U.S. Fish & Wildlife Service

Recovery Plan for *Arctostaphylos pallida* (pallid manzanita)

Arctostaphylos pallida (pallid manzanita). Photograph by Martha Lowe, Environmental Science Associates.

Recovery Plan for *Arctostaphylos pallida* (pallid manzanita)

2015

Region 8
U.S. Fish and Wildlife Service
Sacramento, California

Approved: Alexandra Pitts

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

Date: 7·27·15

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Literature Citation Should Read as Follows:

U.S. Fish and Wildlife Service. 2015. Recovery plan for *Arctostaphylos pallida* (pallid manzanita). U.S. Fish and Wildlife Service, Pacific Southwest Region, Sacramento, California. vi, + 39 pp.

An electronic copy of this recovery plan will be made available at:
http://www.fws.gov/endangered/species/recovery-plans.html

Acknowledgements

The recovery planning process has benefitted from the advice and assistance of many individuals, agencies, and organizations. We thank the following individuals for their assistance and apologize to anyone whose name was omitted inadvertently from this list:

David Amme, East Bay Regional Park District

Neal Fujita, East Bay Regional Park District

Josh Hull, Sacramento Fish and Wildlife Office

Ralph Kanz, Alameda Creek Alliance

Wilde Legard, East Bay Regional Park District

Martha Lowe, Environmental Science Associates

Kimra McAfee, Friends of Sausal Creek

Martin Matarrese, City of Oakland

Bert Mulchaey, East Bay Municipal Utility District

Larry Rabin, Pacific Southwest Regional Office

Ben Solvesky, Sacramento Fish and Wildlife Office

Ted Swiecki, Phytosphere Research

Kirsten Tarp, Sacramento Fish and Wildlife Office

Michael Vasey, San Francisco State University

Betty Warne, Sacramento Fish and Wildlife Office

Executive Summary

Current Species Status

Arctostaphylos pallida was listed as threatened throughout its entire range in 1998. The species is endemic to the San Francisco East Bay, and currently consists of two naturally occurring populations and an out-planted population, totaling 1,353 mature plants.

Habitat Requirements and Limiting Factors:

Arctostaphylos pallida requires frequent summertime fog and, as a component of the maritime chaparral vegetation type, it occurs on relatively cool, moist, and stable sites in close proximity to the San Francisco Bay. It is highly shade intolerant and adapted to a particular fire regime. Although the species requires fire for natural seed germination, too frequent a fire regime, one that depletes the soil seed bank before enough seeds have become deeply buried enough in the soil to withstand fire, represents a significant threat to the species. Approximately one third of all plants occur within the backyards of homeowners and almost all individuals occur in close proximity to human structures. Consequently, the plants represent an extreme wildfire hazard and have been targeted for removal to reduce the threat of wildfire. Finally, an incurable and virulent non-native pathogen, *Phytophthora cinnamomi*, has been identified as killing *A. pallida* plants at two locations.

Recovery Priority

The recovery priority number for *Arctostaphylos pallida* is 5; this number indicates the taxon is a species, faces a high degree of threat, and has a low potential for recovery.

Recovery Strategy, Goal, Objectives, Criteria and Actions Needed

To sufficiently minimize or ameliorate threats to *Arctostaphylos pallida* and allow for its removal from the list of threatened and endangered species, existing stands must be expanded, additional stands must be established, and management plans must be implemented that include and prioritize: 1) the control of *Phytophthora cinnamomi* at the stand level; 2) *P. cinnamomi* spread abatement at the landscape level; 3) management of competing native and non-native vegetation; 4) maintaining viable soil seed banks; 5) appropriately timed stand regeneration; 6) maintenance of genetic diversity; and 7) compatible fuel reduction treatments and methods. The recovery criteria comprise a combination of conditions that, when met, indicate *A. pallida* may warrant delisting. These criteria are described in detail in the 'Delisting Criteria' section of this document.

Estimated Date and Cost of Recovery:

Date: 2048
Cost: $1,459,650

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I. Background

A. Overview

Arctostaphylos pallida (pallid manzanita) was listed as endangered by the State of California in November 1979 and as threatened throughout its entire range on April 22, 1998 (Service 1998) under the authority of the Endangered Species Act of 1973, as amended (16 U.S.C. § 1531 *et seq.*) (Act). At the time the species was listed, the Service determined that designating critical habitat would not benefit the species. *Arctostaphylos pallida* was included in the *Draft Recovery Plan for Chaparral and Scrub Community Species East of San Francisco Bay, California* (Service 2002); however, due to the amount of time that has elapsed since the issuance of that draft recovery plan, its highly restricted range within the San Francisco East Bay, and threats unique to the species, we have determined that it would be in the best interest of the species' recovery to issue a species-specific recovery plan. The first 5-year status review for *A. pallida* was signed on April 29, 2011 (Service 2011). Based on an increase in the level of threats and newly defined threats, the 5-year status review recommended uplisting *A. pallida* from threatened to endangered. However, a proposed rule and final rule uplisting the species have not been published due to insufficient resources. The recovery priority number for *A. pallida* is 5; this number indicates the taxon is a species, faces a high degree of threat, and has a low potential for recovery.

B. Description

Arctostaphylos pallida is an upright, evergreen, non-burl-forming, obligate-seeding shrub. It grows up to 4 meters (13 feet) in height, with rough, gray, or reddish bark. The twigs (terminal branches) are bristly and canescent (covered with whitish fine hairs). The pale green leaves surround the stem and are attached by a petiole less than 2 millimeters (0.08 inch). The leaves are closely imbricated (overlap), and are cordate (heart-shaped) and glabrous (hairless). The leaf blade is 2.5 to 4.5 centimeters (1.0 to 1.8 inches) long, 2 to 3 centimeters (0.8 to 1.2 inches) wide, ovate or oblong-ovate, glaucous (covered with a whitish waxy covering), dull, and smooth (Wells 1993). The inflorescences (cluster of flowers) are dense, 3 to 5 per branch; the bracts (leaflike organ subtending an inflorescence) are 5 to 9 millimeters (0.2 to 0.35 inch), widely lanceolate (narrow and tapering at both ends), and acute (sharply pointed) (Wells 1993). The flowers are white, rose, or white-rose in color, urn-shaped, and 6 to 7 millimeters (0.2 to 0.3 inch) long; and flowering occurs from December to March. Fruits are 8 to 10 millimeters (0.3 to 0.4 inch), globe-shaped, and sticky (Wells 1993).

C. Taxonomy

Arctostaphylos pallida is a member of the Ericaceae (heath family). The genus *Arctostaphylos* is taxonomically complex, including over 100 taxa of evergreen shrubs and trees, only 8 of which are found outside the California Floristic Province (Wells 2000). Species diversity is highest along the coast of California, from Mendocino County to San Luis Obispo County, with over 30 species (Boykin et al. 2005). *Arctostaphylos* diversification has been attributed to local adaptation to diverse soil types, microclimates, and an increased fire frequency associated with the emergence of a progressively more severe Mediterranean-type climate (Raven and Axelrod 1978; Axelrod 1981; Axelrod 1989). Polyploidy and diploid hybridization are considered to be significant evolutionary processes involved in the rapid speciation of the genus (Stebbins and Major 1980). Due to vegetative diversification in *Arctostaphylos,* with little divergence in floral characters, there have been varying taxonomic interpretations of the genus (Jepson 1922, Eastwood 1934, McMinn 1939, Adams 1940, Wells 2000). Based on a study of the internal transcribed spacer region of the nuclear genome of 38 species of *Arctostaphylos*, including *A. pallida*, Boykin et al. (2005) found that some of the characters used for classification (including rough or shreddy bark and stomatal distribution) may have arisen more than once during the evolution of the genus. As a result, Boykin et al. (2005) suggested a reexamination of the current classification of the genus is warranted.

Arctostaphylos pallida was first described by Eastwood (1933), based on a specimen collected by W. W. Carruth in 1902 from the "East Oakland Hills." Prior to Eastwood (1933), the specimen was included in *Arctostaphylos andersonii*. Jepson (1922; 1939) did not recognize *A. pallida* as a separate species and continued to include it in *Arctostaphylos andersonii*. McMinn (1939) published the combination *A. andersonii* var. *pallida*, apparently agreeing with J. E. Adams' conclusions (first presented in his 1935 dissertation at the University of California at Berkeley) that the Oakland specimen was distinct but related to *A. andersonii*. This combination was not published until several years later (Adams 1940). In their floristic treatment of California, Munz and Keck (1959) followed McMinn's treatment. Wells (1969) recognized *A. pallida* as a species separate from *A. andersonii* and retained this treatment in the Jepson Manual (Wells 1993). The phylogenetic analysis and relationships outlined in Boykin et al. (2005) do not support *A. pallida* as being a variety of *A. andersonii*. Although Parker et al. (2012) revised the taxonomy of several *Arctostaphylos* species for the second edition of the Jepson Manual; no taxonomic revisions were made to *A. pallida*. *Arctostaphylos pallida* is recognized as a full species (Parker et al. 2012).

D. Historic Distribution

The type specimen of *Arctostaphylos pallida* was collected on the summit of East Oakland Hills, January 1902, and was also noted to be found on the "hills back of Piedmont, Alameda County" (Eastwood 1933). A second population was believed to have been first reported in the 1940's or 1950's from Sobrante Ridge in Contra Costa County (Amme et al. 1987). Based on a personal communication with the late James Roof, the founding director of East Bay Regional Parks District's (EBRPD) Tilden Regional Park Botanical Garden (Tilden Park; Amme et al. (1987) noted that Mr. Roof planted several dozen *A. pallida*, in the period between 1939-1940, along Shasta Road and Golf Course Drive in Tilden Park.

E. Current Distribution and Abundance

There are two geographic areas that support extant naturally occurring populations of *Arctostaphylos pallida* (Table 1 and Figure 1): Huckleberry Ridge in Alameda County and Sobrante Ridge in Contra Costa County. It is likely dormant, viable soil seed banks of *A. pallida* exist within the range of the species, as indicated by the germination of seeds at several sites within Joaquin Miller Park following soil disturbance and/or burning. In addition, a small out-planted population consisting of two *A. pallida* stands occurs at Tilden Park.

Table 1. *Arctostaphylos pallida* plant count survey results. First survey year plant counts are from the California Natural Diversity Database (CNDDB 2012). Recent Survey Year plant counts were obtained from Kanz (2004), EBMUD, EBRPD, and H. Bartosh (Nomad Ecology, pers. com, 2010).

Huckleberry Ridge Population (naturally occurring)	**Ownership**	**First Survey Year**	**Plant Count**	**Recent Survey Year**	**Plant Count**
Huckleberry Preserve	EBRPD*	1985	Estimated 2,400 to 2,700	2004	325 mature, 176 seedlings
Private Homes, Adjacent to Huckleberry Botanical Preserve	Private	NA	NA	2004	326
Tennis Club, Adjacent to Huckleberry Botanical Preserve	Private	NA	NA	2004	96
Redwood Park #1	EBRPD*	1985	1	2010	1 mature, 10 seedlings
Redwood Park #2	EBRPD*	2010	1	2010	30 seedlings
Redwood Park #3	EBRPD*	2010	1	2010	1 seedling
Sibley Volcanic Preserve	EBRPD*	1992	3	2004	3
Pinehurst Rd.	EBMUD**	1985	25	2010	10 mature, 80+ seedlings
Joaquin Miller Park, Manzanita Flat	City of Oakland	1989	19	2004	0
Joaquin Miller Park, Chabot	City of Oakland	1994	21	2006	10
Joaquin Miller Park, Big Trees Trail***	City of Oakland	1989	65	2006	51 mature, 40 seedlings
Joaquin Miller Park, Sequoia-Bayview	City of Oakland	1999	1	2010	0
Manzanita Dr.	Private	1985	< 100	2004	< 50
Exeter Dr.	Private	2001	NA	2004	7
Ascot Dr.	Private	1986	1	2004	0
				Total Mature 879	
				Total Seedlings 337	

Sobrante Ridge Population (naturally occurring)					
Sobrante Ridge	EBRPD*	1985	Estimated 1,700 to 2,000	2004	454

Tilden Park Population (out planted)					
Shasta Rd.	EBRPD*	1981	< 50	2004	12
Wildcat Canyon Rd.	EBRPD*	1986	NA	2004	8
				Total Mature 20	

*East Bay Regional Park District

**East Bay Municipal Utility District

***Referred to as "Roberts" in CNDDB

Total Existing Mature 1353

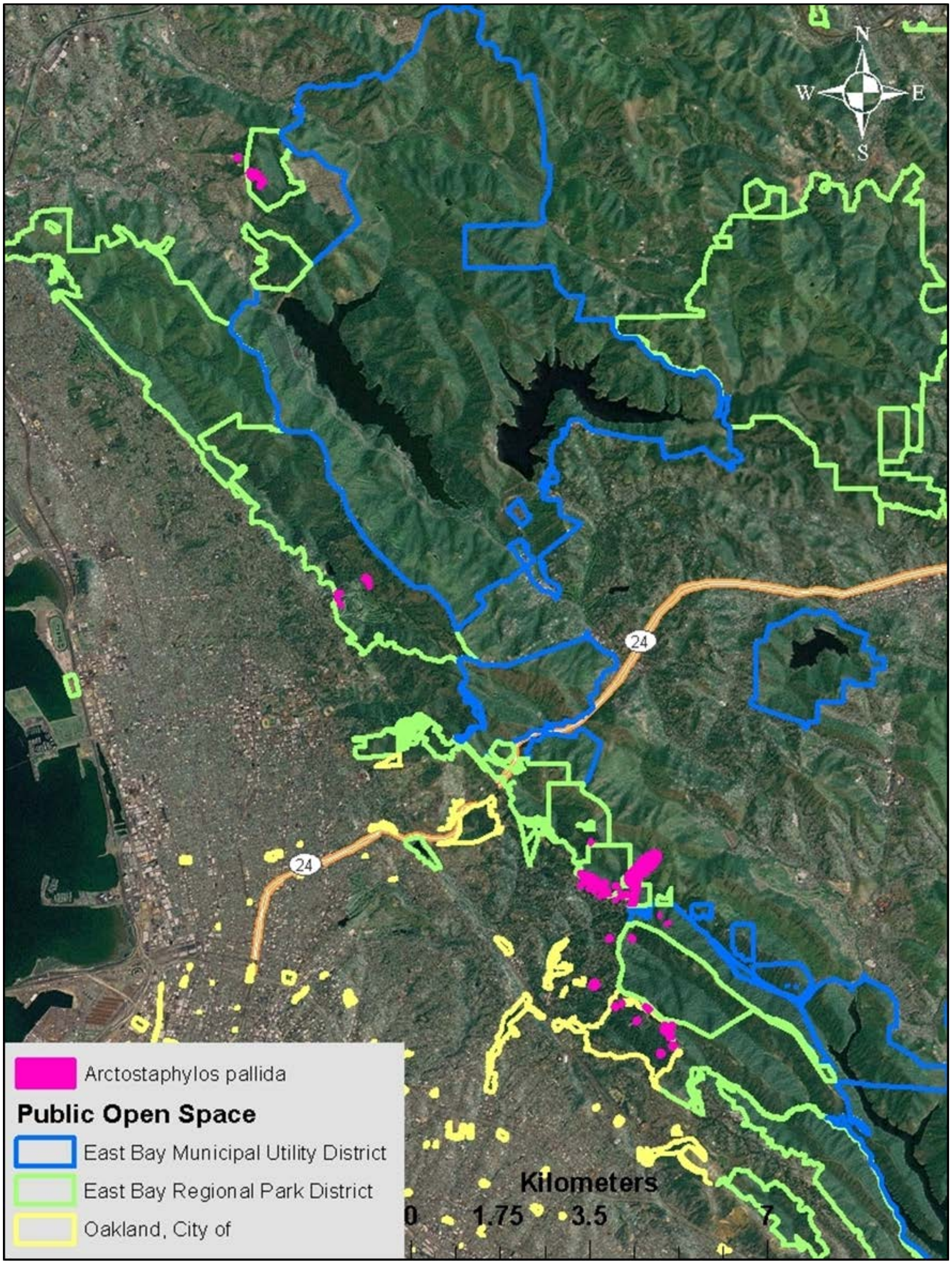

Figure 1. 2012 California Natural Diversity Database occurrence records for *Arctostaphylos pallida*, public open space parcels, and California State Route 24.

The largest concentration of *Arctostaphylos pallida* occur on Huckleberry Ridge in Alameda County, with many satellite stands scattered across connected and adjacent ridge tops. The total Huckleberry Ridge population (all *A. pallida* found south of California State Route 24) consists of 879 mature plants and 337 seedlings (Table 1). The largest stands and largest concentration of stands occur along the boundary that separates EBRPD's Huckleberry Botanic Regional Preserve (Huckleberry Preserve) from private properties to the west, primarily on northeast-facing slopes, extending southwest over the top of the ridge onto private property within the urban development along Skyline Boulevard. An assessment conducted in the mid-1980's estimated that the number of mature *A. pallida* plants within the Huckleberry Preserve area was 2,400 to 2,700 plants (Amme et al. 1987). A census of all *A. pallida* occurring on EBRPD lands was conducted in 2004 by EBRPD biologists, during which each individual plant's location and canopy radius was mapped. Based on these results, there were 747 mature plants with a canopy cover that occupied 2.01 acres (0.81 hectare). Of these 747 mature plants, 325 occur within Huckleberry Preserve, 326 within the yards of several private homes adjacent to Huckleberry Preserve, and 96 on property owned by a tennis club which is also adjacent to Huckleberry Preserve. The extent to which the number of plants in the Huckleberry Preserve area has decreased since the estimate from the mid-1980s is not known, since Amme et al. (1987) likely overestimated the number of plants at this site in 1985 and signs of a die-off of this magnitude are not apparent (W. Legard, EBRPD, 2010 pers. com.).

Based on the distribution of *Arctostaphylos pallida* that occurs along Ascot, Exeter, and Manzanita Drives, within the suburban development southwest of large stands that occur at Huckleberry Preserve and on private properties adjacent to the Huckleberry Preserve, it is likely these scattered plants represent what was once a much larger stand or a group of stands that, prior to suburban development in the early 1970's, would have been connected to the large concentration of stands at Huckleberry Preserve. According to Kanz (2004), the suburban development that occurred in this area in the early 1970's resulted in the loss of as many as half of the *A. pallida* plants found along Huckleberry Ridge.

The Huckleberry Ridge satellite stands occur along the ridge tops connected and adjacent to Huckleberry Ridge, on properties managed by EBRPD, including Robert Sibley Volcanic Regional Preserve and Redwood Regional Park; at Joaquin Miller Park, which is owned by the City of Oakland; on privately owned properties along Ascot Drive, Manzanita Drive, and Exeter Drive in the City of Oakland; and above Pinehurst Road on lands owned by East Bay Municipal Utility District (EBMUD).

Of the Huckleberry Ridge satellite stands occurring on public lands, two of the larger stands are found at Joaquin Miller Park and are referred to as "Chabot" and "Big Trees Trail." According to M. Matarrese (City of Oakland, pers. comm. 2011), both of these stands are naturally occurring; unlike the Manzanita Flat stand that also occurred at Joaquin Miller Park, which is believed to have been established as a result of soil containing *Arctostaphylos pallida* seed being transported to the site from homebuilding activities on Manzanita Drive in the 1970's. The Manzanita Flat stand has since been extirpated through City of Oakland goat grazing activities for the purpose of reducing fire fuel loads.

The Chabot stand occurs along the western side of the Chabot Space and Science Center (Science Center). In 1985, prior to the construction of the Science Center, City of Oakland personnel cut *Eucalyptus* species and *Pinus radiata* (Monterey pine) at the site, followed by burning the limbs and other vegetation debris (M. Matarrese, City of Oakland, pers. comm. 2011). Seemingly, these activities stimulated germination of a dormant viable soil seed bank of *Arctostaphylos pallida*, as the species was not known from the site prior to vegetation removal and burning. The number of plants at the site declined from 21 in 1994 to 10 in 2006, and the condition of many of the remaining plants continue to decline due to shading from surrounding vegetation.

Of all of the Huckleberry Ridge satellite stands of *Arctostaphylos pallida*, the Big Trees Trail has the largest number of mature plants. Prior to 1988, *A. pallida* plants were not known to occur at Big Trees Trail (M. Matarrese, City of Oakland, pers. comm. 2011). In 1988, the City of Oakland removed a large *Pinus radiata* that had fallen onto a wooden storage building. It is believed that the logging equipment used to remove the fallen pine disturbed an *A. pallida* seed bank, scarifying seed coats and increasing light levels, resulting in regeneration. Between 1989 and 2006, 14 of the 61 plants died. Since 2006, the stand has continued to decline due to shading by *Pinus radiata*, *Hesperocyparis macrocarpa* (Monterey cypress), and *Arbutus menziesii* (Pacific madrone) and pruning and plant removal for road-side vegetation management conducted by the City of Oakland.

The non-native water mold pathogen *Phytophthora cinnamomi* has been confirmed infecting the largest stand of *Arctostaphylos pallida* plants at Huckleberry Preserve (Swiecki et al. 2011) and Big Trees Trail (Phytosphere Research 2010). The extent of the infestation at these sites is not known at this time. *Phytophthora cinnamomi* causes a root and crown rot of *A. pallida* and many other native and introduced woody species. When *A. pallida* plants become infected with *P. cinnamomi*, they do not exhibit the slow branch die-back over multiple years that is typical of a decline from shading or native fungal pathogens; rather, the plant dies within several months. Based on a site visit in August 2013, dozens of plants at Big Trees Trails have died or appear to be infected and many *Arbrutus menziesii* (Pacific madrone) at the site, which are also susceptible to *P. cinnamomi*, appear to be infected (B. Solvesky, Service, pers. obs. 2013).

The second largest population of *Arctostaphylos pallida* occurs at Sobrante Ridge (454 mature plants), within EBRPD's Sobrante Ridge Ecological Preserve. This population is the most isolated from all other stands, occurring 8 kilometers (5 miles) north of the out-planted population at Tilden Park and 15 kilometers (9.5 miles) north of the Huckleberry Ridge population. Kanz (2004) noted that shading of the site by native trees is gradually increasing and that numerous plants along the trail have been pruned as part of trail maintenance. A status survey in the mid-1980s indicated the Sobrante Ridge population had an estimated 1,700 to 2,000 plants (Amme et al. 1987). However, a 2004 survey by EBRPD biologists indicated there were 454 plants with a canopy cover that occupied 1.33 acres (0.54 hectare) at Sobrante Ridge. According to W. Legard (EBRPD, pers. comm. 2010), Amme et al. (1987) likely overestimated the number of plants at this site, because signs of a population die-off of this magnitude are not apparent.

The small naturalized population of 20 *Arctostaphylos pallida* plants at Tilden Park can be divided into two small stands, one scattered along the roadside of Wildcat Canyon Road and the other along the Selby Trail north of Shasta Road. It is not known how many plants Roof planted in 1939 or 1940, or if there has been any regeneration at the site. A 1981 account of the Shasta Road stand indicated there were less than 50 plants; however, the accuracy of the 1981 estimate is unclear so we are unable to determine if the 2004 survey result of 12 plants indicates there has been significant decline.

Amme and Havlak (1987) and Kanz (2004) have attributed mortality or declines to: 1) removal for wildfire fuel reduction purposes (Manzanita Drive); 2) herbicide use below Pacific Gas and Electric (PG&E) powerlines (Manzanita Drive); 3) shading by native plant species, including *Arbutus menziesii* (Pacific madrone), *Quercus* species (oak species) and *Sequoia sempervirens* (coast redwood) (Huckleberry Preserve, Redwood Park, Chabot, Manzanita Flat, Wildcat Canyon Road, Big Trees Trail, and Sobrante Ridge); 4) shading by non-native plant species, including *Pinus radiata* (Monterey pine), *Genista monspessulana* (French broom), *Hesperocyparis macrocarpa* (Monterey cypress), and *Eucalyptus* species (Exeter Drive, Manzanita Drive, Big Trees Trail, and Huckleberry Preserve); 5) removal for the purpose of development (Manzanita Drive, Exeter Drive, and Ascot Drive); 6) goat grazing (Manzanita Flat and Big Trees Trail); 7) root disease (Huckleberry Preserve, Manzanita Flat, and other stands within the Huckleberry Ridge population); and 8) trail maintenance (Sobrante Ridge).

F. Geography and Climate

Arctostaphylos pallida is found in the northwestern extremity of the Diablo Range, between 200 to 445 meters (656 to 1,460 feet) elevation, in an area sometimes referred to as the Oakland/Berkeley Hills. All known occurrences are found within 11 kilometers (7 miles) of the San Francisco Bay. The Diablo Range in this area consists of hills and mountains whose orientation is from northwest to southeast. These mountains and their orientation act as barriers that impede the mixing of the inland air mass with the one that lies over the ocean. Therefore, the climate closer to the waters of the San Francisco Bay, where *A. pallida* is found, is cooler and more moist and stable than the climate farther inland. Due to a shift in the Pacific high pressure cell polarward in the summer and equatorward in the winter, the area experiences a Mediterranean climate. In the summer, fog forms on the coast. As the air in California's Central Valley becomes hot, it rises, causing the cooler air and fog to be drawn in from the coast. The higher ridges of the Oakland/Berkeley Hills often prevent low-lying fog from reaching the valleys and mountains farther to the east. *A. pallida* is only known to occur in areas that experience a high frequency of dry season fog, but the number of dry season fog days required to support the species is not known. Fog reduces transpiration and increases soil moisture during a period of time when precipitation is uncommon. In addition, a substantial amount of fog moisture can condense on the leaves of *Arctostaphylos* species and it is possible some species are capable of absorbing this moisture through foliar uptake (M. Vasey, San Francisco State University, pers. comm. 2010).

In contrast to the low-lying fog commonly associated with the San Francisco Bay Area, foëhn winds can also occur. These winds, sometimes referred to as the Diablo Winds by locals, are created when a high pressure weather system is located over the Great Basin of the inland western states, accompanied by an offshore low pressure system. The high pressure system imports chilled air from the far north, with extremely low moisture content. The interaction of the two pressure systems and their counter-rotational forces create a wind flow from northeast to southwest, while the pressure differential forces the dry air from high altitudes down to ground level. The result is a strong wind of exceptionally dry air, blowing through the mountain passes and spilling over the coastal hills toward the Pacific Ocean. Increased pressure also heats the air mass (adiabatic compression), which often results in drastically increased air temperatures at sea level, with less than 10 percent relative humidity and wind velocities of 35 to 70 miles per hour. Many of the major wildfires in the California Coast Range have occurred during foëhn wind conditions, which occur most frequently between mid-September and late-November.

G. Soils and Vegetation Communities

The primary soil series *Arctostaphylos pallida* occurs on, including the large stands and satellite stands along Huckleberry Ridge and portions of Sobrante Ridge and Tilden Park, is Millsholm loam (NRCS 2013). The Millsholm soil series consists of shallow, well-drained soils that formed in material weathered from sandstone, mudstone, and shale. In addition to Millsholm loam, *A. pallida* occurs on other shallow well-drained soils series, rock formations, and soil complexes with parent materials that include shale, schist, greenstone, sandstone, silty clay loam, or conglomerate.

The Huckleberry Preserve and the Sobrante Ridge stands grow on soil composed of Middle Miocene cherts and shales of the Monterey Group (Amme and Havlik 1987). These soils are thin, well drained at the surface, and deficient in many essential plant nutrients. However, the fractured and bedded rocks below hold water that is accessible to deep roots. Satellite stands along Skyline Boulevard occur on Pinehurst Shale and the Joaquin Miller Formation; both substrates are mixtures of shale, sandstone, and minor conglomerate. The stand along Exeter Drive occurs on soft sandstone. *Arctostaphylos pallida* appears to only grow on these soils in areas that experience maritime summer fog, and have not been found on the same substrates where summer air and soil temperatures are higher (Johnson 1983).

Arctostaphylos pallida is a component of the maritime chaparral vegetation type and appears to be co-dominant with other woody shrubs and shrub-form trees, including *A. crustacea* subsp. *crustacea* (brittle leaf manzanita), V*accinium ovatum* (California huckleberry), *Chrysolepis chrysophylla* var. *minor* (golden chinquapin), and several shrub-form *Quercus* species. Maritime chaparral represents a plant community of special concern because of the high density of narrowly distributed endemic species, its patchy distribution, and its association with forest edges or odd soils (Parker 2007).

Arctostaphylos pallida is shade intolerant and will slowly die when shaded by larger trees and shrubs. However, based on the results of vegetation management activities conducted in the mid-1980s at Huckleberry Preserve, Chabot, and Big Trees Trail and in the mid-2000s at Redwood Regional Park and Big Trees Trail, *A. pallida* responds positively to activities that reduce light competition and disturb the soil.

Four vegetation types exist on Sobrante Ridge: maritime chaparral, oak woodland, coastal scrub, and grassland (Amme and Havlik 1987). The area outside of the shale soil formation is dominated by open park-like coast live oak woodland, interspersed with grassland and coastal scrub; while the area within the shale soil formation is dominated by maritime chaparral, including *A. pallida* and *A. crustacea* subsp. *crustacea*. Within the approximately 3.6-hectare (9-acre) shale soil formation, primarily along the edges, are *A. custacea* subsp. *crustacea*; within the center of the formation is the largest concentration of *A. pallida*, occurring on both east- and southwest-facing slopes.

There are two vegetation types within the Huckleberry Preserve stand: maritime chaparral and oak/California bay laurel (*Quercus* species/*Umbellularia californica*) woodland. As is the case at Sobrante Ridge, the most barren soils at Huckleberry Preserve are occupied by the largest concentrations of *Arctostaphylos pallida*. Unlike the large stand at Huckleberry Preserve and the Sobrante Ridge, the soils of the satellite stands of the Huckleberry Ridge population are more developed and less nutrient deficient, capable of supporting redwood and coast live oak vegetation types. As such, the *A. pallida* at these sites occur mainly on roadcuts and within forest gaps.

H. Reproduction and Ecology

Arctostaphylos pallida is diploid, obligate seeding, and shade-intolerant (Amme and Havlik 1987). Bees and other insects in the superfamily Apoidea, in particular European honeybees (*Apis melifera*), appear to be important pollinators (Amme and Havlik 1987, B. Solvesky, Service, pers. obs. 2010). Two basic life history patterns are found among species within the genus *Arctostaphylos* with respect to wildfire; *Arctostaphylos* plants either survive wildfire and resprout from a basal burl (sprouter) or *Arctostaphylos* plants are killed by fire and regenerate from seeds stored in the soil (obligate seeder). Obligate seeding *Arctostaphylos* species, like *A. pallida*, may require 5 to 25 years before substantial seed crops are produced (Keeley 1986). Seeds typically suffer high rates of predation (Kelly and Parker 1990); however, seed caching by seed predators may be an important mechanism by which seeds are buried to a sufficient depth at which they may survive high-intensity wildfires. Parker (2010) found that while overall seedling density declined with fire intensity, the proportion of seedlings emerging from rodent caches increased. Seeds that are not depredated on are slowly added to the soil seed bank, eventually reaching depths at which they can survive fire (Parker 2007). Obligate seeding *Arctostaphylos* species tend to have fire-dependent seedling recruitment; and mature stands tend to be even-aged, exhibiting little to no regeneration during fire-free intervals (Safford and Harrison 2004). Mechanical disturbance may be an alternative to fire under certain conditions. The regeneration of seedlings at stands where vegetation management activities disturbed the soil and increased light levels, in the absence of fire, indicates fire is not required for seed germination to occur. However, based on the large number of seedlings that occur at Huckleberry Preserve as the result of a pile burn, compared to other stands with seedlings where fire has not occurred, fire is likely a more effective means of stimulating germination.

In addition to being an obligate seeder, *A. pallida* can reproduce vegetatively by layering. Layering occurs when branches become partially or fully buried in soil or litter and produce roots. Some extensive clones of *A. pallida* have developed in this manner within the Sobrante Ridge population (Amme and Havlik 1987).

The understory of mature *Arctostaphylos pallida* stands and chaparral vegetation in general is typically free of vegetation, including regeneration. The cause of the lack of vegetation beneath chaparral species has been attributed to allelopathy (inhibitory biochemical interactions between plants), small mammal herbivory, and/or fire dependant seed banks. Keeley and Keeley (1989) concluded that in nature, a substantial proportion of the seed pool of some chaparral species is unlikely to germinate in the absence of fire and that dormancy mechanisms minimize seed germination during periods of low-survival probability. However, they also note that a portion of the seed pool is potentially capable of germinating in the absence of fire.

A study comparing the regeneration and recolonization of obligate-seeding to sprouting *Arctostaphylos* after fire found that the seedlings of obligate seeders did not compete well against sprouters post-fire; thus, seedlings are adapted to openings in chaparral after fire (Keeley and Zelder 1978). Based on this observation, Keeley and Zelder (1978) hypothesized that longer fire-free periods favor obligate seeders by creating more and larger openings in chaparral post-fire, because: (1) longer fire-free periods result in higher fuel loads and more intense fires, thereby reducing the number of sprouters that survive fire; and (2) long fire-free periods allow for increased stem-exclusion, thereby reducing the density of potential sprouters after a fire. In support of this hypothesis, Odion and Davis (2000) found that chaparral with dense canopy cover prior to fire tended to be barren after fire, where heating was relatively high, except for the occasional obligate seeding *Arctostaphylos* and obligate seeding *Ceanothus*. The authors also noted that obligate seeders tended to have deeply buried seeds, allowing them to withstand prolonged soil heating. A study of the effects of prescribed fire on *A. morroensis* (Morro manzanita), a closely related species to *A. pallida* (Boykin et al. 2005) and a federally endangered obligate-seeding species from Morro Bay, California, found that *A. morroensis* may require considerably longer than 40 years between fires to establish a deeply buried seed bank with enough viable seed to adequately compensate for mortality and prevent population decrease or local extinction (Odion and Tyler 2002). However, it is not clear how long it takes to produce a persistent soil seed bank in which seeds are buried deep enough to withstand fire (Parker 2007).

I. Reasons for Listing and Current Threats

The following is a summary of the interacting influences of physical, chemical, and biological factors that continue to threaten *Arctostaphylos pallida*. In determining whether to list, delist, or reclassify a species under section 4(a) of the Act, we evaluate the threats to the species based on the five categories outlined in section 4(a)(1) of the Act: (A) the present or threatened destruction, modification, or curtailment of its habitat or range; (B) overutilization for commercial, recreational, scientific, or educational purposes; (C) disease or predation; (D) the inadequacy of existing regulatory mechanisms; and (E) other natural or manmade factors affecting its continued existence.

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

At the time of listing (Service 1998), we did not find there to be any Factor A threats to the species, because most of the remaining population at Huckleberry Ridge and the population at Sobrante Ridge were on lands owned by EBRPD and not subject to further residential development. However, since the time of listing and the most recent 5-year status review (Service 2011), we now know that approximately 36 percent of all *Arctostaphylos pallida* occur on private properties adjacent to Huckleberry Preserve, and not within the Huckleberry Preserve boundaries. Because these plants occur within the backyards of private homes and on property owned by a tennis club, they are at risk from development associated with home remodeling, new home construction, and tennis club remodeling and expansion. However, much of the area occupied by these plants is an extremely steep slope, which reduces the threat of development pressure to a moderate level. In addition, the potential exists for City of Oakland or EBRPD-funded development projects (e.g., museums or recreation support facilities) to remove or modify habitat.

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

Overutilization for any purpose was not known to be a factor in the 1998 final listing rule (Service 1998). Overutilization for any purpose does not appear to be a threat at this time.

FACTOR C: Disease or Predation

At the time of listing, we cited an unidentified fungal pathogen, possibly a *Botryosphaeria* species, which affected approximately 50 percent of the Huckleberry Ridge population of *Arctostaphylos pallida* as a threat. However, this unidentified fungal pathogen did not result in large-scale mortality. Rather, it caused branch and stem dieback and the remaining healthy branches and meristems exhibited good vigor and produced a large crop of seeds (Johnson 1983, Amme and Havlik 1987). Recently, *Phytophthora cinnamomi* has been confirmed infecting and killing *A. pallida* plants at Huckleberry Preserve and the Big Trees Trail stands. In contrast to the unidentified fungal pathogen, *A. pallida* infected with *P cinnamomi* die within several months of signs of infection and do not experience branch or stem dieback while maintaining healthy branches and meristems. To our knowledge, the extent of the infestation within stands of *A. pallida* has not been quantified and the potential for widespread population decline is still unknown.

The soil-borne pathogen, *Phytophthora cinnamomi*, has long been known as a world-wide threat to commercial and ornamental plants. *Phytophthora cinnamomi* is a fungus-like organism most closely related to diatoms and kelp (Kingdom Stramenopila) rather than to the true fungi (Kingdom Fungi or Eumycota). It is an introduced non-native pathogen in North America. In California, it is known to infect orchard trees, ornamental plants, and Christmas tree farms (Swiecki and Bernhardt 2003). In the East Bay Hills it is partially responsible for mortality of *Quercus agrifolia* (coast live oak) (Garbelotto et al. 2006), is a primary pathogen of *Arbutus menziesii* (Pacific madrone), *Umbellularia californica* (California bay laurel) and other species in a number of northern California plant communities where it has been introduced (Swiecki et al. 2011), and has been the cause of the decline and death of the federally threatened *A. myrtifolia* (Ione manzanita) near Ione in the Sierra Nevada foothills. *Phytophthora cinnamomi* causes root and crown rot; and in *A. myrtifolia*, this pathogen causes decay of the root system. The loss of functional roots causes the plant to desiccate (Swiecki and Bernhardt 2003). Because plants infected by *P. cinnamomi* become water-stressed, the effects of opportunistic pathogens such as *Botryosphaeria* may also become more severe on these plants. This may lead to confusion as to which disease(s) may be affecting a given stand (Swiecki and Bernhardt 2003).

The pathogenic activity of *Phytophthora cinnamomi* is favored by free moisture, and under wet conditions multiple infection cycles are likely to occur. *Phytophthora cinnamomi* is primarily spread to new areas through the movement of infested soil by humans, particularly on vehicle tires, but also on shoes, tools and equipment that become contaminated with infested soil (Swiecki and Bernhardt 2003). In addition, *P. cinnamomi* has been isolated from container stock purchased from several native plant nurseries, suggesting nursery stock used for restoration projects or planted within the Wildland Urban-Interface (WUI) can provide a vector for this disease (Swiecki et al. 2011). In addition, a high percentage of woody plant materials from commercial nurseries are infested with various root-rotting *Phytophthora* species, including *P. cinnamomi*. This not only increases the likelihood that remnant plants in landscapes will be killed by this pathogen, but further increases the risk to stands in the vicinity of landscaped parcels, especially where landscaped parcels are located upslope of *A. pallida* stands (e.g., Manzanita Drive area) (T. Swiecki pers. comm. 2012).

Human transport of contaminated soil is the primary vector for introducing *Phytophthora cinnamomi* into new areas. Most *Arctostaphylos pallida* stands occur along ridge tops, adjacent to unpaved maintenance roads and trails, increasing the likelihood contaminated soils will be spread throughout the East Bay Hills on shoes, bicycles, and vehicles. Once *Phytophthora cinnamomi* has been introduced into an area, its movement is facilitated by water flow, especially downhill. Swiecki et al. (2005) noted that the local spread of *P. cinnamomi* in *A. myrtifolia* occurs during the wet season at a cross-slope and upslope rate of approximately 0.25 meter (0.8 foot) per year. Down slope spread has been calculated at 2 meters (6.5 feet) per year, presumably due to transport via flowing water (Swiecki et al. 2005). Over a longer time interval, Swiecki and Bernhardt (2012) have documented that *P. cinnamomi* has spread at average rates about 1 meter (3.3 feet) per year in relatively level sites within *A. myrtifolia* stands.

Introduction of *Phytophthora cinnamomi* into *Arctostaphylos pallida* habitat represents a long-term and substantial threat. *Phytophthora cinnamomi* can persist in the environment in the absence of susceptible hosts, surviving in the soil in infected roots, or as long-lived resident spores (Swiecki and Bernhardt 2003). There is no known cure for plants that have been infected. Prevention of this disease depends on the exclusion of the pathogen from areas that contain host plants.

Phosphite (neutralized phosphorous acid), is a biodegradable systemic fungicide that, in part, potentiates plant defense mechanisms so that there is a more rapid and robust response to the pathogen. Phosphite stresses *Phytophthora cinnamomi*, causing it to release chemical signals that trigger the natural defense mechanisms of the host plant, thereby reducing the ability of *P. cinnamomi* to colonize and reproduce within the host (Suddaby and Liew 2008). Phosphite can be applied as a low volume aerial spray, high volume foliar spray, or by trunk injection of individual plants. The dosage of phosphite required to protect individual plant species is not universal. Applications that are too high for a particular plant species will have side-effects, such as leaf burning and a reduction in pollen viability, however, these effects may be temporary (Suddaby and Liew 2008). The efficacy of phosphite is not permanent and reapplication is required. The appropriate treatment regime (including an understanding of season, dose, application type, frequency, etc.) for *Arctostaphylos pallida* is not known at this time, but treatment frequency could be as often as once every 2 years. Low volume aerial application rates in Western Australia have ranged from 12 to 24 kilograms per hectare (11 to 21 pounds per acre) with disease control anticipated for approximately 2 years post-spray (Barrett et al. 2001). A study is currently underway to assess the efficacy of phosphite for limiting the spread of root disease caused by *P. cinnamomi* in native *A. myrtifolia* stands (Swiecki and Bernhardt, 2012).

The susceptibility of *Arctostaphylos pallida* to diseases and pathogens like *Phytophthora cinnamomi* could be exacerbated by other threats, such as shading by native and non-native invasive species, lack of fire, and climate change. There is no known cure for *P. cinnamomi* and it is capable of remaining in the soil and killing seedlings. Since *P. cinnamomi* is not known to infect the Sobrante Ridge population at this time and because it is easily transported to new sites, the spread of *P. cinnamomi* to Sobrante Ridge represents a substantial threat to the species. Due to the highly connected network of hiking and cycling trails within the East Bay Hills, many of which occur along ridge tops adjacent to *A. pallida* stands, the Huckleberry Ridge population is highly susceptible to infection by *P. cinnamomi*. In addition, management activities that are conducted within or near *A. pallida* stands also have the potential to spread *P. cinnamomi* via contaminated vehicles, clothing and boots, and other equipment if precautionary measures are not taken to minimize and avoid its spread.

FACTOR D: Inadequacy of Existing Regulatory Mechanisms

At the time of listing (Service 1998), regulatory mechanisms thought to have some potential to protect *Arctostaphylos pallida* included: the California Endangered Species Act (CESA), California Environmental Quality Act (CEQA), and Native Plant Protection Act (NPPA). In addition to State of California regulatory mechanisms, *A. pallida* also receives some protection though the National Environmental Protection Act (NEPA) and the Act. The following is a summary of the existing regulatory mechanisms that may reduce some of the Factor A, B, C, and E threats to *A. pallida*:

State Laws and Regulations

The State's authority to conserve rare wildlife and plants is comprised of three major pieces of legislation: CESA, NPPA, and CEQA.

CESA and NPPA: As a State-listed species, CESA (California Fish and Game Code, section 2080 *et seq*.) prohibits the unauthorized take of *Arctostaphylos pallida*. Pursuant to CESA, it is illegal to import, export, "take," possess, purchase, sell, or attempt to do any of those actions to species that are designated as threatened, endangered, or candidates for listing, unless permitted by California Department of Fish and Wildlife (CDFW). "Take" is defined as "hunt, pursue, catch, capture, or kill, or attempt to hunt, pursue, catch, capture, or kill." The NPPA (Division 2, Chapter 10, section 1908) prohibits the unauthorized take of State-listed rare or endangered plant species. CESA requires State agencies to consult with the CDFW on activities that may affect a State-listed species and mitigate for any adverse impacts to the species or its habitat. The State may authorize permits for scientific, educational, or management purposes, and to allow take that is incidental to otherwise lawful activities.

Furthermore, with regard to prohibitions of unauthorized take under NPPA, landowners are exempt from this prohibition for plants to be taken in the process of habitat modification. Where landowners have been notified by the State that a rare or endangered plant is growing on their land, the landowners are required to notify the CDFW 10 days in advance of changing land use in order to allow salvage of listed plants.

CEQA: CEQA requires review of any project that is undertaken, funded, or permitted by the State or a local governmental agency. If significant effects are identified, the lead agency has the option of requiring mitigation through changes in the project or to decide that overriding considerations make mitigation infeasible (CEQA section 21002). Protection of listed species through CEQA is, therefore, dependent upon the discretion of the lead agency involved.

Federal Laws and Regulations

NEPA: NEPA (42 U.S.C. 4371 *et seq*.) provides some protection for listed species that may be affected by activities undertaken, authorized, or funded by Federal agencies. Prior to implementation of such projects with a Federal nexus, NEPA requires the agency to analyze the project for potential impacts to the human environment, including natural resources. In cases where that analysis reveals significant environmental effects, the Federal agency must propose mitigation alternatives that would offset those effects (40 C.F.R. 1502.16). These mitigations usually provide some protection for listed species. However, NEPA does not require that adverse impacts be fully mitigated, only that impacts be assessed and the analysis disclosed to the public.

***Endangered Species Act of 1973, as amended*:** The Act is the primary Federal law providing protection for this species. Since listing, the Service has analyzed the potential effects of Federal projects under section 7(a)(2), which requires Federal agencies to consult with the Service prior to authorizing, funding, or carrying out activities that may affect listed species. A jeopardy determination is made for a project that is reasonably expected, either directly or indirectly, to appreciably reduce the likelihood of both the survival and recovery of a listed species in the wild by reducing its reproduction, numbers, or distribution (50 CFR 402.02). A non-jeopardy opinion may include reasonable and prudent measures that minimize adverse effects to listed species associated with a project.

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

Fire Frequency

At the time of listing, we cited past and present fire suppression policies and inactive or ineffective fire management plans as one of the greatest threats to the continued existence of the species. We determined that a lack of frequent small fires to stimulate regeneration and reduce fuel loads within stands of chaparral represented one of the greatest threats to the species. There has been considerable debate about the effects of decades of fire suppression on chaparral ecosystems (Moritz 2003). One side of the debate argues that fire suppression has increased fuel loads which lead to fewer, but larger wildlfires. This theory is supported by studies contrasting shrubland fire regimes north and south of the U.S.-Mexican border (Minnich 1983, 1995, 2001), suggesting that the pattern of frequent small fires south of the boarder is a model of what fire regimes were like north of the boarder prior to fire suppression policy. Based on this assumption, proponents of this theory suggested that California-shrubland WUI management should de-emphasize fire suppression and reestablish an age mosaic of shrublands to return the landscape to a condition in which fire size is constrained by discontinuities in fuels due to smaller, more frequent fires.

In contrast, others contend that relatively large stand-replacing crown fires are a natural part of these ecosystems and that urban expansion into these ecosystems has increased the rate of fire incidence through human ignition sources, resulting in more destructive (that is, expensive due loss the of human structures) fires. This is supported by research that has shown that frequency and area burned have not declined as a result of fire suppression (Keeley 1999); extremely large, stand replacing crown fires in California shrubland ecosystems predate fire suppression policy (Keeley and Fotheringham 2001, Keeley and Zedler 2009); over the last 130 years there has been no significant change in the incidence of large fires greater than 10,000 hectares (24,710 acres); fire suppression has not reduced the area burned (Conrad and Weise 1998, Keeley et al. 1999); large extensive fires are not dependent on stand age (Keeley et al. 1999, Moritz 2003); and when wildfires occur under severe fire conditions they burn through all but the youngest age-class of chaparral and coastal scrub (Keeley et al. 1999, Keeley 2002). Keeley and Fotheringham (2001) question the use of current fire regimes south of the border as a model of what fire regimes were like north of the border prior to fire suppression for the following reasons: (1) fire frequency from human ignition sources is five times greater south of the boarder; (2) most fires in northern Baja California, Mexico are driven by on-shore northwestern breezes, which have a different capacity for fire spread than fires driven by foëhn winds; (3) areas south of the border tend to receive less precipitation and soils tend to be less fertile, both of which affect fuel production; (4) much of the chaparral-dominated landscape south of the boarder is a plateau, lacking topographic heterogeneity, which affects the rate of fire spread and increases solar evaporation and reduced fuel production; and (5) few, if any, contiguous chaparral stands south of the boarder reach the sizes of those north of boarder.

In a study of relative frequency of human-caused and lightning-caused fires in the coast range east of San Francisco Bay, Keeley (2005) found that most years were without any lightning-ignited fires: in Contra Costa County 86 percent of the years had no lightning-ignited fires and in Alameda County the figure was 74 percent. Wildfire in Alameda and Contra Costa counties is most often human caused; thus, the fire return interval is likely no longer within the evolutionary bounds of the species. Odion and Tyler's (2002) study of *Arctostaphylos morroensis* indicates that a fire return interval of 40 years or less would likely result in the extirpation of the species, and other studies on obligate seeding *Arctostaphylos* similarly found that long fire-free intervals (with an interval greater than one fire every 100 years) likely do not represent a significant threat (Keeley and Zelder 1978, Odion and Davis 2000). Consequently, a relatively short fire-return interval, one that depletes the soil seed bank before it can be replenished, is likely a greater threat to *A. pallida* than a relatively long fire-return interval.

Still, because fire is essential to the natural regeneration of *Arctostaphylos pallida* and regeneration can be difficult in the absence of fire, fire suppression remains a threat. The Huckleberry Preserve site has likely not experienced a stand-replacing fire for more than 80 years and would benefit from fire or other management activities that stimulated regeneration and reduced competition with native and non-native species. The Sobrante Ridge site likely experienced a stand-replacing fire 30 to 40 years ago (Service 1998) and appears to be healthy and vigorous. EBRPD does not typically conduct broadcast burning in the WUI due to the threat of fire escape and liability; however, EBRPD is proposing to burn slash piles at Huckleberry Preserve as part of their Wildfire Hazard Reduction and Resource Management Plan (LSA Associates, Inc. 2009) (WHRRMP). The limited opportunities to use fire to stimulate regeneration of *A. pallida* represents a threat to the species, because the effectiveness of mechanical soil disturbance to stimulate regeneration has not been proven to provide adequate regeneration.

Wildfire Fuel Reduction Treatments

Mediterranean-climate shrublands of California are one of the most fire hazardous landscapes in North America. For example, the Tunnel Fire of 1991 started in the WUI of the Oakland/Berkeley Hills under severe fire hazard conditions. The Tunnel Fire burned 648 hectares (1,600 acres) of coastal scrub, maritime chaparral, and other vegetation types; killed 25 people, destroyed 3,354 homes and 456 apartments, and resulted in an estimated $1.5 billion in damages. Of primary concern to the municipalities and land management agencies in the WUI is reducing wildfire hazard to protect property and human lives. One of the only effective means of reducing this threat is to reduce the amount and/or structure of fire carrying fuels. All of the known stands of *Arctostaphylos pallida* occur in the WUI; the Huckleberry Preserve stands abut a housing development and the El Sobrante population is within 50 meters (165 feet) of urban development. Therefore, these stands are potential targets for wildfire fuel reduction treatments.

EBRPD's Wildfire Hazard Reduction and Resource Management Plan: According to EBRPD's Wildfire Hazard Reduction and Resource Management Plan (WHRRMP) the maritime chaparral vegetation type represents an extreme wildfire hazard. To reduce the hazard, the WHRRMP aims to focus mechanical fuel treatment efforts on key locations, including almost all stands of *Arctostaphylos pallida*. To minimize the effects of the WHRRMP, the Service is working with the Federal Emergency Management Agency and EBRPD to complete a long-term *A. pallida* management plan. Although the WHRRMP threatens *A. pallida*, the WHRRMP includes the removal of both native and non-native vegetation that grows within and adjacent to stands of *A. pallida* to reduce wildfire hazard. Shading by native and non-native species poses a significant threat to the existence of *A. pallida* (see Factor E section on <u>Succession and Non-native Invasive Species</u>); thus, the WHRRMP, if implemented in conjunction with an *A. pallida* management plan, may benefit the species.

Goat Grazing: Both EBRPD and the City of Oakland have used domestic goat (*Capra aegagrus*) grazing as a tool to reduce fuel loads and wildfire hazard within the WUI of the East Bay Hills. Due to the relatively indiscriminant food selection preferences of the domestic goat, this practice poses a serious, yet easily avoidable, threat to *Arctostaphylos pallida*. According to Kanz (2004) goat grazing by the City of Oakland is responsible for the extirpation of the Manzanita Flat stand and has caused damage to *A. pallida* plants at the Big Trees Trail site. The WHRRMP specifically excludes the use of goat grazing near stands of *A. pallida*. Goat grazing is a minor threat in areas other than City of Oakland properties, but is a significant threat to *A. pallida* occurring on City of Oakland properties.

Defensible Space: In January 2005, a new California state law became effective that extended the defensible space clearance around homes and structures from 9 meters (30 feet) to 30 meters

(100 feet). Proper clearance to 30 meters dramatically increases the chance of a structure surviving a wildfire. This defensible space also provides for firefighter safety when protecting homes during a wildfire. Since the largest stand of *Arctostaphylos pallida* at Huckleberry Preserve and on adjacent private properties occurs within the 30 meter defensible clearance space, plants nearest homes are threatened with removal by homeowners in the area who are concerned about protecting their homes and their lives from wildfire. This threat is also of particular concern for *A. pallida* that occur on private properties within the WUI, adjacent to Huckleberry Preserve. Vegetation removal, including *A. pallida*, within 30 meters of homes and structures would reduce the total number of *A. pallida* by at least one-third. However, we have no indication at this time that such removal is occurring. Therefore, this threat is not currently considered significant.

Succession and Non-native Invasive Species

Succession of maritime chaparral to oak/California bay laurel (*Quercus* species/*Umbellularia californica*) woodland and shading by non-native invasive species such as *Eucalyptus* species and *Pinus radiata* were cited as significant threats to *Arctostaphylos pallida* at the time of listing and continue to represent one of the most significant threats to the species. Mosaics of grassland, oak woodland, coastal scrub, and chaparral, in some locations, have been reported to correlate with geological substrate (Cole 1980, Davis et al. 1988) and soil characteristics (Harrison et al. 1971). However, Callaway and Davis (1993) found each of these vegetation types represented abundantly on most soil depths, slope aspects, and all geological substrates. Cyclical changes between chaparral, oak woodland, grassland, and coastal scrub do occur. However, the interactions between variables responsible for vegetation type conversion and the rate of conversion are complex and site-specific. Callaway and Davis (1993) found that transition rates varied with substrate and topographic position, indicating fire, grazing, and the physical environment interacted to determine direction and rate of conversion. Variation in transition on different substrates suggests that only portions of the vegetation on the landscape may be dynamic, with some patches in certain combinations of environment and disturbance that change rapidly, and other patches that remain static as edaphic or topographic climax communities. As a broad generalization, in the absence of disturbance and on sites with environmental factors that allow for transition from one vegetation type to another, grasslands tend to transition to coastal scrub, coastal scrub to chaparral or oak woodland, chaparral to oak woodland, and oak woodland to grassland (Callaway and Davis 1993).

Arctostaphylos pallida is highly shade intolerant and the invasion of tree-form plant species creates shade that causes *A. pallida* shrubs to slowly die over several years if management action is not taken. All of the stands of *A. pallida*, to some degree, show signs of succession to oak/ California bay laurel woodland and/or are being shaded by non-native trees. The Huckleberry Preserve stands and all of the satellite stands of the Huckleberry Ridge population are in severe decline due to shading via native species and non-native invasive species. For example, the Chabot stand will likely be extirpated within a decade if action is not taken that addresses this issue. Shading lowers seed production, reduces vegetative growth, causes branch dieback and ultimately results in plant death. However, *A. pallida* stands that experience 100 percent mortality will likely have a viable, although declining, seed bank for many decades.

Nitrogen Deposition

Atmospheric nitrogen deposition is a complex process by which reactive chemical species of nitrogen (N), nitrogen oxides (NO_X), ammonia (NH_3), and their reaction products are deposited onto surfaces and enter ecosystems as N-fertilizer. As a consequence of anthropogenic inputs, the global nitrogen cycle has been significantly altered over the past century (Weiss 2006). The added N has been shown to allow nutrient-deficient soils, such as serpentine, to be invaded by both native and non-native species that require added nutrients to survive (Weiss 2006). Although it has been posited that the succession of maritime chaparral to oak/bay (*Quercus* species/*Umbellularia californica*) woodland in the East San Francisco Bay is due to fire exclusion or is a natural process, it is also possible N-deposition has created conditions that have allowed vegetation-type conversion, from maritime chaparral to oak-bay woodland, to occur on the nutrient deficient soils that are typical of *Arctostaphylos pallida*.

Hybridization

Hybridization between *Arctostaphylos pallida* and other *Arctostaphylos* species was cited as a threat at the time of listing and continues to threaten the species today. Hybridization is known to occur naturally between *A. pallida* and *A. crustacean.* However, several species of *Arctostaphylos* not known to co-occur with *A. pallida* have been used for landscaping on private lands within the urban development adjacent to Huckleberry Preserve and threaten nearby *A. pallida* individuals through pollen swamping and hybridization leading to genetic assimilation. While most *Arctostaphylos* are diploid, about 30 percent are tetraploid. Differences in ploidy level are not a complete barrier to hybridization, and several diploid-tetraploid crosses have been observed in the field (e.g., *A. crustacea* X *A. pallida*) (Wahlert et al. 2006). From examination of populations of co-occurring diploid *Arctostaphylos* species in the field, in which the co-occurring *Arctostaphylos* species are from different genetic clades as defined in Boykin et al. (2005), there is very little or no hybridization (V.T. Parker and M.C. Vasey, unpublished data). However, *A. glauca*, *A. pajaroensis* and *A. pallida* are from the same genetic clade (Boykin et al. 2005) and are all diploid (Parker et al. 2012). Furthermore, hybrids have been observed between *A. pallida* and *A. glauca* (bigberry manzanita) and hybridization may be occurring in areas where residents have planted *A. pajaroensis* (Pajaro manzanita). This calls into question the genetic integrity of the seed bank within the City of Oakland residential development along Huckleberry Ridge and, to some extent, within the adjacent Huckleberry Preserve stands. If the seed bank in this area, including that of the Huckleberry Preserve stands, has been genetically compromised though hybridization with non-native *Arctostaphylos* species, regeneration in the area could result in a hybrid swarm and a blurring of the genetic integrity of all future stands of *A. pallida* in the area. At this time, the extent to which hybridization has occurred and the extent to which hybridization threatens *A. pallida* is not known.

Landscaping

Arctostaphylos pallida plants that occur within the yards of private residences (less than 57 plants) in City of Oakland residential neighborhoods are highly susceptible to mortality from landscaping activities. The majority of these plants will likely be lost in the foreseeable future due to these activities and a lack of regeneration. In addition, the genetic integrity of the soil seed bank is questionable due to hybridization with non-native *Arctostaphylos* species (see

Factor D, Hybridization above). Due to the susceptibility of these plants to mortality from landscaping and home improvement projects, and ongoing hybridization with non-native *Arctostaphylos* species, these plants and the associated seed bank will not contribute to meeting any of the recovery criteria for this species.

Herbicide Use

At the time of listing, herbicide use for the purpose of controlling roadside vegetation in the residential development adjacent Huckleberry Preserve was cited as a threat to *Arctostaphylos pallida*. Kanz (2004) indicated that *A. pallida* plants below the Pacific Gas and Electric Company power lines, between Manzanita Drive and Skyline Boulevard, exhibited evidence of herbicide use. Herbicide use continues to be a minor threat to *A. pallida*, particularly within the urban development and associated *A. pallida* stands adjacent to Huckleberry Preserve.

Small Population Size and Stochasticity

Because *Arctostaphylos pallida* exists as three populations with only two large stands and several small satellite stands, inbreeding depression and stochastic events represent significant threats to the species. Inbreeding depression can result in reduced fitness, which, coupled with small population size may result in a higher susceptibility to stochastic events, such as excessive rain, drought, and landslides, that further increase the likelihood of loss of genetic variability. Stochastic events, such as prolonged rainy periods, can also increase susceptibility to other threats, such as fungal pathogens and *Phytophthora cinnamomi*.

Climate Change

Effects to this species as a result of climate change are unclear. A trend of warming in the mountains of western North America is expected to decrease snowpack, hasten spring runoff, and reduce summer stream flows, and increased summer heat may increase the frequency and intensity of wildfires (IPCC 2007). While it appears reasonable to assume that the species may be affected, we lack sufficient certainty on knowing how and to what degree climate change will affect the species, the extent of average temperature increases in California/Nevada, or potential changes to the level of threat posed by drought, fire, etc. The most recent literature on climate change includes predictions of hydrological changes, higher temperatures, and expansion of drought areas, resulting in a northward and/or upward elevation shift in range for many species (IPCC 2007).

A modeling study by Loarie et al. (2008) provides an evaluation of potential trends to California's floristic communities under climate change scenarios. In general, large numbers of plant species will tend to move to higher elevations, towards the coast, or northwards. The models suggest that climate change has the potential to break up local floras, resulting in new species combinations, with new patterns of competition and biotic interactions (Loarie et al. 2008). Based on these models, *Arctostaphylos pallida* plants would likely be unable to shift their range naturally because of their dependence on specific soil types and a maritime climate and due to the presumably low dispersal potential of the species.

Climate change may also affect summer fog frequency and have a substantial impact on *Arctostaphylos pallida*, which is dependent on a fog-influenced maritime climate. According to M. Vasey (personal communication 2010), coastal endemic *Arctostaphylos* species are more vulnerable to summer drought stress than interior species, and if the frequency of coastal fog declines, the hydrologic regime of coastal *Arctostaphylos* species will likely become more challenging as they are not well-adapted to water stress. In addition, summer fog increases plant, soil, and atmospheric moisture, which decreases fire hazard and decreases the threat of too-frequent fire. Based on observational (Bakun 1990, Lebassi et al. 2009) and modeling studies (Diffenbaugh et al. 2004, Snyder et al. 2003) climate change may intensify upwelling, an important process in fog production off the coast of California, suggesting increases in fog in response to increased carbon emissions. However, Johnstone and Dawson (2010) found empirical evidence for moderate fog reductions since 1951, with interannual and multidecadal variations governed largely by ocean-atmosphere circulation and temperature anomalies.

J. Past Conservation Efforts

The following conservation efforts have occurred since *Arctostaphylos pallida* was listed:

1) In 2009, as part of a Low Effect Habitat Conservation Plan for EBMUD lands in the San Francisco East Bay, a large *Pinus radiata* that shaded the Pinehurst Road stand was removed. Prior to the removal of this tree, the stand had declined from 25 to 11 mature *Arctostaphylos pallida* plants. Apparently, the increased light not only invigorated the plants that had been shaded, but the mild disturbance to the site, caused by horse logging activities, stimulated a portion of the soil seed bank and over 52 *A. pallida* seedlings germinated. EBMUD continues to survey the Pinehurst Road stand on an annual basis.

2) In the summers of 2004 and 2005, approximately 500 square feet (152 square meters) were cleared by EBRPD at Huckleberry Preserve, leaving only *Arctostaphylos pallida* plants. Cut material and dead wood were placed into piles. In late February and early March of 2007, the piles were burned. In 2008, 176 seedlings had sprouted within the burned area.

3) The Big Trees Trail stand is likely to have sustained greater mortality if not for vegetation management activities conducted by a local volunteer watershed restoration organization, the Friends of Sausal Creek (FOSC). The FOSC conducts surveys of the site and occasionally removes both native and non-native plants that shade *Arctostaphylos pallida* plants. The management of the Big Trees Trail stand was included in the Chabot management plan to allow for a memorandum of understanding between FOSC and CDFW to permit FOSC to conduct restoration activities at both sites. A small number of *A. pallida* seeds have again germinated at the Big Trees Trail site in the absence of fire. Seed germination is likely due to soil disturbance caused by vegetation removal activities that scarified the seed coats.

4) A 1995 Environmental Impact Report prepared for the construction of the Science Center in Oakland California required that an *A. pallida* management plan be created and implemented. The plan was finalized in September 2009, and proposes to restore habitat and maintain a minimum of 21 plants at the site (Nomad Ecology 2009). According to the management plan, restoration activities were to begin in October 2009; however, the *A. pallid* at the Science Center have continued to decline and management activities did not begin until 2013.

II. Recovery Program

A. Recovery Strategy

Because *Arctostaphylos pallida* is an obligate-seeding species naturally occurring as even-aged stands with a long-lived soil seed bank, the primary management goal, at the stand level, should be to maximize seed production and to ensure the soil seed bank is adequate to replace all mature plants within a stand in the event of fire. At this time, the most significant long-term threats to seed production and stand regeneration, and in effect, the continued existence of the species, are: 1) the fungal pathogen *Phytophthora cinnamomi* which directly kills *A. pallida* plants and results in perpetual soil contamination; 2) competition, via succession, with native and non-native vegetation for light and space; 3) an altered fire regime that may prematurely deplete soil seed banks; 4) fire fuels management; and 5) small population and stand sizes that increase the likelihood stochastic events will extirpate a stand or population. In addition to ensuring habitat loss does not occur as a result of development, these threats can be minimized or ameliorated through the implementation of management plans that include and prioritize the control of *P. cinnamomi* at the stand level, *P. cinnamomi* spread abatement at the landscape level, management of competing native and non-native vegetation, perpetual stand regeneration, maintenance of genetic diversity, stand expansion, establishment of additional stands, and compatible fuel reduction treatments and methods.

B. Recovery Goal

The ultimate goal of this recovery plan is to outline specific actions that, when implemented, will sufficiently reduce the threats to *Arctostaphylos pallida*, ensure its long-term viability in the wild, and allow for its removal from the list of threatened and endangered species.

C. Recovery Objectives

To meet the recovery goal, the following objectives have been identified:

- Minimize the spread of *Phytophthora cinnamomi*.
- Treat stands infected with *Phytophthora cinnamomi*.
- Manage native and non-native vegetation that shade *Arctostaphylos pallida*.
- Expand existing stands.
- Establish additional stands.
- Ensure stands are protected from incompatible uses and incompatible wildfire fuels reduction activities.

D. Recovery Criteria

An endangered species is defined in the Act as a species that is in danger of extinction throughout all or a significant portion of its range. A threatened species is one that is likely to become endangered within the foreseeable future throughout all or a significant portion of its range. When we evaluate whether or not a species warrants downlisting or delisting, we consider whether the species meets either of these definitions. A recovered species is one that no longer meets the Act's definitions of threatened or endangered due to amelioration of threats. Determining whether a species should be downlisted or delisted requires consideration of the same five categories of threats which were considered when the species was listed and which are specified in section 4(a)(1) of the Act.

Recovery criteria are conditions that, when met, are likely to indicate that a species may warrant downlisting or delisting. Thus, recovery criteria are mileposts that measure progress toward recovery. Because the appropriateness of delisting is assessed by evaluating the five threat factors identified in the Act, the recovery criteria below pertain to and are organized by these factors. These recovery criteria are our best assessment at this time of what needs to be completed so that the species may be removed from the list of threatened and endangered species. Because we cannot envision the exact course that recovery may take and because our understanding of the vulnerability of a species to threats is very likely to change as more is learned about the species and its threats, it is possible that a future status review may indicate that delisting is warranted although not all recovery criteria are met. Conversely, it is possible that the recovery criteria could be met and a future status review may indicate that delisting is not warranted.

E. Delisting Criteria

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

To delist *Arctostaphylos pallida*, threats to the species habitat must be reduced. This will be accomplished when the following has occurred:

A/1 The 6,700 mature *Arctostaphylos pallida* plants counted toward recovery in delisting criterion E/2 are protected from incompatible uses through long-term conservation agreements with landowners.

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

Overutilization for any purpose is not known to threaten *Arctostaphylos pallida* at this time. Therefore, no recovery criteria have been developed for this factor.

FACTOR C: Disease or Predation

Predation is not known to threaten *Arctostaphylos pallida* at this time. Therefore, no recovery criteria have been developed to reduce the threat of predation. To delist *A. pallida*, the threat of disease must be controlled or eliminated. This will be accomplished when the following have occurred:

C/1 Tools or treatments have been developed and are effectively being utilized that have stopped the spread of *Phytophthora cinnamomi* and any individual mortality.

C/2 Treatments have been developed that allow *Arctostaphylos pallida* plants infected with *Phytophthora cinnamomi* to produce viable seed during or after treatment in quantities similar to uninfected healthy *A. pallida* plants.

C/3 A *Phytophthora cinnamomi* monitoring plan has been developed and implemented for all *Arctostaphylos pallida* stands and areas within watersheds of stands, to determine if stands are infected, the extent of infection, and to identify potential sources of future infection.

FACTOR D: Inadequacy of Existing Regulatory Mechanisms

The inadequacy of existing regulatory mechanisms is not known to threaten *Arctostaphylos pallida* 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 *Arctostaphylos pallida* include: fire frequency, wildfire fuel reduction treatments, succession and non-native invasive species, and small population size and stochasticity. To delist *A. pallida*, these threats must be reduced. This will have been accomplished when the following have occurred:

E/1 There are at least **three** separate populations of mature *Arctostaphylos pallida* plants: at least **one** population south of California State Route 24 (SR24) and at least **two** populations north of SR24, each with at least **1,700** genetically pure mature *A. pallida* plants.[1] For the purpose of recovery, a population is considered to be separate as long as it is more than 3.0 kilometers (1.9 miles) from the nearest *A. pallida* stand, and a mature plant is defined as being 25 years of age or greater.[2, 3]

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[1] Kanz (2004) estimated the Huckleberry Ridge population consisted of approximately 1,700 individuals prior to urban development in the 1970s. The Huckleberry Ridge population occurs as a cluster of stands, unlike Sobrante Ridge, which buffers from it from stochastic events. In addition, Huckleberry Ridge is the oldest population, providing the best evidence of what constitutes as viable population that would be sustainable over time.

[2] European honeybees are believe to be an important pollinator of *A. pallida* and 3.0 kilometers (1.9 miles) is twice the mean European honeybee foraging distance observed in differentially structured landscapes (Steffan-Dewenter and Kuhn 2003). This is greater than twice the mean foraging distance of 2.3 kilometers (1.4 miles) observed for honeybees in suburban environments (Waddington et al. 1994), and less than twice the mean foraging distance of 4.5 kilometers (2.8 miles) observed for a temperate deciduous forest (Visscher and Seeley 1982).

[3] Obligate seeding *Arctostaphylos* species may require 5 to 25 years before substantial seed crops are produced (Keeley 1986).

E/2 There are at least **6,700** genetically pure mature *Arctostaphylos pallida* plants.[4]

E/3 Competing native and non-native vegetation is controlled to a level whereby *Arctostaphylos pallida* vigor is not negatively affected and landowners have committed to provide long-term vegetation control that will conserve resident *A. pallida*.

E/4 Stand regeneration methods (mechanical or fire) result in an increasing trend in the number of mature *Arctostaphylos pallida* over a 25-year period.

E/5 Seed, representative of the breadth of the species' genetic diversity, is stored at a seed storage facility.

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[4] Based on a stand regeneration interval of 80 years, 25 years for *A. pallida* to reach maturity, and a total of 5,100 mature *A. pallida* plants needed for recovery, there should be approximately 1,600 additional mature *A. pallida* plants to buffer the effects of stand regeneration techniques, such as fire, on the total number of *A. pallida* needed for recovery.

III. Recovery Action Narrative and Implementation Schedule

The following step-down narrative and implementation schedule is comprised of three overarching elements which then tier down to individual recovery actions for implementation. The implementation schedule outlines actions and estimated costs for this recovery plan. It is a guide for meeting the objectives discussed in Chapter II. This schedule also prioritizes actions, provides an estimated timetable for performance of actions, and proposes the responsible parties for actions. For the sake of brevity in the Implementation Schedule, annual costs are shown for the first 5 years, along with an estimated total cost to achieve full recovery. Actions are subject to modification as dictated by new findings, changes in species status, and the completion of recovery actions. The most detailed actions are assigned a priority number for implementation. The actions in the Implementation Schedule, when accomplished, should further the recovery and conservation of the species.

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

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

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

Priority 2: An action that must be taken to prevent a significant decline in 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.

Definition of Action Durations:

Continual: An action that is not currently underway but will be implemented throughout the recovery period on a routine basis, once initiated.

Ongoing: An action that is currently being implemented and will continue throughout the recovery period.

TBD: To Be Determined.

Responsible Parties:

EBMUD	East Bay Municipal Utility District
EBRPD	East Bay Regional Park District
FWS	U.S. Fish and Wildlife Service
OAK	City of Oakland

PVT	Private Contractor
STO	Organization to Store/Propagate Seeds or Cysts (e.g., Rancho Santa Ana Botanic Garden)
UNIV	University
VOL	Volunteers

Responsible parties are those agencies who may voluntarily participate in implementation of particular actions listed within this recovery plan. Responsible parties may willingly participate in project planning, or may provide funding, technical assistance, staff time, or any other means of implementation; however, responsible parties are not obligated to implement any of these actions. Other parties are invited to participate in the recovery of *A. pallida*, as well.

Recovery Action Narrative and Implementation Schedule for the Recovery Plan for *Arctostaphylos pallida*.

Action Number	Priority	Description	Duration	Responsible Parties	Cost Estimate (in $1,000 units)						Comments
					Total	FY 2016	FY 2017	FY 2018	FY 2019	FY 2020	
1		**Control *Phytophthora cinnamomi* within infected *A. pallida* stands.** *Phytophthora cinnamomi* is an incurable root rot pathogen that has been shown to kill *Arctostaphylos pallida*. Once introduced and established, this disease is likely to spread throughout stands as long as conditions are suitable. At this time, the extent of infection within the Big Trees Trail and Huckleberry Preserve stands is unknown. Phosphite treatment has been shown to increase a plant's natural defense mechanisms to *P. cinnamomi*.									
1.2	1	**Determine the appropriate *P. cinnamomi* treatment.** Appropriate treatments should be developed that will identify an active ingredient(s), as well as season, dose, application type, frequency, etc. that will protect *A. pallida* from *P. cinnamomi*. Phosphite, or other fungicide(s) with similar or greater efficacy and relatively benign non-target environmental effects, should be prioritized for testing.	3 years	PVT, UNIV	30	30	–	–	–	–	Funding will occur in year 1, but the study will take 3 years to complete.
1.3	1	**Treat all viable *A. pallida* stands infected by *P. cinnamomi* and monitor treatment effects.**	Continual	EBMUD, EBRPD, OAK, VOL	TBD	TBD	TBD	TBD	TBD	TBD	Cost will vary depending on the extent of infection and will increase as infection spreads.

Action Number	Priority	Description	Duration	Responsible Parties	Cost Estimate (in $1,000 units)						Comments
					Total	FY 2016	FY 2017	FY 2018	FY 2019	FY 2020	
2		**Minimize the spread of *Phytophthora cinnamomi* within and between *A. pallida* stands.**									
2.1	1	**Implement measures to avoid and minimize the spread of *P. cinnamomi* from management activities.** The City of Oakland, EBRPD, EBMUD, and other agencies responsible for conducting management activities that may spread *P. cinnamomi* to *A. pallida* should adopt and implement best management practices that have been shown to minimize and avoid the spread of *P. cinnamomi* when working within watersheds with *A. pallida* stands. Best management practices include, at a minimum, vehicle, equipment, and personnel hygiene protocols; procedures for conducting activities in infected areas; and timing restrictions that avoid working when soils are moist and the likelihood of spreading *P. cinnamomi* is greatest.	Continual	EBMUD, EBRPD, OAK	70	2	2	2	2	2	
2.2		**Implement measures to avoid and minimize the spread of *Phytophthora cinnamomi* from recreational activities.**									
2.2.1	1	**Develop a *P. cinnamomi* spread avoidance plan for roads and trails.** This plan would determine if seasonal closures, realignments, or enhancements of unpaved roads and trails within watersheds with *A. pallida* stands are necessary to minimize the spread of *P. cinnamomi*. Unpaved roads and trails occurring upslope of any *A. pallida* stands would be prioritized for realignment, seasonal closure, or enhancements that result in drier surface conditions. In addition, the feasibility of implementing soil hygiene stations at trailheads should be examined.	1 year	EBMUD, EBRPD, FWS, OAK	40	40	–	–	–	–	

Action Number	Priority	Description	Duration	Responsible Parties	Cost Estimate (in $1,000 units)						Comments
					Total	FY 2016	FY 2017	FY 2018	FY 2019	FY 2020	
2.2.2	1	**Implement spread avoidance plan, including realignments, seasonal closures, or enhancements of roads and trails.** Once a spread avoidance plan for roads and trails has been developed, it should be fully implemented. In the interim, a priority action to avoid the spread of *P. cinnamomi* is the closure of Manzanita Loop Trail and rerouting the Heavenly Ridge Trail and Manzanita Trail so that these trails no longer traverse through the Sobrante Ridge *A. pallida* population, the largest uninfected stand and population of *A. pallida*.	TBD	EBMUD, EBRPD, OAK	TBD	TBD	TBD	TBD	TBD	TBD	Cost will depend on findings of study in 2.2.1.
2.3	3	**Develop and implement an East Bay Hills *P. cinnamomi* public outreach and education program.** Public outreach and education on the environmental effects of *P. cinnamomi* and how to minimize and avoid spreading the disease as a result of recreational activities should focus efforts at trailheads. Such a program would include signage and pamphlets describing environmental consequences of spreading *P. cinnamomi*, conditions that facilitate disease spread, susceptible host plants, and measures individuals can take to minimize spread while recreating.	Continual	EBMUD, EBRPD, OAK	127	25	3	3	3	3	Develop plan in year 1, implement plan in perpetuity.

Action Number	Priority	Description	Duration	Responsible Parties	Cost Estimate (in $1,000 units) Total	FY 2016	FY 2017	FY 2018	FY 2019	FY 2020	Comments
3		**Manage and expand existing *A. pallida* stands and establish additional stands.** It is imperative that all native and non-native plant species that compete with *Arctostaphylos pallida* plants for light and space are sufficiently controlled. In portions of stands where seed production appears to be declining, management actions should be implemented to increase health, vigor, and seed production by reducing competition with native and non-native species. If it is not possible to increase health, vigor, and seed production through vegetation management, then mechanical, fire, or other techniques to stimulate seed germination should be implemented. If regeneration or seedling survival appears inadequate to sustain a stand, regeneration should be augmented with propagules. To manage for genetic integrity within stands, verified hybrid (*A. pallida* x non-endemic *Arctostaphylos*) seedlings and plants should be removed as soon as hybrid identification is possible. *Phytophthora cinnamomi* spread minimization and avoidance measures (See Recovery Action 2 above) should be implemented when conducting any management activity within *A. pallida* stands.									
3.1	1	**Determine the optimal mechanical, fire, or other seed germination techniques for *A. pallida*.** Although fire stimulation is the natural mechanism by which seed germination in *A. pallida* typically occurs, it has been shown that seeds can germinate in the absence of fire cues by scarifying seed coats through soil disturbance. Since fire can result in considerable seed mortality, with seed mortality greatest near the soil surface, the germination of seeds near the soil surface through seed coat scarification would reserve deeply buried seeds for unplanned wildfire events. In addition, germination via seed coat scarification would reduce the need to consider prescribed burns near residential areas, where implementing such a practice might prove challenging for land managers. However, more research is needed to demonstrate if regeneration though seed coat scarification is capable of producing enough recruitment to sustain or increase the number of individuals within a stand.	3 years	UNIV, PVT, EBMUD, EBRPD, OAK	30	30	_	_	_	_	Funding will occur in year 1, but the study will take 3 years to complete.

Action Number	Priority	Description	Duration	Responsible Parties	Cost Estimate (in $1,000 units)						Comments
					Total	FY 2016	FY 2017	FY 2018	FY 2019	FY 2020	
3.2	1	**Manage competing vegetation and stimulate seed germination.** Conduct vegetation management activities and seed regeneration techniques at stands where declines in the number of mature plants have occurred or seed production is low. Sites that are no longer occupied by *A. pallida* plants or have suffered severe declines and produce little seed, but contain a viable seed bank and are not known to be infected by *P. cinnamomi* (i.e., Manzanita Flat, Chabot, Park Hill Road, and Sibley Volcanic Preserve), should be prioritized for restoration. Restoration of these stands will help insure that any genetic diversity unique to the site will not be lost.	Continual	EBMUD, EBRPD, OAK, VOL	525	15	15	15	15	15	
3.3	1	**Develop and implement Service-approved vegetation and regeneration management plans.** Management plans should include activities that will provide for the perpetual control of competing native and non-native vegetation; stand regeneration, through appropriate use of either fire or mechanical disturbance; compatible fuels management; maintenance of genetic integrity and diversity, the removal of hybrids of *A. pallida* and non-locally endemic Arctostaphylos species, and long-term monitoring, for all *A. pallida* stands.	Continual	EBMUD, EBRPD, FWS, OAK	TBD	50	TBD	TBD	TBD	TBD	Develop plan in year 1, implement plan in perpetuity.
3.4	2	**Store *A. pallida* seed, representative of the breadth of the species' genetic diversity, at a seed storage facility.**	1 month	STO	2.65	2.65	_	_	_	_	Per Rancho Santa Ana Botanical Gardens: $2500 flat rate + $150 per population.

Action Number	Priority	Description	Duration	Responsible Parties	Cost Estimate (in $1,000 units)						Comments
					Total	FY 2016	FY 2017	FY 2018	FY 2019	FY 2020	
3.5	2	**Establish landowner agreements between the Service, EBRPD, and private property owners adjacent to Huckleberry Preserve to preserve and manage *A. pallida* plants that occur on the private properties.**	Continual	EBRPD, FWS, PVT	5	5	–	–	–	–	Legal fees.
3.6	2	**Expand existing *A. pallida* stands.** Assess areas directly adjacent to existing *A. pallida* stands to determine if stand expansion is feasible. If stand expansion is feasible, any vegetation that may inhibit stands expansion should be removed, followed by direct seeding from a genetically appropriate seed source and an appropriate seed germination technique.	Continual	EBMUD, EBRPD, OAK, VOL	525	15	15	15	15	15	
3.7	3	**Establish additional *A. pallida* stands.** Develop and implement an introduction plan, including the identification of potential introduction sites, site preparation techniques, identifying genetically appropriate source populations, plant propagation or seeding and regeneration techniques, appropriate planting density values, seedling maintenance practices, measures of success, and monitoring methods.	Continual	EBMUD, EBRPD, OAK, VOL	TBD	50	TBD	TBD	TBD	TBD	Develop a plan in year 1.
3.8	3	**Secure long-term commitments from public agency landowners that protect *A. pallida* stands from incompatible uses.**	1 year	EBMUD, EBRPD, OAK	5	5	–	–	–		Legal fees.
Estimated Total Cost of Recovery = $1,459,650											

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V. Appendix: Summary of Public Comments and Peer Review Comments

A. Summary of Public Comments

On March 3, 2014, we released the draft recovery plan for pallid manzanita for public comment (79 FR 11816). We received no comments from the public in response to our Federal Notice announcing the publication of the draft recovery plan.

B. Summary of Peer Review Comments

Peer review comments of the draft plan were solicited prior to publication of the draft. We received technical comments from two experts: Dr. Courtney Angelo and Dr. Tedmund Swiecki. Their comments are summarized below and were incorporated into the plan.

Comments from Courtney Angelo, Ph.D.:

1. Dr. Angelo provided technical comments on the impact of modern fire suppression methods on *Arctostaphylos pallida*. Her comments were incorporated in the discussion of fire frequency and suppression under Factor E in the threats analysis.
2. Dr. Angelo asked for clarification on how the population target in delisting criterion E/2 was determined. We have included a description of our derivation of this number at a footnote.
3. Dr. Angelo agreed that use of disinfectant methods is a good strategy for limiting the spread of *Phytophthora cinnamomi* and noted the effectiveness of this method in limiting the spread of other species of *Phytophthora*.

Comments from Tedmund Swiecki, Ph.D.:

Dr. Swiecki provided several comments related the ecology of the plant pathogens discussed in the plan including *Botryosphaeria* and *Phytophthora cinnamomi*. We incorporated each of the suggestions provided.
1. Dr. Swiecki noted that the description of *Botryosphaeria* should be clarified.
2. Dr. Swiecki also suggested that the term fungal should not be used for *Phytophthora cinnamomi* because water molds are classified in a different taxonomic kingdom that fungi.
3. Dr. Swiecki also suggested that the plan should emphasize that infestation of soil with *Phytophthora cinnamomi* essentially destroys habitat for the species because there is at present no practical method to eradicate the pathogen from soils that have become infested.