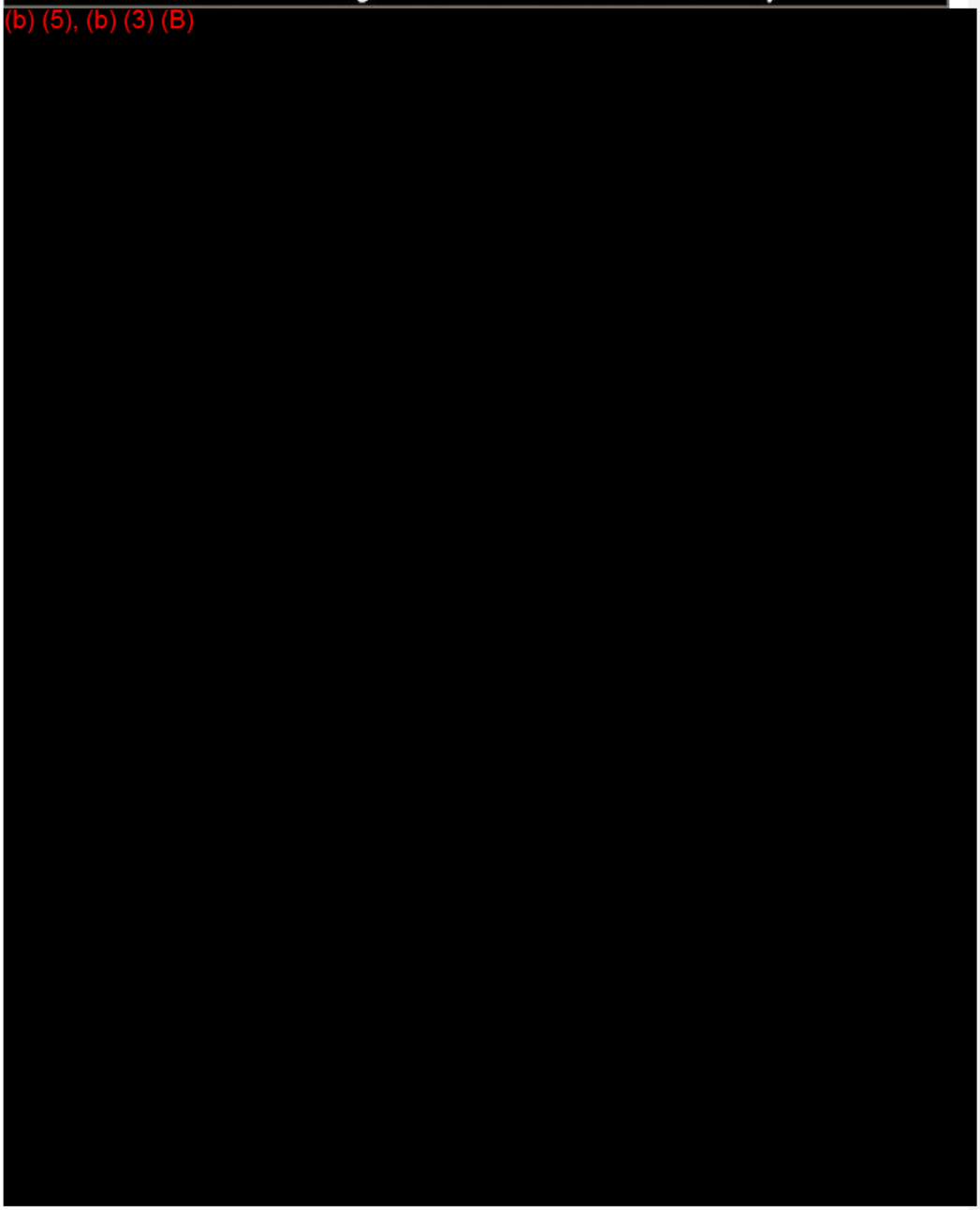
Rare Plant Density (individuals/hectare)
GOGA-Managed Land in San Francisco County

(b) (5), (b) (3) (B)



Rare Plant Density (individuals/hectare)
GOGA-Managed Land in San Mateo County

(b) (5), (b) (3) (B)



Maps for next draft:

*Figure **4.6.4.4**. Potential Rare Plant Habitat in Marin County*

*Figure **4.6.4 5**. Potential Rare Plant Habitat in San Francisco County*

*Figure **4.6.4.6** Potential Rare Plant Habitat in San Mateo County*

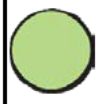
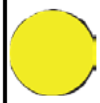
4.6.5 Summary of Resource Condition

The Critical Questions posed for rare plant resource at GOGA were the following:

1. What is the current status and distribution of threatened and endangered species of interest within GOGA?
2. What are significant stressors for threatened and endangered species of interest within GOGA?
3. Has climate influenced population trends for Presidio clarkia (*Clarkia franciscana*), Marin dwarf flax (*Hesperolinon congestum*), or San Francisco lessingia (*Lessingia germanorum*)?
4. What areas within GOGA have high numbers of threatened, endangered and rare plant species of interest?
5. Where, within GOGA, is potential habitat for threatened and endangered plants?

The first three Critical Questions were addressed in Section 4.6.3 for each of the eight species of interest: Franciscan manzanita (*Arctostaphylos franciscana*), Presidio manzanita (*Arctostaphylos montana* ssp. *ravenii*), marsh sandwort (*Arenaria paludicola*), Tiburon paintbrush (*Castilleja affinis* ssp. *neglecta*), Presidio clarkia (*Clarkia franciscana*), Marin dwarf flax (*Hesperolinon congestum*), San Francisco lessingia (*Lessingia germanorum*), and Hickman's cinquefoil (*Potentilla hickmanii*). The condition of eight species was examined through USFWS documentation and NPS monitoring reports. The conditions were also summarized by management unit in order to identify regions where rare plant condition may warrant concern. The condition and confidence in assessment for each of the three indicators are summarized below.

Summary of Indicators for GOGA Rare Plants

Indicator of Condition	Specific Measure	Condition Status	Rationale
How many of the natural populations observed since GOGA management began are still extant?	Proportion of extant natural populations with > 0 individuals in 2012 and 2013. Populations not monitored will not be counted toward score.		Of the eight species of interest, seven were in good condition, and one had an unknown condition. Five conditions had high confidence in the rating, one had moderate confidence, and one had low confidence. One unknown condition with low confidence was omitted from this summary.
Have introduction efforts been successful?	Proportion of successful introductions into new sites. This does not include natural populations.		Of the eight species of interest, three were in good condition. The condition of two warranted moderate concern and the condition of one warranted significant concern. One condition had high confidence in the rating. Three conditions had moderate confidence, and two had low confidence.

			Two conditions were unknown or not applicable. The unknown conditions and confidence levels were omitted from this summary.
Have the USFWS Recovery Plan goals been fulfilled for populations within GOGA lands?	Proportion of interim and long-term goals realized or in progress. Goals carried out by other entities will not be counted toward score.		Of the eight species of interest, four were in good condition, and three warranted moderate concern. One condition was unknown. Six conditions had moderate confidence in the rating and one had low confidence. The unknown condition was omitted from this summary.

In general, the natural populations that had been observed within GOGA lands (excluding historical observations) continued to persist under GOGA management and monitoring. The condition of the natural population of marsh sandwort was not applicable for this analysis because the GOGA population was introduced. Overall, confidence ratings were high for the condition status rates given the consistent annual monitoring conducted by GOGA. However, at the time of data compilation for this report, there was low confidence in the status of GOGA population of Hickman's cinquefoil because there was no monitoring data to support observations made by NPS staff (Chasse pers. com. 2015). The condition of Marin dwarf flax was considered moderately confident because the Nicasio Ridge population was not consistently monitored.

Comment [50]: should we delete this and say he population is stable based on exis ing data not analyzed in this report?

The success of introduction efforts ranged from successful to failure depending on species and site. Two species, Tiburon paintbrush and Hickman's cinquefoil, had not had any documented introduction efforts by GOGA. Marin dwarf flax had two failed introduction attempts, warranting significant concern. The San Francisco lessingia and Presido clarkia introduction efforts had both successes and failures, warranting moderate concern. Confidence levels ranged from high to low in condition statuses that were assessed. Low and moderate confidence levels occurred where monitoring protocols were unknown or had been modified for some or all populations.

Many of the recovery criteria outlined in Recovery Plans for the species of interest were in progress, partially met, or met for GOGA-managed populations. Most criteria involved preservation of habitat, management of threats, and introduction of new populations. However, long-term criteria were often not met. Downlisting criteria were not considered in this analysis where the criteria overlapped the recovery criteria. There was low confidence in the status of Hickman's cinquefoil because there were no site-specific data reviewed for this analysis. No analysis of recovery criteria was conducted for Franciscan manzanita because no Recovery Plan had been completed for the species.

The overall condition of rare plant populations managed by GOGA is good, as calculated by the suggested set of rules for Natural Resource Condition Assessments. This overall score does not include a trend analysis because the population data for the rare plants of interest was not robust enough. Furthermore, the first indicator is limited to assessing populations as extant or potentially extirpated. This does not include any assessment of viable population levels or

threshold population levels determined by the USFWS or another entity. Continued monitoring and management of the rare plants within GOGA is most important to sustain populations in a changing climate and with increasing urban population.

SUMMARY MAPS for next draft

*Figure **4.6.5.1** Condition Summary Map for Marin County*

*Figure **4.6.5.2**. Condition Summary Map for San Francisco County*

*Figure **4.6.5.3**. Condition Summary Map for San Mateo County*

4.6.12 Information Sources

Sources of Expertise

This review incorporates data reported in the most recent USFWS Recovery Plans, USFWS 5-year Reviews, NPS reports submitted to USFWS and data collected by NPS. Selection of indicator conditions and specific measures were chosen in consultation with GOGA staff in order to represent the condition of the species of interest.

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