Ceanothus ferrisiae
(Coyote ceanothus)

5-Year Review:
Summary and Evaluation

Photo Credit: Janell Hillman, Botanist, Santa Clara Valley Water District

U.S. Fish and Wildlife Service
Sacramento, California

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5-YEAR REVIEW

Ceanothus ferrisiae (Coyote ceanothus)

I. GENERAL INFORMATION

Purpose of 5-Year Reviews:

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

Species Overview:

Ceanothus ferrisiae (Coyote ceanothus) is an erect evergreen shrub belonging to the buckthorn family (*Rhamnaceae*) (Schmidt 1993). It grows on arid slopes in serpentine chaparral, valley, and foothill grasslands below about 300 meters (about 1,000 feet) (Munz and Keck 1959; Hickman 1993). *C. ferrisiae* is a perennial, flowering from January to March (Munz and Keck 1959). It is an obligate seeder and most likely self-incompatible (D. Wilken, Pers. comm., 2010). This endangered plant is known from only three locations: Anderson Dam, Kirby Canyon, and Llagas Road, all located in Morgan Hill, California. All of these locations occur within approximately four to five miles of each other, within Santa Clara County, California. Recently documented observations of mass *C. ferrisiae* seedling germination following fire, new information from experts familiar with this species, and traditional ecological knowledge from California Native American tribes strongly suggest that periodic fire events may be crucial for regeneration of senescent stands of this plant (Keeley 2002; Pfeiffer and Ortiz 2007; J. Hillman, pers. comm., 2009 and 2010; D. Hankins, pers. comm., 2010).

Methodology Used to Complete This Review:

This review was prepared by the Sacramento Fish and Wildlife Office, following the Region 8 guidance issued in March 2008. We used information from the Recovery Plan for Serpentine Soil Species of the San Francisco Bay Area (Recovery Plan), survey information from experts who have been monitoring various localities of this species, and the California Natural Diversity Database (CNDDB) maintained by the California Department of Fish and Game. The Recovery Plan published peer-reviewed literature, field surveys, and personal communications with experts

were our primary sources of information used to update the species' status and threats. We received no information from the public in response to our Federal Notice initiating this 5-year review. This 5-year review contains updated information on the species' biology and threats, and an assessment of that information compared to that known at the time of listing or since the last 5-year review. We focus on current threats to the species that are attributable to the Act's five listing factors. The review synthesizes all this information to evaluate the listing status of the species and provide an indication of its progress towards recovery. Finally, based on this synthesis and the threats identified in the five-factor analysis, we recommend a prioritized list of conservation actions to be completed or initiated within the next 5 years.

Contact Information:

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Federal Register (FR) Notice Citation Announcing Initiation of This Review: A notice announcing initiation of the 5-year review of this taxon and the opening of a 60-day period to receive information from the public was published in the Federal Register on March 25, 2009 (74 FR 12878-12883).

Listing History:

Original Listing
FR Notice: 60 FR 6671
Date of Final Listing Rule: February 3, 1995
Entity Listed: *Ceanothus ferrisiae*, a plant species
Classification: Endangered

Review History: No previous 5-Year Reviews or other relevant documents have been written for *Ceanothus ferrisiae*.

Species' Recovery Priority Number at Start of 5-Year Review: The recovery priority number for *Ceanothus ferrisiae* is 14 according to the Service's 2010 Recovery Data Call for the Sacramento Field Office, based on a 1-18 ranking system where 1 is the highest-ranked recovery priority and 18 is the lowest (Endangered and Threatened Species Listing and Recovery Priority Guidelines, 48 FR 43098, September 21, 1983). This number indicates that the taxon is a species that faces low degree of threat and has a high potential for recovery.

Recovery Plan

Name of Plan: Recovery Plan for Serpentine Soil Species of the San Francisco Bay Area
Date Issued: September 30, 1998

II. REVIEW ANALYSIS

Application of the 1996 Distinct Population Segment (DPS) Policy:

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

Information on the Species and its Status:

Species Biology and Life History:

Ceanothus ferrisiae (Coyote ceanothus) is an erect evergreen shrub belonging to the buckthorn family (*Rhamnaceae*) (Schmidt 1993). McMinn (1933) originally described the species based on specimens collected above Coyote Creek, along Madrone Springs Road. This plant can reach 1 to 2 meters (3 to 6 feet) in height at maturity, and is characterized by long, stiff divergent branches that can become woody with age (McMinn 1933; Munz and Keck 1959; Schmidt 1993). The leaves are opposite and round with a dark green, hairless upper surface and a lighter green undersurface with minute hairs (Schmidt 1993). Leaf margins have short teeth or sometimes lack teeth; the leaf base is abruptly tapering or rounded. Small white flowers are borne in clusters 1.3 to 2.5 centimeters (0.5 to 1.0 inch) in length (McMinn 1933; Schmidt 1993). Seed capsules are seven to nine millimeters (0.3 to 0.35 inch) in width and have conspicuous apical horns (protuberances situated at the tip) (McMinn 1933; Schmidt 1993).

Ceanothus ferrisiae is a perennial, flowering from January to May (Munz and Keck 1959). It is an obligate seeder with fertilization and seed production occurring from February through June (D. Wilken, pers. comm., 2010). Seed dispersal begins in May and can last though late October. *C. ferrisiae* is most likely strictly self-incompatible, meaning that their ova cannot be fertilized with pollen that share identical S-alleles, genes that control self fertilization (Table 1) (Takayama and Isogai 2005; T. Parker, pers. comm., 2010; D. Wilken, pers. comm., 2010). The average lifespan for this species is estimated to range from 20 to 50 years (Keeley 1975; T. Parker, pers. comm., 2010; D. Wilken, pers. comm., 2010).

Insect pollinators may play a significant role in conservation and restoration of native plants (Montalvo et al. 1997; Rogers and Montalvo 2004). Geographic distance, intervening habitat-type, urban development, and other landscape features may influence pollinator-mediated gene flow among populations (Montalvo et al. 1997; Rogers and Montalvo 2004; Leimu et al. 2006). *Ceanothus ferrisiae* is insect-pollinated mostly by generalist native and some non-native bee taxa (Kremen et al. 2002; Thorp et al. 2002; S. Boyd, pers. comm., 2010; R. Thorp, pers. comm., 2010). Foraging home-ranges may be as low as 150 to 300 meters (492 to 984 feet) for the smaller native bees, and up to 1,200 meters (3,937 feet) for the larger non-native bee species. Therefore, populations of *C. ferrisiae* that are separated by more than 1,200 meters may not be connected by insect-mediated gene flow (Table 1 and Table 2).

The ecological role of fire for *Ceanothus ferrisiae* has been a subject of debate among botanists. Freas (*in litt*., 1993) suggested that fire was not an important factor for germination of *C. ferrisiae* seeds, and proposed that fire may even be a threat to the persistence of this plant. Greenhouse studies conducted by Freas (*in litt*., 1993) found no differences in seed germination rates among various heat treated seeds, seeds subjected to stratification (process of pre-treating seeds to simulate natural winter conditions for germination), and untreated seeds. However, stratification resulted in more rapid germination in comparison to the other treatments. Quick and Quick (1961) found that heat treatment of several varieties of 15 to 20 year old *Ceanothus* seeds resulted in an 80 percent germination rate. D. Wilken (pers. comm., 2010) and T. Parker (pers. comm., 2010) recommend heat treatment of *C. ferrisiae* seeds to induce germination as well.

Freas (*in litt*., 1993) detected minimal evidence of recruitment among existing populations of *Ceanothus ferrisiae* during monitoring over a three-year period and attributed low recruitment rates to seed predation, grazing, and insufficient precipitation for young plants to survive the dry summer seasons following germination. In fact, only the Kirby Canyon population, which experienced a fire event during December 1992 showed significant evidence of recruitment during a three-year time period following the fire. Over 95 percent of the Kirby Canyon population suffered mortality, while the surviving plants supported only a few branches that produced flower buds. Despite sufficient precipitation for germination, no seedlings were observed in the summer of 1992. However, over 2,000 seedlings were observed during the following spring at this site. Prior to 2003, only several hundred plants existed on the west side of Anderson Dam. Over 100,000 seedlings emerged during the following spring after a major fire at this site in 2003. Many of these plants have survived to reach maturity, flowering for the first time in the spring of 2010. These observations follow a similar pattern of fire events followed by subsequent germination documented for other *Ceanothus* species, whereby widespread germination occurs only during the first winter and spring following a fire (Schlesinger and Gill 1978; Lawson et al. 2010).

Ceanothus species are an important cultural resource for Native American tribes who used these plants for producing baskets, cradles, teas, and medicines (Salazar-Aranda et al. 2009; C. Striplen, pers. comm., 2010; D. Hankins, pers. comm., 2010). Indigenous North Americans have long recognized the benefits of fire for regeneration and regularly applied this tool to create habitat that would attract ungulates, such as bison and elk, for hunting (Denevan 1992). Many tribes used fire for agricultural purposes as well. California tribes, such as the Amah Mutsun Tribal Band (Ohlone) and Miwok, used fire periodically to regenerate stands of *Ceanothus* (Pfeiffer and Ortiz 2007; D. Hankins, pers. comm., 2010).

Recently documented observations of mass *Ceanothus ferrisiae* seedling germination following fire, new information from experts familiar with this species, and traditional ecological knowledge from California Native American tribes strongly suggest that periodic fire events may be crucial for regeneration of senescent stands of this plant (Table 1) (Keeley 2002; Pfeiffer and Ortiz 2007; J. Hillman, pers. comm., 2009 and 2010; D. Hankins, pers. comm., 2010). Studies of other *Ceanothus* species have revealed life history characteristics that appear to be adaptations to periodic fire events. Lawson et al. (2010) used a spatially explicit model and parameters based on life history characteristics of six other *Ceanothus* species to determine the optimal fire return

interval for a rare, range-limited species of *Ceanothus* (*Ceanothus verrucosus*). Their analyses determined that a fire return interval of 35 to 50 years resulted in the highest population abundances (Lawson et al. 2010).

Keeley (1975) observed that aging *Ceanothus* shrubs tend to develop numerous channeled, woody stems, while allocating resources to only a few stems that produce flowers and seeds. This observation suggests this characteristic may be an adaption that allows *Ceanothus* shrubs to compete for resources in the arid chaparral environment while maintaining its ability to produce seed in an effort to overcome seed predation by small mammals and low seed viability (Keeley 1975). Keeley (1975) also noted that many 20 to 40-year old *Ceanothus* stands experience high mortality from fire. This may also suggest that aging *Ceanothus* stands become increasingly prone to fire as plants accumulate woody stems over time, thus providing their own fuel for fire necessary for regeneration from the soil seed bank. Further studies may be warranted to determine whether *Ceanothus ferrisiae* shares these adaptations and whether periodic fire may be crucial for regeneration of this species (Table 1).

Table 1. Summary of life history traits and associated conservation challenges.

Trait	Description	Conservation Challenges
Mating system	Seed obligate; Self-incompatible. Will hybridize with other species or sub-species in situations where only one plant exists or there is genetic incompatibility with surrounding plants of the same species. Reduced fecundity in offspring due to genetic incompatibilities.	1. Need multiple, large populations within close promixity to allow genetic migration to occur via pollination. 2. Seed collections need to be designed to capture most genetic variation in existing populations to maximize genetic effective population size and minimize probability of genetic Allee effects in restored populations.
Fire ecology	The role of fire in the ecology of this plant remains unclear. However, recruitment was observed to be very high following a fire in 2003. As stands mature, competition increases for light, water, and nutrients. Plants will restrict resource allocation to a few branches and allow remaining plant tissue to die and become woody debris. The woody debris in older stands may provide a rich fuel supply for fires. Fire appears to destroy all mature and older plants, and stimulate regeneration from soil seed banks.	Greater than 95% of *C. ferrisiae* populations occur on private lands where fire may be precluded from use as a form of management.
Demography	Ceanothus reach reproductive maturity after 5-6 years. Plants live for an average of 20-40 years. Some have been documented to live for as long as 80-100 years. Recruitment is low in the absence of fire and in the presence of cattle grazing. Populations that emerge post-fire experience mortality of > 50 percent of initial recruits after 8-12 years due to competition and crowding.	1. Without fire recruitment is low. 2. Cattle grazing and other activities conducted on private land may significantly reduce survival and recruitment of this species, thereby increasing the vulnerability of current populations to extinction as a result of demographic stochasticity.

Spatial Distribution

The pre-contact (period of time before contact of North American indigenous people with outside cultures) distribution of *Ceanothus ferrisiae* has not been well documented. It may be possible to develop an historic environmental baseline for this species through inquiry of local tribes who have traditional ecological knowledge regarding this plant acquired through cultural and historic associations with the Santa Clara Valley. Studies using both plant macrofossils and pollen records from this area may reveal the historic distribution of *C. ferrisiae* in the Santa Clara Valley as well (Birks and Birks 2000).

Fewer than 6,000 *Ceanothus ferrisiae* plants were known to exist among only three locations at the time of listing: Anderson Dam, Kirby Canyon, and Llagas Road, all located in Morgan Hill. All of these locations occur within approximately four to five miles of each other, within Santa Clara County, California. The current geographic distribution of *C. ferrisiae* remains restricted to these same three locations.

The Anderson Dam population is subdivided by the dam itself, resulting in three physically fragmented subpopulations. The first subpopulation consists of approximately 250 plants located east of the dam (Anderson Dam-East (ADE)), which is separated by over 500 meters from the second subpopulation of 3,600 plants on the west side if the dam (Anderson Dam-West (ADW)) (Table 2). The third, and largest subpopulation, is located on private ranch land adjacent to the west side of the dam. This subpopulation consists of >100,000 plants distributed among two geographically distinct patches separated by about 900 meters (south to north) (Table 2). These large patches (Anderson Dam Ranch-South (ARS) and Anderson Dam Ranch-North (ARN), respectively) are separated from the ADE and ADW subpopulations by 400 to 1,700 meters (Table 2). The majority of the plants in the larger ARS subpopulation emerged following the fire in 2003 (J. Hillman, pers. comm., 2010). The Kirby Canyon population consists of approximately 150 plants, and is located at least 1,700 meters from the nearest Anderson Dam subpopulation (F. Gardipee, pers. obs., 2010; J. Hillman, pers. comm., 2010). The Llagas Road population (estimated 600 – 650 plants) is the most geographically isolated, located at least 4,000 to 5,000 meters from the Kirby Canyon and Anderson Dam populations (Table 2).

Abundance

Less than 6,000 *Ceanothus ferrisiae* plants were documented at the time of listing. A 1988 survey estimated several hundred plants at Kirby Canyon (CNDDB 2010). Over 500 plants were documented at the Llagas Road location in 1988 as well. The majority of plants were found at the Anderson Dam location.

The current *Ceanothus ferrisiae* population at Anderson Dam is physically subdivided by the dam itself with about 250 plants (200 mature, 50 seedlings along the bank) on the east side along the reservoir shoreline, approximately 3,600 plants on the west side of the dam abutment, and > 100,000 plants on private land adjacent to the west side of the dam (the majority of which germinated from the soil seed bank after a fire in 2003) (ICF Jones and Stokes, 2009; J. Hillman, pers. comm., 2009 and 2010). Greater than 95 percent of recruitment, due to fire, has occurred

on private land. Over 50 percent of all *C. ferrisiae* plants that emerged after the 2003 fire produced seed during the 2010 season (F. Gardipee pers. obs., 2010; T. Willsey, pers. obs., 2010; J. Hillman, pers. obs., 2010).

Over 5,000 *Ceanothus ferrisiae* plants were documented at Kirby Canyon in 1987, and only several hundred were observed during the following year. A fire in 1992 destroyed about 95 percent of those plants. Approximately 2,000 seedlings were observed at Kirby Canyon in 1993 following the 1992 fire (Freas, pers. comm. 1993). Population size for the Kirby Canyon occurrence was estimated at approximately 150 plants during a recent survey conducted in fall 2010 by the Service and the Santa Clara Valley Water District (SCVWD) (F. Gardipee, pers. obs., 2010; J. Hillman, pers. comm., 2010). Approximately 500 *C. ferrisiae* plants were observed at the Llagas Road location in 1988 along with just ten plants observed in the east colony of the Llagas Road location during a 2002 survey (CNDDB 2010). Approximately 600 to 650 plants were observed at this same location in fall 2010 (F. Gardipee and T. Willsey, pers. obs. 2010; J. Hillman, pers. comm., 2010).

Table 2. Estimated distances (meters) among populations and subpopulations at the Anderson Dam, Kirby Canyon, and Llagas Road populations of *Ceanothus ferrisiae*.

Area Sampled	ADE	ADW	ARS	ARN	KB	LL
Anderson Dam-East (ADE)	-					
Anderson Dam-West (ADW)	520	-				
Anderson Dam Ranch-South (ARS)	860	400	-			
Anderson Dam Ranch-North (ARN)	1,700	1,280	900	-		
Kirby Canyon (KB)	3,380	2,800	2,600	1,700	-	
Llagas Road (LL)	5,000	5,100	5,100	5,200	4,000	-

Table 3. Total acres of suitable habitat for *Ceanothus ferrisiae* identified by the proposed SCVHP.

Vegetation Type	Acres	Percent of SCVHCP Area
Serpentine bunchgrass grassland	10,012	1.9
Serpentine rock outcrop	262	0.05
Serpentine seep	32	0.01
Mixed serpentine chaparral	3,881	0.8
Totals:	14,187	3

Habitat or Ecosystem:

Ceanothus ferrisiae grows on arid slopes in mixed serpentine chaparral, valley, and foothill serpentine bunchgrass grasslands below 300 meters (about 1,000 feet) (Munz and Keck 1959; Hickman 1993). Rare species associated with *C. ferrisiae* include the federally listed bay checkerspot butterfly (*Euphydryas editha bayensis*), Santa Clara Valley dudleya (*Dudleya setchellii*), and most beautiful jewelflower (*Streptanthus albidus* ssp. *peramoenus*) (Evens and San 2004). It is also associated with bigberry manzanita (*Arctostaphylos glauca*), California coffee berry (*Rhamnus californica*), California sagebrush (*Artemesia californica*), common yarrow (*Achillea millefolium*), foothill pine (*Pinus sabiniana*), leather oak (*Quercus durata*), and toyon (*Heteromeles arbutifolia*) (Corelli 1991; Evens and San 2004). However, some occurrences of *C. ferrisiae* are nearly pure stands of this species.

Changes in Taxonomic Classification or Nomenclature:

There have been no changes in taxonomic status or nomenclature since *Ceanothus ferrisiae* was listed.

Genetics:

No assessments of genetic diversity and population subdivision have been conducted specifically for *Ceanothus ferrisiae* prior to or since the time of its listing. However, Hardig et al. (2000 and 2002) included samples of two *C. ferrisiae* individuals collected from a location near Anderson Dam in phylogenetic studies of the *Ceanothus* genus (T. Hardig, pers. comm., 2010). Data from genetic markers, isolated from nuclear DNA, were used to delineate the 33 *Ceanothus* species sampled into two subgenera; *Cerastes* and *Ceanothus* (Hardig et al. 2000). Phylogenetic analyses further divided the two subgenera into geographic regions. *C. ferrisiae* falls under the Northwestern geographic region of the *Cerastes* subgenus where it shares identical nuclear DNA sequences with *Ceanothus mansonii* and *Ceanothus sonomensis* (Hardig et al. 2000). Sequence data from another set of genetic markers isolated from chloroplast DNA (cpDNA) revealed that *C. ferrisiae* occurs as a sister species to *Ceanothus megacarpus* var. *insularis* in the *Cerastes* subgenus (Hardig et al. 2000). The degree of incongruence between trees generated from

nuclear ITS sequences and cpDNA *MatK* sequences may be best explained by natural hybridization among *Ceanothus* species (Hardig et al. 2000).

The incongruence between phylogenetic trees for nuclear and cpDNA observed in Hardig et al.'s (2000) study is concordant with anecdotal accounts of hybridization among *Ceanothus* species (Hardig et al. 2000). Interspecific hybridization may occur because strict self- incompatibility may increase susceptibility to pollination by other *Ceanothus* species as an evolutionary "bet-hedging" strategy against reduced reproduction (D. Wilken, pers. comm., 2010). This condition was observed among 20 different *Ceanothus* species growing in the Santa Barbara Botanic Garden (SBBG). Most of the *Ceanothus* species in the SBBG, which were represented by only a few or single individuals, produced profuse flowers every year but rarely produced fruits (D. Wilken, pers. comm., 2010). The few seeds that were produced were infertile or produced interspecific hybrids with reduced pollen fertilities as low as 50 percent (D. Wilken, pers. comm., 2010). The only species in the SBBG to successfully produce large quantities of fertile seeds was *Ceanothus spinonus*, which was represented by numerous individuals (D. Wilken, pers. comm., 2010).

Reduced fertility among seeds and plants produced through interspecific hybridization as a result of genetic incompatibilities may be caused by chromosomal differences and genic interactions among alleles at multiple loci, known as Dobzhansky-Muller incompatibilities (Dobzhansky 1951; Allendorf and Luikart 2007). Genetic incompatibilities can lead to the existence of tension hybrid zones among species, whereby first and second generation hybrids are less fit than the parental types (Arnold 1997). Tension hybrid zones may commonly exist among self-incompatible plants such as *Ceanothus*. The occurrence of tension hybrid zones may limit introgression while maintaining species integrity and conserving co-adapted gene complexes (Arnold 1997). The existence of tension hybrid zones may provide a plausible explanation for the genetic distinctions that delineate species of *Ceanothus* that are somewhat blurred by incongruencies between nuclear and cpDNA observed in Hardig et al.'s (2000 and 2002) studies. However, it is important to note that no other subspecies of *Ceanothus* have been observed within the current range of known *Ceanothus ferrisiae* occurrences within the Santa Clara Valley. Genetic studies of this plant may offer further insight regarding its genetic status, ecology, and mating system that will provide useful information for the restoration and recovery of this species (Frankham 2005).

Species-specific Research and/or Grant-supported Activities:

A study plan and research proposal for genetic studies from samples collected from *Ceanothus ferrisiae* during July, 2010 is in progress. Population data and genetic samples from *C. ferrisiae* populations, in burned and unburned areas, have been collected by the Service and the SCVWD. The Service and the SCVWD are collaborating with scientists at the University of California, Davis and Pepperdine University on studies to assess genetic diversity and population structure of *C. ferrisiae*.

Five-Factor Analysis

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

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

Development on recreational and private lands, which would result in loss, modification, and destruction of *Ceanothus ferrisiae* habitat, were considered potential threats at the time of listing.

Destruction and modification of habitat, and development on recreational and private lands continues to be a threat for *Ceanothus ferrisiae*. Construction of a commercial landfill at Kirby Canyon beginning in 1986 (prior to the listing of *C. ferrisiae* in 1995) may have resulted in the undocumented loss of thousands plants, as evidenced by the decline of this population from 5,000 in 1987 to about 100 individuals observed in 1992 (Freas, pers. comm. 1993; LSA Associates 1992). The remaining population is currently threatened by altered fire regime and lack of recruitment. Proximity to the commercial landfill and urban development may limit or prevent the use of fire for regeneration. Future expansion of the commercial land fill may result in further curtailment and loss of currently available habitat for this population. Five Fill Areas were originally proposed for the Kirby Canyon Landfill (LSA Associates 1992). Fill Areas 1 and 2 have already been developed since 1986. It is anticipated that Fill Areas 3 and 4 will be developed within the near future as covered activities under the proposed SCVHP (ICF Jones and Stokes 2009). Fill Area 4 is proposed to be developed within less than 1,000 feet of the existing Kirby Canyon *C. ferrisiae* population (LSA Associates 1992). Activities associated with the development of Fill Areas 3 and 4 could pose significant threats the persistence of this very small population.

The Llagas Road population exists on private land that is nearly surrounded by residential development. Future development could result in increased encroachment upon existing habitat necessary for expansion of the Llagas Road population to meet recovery goals. The proximity of urban development may limit or prevent the use of fire to regenerate this population as well. Cattle have been grazing on the property for many years and may be negatively affecting the habitat and limiting recruitment for the Llagas Road population. The unprotected portion of the property where cattle grazing is permitted is nearly denuded of native chaparral vegetation with large areas of exposed soil and serpentine rocks evident (F. Gardipee pers. obs., 2010; T. Willsey, pers. obs., 2010; J. Hillman, pers. obs., 2010). Less than 10 to 20 *Ceanothus ferrisiae* plants have persisted within a small, narrow draw on this portion the property, with little evidence of recruitment (F. Gardipee pers. obs., 2010; T. Willsey, pers. obs., 2010; J. Hillman, pers. obs., 2010). The cattle have gained access into the existing conservation easement through broken fencing thereby allowing them to browse on inflorescences of young *C. ferrisiae* plants before seed production can occur (F. Gardipee pers. obs., 2010; T. Willsey, pers. obs., 2010; J. Hillman, pers. obs., 2010). The combined effects of altered fire regime, degradation and loss of habitat, and heavy browsing may limit the expansion and long-term persistence of this population.

The population located at Anderson Dam is threatened by loss and modification of habitat as a result of activities associated with the dam, actions to protect against damage from potential seismic activity, and un-regulated land management practices. Anderson Dam was constructed upon unstable materials and is positioned on a seismically active fault line (SCVHP 2010). Anderson Reservoir is currently operated at less than 50 percent capacity to minimize risk of failure from seismic activity and a major retrofitting is proposed to improve the stability of Anderson Dam. The proposed seismic retrofit project for Anderson Dam may result in the loss of another subpopulation of 3,600 plants located on the dam abutment (J. Hillman, pers. comm. 2009 and 2010; SCVHP 2010). Inundation may occur when Anderson Reservoir is once again operated at full capacity and will result in the loss of an entire subpopulation of 200 to 250 plants located below the high water mark east of the dam (J. Hillman, pers. comm. 2009 and 2010). The largest subpopulation (>100,000), which occurs on private land adjacent to Anderson Dam, is subject to heavy browsing by cattle, habitat modification by wild boars, and other un-regulated land management practices such as fire control, grading, and management of invasive plants.

Summary of Factor A: Urbanization, residential development, expansion of the Kirby Canyon Landfill, and the Anderson Dam seismic retrofit project may result in the loss of existing populations and modification of currently occupied habitat. Suitable unoccupied habitat may be also threatened by modification and destruction. Over 700 of 14,187 acres of potential serpentine habitat for *Ceanothus ferrisiae* restoration and recovery may be permanently lost due to activities covered under the proposed SCVHP (ICF Jones and Stokes 2009). Cumulative loss and modification of occupied and available suitable habitat may threaten the survival and recovery of *C. ferrisiae*.

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

Overutilization for commercial purposes was not known to be a factor in the 1995 final listing rule (60 FR 48136) (Service 1995). Overutilization for any purpose does not appear to be a threat at this time.

FACTOR C: Disease or Predation

Disease and predation were not considered as threats in the 1995 Final Listing Rule (60 FR 48136) (Service 1995). Since the time of listing, no fungal, viral, or bacterial diseases have been documented as a significant source of mortality for *Ceanothus ferrisiae*. However, several insect species have been noted to infest *Ceanothus* species in California and predation in the form of herbivory by native ungulates and seed consumption by small mammals, insects, and birds is common (Deveny and Fox 2006).

The western tent caterpillar (*Malacosoma californicum*) is known to construct large web-like tents on the branches of *Ceanothus* species (USDA 2006). Larvae feed on the leaves within the tent, often defoliating entire branches (USDA 2006). Western tent caterpillar tents were observed on *Ceanothus ferrisiae* plants during a survey conducted in mid-July, 2010 (F. Gardipee, pers. obs., 2010; T. Willsey, pers. obs., 2010). Moderate presence of western tent caterpillars has not been documented as a threat to *C. ferrisiae*. However, large numbers of tents

may cause significant defoliation resulting in mortality of individual host plants.

The western tussock moth (*Orgyia vetusta*) has been reported on *Ceanothus* species (USDA 2006). Large masses of cocoons may be observed on branches in late spring. Western tussock moth larvae feed on leaves and young growth, sometimes causing substantial defoliation and branch dieback. No information regarding specific effects of western tussock moth on *Ceanothus ferrisiae* is available at this time.

The western sycamore borer (*Synanthedon resplendens*) may attack *Ceanothus* species (USDA 2006). Adults emerge in May through early August and lay eggs within cracks, depressions, and injured tissues in the bark of old or slow-growing plants (USDA 2006). After hatching, larvae tunnel into the inner bark, creating winding tunnels that extend over 100 square centimeters (about 15.5 square inches). The amount of damage caused by western sycamore borers is generally considered to be insignificant (USDA 2006). However, repeated infestations may retard plant growth. No information regarding specific effects of the western sycamore borer on *Ceanothus ferrisiae* is available at this time.

Herbivory may retard plant growth, destroy plants, and often reduces seed production (Boyd 2003; Deveny and Fox 2006). Black-tailed deer (*Odocoileus hemionus columbianus*) are primary browsers of *Ceanothus ferrisiae* (Deveny and Fox 2006). Herds of black-tailed deer make their home in the Anderson Dam area. Evidence of browsing on fresh shoots, inflorescences, and leaves of young *C. ferrisiae* plants was observed among all populations surveyed in mid-July and fall 2010 (F. Gardipee, pers. obs., 2010; T. Willsey, pers. obs., 2010; J. Hillman, pers. obs., 2010). A small population of about 300 tule elk (*Cervus canadensis nannodes*) is present in the Santa Clara Valley that may browse on these plants as well.

Indiscriminate grazing by cattle (*Bos taurus*) may result in browsing upon young *Ceanothus ferrisiae* plants. Cattle may also trample young plants as they move through open areas of chaparral. About 500 cow-calf pairs are allowed to graze on private land west of Anderson Dam where the largest subpopulation of *C. ferrisiae* exists. Grazing by cattle also occurs within the Llagas Road site. Heavy browsing by cattle and wild ungulates was observed among young, reproductive-age, plants during the fall 2010 survey at all sites (F. Gardipee pers. obs., 2010; T. Willsey, pers. obs., 2010; J. Hillman pers. comm., 2010).

Pre-dispersal seed predation may reduce the soil seed bank by as much as 50 percent for *Ceanothus* species (O'Neil and Parker 2005). Birds, and insects such as beetles, wasps, and weevils have been observed to consume seeds prior to dispersal (O'Neil and Parker 2005; Deveny and Fox 2006). Three species of beetles, in the genus *Zabrotes,* have been found to be a primary causal agent of pre-dispersal seed predation among *Ceanothus* species (O'Neil and Parker 2005). Post-dispersal seed predation may remove up to 70 percent of seeds in the ground litter. Small mammals, such as mice (*Peromyscus* species) and rats (*Neotoma* species) have been documented to consume *Ceanothus* seeds dispersed on the ground (O'Neil and Parker 2005; Deveny and Fox 2006). A comparison between older seeds collected from the soil seed bank and those removed directly from plants prior to dispersal revealed a 30 percent reduction in viability among older seeds (O'Neil and Parker 2005).

Factor C summary: It unknown whether any of these factors alone may pose a serious threat to the persistence of *Ceanothus ferrisiae*. However, synergistic effects of diseases, pest infestations, herbivory, and seed predation could significantly reduce population viability, and threaten the continued existence of this endangered plant. Therefore, long-term monitoring of existing *C. ferrisiae* populations may be necessary to assess effects of diseases, insects, and herbivory on viability and evaluate potential threats to their persistence.

FACTOR D: Inadequacy of Existing Regulatory Mechanisms

Factor D threats known at the time of listing

At the time of listing, regulatory mechanisms thought to have some potential to protect *Ceanothus ferrisiae* included: (1) listing under the California Endangered Species Act (CESA) and Native Plant Protection Act (NPPA); (2) the California Environmental Quality Act (CEQA) and the National Environmental Policy Act (NEPA); and (3) the Federal Endangered Species Act. The Listing Rule (60 FR 6671) provides an analysis of the level of protection that was anticipated from those regulatory mechanisms. This analysis appears to remain currently valid. There are several State and Federal laws and regulations that are pertinent to federally listed species, each of which may contribute in varying degrees to the conservation of federally listed and non-listed species. These laws, most of which have been enacted in the past 30 to 40 years, have greatly reduced or eliminated the threat of wholesale habitat destruction.

Factor D threats currently known:

No substantial changes have been made to the above regulations. No additional legal protections are afforded to the species.

The following list includes a brief summary of laws and regulations that were evaluated for this 5-year review.

California Endangered Species Act (CESA) and Native Plant Protection Act (NPPA): The CESA (California Fish and Game Code, section 2080 et seq.) prohibits the unauthorized take of State-listed threatened or endangered species. The NPPA (Division 2, Chapter 10, section 1908) prohibits the unauthorized take of State-listed threatened or endangered plant species. The CESA requires State agencies to consult with CDFG on activities that may affect a State-listed species and mitigate for any adverse impacts to the species or its habitat. Pursuant to CESA, it is unlawful to import or export, take, possess, purchase, or sell any species or part or product of any species listed as endangered or threatened. The State may authorize permits for scientific, educational, or management purposes, and to allow take that is incidental to otherwise lawful activities. The California Fish and Game Commission (CFGC) was petitioned to list *Ceanothus ferrisiae* as endangered under CESA in July 1991. However, the CFGC ultimately declined listing of this species.

California Environmental Quality Act (CEQA): The 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.

National Environmental Policy Act (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 CFR 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 (Act): The Act is the primary Federal law providing protection for these species. The Service's responsibilities include administering the Act, including sections 7, 9, and 10 that address take. 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 the amount or extent of incidental take of listed species associated with a project.

Section 9 prohibits the taking of any federally listed endangered or threatened species. Section 3(19) defines "take" to mean "to harass, harm, pursue, hunt, shoot, wound, kill, trap, capture, or collect, or to attempt to engage in any such conduct." Service regulations (50 CFR 17.3) define "harm" to include significant habitat modification or degradation which actually kills or injures wildlife by significantly impairing essential behavioral patterns, including breeding, feeding or sheltering. Harassment is defined by the Service as an intentional or negligent action that creates the likelihood of injury to wildlife by annoying it to such an extent as to significantly disrupt normal behavioral patterns which include, but are not limited to, breeding, feeding, or sheltering. The Act provides for civil and criminal penalties for the unlawful taking of listed species. Incidental take refers to taking of listed species that results from, but is not the purpose of, carrying out an otherwise lawful activity by a Federal agency or applicant (50 CFR 402.02). For projects without a Federal nexus that would likely result in incidental take of listed species, the Service may issue incidental take permits to non-Federal applicants pursuant to section 10(a)(1)(B). To qualify for an incidental take permit, applicants must develop, fund, and implement a Service-approved Habitat Conservation Plan (HCP) that details measures to minimize and mitigate the project's adverse impacts to listed species. Regional HCPs in some areas now provide an additional layer of regulatory protection for covered species, and many of these HCPs are coordinated with California's related Natural Community Conservation Planning program. With regard to federally listed plant species, section 7(a)(2) requires Federal agencies to consult with the Service to ensure any project they fund, authorize, or carry out does not jeopardize a listed plant species. Section 9 of the Act and Federal regulations pursuant to section

4(d) of the Act prohibits the "take" of federally endangered wildlife; however, the take prohibition does not apply to plants. Instead, plants are protected from harm in two particular circumstances. Section 9 prohibits (1) the removal and reduction to possession (i.e., collection) of endangered plants from lands under Federal jurisdiction, and (2) the removal, cutting, digging, damage, or destruction of endangered plants on any other area in knowing violation of a state law or regulation or in the course of any violation of a state criminal trespass law. Federally listed plants may be incidentally protected if they co-occur with federally listed wildlife species.

Natural Community Conservation Planning Act: The Natural Community Conservation Program is a cooperative effort to protect regional habitats and species. The program helps identify and provide for area wide protection of plants, animals, and their habitats while allowing compatible and appropriate economic activity. Many Natural Community Conservation Plans (NCCPs) are developed in conjunction with Habitat Conservation Plans (HCPs) prepared pursuant to the Federal Endangered Species Act. Habitat conservation and land acquisition for protection of existing *Ceanothus ferrisiae* populations has been proposed in the proposed SCVHP. Acquisition of currently unoccupied serpentine chaparral habitat where two additional *C. ferrisiae* populations may be reintroduced is also proposed under the proposed SCVHP. The use of fire for regeneration of senescing stands of *C. ferrisiae* has also been proposed by the SCVWD as a means of increasing recruitment to enhance and restore populations under the proposed SCVHP as well.

Summary of Factor D: In summary, the Act is the primary Federal law that has provided protection for this species since the dates of its listing as endangered in 1995. Other Federal and State regulatory mechanisms provide discretionary protections for the species based on current management direction, but do not guarantee protection for the species absent their status under the Act. Therefore, we continue to believe other laws and regulations have limited ability to protect the species in absence of the Act.

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

At the time of listing the primary natural or manmade threats to the continued existence of *Ceanothus ferrisiae* were residential and recreational development, unauthorized dumping, landfill activities, lack of natural recruitment, altered fire regimes, grazing, and stochastic events (Service 1998). These same natural or manmade threats identified at the time of listing continue to exist.

Genetics:

A genetic Allee effect may occur as a result of limited availability of genetically suitable pollen mates in small populations of plants, thereby decreasing reproductive rates and increasing the risk of extinction (Berec et al. 2006; Wagenius et al. 2007). Habitat loss and fragmentation, small population size, and genetic isolation may increase the risk of a genetic Allee effect for self-incompatible species, such as *Ceanothus ferrisiae*, and ultimately result in a subsequent loss of long-term population viability (Willi et al. 2005; Berec et al. 2006: Leimu et al 2006; Honnay and Jacquemyn 2007; Wagenius et al. 2007; Pickup and Young 2008). Leimu et al. (2006) observed a strong positive relationship between genetic variation and fitness for self-

incompatible plants. They also observed a much stronger positive correlation between population size and genetic diversity for self-incompatible plants than for selfing species (Leimu et al. 2006). Reed (2005) suggested a minimum population of 5,000 individuals may be necessary to maintain 95 percent relative fitness for plants. The survival and recovery of existing *C. ferrisiae* populations may be threatened by limited genetic diversity as a result of small or declining population size, habitat loss and fragmentation, and geographic isolation that may limit insect-mediated gene flow.

The *Ceanothus ferrisiae* population located at Anderson Dam has been subdivided into two small subpopulations, and a single large population (250, 3,600, and >100,000, respectively). The subdivision of this population has resulted in possible isolation and reduced connectivity, thus increasing the risk of genetic Allee effects and decreased population viability. Only the largest *C. ferrisiae* subpopulation (> 100,000) at Anderson Dam meets the minimum population size suggested by Reed (2005) for maintaining 95 percent relative fitness. This subpopulation may be the most genetically viable because it consists of large number of individuals representing multiple age classes, and nearly all of the younger plants which emerged post-fire are now producing seed. The remaining Anderson Dam subpopulations are below the minimum population size suggested by Reed (2005) to maintain 95 percent relative fitness and exhibit low recruitment. Therefore, these two small subpopulations may be at greater risk of losing genetic diversity a higher rate and experiencing a genetic Allee effect than the largest subpopulation.

The population of *Ceanothus ferrisiae* located at Kirby Canyon, which is the smallest (< 150 plants) and most senescent population, exhibits extremely low recruitment. This population may be at greatest risk of extinction due to genetic Allee effects as a result of small population size and genetic isolation. The small *C. ferrisiae* population located at Llagas Road exhibits low recruitment, and may be the most genetically isolated given its distance (4,000 to 5,000 meters) from all other existing populations. This population may also be at risk of genetic Allee effects as a result of these factors.

Fire:

Fire was not considered to play an important role in the ecology of *Ceanothus ferrisiae* at the time of listing. In fact, fire has previously been considered a potential threat to the persistence of this species (Service 1995 and 1998). New information regarding the benefits of fire for *C. ferrisiae* has become available to the Service since its listing that strongly suggests absence of fire may be detrimental to its recovery and long-term persistence (Keeley 2002; Pfeiffer and Ortiz 2007; J. Hillman, pers. comm., 2009 and 2010; D. Hankins, pers. comm., 2010).

It has been suggested that traditional use of fire by tribes may have affected the evolution of chaparral plants, such as *Ceanothus*, over thousands of years (Keeley 2002; Pfeiffer and Ortiz 2007). *Ceanothus* species are among several culturally significant plants used by California Native American basket-weavers. Tribal basket-weavers often maintained these plants through pruning, thinning, selection, and burning (Pfeiffer and Ortiz 2007; D. Hankins, pers. comm., 2010). Of these practices, fire was the most widely applied tool employed by California tribes for maintaining stands of *Ceanothus* for traditional uses (Keeley 2002; Pfeiffer and Ortiz 2007). Post-contact alterations in land use, management practices, and fire regimes may pose significant

threats to the persistence of *Ceanothus ferrisiae.* The proximity of *C. ferrisiae* to residential development may preclude or limit the use of fire that may be necessary for stand regeneration. Further research regarding the role of fire for *C. ferrisiae* is warranted to insure effective use of this management tool can be applied to benefit the long-term conservation of this species.

Habitat loss and fragmentation:

All current *Ceanothus ferrisiae* populations are geographically fragmented, limited to small tracts of land, and nearly surrounded by development and urbanization. Previous loss of habitat has occurred as a result of residential and commercial development, such as the Kirby Canyon Landfill. Future habitat loss may result from further residential development, the seismic retrofit proposed for Anderson Dam, inundation from operating the Anderson Reservoir at full capacity following the dam retrofit, and expansion of the Kirby Canyon Landfill. The SCVHP identified approximately 14,000 acres of remaining serpentine chaparral where *C. ferrisiae* populations may be created. However, the majority of these lands exist as privately-owned, geographically isolated parcels (SCVHP 2010). Therefore, acquisition of contiguous serpentine chaparral habitat for *C. ferrisiae* recovery may be difficult to achieve.

Global climate change:

Current climate change predictions for terrestrial areas in the Northern Hemisphere indicate warmer air temperatures, more intense precipitation events, altered fire regimes, and increased summer continental drying (Field et al. 1999; Cayan et al. 2005; IPCC 2007). However, predictions of climatic conditions for smaller sub-regions such as California remain uncertain. It is unknown at this time if climate change in California will result in a warmer trend with localized drying, higher precipitation events, or other effects. However, climate change may exacerbate the effects of altered fire regimes on population viability of *Ceanothus* species endemic to California (Lawson et al. 2010). While we recognize that climate change is an important issue with potential effects to listed species and their habitats, we lack adequate information to make accurate predictions regarding its effects to particular species at this time.

Summary of Factor E: Synergistic effects of altered fire regime, small population size, limited recruitment, habitat fragmentation, and genetic isolation of populations may pose a serious threat to the genetic viability long-term persistence of *Ceanothus ferrisiae*. Research regarding genetic diversity within and among *C. ferrisiae* populations, including sampling within burned and unburned areas, may provide crucial information for the management, conservation, and recovery of this species.

III. RECOVERY CRITERIA

Recovery plans provide guidance to the Service, States, and other partners and interested parties on ways to minimize threats to listed species, and on criteria that may be used to determine when recovery goals are achieved. There are many paths to accomplishing the recovery of a species and recovery may be achieved without fully meeting all recovery plan criteria. For example, one or more criteria may have been exceeded while other criteria may not have been accomplished. In that instance, we may determine that, over all, the threats have been minimized sufficiently,

and the species is robust enough, to downlist or delist the species. In other cases, new recovery approaches and/or opportunities unknown at the time the recovery plan was finalized may be more appropriate ways to achieve recovery. Likewise, new information may change the extent that criteria need to be met for recognizing recovery of the species. Overall, recovery is a dynamic process requiring adaptive management, and assessing a species' degree of recovery is likewise an adaptive process that may, or may not, fully follow the guidance provided in a recovery plan. We focus our evaluation of species status in this 5-year review on progress that has been made toward recovery since the species was listed (or since the most recent 5-year review) by eliminating or reducing the threats discussed in the five-factor analysis. In that context, progress towards fulfilling recovery criteria serves to indicate the extent to which threat factors have been reduced or eliminated.

Measures to Downlist:

1. Protection and management of the four known occurrences of *Ceanothus ferrisiae* by working with Santa Clara County, the SCVWD, and private landowners to ensure long-term survival of the species on their lands. (This criterion addresses listing factors A and E). The criterion is up-to-date and relevant to the species' current status and threats.
   This criterion is still valid and has been partially met. Biological goals and objectives for *Ceanothus ferrisiae* have been proposed within the draft SCVHP (ICF Jones and Stokes 2009). *C. ferrisiae* plants on land owned and managed by the SCVWD are currently protected. Approximately 40 percent of the *C. ferrisiae* plants located at the Llagas Road exist within a conservation easement. The *C. ferrisiae* plants located in Kirby Canyon exist on land managed by Waste Management, Inc. within an area set aside as wildlife habitat. The largest populations of *C. ferrisiae* plants, which occur on private land adjacent to Anderson Dam, are not currently under any agreements for their protection. However, existing populations would be partially protected under the proposed draft SCVHP through acquiring land for a Reserve System that currently supports these populations (ICF Jones and Stokes 2009). Any existing occurrences lost as a result of actions permitted under the proposed SCVHP, such as the seismic retrofit of Anderson Dam, will be replaced through creation of new populations. Land acquisition would occur through fee title purchase or conservation easements. *C. ferrisiae* populations would be protected from adverse land uses under the proposed SCVHP through the creation of 500 foot buffers and use of existing physical barriers (ICF Jones and Stokes 2009).

2. Survey of other potential serpentine habitats to identify potential habitat. (This criterion addresses listing factors A and E). The criterion is up-to-date and relevant to the species' current status and threats.

   The criterion is still valid and has been met. Serpentine habitats have been identified and mapped for the proposed SCVHP. Suitable serpentine habitat for *Ceanothus ferrisiae* comprises only about three percent of the area included under the proposed SCVHP (Table 3) (ICF Jones and Stokes 2009). This information will be used to identify suitable sites for restoration of *C. ferrisiae*.

3. Seed collection and research. Collection and banking of seed in Center for Plant Conservation certified botanic gardens is prudent to guard against extinction of the species from catastrophic events and to provide potential material for enhancement efforts in existing populations, repatriations, and/or introductions to new sites. All known populations should be represented in seed collections. Care should be taken to ensure that seed collection does not adversely affect the donor populations. (This criterion addresses listing factors A and E). The criterion is up-to-date and relevant to the species' current status and threats.

   This criterion is still valid and has been partially met. Samples for genetic studies of existing *Ceanothus ferrisiae* populations were collected in July and in the fall of 2010. These studies will be used to inform seed banking efforts in terms of developing seed collection strategies aimed at capturing the genetic diversity represented across the current range of *C. ferrisiae*. The seeds collected for banking may be used to restore *C. ferrisiae* populations in currently unoccupied serpentine habitat in an effort to achieve recovery goals for this species.

4. Research on demography, fire ecology, and effects of grazing. Important research questions include how grazing impacts the reproduction, recruitment, and survival of the species, and why so little recruitment is observed in natural populations. (This criterion addresses listing factors C and E). The criterion is up-to-date and relevant to the species' current status and threats.

   The criterion is still valid and has been partially met. Occasional demographic surveys have been conducted and several anecdotal accounts of response to fire and grazing have been documented (Quick and Quick 1961; Keeley and Zedler 1978; Freas, *in litt*., 1993; J. Hillman pers. comm., 2010). However, formal research regarding the demography, fire ecology of *Ceanothus ferrisiae* and effects of grazing on these plants has not been conducted or published since its listing.

5. Establishment of new populations to meet recovery goal of eight populations representing the entire historic range. *Ceanothus ferrisiae* should not be considered for delisting unless eight populations, consisting of at least, 2,000 individuals, within its historic range and representing its entire historic range. (This criterion addresses listing factors A and E). The criterion is up-to-date and relevant to the species' current status and threats.

   The criterion is still valid and has been partially met. Two of the four existing occurrences have population sizes greater than 2,000 individuals (3,600 and > 100,000, respectively). However, new information available to the Service suggests a minimum population size of 5,000 may be necessary to maintain 95 percent fitness for plants (Reed 2005). The largest population resulted from seedlings that emerged following a fire in 2003. Further research may offer more insight into the role of fire for restoration and management of *Ceanothus ferrisiae* populations. Under the proposed SCVHP three of four *C. ferrisiae* populations would be protected and two additional populations will be created (ICF Jones and Stokes 2009). However, these proposed activities would result in the protection of only five *C. ferrisiae* populations by Year 40 of the plan (ICF Jones and Stokes 2009). No further plans to meet the total recovery goal of eight populations representing the historic range have been proposed at this time. And, no information regarding the historic distribution of populations

is currently available at this time. Investigations of Traditional Ecological Knowledge with tribes who have cultural ties to the Santa Clara Valley and use of this plant, and concurrent studies using both plant macrofossils and pollen records may reveal the historic distribution of *C. ferrisiae* (Birks and Birks 2000).

IV. SYNTHESIS

At the time of listing in 1995, three populations of *Ceanothus ferrisiae* were known to exist within Santa Clara Valley; currently up to three putative populations remain recognized (Service 1995). Few conservation efforts have been implemented for this species and the number of populations has not increased since the time of listing. The threats to the survival and recovery of *C. ferrisiae* identified at the time of listing still exist and have continued to increase. Therefore, the status of the species remains endangered due to consistently low numbers of individuals (with the exception of the single large population adjacent to Anderson Dam), few existing populations, low recruitment, urbanization, habitat loss and fragmentation, isolation, altered fire regime, and limited insect-mediated gene flow. Therefore, we believe *C. ferrisiae* still meets the definition of endangered, and recommend no status change at this time.

V. RESULTS

Recommended Listing Action:

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

New Recovery Priority Number and Brief Rationale: The Service has determined that the new priority number for *Ceanothus ferrisiae* should be upgraded from 14 to 8C, which indicates a moderate degree of threat, including threats from construction activities, and a high potential for recovery. Since the time of listing, threats to the survival and recovery of this endangered plant species have steadily increased. Only a small portion (40 percent of the Llagas Road population) of the three known populations of *C. ferrisiae* has been protected in a single conservation easement. Urbanization and development have continued to encroach upon the habitat of existing populations. The Llagas Road population is nearly surrounded by encroaching residential development. Less than 5 percent of the *C. ferrisiae* plants in the Anderson Dam population are protected on small tracts of public land owned and managed by the SCVWD. The two smaller subpopulations of *C. ferrisiae* plants may be lost due to inundation from the dam and the seismic retrofit project proposed for Anderson Dam. The largest subpopulation located at Anderson Dam is not protected through any other regulatory mechanism except the Act. The existence of this large subpopulation may provide a buffer against extinction of the species if additional protection through the creation of a conservation easement along with careful management and long-term monitoring. However, this population

currently remains vulnerable to threats such as intensive cattle grazing practices, alteration of habitat by wild boars, and altered fire regime. The Kirby Canyon population is at greatest risk of extinction due to small population size, senescence, extremely low recruitment, browsing pressure, genetic isolation, altered fire regime, and further development of the Kirby Canyon Landfill. All existing populations may suffer decline or become extinct as a result stochastic events such as fire, insect infestations, or disease. The absence of an optimal fire regime may pose one of the most significant threats to the restoration and recovery of this species. Appropriate use of fire may result in significant recruitment and restoration of existing population. Over 14,000 acres of serpentine habitat suitable for creation of *C. ferrisiae* populations to achieve recovery goals have been recently identified. The implementation of the SCVHP will result in the creation of at least two additional populations. Based on our analysis of the existing threats to the *C. ferrisiae* and the potential to achieve recovery goals through implementation of the proposed SCVHP, the Service concludes that upgrading the Recovery Priority number from 14 to 8C is warranted.

VI. RECOMMENDATIONS FOR ACTIONS OVER THE NEXT 5 YEARS

1. Habitat conservation to support the survival and recovery of *Ceanothus ferrisiae* should be accomplished through land acquisition and establishment of conservation easements where possible. Protection of *C. ferrisiae* populations on private lands through additional conservation easements and land purchases, and restoration of additional populations within the historic range should be prioritized to minimize the likelihood of extinction.

2. Research that will inform management decisions, conservation planning, and restoration efforts for *Ceanothus ferrisiae* should be conducted as prioritized in Table 4.

3. Establishment of additional *Ceanothus ferrisiae* populations where appropriate serpentine chaparral habitat has been identified in the proposed SCVHP. Restoration efforts should target habitat sites that can support a minimum population of at least 5,000 individuals.

4. Enhancement and regeneration of existing populations of *Ceanothus ferrisiae* to achieve minimum populations of 5,000 plants through various strategies. For example, implementation of an optimal fire regime (determined through research) to stimulate seedling production from the soil seed bank may prove to be a successful strategy to increase small population sizes. Fire applied to small areas over several years may yield large, sustainable populations, consisting of a mosaic of age classes and genotypes, which may be less vulnerable to stochastic events and senescence. Translocation efforts may prove successful as well.

Table 4. Research priorities for restoration and recovery of *Ceanothus ferrisiae*.

Priority	Study type	Conservation issues to be addressed	Justification	Comments
1	**Fire Ecology**	1. Gain insight into the role of fire in the ecology of *Ceanothus ferrisiae*. 2. Identify the optimal fire regime or interval that would best achieve conservation goals for this species.	If *Ceanothus ferrisiae* relies on a regular fire interval for regeneration, we need to identify the most appropriate fire management plan and how to best apply it in an urbanized environment.	Expert opinion and current literature strongly suggest that fire is important for *Ceanothus ferrisiae* .
2	**Demographic Studies**	Determine the current demographic status (census, age structure, seed production, recruitment & survival rates) of existing *Ceanothus ferrisiae* populations.	Demographic studies are necessary for evaluating the status of existing *Ceanothus ferrisiae* populations. The data would provide a baseline for long term monitoring and parameters for population viability analysis modeling.	The majority of existing *Ceanothus ferrisiae* populations have not been surveyed since the late 1980's, or monitored over extended periods of time.
3	**Pollination Studies**	1. Identify the primary insect species that pollinate *Ceanothus ferrisiae* , and determine whether they are specialists or generalist pollinators. 2. Determine distances among *C. ferrisiae* populations that will allow various rates of gene flow via pollination.	This information is necessary for developing restoration/recovery efforts that will ensure sufficient pollination among *Ceanothus ferrisiae* populations for production of viable seeds and maintaining genetic connectivity.	Populations of *Ceanothus ferrisiae* that are separated by more than 1,200 meters may not be connected by gene flow though insect pollination.
4	**Propagation Methods**	1. Identify the propagation method that would be most successful for restoring *Ceanothus ferrisiae* to new areas (seeds, cuttings, or transplantation). 2. Determine which seed treatment (fire vs. scarification) that will provide the most successful yield of seedlings.	We need to identify the propagation method that will ensure the greatest success for restoration/recovery efforts.	Most experts suggest that cuttings do not survive well, and that propagation by seed is the only appropriate method for restoration.
5	**Genetic Studies**	1. Assess genetic diversity within and among *Ceanothus ferrisiae* populations at both the S-locus and neutral markers. 2. Estimate current and historic effective population size. 3. Determine whether there are differences in genetic diversity between burned and unburned areas.	An assessment of genetic diversity would provide vital information for selecting plants/populations for seed banks and restoration/recovery efforts. This information is also necessary for evaluating current recovery goals and listing status.	T.M. Hardig conducted genetic studies on 33 *Ceanothus* species that included only two samples of *Ceanothus ferrisiae* .
6	**Traditional Ecological Knowledge (TEK)**	1. Gain insight into the scale and frequency of tribal fire regimes with respect to *Ceanothus* . 2. Assess effects of traditional tribal approaches to fire management on genetic diversity of *Ceanothus ferrisiae* through the use of computer models with realized and idealized parameters.	This study may help us identify the optimal burn interval that would maintain the greatest genetic diversity for *Ceanothus ferrisiae*. TEK may also provide insight into successful propagation methods previously employed by local tribes, which could be adopted for current restoration efforts.	There is disagreement concerning whether the frequency of lightening-caused fire or tribal fire regimes had the greatest influence on fire adaption in chaparral plants.
7	**Pollen record and macrofossil studies**	Map the historic distribution of *Ceanothus ferrisiae* in the Santa Clara Valley using both plant macrofossils and pollen records from currently unoccupied, yet suitable, serpentine habitats in this area.	This information would provide a pre-contact ecological baseline and assist with restoration planning for *Ceanothus ferrisiae* .	The historic range of *Ceanothus ferrisiae* is currently unknown.

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

***Ceanothus ferrisiae* (Coyote ceanothus)**

Current Classification:

Recommendation Resulting from the 5-Year Review:

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

Review Conducted By: Florence M. Gardipee, Sacramento Fish and Wildlife Office

FIELD OFFICE APPROVAL:

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

Approve _____ Date 8 Sept 2011