

Island Barberry
(*Berberis pinnata* subsp. *insularis*)

**5-Year Review:
Summary and Evaluation**



J.S. Peterson USDA-NRCS Plants Database

**U.S. Fish and Wildlife Service
Ventura Fish and Wildlife Office
Ventura, California**

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5-YEAR REVIEW
Island Barberry (*Berberis pinnata* subsp. *insularis*)

I. GENERAL INFORMATION

Purpose of 5-year Review:

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:

Berberis pinnata subsp. *insularis* (island barberry) is a long-lived colonial shrub in the Barberry family (Berberidaceae), which was once thought to exist on three of the California Channel Islands (Anacapa, Santa Cruz, and Santa Rosa), but is now known from only Santa Cruz Island. Although historical accounts document multiple individuals comprising each population, we now understand that each of the five remaining populations of island barberry is comprised of only one plant (McEachern et al. 2010). On Santa Cruz Island, it is associated with north facing, rocky slopes in chaparral, oak woodlands, and pine forests. At the time of listing, the subspecies was threatened by soil loss from habitat disturbances by nonnative ungulates on Santa Cruz Island. As of 2007, all nonnative ungulates were removed from the island; however, the subspecies continues to exhibit low levels of natural recruitment from seeds. All extant plants occur on private land owned and managed by The Nature Conservancy on Santa Cruz Island.

Methodology used to complete the review:

This review was conducted by staff of the Ventura Fish and Wildlife Office. The review is based on the following: information available in current published and unpublished literature, discussions with other agency biologists, discussions with species experts, information available on the internet, and the Ventura Fish and Wildlife Office species files. Reports by the U.S. Geological Survey-Western Ecological Research Center (USGS) (McEachern et al. 2007, 2010) were the primary source for information on the most current population trends, threats, and projects that are focused on species recovery.

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Federal Register Notice Citation Announcing Initiation of This Review:

On April 27, 2012, the U.S. Fish and Wildlife Service announced in the Federal Register (FR) initiation of the 5-year review for island barberry and asked for information from the public regarding the subspecies' status (77 FR 25112). No information was received as a result of this request.

Listing History

Original Listing

FR notice: 62 FR 40954

Date listed: July 31, 1997

Entity listed: subspecies (*Berberis pinnata* subsp. *insularis*)

Classification: endangered

State Listing

This taxon was listed as endangered by the State of California in 1979.

Associated Rulemakings: None

Review History

The previous status review of island barberry was published in May 2008. The 2008 5-year review did not recommend a change to the listing classification of endangered.

Species' Recovery Priority Number at Start of 5-year Review: 6

The previous 5-year review resulted in a recommendation for the taxon's recovery priority number to change from 3 to 6, where 1 is the highest-ranked recovery priority and 18 is the lowest. The number 6 indicates that the taxon is a subspecies that faces a high degree of threat and has a low potential for recovery (Service 1983).

Recovery Plan or Outline

Name of plan or outline: Thirteen Plant Taxa from the Northern Channel Islands Recovery Plan.

Date issued: September 26, 2000

Dates of previous revisions: N/A

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 of any species of vertebrate wildlife. This definition limits listings as distinct population segments (DPS) only to vertebrate species of fish and wildlife. Because the species under review is a plant and the DPS policy is not applicable, the application of the DPS policy to the species listing is not addressed further in this review.

Updated Information and Current Species Status

Description and Taxonomy

Berberis pinnata Lagasca subsp. *insularis* Munz (island barberry) (previously *Mahonia pinnata* (Lagasca) Fedde subsp. *insularis* (Munz) J.B. Roof) is a long-lived colonial shrub in the Barberry family (Berberidaceae). The taxon was first collected by Mason in 1927, but was first described by Munz (Munz and Roos 1950) based on a specimen collected by Wolf in 1932 “west of the summit of Buena Vista Grade (also known as Centinela Grade), interior of Santa Cruz Island.” The plant has spreading stems that reach 2 to 4 meters (5 to 12 feet) tall (McEachern et al. 2007), with large leaves divided into five to nine glossy green leaflets. At the branch tips, clusters of yellow flowers are produced in February; each flower generally produces two or three ovules. The round grayish blue berries develop in late May, and they are covered with a white, waxy coating. The berries range in size from 4 to 6 millimeters (0.16 to 0.2 in).

Life History

Island barberry reproduces through asexual reproduction (vegetatively) as well as through sexual reproduction, though the latter is rarely achieved. Because it sprouts from an underground root stalk, or rhizome, a single plant can consist of several stems spread over many square meters and represent one genetic clone (Hochberg et al. 1980, California Native Plant Society 1984, Williams 1993). These clones are long-lived; one individual from Santa Cruz Island is likely more than 80 years old and presumed to be the same plant that Mason collected in 1927 (McEachern et al. 2007). Cuttings from this plant have been in cultivation for several decades at the Santa Barbara Botanic Garden (SBBG) (Wilken, pers. comm. 2012; Wilken 1996).

Reproduction Ecology

Seed production

Although pollinator studies have not been conducted specifically for island barberry, other species of *Berberis* in California have been observed to be pollinated by bees (Bombyliidae), particularly in the genus *Andrena* (Moldenke 1976). Island barberry is genetically self-compatible (pollen from the same plant is able to produce fertile seeds); however, it still requires insect visitation for pollination to be achieved (Wilken 1996). Island barberry plants only produce a limited number of fruits each season, and many of these fruits do not make it to maturity. Observations of seed production in the wild are limited, due to the difficulty of accessing the plants. In 1996, Wilken observed a single plant on Santa Cruz that had more than 100 flowers in bud in January, but with only 7 immature fruits that had developed by May (Wilken 1996). Wilken theorizes that limited fruit production may be linked to limited

pollination, and furthermore, insect and bird predators may destroy the fruits before they are able to produce viable seed (Center for Plant Conservation (CPC) 2010).

During a field visit to Santa Cruz Island in 2005, USGS botanists documented two island barberry plants in flower. These two plants were visited several times during the flowering season. During the second site visit, approximately one month after the first, a total of five fruits were observed on the two plants, and evidence of insect boring was visible on two of four fruits on one of the plants (McEachern and Chess 2006). During another field visit later in 2005, there were only two fruits remaining on only one of the plants. These two remaining fruits were protected with mesh cages to prevent potential predation by birds. During the final field visit in 2005, the remaining two fruits were shriveled and dried. There was no visible evidence of insect or fungal activity on these two fruits that could have led to fruit abortion (McEachern et al. 2007).

In 2006, USGS researchers found flowers on the same two plants that were seen flowering in 2005. However, these same plants produced substantially fewer flowers in 2006 than in the previous year (McEachern et al. 2007). Only one of these plants reached fruit production; no more than 10 fruits were observed, and these fruits aborted before reaching maturity (McEachern et al. 2010). Insects were observed eating the developing flower buds on the other plant and it did not produce fruits in 2006 (McEachern et al. 2007). An additional plant that did not produce flowers in 2005 did not produce flowers in 2006. A fourth plant, found at a fourth site, produced flowers and fruits, although in limited numbers (McEachern et al. 2007).

The difficulty of accessing the remote sites largely restricts studies of island barberry reproductive biology to plants grown offsite, such as the collection at SBBG that was derived from cuttings of the natural populations (Wilken 1996). These cuttings from an individual on Santa Cruz have been in cultivation for several decades at the SBBG (Wilken pers. comm. 2012, Wilken 1996). Botanists at SBBG have had limited success in achieving seed set from hand-pollinating island barberry plants (McEachern et al. 2010, Wilken 1996). They have been observed to set fruit only occasionally (McEachern et al. 2010).

Recruitment

In addition to low seed production in island barberry, natural recruitment from seed is not occurring in the wild, and the cause or causes are unknown (Wilken 1996; McEachern and Chess 2006; McEachern et al. 2007). Years of habitat degradation, caused by feral pigs and sheep, may have left many areas inhospitable for the germination of dispersed seeds (Wilken 1996). In seed germination experiments at SBBG, only 8 out of 40 seedlings survived long enough to produce secondary leaves (Wilken 1996).

In 2006, the Cincinnati Zoo and Botanical Garden in collaboration with the CPC received a grant to conduct research on the reproductive issues of 39 endangered species, including island barberry. The researchers attempted to propagate the seed, but were unable to establish any plants before the grant expired (Pence in litt. 2013). No further research on island barberry reproduction is anticipated at the Cincinnati Zoo in the absence of additional funding (Pence pers. comm. 2012).

Island barberry plants have been cultivated at several botanical gardens in California, and show variation among leaf structure and color. This suggests that ex situ collections may be important for recovery purposes (CPC 2010) as they can help maintain and propagate the current genetic stock in the absence of natural reproduction in the wild.

Distribution

This taxon was known to exist on two of the northern Channel Islands (Anacapa and Santa Cruz), and was at one time thought to have occurred on Santa Rosa Island as well. The status of the plants on each island is discussed below.

Anacapa Island

The occurrence on Anacapa Island was first documented in 1980, and was reported to be growing with chaparral species in the middle of a poison oak (*Toxicodendron diversilobum*) patch. In 1994, the only known plant on Anacapa Island had died (Chaney 1994). Island barberry is now believed to be extirpated from Anacapa Island (McEachern et al. 2010, Service 2000).

Santa Cruz Island

There are seven historical locations of island barberry on Santa Cruz Island. USGS conducted field surveys at 6 of the 7 historical locations on Santa Cruz Island during the flowering seasons of 2005, 2006, and 2008, and found 5 extant plants (McEachern et al. 2010). Island barberry may have up to six occurrences on Santa Cruz Island; however, only five were recently documented, and one remains unconfirmed. As of the last surveys in 2008, island barberry is known to have five extant occurrences in the wild, each containing only one plant, and each at a different location on Santa Cruz Island (McEachern et al. 2010). All extant plants occur on land owned by The Nature Conservancy. Not all locations were visited each year due to time constraints, feral pig eradication activities, and difficulty accessing the remote locations.

Santa Rosa Island

Hoffmann reported a voucher specimen of island barberry from Santa Rosa Island in 1930. This was the only recorded occurrence on Santa Rosa Island and has never since been rediscovered (McEachern et al. 2010, Service 2000). This has led botanists at the Channel Islands National Park to question the validity of the collection location reported by Hoffmann in 1930. The location can no longer be confirmed (Rodriguez in litt. 2012) because the geographic landmarks are not on published maps, nor currently in use; therefore, the botanists believe that Hoffmann may have made an error in reporting his island barberry collection from Santa Rosa Island. In reviewing his collecting dates, the possibility exists that he may have collected island barberry from Santa Cruz Island rather than Santa Rosa Island (Rodriguez in litt. 2012). USGS researchers conduct annual surveys for island barberry on Santa Rosa Island, but this subspecies has never been located there (Service 2000; McEachern pers. comm. 2007a).

Habitat

Island barberry appears to favor shady, mesic conditions in closed-cone pine forest, oak woodland, and chaparral habitats below 350 meters (1,150 feet) (Williams 2012). It occurs in the shaded understory of mixed pine forest-chaparral and riparian woodland, on rocky, north facing slopes and canyons (McEachern et al. 2010, Junak et al. 1995). Habitat associations

based on herbarium specimens collected on Santa Cruz Island also suggest the taxon is restricted to shaded, cool, moist, and well-drained sites in canyons (Wilken 1996). On West Anacapa Island, island barberry was reported to be associated with chaparral species, including poison oak, bush monkeyflower (*Mimulus aurantiacus*), coyote bush (*Baccharis* spp.), goldenbush (*Hazardia detonsus*), island alum-root (*Heurchera maxima*), and wild cucumber (*Marah macrocarpus*) (Chaney 1994).

The introduction of cattle, deer, elk, sheep, and pigs to the northern Channel Islands resulted in severe degradation of the shady, mesic habitat upon which the subspecies depends (Van Vuren and Coblenz 1987). Sheep were introduced to Santa Cruz Island in the 1800s and subsequently became feral (Bowen and Van Vuren 1997), achieving population numbers of up to 50,000 by the end of the century. They were eradicated from most of the island in 1988 (Klinger et al. 2002) after causing severe damage to the native vegetation (Van Vuren and Coblenz 1987). The sheep exhibited a strong dietary preference for insular endemic plants over nonendemic species (Van Vuren & Coblenz 1987), suggesting that plants endemic to Santa Cruz Island may lack defenses against mammalian herbivores (Bowen and Van Vuren 1997). Cattle and feral pigs resided on the island for over 150 years before eradication efforts began (Klinger et al. 2002). The cattle were removed from most of the island in 1988 (Klinger et al. 2002), and feral pigs were completely eradicated from the island in 2007 (Parkes et al. 2010). After the cattle and sheep were removed from the island, there was a noticeable reduction in soil loss and an improvement in the quality of the watersheds in the study (Klinger et al. 2002). Annual nonnative grasses increased most rapidly, especially in areas where sheep were most abundant, resulting in the displacement of native species (Klinger et al. 2002). However, there was an overall increase in distribution and abundance of endemic species (Klinger et al. 2002). Of the endemic species that showed a positive response to removal, the vast majority were woody shrubs or trees (Klinger et al. 2002).

Five-Factor Analysis

Although Listing Factors B and D were considered relevant to the subspecies at the time of listing, they were not considered primary threats and were not addressed in the downlisting or delisting criteria in the recovery plan (Service 2000). Currently we do not consider threats under Factors B or D to be impacting the subspecies. We will address these Listing Factors in the following sections.

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

At the time of listing in 1997, island barberry was threatened by soil loss and alteration of its native habitat (62 FR 40954). The introduction of nonnative sheep, pigs, and cattle over the past two centuries resulted in the substantial loss of native vegetation and soils (Van Vuren and Coblenz 1987). At the time the subspecies was listed, sheep and most of the cattle had been removed from Santa Cruz Island. However, the listing rule did identify sheep as a major contributor to past alteration of the habitat, with sheep being one of the greatest contributors to soil erosion. Pigs continued to contribute to habitat alteration on Santa Cruz Island by rooting up

native vegetation, causing massive erosion, and spreading invasive weeds (National Park Service 2005).

Sheep and cattle were removed from Santa Cruz Island in the 1980s, and the removal of feral pigs was completed in March 2007 (Parkes et al. 2010). The loss of canopy and understory plant species, due to rooting by feral pigs, resulted in a reduction of the mesic conditions on which island barberry depends (McEachern pers. comm. 2007a). This may have caused a reduction in the amount of habitat that is suitable for the germination of dispersed seeds (Wilken 1996). The removal of these non-native animals should improve soil stability and habitat conditions for island barberry as time goes on.

Our current assessment is that, because nonnative animals were removed from the islands, island barberry is not at risk from ongoing or threatened destruction of its habitat or range. However, native habitat for the subspecies is still recovering from past alteration. Because both the biotic and physical properties of the soils had been degraded or lost altogether, the soils that remain behind provide degraded conditions for seedlings to germinate and establish. In addition, because island barberry occurs only on private lands owned and conserved by The Nature Conservancy (Santa Cruz Island), and with historical habitat existing only on public lands managed by the National Park Service (Anacapa Island), major changes in land use, such as development projects, are not likely to occur. Therefore, the threat to the taxon from additional habitat modification or destruction has essentially been eliminated, as compared to the time of listing.

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

At the time of listing, we discussed how the collection of whole plants or the reproductive parts of species with fewer than 100 known individuals, including island barberry, could adversely affect the genetic viability and survival of the taxa (62 FR 40954). While the cutting of reproductive parts of the island barberry can negatively impact recovery in the short term, cuttings collected for scientific purposes can allow researchers to study the subspecies without enduring harsh field conditions. Due to the inaccessibility of most of the island barberry occurrences, research would be more difficult to conduct and could occur only sporadically without these cuttings. The cuttings and propagation of the taxon *ex situ* can bolster our knowledge about the subspecies.

Cuttings were taken from island barberry plants on Santa Cruz Island many decades ago, which are still in cultivation at the SBBG and the Arboretum at the University of California, Santa Cruz. Additional cuttings could facilitate future research on the reproductive and recruitment strategies of island barberry. Additionally, cuttings from the wild may be the only opportunity to build up the genetic stock of the subspecies in the absence of natural recruitment. Our current assessment is that this plant is not overutilized for scientific purposes because island barberry has not been collected for many decades and the *ex situ* plants offer research opportunities that would be difficult to conduct in the field. Lastly, overutilization for other purposes (commercial, recreational, or educational) is not a threat because this plant occurs on private preserve land with only limited public access.

FACTOR C: Disease or Predation

At the time of listing, island barberry was not known to be threatened by disease or predation. Consumption by feral pigs was unlikely because the roots of *Berberis* species are often toxic to mammals (Williams 2012) and island barberry plants did not show any sign of pig rooting (Wilken pers. comm. 2007). Predation of island barberry fruits by island scrub jays (*Aphelocoma insularis*) has been observed in the wild (Wilken pers. comm. 2012). Because the fruits of *Berberis* species can be eaten and dispersed by birds (Martin et al. 1951), some predation by birds is likely part of the natural dispersal strategy of island barberry. However, years of habitat destruction, caused by feral pigs and sheep, may have left many areas inhospitable for the germination of dispersed seeds (Wilken 1996).

In addition, because the amount of fruit being produced is so low, the USGS is attempting to minimize the predation of any fruits by birds in order to harvest the fruit and grow plants for tissue cultivation and eventual outplanting back into the wild (McEachern pers. comm. 2007b). In 2005, USGS researchers erected wire mesh cages around the only two developing island barberry fruits at one location to protect them from predation by birds. However, when the cages were removed approximately two months later (when they should have been mature), the fruits had aborted (McEachern and Chess 2006, McEachern et al. 2007).

The factor that caused these and other fruits to fail is unknown. Insect predation on fruits and developing flower buds has been documented (McEachern et al. 2010), appears extensive (McEachern pers. comm. 2007a), and is a likely cause of fruit failure (McEachern pers. comm. 2007b). However, it is unknown which insect species are damaging the fruits and flowers (McEachern pers. comm. 2007a). The limited fruit production (McEachern et al. 2010) is restricting island barberry from natural recruitment in the wild. Therefore, our current assessment is that predation of any fruits by birds or predation of fruits and flowers by insects are a threat to this subspecies. However, if the native habitat recovers and the threat, or threats, inhibiting fruit production are able to be remedied, natural seed dispersal by birds would be a favorable method of increasing the island barberry population (McEachern pers. com. 2007b).

The small number of extant individuals (five) with an extremely narrow distribution, combined with the potential for reduced fitness due to its small gene pool, would also appear to make this subspecies susceptible to extirpation by disease. However, there is no evidence that disease is a problem at the current time.

FACTOR D: Inadequacy of Existing Regulatory Mechanisms

At the time of listing, we discussed the Federal and State regulations applicable to the subspecies. We determined that most of the State regulatory mechanisms applicable to island barberry (Native Plant Protection Act and the California Endangered Species Act) would not likely be invoked because major changes in land use, such as development projects, are not likely to be proposed on Santa Cruz Island, which is managed by The Nature Conservancy. Therefore, we did not believe that this taxon lacked protection from inadequate regulatory

mechanisms on private lands or lands managed by the National Park Service (a portion of Santa Cruz and all of Anacapa).

Federal Regulations

At the time of listing, we discussed the various Federal regulations and policies available in regards to historical island barberry habitat on Santa Rosa Island. These included several Federal laws, including the National Environmental Policy Act and the Endangered Species Act, as well as Department of the Interior policies, and National Park Service policies and guidelines that apply to the management of National Park Service lands. In addition, the Congressional legislation enabling purchase of Santa Rosa Island as a national park from the Vail and Vickers Company (Public Law 96-199, 94 Stat. 67, March 5, 1980) directed the Secretary of the Interior to complete a natural resources study that would provide an inventory of all terrestrial and marine species and indicate their population dynamics and probable trends as to future numbers and welfare, and to recommend action that should be adopted to better protect the natural resources of the park. Despite these laws and regulations, modification and destruction of habitat was still occurring due to the populations of introduced animals (deer, elk, and cattle on Santa Rosa) that occupied the island.

Under a court-approved settlement agreement, the Vail and Vickers Company removed their cattle from Santa Rosa Island in 1998, removed all deer and elk at the end of 2011, and turned management of the entire island over to Channel Islands National Park at that time. These actions should help reduce, and could potentially eliminate, the impact nonnative ungulates had on the potential island barberry habitat on Santa Rosa Island. Because the island is now managed entirely by the National Park Service and the nonnative ungulates have been removed, we do not consider the inadequacy of existing regulatory mechanisms a threat to the potential habitat on Santa Rosa Island. In addition, inadequacy of existing regulatory mechanisms is not a threat on Anacapa Island, where known historical habitat exists.

State Regulations

Island barberry is listed as endangered by the State of California under the Native Plant Protection Act (sec. 1900 et. seq. of the Fish and Game Code), and the California Endangered Species Act (sec. 2050 et. seq.). These state laws and regulatory mechanisms would provide some level of protection to state-listed species on private lands. However, these State regulatory mechanisms have not and are not likely to be invoked. The mission of The Nature Conservancy (Santa Cruz Island) is to conserve the lands and waters on which all species depend, so it is unlikely to propose major changes in land use, such as development projects, that would impact this subspecies and its habitat. Therefore, we do not consider the inadequacy of existing regulatory mechanisms a threat to island barberry on Santa Cruz Island, where the only known extant populations occur.

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

At the time of listing, the subspecies was threatened by stochastic events due to small population size and limited distribution. In addition, in this 5-year review, we recognize climate change as a potential threat to the subspecies.

Small Population Size

The small population size due to a lack of recruitment continues to threaten island barberry. The conservation biology literature commonly notes the vulnerability of taxa known from one or very few locations and/or from small populations (e.g., Shaffer 1981, 1987; Primack 2006; Groom et al. 2006). The loss of genetic diversity island barberry has suffered due to the extremely small number of extant individuals may be contributing to its reduced fitness and reduced reproductive vigor, and potentially a factor contributing to the demonstrated lack of recruitment in this subspecies (Wilken 1996; McEachern et al. 2007).

Vulnerability to Stochastic Events

Species with few populations and individuals are threatened by stochastic events in several ways: loss of genetic diversity, susceptibility to factors that inhibit the successful completion of their life cycle, and random natural events (62 FR 40970). The extremely small population size, and limited range and distribution (five known individuals on one island) also make this subspecies susceptible to extinction by stochastic events such as fire, erosion, pests, and disease. Our current assessment is that stochastic extinction is still a threat to this subspecies.

Climate Change

Although not considered a threat at the time of listing or in the last 5-year review, our analysis under the Endangered Species Act includes consideration of ongoing and projected changes in climate. Scientific measurements spanning several decades demonstrate that changes in climate are occurring, and that the rate of change has been faster since the 1950s. Current climate change predictions for the northern hemisphere indicate warmer air temperatures and more intense precipitation events (Field et al. 1999, Cayan et al. 2005, IPCC 2007).

Island barberry's small and isolated range increases its vulnerability to random fluctuations in annual weather patterns and environmental disturbances such as can be brought about by climate change. The potential impacts of climate change on the flora of California were discussed by Loarie et al. (2008). Based on modeling, they predicted that species' distributions will shift in response to climate change; specifically that the species will "move" or disperse to higher elevations and northward, depending on the ability of each species to do so. Species diversity will also shift in response to these changes with a general trend of diversity increases shifting towards the coast and northwards with these areas becoming de facto future refugia. However, predictions of climatic conditions for smaller sub-regions, such as the Channel Islands, remain uncertain. It is unknown at this time if climate change will result in a warmer trend with localized drying, higher precipitation events, or other effects. 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 island barberry at this time. Small-ranged species such as island barberry, however, are more vulnerable to extirpations due to these changing conditions (Loarie et al. 2008).

In summary, the extremely small population size from the consistent lack of recruitment, and limited range and distribution make this subspecies susceptible to extirpations by climate change and stochastic events.

Research and Recovery

USGS received a grant from the National Park Service to implement several actions over a three-year period (2013-2015) for this taxon and 13 other Channel Islands species, with the goal of increasing the number of plants and populations and their long-term resiliency and persistence (McEachern et al. 2012). In addition, they are leveraging a parallel project funded by the National Science Foundation to develop population models that will evaluate the long-term effects of these proposed management actions on population growth under various scenarios of post-grazing succession and climate change.

Specifically for island barberry, the grant gives USGS the funding to collect cuttings for living collections at the SBBG. These stem and root-shoot cuttings will add to the live plant conservation collections at the SBBG and should allow for genome conservation and future recovery. The highest priority will be to obtain cuttings of the individuals not yet represented in living collections. Additionally, the CPC continues to sponsor research on island barberry tissue culture. USGS plans to collect tissue from the five remaining wild plants, taking care not to collect cuttings from wild plants if they will be stressed or harmed by cutting, and not taking large amounts of tissue from any one plant. Lastly, the grant provides funds for additional surveys for historic populations of island barberry.

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 subspecies 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.

Downlisting criteria

The recovery plan (Service 2000) contains generalized downlisting criteria for a suite of 13 species that occur on the northern Channel Islands. Downlisting criteria specific to island barberry are included as follows:

1) *Discover or establish five populations on Santa Rosa and Santa Cruz Islands, and two to three populations on Anacapa Island* (addresses Listing Factors A, C, and E).

At this time, five populations in areas of historical occurrence have been located on Santa Cruz Island, but there is only one clonal individual in each location. There are no extant populations on either Anacapa or Santa Rosa Islands. With the removal of elk and deer from Santa Rosa Island at the end of 2011, there are no longer ungulate species to degrade potential habitat for island barberry on the island. Because there is no longer a threat to habitat from overgrazing or trampling by large ungulates, habitat restoration activities on Santa Rosa Island may increase and allow potential outplantings of island barberry. However, botanists at the Channel Islands National Park have not discussed outplanting island barberry to Santa Rosa Island because the collection location reported by Hoffmann in 1930 cannot be confirmed (Rodriguez in litt. 2012). Channel Islands National Park has not attempted to reestablish a population on Anacapa Island.

This criterion has not been met. We recommend that this criterion be updated to include this recent information from Channel Islands National Park botanists concerning Hoffmann's putative collection from Santa Rosa Island. We recommend this criterion should eliminate the requirement to have at least five populations on Santa Rosa Island because of the uncertainty surrounding its origins from that island. With this change incorporated, we believe this criterion is adequate and appropriate with respect to the recovery of the subspecies.

2) *Maintain populations as stable or increasing with evidence of natural recruitment for a period of 15 years that includes the normal precipitation cycle* (addresses Listing Factors A, C, and E).

At the time the subspecies was listed, island barberry was known from only three locations on Santa Cruz Island. Since listing, the taxon has been rediscovered in two additional historical locations. Although there has been an increase in the known number of locations where the species is represented (for a current total of five), each comprises only one plant and has not shown evidence of natural recruitment. This criterion has not been met.

Because the species exhibits low seed production, low germination and establishment success in controlled garden conditions, and no observed recruitment in the wild, evidence of successful natural recruitment may take longer than the 15-year time span specified in the criterion. Furthermore, with the uncertainty surrounding the effects of climate change on the normal precipitation regime, a criterion that depends on a normal precipitation cycle over a period of 15 years may be increasingly difficult to attain. We recommend rewording the criterion to extend the period of time over which natural recruitment could occur.

Delisting criteria

In the recovery plan, general delisting criteria for the suite of 13 plants include increasing the number of populations through either surveying historical sites and potential habitat within historical range to locate currently unknown populations, or repatriating or introducing several additional populations of the species. Delisting criteria specific to island barberry comprise the following:

1) *Discover or outplant five additional populations per island* (addresses Listing Factors A, C, and E).

This criterion has not been met. As indicated in the downlisting section, we recommend that this criterion be updated to include recent information from Channel Islands National Park botanists concerning Hoffmann's collection from Santa Rosa Island. The criterion should not include the requirement to have additional populations on Santa Rosa Island because of the uncertainty surrounding its origins from the island. With this change incorporated, we believe this criterion is adequate and appropriate with respect to the recovery of the subspecies.

2) *No decline after downlisting for 10 years* (addresses Listing Factors A, C, and E).

This criterion has not been met. We believe this criterion may need to be revised in the future to define how population decline (and stability) would be measured. In addition, given the long-lived nature of this taxon, a 10-year period may not be sufficient to determine long-term population trends. We recommend rewording the criterion to extend the period of time over which population trends would be assessed.

IV. Synthesis

The low number of extant individuals and lack of natural recruitment in the wild continue to inhibit recovery. The cause, or causes, of the reproductive failure is unknown. However, limited pollination, predation by insects, and habitat degradation may be key factors. Until the subspecies' lack of reproductive success in the wild is remedied, recovery is unlikely. The first major step toward the recovery of island barberry has been the removal of nonnative ungulates, including sheep, pigs, deer, and elk, from the Channel Islands. With the ungulates gone, we expect the shady, mesic habitat conditions the subspecies requires to improve substantially. USGS, the National Park Service, and the Santa Barbara Botanic Garden are continuing to conduct research on island barberry. These efforts include conducting field surveys to locate extant populations, to propagate and maintain, ex-situ, as many genetically distinct individuals as possible, and to identify outstanding threats and management strategies to address those threats.

The extremely narrow range and distribution of island barberry, combined with degraded habitat quality and a lack of recruitment (both in the wild and in controlled garden conditions) indicate the subspecies remains in danger of becoming extinct in the wild. Therefore, the subspecies continues to meet the definition of endangered.

V. RESULTS

Recommended Classification

- Downlist to Threatened
- Uplist to Endangered
- Delist (Indicate reasons for delisting per 50 CFR 424.11):
 - Extinction
 - Recovery
 - Original data for classification in error
- No change is needed

New Recovery Priority Number: N/A

VI. RECOMMENDATIONS FOR FUTURE ACTIONS

The National Park Service, The Nature Conservancy, USGS, and the Service should pursue the following actions to further the recovery of island barberry:

- 1) Continue field surveys and monitoring, demographic monitoring, population viability analyses, and further investigations into recovery prescriptions;
- 2) Study the predation of island barberry fruit and other potential sources of reproductive failure;
- 3) Restore native habitat at historical locations on Santa Cruz and Anacapa Islands; and
- 4) Implement outplanting at historical locations on Santa Cruz and Anacapa Islands.

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U.S. FISH AND WILDLIFE SERVICE
5-YEAR REVIEW of *Berberis pinnata* subsp. *insularis* (Island Barberry)

Current Classification: Endangered

Recommendation Resulting from the 5-Year Review:

- Downlist to Threatened
- Uplist to Endangered
- Delist
- No change needed

Appropriate Listing/Reclassification Priority Number, if applicable: N/A

Review Conducted By: Kirstina Barry

FIELD OFFICE APPROVAL:

Field Supervisor, Fish and Wildlife Service

Approve Diane K. Noh Date 5/9/13