

METHODOLOGY USED TO COMPLETE THE RECOVERY PLAN AMENDMENT

The updated recovery plan for the Raven's manzanita (also called the Presidio manzanita) (*Arctostaphylos hookeri* ssp. *ravenii*) did not include delisting criteria and notes that delisting may be reconsidered in the distant future if success of long-term recovery significantly exceeds current expectations. However, the Recovery Plan did include Long-term Recovery Criteria, which the Service used in developing delisting criteria. The revised Recovery Criteria presented here follow the five factors used to determine whether any species is an endangered species or a threatened species: the present or threatened destruction, modification, or curtailment of its habitat or range; the overutilization for commercial, recreational, scientific, or education purposes; disease or predation; the inadequacy of existing regulatory mechanisms; and other natural or manmade factors affecting its continued existence. The Recovery Criteria also address the biodiversity principles of representation, resiliency, and redundancy as defined in the U.S. Fish and Wildlife Service (Service) Species Status Assessment Framework (Service 2016). Representation describes the ability of a species to adapt to changing environmental conditions over time. It is characterized by the breadth of genetic and environmental diversity within and among populations. Resiliency describes the ability of populations to withstand stochastic disturbance. Resiliency is positively related to population size and growth rate. Further, it might be influenced by connectivity among populations. Generally, populations need abundant individuals within habitat patches of adequate area and quality in order to survive and reproduce in spite of disturbance. Redundancy describes the ability of a species to withstand catastrophic events. Generally, species that have adequate individuals within multiple populations can better withstand potential loss from catastrophic events. Redundancy is high when multiple, resilient populations are distributed within the species' ecological settings and across the species' range. The amended criteria will be peer reviewed in accordance with the OMB Peer Review Bulletin following the publication of the Notice of Availability.

The most recent 5-year review of the species, completed in 2012, notes that the scientific community has recognized a reclassification and therefore referred to Raven's manzanita as *Arctostaphylos montana* ssp. *ravenii*. Despite that recognition, we use the original classification here (*Arctostaphylos hookeri* ssp. *ravenii*) to be consistent with the published recovery plan and with the currently listed entity, since a taxonomic revision of the listed entity has not yet been completed.

Emails were sent to species experts to provide input in identifying delisting criteria. However, due to time constraints, there was limited opportunity for collaboration in developing these criteria. The Service did not contract out this review.

ADEQUACY OF RECOVERY CRITERIA

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

Recovery Criteria

See the previous version of the criteria in the original recovery plan on pages 147 to 150.

Synthesis

The 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; Parker and Frey 2010). The flowers are urn-shaped, with five-lobed white corollas 4 to 5 millimeters (mm) (0.25 in) long (Wells 1993; Parker and Frey 2010). Flowers appear from late January to the end of April (Gambel 2012) depending on rainfall and temperature patterns (Parker and Frey 2010). 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). The species is restricted to a single clonal population in the San Francisco Presidio on the San Francisco peninsula. It is found in a maritime chaparral-coastal prairie community (Parker and Frey 2010) which is influenced by summer coastal fog, humidity, and cool temperatures. The original population consists of one wild (mother) plant and identical daughter clones of the mother plant from cuttings. The population is found on serpentine soil. All historical 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 (CNDDDB) 2018). 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). All *Arctostaphylos* species, including *A. bookeri* 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). For a status assessment of the Raven's manzanita, see the 2012 5-year Review (Service 2012).

Spatial Distribution

The only wild plant known at the time of listing in 1979 existed in the San Francisco Presidio. No additional occurrences have been discovered since that time. The Raven's manzanita is currently found on a serpentine outcrop on the San Francisco Presidio (Wells 1993). Historical occurrences were found on serpentine and greenstone soils in the San Francisco area (Parker and Frey 2010; Chasse 2013; CNDDDB 2018). Chasse (2013) developed habitat models based on localities of herbarium collections and the current population to identify potential reintroduction and introduction sites for the manzanita in and around the San Francisco area. Reintroduction efforts stemming from Chasse (2013) are not currently being implemented.

Soil Pathogens

Little is known about the effects of soil pathogens on the Raven's manzanita. Should the wild plant become contaminated with *Phytophthora 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 (Service 2012). Any seedlings that germinate from this seedbank could also be contaminated and not survive. Leaves from the Raven's manzanita were collected in the Presidio in March 2018 to diagnose unknown health issues with the mother plant and adjacent clones; there is evidence that *P. pseudocryptogea* is present in the soil (Swiecki and Berhardt 2018). The long-term effects of *P. pseudocryptogea* on the Raven's manzanita are unknown, but currently, the plants are experiencing rapid dieback likely due to *P. pseudocryptogea*.

AMENDED RECOVERY CRITERIA

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

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

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

We provide delisting criteria for the Raven's manzanita, which will supersede those included in Recovery Plan for Coastal Plants of the Northern San Francisco Peninsula, as follows:

Downlisting Recovery Criteria

The updated Recovery Plan for the Raven's manzanita had downlisting criteria. The criteria are relevant and do not warrant changing. However, the term "colony" has been changed to "population."

Raven's manzanita may be considered for reclassification to threatened status when all interim recovery criteria are fully achieved, and: (1) at least five spontaneously reproducing variable populations¹ are established in reserves on bedrock outcrops outside the Presidio in San Francisco, at least three of which must be on serpentine outcrops; (2) at least two sexually-reproduced generations are established within the Presidio; and (3) at all the sites, population size and individual clone size increase over a period of 30 years.

¹ A population is a group of individuals in a small geographic area.

Interim Recovery Criteria

1. *Habitat and Population Stabilization in the Presidio.* The site of the original remnant clone 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 majority of individuals at these sites must exhibit significant net growth (see Appendix IV) over a 10-year period, while the number of daughter clones must increase. These recovery criteria address listing Factor A (present or threatened destruction, modification, or curtailment of its habitat or range) and listing Factor D (the inadequacy of existing regulatory mechanisms).
2. *Propagation of Seedling and Clonal Stock.* Multiple nursery populations¹ of propagated Raven's manzanita must be established within the Golden Gate National Recreation Area 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 Tamalpais manzanita (*Arctostaphylos montana*) individuals (and possibly Franciscan or other manzanita taxa) on Raven's manzanita 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 (see Recovery Strategy). The panel should develop a genetic management plan in cooperation with us 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 (or original Presidio plant) at all times, with a goal of 50 seedling plants (preferably inbred, at least initially) that have at least two clonal replicated each (total 200 plants). This recovery criterion primarily addresses listing Factor A (present or threatened destruction, modification, or curtailment of its habitat or range) and listing Factor E (other natural or manmade factors affecting its continued existence).
3. *Establishment of New Daughter Clones on Presidio Serpentine Bluff Sites.* At least five additional populations¹, each comprising at least five of the 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 populations¹ must exhibit net growth 5 years after transplanting with intensive maintenance, and for an additional 5 years after cessation of intensive maintenance. This recovery criterion primarily addresses listing Factor A (present or threatened destruction, modification, or curtailment of its habitat or range).
4. *Investigation of Taxonomic Relationships and Reproduction.* Studies must be conducted to clarify the taxonomic relationships between Raven's manzanita and Monterey County *Arctostaphylos hookeri* subspecies *bearstiorum* and *hookeri*, Tamalpais manzanita (*A. montana*), bearberry (*A. uva-ursi*), Franciscan manzanita (*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 clone of Raven's manzanita. Other topics to investigate include variation in reciprocal hybrids among these species, pollen viability of interspecific (between-species) hybrid plants, and chromosome counts of hybrids.

Experimental studies of natural ecological conditions favoring seed production and seedling recruitment should be conducted. Fitness of inbred Raven's manzanita plants (e.g., comparison of characteristics related to growth rate, plant size, and reproductive traits), and reference populations of Tamalpais manzanita from serpentine sites (or other appropriate reference populations of representative manzanas) should be studied on serpentine and nonserpentine substrates.

Results of these investigations will make it possible to evaluate the need for an introgressive breeding program to restore sexual reproduction and adaptive variability in the species. If introgressive breeding of Raven's manzanita is justified by scientific evaluation of its reproductive biology and taxonomy (see (b) above), similar studies would probably be needed on backcross breeding lines as well. The need for such research should be addressed in the genetic management plan. This recovery criterion primarily addresses listing Factor E (other natural or manmade factors affecting its continued existence).

Delisting Recovery Criteria

The Raven's manzanita will be considered for delisting when:

Factor A: Present or Threatened Destruction, Modification, or Curtailment of Habitat or Range

To delist the Raven's manzanita, threats to the species and its habitat must be reduced. This reduction will be accomplished when the following has occurred:

- A/1** *Establishment and Protection of New Presidio Populations.* Establish five new populations¹ of Raven's manzanita in the Presidio. The new populations must be established on relatively stable, exposed serpentine or greenstone outcrops within or above the Presidio bluffs or in suitable inland outcrop areas, in areas where pre-existing vegetation is sparse, particularly on steep slopes².
- A/2** *Establishment and Protection of New Interior Populations.* At least five mixed populations¹ of Raven's and Franciscan manzanita 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 or greenstone outcrop sites². All reintroduction sites must be permanently protected, and the perpetuation of suitable habitat must be ensured³.

² There are eight sites of varying sizes and vegetation communities on serpentine soils spread throughout the Presidio and San Francisco that are suitable or potentially suitable to the Raven's manzanita (Chasse 2013). The Raven's manzanita can potentially be able to live on other soil substrates similar to the species namesake Tamalpais manzanita (Chasse 2013).

³ The inland sites will require adaptive management to protect the reintroduced populations from the invasion of competing vegetation, the degeneration due to recreational misuse, or other unforeseen threats.

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

The overutilization for commercial, recreational, scientific, or educational purposes is not known to threaten the Raven's manzanita at this time. Therefore, no recovery criteria have been developed for this factor.

Factor C: Disease or Predation

Diseases, such as those caused by *Phytophthora* spp., and predation by mammals and insects are known to threaten the Raven's manzanita. To delist the Raven's manzanita, the threat of disease must be controlled. This will be accomplished when the following has occurred:

- C/1** *Effects of pathogens.* Negative effects to the populations from infestation by *Phytophthora* spp., *Botryosphaeria* spp., and other pathogens must fall below a level at which a population viability analysis indicates that the pathogens are negatively affecting long-term persistence⁴.

Factor D: Inadequacy of Existing Regulatory Mechanisms

The inadequacy of existing regulatory mechanisms is not known to threaten the Raven's manzanita at this time. Therefore, no recovery criteria have been developed for this factor.

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

Other natural or manmade factors believed to affect the continued existence of the Raven's manzanita: water stress, changes in environmental conditions resulting from climate change, altered fire regime, trampling and vandalism by people visiting the Presidio, wildfire fuel reduction treatments, natural succession, non-native invasive species, loss of genetic diversity, stochastic (chance) events, and small population size. To delist the Raven's manzanita, these threats must be reduced. This reduction will have been accomplished when the following have occurred:

- E/1** *Reproduction and Growth in the New Presidio Bluff Populations.* Each new population from A/1 will consist of at least 50 plants⁵. Over 50 percent of the plants within all five populations must exhibit progressive and significant net growth (see Appendix IV) until

⁴ Swiecki and Bernhardt (2018) discovered *P. pseudocryptogea* at the mother plant site. To prevent the decline cause by pathogens, as is the case for other rare *Arctostaphylos* species (Swiecki et al. 2011), and to account for the presence of native pathogens, this criteria seeks a balance between soil pathogens and the manzanita.

⁵ Based on the ecology of a closely related species (*A. pallida*), a healthy population likely would be comprised of at least 1,500 mature plants. Because of the limited geographic area occupied by the Raven's manzanita and the low population numbers, it is unlikely that this target could ever be reached. In order to increase population resilience, the number of plants in each population should be at least 50 plants. This number is based on the goal of increased demographic stability and feasibility of implementation, and does not necessarily meet long term needs of the species. Future population viability analyses will define this criterion.

maturity. All populations must exhibit signs of natural recruitment⁶. For the purpose of recovery, a mature plant is defined as being 25 years of age or greater⁷.

E/2 *Reproduction and Growth in the New Interior Populations.* Each new population from A/2 will consist of at least 50 plants⁵. Over 50 percent of the founder plants at each new population must exhibit net growth in size over a 10-year period. All populations must exhibit signs of natural recruitment, and the significant recurrent production of viable seed must be evident⁶. For the purpose of recovery, a mature plant is defined as being 25 years of age or greater⁷.

E/3 *Permanent Reserve Cultivated Populations in Botanical Gardens.* Horticultural propagation of Raven's manzanita (also Downlisting Criteria 2) must be dedicated in perpetuity in at least one botanical garden in no fewer than two California coastal regions⁸.

Rationale for Recovery Criteria

Our understanding of the species' status, threats, and recovery needs has not significantly changed since the Service finalized the updated Recovery Plan. The *in situ* extent of Raven's manzanita still is only one wild individual with several daughter clones at the original site and other sites nearby in the Presidio in San Francisco. Our knowledge base for the species has not significantly increased. The majority of the research conducted has been on the taxonomic status of the manzanita (Service 2012). There has also been research in understanding what pollinators visit the manzanita and the needs of the associated plant and pollinator community (Gambel 2012; Van Der Berg et al. 2010). At present, there are still data gaps that exist that could impede recovery progress. One data gap is how climate change will impact the currently small amount of suitable habitat for the manzanita (Service 2012). Another data gap is the effect of hybridizing the plant with closely related species in order to increase genetic diversity and thus increase representation (Service 2012).

The spread of *P. cinnamomi* was noted in both the Recovery Plan (2003) and the latest 5-year Review (2012) as a potential threat to the species. *Phytophthora* spp. caused the decline of other rare *Arctostaphylos* species, including those in the San Francisco Bay Area (Swiecki et al. 2011; Service 2012). Since the mother plant and some of its clones have been infected with *P. pseudocryptogea*, the Service feels this threat warrants the addition of a new recovery criterion (Delisting Criteria C/1).

The delisting criteria above mitigate threats according to Listing Factors A (present or threatened destruction, modification or curtailment of the species habitat or range), C (disease or predation), and E (other natural or manmade factors).

Threats identified under Factor A include habitat loss from the growth of San Francisco, and the conversion of the plant community (Service 2003; Service 2012). Delisting Criteria A/1 addresses Factor A by establishing five new populations within the Presidio. From Downlisting Criteria 1, the Presidio will dedicate any land where new populations occur on the Presidio to permanent habitat

⁶ To date, there are no signs of natural recruitment although the plant was observed setting seed (Service 2012). The plant must be able to reproduce naturally. This criterion also requires the availability of pollinators to aid in the development of seeds, and small mammals to cache the seeds.

⁷ Obligate seeding *Arctostaphylos* species may require 5 to 25 years before substantial seed crops are produced (Keeley 1987).

⁸ 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.

protection, maintain the land for the manzanita, and will protect the land in perpetuity. Delisting Criteria A/2 addresses Factor A by establishing new population in the interior of San Francisco. Both delisting criteria require maintaining the suitability of the land for the manzanita by removing invasive species and ensuring the surrounding plant community doesn't cause a dieback of the manzanita by over topping. Both delisting criteria address redundancy and resiliency by ensuring there are enough populations spread throughout the San Francisco peninsula to withstand catastrophic and stochastic events.

The threat identified under Factor C is the invasion of harmful soil pathogens (Service 2012). Delisting Criteria C/1 addresses Factor C by ensuring that pathogens do not cause long-term harm or a declining population. This delisting criterion ensures that populations are resilient.

Threats identified under Factor E include small populations and stochastic events, loss of pollinators and seed stashes, loss of genetic diversity, and climate change (Service 2003; Service 2012). Delisting Criteria E/1 and E/2 will increase the number of populations and the number of individuals, and lessen the threat of extinction due to stochastic events faced by small populations (Gilpin and Soule 1986). However, Delisting Criteria E/1 and E/2 establishes new populations that are genetically the same as the wild plant. Since only a single wild plant exists, the genetic diversity of these new populations will be low. By increasing the population size and adding more populations, the species will have more representation in a changing environment and be able to improve genetic health. Increasing the number of populations also makes the population more redundant. Delisting Criteria E/3 will increase the redundancy and further protect the species from catastrophic events, which will make the species more redundant. This criterion may also increase the representation of the species by allowing novel mutations to arise in the altered selection regime of the botanical gardens. However, propagation and cultivation of Raven's manzanita at botanical gardens different from Downlisting Criteria 2 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. The recovery criteria do not address climate change because there is little information on how climate change will influence marine chaparral habitat (Service 2012).

The recovery strategy and the recovery actions in the original recovery plan still reflect the needs of the Raven's manzanita.

ADDITIONAL RECOVERY ACTIONS AND THEIR PRIORITIES

The actions identified below are those that, based on the best available science, are necessary to bring about the recovery of the Raven's manzanita. However, these actions are subject to modification as might be indicated by new findings, changes in species status, and the completion of other recovery actions. Each action has been assigned a priority for implementation, according to our determination of what is most important for the recovery of these species based on life history, ecology, and threats.

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

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

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

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

The following site-specific recovery actions are recommended in order to implement the strategies leading to attainment of described delisting criteria.

1. Assess the recovery efforts of the Raven's manzanita

1. Develop and implement a demographic monitoring plan. **(Priority 2)**
2. Create a shared database for Raven's manzanita recovery information to facilitate in the gathering of information from the demographic monitoring plan. **(Priority 2)**
3. Develop a predictive computer model to test the long-term survivability of populations using data derived from demographic monitoring. **(Priority 2)**
4. Conduct long-term population viability analyses using the computer model. **(Priority 2)**

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