Dudleya traskiae
(Santa Barbara Island Liveforever)

5-Year Review:
Summary and Evaluation

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

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5-YEAR REVIEW
Dudleya traskiae (Santa Barbara Island liveforever)

1. GENERAL INFORMATION

Purpose of 5-Year Reviews:

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

Species Overview:

As summarized from the Recovery Plan for this species, *Dudleya traskiae* is a succulent, basal rosette-forming perennial plant in the stonecrop family (Crassulaceae). This species typically blooms in spring and is found only on Santa Barbara Island, the smallest island within the Channel Island National Park (Park) system. The island supports roughly 11 colonies of *D. traskiae*, with an estimated 1000 individuals in existence. *Dudleya traskiae* is generally found in soil pockets on the rocky cliffs and marine terraces that measure 15-110 meters (m) (49-360 feet (ft)) in height that surround Santa Barbara Island. The largest colony of these plants resides in close proximity to Signal Peak, the highest point of the island with an elevation of 193 m (635 ft). Today, this species is threatened by trampling by California brown pelicans (*Pelecanus occidentalis californicus*), competition from non-native plants, herbivory from deer mice and owlet moth larvae, soil loss, and stochastic events.

Methodology Used to Complete the Review:

This review was completed by staff in the Ventura Fish and Wildlife Office. For the 2006 5-year review, information was gathered from a variety of sources (internet, literature review, and extensive coordination with staff at the Park). The most relevant sources of information consisted of the following: 1) ecological and demographic studies carried out by Ms. Ronilee Clark (1989) over a 3-year period for her master's thesis; 2) propagation and outplanting efforts

carried out by Park staff (CINP 2006); and 3) follow-up surveys carried out by Clark and Park staff to document the status of colonies in 2003, 2004, and 2006 (Chaney *in litt.* 2006, Chaney 2007).

This 5-year review incorporates information gathered from the 2006 5-year review and a basic population survey conducted in 2011 by Sarah Chaney and Nicole Swabey (Park staff) and Matt Blazek (former Service staff). This 5-year review contains updated information on the species' biology and threats, as well as an assessment of that information compared to what was known at the time of listing and 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.

Because the entire species is on lands managed by the Park, we requested that Park staff review the draft document for accuracy of information and have incorporated their comments.

Contact Information:

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Federal Register (FR) Notice Citation Announcing Initiation of this Review: The FR notice initiating this review was published on May 25, 2011 (76 FR 30377). This notice opened a 60-day request for information period, which closed on July 25, 2011. No new information was received as a result of this request.

Listing History:

Original Listing
FR notice: 43 FR 17916
Date listed: April 26, 1978
Entity listed: species (*Dudleya traskiae*)
Classification: endangered

Associated Rulemaking:

1979: Listed by the State of California as endangered.

1983: Listed by Convention on the International Trade of Endangered Species (CITES) as an Appendix 1 species (those species threatened with extinction which are or may be affected by trade. Permits for international commercial trade are rarely issued).

2003: Moved to CITES Appendix II list (those species which although not necessarily now threatened with extinction may become so unless trade in specimens of such species is subject to strict regulation in order to avoid utilization incompatible with their survival).

2012: A proposal was published to remove *Dudleya traskiae* from Appendix II on April 11, 2012 (77 FR 21798).

Review History: A 5-year review was completed for *Dudleya traskiae* in 2007 (73 FR 11945, March 5, 2008).

Species' Recovery Priority Number at Start of 5-year Review:
The recovery priority number for *Dudleya traskiae* is 8, 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 a moderate degree of threat and has a high potential for recovery.

Recovery Plan or Outline:

Name of Plan: Santa Barbara Island Liveforever Recovery Plan

Date issued: June 27, 1985

Previous Revisions: None

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.

Updated Information on Current Species Status, Biology, and Habitat:

Description and Life History
Dudleya traskiae is a small, perennial herb with five-parted flowers; five petals and carpels, and ten stamens (Service 1985). The flowering stems rise from the axils of basal rosettes. According to the Recovery Plan for the species, clusters of 20 to 100 rosettes per plant are typically found,

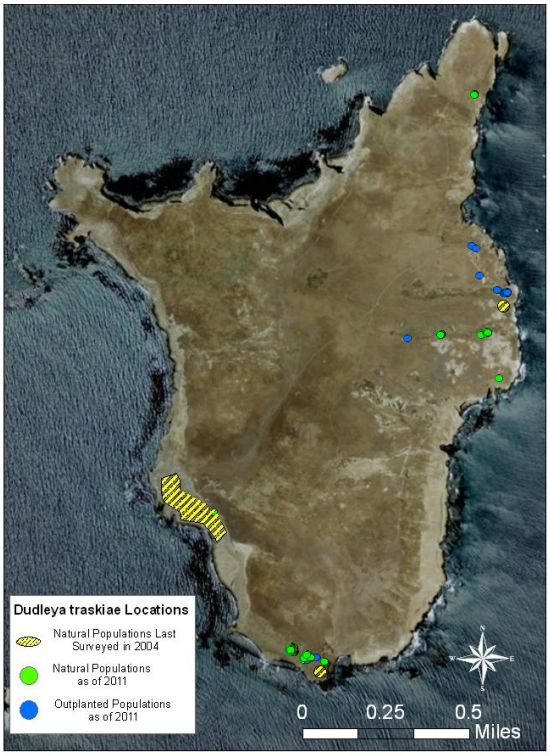
with 25 to 35 leaves per rosette (Service 1985). Rosette leaves range up to 15 centimeters (cm) (5.9 inches (in)) long and up to 4 cm (1.6 in) wide. The foliage of *D. traskiae* is glaucous gray or non-glaucous green while the flowers are usually bright yellow with red veins (Moran 1951). The plant blooms mid spring, usually from April to May (Moran 1978), but sometimes extends to July (Service 1985, CNPS 2001). The flowers are acute at the tip, with floral stems standing 20-30cm tall. Reduced triangular-ovate cauline leaves attached to the floral stems decrease in size as they progress from the rosettes to the flowers (Service 1985).

Historic and Current Distribution

Dudleya traskiae has always been restricted to Santa Barbara Island (See Figure 1), located 38 miles (61 kilometers) from the mainland. The island comprises only 652 acres (264 hectares) and is bounded by rugged, precipitous cliffs. The prominent topographic feature of the island is Signal Peak, which rises to 193 meters (635 feet) in elevation on the southwest margin of the island. A low, north-south oriented saddle runs between Signal Peak and North Peak, which is on the north rim of the island. Much of the island consists of marine terraces that slope gently down to the edge of the coastal cliffs to the east and west. Due to the influence of nonnative herbivores, it is believed that the species was more abundant and probably occupied much more of the island prior to the time herbivores were introduced (see Habitat Trends below), and that the sea bluff and interior cliffs and slopes acted as refuges for native vegetation (Philbrick and Haller 1988). However, this cannot be confirmed for *D. traskiae* because no observations on the plant were made prior to the era of farming and feral animal introductions (Clark and Halvorson 1987).

Figure 1:

Dudleya traskiae Approximate Locations For Santa Barbara Island 2011



Map Created By: Matthew Blazek
ESRI ArcGIS Online and data partners, including imagery from agencies supplied via the Content Sharing Program
Dudleya traskiae Locations - Channel Islands GIS May 2006 and July 2011

At the time of listing in 1978, the species was known from only two unspecified sites on the island. By 1985, the species had been found at approximately 10 sites on the island; these sites were concentrated in four portions of the island: along the southwestern margin in the Signal Peak area, the southern tip near Cat Canyon, along the eastern margin in Cave, Middle, and Graveyard Canyons, and in the northeast in Arch Canyon (Service 1985). The discovery of an additional site in Middle Canyon now brings the total number of sites supporting *Dudleya traskiae* individuals to 11.

For this 5-year review, we have modified the terminology used to refer to a group of *Dudleya traskiae* individuals growing in close proximity to each other from population to colony; a colony denotes a clustered aggregation of individuals within a population. We have done this for two reasons: 1) The number of original biological populations represented by the *D. traskiae* plants at these 11 sites is uncertain because we now believe that what were initially documented to be separate sites are most likely remnant portions of what was once a more continuous population. For instance, three separately marked populations in Middle Canyon are within 500 ft (150 meters) of each other and likely were once part of a continuous population. In 2003, using the old terminology, a fourth population was located in Middle Canyon midway between two known populations, further supporting the ideas that the entire canyon may have supported a more continuous population historically. Using the new terminology, Middle Canyon is described as supporting four colonies; although we are not certain, these four colonies likely represent the remnants of one population. 2) Referring to colonies will make the 5-year review more consistent with terminology used in the recovery plan criteria. We still use the term population in a generic sense, as when referring to population monitoring.

Based on outplanting experiments carried out by Clark (1989), she suggested that some areas outside of the habitat known at the time might also be suitable for *Dudleya traskiae*. However, in the intervening 24 years (1987 to 2011), no new colonies have been found outside the known distribution of the species. Moreover, the boundaries of most of the colonies have not undergone natural expansion to any great degree. Exceptions are two of the colonies near Cat Canyon, which have significantly expanded in area (Chaney 2007). In Middle Canyon, two other colonies have increased in density, and new individuals have been observed between existing colonies (Chaney *in litt*. 2006, Chaney 2007).

Habitat Trends

The vegetation on Santa Barbara Island had a long history of being altered by human activities. While Native Americans inhabited or at least visited Santa Barbara Island, their impact on the vegetation is unknown and the subject of speculation (Service 1985). The most likely impacts were either from burning of the vegetation or from consumption. Impacts associated with colonization by settlers, however, were much more severe. By 1850, the island was already "densely populated" with goats (Philbrick 1972). Other introductions included: cats in the 1880s, sheep in the early 1900s, New Zealand red rabbits in 1915, and Belgian hares in 1942 (McEachern 2004). Each of these species inflicted damage to the natural vegetation. The island was also farmed for oats, barley, and potatoes over nearly one-half of the island in the first half of the 1900s, and was used as an aircraft early warning outpost from 1942 to 1947 (McEachern 2004, Service 1985).

In 1984, the Park instituted long-term plant community monitoring programs on all the islands within the Park including Santa Barbara Island. Transects are located in the following communities: boxthorn scrub, cactus scrub, coastal sage scrub, coreopsis (*Coreopsis gigantea*) scrub, grassland, seablite scrub, and seacliff scrub (Johnson 1998, Johnson and Rodriguez 2001). An analysis of long-term recovery trends suggest that mainly native shrubs are increasing in numbers and nonnative grass abundance is either declining or stable (Corry 2006).

Clark (1989) analyzed site characteristics for habitat occupied by *Dudleya traskiae* at the time (1985-1987). She found that the biotic and abiotic habitat components – specifically, associated plant species, slope, aspect, and elevation – were homogeneous throughout the habitat type, with sites occupied by *D. traskiae* being indistinct. This suggested that the availability of suitable habitat is not limiting population growth.

Abundance

The Smithsonian report (1975 in Service 1978) noted that *Dudleya traskiae* had not been collected since 1968 and that it was possibly extinct. Also in 1975, several plants were discovered regenerating from stubs that had been gnawed to the ground by hares (Service 1978). This regeneration was attributed to the efforts of the Park to eradicate the hares and rabbits. The Park continued hare eradication efforts until 1981, at which time they were eliminated from the island. The Park surveyed the island for *D. traskiae* in 1982, 1983, and 1984; these surveys resulted in the location of additional colonies, while at the same time revealing the precarious status and rarity of the species (Service 1985). Of the ten colonies located by 1983, 3 comprised less than 10 individuals each, 6 comprised less than 100 individuals each, and only the Signal Peak colony comprised over 100 individuals (approximately 120) (Drost *in litt.* 1983). In 1984, additional plants were found farther north on the cliff below Signal Peak, bringing the total estimated number of individuals in the Signal Peak area to 534 (Drost *in litt*. 1984).

An effort to census colonies (excluding Signal Peak cliff) from 1985 through 1987 was done by tracking the abundance of individuals at 10 plots over the range of the species (Clark 1989). Over the 3-year period, the study found the following:

- The number of plants in censused plots was essentially stable over the 3-year period. However, this included a recruitment event in the 2nd year (due to higher than average rainfall), followed by a decrease in seedlings the 3rd year (due to a drought).

- The structure of the entire island population, measured on the basis of distribution of the number of individuals in rosette number classes, changed dynamically during this study, with a trend towards larger, more mature individuals. The total number of censused rosettes increased by 22 percent from 1985 to 1987.

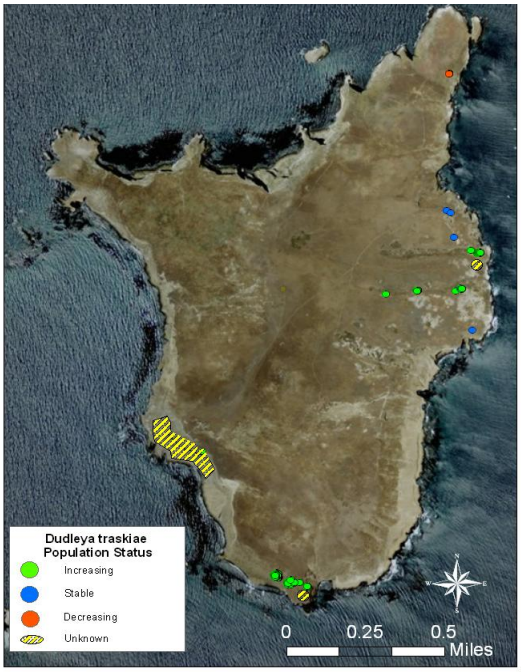
In 2003, Clark and Park staff successfully located all the colonies, some of which had not been observed in 15 years; these colonies were subsequently censused in 2004. They found that three colonies had increased in size, three colonies were small but stable, and four colonies had decreased in size and were at serious risk of extirpation (Chaney 2007). Data on size classes and productivity were also gathered to compare to Clark's data set; however, analysis is not complete (Chaney 2007). The total number of individuals in the eight colonies that were censused (excludes the Signal Peak colonies and one Cat Canyon colony) in 2004 was approximately 138 individuals. By assuming that the Signal Peak colonies and the Cat Canyon colonies were the same size as when they were last censused, we conservatively estimated the total number of individuals to be 852 for 2007 (Chaney 2007).

In November 2006, Park staff censused all accessible colonies (excluding the Signal Peak colonies) and also noted the extent of damage from pelican nesting and roosting activity, which

had greatly expanded in the previous two years. Park staff reviewed Signal Peak population survey data and postulated that, based on a comparison of the accessible portion of this colony and the Cat Canyon colony (which is similar in topographic position along the south side of the island), the Signal Peak cliff colony may have increased in size over the 20 years from 1986 to 2006 (Chaney 2007) (See Figure 2). Even if the colony is stable and has not increased in size from the 534 individuals estimated in 1984, this one colony is larger than all the other colonies combined. By assuming that the Signal Peak colonies were the same size as when they were last censused, we conservatively estimated the total number of individuals to be 928 for 2007 (Chaney 2007).

Figure 2:

Dudleya traskiae Population Status
For Santa Barbara Island as observed in 2011



Map Created By: Matthew Blazek
ESRI ArcGIS Online and data partners, including imagery from agencies supplied via the Content Sharing Program
Dudleya traskiae Locations - Channel Islands GIS May 2006 and July 2011

An additional 80 individuals have become established through outplanting efforts in April 2005 by Park staff; these are located adjacent to the Cave Canyon and Cat Canyon colonies (see Recruitment below) (Chaney *in litt*. 2006, Chaney 2007). There have been no new outplanting efforts since then.

In 2011, Chaney, Swabey and Blazek conducted a basic population survey which included a size estimate of six colonies and a census of plots found in the Middle Canyon, Cat Canyon, and Arch Canyon colonies. *Dudleya traskiae* colonies located in Cave Canyon, at the mouth of Middle Canyon, the eastern slope of Cat Canyon, and at Signal Peak were not censused. Colonies surveyed in Middle Canyon and Cat Canyon showed signs of recruitment and had increased in number (Chaney et al. pers. obs. 2011). The colony in Arch Canyon was the only censused colony that showed a decrease in number (Chaney et al. pers. obs. 2011). Assuming again that the colony around Signal Peak remained the same size at 534 individuals, we estimate the total number of *D. traskiae* individuals in 2011 to be 1003 (see Table 1 for a summary of population records). In addition, the majority of the outplantings established in 2005 were surviving, mainly around Cave and Cat Canyon, and some were also showing signs of recruitment (Chaney et al. pers. obs. 2011).

Recruitment

Very little natural recruitment of new seedlings has been observed since Clark's (1989) 3 years of observations. In 2003, a colony of 18 individuals was located in Middle Canyon; due to the size of the individuals, Park staff deduced that their establishment occurred sometime after Clark's observations were completed. In addition, near Cat Canyon, one colony (NPS #8) increased from 27 plants in 1984, to 210 plants in 2006, to 223 plants in 2011 (Chaney 2007, Blazek pers. obs. 2011). However, in 23 intervening years, these are the only significant natural

Table 1: Population Records for *Dudleya traskiae* extracted from California Natural Diversity Data Base (CNDDB) 2011, Chaney et al. pers. obs. 2011, Chaney 2007, and McEachern 2004.

NPS ID # (CNDDB #)	Location	Last Known Trend	Threats	Last observed/ documented	Colony size	Reference
Signal Peak area						
9 (4)	*Southwest facing slope of Signal Peak*	*Unknown*	*Pelican nesting (Chaney 2007); Soil Erosion (McEachern 2004)*	*1987*	*1987 - 534*	*CNDDB 2011 [Last Updated 12/19/2005]*
NA (1)	*West Slope, North of Signal Peak*	*Extirpated*	*NA*	*04/27/1941*	*1979 - 0*	*CNDDB 2011 [Last Updated 02/28/2006]*
Cat Canyon area						
6 (3)	*East facing slope of Cat Canyon*	*Increasing gradually*	*Pelican nesting (Chaney 2007); Soil erosion (McEachern 2004)*	*1989*	*1984 - 21 1985 - 28*	*Chaney 2007;*
7 (3)	*West of mouth of Cat Canyon*	*Increasing*	*Pelican nesting (Chaney 2007); Soil erosion (McEachern 2004)*	*07/26/2011*	*1984 - 1 1985 - 7 2006 - 21 2011 - 77**	*Chaney 2007; Chaney et al.* pers. obs. *2011*
8 (3)	*West of mouth of Cat Canyon*	*Increasing*	*Pelican nesting (Chaney 2007); Soil erosion (McEachern 2004)*	*07/26/2011*	*1984 - 27 1985 - 51 1989 - 56 2006 - 210 2011 - 223*	*Chaney 2007; Chaney et al.* pers. obs. *2011*
Eastern Canyons area						
1	*North facing slope of Cave Canyon; near mouth*	*Increasing gradually*	*NA*	*2006*	*1984 - 5 1985 - 25 2004 - 23 2006 - 36*	*Chaney 2007*
2 (2)	*South facing slope of Middle Canyon, near mouth*	*Increasing*	*Pelican nesting (Chaney 2007)*	*1989*	*1984 - 7 1985 - 17*	*Chaney 2007*
3 (2)	*North facing slope of Middle Canyon, near middle of canyon*	*Increasing*	*Pelican nesting (Chaney 2007)*	*07/25/2011*	*1984 - 67 1985 - 64 2006 - 33 2011 - 88*	*Chaney 2007; Chaney et al.* pers. obs. *2011*
4 (2)	*South facing slope of Middle Canyon, near mouth*	*Increasing gradually*	*Pelican nesting (Chaney 2007)*	*1989*	*1984 - 2 1985 - 2 2004 - 4 2006 - 5*	*Chaney 2007*
5	*Between Middle Canyon and Graveyard Canyon*	*Stable*	*Soil erosion, pelican nesting, and low seed viability (Chaney et al.* pers. obs. *2011)*	*07/25/2011*	*1984 - 1 1985 - 1 2003 - 1 2006 - 1 2011 - 1*	*Chaney 2007; Chaney et al.* pers. obs. *2011*
Northeastern tip area						

10 (5)	*Seaslope between Cliff Canyon and Arch Canyon*	*Decreasing*	*Mouse herbivory (Chaney et al.* pers. obs. *2011) Pelican nesting (Chaney 2007); Soil erosion (McEachern 2004)*	*07/27/2011*	*1983 - 8 1984 - 7 1985 - 11 1989 - 14 2004 - 4 2006 - 3*	*CNDDB 2011 [Last Updated 12/19/2005]; Chaney et al.* pers. obs. *2011*
11	*North facing slope of Middle Canyon, near mouth*	*Increasing gradually*	*Pelican nesting (Chaney 2007)*	*07/24/2011*	*1984 - 1 1985 - 1 2004 - 19 2006 - 18 2011 - 24*	*Chaney 2007; Chaney et al.* pers. obs. *2011*

*In 2011, 77 individuals were counted. These included naturally occurring individuals and nursery raised plants that survived from the Park's outplanting effort in April 2005.

recruitment events that have been observed; all other observed recruitment has been comprised of fewer individuals, and has occurred within or adjacent to previously known colonies. Clark's demographic studies (Clark 1989) suggest that new population growth in *Dudleya traskiae* may be limited by the following five factors:

1. *Viable seed production:* The production of viable seeds (as measured by the number of filled seeds produced per fruit and total viable seed production) varied significantly among individuals within colonies and among sites. Viability of seed ranged from 40 to 80 percent at different sites. Seed production also varied, with increased seed production correlated with larger colony size. Since the variation was due exclusively to an increase in the number of filled seeds per fruit, Clark hypothesized that pollination may be limiting in the smaller colonies (Clark 1989).

2. *Seed herbivory:* Seed herbivory was inferred from observations of *Dudleya* fruit and fruit debris in cases at the openings of deer mouse burrows (Clark 1989). Similar observations have been made by Park staff in subsequent years (Chaney *in litt.* 2006). The Arch Canyon colony of *D. traskiae* (NPS #10) was shown to be particularly affected by mouse seed herbivory (Chaney et al. pers. obs. 2011).

3. *Seed dispersal:* Seed dispersal may be naturally limited in this species of *Dudleya* as it is for others in the genus (Moran in Clark 1989), and may be a factor in maintaining the small, localized colonies that give rise to the high degree of endemism displayed by the genus. Seed caching by deer mice may result in herbivory of some seed, but aid in dispersal of the unconsumed portion of seed (Sieg 1987). The Graveyard Canyon colony of *D. traskiae* (NPS#5) is particularly limited by seed dispersal because the colony resides on the edge of a cliff where seeds, which are most likely dispersed by water splash, fall into the ocean below (Chaney et al. pers. obs. 2011).

4. *Seedling herbivory:* Herbivory of seedlings was documented by Clark (1989) in a series of experiments in which outplanted seedlings were placed in one of three treatments (exclosure, roof treatment, and open). Herbivory was more extensive in the open and roof treatments than in the exclosures. Herbivory was more extensive in grassland and cactus-dominated habitats than in tarplant (*Hemizonia* sp.) or coreopsis-dominated habitats. In addition to deer mice, owlet moth larvae are suspected of being a primary herbivore of *Dudleya* seedlings (Clark 1989).

Evidence of herbivory by deer mice and possibly birds has also been observed by Park staff (Chaney *in litt*. 2006, Chaney 2007) and others while censusing *Dudleya* colonies and monitoring outplanted colonies.

5. *Seedling death from drought:* In Clark's (1989) outplanted seedling experiments, many of the seedlings that did not die from herbivory ultimately died from desiccation. Chaney (2006) also reported that of 800 seedlings outplanted in April 2005, only 15 percent survived to January 2006, due to the late timing of the outplanting, the lack of spring rains in 2005, and the subsequent desiccation of individuals.

Clark (1989) concluded that the findings of her studies indicated that *Dudleya traskia*e was capable of maintaining itself without active manipulation. She cautioned, however, that 3 years of study was insufficient to predict long-term population trends.

The few seedlings that survived Clark's outplanting experiments were subsequently removed from the island. Since then, assisted recruitment has been attempted by Park staff on two occasions over the past 10 years:

- In 1996-1997, outplantings of seedlings greenhouse-grown from seed of two colonies were outplanted near their source colonies. Both plantings have persisted and have been flowering and producing seed since 1999 (Chaney *in litt.* 2006).

- In 2005, about 800 seedlings were outplanted from seed collected from seven colonies. Due to drought conditions, however, only 15 percent had survived after the first 9 months (Chaney 2007).

Conservation Efforts

Management: The Park has undertaken numerous management actions designed to restore natural processes and remove external sources of disturbance on Santa Barbara Island, including: all visitors are restricted to a designated trail system, camp area, and landing cove, with no off-trail exploration allowed; trails have been removed from Cave and Middle Canyons; hare eradication was completed in 1981; seasonal restrictions are applied as needed. For instance, since 2006, access to the island has been restricted to the public during pelican nesting season (National Park Service 2006). Restoration trials that focused on the removal of crystalline iceplant from the island were also undertaken in the mid- to late-80s (Halvorson 1993), though to what extent this occurred in areas of potentially suitable habitat for *Dudleya traskiae* is uncertain.

Research: The Park supported the research carried out by Clark (1989), which contributed greatly to our understanding of the demographics of *Dudleya traskiae*. The research was funded by the Service through a section 6 grant to the California Department of Fish and Game.

Outplanting experiments: Park staff has conducted three outplanting trials of *Dudleya* seedlings; these efforts are discussed in the previous section on Recruitment. In 2011, the Park was considering a fourth outplanting effort intended to occur in the near future. Because successful

seedling establishment appears to be one of the limiting factors in the continued expansion of existing colonies and the reestablishment of colonies within what appears to be suitable habitat, these efforts are critical to the eventual recovery of the species.

Five-Factor Analysis

In the final rule to list *Dudleya traskiae* as endangered in 1978, only Factor A and C threats were discussed, and then only briefly. Although not presented within a "Five Factor" format, additional information about historic threats was gleaned from the Recovery Plan (Service 1985).

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

At the time *Dudleya traskiae* was listed (Service 1978), habitat alteration was discussed on the landscape level scale because by then only two colonies had been located: one consisting of three individuals that were regenerating from "stubs that had been gnawed to the ground" by the hares; and one colony of several hundred individuals that were found clinging to the face of a sea cliff, which presumably had been out of reach of the hares. Much of the rest of the island had been subject to burning, farming, livestock grazing, and subsequent increase in the cover of nonnative species such as iceplant, which can cover large patches of ground precluding the re-establishment of native species. All nonnative herbivores have been removed from the island; the last rabbits were removed in 1981.

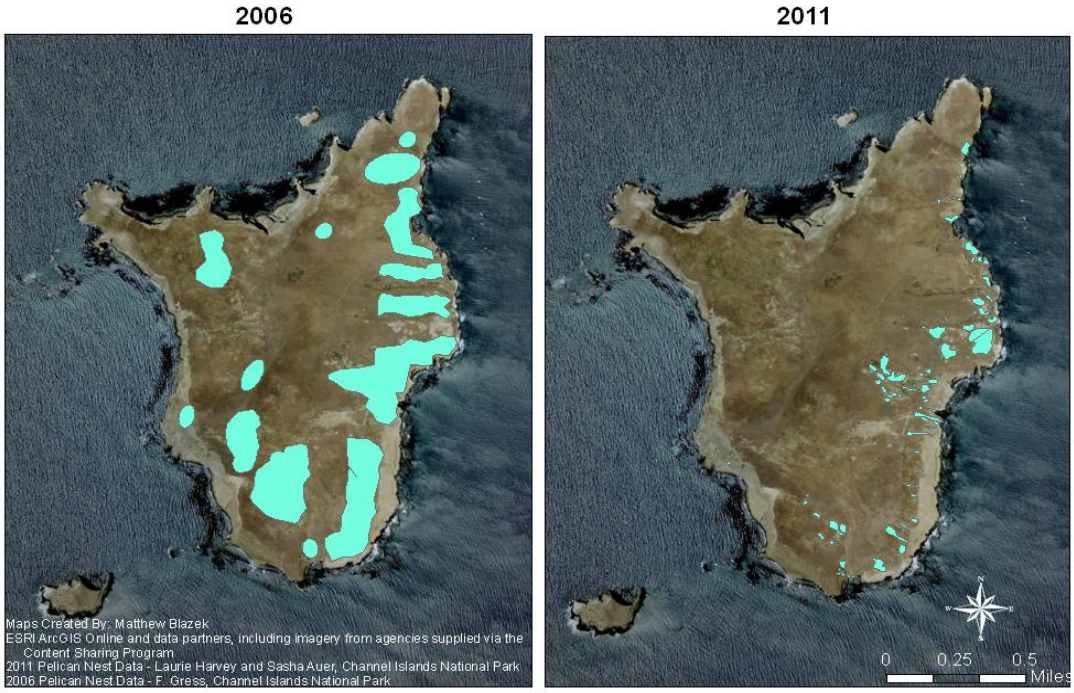
Though habitat alteration on a landscape scale has ceased with the establishment of the Park (originally designated a National Monument in 1938), residual impacts remain. Specifically, nonnative plant taxa whose spread was favored by the previous disturbances are still present. In areas with steep slopes, another residual impact is soil erosion caused by previous disturbances and high clay composition (Halvorson et al 1988) restoring slope stability may take decades, if not longer (McEachern 2004).

In 2004, during surveys, Park staff observed that the federally endangered (at the time) brown pelicans had expanded their roosting habitat onto Santa Barbara Island. By early 2006, pelican roosting activity had expanded greatly, and the Park closed access to the eastern portion of the island (National Park Service 2006). According to Laurie Harvey (NPS Seabird Biologist), the pelican colony on Santa Barbara Island reached a historic maximum in 2006 with an estimated 4,000 nests (Gress and Harvey in prep) (See Figure 3). Since 2006, pelican populations have been much smaller on the island. As a result, short-term effects from pelicans on *Dudleya traskiae* and the surrounding habitat may vary depending on the abundance and locations of pelican nests.

Long term effects on the habitat, however, may linger despite the fluctuations in yearly pelican population sizes. Droppings from pelicans tend to be high in nitrates, which can burn *D. traskiae* and act as fertilizer for nonnative plants thereby increasing numbers of nonnative grasses which may outcompete *D. traskiae* (Rodriguez *in litt*. 2011). In addition, destabilization of slopes result from nesting and roosting pelicans due to the birds' size and weight. A continuous impact

from pelican presence can often lead to erosion of soils from canyon slopes and cliff sides, which is where *D. traskiae* are usually found.

Figure 3: **California Brown Pelican (Pelecanus occidentalis californicus) Nesting Locations on Santa Barbara Island**



*Note for 2006, the method used to collect data did not involve utilizing a GPS coordinate system; rather it represents general locations of the nests. Thus the data is less accurate and is skewed in comparison to the 2011 information.

In 1983, Drost noted that 2 large *Dudleya traskiae* individuals were "stripped from the rocks by exceptionally large waves from a severe winter storm" (Drost *in litt.* 1983). During the 2006 assessment (Chaney 2007), Park staff also noted that erosion, caused either by pelican activity or natural sloughing, was affecting 7 of the 11 *D. traskiae* colonies (Chaney 2007). Since the time of listing, threats to *D. traskiae* habitat from hare and other nonnative grazers have been removed. However, pelican populations continue to alter *D. traskiae* habitat. Threats from pelican nesting vary with the fluctuating population numbers of the birds as well as their nesting locations. In years where pelican presence is high, *D. traskiae* will more likely be adversely affected from both short term and long term effects.

Overall, due to prior farming and introduced grazers, impacts such as soil erosion and invasive plants continue to be observed on Santa Barbara Island. Currently, threats from nonnative grazers have been removed, but pelican nesting is also contributing to alteration of habitat. The input of nitrates from pelican droppings and slope destabilization from nesting activity can also lead to soil erosion as well as competition between *D. traskiae* and nonnative grasses, though these threats fluctuate each year with the varying pelican population levels.

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

Overcollection was not considered a threat in the final rule to list *Dudleya traskiae* as endangered in 1978. However, the species was placed on the CITES Appendix I List in 1983 due to concern that it could be sought after for international trade. The concern most likely was based on the interest that dudleyas in general generate within the commercial nursery trade. Collection was also mentioned as a concern in the 1985 recovery plan, though at that time there was no evidence that collection had occurred.

In 2003, the species was moved from the CITES Appendix I List to the CITES Appendix II List. This move was based on the lack of evidence that the species was subject to collecting pressure or that it was coveted within the commercial nursery trade (CITES 2003). In general, it does not appear that overutilization constitutes a threat to this species (S. Chaney, Channel Islands National Park, pers. comm. 2006). Park staff noted that one incident of collection occurred from one plot that was being monitored by Clark between 1985 and 1987; however, no other incidences have been noted since then.

In 2004, a special issue of the Cactus and Succulent Journal was devoted to dudleyas; several articles specifically mention *Dudleya traskiae* (McCabe 2004). Whether this publicity has elicited additional interest among collectors to seek out the species is unknown at this time. As of our 5-year review in 2011, overutilization does not appear to be a threat (Blazek pers. obs. 2011). The CITES proposed to remove this species from Appendix II on April 11, 2012; no final action has been taken yet.

FACTOR C: Disease or Predation:

At the time *Dudleya traskiae* was listed, predation by rabbits was considered one of two primary threats to the persistence of the species. The "New Zealand red" rabbits were introduced in 1942, peaked in 1955, and were finally eliminated by the Park in 1981 (McEachern 2004). There is no reason to believe that the sheep and goats that also populated the island between the 1850s and 1915 did not consume those individuals that were accessible (Hochberg et al. 1979). In the same year the species was listed (1978), the largest colony was located on the cliffs west of Signal Peak on the southwestern margin of the island. The remote and rocky location protected *D. traskiae* from being consumed by these mammal herbivores. By 1984, after 3 years of intensive surveys, Park staff located a total of 10 colonies, ranging in size from 1 to more than 420 individuals (Halvorson et al.1992; Junak et al. 1993). Because nonnative herbivores have been eliminated from the island, predation from these animals is no longer considered a threat.

At least by 1979, biologists from the Santa Barbara Museum of Natural History observed that the native deer mice (*Peromyscus maniculatus* subsp. *exilis*) were feeding on *Dudleya traskiae* (Collins et al. 1979). Park staff also observed deer mice feeding on *D. traskiae*, and noted that 30 to 40 percent of their fruiting stalks were gnawed through and broken (Drost 1983 *in* Service 1985). Moreover, caches of *D. traskiae* fruits and fruit debris were observed at the openings of deer mouse burrows (Clark 1989). Herbivory thus could reduce the vigor of individuals through reduction in leaf tissue, and also reduce the amount of seed available to contribute to the seed

bank. However, seed caching associated with herbivory may also serve to disperse seed to potentially suitable habitat. It has been documented that mice populations have a positive correlation with the abundance of nonnative grasses. When nonnative grasses increase, mice populations, which rely on grasses and seeds as other major food sources, also increase in number. Thus, overall effects on *D. traskiae* from mice vary over time.

Predation by rabbits has ceased, but the extent to which deer mice and owl moth larvae predation threaten *Dudleya traskiae* colonies is uncertain. Owl moth larva predation has not been observed recently, and so is not considered a major threat for this 5-year review (Blazek pers. obs. 2011). Threats from mouse herbivory, as mentioned, varies with the abundance of invasive grasses and associated deer mice populations.

FACTOR D: Inadequacy of Existing Regulatory Mechanisms:

Inadequacy of existing regulatory mechanisms was not considered a threat to *Dudleya traskiae* at the time of listing and is not considered a threat at this time. Because all colonies occur on one island that is managed by Channel Islands National Park, the Park has and continues to have the ability to impose restrictions on access to and use of the island to protect sensitive resources. Since the last 5-year review was conducted in 2006, the brown pelican has been removed from the list of endangered species. This may allow the Park additional flexibility in undertaking management actions to benefit *D. traskiae* where they overlap in range with pelican activity.

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

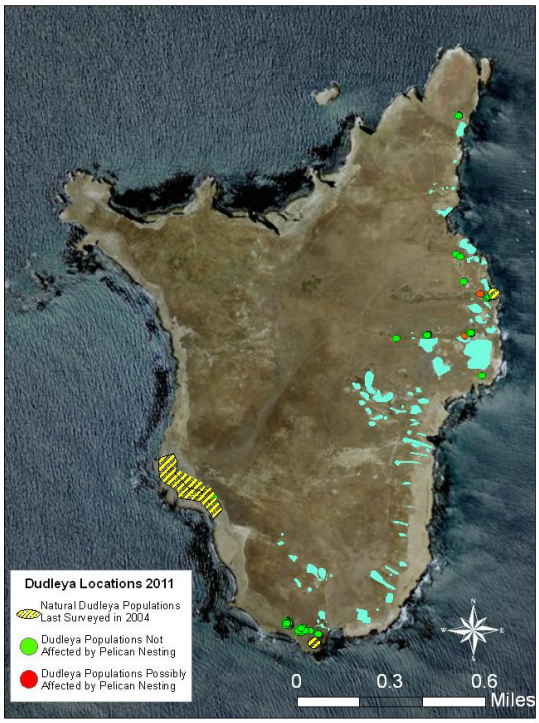
At the time *Dudleya traskiae* was listed, fires were mentioned in the context of agricultural practices that had occurred on the island in the first half of the 1900s. In the Service's recovery plan (1985), we briefly mention that "fire and nonnative vegetation remain as potential threats to the species." While intentional fires were previously used to help clear the more level portions of the island for agriculture, any current threat of fire is based more on the presence of nonnative species (such as grasses) that would carry an accidental fire more readily than native vegetation. In the last 5-year review in 2006, we discussed low reproduction and trampling as threats to the species. We also identified the most likely causes of extirpation as being pelican nesting, pelican roosting, and slope erosion.

<u>Low Reproduction</u>
Recruitment rates may not keep pace with rates of mortality. Although good recruitment rates under greenhouse conditions have been achieved, recruitment rates observed in the wild appear to be extremely low and episodic. Small colonies may be even more vulnerable to reduced viability because the seed they produce have lower germination rates than those produced by larger colonies (Clark 1989, Chaney 2007).

<u>Trampling</u>
In Factor A, we discussed impacts to *Dudleya traskiae* habitat from pelican nesting and roosting activity. Here in Factor E, we discuss impacts to individual plants. Pelican nesting and roosting results in trampling of rosettes, breakage of floral stems, destabilization of slopes which cause plants to become dislodged, and loss of substrate which precludes new seedlings from becoming

Figure 4:

Dudleya traskiae and Brown Pelican Locations
For Santa Barbara Island 2011



Map Created By: Matthew Blazek
ESRI ArcGIS Online and data partners, including imagery from agencies supplied via the Content Sharing Program
Dudleya traskiae Locations - Channel Islands GIS May 2006 and July 2011
Brown Pelican Locations - Laurie Harvey and Sasha Auer, Channel Islands National Park 2011

established. In 2006, an assessment of pelican impacts on *D. traskiae* colonies was conducted. Seven of the 11 colonies of *D. traskiae* were characterized as having sustained impacts or were immediately vulnerable to impacts from pelican activities (Chaney 2007). Of these, five colonies were characterized as being at extreme or high risk of extirpation from these impacts (Chaney 2007). Most of these colonies were located along the east margin of the island in the stretch between Arch Canyon and Middle Canyon, and one was located at Cat Canyon on the southern tip of the island. In 2011, only a few colonies in Middle Canyon and Arch Canyon were in close proximity to pelican nests (See Figure 4) (Blazek pers. obs. 2011).

In this 5-year review, we have identified climate change and stochastic events as new threats; they are discussed below.

Climate Change

Current climate change predictions for terrestrial areas in the northern hemisphere indicate warmer air temperatures, more intense precipitation events, and increased summer continental drying (Field et al. 1999, Cayan et al. 2005, Intergovernmental Panel on Climate Change (IPCC) 2007). In addition, an increase in the rate of sea level rise has been predicted for the coast of California (California Coastal Commission (CCC) 2001, California Climate Change Center 2006). In particular, ocean bluffs along the coast will likely be subject to greater and more frequent wave attack, resulting in erosion and shoreline retreat (CCC 2001). The California Coastal Commission estimated that for every foot (0.3 m) the sea level rises in California, approximately 50 -100 ft (15.25 - 30.5 m) of shoreline might be lost on average (California Coastal Commission (CCC) 2001). Estimates for the amount of sea level rise range anywhere from approximately 0.59ft to 6.2ft (0.18 to 1.9 m) by the end of this century (Vermeer and Rahmstorf 2009).

Recently, 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 and that the species will "move" to higher elevations and northward, depending on the ability of each species to do so. In the case of smaller island ecosystems, such as Santa Barbara Island, the opportunities to move to higher elevations or further north are limited. We lack adequate information to make specific and accurate predictions regarding how climate change, in combination with other factors such as limited geographical distribution, will

affect federally listed species; however, small-ranged species such as *Dudleya traskiae* are more vulnerable to extinction due to these changing conditions (Loarie et al. 2008). Wilken (1996) noted that because most colonies of *D. traskiae* occur on cliff sides in close proximity to the ocean, the species is subject to a wide range of climatic conditions, such as occasional salt spray, which may directly affect the soils and plants at Signal Peak.

The largest colony at Signal Peak, which is located on the face of a sea cliff, is vulnerable to cliff failure. The combination of threats associated with erosion, shoreline retreat, limited habitat range, and existence of only a few small colonies of *Dudleya traskiae* may make this species particularly vulnerable to the effects of climate change.

Stochastic Extinction

Stochastic extirpation of colonies and extinction of the species also pose a potential threat to the species and are exacerbated by low recruitment rates. Those colonies with low numbers of individuals are particularly vulnerable to extirpation from stochastic events because, due to their tendency to be clumped into colonies, the stochastic event is likely to affect the entire population (Meffe and Carroll 1997).

At the time of listing, we noted that, due to the limited number of individuals and geographic range of *Dudleya traskiae*, this species was at risk of extinction from naturally occurring events, such as fire, drought, disease, or landslides (Service 1985). We believe that, since the majority of *D. traskiae* reside in one location (near Signal Peak) and on a cliff side, this places the species at risk of extinction from stochastic events. The conservation biology literature commonly notes the vulnerability of taxa known from one or very few locations and/or from small and highly variable populations (Shaffer 1981, Primack 2006, Groom et al. 2006). The small size of the populations makes it difficult for this species to persist while sustaining the impacts of soil damage through erosion and landslides. In addition, as a result of its limited range, the resilience of *D. traskiae* to human caused or natural disasters may be greatly reduced (Menges 1991).

Combination of Factors

There are several natural and human-caused factors that may cause *Dudleya traskiae* to be at risk of extinction: low reproduction, trampling, the effects of climate change (such as those associated with sea level rise). In addition, these factors can work in combination with each other to increase the risk of extinction. For instance, the effects of sea level rise and the continued erosion of the ocean-front cliffs at Signal Peak and Cat Canyon from high surf and storm events, in addition to climate variability - both from year to year and due to large-scale climate change – may pose an even greater threat to the relatively small and exposed *D. traskiae* colonies that have also been impacted by pelican nesting activities.

Summary of Five Factors

Overall, the two main threats that were considered at the time of listing were: Factor A) alteration and destruction of habitat due to historical use of the island for ranching and farming, and associated impacts such as invasion of nonnative species and fires; and Factor C) predation by rabbits. Stochastic extinction (Factor E) was mentioned at the time of listing, and is still considered a threat. Factors B and D were not considered threats at the time of listing and are not considered threats now. A number of threats exist today that were not recognized at the time

the recovery plan was written: alteration and destruction of habitat resulting from pelican nesting and roosting, predation by deer mice and owlet moth larvae, climate change, and stochastic threats such as landslides.

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.

As discussed in the Five Factor analysis above, a number of threats exist today that were not addressed at the time the recovery plan was written: alteration and destruction of habitat resulting from pelican nesting and roosting, predation by deer mice and owlet moth larvae, climate change, and stochastic threats such as landslides. Predation by deer mice was considered when the recovery plan was developed, but was not considered a great enough threat to warrant its own recovery criterion. Additional recovery criterion should be considered for these new threats.

Downlisting and delisting criteria are presented in the recovery plan (Service 1985) in a narrative format and essentially consist of the following:

Downlisting Criteria:

1. Secure all 11 colonies of the species in a vigorous, self-sustaining condition (addresses Factors A and C). This criterion has not been met. We consider this criterion to be appropriate with respect to the recovery of the species.

2. Expand the distribution of the plant to include 50 percent of the suitable potential habitat. The recovery plan notes that, "criteria for identifying suitable habitat will be determined following studies." Figure 3 of the recovery plan shows a theorized historical distribution based on soils, slope, and aspect (addresses Factors A, C, and E). This criterion has not been met: only

2 out of 11 colonies have had a notable increase in distribution. We believe this criterion is appropriate; however, what is considered suitable habitat needs to be better defined.

Delisting Criterion:
In addition to meeting the downlisting criteria above, for delisting, the following criterion needs to be met:

1. Expand the distribution of the plant to include 95 percent of the suitable potential habitat (addresses Factors A, C, and E). This criterion has not been met; only 2 out of 11 colonies have had a notable increase in distribution. We believe this criterion is appropriate, but that what is considered suitable habitat needs to be better defined.

These downlisting and delisting criteria focus on the desired outcome of recovery actions and are measurable, but do not specifically address threats to the species (i.e., are not "threats-based"). In the Background section of the recovery plan, the Service acknowledges that predation by rabbits had already been removed as a primary threat to the species by the Park since the time of listing. In addition to a generalized discussion of other threats in the Background section of the recovery plan, the Recovery Objectives section specifically mentions the following threats: low population numbers (Factor E), nonnative vegetation (Factor E), collection (Factor B), and wildfire (Factor E). Of these, we believe that low population numbers is the largest threat, followed by nonnative vegetation and wildfire. In addition, we do not believe that Factor B is currently a threat.

In regards to the recovery plan for *Dudleya traskiae*, predation by deer mice was considered a threat when the recovery plan was developed, but was not considered a great enough threat to warrant its own recovery criterion. As a result, additional recovery criteria should be developed to address this threat. As mentioned in the Five Factor Analysis above, new threats not mentioned at the time of listing or at the time the recovery plan was prepared include pelican roosting and nesting, and climate change; these should also be addressed in revised recovery criteria.

IV. SYNTHESIS

At the time of listing, only two colonies comprising "a few hundred" individuals were known from Santa Barbara Island. Both of these colonies appeared to be remnants of a more widespread distribution on the island which had been browsed by rabbits and hares. One colony was comprised of several plants "regenerating from stubs that had been gnawed to the ground by the hares," and the other comprised a few hundred individuals on the face of a sea cliff where the hares could not reach them (Service 1978). By the time the species was listed, the Park had already initiated an aggressive campaign to eliminate the hares; this task was completed 3 years later in 1981.

As of 1981, all nonnative animal species have been removed; however, residual effects in the form of soil compaction, soil erosion, and slow rates of recovery by natural vegetation cover,

may be affecting the ability of *Dudleya traskiae* to recover more quickly than it has over the last 20 years.

The Park has undertaken many of the recovery tasks included in the Service's recovery plan (1985). Park management for this species has included landscape-level protective measures; additional surveys that increased the known number of individuals and colonies; research that has contributed to our understanding of the life history of the species; and efforts to expand existing and establish new colonies. All of these measures have contributed to stabilizing and improving the status of the species.

Currently, the primary concerns for this species are: 1) alteration of habitat through pelican nesting and roosting, 2) low recruitment rates, 3) deer mice herbivory, and 4) climate change. At the time of listing, most of the discussion of threats focused on historical alteration of habitat due to the presence of nonnative animal species; low recruitment rates were acknowledged as a potential concern, but little was known at the time to substantiate the level of concern.

Pelican nesting, roosting, and flight activity emerged as a potential threat to *Dudleya traskiae* and its habitat since pelicans started rebounding from their low population numbers, approximately 7 years ago. The extent of this potential threat to the species needs to be assessed over the next few years, and measures taken to ensure that *D. traskiae* colonies are protected. After an initial assessment in November 2006 of the magnitude of the threat from pelicans, it appears that most of the colonies (all of them small colonies between 1 and 100 individuals each) were being affected by pelican activities. Not only were the *D. traskiae* colonies being affected, but habitat was being altered such that future recruitment was likely being compromised. As of 2011, pelican populations on the island have diminished (Gress and Harvey in prep.) and only *D. traskiae* found in the same locations as the pelican nests may be affected in the short term. Assessments are necessary to determine how *D. traskiae* is responding. Because of the variability in pelican nesting numbers and locations, it is difficult to assess long term effects on *D. traskiae* colonies from this threat. If pelican populations continue to recover, it is likely their effects on *D. traskiae* colonies will more likely reflect those observed in 2006.

Along with the threat of pelican activities, recovery of *Dudleya traskiae* appears to be hampered by the lack of natural recruitment. Bottlenecks to recruitment appear to include both intrinsic as well as extrinsic factors. While the Park has undertaken efforts to expand colonies and is committed to continuing these efforts, it is uncertain at this time to what extent this will contribute to recovery of the species.

Climate change and the ensuing effects may lead to sea level rise, stronger storms, and stronger storm surges. These processes can increase cliffside erosion, putting the largest *Dudleya traskiae* colony in danger of extirpation and the species as a whole at risk of extinction.

As of this review in 2011, we believe that *Dudleya traskiae* continues to be threatened with extinction due to its small numbers of colonies and individuals, threats from pelican nesting and roosting, low recruitment, and risk from stochastic events. Therefore, we find that the species still meets the definition of endangered, and we recommend that no change in species listing status occur at this time.

V. RESULTS

Recommended Listing Action:

____ Downlist to Threatened
____ Uplist to Endangered
____ Delist
_X_ No change

New Recovery Priority Number and Brief Rationale: NA. We recommend that the recovery priority number remain at 8.

VI. RECOMMENDATIONS FOR FUTURE ACTIONS

Over the years, the Park, USGS, and the Service have coordinated on prioritizing needed recovery tasks for a large suite of species that are endemic to the northern Channel Islands. The Service should continue to coordinate with the Park and USGS to support needed recovery tasks for *Dudleya traskiae* including:

1. Continue assessing the threat to *Dudleya traskiae* colonies from pelican nesting, roosting, and flight activity. Undertake actions to protect those colonies found to be at-risk, as appropriate. For example, cages and netting could be placed over individual plants during pelican nesting season.

2. Continue efforts to expand existing colonies and establish new colonies of *Dudleya traskiae*. These efforts should include sufficient logistical support to maximize the success of the efforts (e.g., sufficient staff, funding, and logistical support to carry out and monitor the program). In 2011, Chaney suggested salvaging the surviving *D. traskiae* colony at Arch Canyon (NPS #10), which has been in decline as documented by past surveys, and relocate the colony closer to the Park visitor center where it can be better managed and observed (Chaney et al. pers. obs. 2011).

3. Bank seed from any colonies that are not yet represented in seedbank collections. In addition to maintaining collections at the Park, a portion of the seed banks should be maintained by a facility within the Center for Plant Conservation network (likely Santa Barbara Botanic Garden or Rancho Santa Ana Botanic Garden).

4. Due to the lack of recent surveys and monitoring, particularly on the largest *Dudleya traskiae* colony at Signal Peak, it is recommended that new assessments be made to evaluate the status of *D. traskiae*. New information may clarify the extent of various threats and more effective recovery initiatives.

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U.S. FISH AND WILDLIFE SERVICE
5-YEAR REVIEW of
Dudleya traskiae (Santa Barbara Island liveforever)

Current Classification: Endangered

Recommendation Resulting from the 5-Year Review:

____ Downlist to Threatened
____ Uplist to Endangered
____ Delist
__X__ No change

Appropriate Listing/Reclassification Priority Number: N/A

Review Conducted By: Matt Blazek and Connie Rutherford

FIELD OFFICE APPROVAL:

Field Supervisor, Fish and Wildlife Service

Approve Diane K Noda Date 8/24/12