Arctostaphylos montana ssp. *ravenii*
(Presidio manzanita)

5-Year Review:
Summary and Evaluation

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Sacramento Fish and Wildlife Office
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5-YEAR REVIEW

Arctostaphylos montana ssp. *ravenii* (Raven's manzanita)

I. GENERAL INFORMATION

Purpose of 5-Year Reviews:

The U.S. Fish and Wildlife Service (Service) is required by section 4(c)(2) of the Endangered Species Act (Act) to conduct a status review of each listed species at least once every 5 years. The purpose of a 5-year review is to evaluate whether or not the species' status has changed since it was listed (or since the most recent 5-year review). Based on the 5-year review, we recommend whether the species should be removed from the list of endangered and threatened species, be changed in status from endangered to threatened, or be changed in status from threatened to endangered. Our original listing of a species as endangered or threatened is based on the existence of threats attributable to one or more of the five threat factors described in section 4(a)(1) of the Act, and we must consider these same five factors in any subsequent consideration of reclassification or delisting of a species. In the 5-year review, we consider the best available scientific and commercial data on the species, and focus on new information available since the species was listed or last reviewed. If we recommend a change in listing status based on the results of the 5-year review, we must propose to do so through a separate rule-making process defined in the Act that includes public review and comment.

Species Overview:

As summarized from the Recovery Plan for Coastal Plants of the Northern San Francisco Peninsula (Recovery Plan) (Service 2003), *Arctostaphylos montana* ssp. *ravenii* (Presidio manzanita also referred to as Raven's manzanita) is a prostrate to ascending evergreen shrub in the heath family (Ericaceae). The plant's leathery, evergreen, round-elliptic to elliptic leaves are 1 to 2 centimeters (cm) (0.4 to 0.8 inches (in)) long, 1 to 1.5 cm (0.4 to 0.6 in) wide, and are isofacial (have the same type of surface and color on both sides) (Wells 1993, p. 552; Parker and Frey 2010, p. 6). The flowers are urn-shaped, with five-lobed white corollas 4 to 5 millimeters (mm) (0.25 in) long (Wells 1993, p. 552; Parker and Frey 2010, p. 9). Flowers appear from February to March (California Native Plant Society (CNPS 2001, p. 77)) depending on rainfall and temperature patterns (Parker and Frey 2010, p. 9). The small, round fruit (a drupe) is 4 to 5 mm (0.16 to 0.20 in) in diameter with a dry, smooth surface (Parker and Frey 2010, p. 9). The species is restricted to a single clonal colony in the San Francisco Presidio on the San Francisco peninsula. It is found in a maritime chaparral-coastal prairie community (Parker and Frey 2010, p. 14) which is influenced by summer coastal fog, humidity, and cool temperatures. The population, which consists of one wild plant augmented by identical daughter clones of the mother (wild) plant, is found on serpentine soil. All historic localities are recorded from the San Francisco peninsula; however, with the exception of the remaining Presidio occurrence, all other localities were extirpated before this plant was rediscovered in 1950 (California Natural Diversity Database (CNDDB 2011)). The wild plant has been observed to set seed although no natural seedling establishment is known to have occurred. The plant lacks burls (specialized flattened trunk-like structures that are adapted to rapid vegetative regeneration following fires).

The species is an obligate seeder and reproduces only from seeds that germinate following a fire or other disturbance (Parker and Frey 2010, p. 3). All *Arctostaphylos* species, including *A. montana* ssp. *ravenii*, are dependent on a mutualistic relationship with mycorrhizal fungi in the soil for nutrition in poor soils such as serpentine soils (Parker and Frey, 2010, p. 16).

Methodology Used to Complete This Review:

This review was prepared by the Sacramento Fish and Wildlife Office (SFWO), following the Region 8 guidance issued in March 2008. We used information from the Recovery Plan (Service 2003), survey information from experts who have been monitoring this species, and the CNDDB maintained by the California Department of Fish and Game. The Recovery Plan and personal communications with experts were our primary sources of information used to update the species' status and threats. We received no information from the public in response to our Federal Notice initiating this 5-year review. This 5-year review contains updated information on the species' biology and threats, and an assessment of that information compared to that known at the time of listing or since the last 5-year review. We focus on current threats to the species that are attributable to the Act's five listing factors. The review synthesizes all this information to evaluate the listing status of the species and provide an indication of its progress towards recovery. Finally, based on this synthesis and the threats identified in the five-factor analysis, we recommend a prioritized list of conservation actions to be completed or initiated within the next 5 years.

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Federal Register (FR) Notice Citation Announcing Initiation of This Review: A notice announcing initiation of the 5-year review of this taxon and the opening of a 60-day period to receive information from the public was published in the Federal Register on May 21, 2010 (75 FR 28636). No reports of information were received.

Listing History:

> **Original Listing**
> **FR Notice**: 44(209): 61910-61911.
> **Date of Final Listing Rule:** October 26, 1979.
> **Entity Listed:** *Arctostaphylos hookeri* ssp. *ravenii*, a plant subspecies.
> **Classification:** Endangered
>
> **State Listing** *Arctostaphylos hookeri* ssp. *ravenii* (Presidio manzanita) was listed by the State of California as endangered in November 1978.

Review History: The Raven's Manzanita Recovery Plan was published by the Service in 1984 (U.S. Fish and Wildlife Service (Service) 1984) and merged into the updated Recovery Plan for Coastal Plants of the Northern San Francisco Peninsula (Service 2003). No other reviews or analyses are known to have been conducted.

Species' Recovery Priority Number at Start of 5-Year Review: The recovery priority number for *Arctostaphylos montana* ssp. *ravenii* is 12 according to the Service's 2011 Recovery Data Call for the Sacramento Fish and Wildlife Office, based on a 1-18 ranking system where 1 is the highest-ranked recovery priority and 18 is the lowest (Endangered and Threatened Species Listing and Recovery Priority Guidelines, 48 FR 43098, September 21, 1983). This number indicates that the taxon is a subspecies or variety that faces a moderate degree of threat and has a low potential for recovery.

Recovery Plan or Outline

> **Name of Plan or Outline:** Recovery Plan for Coastal Plants of the Northern San Francisco Peninsula
> **Date Issued:** August 8, 2003
> **Dates of Previous Revisions:** 1984
> The original recovery plan (Service 1984) was written for the recovery of *Arctostaphylos montana* ssp. *ravenii*, then known as *Arctostaphylos hookeri* ssp. *ravenii* (Raven's manzanita). In 2003, this species was included in the Recovery Plan for Coastal Plants of the Northern San Francisco Peninsula, which revised the recovery criteria and threats for the species.

II. REVIEW ANALYSIS

Application of the 1996 Distinct Population Segment (DPS) Policy

The Endangered Species Act defines "species" as including any subspecies of fish or wildlife or plants, and any distinct population segment (DPS) of any species of vertebrate wildlife. This definition of species under the Act limits listing as distinct population segments to species of vertebrate fish or wildlife. Because the species under review is a plant, the DPS policy is not applicable, and the application of the DPS policy to the species' listing is not addressed further in this review.

Information on the Species and its Status

Species Biology and Life History

Spatial Distribution At the time of listing in 1979, only one wild plant in the San Francisco Presidio was known to exist. No additional occurrences have been discovered since that time. The historical distribution of the species included possibly five locations on the San Francisco peninsula: the former Laurel Hill Cemetery, the former Masonic Cemetery, Mount Davidson, Mount Tamalpais, and the Protestant Orphan Asylum. Although some of these records may be questionable, particularly the latter two, the species was likely more widespread historically in

San Francisco (Parker and Frey 2010, p. 21). No *Arctostaphylos montana* ssp. *ravenii* plants were salvaged from these former locations before the sites were destroyed for development. Early surveys for *A. montana* ssp. *ravenii* are lacking because the species was not recognized as a distinct entity until long after all but the existing occurrence of *Arctostaphylos montana* ssp. *ravenii* were extirpated. In addition to the single wild plant, a number of clones have been propagated since the time of listing and continue to exist at the locations described below in Abundance.

Abundance One *Arctostaphylos montana* ssp. *ravenii* plant was known to occur in the wild on the San Francisco Presidio at the time of listing. No additional wild plants have been discovered since that time. Between 1961 and 1999, clones and seeds from the wild plant were planted at several locations including: seven locations in the Presidio, two Golden Gate National Recreation Area nurseries, five botanical gardens, and two commercial nurseries (Parker and Frey 2010. p. 25). Currently, living *A. montana* ssp. *ravenii* clones remain at three locations on the Presidio, at three botanic gardens, UC Berkeley Botanic Garden (H. Forbes, pers. comm., October 6, 2011), San Francisco Botanic Garden at Strybing Arboretum (www.sfbotanicalgarden.org 2011), and East Bay Regional Park, Regional Parks Botanic Garden (S. Edwards, pers. comm., October 11, 2011), and at at least one commercial nursery, Yerba Buena Nursery (Parker and Frey 2010. p. 25).

Habitat or Ecosystem *Arctostaphylos montana* ssp. *ravenii* is currently found on a serpentine outcrop on the San Francisco Presidio (Wells 1993). Historic occurrences were found on serpentine and greenstone soils in the San Francisco area (Parker and Frey 2010, p. 22; CNDDB 2011). The plant community in which the single remaining wild plant is found is maritime chaparral-coastal prairie. *Arctostaphylos montana* ssp. *ravenii* is a member of maritime chaparral because of the moderating influence of coastal fog, particularly summer fog, on its habitat (Parker and Frey 2010, p. 17). No new information is available on the plant's habitat or ecosystem since the time of listing.

Changes in Taxonomic Classification or Nomenclature The Raven's manzanita and *Arctostaphylos franciscana* (Franciscan manzanita), both endemic to the San Francisco peninsula, were long considered to be variations of the same species (Roof 1976; Service 2003). In 1968, prior to the listing, Wells separated the Raven's manzanita from *A. franciscana* and described the former as a subspecies of a Monterey Bay species, *A. hookeri* ssp. *ravenii* (Parker and Frey 2010, p. 10). Parker, Vasey, and Keeley published revisions to *Arctostaphylos* in the journal Madrõno (Parker *et al*. 2007), in the Flora of North America (Parker *et al*. 2009), and in The Jepson Manual (Parker *et al*.,in press) which now names the species as *A. montana* subsp. *ravenii*.

Genetics No known genetic changes have occurred to the species since the time of listing. All clones which have been planted since 1979 were taken from the wild plant and are, therefore, genetically identical to it. Loss of genetic diversity occurred to the species prior to the listing when it was reduced to a single plant. Any new populations starting from the wild plant will have reduced genetic variation compared to historic populations. The generation with the smallest number of individuals has the greatest effect on the genetic variation of subsequent generations. Even if the number of plants is increased, it will not reverse the previous genetic loss known as the "bottleneck effect" (Allendorf and Luikart 2007, p. 158). Bottlenecks

generally have a greater and more lasting effect on the loss of genetic variation in species that have slow growth rates (long-lived species with few offspring) (Allendorf and Luikart 2007, p. 133). The wild plant, which was discovered at the Presidio in 1952, shows evidence of this life history pattern (long-lived with few offspring) because it is possibly over 100 years of age (Service 2003) and is not known to have produced any offspring in the wild since its discovery nearly 60 years ago. Genetic studies by Markos *et al*. (1998) and others (Parker and Frey 2010, p. 11) suggest that *Arctostaphylos montana* ssp. *ravenii* may be the result of hybridization among diploids including *A. hookeri* spp. *franciscana* and *A. hookeri* ssp. *hookeri*. The relationship of the taxon with other species of *Arctostaphylos* has also been analyzed by Boykin *et al.* 2005 and Wahlert *et al.* 2009 (as cited in Parker and Frey 2010, pp. 12, 13). Parker has also investigated relationships between *A. montana* ssp. *ravenii* and other species of *Arctostaphylos* (Parker and Frey 2010, pp. 13, 64, 65).

Species-specific Research and/or Grant-supported Activities Markos *et al.* (1998) re-evaluated previous treatments of the *A. hookeri* complex in which *Arctostaphylos montana* ssp. *ravenii* had been placed (Parker and Frey 2010 p., 11). The taxonomic relationship of the species has been reevaluated (Parker *et al.* 2007, Parker *et al.* 2009, and Parker *et al*., *in press*). The relationship of the taxon with other species of *Arctostaphylos* has also been analyzed in Boykin *et al.* 2005 and Wahlert *et al.* 2009 (as cited in Parker and Frey 2010, pp. 12, 13). Parker has also investigated relationships between *A. montana* ssp. *ravenii* and other species of *Arctostaphylos* (Parker and Frey 2010, pp. 13, 64, 65, unpublished data).

Five-Factor Analysis

The following five-factor analysis describes and evaluates the threats attributable to one or more of the five listing factors outlined in section 4(a)(1) of the Act.

FACTOR A: Present or Threatened Destruction, Modification, or Curtailment of Habitat or Range At the time of listing, the threats noted for Factor A for *Arctostaphylos montana* ssp. *ravenii* were potential single inadvertent actions that could destroy the last remaining plant. Potential development and competition with nonnative plants were said to present serious threats to native plants on the Presidio. Aggressive plant competitors that were noted in particular were *Cupressus macrocarpa* (Monterey cypress), *Eucalyptus* spp. (eucalyptus or gums), and *Mesembryanthemum* spp. (ice plants). Currently, potential single inadvertent actions that could destroy the plant continue to be a threat to the species. The three invasive plant species noted above no longer directly threaten *Arctostaphylos montana* ssp. *ravenii*. However, nearby stands of *Pinus radiata* (Monterey pine) and *Cupressus macrocarpa* currently limit expansion of *A. montana* ssp. *ravenii* habitat and may alter wind patterns relative to former conditions (M. Chassé, *in litt*., July 5, 2011, p. 2). Current threats from nonnative species are mostly from herbaceous plants such as the urban weed, *Oxalis pes-caprae* (Bermuda buttercup) (M. Chassé, *in litt*., July 5, 2011, p. 2). Introduced plants may also impact the habitat of *A. montana* ssp. *ravenii* by modifying the generally depauperate serpentine soils through nutrient enrichment and modifying the available soil moisture (Parker and Frey 2010, 16). Either of these changes could lead to the conversion of the plant community toward more competitive species and make the site less suitable to *A. montana* ssp. *ravenii* (Parker and Frey 2010, 16).

Several native plants are having negative impacts on the original wild plant and daughter clones. For example, areas of *Arctostaphylos montana* ssp. *ravenii* that are shaded by the leaves of *Chlorogalum pomeridianum* (soap-plant), have experienced dieback (Parker and Frey 2010, p. 26). Other native species that have caused dieback of *A. montana* ssp. *ravenii*, apparently from shading, include *Grindelia hirsutula* ssp. *maritima* (gumweed) and *Baccharis pilularis* (coyote brush). *Ceanothus thyrsiflorus* (blue blossom) is encroaching on many of the clones (M. Chassé, *in litt*., July 5, 2011, p. 2).

Work is planned to occur on trails in the Presidio that are near the wild plant. Planning for the trails; however, is still underway and the resulting trail routes are proposed to be further away from the wild plant than they are currently (M. Frey and S. Estelle, *in litt*., July 5, 2011, p1).

In summary, *Arctostaphylos montana* ssp. *ravenii* continues to be threatened by competition from native and nonnative plant species.

FACTOR B: Overutilization for Commercial, Recreational, Scientific, or Educational Purposes

The final listing rule notes that *Arctostaphylos* species are often a part of native plant gardens in California and that a plant collector could remove or harm the single wild plant. It is further noted, however, that this species is maintained in at least one local botanic garden which could serve as a source of plant material. Since the time of listing, no collection of cuttings or clones of the plant or vandalism of the plant has been observed (S. Estelle, *in litt*., October 4, 2011, p. 2; M. Chassé *in litt*., July 5, 2011, p. 2). The locations of the wild plant and its clones have not been revealed to the public by NPS in order to protect the plant from vandalism. No damage to the plant has been observed to date; however, trampling or the taking of cuttings could occur if the identification and location of the plants become known.

In summary, overutilization for commercial and recreational purposes is a threat to the wild *A. montana* ssp. *ravenii* plant and its clones.

FACTOR C: Disease or Predation

Disease and predation were not known to be threats to the species at the time of listing. In 1999, an irruption of tussock moth caterpillars resulted in partial defoliation of many of the daughter clones of *Arctostaphylos montana* ssp. *ravenii*. The caterpillars were removed by hand. Since 2000, occurrences of insect infestation have occurred but not with the severity of the 1999 irruption (M. Frey and S. Estelle, *in litt*., July 5, 2011, p. 1). No tussock moth caterpillars have been seen on the plants in 2011 (M. Chassé, *in litt*., July 5, 2011, p2). Leafrollers, which infested the *Arctostaphylos franciscana* (Franciscan manzanita) in the Presidio in 2010, have not been observed on *A. montana* ssp. *ravenii* (M. Frey and S. Estelle, *in litt*., July 5, 2011, p. 1).

Twig blight, a fungus that causes tissue death in leaves, has infected *Arctostaphylos montana* ssp. *ravenii* in years of frequent and late rains. A slow dieback of branches, especially on the original wild plant and the daughter clones surrounding it, has occurred over the past decade (M. Chassé, *in litt*., July 5, 2011, p. 2). The dieback is not as severe on other clones of *A. montana*

ssp. *ravenii* in the area. Some of this dieback may be due to other native vegetation, such as the *C. pomeridianum* noted in the Factor A discussion above, growing over the *A. montana* ssp. *ravenii* branches (M. Chassé, *in litt*., July 5, 2011, p. 2).

The introduced soil-borne pathogen, *Phytophthora cinnamomi*, has long been known as a world-wide threat to commercial and ornamental plants. *P. cinnamomi* is a fungus-like organism most closely related to diatoms and kelp (Kingdom Stramenopilia) rather than to the true fungi (Kingdom Fungi or Eumycota). Human-related activities, including the international plant trade have facilitated spread of *P. cinnamomi* into many habitats worldwide (Swiecki *et al.* in press, p. 3). *P. cinnamomi* was introduced to California early in the 20th century and recently has been identified as a serious threat to the State's native plants and their habitats (Swiecki *et al.* in press, p. 3).

Phytophthora cinnamomi has been the cause of the decline and death of rare *Arctostaphylos* species, including *A. pallida* (pallid manzanita) in the Oakland Hills of the East San Francisco Bay region, and *A. myrtifolia* (Ione manzanita) near Ione in the Sierra Nevada foothills, and of other woody native species in the San Francisco Bay area (Swiecki *et al.* in press, pp. 3 to 5). This organism causes root decay but can also kill above-ground portions of some plants (Swiecki *et al.* in press, p. 3). *P. cinnamomi* is persistent in soil, and once introduced to native habitat, it cannot be eradicated (Swiecki *et al.* in press, p. 3). *P. cinnamomi* is transmitted by contaminated shoes, tools, and infested soil clinging to tires, and by using contaminated nursery stock, including native plant stock. Many areas showing plant mortality caused by *P. cinnamomi* are associated with hiking trails, landscaping with ornamental plants, and, in the case of the Apricum Hill Preserve, with use by visitors including researchers, agency personnel, and students (Swiecki *et al.* in press, p. 4). This pathogen poses a threat in the foreseeable future to *A. montana* ssp. *ravenii* through the potential for infestation by the public and by staff who work with the plant. It is not possible to predict when the pathogen might infect the wild plant since the disease is generally transmitted directly or indirectly by humans or human activity. Should the wild plant become contaminated with *P. cinnamomi*, the result would be the decline and death of the wild plant, and any clones planted nearby, and the permanent contamination of the soil and seedbank beneath the plants. Any seedlings that germinate from this seedbank could also be contaminated and not survive. No crown rot, *P. cinnamomi*, has been observed on the mother plant or clones (S. Estelle, *in litt*., October 4, 2011, p.2). Leaves from *A. montana* ssp. *ravenii* as well as other plant species were collected in the Presidio in April 2011 to test for presence of sudden oak death (*P. ramorum)*; however, no evidence of the disease was detected in any of the collected material (S. Estelle, *in litt*., October 4, 2011 p. 2).

In summary, *Arctostaphylos montana* ssp. *ravenii* continues to be threatened by a variety of diseases.

FACTOR D: Inadequacy of Existing Regulatory Mechanisms

At the time of listing, regulatory mechanisms thought to have some potential to protect *Arctostaphylos montana* ssp. *ravenii* included: listing under the California Endangered Species Act (CESA) and the Federal Endangered Species Act. The listing rule (44 FR 61910) provides an analysis of the level of protection that was anticipated from those regulatory mechanisms.

This analysis appears to remain currently valid. The Federal listing was expected to reinforce the protection from CESA already available before the Federal listing. Because the species grew on land controlled by a U.S. government agency, section 7 of the Federal Endangered Species Act would be important in assuring its preservation.

In summary, the Endangered Species Act is the primary Federal law that provides protection for this species since its listing as endangered in1979. Other Federal and State regulatory mechanisms provide discretionary protections for the species based on current management direction, but do not guarantee protection for the species absent its status under the Act. Therefore, we continue to believe other laws and regulations have limited ability to protect the species in absence of the Endangered Species Act.

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

Loss of pollinators

The final listing rule notes that members of the genus *Arctostaphylos* are pollinated by large bees (e.g., *Bombus* (bumblebees) and *Anthophora* (mining bees)) and that native insect populations have been seriously reduced in San Francisco. The final rule also notes that it is important to the recovery of *Arctostaphylos montana* ssp. *ravenii* to maintain healthy populations of pollinators in a natural state in the vicinity of the plant. Although no surveys of pollinators of *A. montana* ssp. *ravenii* have been done since the time of listing, two recent studies of bee diversity in the Presidio have been conducted at several sites in the Presidio (Wood *et al*. 2005, Van Den Berg *et al*. 2010). The study conducted in 2004 (Wood *et al*, 2005) established a baseline of species and numbers of bees found at nine sites on the Presidio. The study conducted in 2008 (Van Den Berg *et al*. 2010) resampled three of these sites, which included the site near the wild *A. montana* ssp. *ravenii* plant, and added a new previously unsampled site. A comparison of the results of the two studies at the three sites in common, Thompson Reach, Lobos Dunes, and the site near the *A. montana* ssp. *ravenii* plant, revealed a number of differences between the studies. Overall, the average bee species richness and abundance at the three previously samples sites were greater in 2004 with 47 species and 1,283 individuals compared to 36 species and 878 individuals in 2008 (Van Den Berg *et al*. 2010, p. 4). At the sampling site near the *A. montana* ssp. *ravenii*; however, a different trend was observed in 2008. Bee diversity increased from 15 species in 2004 to 26 species in 2008 although five species including the common bumblebee, *Bombus vosnesenskii*, had declined dramatically. Abundance of bees at this site more than doubled from 192 individuals in 2004 to 391 in 2008 (Van Den Berg *et al*. 2010, p. 5). A new study is proposed to begin in November 2011 to identify the pollinators visiting *A. montana* ssp. *ravenii* and *A. franciscana* and to compare the bloom periods for both plant species to provide information for future outplanting of the species and managing the habitat for their associated pollinators (Gambel 2011, p.1).

Additional threats identified since the time of listing:

Climate change

Climate is predicted to change in California during the 21st century (Field *et al*. 1999; Cayan *et*

al. 2005). Even modest changes in warming could result in a reduction of the spring snowpack, earlier snowmelt, and more runoff in winter with less runoff in spring and summer, more winter flooding, and drier summer soils (Field *et al*. 1999; Cayan *et al*. 2005). The predicted impacts on California's ecosystems projected with a high certainty include higher sea level; decreased suitable habitat for many terrestrial species as climate change intensifies human impacts; and increased competition among urban, agricultural, and natural ecosystem uses (Field *et al*. 1999). Although the specific effects of climate change on *Arctostaphylos montana* ssp. *ravenii* are unknown, the effects of increased winter flooding and drought conditions in the spring have the potential to adversely affect this species. In addition, it is not known how climate change will influence ocean currents and in turn affect the frequency of coastal summer fog which is an important element of the species' maritime chaparral habitat.

Loss of seed predators that cache seeds

The seeds of *Arctostaphylos* species are dispersed primarily by mammals, including coyotes, foxes, and rodents (T. Parker pers. comm., 2011). Animals such as coyotes and foxes eat the *Arctostaphylos* fruit and may travel long distances before depositing their scat. Any undigested fruit left in the scat can then be harvested by rodents and either eaten or buried. Parker (2010, p. 1) found that 70 percent of the fruits buried by rodents were located deeper than 2 centimeters (cm) (0.78 in), which is the maximum soil depth at which seeds are typically killed by wildfire. This activity inadvertently protects the soil seedbank from destruction by wildfire. A small mammal eradication program in the Presidio could have long-term negative effects on *A. montana* ssp. *ravenii* by removing this protection from wildfire. Currently, however, there is no gopher control program in the immediate area around the original *A. montana* ssp. *ravenii* plant although gopher control does happen in irrigated turf areas nearby (M. Frey and S. Estelle, *in litt*., 2011, p. 2).

Loss of mutualistic mycorrhizal fungi

Arctostaphylos species are dependent on mutualistic relationships with mycorrhizal fungi for nutrition (Parker and Frey 2010, p. 16). Some invasive plant species can modify the composition of the soil microbial community to their advantage when they invade new soils (Callaway *et al.* 2004, p. 731); therefore, invasion by nonnative plants could impact *Arctostaphylos montana* ssp. *ravenii* by shifting the community composition of the mycorrhizal fungi away from those that benefit *A. montana* ssp. *ravenii* to those that benefit the invading species (Parker and Frey 2010, p. 16 .

Loss of Genetic Diversity

Any new population starting from the single wild plant is likely to have reduced genetic variation compared to historical populations. The generation with the smallest number of individuals has the greatest effect on the genetic variation of subsequent generations. Even if the number of plants is expanded, it may not reverse the previous genetic loss known as the "bottleneck effect" (Allendorf and Luikart 2007, p. 158). Bottlenecks generally have a greater and more lasting effect on the loss of genetic variation in species that have slow growth rates (long-lived species with few offspring) (Allendorf and Luikart 2007, p. 133).

Reduced genetic variation may result in the plant's offspring not being able to adapt to changes in habitat such as those noted above in the discussion on climate change (decrease in fog), or loss of pollinators (see pollinator discussion above). *Arctostaphylos montana* ssp. *ravenii* is capable of self-pollination. In general, self-pollination results in a decrease in genetic variation in the offspring of a plant (Allendorf and Luikart, 2007, p. 123); therefore, a loss of genetic variation is expected if *A. montana* ssp. *ravenii* is dependent on self-pollination to produce seed. In a study on the effects of habitat fragmentation on a non-self-pollinating plant (Lennartsson 2002, pp. 3065, 3066, 3068), the author found that fragmented populations exhibited dramatically reduced seed set and population viability, both caused by a reduction in number of pollinators.

Stochastic Events and Small Population Size

Chance events constitute a serious threat to the species. Because the known population of *Arctostaphylos montana* ssp *ravenii* in the wild is currently limited to a single wild plant and its clones, the species is extremely vulnerable to stochastic events—normal but damaging environmental perturbations and catastrophes such as droughts, storm damage, and fires, from which large, wide-ranging populations can generally recover, but which may lead to extirpation of small, isolated populations (Gilpin and Soule 1986, pp. 25–31). Suitable pollinators may be critical for seed production for this obligatory-seeding species. If pollinators are not present or are in insufficient numbers, viable seeds may not be produced to develop and maintain the seedbank. Pollinators have been observed on the wild plant; however, no surveys have yet taken place to identify the most important pollinators.

The wild plant is also threatened by the Allee effect, which is a decline in population growth rate due to declining plant density (Akçakaya *et al.* 1999, p. 86). For the wild plant, the Allee effect may result from a lack of other available *Arctostaphylos montana* ssp *ravenii* plants with which to cross-pollinate and produce viable seed.

In summary, the potential loss of pollinators, loss of mutualistic mycorrhizal fungi, climate change, loss of seed predators that cache seeds, low genetic diversity due to the bottleneck effect, and little gene flow among the clones continue to threaten *A. montana* ssp. *ravenii* due to its extremely small range and small population size.

III. RECOVERY CRITERIA

An approved final recovery plan, *Recovery Plan for Coastal Plants of the Northern San Francisco Peninsula* (Service 2003), which included this species, was published in 2003. Recovery is the process by which the decline of an endangered or threatened species is arrested or reversed, and the threats to its survival are neutralized, so that its long-term survival in nature can be ensured. The goal of this process is the maintenance of secure, self-sustaining wild populations of the species. Recovery plans provide guidance to the Service, States, and other partners and interested parties on ways to minimize threats to listed species, and on criteria that may be used to determine when recovery goals are achieved. There are many paths to accomplishing the recovery of a species and recovery may be achieved without fully meeting all recovery plan criteria. For example, one or more criteria may have been exceeded while other criteria may not have been accomplished. In that instance, we may determine that, over all, the

threats have been minimized sufficiently, and the species is robust enough, to downlist or delist the species. In other cases, new recovery approaches and/or opportunities unknown at the time the recovery plan was finalized may be more appropriate ways to achieve recovery. Likewise, new information may change the extent that criteria need to be met for recognizing recovery of the species. Overall, recovery is a dynamic process requiring adaptive management, and assessing a species' degree of recovery is likewise an adaptive process that may, or may not, fully follow the guidance provided in a recovery plan. We focus our evaluation of species status in this 5-year review on progress that has been made toward recovery since the species was listed (or since the most recent 5-year review) by eliminating or reducing the threats discussed in the five-factor analysis. In that context, progress towards fulfilling recovery criteria serves to indicate the extent to which threat factors have been reduced or eliminated. The Recovery Plan concludes that recovery sufficient to warrant full delisting is not projected in the foreseeable future for *Arctostaphylos montana* ssp. *ravenii* and may not be possible. The Plan further states that this conclusion may be reconsidered in the remote future if success of long-term recovery exceeds current expectations.

Arctostaphylos montana ssp. *ravenii* may be downlisted to threatened status when the following interim and long-term criteria are met:

Interim Recovery Criteria

1. *Habitat and Population Stabilization in the Presidio*. The site of the original wild plant and all daughter clones established in the Presidio must be dedicated to permanent habitat protection, maintained, and protected in perpetuity (principally by removing nonnative vegetation). The original and daughter clones must exhibit significant net growth over a 10-year period, while the number of daughter clones must increase. These recovery criteria address Factor A (Present or threatened destruction modification, or curtailment of its habitat or range) and Factor D (Inadequacy of existing regulatory mechanisms).

This criterion has been partially met. The single wild plant known at the time of listing is protected by removal and pruning of competing native and nonnative plants (Parker and Frey 2010). However, several native plants are having negative impacts on the original and daughter clones. For example, areas of *Arctostaphylos montana* ssp. *ravenii* that are shaded by the leaves of *Chlorogalum pomeridianum* (soap-plant) exhibit dieback (Parker and Frey 2010, p. 26). Other species that have caused dieback of the *A. montana* ssp. *ravenii*, apparently by shading, include *Grindelia hirsutula* ssp. *maritima* (gumweed) and *Baccharis pilularis* (coyote brush) (Parker and Frey 2010, pp. 26, 28). The daughter clones of the original plant have exhibited sufficient growth that it is no longer possible to distinguish and count individual clones without damaging plants due to the intermingling of branches between plants (Parker and Frey 2010, pp. 49, 50). Currently there are approximately 17 daughter clones growing in the Presidio (Parker and Frey 2010, p. 49). This criterion is relevant and up to date.

2. *Propagation of Seedling and Clonal Stock*. Multiple nursery populations of propagated *Arctostaphylos montana* ssp. *ravenii* must be established within the Golden Gate Natural Recreation Area (GGNRA) and at two or more botanical gardens that are committed to conservation of this species. Nursery populations must consist of both clones and seedling-grown

plants. Seedling-grown plants must be derived at least from self-pollinated inbred lines (highest priority), but may include separate experimental breeding lines composed of recurrent backcrosses of selected *Arctostaphylos montana* (Tamalpais manzanita) individuals (and possibly *A. franciscana* or other *Arctostaphylos* taxa) on *A. montana* ssp. *ravenii* if production of inbred lines is not feasible, and if the strategy is recommended by a scientific review panel of manzanita experts, plant conservation geneticists, and others. The panel should develop a genetic management plan in cooperation with the Service before any hybridization. Genetic management of the species should be subject to expert peer review. Artificially bred stock should be maintained in both permanent outdoor collections for unrestricted growth (and future potential propagation stock), and in container-grown collections available for outplanting at restoration sites. The total cultivated population size must be maintained at 50 or more daughter clones(of original Presidio plant) at all times, with a goal of 50 seedling plants (preferably inbred, at least initially) that have at least two clonal replicates each (total 200 plants). This recovery criterion primarily addresses Factor A (Present or threatened destruction modification, or curtailment of its habitat or range) and Factor E (Other natural or manmade factors affecting its continued existence).

This criterion has been partially met. *Arctostaphylos montana* ssp. *ravenii* plants have been established at three botanical gardens that are committed to the conservation of the species, UC Berkeley Botanic Garden, San Francisco Botanic Garden at Strybing Arboretum, and East Bay Regional Park, Regional Parks Botanic Garden. However, only the UC Berkeley Botanic Garden population contains seedling-grown plants. The total number of clones in all populations is less than 50 clones and less than 50 plants are seedling-grown (Parker and Frey 2010, p. 25). Parker and Frey (2010, p. 33) state that developing a breeding program using close relatives and then backcrossing is not recommended at this time because the plant can produce viable seed and there may be sufficient variability among the seedlings to establish a reproductive population. Therefore, this criterion is relevant but not up to date.

3. *Establishment of new daughter clones on Presidio serpentine bluff sites.* At least five additional colonies, each comprising at least five daughter clones (with a goal of at least five inbred seedling-grown plants), must be established on relatively stable, exposed serpentine outcrops within or above the Presidio bluffs or in suitable inland outcrop areas, in areas where pre-existing vegetation is sparse, particularly on steep slopes. New colonies must exhibit net growth 5 years after transplanting with intensive maintenance. This recovery criterion primarily addresses Factor A (Present or threatened destruction modification, or curtailment of its habitat or range).

This criterion has been partially met. Seventeen clones have been established and have exhibited net growth over several years. No colonies have been established yet from inbred seedling-grown plants. This criterion is up to date and relevant.

4. *Investigation of taxonomic relationships and reproduction*. Studies must be conducted to clarify the taxonomic relationships between *Arctostaphylos montana* ssp. *ravenii* and Monterey County species *Arctostaphylos hookeri* ssp. *hearstiorum* and ssp. *hooker*i, *A. montana* (Tamalpais manzanita), *A. uva-ursi* (bearberry), and *A. franciscana*, and other relevant taxa. The breeding systems of these taxa including comparisons of fruit set and seed viability resulting

from within-species crosses and self-pollination, should also be studied. An especially high priority is to experimentally determine the level of self-compatibility (level of viable seed production resulting from self-pollination) in the one remaining wild *A. montana* ssp. *ravenii*. This recovery criterion primarily addresses Factor E (Other natural or manmade factors affecting its continued existence).

This criterion has been partially met. Progress has been made on the investigation of the taxonomic relationships. Prior to the listing, Wells (1968) identified a cluster of five coastal manzanitas as being sufficiently closely related to all be subspecies of *Arctostaphylos hookeri*. The three northernmost of the subspecies were *A. hookeri* ssp. *montana*, ssp. *ravenii*, and ssp. *franciscana*. All three of these subspecies are found only on serpentine soils. The two southernmost subspecies are *A. hookeri* ssp. *hearstiorum* and ssp. *hookeri*. Two of the three northern taxa (ssp. *ravenii* and ssp. *montana*) are tetraploid species with twice the number of chromosomes. The other northern taxon (ssp. *franciscana*) and the two southern taxa are diploids (Parker and Frey 2010, p. 11). Markos *et al.* (1998) found that the two southern subspecies were related closely by nuclear ribosomal spacer DNA sequences, but that the 3 northern subspecies differed considerably from the 2 southern subspecies. Subsequent genetic work using a variety of nuclear genes confirmed the distinction of the northern diploid species, ssp. *franciscana*, from the two southern diploid subspecies (Parker and Frey 2010, p. 11). The genetics suggests that ssp. *ravenii* may be the result of hybridization among diploids including ssp. *franciscana* and ssp. *hookeri*. The relationship of the taxon with other species of *Arctostaphylos* has also been analyzed by Boykin *et al.* 2005 and Wahlert *et al.* 2009 (as cited in Parker and Frey 2010, pp. 12, 13). As noted earlier, Parker, Vasey, and Keeley published revisions to *Arctostaphylos* in the journal Madrõno (Parker *et al*. 2007), in the Flora of North America (Parker *et al*. 2009), and in The Jepson Manual (Parker *et al*., in press) which now names the species as *A. montana* subsp. *ravenii*. Parker has also investigated relationships between *A. montana* ssp. *ravenii* and other species of *Arctostaphylos* (Parker and Frey 2010, pp. 13, 64, 65). Comparisons of fruit-set and seed viability in *A. montana* ssp. *ravenii* plants of different origins (self-pollinated and out-crossed) have not yet been studied. This criterion is relevant and partly up to date.

In addition to the foregoing interim (downlisting) recovery criteria, *Arctostaphylos montana* ssp. *ravenii* may be considered for reclassification to threatened status when all of the recovery criteria noted above are fully achieved and the following criteria are also fully achieved. The following recovery criteria (5 through 7) primarily address Factor A (Present or threatened destruction modification, or curtailment of its habitat or range) and Factor E (Other natural or manmade factors affecting its continued existence).

5. *At least five spontaneously reproducing variable populations are established in reserves on bedrock outcrops outside the Presidio in San Francisco, at least three of which must be on serpentine outcrops.*

This criterion has not been met. There are no populations established outside of the Presidio in San Francisco.

6. *At least two sexually reproduced generations are established within the Presidio.*

This criterion has not been met. Although the original wild plant has produced seed, no seedlings have been produced within the Presidio.

7. *At all sites, population size and individual clone size increase over a period of 30 years*

This criterion has been partially met. The clones have increased in size; however, because the clones on the Presidio were first planted in 1987, they have been measured for less than 30 years.

Long-term Recovery Criteria

1. *Reproduction and growth in the Presidio population*: If feasible, at least one generation of spontaneously established inbred (not experimental hybrid backcross) seedlings of *Arctostaphylos montana* ssp. *ravenii* must grow to reproductive maturity in at least one colony out of five new Presidio bluff subpopulations within 30 years after establishment. Over 50 percent of plants within all five colonies must exhibit progressive and significant net growth over 20 years. This recovery criterion primarily addresses Factor A (Present or threatened destruction modification, or curtailment of its habitat or range) and Factor E (Other natural or manmade factors affecting its continued existence).

This criterion has not yet been met. All plants that have been outplanted were propagated from cuttings. This criterion is up-to-date and relevant.

2. Establishment and protection of new interior populations. At least five mixed populations (*A. montana* ssp. *ravenii* and *A. franciscana*) consisting of original clones and cloned seedlings (preferably inbred lines, if they are feasible and found to be suitable for reintroduction to novel reintroduction sites) must be established at separate interior San Francisco serpentine outcrop sites. Over 50 percent of founder plants at each new population must exhibit net growth in size over a 10-year period. At least one generation of spontaneously recruited seedlings of *A. montana* ssp. *ravenii* must establish within 25 years in at least one interior site. Significant recurrent production of viable seed must be in evidence at all five sites. All reintroduction sites must be permanently maintained to prevent reinvasion by competing nonnative vegetation, degeneration from recreational misuse, or unforeseen threats that require adaptive management. This recovery criterion primarily addresses Factor A (Present or threatened destruction modification, or curtailment of its habitat or range) and Factor D (Inadequacy of existing regulatory mechanisms).

This criterion has not been met. No populations of *A. montana* ssp. *ravenii* from seedlings or populations of *A. franciscana* have been established at any sites. This criterion is up-to-date and relevant. A wild *A. franciscana* plant was discovered in the Presidio in 2009 and has been transplanted and propagated. Efforts to establish wild populations of *A. franciscana* within the Presidio will be conducted and outplanting of mixed *A. montana* ssp. *ravenii* and *A. franciscana* populations will be considered by *Arctostaphylos* experts and the agencies.

3. *Permanent reserve cultivated populations in botanical gardens*. Horticultural propagation of *Arctostaphylos montana* ssp. *ravenii* (also interim recovery criteria) must be dedicated in

perpetuity at no fewer than four botanical gardens in California. Multiple independent garden collections in different California coastal regions reduce the chance that region-wide catastrophic events (e.g., virulent new pathogens, extreme rainfall) could cause general loss from cultivation. Propagation and cultivation of *A. montana* ssp. *ravenii* for other specific educational, scientific or outreach efforts in support of recovery actions recommended in this plan may be needed on a case-by-case basis for recovery implementation, but such propagation and cultivation are not treated as recovery criteria. This recovery criterion primarily addresses Factor A (Present or threatened destruction modification, or curtailment of its habitat or range).

This criterion has partially been met. Permanent cultivated plants are being grown at three botanical gardens: UC Berkeley Botanic Garden, San Francisco Botanic Garden at Strybing Arboretum, and East Bay Regional Park, Regional Parks Botanic Garden. No permanent collections are known to be established in other coastal regions. This criterion is up to date and relevant.

The Recovery Plan does not include delisting criteria but notes that delisting may be reconsidered in the distant future if success of long-term recovery significantly exceeds current expectations.

IV. SYNTHESIS

The status of *Arctostaphylos montana* ssp. *ravenii*, which is restricted to a single known wild plant on the San Francisco Presidio, has not significantly changed since its listing in 1979. Seventeen clones of the wild plant have been established on the Presidio; however, they are genetically identical to the wild plant. The small occurrence size, low genetic diversity due to the bottleneck effect, and little gene flow among the clones continue to threaten *A. montana* ssp. *ravenii* due to its extremely small range and the vulnerability of small populations to many environmental, demographic, and genetic stochastic factors. A program for outplanting *A. montana* ssp. *ravenii* and control of invasive plants in its habitat by the National Park Service and Presidio Trust, with input from species experts such as Dr. V. Thomas Parker, is ongoing and has alleviated some of the threats due to small population size. Despite these efforts, the status of the species remains endangered due the existence of a single wild plant, low numbers of outplanted cloned individuals, absence of reproductive success (seed germination) in the field, disease, competition from other plant species, and potential negative effects of climate change on the Presidio's maritime climate. Therefore, we believe *A. montana* ssp. *ravenii* still meets the definition of endangered, and recommend no status change at this time.

V. RESULTS

Recommended Listing Action:

____ Downlist to Threatened
____ Uplist to Endangered
____ Delist (indicate reason for delisting according to 50 CFR 424.11):
    ____ *Extinction*
    ____ *Recovery*
    ____ *Original data for classification in error*
__X__ No Change

New Recovery Priority Number and Brief Rationale: No change recommended.

VI. RECOMMENDATIONS FOR ACTIONS OVER THE NEXT 5 YEARS

The following recommendations were developed, in part, at the September 1, 2008 Workshop on Presidio Manzanita Conservation and Management held at the Presidio of San Francisco. The recommendations were summarized in Management of *Arctostaphylos montana* ssp. *ravenii* in the Presidio of San Francisco (Parker and Frey 2010, pp. 34-38).

1. *Increase the number of potentially different genetic A. montana ssp. ravenii individuals using seed from the seedbank beneath the wild plant*. This species has a persistent seedbank and any seed which exists there could contain additional genetic variation from other parents that no longer exist (Parker and Frey 2010, p. 34). Germination of *Arctostaphylos* seedbanks can be difficult and may require chemicals from smoke; however, additional unknown factors also appear to be necessary because smoke alone results in low germination rates. The first step in determining the germination requirements of *A. montana* ssp. *ravenii* is to develop germination methods on other closely related species (e.g., *A. montana*) After these methods have proven to be successful with surrogate species, the methods could be applied to small soil samples from the seedbank of the wild *A. montana* ssp. *ravenii* plant.

2. *Understand the phenology and pollinator ecology for the community that contains A. montana ssp. ravenii.* Research which was recommended during the 2008 workshop included a study to quantify the phenology and the pollination ecology of *A. montana* ssp. *ravenii*, *A. franciscana*, and an undescribed *A. bakeri* subspecies and other common shrubs in the Presidio maritime chaparral community such as *Ceanothus thyrsiflorus* (blueblossom). The goal of the study would be to understand how to create a continuous bloom period for the community in order to support a larger and more persistent pollinator community thus maximizing the reproductive potential of the species involved including the *A. montana* ssp. *ravenii*. As part of this study, the pollinator species still present in the Presidio would be identified as well as those that are missing.

3. *Develop techniques to ensure outplanting success.* Experimentally investigate the timing of planting of *A. montana* ssp. *ravenii* clones and the soil moisture level necessary during the summer drought. Potted plants from cuttings should be planted just before or after the first fall

rains. Experimental plots should be set up with soil moisture probes. The results of this study will establish which levels of soil moisture are optimal and whether plantings should be watered in the summer months. The study should also address: which site preparations to use, should plants be watered for the first year after installation, what is the optimal plant container size, and is sudden oak death an issue with container soil.

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U.S. FISH AND WILDLIFE SERVICE
5-YEAR REVIEW

***Arctostaphylos montana* ssp. *ravenii* (Raven's manzanita)**

Current Classification: Endangered

Recommendation Resulting from the 5-Year Review:

____ Downlist to Threatened
____ Uplist to Endangered
____ Delist
__X_ No change needed

Review Conducted By: __Elizabeth Warne, Sacramento Fish and Wildlife Office_

FIELD OFFICE APPROVAL:

Lead Field Supervisor, U.S. Fish and Wildlife Service

Approve _____ Date 20 June 2012