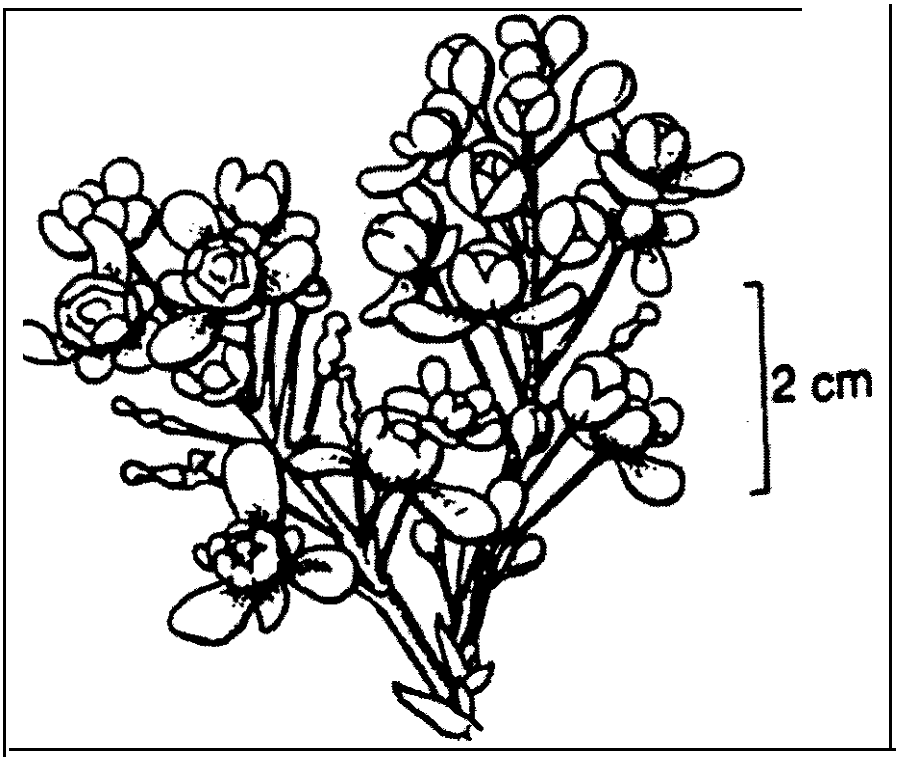
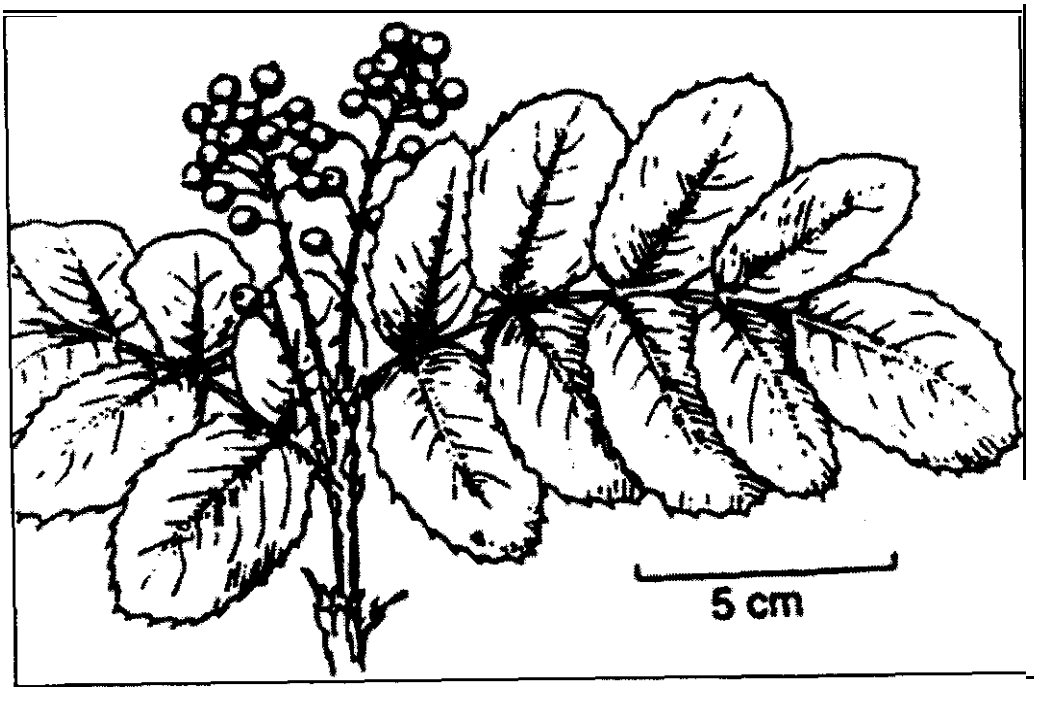
Thirteen Plant Taxa from the Northern Channel Islands Recovery Plan





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THIRTEEN PLANT TAXA

FROM THE

NORTHERN CHANNEL ISLANDS

RECOVERY PLAN

Region 1
U.S. Fish and Wildlife Service
Portland, Oregon

Approved: _____
Manager, California/Nevada Operations Office,
Region 1, U.S. Fish and Wildlife Service

Date: 9/26/00

PRIMARY AUTHOR

The Recovery Plan for Thirteen Plant Taxa from the Northern Channel Islands was prepared by:

Tim Thomas
U.S. Fish and Wildlife Service

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Recovery plans delineate reasonable actions which are believed to be required to recover and/or protect listed species. We (the U.S. Fish and Wildlife Service) publish recovery plans, sometimes preparing them with the assistance of recovery teams, contractors, State agencies, and others. Objectives of the recovery plan will be attained and any necessary funds made available subject to budgetary and other constraints affecting the parties involved, as well as the need to address other priorities. Costs indicated for task implementation and/or time for achievement of recovery are only estimates and are subject to change. Recovery plans do not necessarily represent the views, official positions, or approval of any individuals or agencies involved in the plan formulation other than our own. They represent our official position **only** after they have been signed by the Director, Regional Director, or California/Nevada Operations Office Manager as **approved**. Approved recovery plans are subject to modification as dictated by new findings, changes in species status, and the completion of recovery tasks.

Literature citation should read:

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ACKNOWLEDGMENTS

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EXECUTIVE SUMMARY

Current Species Status: The plant species covered in this recovery plan are listed as endangered except for the threatened Santa Cruz Island dudleya (*Dudleya nesiotica*) and island rush-rose (*Helianthemum greenei*). All 13 taxa are endemic to the northern Channel Islands (Anacapa, Santa Cruz, Santa Rosa, and San Miguel) and Santa Catalina Island (island rush-rose only).

Habitat Requirements and Limiting Factors: These plants occur in a variety of habitats: coastal terrace, coastal bluff scrub, coastal sage scrub, and chaparral. All 13 plant species and their habitats have been or are currently threatened by one or more of the following: soil loss; historic and continuing habitat alteration by mammals alien to the Channel Islands (pigs, goats, sheep, donkeys, cattle, deer, elk, horses, bison); direct predation by these same alien mammals; habitat alteration by native seabirds; competition with alien plant taxa; and increased vulnerability to extinction due to reduced genetic viability, depressed reproductive vigor, and the chance of extinction from random naturally occurring events because of small numbers of individuals and isolated populations.

Recovery Objective: The recovery objective for the endangered species is to reclassify them to threatened and then delist these species. The recovery objective for the threatened species is to delist them.

Recovery Criteria: There are unique recovery criteria for each of the species covered in this recovery plan. However, the following criteria apply to all of these species: (1) provide protection and adaptive management of currently known (and in some cases historic) sites, (2) provide evidence that the populations at these sites are stable or increasing over a number of years, which is determined by the life history of the individual species, (3) preserve the genetic diversity of the species by storing seeds in cooperating facilities, and (4) develop reliable seed germination and propagation techniques.

Actions Needed:

1) Support and intensify active control programs where herbivory or habitat alteration by alien animals exists.

2) Develop and implement a plan to achieve the goals and standards of the Conservation Strategy. The Conservation Strategy is a draft strategy for conservation of island resources prepared by biologists from the National Park Service, U.S. Fish and Wildlife Service, and the U.S. Geological Survey, Biological Resources Division. This Strategy is essentially a primer or guide that provides the basis for the recovery of the species in this recovery plan and should be referred to as a supporting document.
3) Restore habitats and control competitive weeds for long-term management of the listed species and their habitats.
4) Conduct thorough surveys for all species in the recovery plan.
5) Conduct research that aids in the conservation and recovery of the species in the recovery plan.
6) Store seeds at facilities certified by the Center for Plant Conservation and develop successful seed germination and propagation techniques.
7) Develop successful outplanting techniques.

Total Estimated Cost of Recovery: The total estimated cost of recovery for the 13 federally listed species over 40 years is broken down by tasks:

Priority 1 tasks: $31,995,000

Those actions that must be taken to prevent extinction or prevent the species from declining irreversibly in the foreseeable future.

Priority 2 tasks: $18,070,000

Those actions that must be taken to prevent a significant decline in the species population or habitat quality, or some other significant negative impact short of extinction.

Priority 3 tasks: $1,855,000

All other actions necessary to meet the recovery and conservation objectives outlined in this recovery plan.

Date of Recovery: If population stability is established and other recovery criteria are met (see Table 2), the various plant species addressed in this recovery plan may be considered for delisting within 15 to 40 years, depending on the species.

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I. INTRODUCTION

A. BACKGROUND

The Channel Islands comprise eight islands (Anacapa, San Miguel, Santa Barbara, Santa Rosa, Santa Cruz, Santa Catalina, San Clemente, and San Nicolas) that lie off the coast of southern California (Figure 1).

Hoffmann's rock-cress (*Arabis hoffmannii*), Santa Rosa Island manzanita (*Arctostaphylos confertiflora*), island barberry (*Berberis pinnata* ssp. *insularis*), soft-leaved paintbrush (*Castilleja mollis*), island bedstraw (*Galium buxifolium*), Hoffmann's slender-flowered gilia (*Gilia tenuiflora* ssp. *hoffmannii*), Santa Cruz Island bushmallow (*Malacothamnus fasciculatus* var. *nesioticus*), Santa Cruz Island malacothrix (*Malacothrix indecora*), island malacothrix (*Malacothrix squalida*), island phacelia (*Phacelia insularis* var. *insularis*), and Santa Cruz Island fringepod (*Thysanocarpus conchuliferus*) were listed as endangered and Santa Cruz Island dudleya (*Dudleya nesiotica*) and island rush-rose (*Helianthemum greenei*) were listed as threatened on July 31, 1997 (61 FR 40954). They are all California Channel Island endemics. The only endemic species in this group that is not restricted to the four northern islands (Anacapa, Santa Cruz, Santa Rosa, and San Miguel) is the island rush-rose, which is also known from Santa Catalina Island. These species are all at risk of extinction primarily because of the introduction of nonnative mammals. The current number of populations for each taxon is displayed in Table 1.

Some of the most striking examples of extinction have occurred on islands. Notable extinctions on the Channel Islands have included the Santa Barbara Island song sparrow (*Melospiza melodia cooperi*) and Santa Cruz Island monkeyflower (*Mimulus brandegei*). Seventeen plant species have been extirpated from various islands within the northern island group: yellow sand-verbena (*Abronia latifolia*), soft-leaved paintbrush, island ceanothus (*Ceanothus megacarpus* ssp. *insularis*), mock heather (*Ericameria ericoides*), marsh gum-plant (*Grindelia stricta* ssp. *platyphylla*), coastal plantain (*Plantago subnuda*), and island redberry (*Rhamnus pirifolia*) from San Miguel; tower rockcress (*Arabis glabra*), sand cress (*Calyptridium monandrum*), large-leaved filaree (*Erodium*

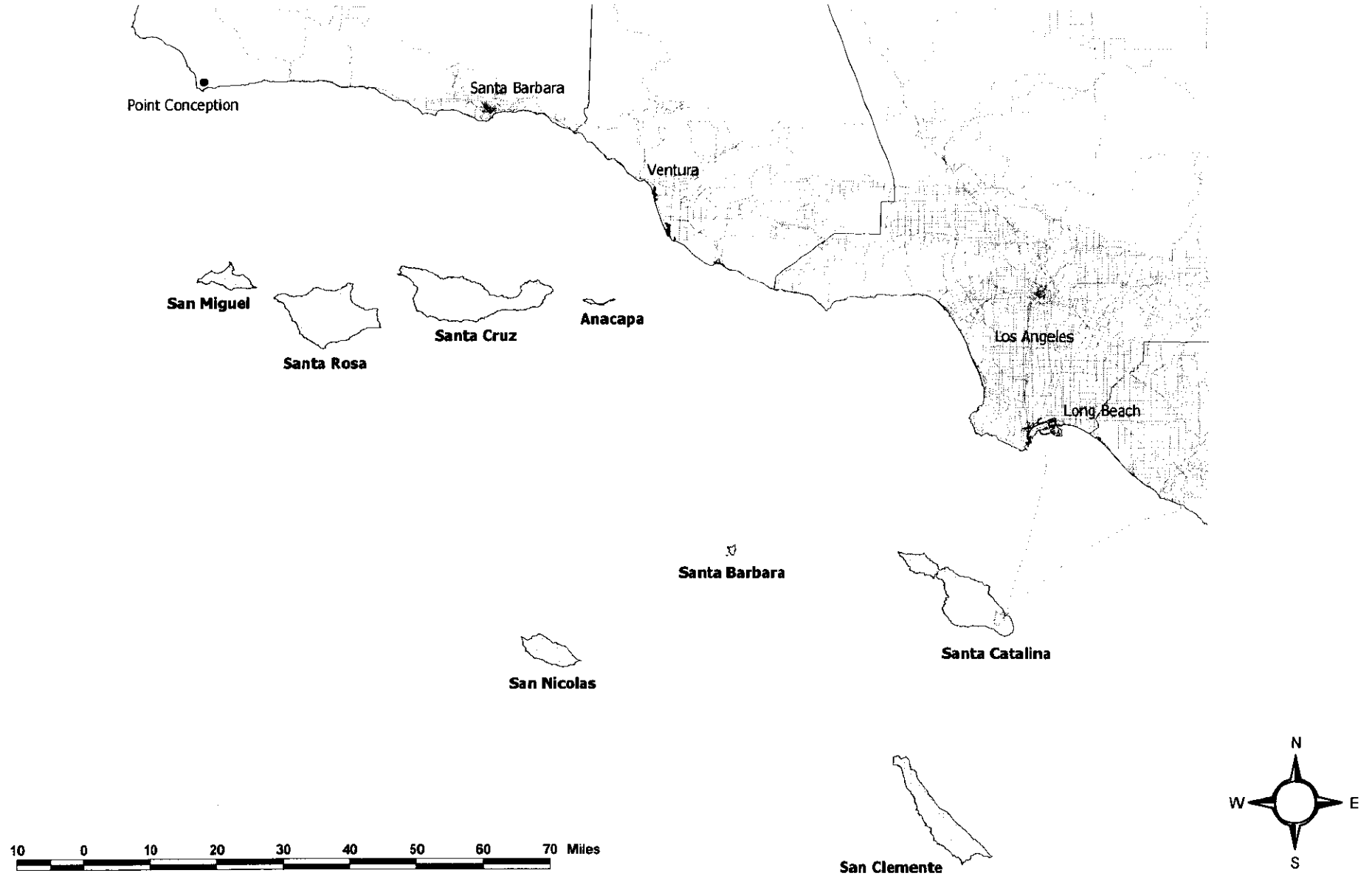

Figure 1. Map of the Southern California Bight

The California Channel Islands

U.S. Fish & Wildlife Service

Table 1. Current Number of Populations for each Taxon

TAXON	Status	POPULATIONS PER ISLAND				
		ANA	SCZ	SRO	SMI	TOTAL
Arabis hoffmannii	E	*	3	1		4
Arctostaphylos confertiflora	E			3		3
Berberis pinnata ssp. *insularis*	E	*	3	*		3
Castilleja mollis	E			2	*	2
Dudleya nesiotica	T		1			1
Galium buxifolium	E		8		2	10
Gilia tenuiflora ssp. *hoffmannii*	E			3		3
Helianthemum greenei	T		14	1		20[1]
Malacothamnus fasciculatus var. *nesioticus*	E		3			3
Malacothrix indecora	E		1	2	3	6
Malacothrix squalida	E	2	*			2
Phacelia insularis var. *insularis*	E			1	3	4
Thysanocarpus conchuliferus	E		1			1

ANA=Anacapa Island; SCZ=Santa Cruz Island; SRO=Santa Rosa Island; SMI=San Miguel Island.

*Historic site or possibly extirpated from that island.

[1] Additional populations (approximately 5) occur on Santa Catalina Island.

T = Threatened status under the Endangered Species Act.

E = Endangered status under the Endangered Species Act.

macrophyllum), dunedelion (*Malacothrix incana*), island malacothrix, Nuttall's scrub oak (*Quercus dumosa*), and Santa Cruz Island rock cress (*Sibara filifolia*) from Santa Cruz; Hoffmann's rockcress from Anacapa, island barberry from West Anacapa and Santa Rosa; and island rush-rose from Santa Rosa and San Miguel (Philbrick 1980, Halvorson *et al.* 1987, Clark *et al.* 1990, Junak *et al.* 1995, Junak *et al.* 1997).

1. *Island Geography*

Located offshore and south of Santa Barbara, the four northern islands (Anacapa, Santa Cruz, Santa Rosa, and San Miguel) are the highest points on a 130-kilometer (80-mile) long seamount (Dibblee 1982). They are included within the boundaries of the Channel Islands National Park. Anacapa Island (Figure 2) is the smallest of the four northern islands and includes three smaller islands, (referred to as East, Middle, and West Anacapa), which total 2.9 square kilometers (1.1 square miles). Anacapa Island is the closest island to the mainland at a distance of 20 kilometers (13 miles). East and Middle Anacapa Islands are flat-topped, wave-cut terraces largely surrounded by steep cliffs. West Anacapa Island is the highest of the three, reaching 283 meters (930 feet) above sea level. Santa Cruz Island (Figure 3) is the largest of the California Channel Islands covering an area of 249 square kilometers (96 square miles) with the highest point being 753 meters (2,470 feet) above sea level. Santa Rosa Island (Figure 4) is 217 square kilometers (84 square miles) in area and 475 meters (1,560 feet) at its highest point. San Miguel Island (Figure 5), the westernmost of the northern group, is 37 square kilometers (14 square miles) in area and 253 meters (830 feet) in height. Santa Catalina Island (Figure 6) lies about 113 kilometers (70 miles) to the southeast of the northern island group; it is 194 square kilometers (75 square miles) in area and its highest elevation is 648 meters (2,125 feet) (Power 1980).

2. *Island Ownership and Management*

The northern Channel Islands (Anacapa, Santa Cruz, Santa Rosa, and San Miguel) are within the boundaries of the Channel Islands National Park and are managed primarily by Federal agencies. Anacapa Island is managed by the National Park Service with an inholding for a U.S. Coast Guard lighthouse. The western 90 percent of Santa Cruz Island is privately owned and managed by The Nature Conservancy. The remaining 10 percent of the island is Federal land managed by the National Park Service. The Nature Conservancy is proposing to place the majority of the island in National Park Service ownership in the future, retaining only the central core of the island. Santa Rosa Island is managed by the National Park Service. San Miguel Island is under the jurisdiction of the U.S.

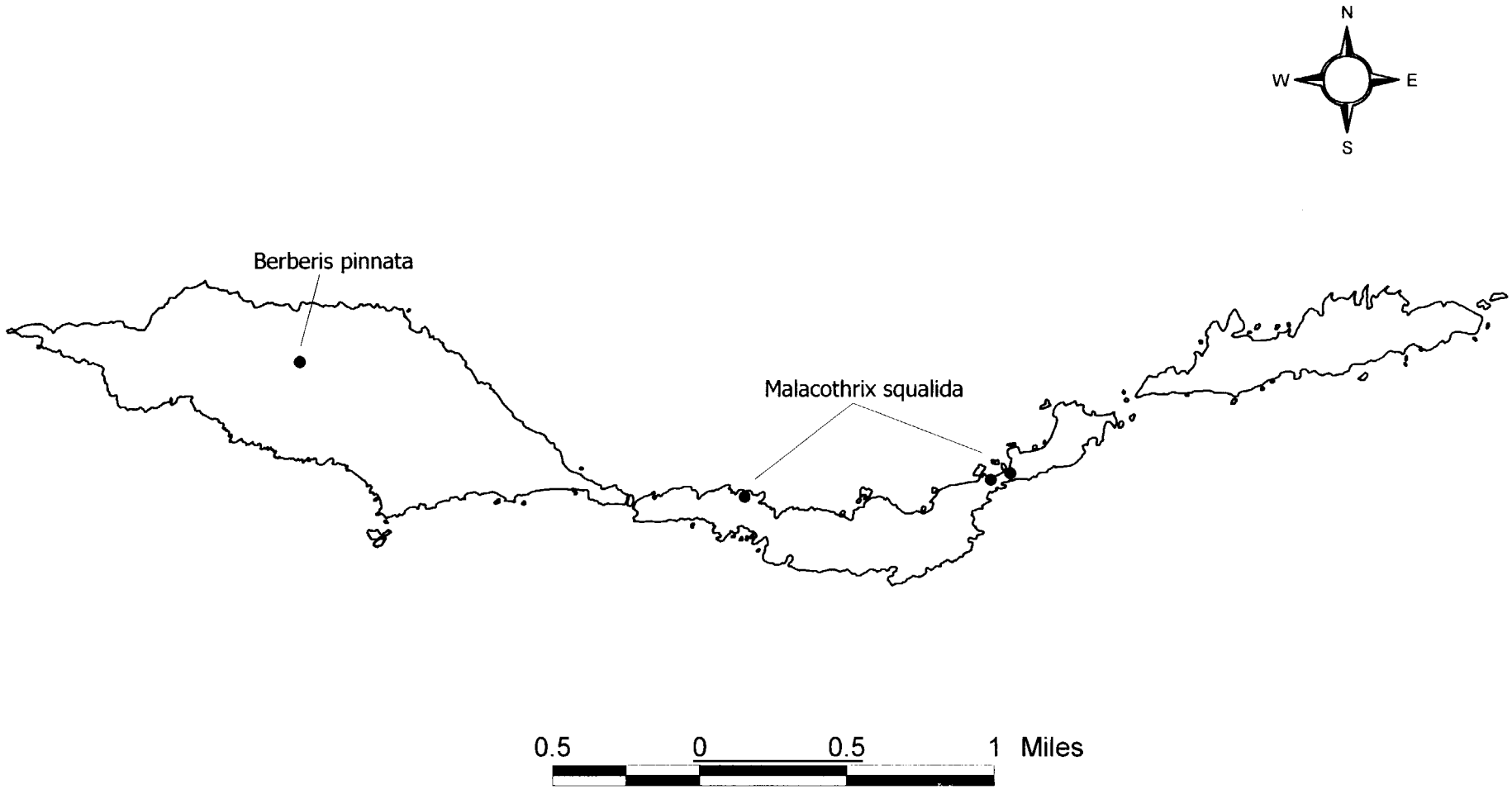

Figure 2. Map of Anacapa Island

Threatened and Endangered Plant Species Locations Anacapa Island, California

U.S. Fish & Wildlife Service

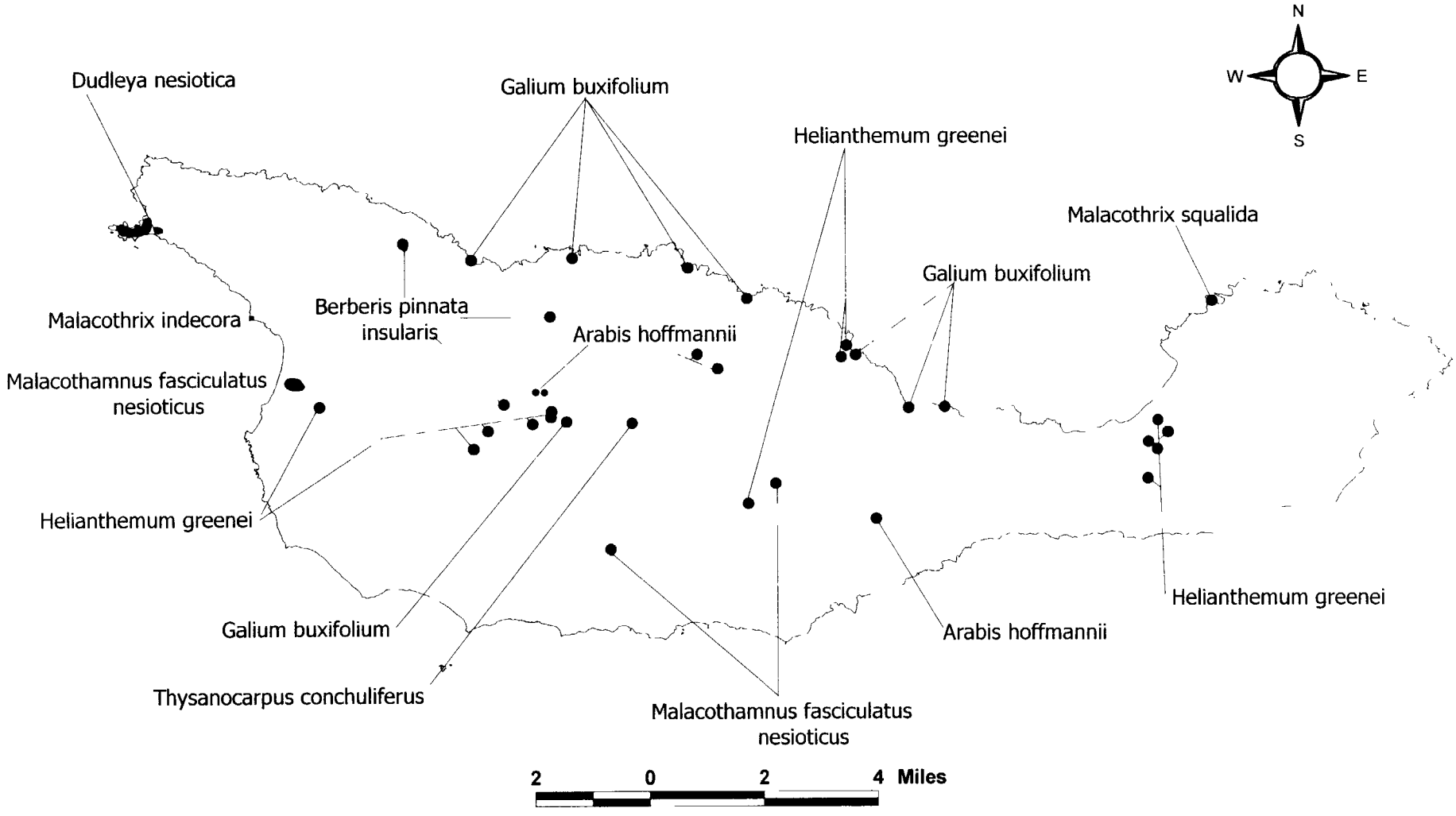

Figure 3. Map of Santa Catalina Island

Threatened and Endangered Plant Species Locations Santa Cruz Island, California

U.S. Fish & Wildlife Service

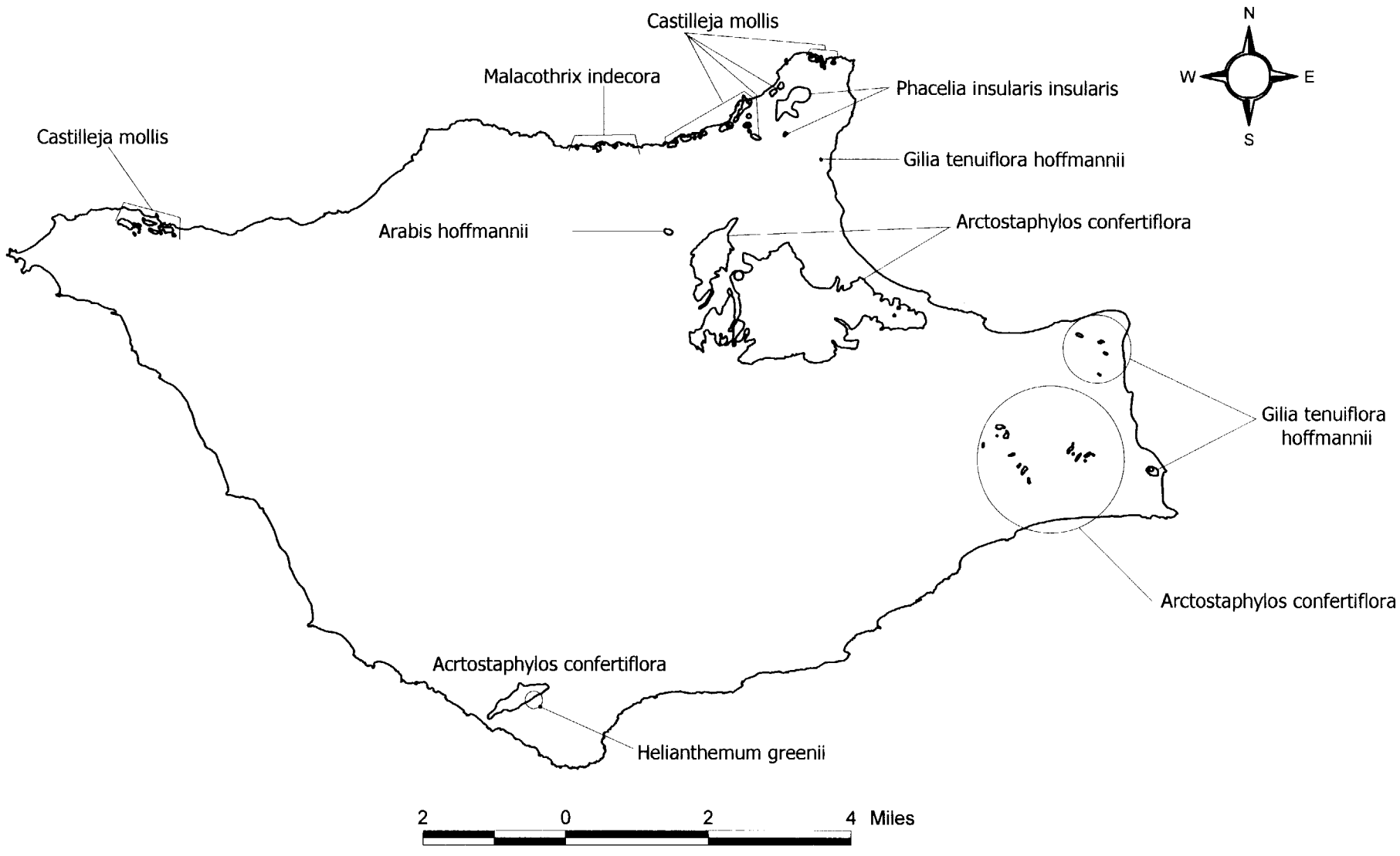

Figure 4. Map of Santa Rosa Island

Threatened and Endangered Plant Species Locations Santa Rosa Island, California

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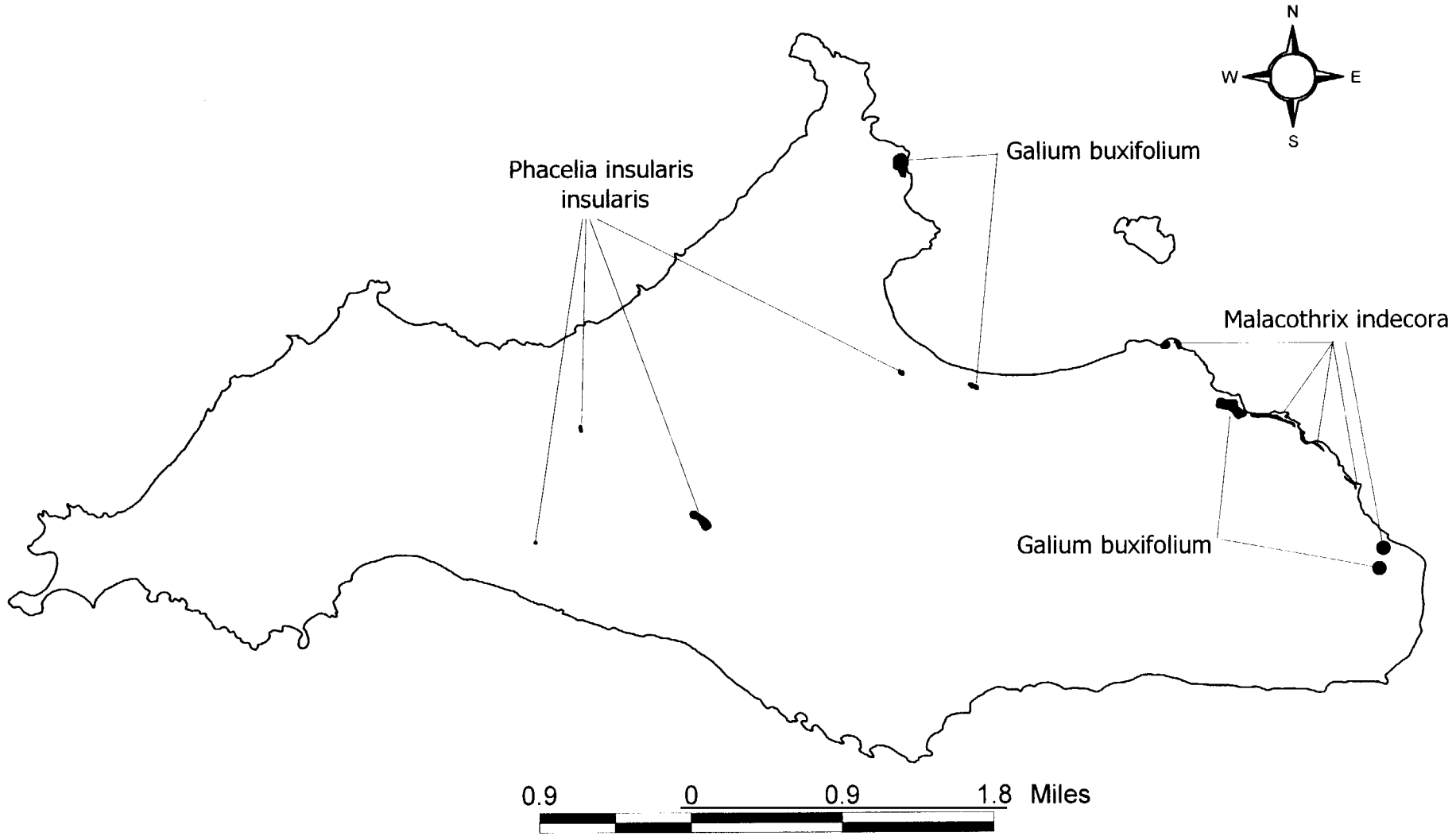

Figure 5. Map of San Miguel Island

Threatened and Endangered Plant Species Locations San Miguel Island, California

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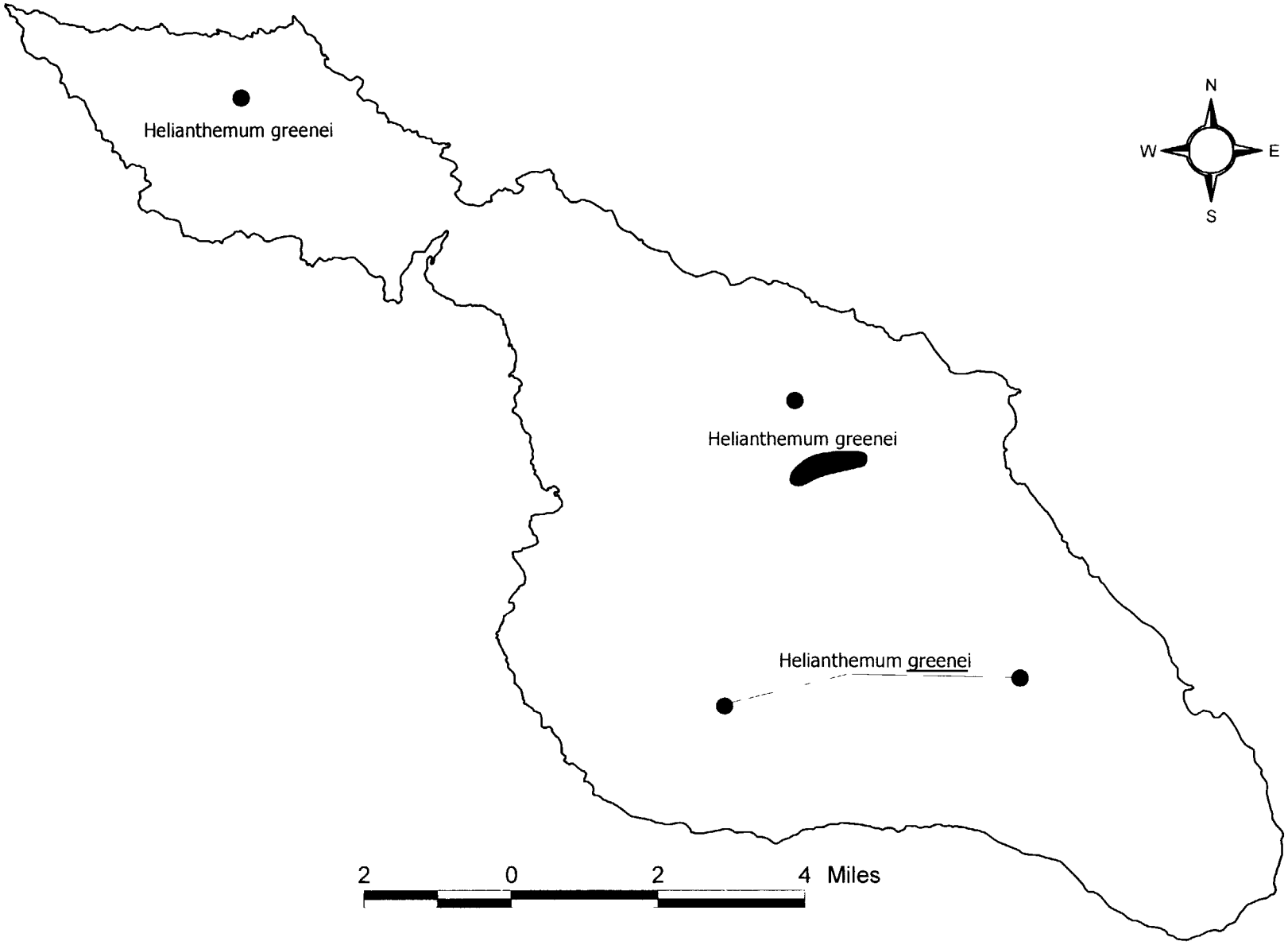

Figure 6. Map of Santa Catalina Island

Threatened and Endangered Plant Species Locations Catalina Island, California

U.S. Fish & Wildlife Service

Department of the Navy, but the National Park Service has operational jurisdiction through a Memorandum of Agreement. The Santa Catalina Island Conservancy owns about 88 percent of Santa Catalina Island.

Management of the islands by the National Park Service began in 1938 when Anacapa Island was designated (with Santa Barbara Island to the south) as a National Monument. In 1980, the U.S. Congress abolished the National Monument and incorporated its lands, waters, and interests into National Park status, adding Santa Cruz Island and Santa Rosa Island (then privately owned) within the boundaries. The National Park Service acquisition of Santa Rosa Island in 1986 was accomplished by outright fee purchase from the Vail and Vickers Ranching Company. A land use condition (private commercial deer and elk hunting operation) on Santa Rosa Island is under a 5-year renewable special use permit, which may continue until the year 2011.

In 1978 the Nature Conservancy bought 4,800 hectares (12,000 acres) of Santa Cruz Island from Dr. Carey Stanton (leasing it back to the Santa Cruz Island Company) and acquired a conservation easement on the remaining 17,000 hectares (42,000 acres) of the western part of the island. The Nature Conservancy acquired full title to all of the western portion in 1987 after the death of Dr. Stanton. The Nature Conservancy's general goals for preserve management include the preservation, protection, restoration, and understanding of the natural resources (R. Klinger, The Nature Conservancy, Santa Cruz Island, pers. comm. 1994). The National Park Service acquired the east end of Santa Cruz Island in February 1997.

3. *History of Land Use*

Prior to European occupation of California, the Channel Islands were populated by native Americans. By the early 1800's, the Spanish missionaries had forced the native Chumash Indians from the northern islands to the mainland (Hobbs 1983). Subsequently, land use practices on the islands focused on the introduction of a variety of livestock including sheep (*Ovis aries*), goats (*Capra hircus*), cattle (*Bos taurus*), pigs (*Sus scrofa*), burros (*Equus asinus*), and horses (*E. caballus*). Other alien mammal species were also introduced, including deer

(*Odocoileus hemionus*), elk (*Cervus canadensis roosevelti*), bison (*Bison bison*), rabbits (*Oryctolagus cuniculus*), wild turkey (*Meleagris gallopavo*), California quail (*Callipepla californica*), and chukar (*Alectoris chukar*) for ranching and hunting purposes (Hochberg *et al.* 1980a, Minnich 1980, Jones *et al.* 1989). On Santa Catalina Island, California quail are native and are considered an endemic island subspecies.

Pigs had been released on Santa Cruz Island by 1854 (Hobbs 1983). Records for Santa Cruz Island indicate that sheep had been introduced in the early 1830's; by 1875, when sheep stocking on Santa Cruz Island was around 50,000 head, botanist J.T. Rothrock reported that the island was so overgrazed that "it was with difficulty that I could get even a decent botanical specimen" (Hobbs 1983). In 1890, perhaps as many as 100,000 sheep grazed on Santa Cruz Island (Hochberg *et al.* 1980a). Droughts occurred in 1864, 1870 to 1872, 1877, 1893 to 1904, 1923 to 1924, 1935, 1946 to 1948, 1964, (Dunkle 1950, Johnson 1980) and most recently 1986 to 91 (Halvorson 1993). These episodes resulted in losses of livestock and other herbivores due to starvation. All of the islands have experienced intensive effects of grazing similar to Santa Cruz Island (Johnson 1980, Sauer 1988). Nearly 35,000 sheep were removed from Santa Cruz Island in 1989 (Schuyler 1993) and all of the pigs had been removed from Santa Rosa Island by 1993 (Lombardo and Faulkner 2000). Sheep have now been removed from all northern islands, though some remain on Santa Catalina Island. Pigs remain on Santa Cruz Island, and deer and elk remain on Santa Rosa Island.

4. *Land Use Effects on Plant Communities*

The introduction of alien herbivores to the islands has had catastrophic effects on island vegetation. Documented effects on plant communities include reduction in native species cover, density, and biomass; increase in cover, frequency, and biomass of nonnative species, particularly annual grasses and short-lived perennial herbs; lack of recruitment in dominant native woody species; elimination of the soil litter layer and loss of seed banks; excessive water runoff resulting from insufficient vegetative cover leading to soil erosion; soil compaction and degradation of soil structure; changes in the composition of soil microflora and microfauna; lowered or altered rates and patterns of nutrient

cycling; and loss of fire-induced successional communities due to inadequate fuels and lack of seed banks (Coonan *et al.* 1996).

Manipulation of the vegetation by more than 150 years of intensive grazing and browsing has resulted in the widespread conversion of native shrublands and perennial grasslands to communities dominated by nonnative annual grasses and weeds. Consequently, the areal extent of nonnative grasslands now exceeds that of other plant communities. Native plant communities are fragmented and discontinuous, with understories of alien grassland species (Minnich 1980, Hobbs 1983).

More than 180 non-native plant species have been documented from the northern island group, and the disruption of native habitats and displacement of native species by alien plants is a major concern for natural resource managers on the islands (Hochberg *et al.* 1979, Halvorson *et al.* 1987). Aggressive non-native weed species displace native species and further threaten the ecological integrity of the island ecosystems (Smith 1989, Simberloff 1990). Numerous aggressive non-native plants, including Australian fireweed (*Erechtites glomerata*), iceplants (*Carpobrotus* spp., *Mesembryanthemum* spp.), thistles (*Centaurea* spp., *Cirsium* spp., *Silybum* sp.), German-ivy (*Senecio mikanoides*), hoary cress (*Cardaria draba*), spiny clot-bur (*Xanthium spinosum*), and Russian thistle (*Salsola tragus*) pose threats to the island ecosystems. Fennel (*Foeniculum vulgare*) was noticed as a pest species prior to the removal of sheep and cattle from Santa Cruz Island as reported in Hobbs (1983). Grazing kept the plants from growing to their full height of 2 meters (6 feet), and since the removal of sheep and cattle the plant has "appeared" over large areas of the island. When fennel is not grazed and cropped close to the ground, its bright green foliage and bright yellow flowers are very conspicuous.

5. *Land Use Effects on Soils*

One of the primary threats to the species included in this recovery plan is the ongoing loss of soils because the soils are the foundation for the unique island ecosystems and their endemic species (Brumbaugh 1980, Hochberg *et al.* 1980a, Cole and Liu 1994). A significant increase in the rate of soil loss, resulting in

substantial alterations of the natural habitats of these species, began with the introduction of nonnative sheep, goat, cattle, deer, elk, bison, and pigs on the various islands in the early 1800's. Soil erosion continues at a rate that remains an order of magnitude greater than that prior to the introduction of alien mammals (Cole and Liu 1994). Soil loss is a significant threat to most existing populations of the listed species, and precludes seedling establishment.

The deep incision of many canyons on Santa Rosa Island illustrates the dramatic loss of sediment and, by inference, entire riparian systems that are virtually absent from the island. These incised canyons cut into fine-grained alluvium built up by thousands of years of deposition, and those incisions and the sedimentation have left a quantitative record of the continuing shift in geomorphic regimes resulting from large herbivores denuding the landscape (Cole and Liu 1994).

The increased loss of soils and the consequent changes in vegetation due to the introduction of alien mammals have been documented from sediment and pollen records in a soil core dating back 5,200 years from the Old Ranch Canyon marsh on eastern Santa Rosa Island (Cole and Liu 1994). Rates of sedimentation prior to the introduction of livestock averaged 0.7 millimeter per year (0.035 inch per year), increased to 23 millimeters per year (0.9 inch per year) during the peak sheep grazing era, and as of the early 1990's averaged 13.4 millimeters per year (0.13 inch per year), 19 times greater than that prior to grazing (Cole and Liu 1994).

Pollen records demonstrate that the conversion of brushland (including coastal sage scrub) to grassland occurred with the onset of ranching in the early 1800's. This change in vegetation is reflected by an increased abundance of grass pollen and a decrease in pollen from the mint and pea families in the soil core (Cole and Liu 1994). Coastal sage scrub is dominated by sage species (mint family), lupines (pea family), and deervetch (pea family). Shallow rooted nonnative grasses now dominate the island and are much less efficient as slope stabilizers than the deep-rooted native shrubs they have replaced.

A comparison of historical descriptions of island vegetation with current conditions also indicates that large-scale habitat alterations caused by large numbers of non-native mammals on the islands resulted in significant loss of soils, as well as changes in the structure, composition, and richness of plant communities. In 1883, Thompson and West described the effects of sheep grazing on Santa Cruz Island: "The island becomes at some times overstocked, and may be said to be in that condition much of the time. The result is that the grasses, being cropped so close, die out, and allow the loosened soil to be removed by wind and rain" (Hochberg *et al.* 1980a). At that time, however, vegetation elsewhere on the island was still relatively intact; Greene described mixed forests of large-leaved maple (*Acer macrophyllum*), live oak (*Quercus agrifolia*), black cottonwood (*Populus trichocarpa*), and willow (*Salix laevigata*) thriving in the canyons (Hochberg *et al.* 1980a). Another account was given by Delphine Adelaide Caire in 1933, who reflected on the conditions of Santa Cruz Island, "Its present natural beauty does not come up to that of the past. The bed of the stream that skirts the Main Ranch on its way from Picacho Diablo was much narrower than it is today; mountain slopes were heavily wooded and centuries-old oaks were numerous. In the course of years, rains have accomplished their ruinous work, carrying off a great amount of topsoil, the innumerable trails cut by sharp sheep trotters having been a contributing factor in such devastation" (Hochberg *et al.* 1980a). The historic and current presence of non-native herbivores and pigs has reduced leaf litter and compacted and degraded the soil structure, resulting in accelerated rates of erosion (Klinger *et al.* 1994, Nishida 1994).

The importance of soils in maintaining habitat for the taxa is found not only in their physical properties, but in their biotic properties as well. Healthy soils provide habitat for a complex assemblage of soil organisms, including fragile microbial components, which assist in such processes as water-holding capacity, soil fertility, and nutrient cycling. These processes have been adversely affected by the activities of alien mammals. For instance, the loss of leaf litter from trampling and rooting changes soil temperatures, increases the loss of moisture, reduces the humus layers, and results in a reduced soil fauna (Bennett 1993). Breakdown of organic material, transport of fungal spores, and nutrient recycling by soil mites have all been documented on Santa Catalina Island (Bennett 1993).

Soil mite diversity decreases with increased disturbance, resulting in impoverished nutrient levels in the soil (Bennett 1993). A feature of arid land soils, such as those in the islands, is the presence of a cyanobacterial-lichen crust that facilitates stabilization of steep slopes and nutrient cycling (Belnap 1994). These crusts are extremely brittle during the dry summer months and can be eliminated by the shattering influences of trampling by non-native herbivores (Belnap 1994). Mycorrhizal associations (fungus symbiotically associated with roots) are likely to occur with most of the species in this recovery plan (E. Painter *in litt.* 1997). Such associations function as extensions of the root system and are of particular importance to arid land plant species such as those in this recovery plan. Overgrazing, trampling, and erosion damage and reduce the efficiency of mycorrhizal associations, thus reducing the health and vigor of their host species.

Herds of grazing animals shatter the crustal integrity of the soil surface and cause dust to coat the foliage of native vegetation. Dust negatively affects plants by reducing photosynthesis, respiration, transpiration, and complicating pollination efficiency (E. Painter *in litt.* 1997). Also, intense winds that blow from the northwest can be highly erosive. When the integrity of the natural habitat is disturbed, erosion rates are accelerated beyond the normal effects of rainfall. Continual nonnative animal disturbance prevents leaf litter or soil from accumulating on exposed ridge tops (Clark *et al.* 1990).

Even after the agents that initiated erosion have been removed, loss of soils continues (Clark *et al.* 1990, Halvorson 1993). Because both the biotic and physical properties of the soils have been degraded or lost altogether, the soils that remain behind provide poor conditions for seedlings to germinate and establish. On Santa Rosa Island, a grove of island oaks (*Quercus tomentella*), a species of special concern, has shown few signs of regeneration on soils severely affected by erosion even after an exclosure was built to eliminate cattle, elk, and deer (Danielsen 1989a, 1989b).

Wherever the lower branches of Santa Rosa Island manzanita shrubs have been browsed to form a canopy, the understory is heavily trampled by deer and elk, and the bedrock is eroding away around the roots (McEachern 1996, McEachern and Wilken 1996). The soil from around the roots of island barberry,

Santa Cruz Island dudleya, and Santa Cruz Island bushmallow on Santa Cruz Island is actively eroding (D. Wilken *in litt.* 1997). Santa Cruz Island dudleya plants at Fraser Point on Santa Cruz Island were observed to have been preferentially rooted by pigs in 1995 and 1996 (E. Painter *in litt.* 1997, McEachern 1996, Wilken 1996). In 1993, perhaps as much as 20 percent of the Carrington Point populations of soft-leaved paintbrush were browsed by deer and individual plants were excavated, leaving depressions in the sandy soils where plants had been observed 5 months earlier (S. Chaney, National Park Service, pers. comm. 1993). More recently, researchers have documented that both deer and elk are damaging both populations of soft-leaved paintbrush (McEachern 1996). Island bedstraw is threatened on Santa Cruz Island where trampling and pig rooting along the sea cliffs increases the likelihood of slope failure (Hochberg *et al.* 1980b). All island rush-rose habitat on Santa Cruz Island is damaged from rooting by pigs (D. Wilken *in litt.* 1997). The recent discovery of Santa Cruz Island malacothrix on Santa Rosa Island included the observation that the prehistoric midden that the plants were growing on was being eroded from damage by livestock (E. Painter *in litt.* 1997).

6. *Native Island Vegetation*

The plant species of the islands have a variety of origins that include relict populations of formerly more widely ranging species such as the endemic island ironwoods (*Lyonothamnus floribundus*), island mallows (*Lavatera assurgentiflora*), and disjunct species such as the Torrey pine (*Pinus torreyana*). Such species typically occur in canyons and on slopes with more moderate environments than those that prevail in surrounding areas. Island endemics, including all of the species in this recovery plan, have been discussed by Raven (1967), Philbrick (1980), and Wallace (1985). Fifty-four island endemic plant species are known from the northern Channel Islands; 21 species are single island endemics (Halvorson *et al.* 1987; Junak *et al.* 1997).

The main native habitat types on the islands include coastal dune, coastal bluff (cliff), coastal sage scrub, grasslands, chaparral, cactus, oak and ironwood woodlands, riparian woodlands, and conifer forest; various subdivisions of these habitat types on the islands have been described by Dunkle (1950), Philbrick and

Haller (1977), Minnich (1980), Clark *et al.* (1990), and Coonan *et al.* (1996). The beach and associated coastal dune habitat occur in the windiest sandy locations on the three westernmost islands. These coastal habitats appear to be relatively undisturbed compared to mainland sites where development and recreation have largely eliminated them. Coastal bluff habitat has provided a refugium for many plants from grazing by non-native animals (Minnich 1980, Halvorson *et al.* 1992).

The upland habitats were formerly shrub-dominated and included coastal sage scrub and chaparral habitats. Historic reports indicate that these upland habitats were impenetrable (Hochberg *et al.* 1980a). Comparison of current landscapes with historical photographs reveals a significant loss of woody (tree and shrub) vegetation from the islands during the last 100 years (Hobbs 1980, Minnich 1980). Coastal sage scrub habitat is composed of soft-leaved, soft-stemmed plants that are easily broken by trampling and palatable to both browsers and grazers. The original coastal sage scrub habitat has been reduced by overgrazing to the extent that it persists only in locations inaccessible to grazing and browsing animals, such as cliffs and marginal habitat in patches of cactus (Minnich 1980, Hobbs 1983, E. Painter *in litt.* 1997, Corry and McEachern 2000). Coastal sage scrub habitat has increased in extent on Anacapa and San Miguel Islands since the removal of grazing (Johnson 1980). Coastal sage scrub recovery on Santa Cruz Island is compromised with the continued presence of pigs on the entire island.

The structure of the remnant chaparral habitats has also been modified by grazing and browsing; the shrub component of the chaparral habitat currently forms arborescent (treelike) shapes or in some areas, extremely low, prostrate forms. Some ridge top chaparral is naturally low growing due to the high wind shear. Continued browsing by deer and elk on Santa Rosa Island has created an open 'skeleton' community reticulated (net-patterned) by game trails that provide access to nearly 100 percent of the habitat (Hochberg *et al.* 1980a; T. Thomas, U. S. Fish and Wildlife Service, pers. obs., 1993). Grasslands are largely composed of non-native annual species, and have greatly expanded at the expense of most other habitat types (Hobbs 1983, Cole and Liu 1994).

The pre-grazing importance of cactus in the island cactus communities will never be known. The ranchers considered 40 percent of the rangeland on Santa Cruz Island to be useless for grazing because of the spread of cactus, which was facilitated by overgrazing (Hochberg *et al.* 1980a). Cactus habitats on Santa Cruz and Santa Rosa Islands have been dramatically reduced to improve cattle operations by the introduction of biological controls (Hochberg *et al.* 1980a; F. Gherinni, former owner of East Santa Cruz Island, pers. comm. 1998).

The oak and ironwood woodlands are characterized by unique endemic plant species and have also been heavily affected by grazing, browsing, and rooting animals seeking summer shelter and food (Clark *et al.* 1990, Halvorson 1993). Riparian woodlands are heavily modified physically and structurally, and in some areas they have been eliminated (Hochberg *et al.* 1980a, Minnich 1980). In the absence of excessive grazing and browsing, a canyon with year-round water would have well-developed riparian vegetation that includes willows (*Salix* spp.), cottonwoods (*Populus* spp.), and oaks (*Quercus* spp.). This vegetation would typically support a rich diversity of organisms, especially neotropical migratory bird species, but years of overutilization by introduced mammals have all but eliminated this formerly resource-rich habitat.

The conifer forest habitat is made up of bishop pine (*Pinus muricata*) and Santa Rosa Island torrey pine (*Pinus torreyana insularis*). The bishop pine forests on Santa Cruz Island that were protected from grazing have well-developed ground litter and reproduction (Hobbs 1978). In contrast, Clark *et al.* (1990) reported that bishop pine forests on Santa Rosa Island that were subjected to grazing lack the protective nutrient layer of ground litter and exhibit no reproduction. The Santa Rosa Island torrey pine forms a community on the eastern edge of Santa Rosa Island that is relatively intact.

Pigs, cattle, deer, elk, goats, sheep, horses, and bison continue to threaten, and further degrade, whole ecosystems on the California islands (Sauer 1988, Halvorson 1993). Many of the taxa in this recovery plan survive only in areas that are inaccessible to the introduced alien ungulates; many of the sites where they persist comprise marginally suitable (highly erodible and unstable) habitat which makes their persistence even more tenuous (E. Painter *in litt.* 1997).

Fire frequencies have probably been altered through the reduction of fuels by intensive grazing and ranching practices. The large scale loss of woody vegetation occurred concurrently with the introduction of nonnative grasses. These grass-dominated landscapes have been constantly reduced to stubble by grazing. The removal of grazing results in a fuel load of tall grass, where wildfire is capable of quick, flashy ignition and spread. These grasses and resulting fuel conditions were never previously present on the islands. Several species of plants on the islands that are adapted to fire have experienced a reduction of seed production and loss of soils and seed banks due to years of overgrazing. Many chaparral plant species maintain banks of dormant seeds in the soil. Several of those species germinate only following a fire event that destroys the adult members of the population. It takes 5 to 7 years for plants to produce an adequate seed bank to recreate a pre-fire population structure. If fires burn through stands of native vegetation that have not regained sufficient capability to reproduce after a fire, those species will be threatened with local extirpation. If fire occurs on islands where nonnative mammals are still present, seedling recruitment would be vulnerable to grazing and browsing.

B. SPECIES ACCOUNTS

1. Hoffmann's rock-cress (*Arabis hoffmannii*)

(Recovery Priority Number 2)[1]

Description and Taxonomy

Hoffmann's rock-cress was described by Philip Alexander Munz as *Arabis maxima* var. *hoffmannii* in 1932 based on specimens collected by Ralph Hoffmann at the "sea cliffs east of Dick's Harbor," now known as Platts Harbor, on Santa Cruz Island in 1932 (Rollins 1936). T.S. Brandegee had collected this rock-cress as early as 1888 from an unspecified location on Santa Cruz Island. In 1936, Reed Clark Rollins elevated the taxon to species status by publishing the name *Arabis hoffmannii*. This nomenclature was retained in the most recent treatment of the genus (Rollins 1993).

Hoffmann's rock-cress is a member of the mustard (Brassicaceae) family. It is a slender herb that lives for several years, flowers, and then dies. The one to several stems reach 0.6 meter (2.0 feet) high and have slightly toothed basal leaves. The white to lavender flowers, with four petals 1 centimeter (0.4 inch) long, are found at the tips of the stems. The slightly curved fruits (siliques) are borne on long stalks. The only other rock-cress that occurs on the islands, tower rock-cress (*Arabis glabra* var. *glabra*), is a taller plant with cream-colored flowers.

Distribution and Population Status

Hoffmann's rockcress has been reported from three islands: Anacapa, Santa Cruz, and Santa Rosa. Since Brandegee's collection in 1888, few

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[1] We prioritize recovery actions by directing resources first to species facing a high (versus moderate or low) degree of threat, with high (versus low) potential for recovery, and to species with a high level of taxonomic distinctiveness. A species that is the only existing member of its genus comes before a species in a genus consisting of more than one species, which comes before a subspecies or variety. The highest priority is 1, the lowest is 18. The priority system was presented in the November 15, 1983, Federal Register, vol. 48 (221), page 51985.

collections of Hoffmann's rock-cress have been made. On Santa Cruz Island, Reid Moran made a collection from the "Central Valley" in 1950 and McPherson collected the plant near Centinela Grade, possibly the same location, in 1967 (Junak *et al.* 1995). It was not until 1985 that Steve Junak relocated a population at this location (Schuyler 1986). For many decades, Hoffmann's original collection site, near Platts Harbor on Santa Cruz Island, was in "an area of intense feral animal (sheep) disturbance," and no plants could be found (Hochberg *et al.* 1980a). In fact, in 1983, we published in the Federal Register (48 FR 53640) a notice of review that considered this species to be extinct. However, surveys conducted by The Nature Conservancy in 1985 were successful in locating the plant in upper Platts Canyon (Schuyler 1986).

According to Moran's field notes, he collected Hoffmann's rock-cress from Anacapa Island in 1941 "on the slopes above Frenchy's Cove" (S. Junak, Santa Barbara Botanic Garden, pers. comm. 1993). However, no specimens from this collection have been found and surveys conducted in the early 1990's failed to relocate the plant on Anacapa Island (S. Junak, pers. comm. 1993).

Hoffmann reported the plant from "the bank above Water Canyon" on Santa Rosa Island in 1930, but numerous recent surveys have failed to locate any plants from that location (McEachern 1996). In 1996, a new population of the plant was discovered on a rock shelf in middle Lobo Canyon on Santa Rosa Island (McEachern 1996, Wilken 1996). Several similar rock shelf habitats upstream and downstream from the one known site in Lobo Canyon were surveyed with no observable occurrences.

Hoffmann's rock-cress is known from three small populations that collectively cover less than 0.4 hectare (1 acre) on Santa Cruz Island. One of these three populations, near Platts Harbor, is located on rocky volcanic cliffs along a north-facing canyon on lands owned by The Nature Conservancy. Because of inaccessibility and the loose structure of the volcanic rock, the cliff site has not been thoroughly surveyed. Only a few dozen plants have been directly observed, but the cliffs may support additional individuals. When Junak relocated the population near Centinela Grade, approximately 30 individuals were seen. The Nature Conservancy has monitored this population since 1990, with

fewer than 30 plants observed each year (Klinger 1994a; R. Klinger, pers. comm. 1998). The third population on Santa Cruz Island was located in 1995 near Stanton Ranch and consisted of 16 plants as of 1996 (Wilken 1996). The Santa Rosa Island population consisted of eight plants, three of which were flowering and the remaining five of which were vegetative rosettes. No plants were observed on Santa Rosa Island in 1998 (National Park Service field data, Channel Islands National Park, 1998).

Habitat Description

The Centinela Grade population is growing on Santa Cruz Island volcanics and is associated with giant coreopsis (*Coreopsis gigantea*), Santa Cruz Island buckwheat (*Eriogonum arborescens*), island hazardia (*Hazardia detonsus*), and coastal prickly pear (*Opuntia littoralis*). The Santa Rosa Island population is located on a rocky shelf overhanging the canyon and is growing with giant coreopsis, Greene's dudleya (*Dudleya greenei*), red buckwheat (*Eriogonum grande* ssp. *rubescens*), indian pink (*Silene laciniata*), and nonnative grasses.

Life History

Recent research by Wilken (1996) on reproductive strategies of Hoffmann's rock-cress shows that individual plants in cultivation may reproduce within 2 years following establishment, with some plants surviving for at least 5 years. Individual rosettes are monocarpic (flower once then die), but some plants have more than one rosette. Hoffmann's rock-cress does not appear to be dependent upon pollinators for seed set, and individual plants may produce as many as 3,000 to 4,000 seeds. However, the small sizes of natural populations indicate that establishment success of new plants is low. Monitoring results at two sites on Santa Cruz Island (Centinela and Stanton) suggest poor establishment success because of a lack of favorable seed germination sites, a high rate of seedling mortality, or a combination of both factors (Wilken 1996). At these two sites, surviving plants tend to be found in the shade of shrubs where the cover of annual species is low, suggesting that Hoffmann's rock-cress cannot tolerate competition with a high cover of annual species. Fewer than 100 plants in total were present in the 3 studied populations (Wilken 1996).

Threats

The major threats to Hoffmann's rock-cress are loss of soil, loss of shrub canopy cover, trampling of potential seed germination sites by nonnative ungulates, predation resulting from feral pig rooting, and competition with annual plants. The species is also threatened by extinction from random naturally occurring events due to its limited distribution.

2. **Santa Rosa Island manzanita (*Arctostaphylos confertiflora*)**
(Recovery Priority Number 2)

Description and Taxonomy

Santa Rosa Island manzanita was described as *Arctostaphylos confertiflora* by Eastwood in 1934 from a collection made by Hoffmann 4 years earlier "in a sheltered dell south of Black Mountain" on Santa Rosa Island (Eastwood 1934). Munz (1958) published the new combination *Arctostaphylos subcordata* var. *confertiflora*. However, in subsequent treatments of the genus, Wells (1968, 1993) has continued to use the original taxonomy.

Santa Rosa Island manzanita is a perennial shrub in the heath (Ericaceae) family that grows 0.1 to 2.0 meters (4 inches to 6.5 feet) high, sometimes reaching as high as 6 meters (20 feet) (Wells 1993; Parker and Vassey *in litt.* 1998) (Figure 7). Santa Rosa Island manzanita occurs in prostrate and upright forms, the former most likely due to climatic influences and herbivory (McMinn 1951). The plant has smooth, dark red-purple bark and densely hairy-glandular branchlets and flower stalks. The leaves are light green, round-ovate with cupped margins. The flowers occur in dense clusters that mature into flattened reddish-brown fruits (McMinn 1951). Another manzanita on Santa Rosa Island, *Arctostaphylos tomentosa*, has three subspecies. These are differentiated from *A. confertiflora* and each other by variously having long, stiff hairs or no glandularity (*A. t.* ssp. *crustacea* - long, nonglandular hairs; *A. t.* ssp. *insulicola* - pubescent, nonglandular hairs; *A. t.* ssp. *subcordata* - long, glandular hairs).

Distribution and Population Status

Surveys of potential habitat by U.S. Geological Survey Biological

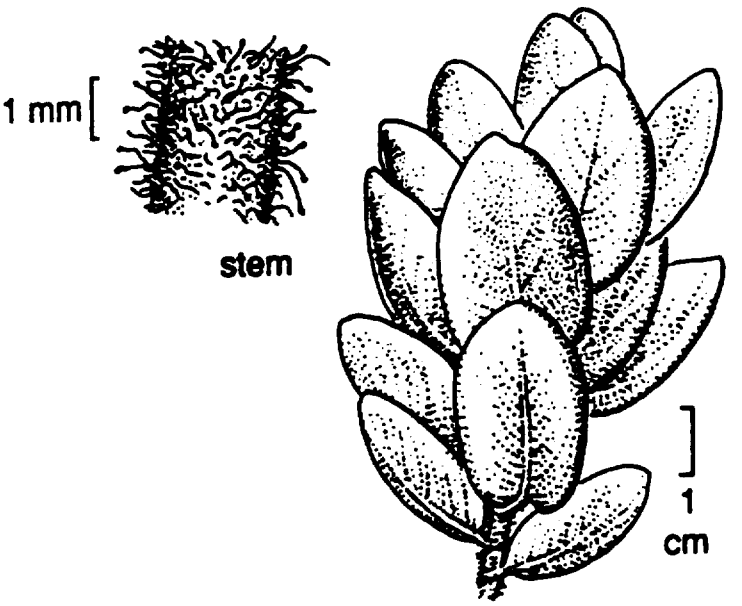

Figure 7. Illustration of Santa Rosa Island manzanita *(Arctostaphylos confertiflora)*. Copyright by the Regents of the University of California, reproduced with permission of the Jepson Herbarium, University of California.

Resources Division staff in 1996 through 1998 have reported Santa Rosa Island manzanita from three areas on Santa Rosa Island; the north-east side of Black Mountain (less than 300 plants) combined with the Torrey Pine vicinity (less than 100 plants), the canyons on the south-east side of the island (less than 1,000 plants), and in the vicinity of South Point (approximately 200 plants).

Habitat Description

The plant is found on sedimentary substrates of Monterey shales and soft sediments derived from San Miguel volcanics (Weaver *et al.* 1969). Near the southern tip of the island, a few individuals are scattered on the slopes above South Point on sandstone outcrops. The taxon occurs as a component of mixed chaparral, mixed woodland, Torrey pine woodland, and island pine woodland communities.

Life History

Currently, little is known about the life history of this species. The Santa Rosa Island manzanita reproduces or spreads only by seeds (obligate seeder) and requires fire for regeneration.

Threats

Santa Rosa Island manzanita is threatened by an altered fuel characteristic, soil loss, low reproductive success, and herbivory by elk and deer that has contributed to reproductive failure. This species possibly requires fire for recruitment. The life history strategy for obligate seeding manzanita species results in adult plants being killed by fire, and recruitment depends on a seed bank that responds to fire stimulus for germination. Currently the seed bank is either absent or so depleted as a result of soil loss that a fire could eliminate the species. If a fire were to occur and prompt germination of seeds, the seedlings might not successfully establish themselves due to the high potential for browse predation from deer. Ungulates have access to more than 90 percent of the plants (McEachern 1996). Despite the steepness of the slopes, deer and elk are capable of traveling along trails which provide access to various portions of the populations. Observed shrubs have had recent twig growth (flowers and fruit) browsed off by deer, and no seedlings or young plants have been observed. Researchers observed that elk and deer bed down in the shade of larger shrubs,

including Santa Rosa Island manzanita, causing compaction and erosion of soils, and exposing the roots of the plants (McEachern and Wilken 1996).

3. Island barberry (*Berberis pinnata* ssp. *insularis*)

(Recovery Priority Number 3)

Description and Taxonomy

Island barberry was described as *Berberis pinnata* ssp. *insularis* 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." Roof (1981) included this taxon in the genus *Mahonia* because the leaves are compound, in contrast with the simple leaves of *Berberis*. However, Moran (1982) made the case that this one character was insufficient to defend *Mahonia* as a distinct natural group, and many subsequent treatments have included all North American taxa previously referred to as *Mahonia* as *Berberis*. Recent treatments for this taxon have all maintained the name *Berberis pinnata* ssp. *insularis* (Munz 1974, Smith 1976, and Williams 1993).

Island barberry is a perennial shrub in the barberry family (Berberidaceae) (Figure 8). The plant has spreading stems that reach 2 to 8 meters (5 to 25 feet) high, with large leaves divided into five to nine glossy green leaflets. Clusters of yellow flowers at the branch tips develop into blue berries covered with a white, waxy coating.

Distribution and Population Status

Island barberry has been reported from three islands: Anacapa, Santa Cruz, and Santa Rosa. In a letter to R. Hoffmann in 1932 concerning Island barberry, P. Munz remarked that, "Brandegee says of *B. pinnata*, that it is 'common' on S.C. [Santa Cruz]" (S. Junak *in litt.* 1994). Island barberry is currently known from three small populations in moist, shaded canyons on Santa Cruz Island. Hoffmann found several individuals "in Elder canyon that runs from west into Cañada de la Casa" on Santa Rosa Island in 1930 (California Natural Diversity Data Base 1998). No plants have been found on Santa Rosa Island since then despite surveys by staff from the U.S. Fish and Wildlife Service, National Park Service, Biological Resources Division, and Santa Barbara Botanic Garden

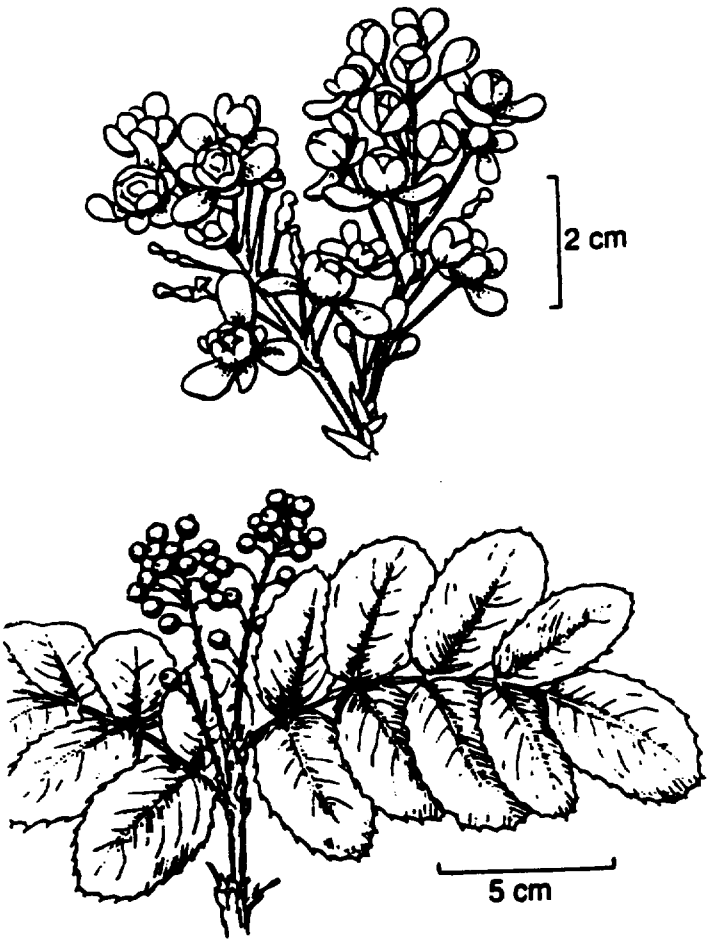

Figure 8. Illustration of island barberry (*Berberis pinnata* ssp. *insularis*). Copyright by the Regents of the University of California, reproduced with permission of the Jepson Herbarium, University of California.

between 1993 and 1998. Dunkle collected island barberry on West Anacapa Island in 1940, but the plant was not found there again until 1980, when one clone (several stems representing one genetic individual) was found in Summit Canyon. In 1994, Junak, Halvorson, and Chaney visited this site and found that the clone had died (Chaney 1994); the plant is therefore believed to be extirpated from Anacapa Island.

The three populations of island barberry occur on Santa Cruz Island. One population on the north slope of Diablo Peak comprises 24 large stems and 75 small stems (Klinger 1994b); this number of stems may represent one or several clonal individuals. In 1979, a second population near Campo Raton (Cañada Cristy) was estimated to be fewer than 10 individuals, but in 1985, only 1 plant was seen (California Natural Diversity Data Base 1998). Habitat for the plant was systematically searched recently in the Campo Raton area, and two individuals were located. Both plants were in danger of being uprooted from erosion. Only one plant flowered, but it did not set fruit (D. Wilken *in litt.* 1997). The third population (believed to be a single plant), at Hazard's Canyon, has been determined to consist of approximately 20 stems (S. Junak, pers. comm. 1998).

Habitat Description

On West Anacapa Island, island barberry was reported to be associated with chaparral species including poison oak (*Toxicodendron diversilobum*), monkeyflower (*Mimulus aurantiacus*), coyote bush (*Baccharis* sp.), goldenbush (*Hazardia detonsus*), island alum-root (*Heuchera maxima*), and wild cucumber (*Marah macrocarpus*) (Chaney 1994). On Santa Cruz Island, it is known from north facing, rocky slopes in chaparral, oak woodlands, and pine forests (Junak *et al.* 1995).

Life History

Recent research indicates that, although pollen from the same plant is able to produce fertile seeds (genetically self-compatible), it requires insect visitation for pollination. Each flower produces from 2 to 3 seeds; however, in seed germination experiments, only 8 out of 40 seedlings survived long enough to produce secondary leaves (Wilken 1996). Observations in 1996 on the single

plant in upper Cañada Christy indicated that, of more than 100 flowers that were in bud in January, only 7 immature fruit had developed by May (Wilken 1996).

New shoots can sprout from underground stems (rhizomes). Therefore, many stems may actually represent one genetic clone (Hochberg *et al.* 1980b, California Native Plant Society 1984, Williams 1993).

Threats

Island barberry is threatened by soil loss and habitat alteration caused by feral pig rooting, and lack of successful sexual reproduction (no new plants). The species is also threatened by extinction from random naturally occurring events due to its limited distribution.

4. Soft-leaved paintbrush (*Castilleja mollis*)
(Recovery Priority Number 2)

Description and Taxonomy

This species was described by Pennell as *Castilleja mollis* in 1947, based on material collected on Santa Rosa Island in 1939 (Ingram 1990, Heckard *et al.* 1991). Hoover (1970) and Munz and Keck (1973) included plants of coastal sand dunes of San Luis Obispo County in the description of this taxon. However, the taxon is now considered to be endemic to Santa Rosa Island (Ingram 1990, Heckard *et al.* 1991).

Soft-leaved paintbrush is a partially parasitic perennial herb in the figwort (Scrophulariaceae) family (Figure 9). The plant has semi-prostrate branches that reach 40 centimeters (16 inches) in length, it has specialized leaves (bracts) and upper leaves that are grayish, fleshy, broad, rounded, and crowded at the apex; the bract and calyx are yellow to yellowish green above (Heckard *et al.* 1991). Ingram (1990) identified several morphological differences between soft-leaved paintbrush and the similar chaparral Indian paintbrush (*Castilleja affinis*), including the indument (covering) of distinctive branched hairs and rounded stem leaves in the former taxon. Observations by Rindlaub (1995) and Biological Resources Division staff (McEachern 1996) indicate that individuals at higher

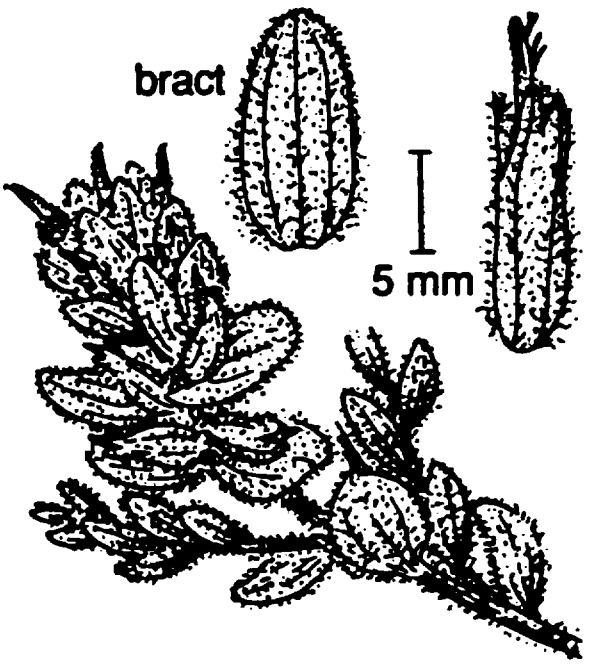

Figure 9. Illustration of soft-leaved paintbrush (*Castilleja mollis*). Copyright by the Regents of the University of California, reproduced with permission of the Jepson Herbarium, University of California.

elevations at one site (Carrington Point) may represent hybrids between *C. affinis* and *C. mollis*.

Distribution and Population Status

Soft-leaved paintbrush has been reported from two islands: San Miguel and Santa Rosa. Two specimens collected from Point Bennett on San Miguel Island by Elmore in 1938 are possibly soft-leaved paintbrush (Wallace 1985; Heckard *et al.* 1991). Despite recent searches, the taxon has not been seen on San Miguel Island since then. Soft-leaved paintbrush is currently known only from two areas on Santa Rosa Island, Carrington Point in the northeast corner of the island, and west of Jaw Gulch and Orr's Camp along the north shore of the island.

In 1993, the Jaw Gulch population was estimated to have up to 1,000 individuals covering an area of less than 2 hectares (5 acres) (C. Rutherford and T. Thomas, U.S. Fish and Wildlife Service, pers. obs. 1993), an estimate confirmed in recent field studies (McEachern and Wilken 1996). During Ingram's field studies in 1990, the Carrington Point population consisted of only 20 individuals (Ingram 1990). The current estimate for the Carrington population is several thousand plants (National Park Service field data, Channel Islands National Park 1998).

In 1994, Rindlaub and McEachern gathered abundance and density data for the two populations. On Carrington Point, population density averaged 0.9 plant per square meter (1.2 plants per square yard), and at Jaw Gulch, population density averaged 2.0 plants per square meter (2.4 plants per square yard). Study plots were established in 1995 in both populations to monitor population characteristics and changes in the number of plants. Mortality rates have been higher than recruitment in study plots from 1995 to 1998. Both populations generally consist of many small reproductive individuals, with few large reproductive plants and very few seedlings (McEachern and Chess 2000).

Habitat Description

At Carrington Point, the plant occurs in stabilized scrub vegetation dominated by goldenbush (*Isocoma menziesii* var. *sedoides*), lupine (*Lupinus albifrons*), and Pacific ryegrass (*Leymus pacificus*). At Jaw Gulch, the soft-leaved

paintbrush occurs with alien iceplants (*Carpobrotus* spp. and *Mesembryanthemum* spp.), alien grasses, native milk-vetch (*Astragalus miguelensis*), goldenbush, red buckwheat, saltgrass (*Distichlis spicata*), and seaside daisy (*Erigeron glaucus*) (McEachern and Chess 2000).

Life History

Soft-leaved paintbrush is dependent on a host plant for water and dissolved resources. Some leaves have reduced chlorophyll and the plant compensates by parasitizing the roots of nearby vascular plants (Chuang and Heckard 1993). The most likely host is goldenbush (*Isocoma menziesii* var. *sedoides*) (E. Painter *in litt.* 1995, M. Wetherwax *in litt.* 1995).

Threats

The most severe threat to soft-leaved paintbrush is deer and elk trampling and uprooting through scraping during rutting season. Other threats to soft-leaved paintbrush are soil loss, herbivory by deer, competition with alien plant taxa, and possible hybridization with *Castilleja affinis* at Carrington Point. Information from the study plots indicates that approximately 50 percent of soft-leaved paintbrush stems were broken, either through browsing or trampling (McEachern 1996, McEachern and Chess 2000). Up to 45 percent of plants in plots were uprooted and killed by deer and elk root scraping during the fall-winter rutting season. The loss of the probable host plant, goldenbush, through these same mechanisms also reduces the ability of soft-leaved paintbrush to reproduce (E. Painter, *in litt.* 1997, M. Wetherwax *in litt.* 1995). The Jaw Gulch population was also used as a bedding area for deer during the fall of 1993 (D. Richards, National Park Service, pers. comm. 1994). The significance of hybrid contamination with *Castilleja affinis* in the Carrington Point area is not known at present.

5. Santa Cruz Island dudleya (*Dudleya nesiotica*)
(Recovery Priority Number 8)

Description and Taxonomy

Santa Cruz Island dudleya was described by Moran (1950) as *Hasseanthus nesioticus* based on a specimen collected from a "flat area near the edge of sea bluff, Fraser Point," on the west end of Santa Cruz Island in 1950. Three years

later, Moran (1953) transferred the species to the genus *Dudleya*, as *Dudleya nesiotica*.

Santa Cruz Island dudleya is a succulent perennial in the stonecrop family (Crassulaceae) (Figure 10). The plant has a stem that resembles a short, thick, underground stem (corm-like) with 8 to 16 narrow leaves in a basal rosette from which several flowering stems 3 to 10 centimeters (1.2 to 4.0 inches) tall arise. The white five-petaled flowers and resulting fruits are erect to ascending. Recent research by Wilken (1996) indicates that the number of flowers per plant ranges from 6 to 12.

Distribution and Population Status

Santa Cruz Island dudleya is known only from one population, the type locality at Fraser Point on the west end of Santa Cruz Island (N. Vivrette *in litt.* 1996). Information on location, extent, and size of populations has been gathered by Wilken (1996). Within the general area near Fraser Point, where 13 hectares (32 acres) are occupied by the plant, four sites of high densities were sampled. From 1994 to 1996, estimates of absolute population size ranged from 30,000 to 60,000 plants (D. Wilken *in litt.* 1997).

Habitat Description

The population is situated on the lowest marine terrace in coastal scrub and grasslands (Junak *et al.* 1995). The west end of the population is associated with California sagebrush (*Artemisia californica*), iceplant (*Mesembryanthemum nodiflorum*), alkali heath (*Frankenia salina*), goldfields (*Lasthenia californica*), and pickleweed (*Salicornia subterminalis*). The east end of the population is associated with Australian saltbush (*Atriplex semibaccata*), brome (*Bromus hordeaceus*), goldfields, purple needlegrass (*Nasella pulchra*), and vulpia (*Vulpia myuros*).

A 25-year study on Fraser Point noted that establishment of a different pattern in dominant species composition occurred several times. Germination and establishment events were rare and typically occurred in response to extreme or unusual weather conditions. Following a shift in dominance, the maintenance of a vegetation pattern usually continues for several to many years. The unique

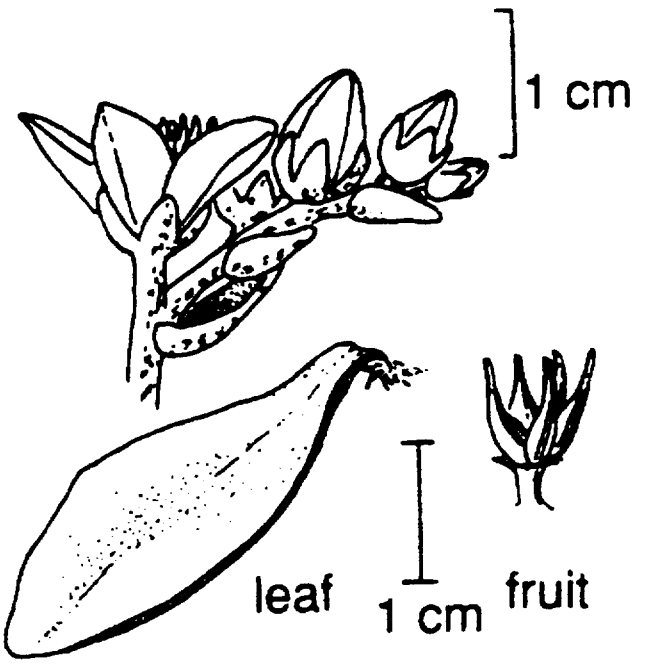

Figure 10. Illustration of Santa Cruz Island dudleya (*Dudleya nesiotica*). Copyright by the Regents of the University of California, reproduced with permission of the Jepson Herbarium, University of California.

response of each species to the meteorological and biotic conditions indicate that many years may be needed to assess trends in the vegetation health and status (Vivrette 2000).

Life History

Santa Cruz Island dudleya is a succulent perennial that dies back to the ground each year. The underground corm takes several years to develop. A first year corm can be the size of a rice grain and is easily dispersed by wind. The corms produce leaf buds in the summer, and the ground can be completely covered with leaves following the winter rains. The white flowers produce 10 to 12 seeds per flower. The Nature Conservancy has calculated density, cover, and height of plants within 30 randomly selected plots since 1991. Annual variations in density, cover, and height of rosettes have ranged from 16.9 to 29.1 plants per square meter (20.2 to 34.8 plants per square yard), 8.7 to 16.1 percent, and 1.27 to 1.68 centimeters (0.50 to 0.66 inch), respectively (Klinger 1995).

Threats

Santa Cruz Island dudleya remains vulnerable to competition from nonnative grasses, soil loss, herbivory by feral pigs, disturbance by pig rooting, and trampling by humans (researchers, visitors, yachtsmen, etc.). Like many dudleyas, Santa Cruz Island dudleya is also vulnerable to collecting for botanical or horticultural use (Moran 1979). The species is also threatened by extinction from random naturally occurring events due to its limited distribution.

6. Island bedstraw (*Galium buxifolium*)

(Recovery Priority Number 2)

Description and Taxonomy

Island bedstraw was described by Greene in 1886 based on specimens collected on Santa Cruz Island (Ferris 1960). In 1958, Dempster included the taxon as a variety of *Galium catalinense* (Dempster 1958). Ferris (1960) suggested that the taxon was subspecifically distinct from *Galium catalinense*. In 1973, Dempster recognized the taxon as a separate species based on differences in the nutlet hairs between it and *Galium catalinense* (Dempster 1973).

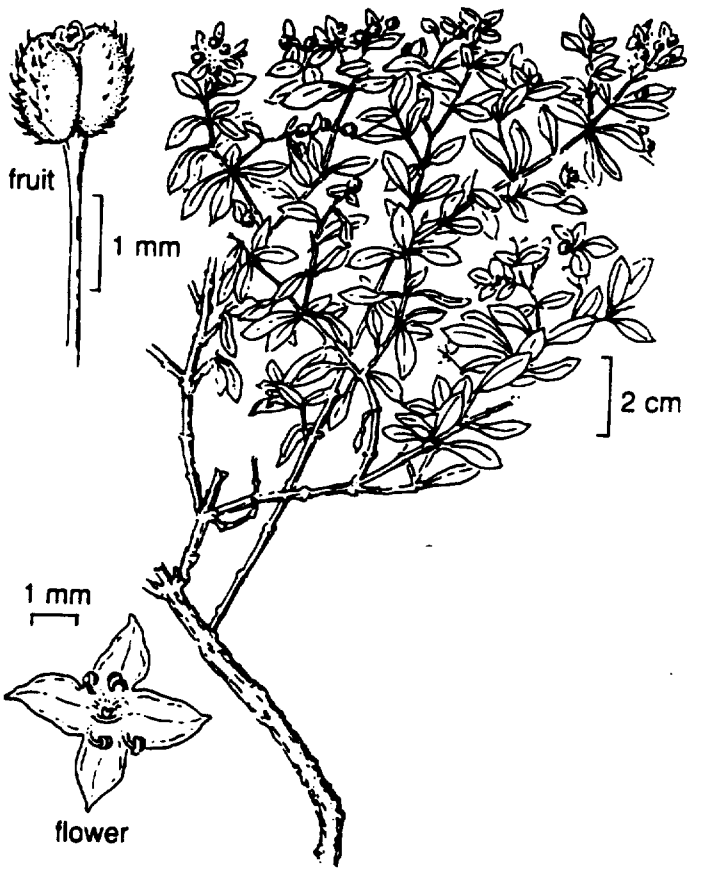

Figure 11. Illustration of island bedstraw (*Galium buxifolium*). Copyright by the Regents of the University of California, reproduced with permission of the Jepson Herbarium, University of California.

Island bedstraw is a small, dioecious (individual plants with two separate sexual units), stout, woody shrub in the bedstraw (Rubiaceae) family (Figure 11). The plant grows to 1.2 meters (4 feet) in height, and has swollen nodes bearing numerous leafy branches. The leaves are larger than those of most other *Galium* taxa, and have conspicuous lateral veins with stout hairs on the lower surface (Dempster 1973). The relatively broad leaves and the tiny upward-curved hairs that cover the fruits are unique characteristics that distinguish it from the six other species of *Galium* that occur on the islands (Hochberg *et al.* 1980b).

Distribution and Population Status

Island bedstraw is currently known from Santa Cruz and San Miguel Islands where it occurs on north-facing sea cliffs. A putative collection of Island bedstraw was made from the "Torrey Pine grove, Santa Rosa Island," in 1941 by Moran; apparently this record was a misidentified collection of San Diego bedstraw (*Galium nuttallii*) (R. York *in litt.* 1987). Therefore, no collections of this taxon are known from Santa Rosa Island. Eight populations occur on The Nature Conservancy lands on Santa Cruz Island. In 1980, Hochberg *et al.* (1980b) noted that 2 of these populations had fewer than 50 individuals each, and the remaining populations had less than 6 individuals each. No recent status information is available for the Santa Cruz Island populations. Two populations were located on San Miguel Island in 1993, one with about 200 individuals, and the other having fewer than 10 plants. These 2 populations were relocated in 1998 with 300 and 121 plants each. Five other historical collections have been made from the island, but no plants have been seen at these other localities for almost 30 years.

Habitat Description

The plant occurs on "bluffs and rocky slopes" (Dempster 1973) in coastal sage scrub and island pine forest. Dominant species that were found with island bedstraw are California sagebrush (*Artemisia californica*), San Miguel Island locoweed (*Astragalus miguelensis*), giant coreopsis (*Coreopsis gigantea*), Greene's dudleya (*Dudleya greenei*), seaside daisy (*Erigeron glaucus*), and red buckwheat (*Eriogonum grande* ssp. *rubescens*) (National Park Service field data, Channel Islands National Park 1998). Other associated species on rocky, exposed cliffs include yarrow (*Achillea millefolium*), San Miguel Island deerweed (*Lotus*

dendroideus var. *veatchii*), cliff aster (*Malacothrix saxatilis* var. *implicata*), wild cucumber (*Marah macrocarpa*), and lemonade berry (*Rhus integrifolia*) (Halvorson *et al.* 1992).

Life History

Currently, there is little life history information available for this species. The species is a short lived shrub that is dioecious.

Threats

Island bedstraw is threatened by soil loss and herbivory from feral pig rooting and erosion resulting from years of sheep grazing. The species is also threatened by extinction from random naturally occurring events due to its limited distribution.

7. Hoffmann's slender-flowered gilia (*Gilia tenuiflora* ssp. *hoffmannii*)
(Recovery Priority Number 3)

Description and Taxonomy

Hoffmann's slender-flowered gilia was described as *Gilia hoffmannii* by Eastwood (1940) based on collections made by Hoffmann "in sandy soil at East Point" on Santa Rosa Island 10 years earlier (Eastwood 1940). Eastwood remarked that, although the taxon is related to *G. tenuiflora*, no variation of the latter included the leafy stems and a tight cluster of flowers at the top of *G. hoffmannii* (Eastwood 1940). Nevertheless, Jepson (1943) included the taxon in the description of *G. tenuiflora* var. *tenuiflora* in his book on the flora of California, as did Abrams (1951) in his book on the flora of the Pacific states. In 1959, Munz included the varieties of *tenuiflora* as subspecies, including ssp. *hoffmannii*, as per a 1956 treatment by the Grants (Munz and Keck 1973). This nomenclature was used in the latest treatment of the genus (Day 1993). Of the four subspecies of *G. tenuiflora*, the subspecies *hoffmannii* is the only one that occurs in southern California. Two other *Gilia* species occur on Santa Rosa Island, but *G. tenuiflora* ssp. *hoffmannii* is distinguished from them by the base of its stem being very fuzzy, as if covered with spider webs.

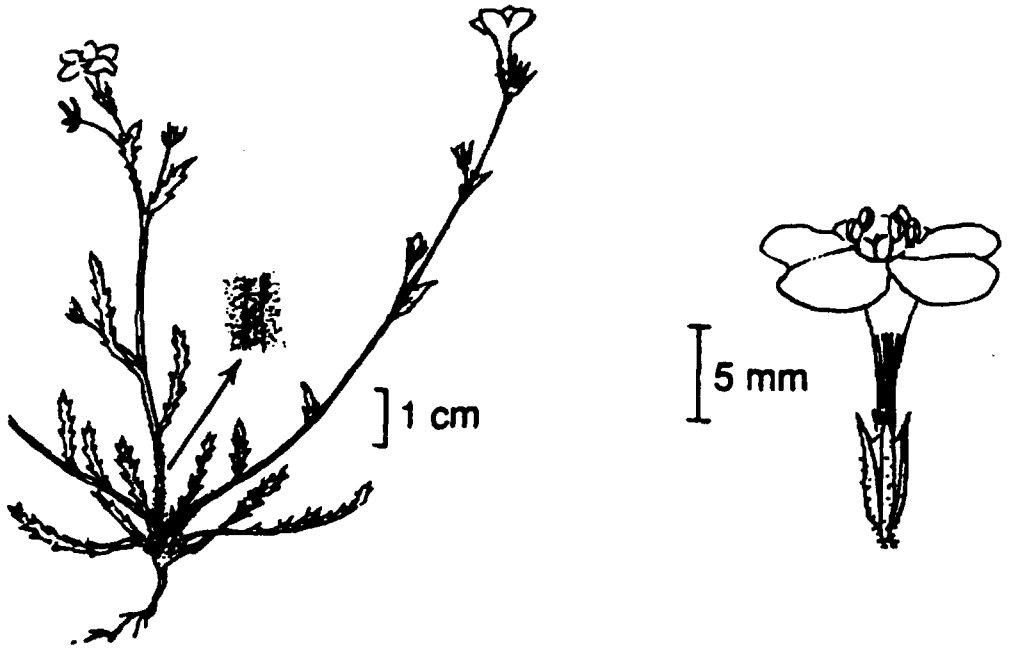

Figure 12. Illustration of Hoffmann's slender-flowered gilia (*Gilia tenuiflora* ssp. *hoffmannii*). Copyright by the Regents of the University of California, reproduced with permission of the Jepson Herbarium, University of California.

Hoffmann's slender-flowered gilia is a small, erect, annual herb in the phlox (Polemoniaceae) family (Figure 12). The central stem grows 6 to 12 centimeters (2.4 to 4.7 inches) tall, arising from a rosette of densely hairy, strap-shaped (narrow and long), short-lobed leaves. The flowers are purplish and funnel-shaped below, widening to five pinkish petals that are partially fused together (corolla lobes).

Distribution and Population Status

Hoffmann's slender-flowered gilia historically has only been collected from two locations on Santa Rosa Island. A collection was made by Reid Moran from the "arroyo between Ranch and Carrington Point" in 1941 (Rutherford and Thomas 1994). In 1994, Rindlaub located a population of 88 individuals covering 2 square meters (5 square feet) that reasonably corresponds to Moran's site and was grazed by cattle (Rindlaub 1995). The other historical location is at the type locality near East Point on Santa Rosa Island, where it is still found. In 1994, this population consisted of about 2,000 plants (Rindlaub 1995). During 1994 surveys, a third population comprising three colonies was found at Skunk Point. This population comprised approximately 3,000 to 3,500 individuals that had been cropped by cattle (Rindlaub 1995).

Habitat Description

Hoffmann's slender-flowered gilia is a component of dune and lupine scrub vegetation. Plants that are commonly found with this species are sand verbena (*Abronia umbellata*), wild oats (*Avena barbata*), rip-gut grass (*Bromus diandrus*), beach evening-primrose (*Camissonia cheiranthifolia*), and sand mat (*Cardionema ramosissima*). Silver beach-weed (*Ambrosia chamissonis*), saltgrass (*Distichlis spicata*), miniature lupine (*Lupinus bicolor*), plantain (*Plantago erecta*), and sand-dune bluegrass (*Poa douglasii*) occur in the habitat (T. Thomas, unpublished field notes, U.S. Fish and Wildlife Service, Ventura Field Office 1993; U.S. Geological Survey Biological Resources Division field data 1998).

Life History

Population monitoring has been conducted annually at the East Point location from 1994 to 1998. Preliminary data analysis indicates that plant density fluctuates about a mean of 9.4 plants per square meter (11.2 plants per square

yard), plant height averages 7 to 9 centimeters (2.8 to 3.2 inches), the numbers of branches and flowers per plant vary greatly, with lower reproduction in drier years. Plant density tends to be low in areas where grass cover is high. Plant density and plant sizes were low throughout its habitat in 1998, when grass cover was high in response to unusually high rainfall (McEachern *in prep.*).

A small beefly (*Oligodranes* spp., Bombyliidae) was observed to be the most numerous and effective pollinator, and a soft-winged flower beetle (Melyridae) was observed as a casual visitor in a pollination study on south coast range *Gilia tenuiflora* populations (Grant and Grant 1965). It is unknown if these species or their counterparts occur on Santa Rosa Island.

Threats

Hoffmann's slender-flowered gilia is threatened by soil damage, competition from nonnative grasses, and habitat alteration resulting from decades of herbivory by sheep, horses, cattle, elk, and deer. A sandy service road used by the National Park Service and ranchers bisects the East Point population. The National Park Service constructed a fence to exclude cattle from a portion of the largest population; however, a considerable portion of the population was affected by increased trampling by cattle as a result of the fence placement and continued impacts from vehicle use of the road. Sheep and cattle have been removed, but horses, deer, and elk still occur in Hoffmann's slender-flowered gilia habitat. Competition from nonnative grasses also reduce the available habitat. The species is also threatened by extinction from random naturally occurring events due to its limited distribution.

8. Island rush-rose (*Helianthemum greenei*)
(Recovery Priority Number 8)

Description and Taxonomy

This species was described by Robinson as *Helianthemum greenei* in 1895 (Abrams 1951). The type locality was described as "a dry summit near the central part of the island of Santa Cruz" (Abrams 1951). This nomenclature was retained in the most recent treatment for the genus (McClintock 1993).

Island rush-rose is a small shrub in the rock-rose (Cistaceae) family. The plant grows to 0.5 meter (18 inches) tall and has alternate leaves covered with star-shaped hairs. The reddish, glandular stalks support yellow-petaled flowers to 2.5 centimeters (1 inch) wide. The fruit is a pointed capsule 0.6 centimeter (0.25 inch) long. A more abundant species found on the islands, peak rush-rose (*Helianthemum scoparium*), is similar in appearance, but it is not glandular-hairy and has greenish stalks and smaller fruits (Hochberg 1980b).

Distribution and Population Status

Island rush-rose has been reported from four islands: San Miguel, Santa Rosa, Santa Cruz, and Santa Catalina. McMinn (1951) and later Thorne (1967) reported seeing island rush-rose on San Miguel Island, but no collections exist from that island (Hochberg *et al.* 1980b, Wallace 1985). Two collections of the plant were made from Santa Rosa Island by Epling, Erickson, and Dunn in the 1930's (Wallace 1985), and a recent discovery of the species has been made inside a deer exclosure for the Santa Rosa Island manzanita near South Point (S. Chaney, pers. comm. 1999). Island rush-rose was reported from the northeast side of Black Jack Mountain on Santa Catalina Island by Thorne (1967) in 1966. No collections have been made at this locality, but a small population has been reported from there (J. Takara, Santa Catalina Island Conservancy, pers. comm. 1994), and there are a few populations at the west end of the island that have become apparent with the alien mammal removal program (P. Schuyler *in litt.* 1999).

In addition to the populations on Santa Catalina and Santa Rosa Islands, island rush-rose is currently known from 14 populations on Santa Cruz Island. In 1980, prior to sheep removal from The Nature Conservancy lands on Santa Cruz Island, Hochberg *et al.* (1980b) found that, of 10 populations, 2 had several dozen individuals, and 6 others have fewer than 6 individuals. Hochberg *et al.* (1980b) indicated that the plant is eliminated by intense feral animal disturbance, and noted that the population recorded by Abrams and Wiggins in 1930 at Pelican Bay had not been relocated. The Biological Resources Division sponsored surveys in 1995 and 1996 reported 14 populations, including 10 small ones (averaging 9 plants) and 4 larger ones (from 500 to 1,000 plants, averaging 663) (McEachern and Wilken 1996). The number of individuals was clearly related to recent fire

history, with the 10 smaller populations being unburned and the 4 larger populations having burned in 1994 (McEachern and Wilken 1996).

Habitat Description

The taxon is found in open, exposed areas in chaparral, coastal sage scrub, and island pine forest. It is apparently responding favorably to fire on Santa Cruz Island where the plant is a successional component on regenerating burn sites.

Life History

Until the fires of the 1990's, the populations were reported to be well dispersed but consisted of only one to four plants each. Observations of a population explosion after fires on Santa Cruz Island would suggest that the species is a fire follower where there are currently thousands of individuals. However, no young individuals have been observed several years after the fire event. Island rush-rose produces 50 to 70 flowers per plant, and every flower produces seed. When the flowers are insect pollinated, the plant produces a maximum of 12 seeds per fruit; seed production is reduced when the plants are self pollinated.

Threats

Island rush-rose is vulnerable to soil damage, reduced fire frequencies, and rooting by feral pigs. Habitat for the plant on Santa Catalina Island is being grazed and browsed by goats, horses, and mule deer.

9. Santa Cruz Island bushmallow (*Malacothamnus fasciculatus* var. *nesioticus*)

(Recovery Priority Number 3)

Description and Taxonomy

Santa Cruz Island bushmallow was described by Robinson in 1897 as *Malvastrum nesioticum*, based on material collected by Greene in 1886 (Robinson 1897). This taxon has been placed in several different genera, as *Malacothamnus nesioticus* (Abrams 1951), *Sphaeralcea nesiotica* (Jepson 1925), *Sphaeralcea fasciculata* var. *nesiotica* (Jepson 1936), and *Malvastrum fasciculatum* var. *nesioticum* by McMinn (Kearney 1951). Kearney (1951) published the

combination *Malacothamnus fasciculatus* var. *nesioticus*. Bates (1993) did not recognize var. *nesioticus* as being distinct noting that *Malacothamnus fasciculatus* is a highly variable species "with many indistinct and intergrading local forms." Of var. *nesioticus*, Bates (1993) noted that the taxon is essentially indistinguishable from the mainland var. *nuttallii*. However, recent studies on the genetics of *Malacothamnus* have determined that var. *nesioticus* is a distinct variety (Swenson *et al.* 1995), and it is recognized as such in the Flora of Santa Cruz Island (Junak *et al.* 1995).

Santa Cruz Island bushmallow is a small soft-woody shrub in the mallow (Malvaceae) family (Figure 13). The plant reaches up to 2 meters (6 feet) tall, and has slender branches covered with star-shaped hairs. The palmately shaped leaves are dark green on the upper surface and gray on the lower surface. The rose-colored flowers are up to 3.75 centimeters (1.5 inches) broad and are scattered along the ends of the branches (Hochberg *et al.* 1980b). It is differentiated from the mainland var. *nuttallii* by its bicolored leaves and genetic distinctiveness (Swenson *et al.* 1995).

Distribution and Population Status

Santa Cruz Island bushmallow, endemic to Santa Cruz Island, was already rare by the turn of the century when Greene wrote that the plant was "rare; only two bushes seen, and these under the protection of large opuntias (cacti); perhaps thus kept from the sheep" (Hochberg *et al.* 1980a). Santa Cruz Island bushmallow is currently known from three small populations on Santa Cruz Island where it occurs within a coastal sage scrub community (Wilken 1996). One population of less than 50 individuals (10 clones) is located on the west shore of the island near the historic Christy Ranch. The second population was discovered in 1993 in the Central Valley near the University of California Field Station. Recent genetic analyses of the Central Valley population indicated that, although there are 19 individual shrubs, they consist of only 3 genotypes, or 3 clones (Swensen *et al.* 1995). A third population of 50 to 60 plants has been discovered on the south slopes of the island in the vicinity of Willows Canyon, on Horqueta ridge (D. Wilken, pers. comm. 1998). Genetic studies indicate there are probably only four genetic individuals.

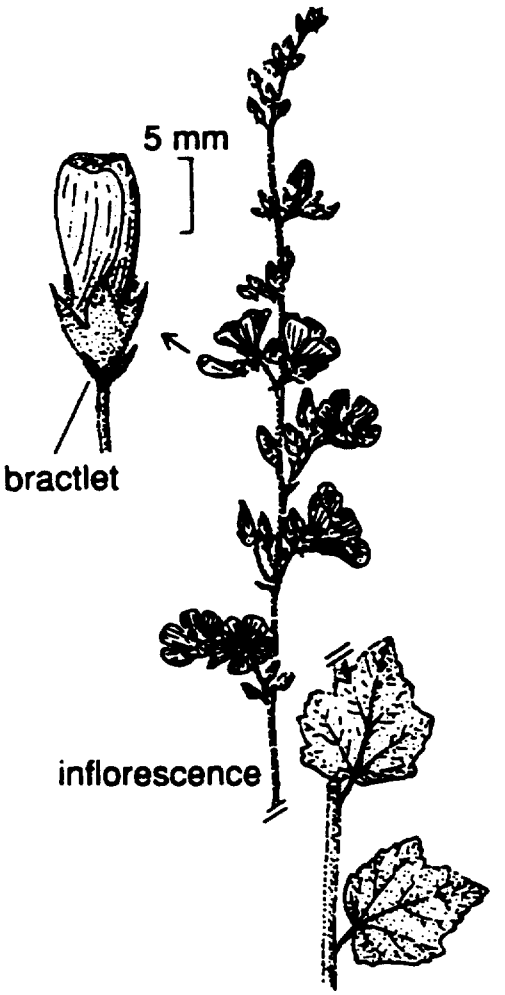

Figure 13. Illustration of Santa Cruz Island bushmallow (*Malacothamnus fasciculatus*). Copyright by the Regents of the University of California, reproduced with permission of the Jepson Herbarium, University of California.

Habitat Description

Santa Cruz Island bushmallow occurs on rocky, south facing slopes in chaparral and coastal scrub in the Central Valley north of the University of California Field Station, in a canyon just south of Christy Ranch, and at the Horqueta ridge site. Associated species include California sagebrush (*Artemisia californica*), Santa Cruz Island buckwheat (*Eriogonum arborescens*), and lemonade berry (*Rhus integrifolia*) at Christy Ranch and California sagebrush, California boneset (*Brickellia californica*), and toyon (*Heteromeles arbutifolia*) at the Central Valley population.

Life History

The species has been grown from cuttings. Garden grown plants developed roots 3 meters (10 feet) from the parent plant in the Santa Barbara Botanic Garden. The plant produces hundreds of flowers early in the season but yields only two to three seeds per plant.

Threats

Santa Cruz Island bushmallow is threatened by soil loss, habitat alteration, and feral pig rooting. In the past, the Christy population was entangled and shaded by the introduced geranium (*Pelargonium* sp.). The species is also threatened by extinction from random naturally occurring events due to its limited distribution.

10. Santa Cruz Island malacothrix (*Malacothrix indecora*)
(Recovery Priority Number 2)

Description and Taxonomy

This species was described by Greene (1886a) as *Malacothrix indecora* based on specimens collected from "islets close to the northern shore" of Santa Cruz Island (Greene 1886b). In 1957, Williams published the combination *Malacothrix foliosa* var. *indecora* (Ferris 1960). Munz (1974) subsequently synonymized the taxon with *Malacothrix foliosa*. However, Ferris (1960) and others (Smith 1976, Davis 1980) continued to recognize the taxon as a separate species with the name *Malacothrix indecora*. The latter nomenclature was retained in the most recent treatments of the genus (Davis 1993; Davis 1998).

Santa Cruz Island malacothrix is a mat-like annual herb in the chicory or dandelion tribe of the aster (Asteraceae) family (Figure 14). The stems, which are 2 to 10 centimeters (0.8 to 4 inches) tall, support numerous fleshy leaves with three to eight pairs of short petals, rounded at the tips (Davis 1998). The strap-shaped (narrow and long), greenish-yellow flowers are exerted only 1 to 4 millimeters (0.04 to 0.16 inch) beyond the small, less than 10-millimeter (0.4-inch) hemispheric heads surrounded by red tinged linear specialized leaves (phyllaries) (Hochberg 1980b; Scott in Junak *et al.* 1995). Four other annual species of *Malacothrix* occur on the same islands as Santa Cruz Island malacothrix, which is distinguished by smaller flowers and the absence of teeth or bristles on the seed (achene) (Scott in Junak *et al.* 1995; Davis 1998).

Distribution and Population Status

Santa Cruz Island malacothrix has been reported from three islands: San Miguel, Santa Rosa, and Santa Cruz. Historical collections of Santa Cruz Island malacothrix were made from several locations on the northeast shore of San Miguel Island, and on Prince Island off the north shore of San Miguel Island by Greene, and later by Hoffmann (Hochberg *et al.* 1979; Davis 1987). In 1978, Hochberg *et al.* (1979) observed three populations. Halvorson *et al.* (1992) reported finding this species at one location during surveys in 1988 and 1989, but no collections were made to confirm identification of the taxon. In 1998, a scattered population of 14,000 plants in 5 sites (2 populations) were documented on San Miguel Island on the northeast facing bluffs in the vicinity of Bay Point (K. Chess *in litt.* 1998). In 1996, Dieter Wilken discovered the species at the mouth of Lobo Canyon, Santa Rosa Island. Surveys in the high rainfall year of 1998 documented more than 13,000 plants in 10 small pockets from Lobo Canyon to about 1 kilometer (0.6 mile) west of Cow Canyon (K. Chess *in litt.* 1998). Steve Junak discovered one population in 1980 at Black Point on the west end of Santa Cruz Island (Davis 1998). Several hundred individuals were observed at this site by Junak in 1985. On a subsequent trip in 1989, only 50 plants were observed in the same location (S. Junak, pers. comm. 1994), and fewer than 100 plants in 1996 (D. Wilken *in litt.* 1997).

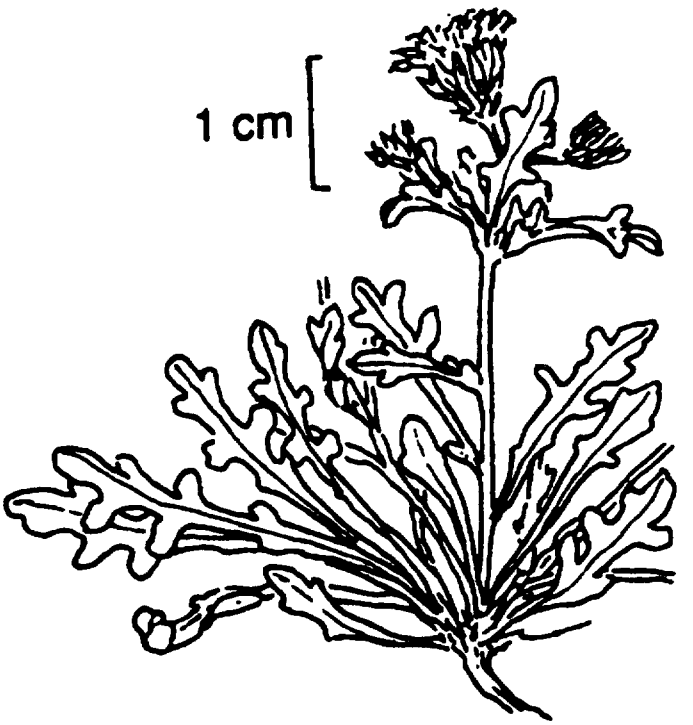

Figure 14. Illustration of Santa Cruz Island malacothrix (*Malacothrix indecora*). Copyright by the Regents of the University of California, reproduced with permission of the Jepson Herbarium, University of California.

Habitat Description

Santa Cruz Island malacothrix occurs along the edge of vegetated habitat along coast bluffs, often on midden soils. On San Miguel Island, it is restricted to soils derived from igneous rocks, and on Santa Rosa Island, the extended population occurs on sedimentary coastal bluffs (Davis 1998). The Black Point, Santa Cruz Island population of Santa Cruz Island malacothrix occurs in exposed coastal flats where it was associated with red buckwheat (*Eriogonum grande* var. *rubescens*) and iceplant (*Mesembryanthemum nodiflorum*) in soils derived from metamorphic and igneous rocks (California Natural Diversity Data Base 1998; Davis 1998).

Life History

Little is known about the life history of Santa Cruz Island malacothrix. This annual species is poorly to moderately self compatible (Davis 1998).

Threats

Santa Cruz Island malacothrix is threatened by soil loss, habitat alteration and herbivory resulting from feral pig rooting, trampling by hikers, and seabird activity. Historical habitat for Santa Cruz Island malacothrix on San Miguel Island and Prince Island has been altered by seabird nesting activity. The species is also threatened by extinction from random naturally occurring events due to its limited distribution.

11. *Malacothrix squalida* (island malacothrix)

(Recovery Priority Number 2)

Description and Taxonomy

Island malacothrix was described by Greene in 1886 from specimens collected from an islet off the northern shore of Santa Cruz Island (Greene 1886a). In 1957, Williams published the combination *Malacothrix foliosa* var. *squalida*; later, Ferris (1960) published the combination *Malacothrix insularis* var. *squalida*. In 1959, Munz recognized the taxon as *Malacothrix squalida*; however, 15 years later, he synonymized it with *Malacothrix foliosa* (Munz 1974). In a review of insular species of *Malacothrix*, Davis (1980) recognized the taxon as *Malacothrix squalida*, a treatment he recently retained (Davis 1998).

Island malacothrix is an annual herb in the aster family (Figure 15). The plant is 4 to 30 centimeters (1.6 to 12 inches) tall, the basal leaves are 4 to 14 centimeters (1.6 to 5.5 inches) in length, oblanceolate, with teeth or narrow sharp lobes, and the upper stem leaves are wider toward their bases to narrowly triangular with sharp lobes. The light yellow flowers are clustered in hemispheric heads 9 to 12 millimeters (0.4 to 0.5 inch) long with 20 to 26 phyllaries (the modified leaves at the base of the head). The achenes generally are without a bristle and the tips of the five strongest ribs are extended, which distinguishes the species from four other annual species of *Malacothrix* that occur on the same islands as island malacothrix (Scott in Junak *et al.* 1995; Davis 1998).

Distribution and Population Status

Island malacothrix has been reported from two islands: Santa Cruz and Anacapa. Island malacothrix has been collected from two locations along the north shore of Santa Cruz Island; Greene collected it near Prisoner's Harbor in 1886, but the species was not seen on the island again until Philbrick and Benedict collected it in 1968 near Potato Harbor where sheep overgrazing is a major problem (Rutherford and Thomas 1994). On Middle Anacapa Island, the plant was first collected by Martin Piehl in 1963. In 1998, Steve Junak observed two populations on Middle Anacapa Island. The plant was known from several small colonies atop coastal bluffs on the east end of the island.

Habitat Description

The species occurs on rocky coastal bluffs in coastal scrub (Junak *et al.* 1995). Collections have been made from Middle Anacapa Island at the east end on a knife edge ridge and on an east facing slope in a canyon draining from Coche Point to Potato Harbor (Davis 1998).

Life History

This annual species was grown in cultivation when it was determined to be self pollinating and self compatible (Davis 1998). Otherwise, nothing is known about the life history of this species.

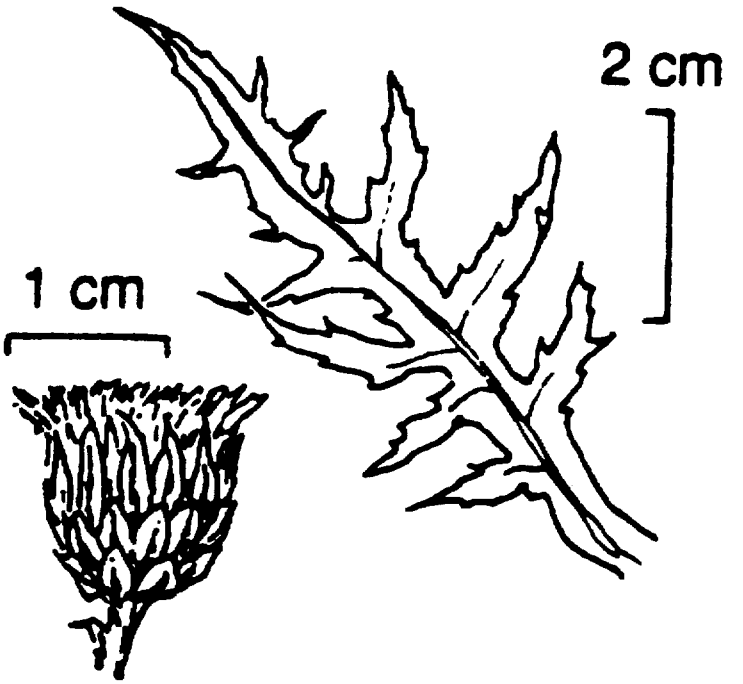

Figure 15. Illustration of island malacothrix (*Malacothrix squalida*). Copyright by the Regents of the University of California, reproduced with permission of the Jepson Herbarium, University of California.

Threats

All of the historical localities for island malacothrix are impacted by soil loss, habitat alteration resulting from more than 100 years of sheep grazing, and ongoing feral pig rooting (Santa Cruz Island). Any extant populations are also likely to be threatened by these factors. Seabird nesting may have localized impacts to some populations on Middle Anacapa Island. The species is also threatened by extinction from random naturally occurring events due to its limited distribution.

12. *Phacelia insularis* var. *insularis* (island phacelia)

(Recovery Priority Number 3)

Description and Taxonomy

Island phacelia was described by Munz (1932) based on plants growing "on sand dunes at northeastern part of Santa Rosa Island". Jepson published the new combination *Phacelia curvipes* var. *insularis* in 1943. After examining specimens from coastal northern California and determining their affinity to the island plants, Howell (1945) re-elevated the taxon to specific level, separating out the northern California plants as *Phacelia insularis* var. *continentis*, leaving *Phacelia insularis* var. *insularis* to refer to the island plants. In 1951, Abrams, who did not have access to collections of *Phacelia* from northern California, included the taxon in the description of *Phacelia divaricata*, a taxon common in southern California. In 1959, Munz published the new combination *Phacelia divaricata* var. *insularis*. Constance agreed with Howell's interpretation and has referred to the taxon as *Phacelia insularis* var. *insularis* (Constance 1979). This nomenclature was retained in the latest treatment of the genus (Wilken *et al.* 1993).

Island phacelia is a reclining, branched annual of the waterleaf (Hydrophyllaceae) family (Figure 16). The short, hairy, and glandular stems grow to 15 centimeters (6 inches) high from a basal rosette of leaves. The small lavender to violet, bell-shaped flowers are borne in loose clusters (cymes). Island phacelia can be distinguished from the other species of *Phacelia* on the islands based on the hastate (arrow-head) leaf shape with basal lobes. The other *Phacelia*

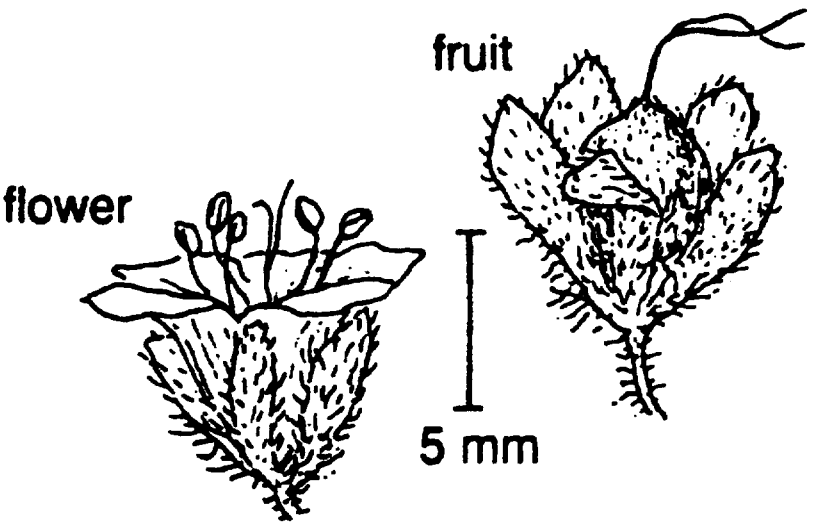

Figure 16. Illustration of island phacelia (*Phacelia insularis* var. *insularis*). Copyright by the Regents of the University of California, reproduced with permission of the Jepson Herbarium, University of California.

have leaflets arranged along the central stem (pinnately divided) or undivided but ovate leaves.

Distribution and Population Status

Island phacelia occurs on Santa Rosa Island and San Miguel Island. Clifton Smith collected the species at Carrington Point on Santa Rosa Island in 1973, where Sarah Chaney also found the species in 1994. In subsequent surveys, 31 plants were reported from this site (Rindlaub 1995) and in 1998, 1,387 plants were reported from the same area (Biological Resources Division field data 1998).

On San Miguel Island, island phacelia was collected by Hoffmann in 1930 and by Munz in 1932. It was not collected again until 1978, when four populations were found (Hochberg *et al.* 1979). Drost relocated one of these sites on a bluff above Cuyler Harbor in 1984 (Halvorson *et al.* 1992). Halvorson *et al.* (1992) documented four occurrences in 1988-1989 surveys. Three populations are currently known from San Miguel Island. Chess located a new population of 2,653 plants in 1998. Three of the four previously known San Miguel Island occurrences were also visited in the 1998 growing season, two of which were relocated with 30 and 234 individuals each.

Habitat Description

Island phacelia is found within the island lupine-grassland community, which is dominated by alien grasses including slender wild oat (*Avena barbata*), ripgut (*Bromus diandrus*), and soft chess (*Bromus hordeaceus*), with scattered native bunch grasses, shrubs, and herbs (Hochberg *et al.* 1979).

Life History

Currently, little life history information is available for this species. This annual flower blooms from March through April.

Threats

Island phacelia is threatened by soil damage, competition with nonnative grasses, and habitat alteration caused by cattle grazing and elk and deer browsing. The species is also threatened by extinction from random naturally occurring events due to its limited distribution.

13. Santa Cruz Island fringepod (*Thysanocarpus conchuliferus*)

(Recovery Priority Number 2)

Description and Taxonomy

Santa Cruz Island fringepod was described by Greene in 1886 based on material he and Brandegee collected on Santa Cruz Island where they found it "common on mossy shelves and crevices of high rocky summits and northward slopes" (Greene 1886b). Four decades later, Jepson published the new combination *Thysanocarpus laciniatus* var. *conchuliferus* as one of three varieties of *Thysanocarpus laciniatus* (Jepson 1925). Later, Abrams (1944) treated the plant as a species. Munz, however, considered it one of six varieties of *Thysanocarpus laciniatus* (Munz and Keck 1973). In the most recent treatment of the genus, Rollins treated the plant as a species (Rollins 1993).

Santa Cruz Island fringe-pod is a small delicate annual herb in the mustard (Brassicaceae) family. The one to several branches grow 5 to 12.7 centimeters (2 to 5 inches) high. The narrow, linearly lobed leaves alternate along the stems, which terminate in a cluster of minute pink to lavender flowers. While all members of this genus have round, flattened fruits with wings, Santa Cruz Island fringe-pod is the only species in the genus that has a bowl-shaped fruit with perforated or lobed margins and spreading pedicels (Junak *et al.* 1995).

Distribution and Population Status

Santa Cruz Island fringepod is endemic to Santa Cruz Island. In 1932, Ralph Hoffmann reported that Santa Cruz Island fringepod was "frequent . . . from the north shore to the southwest portion of the island" (Hochberg *et al.* 1980a). Fourteen historical locations are known from herbarium records. In 1980, eight of these populations were relocated (Hochberg *et al.* 1980b). It has been reported from the north slopes of the island between Lady's and Prisoners' Harbors, the Central Valley near Lagunitas Secas, in Cañada de la Puertozuelo, and on the south side of the island on Sierra Blanca Ridge (Junak *et al.* 1995). The only currently known population is at Puertozuelo comprising only a few individuals.

Habitat Description

Santa Cruz Island fringepod occurs on rocky outcrops on ridges and canyon slopes, and is associated with a variety of herbs, ferns, grasses, dudleya, and bushy spike-moss (*Selaginella bigelovii*) (Santa Barbara Botanic Garden *in litt.* 1990).

Life History

Currently, there is little life history information available for this species. It is a delicate annual, blooming from March through April, which produces only one seed per flower.

Threats

All of the historical localities for Santa Cruz Island fringepod are adversely affected by soil loss, habitat alteration, and predation resulting from feral pig rooting. Any extant populations are also likely to be threatened by these factors. The species is also threatened by extinction from random naturally occurring events due to its limited distribution.

C. CONSERVATION MEASURES

The 1980 legislation authorizing the creation of the Channel Islands National Park (this legislation included Santa Barbara, Anacapa, Santa Clara, Santa Rosa, and San Miguel Islands) required the National Park Service to provide to Congress a resource inventory and monitoring report every 2 years for 10 years. Subsequently, Congressional authorization established a monitoring program for the National Park system. Protocols were established for monitoring programs for terrestrial and marine resources. The results from the monitoring program and reports on the vegetation of the islands documented resource degradation.

The National Park Service, U.S. Fish and Wildlife Service, and the U.S. Geological Survey-Biological Resources Division developed a draft strategy for conservation (Conservation Strategy) of federally listed plants, plant species of concern, and their habitats on the northern Channel Islands (Coonan *et al.* 1996). The team compiled available literature, reviewed information gathered at public

meetings, and conferred with experts to compile data relevant to these species and their communities. The team compiled available literature, reviewed information gathered at public meetings, and conferred with experts to compile data relevant to these species and their communities.

The Conservation Strategy presents interim and long-term restoration goals for both species and habitats as well as measurable standards to evaluate the progress in achieving interim goals. Because of the level of habitat alteration and damage on the islands, an ecosystem-level approach to restoration planning was considered appropriate. Interim goals describe the desired condition of populations and habitats immediately necessary for conservation. Standards quantify measurable conditions that indicate progress toward restoration. Long-term goals provide ecological and community level perspectives for restoration.

Plant taxa and plant communities on the northern Channel Islands share similar symptoms of decline; therefore they also share similar interim conservation goals in the Conservation Strategy that have been formed from holistic, ecosystem level management approaches. For individual plant taxa, interim goals, as appropriate, include increasing reproductive success and recruitment of new individuals into populations; achieving stable-to-increasing population growth rates over the next 10 to 15 years; and expanding population boundaries.

A major long-term goal proposed in the Conservation Strategy is to increase the range and connection of shrub and woodland communities while restoring distribution, range, structure, and function of species within all communities in the northern Channel Islands. For plant communities, interim goals for the next 10 to 20 years include increasing cover, density, and biomass of native taxa; decreasing cover, frequency, and density of nonnative species; controlling or eradicating aggressive weedy species, both native and nonnative; developing a soil litter layer capable of holding a seed bank and functioning as a seed bed for germination; reducing soil compaction and erosion rates; and restoring the processes of nutrient cycling and natural fire regimes across island landscapes.

To monitor restoration progress, specific quantitative ecological standards necessary for restoration of the plant taxa and plant communities were presented in the Conservation Strategy for dominant island communities. The Conservation Strategy provides essential background and direction for the management of the habitats upon which the listed species depend. A range of management actions can be undertaken to achieve interim goals set forth in the Conservation Strategy. Development of specific tasks to reduce, mitigate, or eliminate threats to species and the plant communities that support them will constitute part two of the Conservation Strategy (to be developed in the future).

The team believed the Conservation Strategy would provide both a framework for more specific management actions such as recovery tasks and direction for the National Park Service's Environmental Impact Statement for managing water quality and endangered plant issues on Santa Rosa Island. The Conservation Strategy was subsequently partially adopted as an alternative in the Environmental Impact Statement for the Natural Resource Management Plan for Santa Rosa Island.

A law suit was filed by the Environmental Defense Center on behalf of the National Parks and Conservation Association against the National Park Service for compliance issues with the Federal Endangered Species Act and the State Clean Water Act. The results of the settlement of the lawsuits resulted in a revision of the Natural Resource Management Plan for Santa Rosa Island and the preparation and implementation of the following management prescriptions:

- removal of 5,000 to 6,000 head of cattle from the island by the end of 1998,
- reduction of the deer herd from 1,600 animals to 700 by the end of 1998,
- protection and promotion of recovery of Santa Rosa Island manzanita and soft-leaved paintbrush through establishment of a program to monitor browsing and damage by elk and deer,
- reduction in the size of the elk and deer herds to below levels that would cause unacceptable damage,
- removal of all nonnative animals from the island by 2011,
- restoration of riparian habitat, and
- establishment of a weed management program.

Some progress has been made toward eliminating alien animals from the islands. Sheep were removed from San Miguel, Santa Cruz, and Anacapa Islands and the National Park Service removed burros from San Miguel Island. The National Park Service has removed all the pigs from Santa Rosa Island. All of the cattle were removed, the deer herd was reduced from 1,600 to 700 animals, and the elk herd was estimated at just less than 600 animals on Santa Rosa Island in 1998. Deer and elk will remain at some density on Santa Rosa Island until the year 2011. There is a monitoring program on Santa Rosa Island that consists of deer exclosures around select Santa Rosa Island manzanita populations. To date the raw data indicates that the deer herd size is higher than the limit of 700. The deer population was inventoried at 744 in the fall of 1998, climbing to 1,230 in the spring of 1999, and reduced to 948 in the winter of 1999. This high density of deer has resulted in the continued adverse effects on the manzanita reducing growth (new leaves and branches), recruitment (flowers and fruit), and leaf litter accumulation (unpublished National Park Service data, 2000). The use of adaptive management to reduce the deer herd to a level where there is no significant effect on the manzanita measured through the monitoring program is expected to mitigate the impacts from the continued presence of deer on the island.

The Nature Conservancy has eliminated the cattle and sheep from the western portion of Santa Cruz Island and the National Park Service recently removed the remaining sheep from the east end of the island. The National Park Service purchased the east end of Santa Cruz Island in February 1997. The Nature Conservancy is exploring options for implementing island-wide feral pig removal and other management activities on Santa Cruz Island; these options may include developing an agreement with the National Park Service to manage natural resources on the island. A major removal effort will be needed to eliminate pigs from the island.

A program has been initiated to remove the goats and pigs on Santa Catalina Island. To date all pigs and goats have been removed from the west end of the island with a target of 2004 for the entire island.

The National Park Service and Biological Resources Division have conducted intensive surveys and the Biological Resources Division has conducted monitoring of population characteristics for selected species since the proposed and final rules listing the 13 plants were published. These surveys have produced valuable information on the status and distribution of Santa Rosa Island manzanita, Hoffmann's rock-cress, soft-leaved paintbrush, island bedstraw, Hoffmann's slender-flowered gilia, island rush-rose, Santa Cruz Island malacothrix, and island phacelia (see species accounts section).

We provided funding to the Santa Barbara Botanic Garden to gather data on population characteristics and life history for four of the plants in this recovery plan: Hoffmann's rock-cress, island barberry, Santa Cruz Island dudleya, and Santa Cruz Island bushmallow. The Santa Barbara Botanic Garden maintains living collection (seeds and/or living plants) of these four taxa. Although the research is ongoing, results to date have been included in the species accounts section of this recovery plan.

D. RECOVERY STRATEGY

All 13 species in this recovery plan have experienced threats to their survival from more than 150 years of intense grazing, browsing, and rooting pressure, and subsequent modification of habitat structure and function. The strategy to recover the species in this recovery plan will involve protection from alien mammals, stabilization of declining populations, enhancement of population viability, and restoration of constituent elements of the island ecosystems associated with these species. These actions will be accomplished largely through the development and implementation of a plan to achieve the goals and standards presented in the Conservation Strategy.

Restoration of habitats and control of competitive weeds needs to be a focus for long term management of the listed species and their habitats. Many areas of the islands are remote, have not been adequately or recently surveyed, and will require surveys to update information on the habitat distribution and potential habitat for the listed species in this recovery plan. Research should focus on effects of fire, which are poorly understood for the Santa Rosa Island manzanita, island bedstraw, island rush-rose, and others. Because little is known about a

wide range of ecological and life history aspects of these species, research needs to be conducted to provide that information. Recovery efforts should incorporate and apply the results from survey, monitoring, and research activities in an adaptive management approach to effectively recover and conserve these species and the ecosystems of which they are a part.

II. RECOVERY

A. OBJECTIVES

The overall objective of this recovery plan is to delist the federally listed species covered in this plan. Preliminary goals include (1) stabilizing and protecting populations, (2) conducting research necessary to refine recovery criteria, and (3) reclassifying to threatened (downlisting) those species currently federally listed as endangered. Reclassification is appropriate when a taxon is no longer in danger of extinction throughout a significant portion of its range. Because data upon which to base decisions about reclassification and recovery are mostly lacking, downlisting and recovery criteria in this recovery plan are necessarily preliminary.

B. RECOVERY CRITERIA

In general, downlisting criteria for federally listed endangered plant species are based on (1) the providing of protection and adaptive management of currently known (and in some cases historic) sites, (2) evidence that populations at these sites are stable or increasing over a number of years (years presented in Table 2 are determined by the life history of the individual species), (3) the preservation of the genetic diversity of the species by storing seeds in Center for Plant Conservation certified facilities, and (4) the development of reliable seed germination and propagation techniques. Populations should be monitored at appropriate time intervals. Research on population characteristics should be conducted to identify limiting life history stages. Until research shows otherwise, recovery objectives for downlisting subshrubs and herbaceous species should target securing several populations containing a minimum of 2,000 plants each (but preferably more). For long-lived species, recovery objectives should target a trend with increasing numbers of individuals and populations. The number of populations and the number of individuals will vary depending on the biology and life history of each taxa as well as the amount of suitable habitat available for each taxa. The probability of population persistence over the long-term is expected to be higher for larger populations and taxa with a large number of populations

because large size decreases the likelihood of reduced viability or population extirpations due to random naturally occurring events.

Delisting generally involves meeting the above criteria as well as finding, repatriating, or introducing several additional populations of the species. However, because repatriation and creation of populations are expensive and experimental, surveying historic sites and potential habitat within historic range to locate currently unknown populations is the preferred strategy. Once delisting criteria have been attained, a status review must be conducted to determine whether reclassification is appropriate. Generalized recovery criteria are presented in Table 2.

In Table 2, progress of species in achieving population goals depends on monitoring showing stable or increasing numbers during a precipitation cycle. A precipitation cycle includes periods of drought and wet years, with annual rainfall starting at 100 to 135 percent of average, dropping below 65 percent of average, and returning to at least average. Typically a precipitation cycle covers 10 to 15 years, but Nancy Vivrette's continuous 25 year study of vegetation patterns associated with the Santa Cruz Island dudleya indicate that the time period for understanding trends might be considerably longer than the 'normal' 10 to 15 year cycle. The criteria should be adjusted when additional research indicates otherwise, as we are apparently entering a dry climatic cycle complicated by the trend of global warming. Because populations of most or all species included here fluctuate dramatically, stability is a relative term and should take into account the phase of the precipitation cycle. Increasing population size means that the population has increased over a previous or baseline year measured during a similar portion of a precipitation cycle. Range wide population monitoring programs will have to be established for all species to measure progress in meeting recovery criteria.

Table 2. Recovery Criteria for each of the 13 Plant Taxa

SPECIES	ACTION	POPULATION STANDARDS	OTHER ACTIONS
Arabis hoffmannii Hoffmann's rockcress	Downlist	Discover or establish 10 populations per island (Santa Rosa and Santa Cruz); stable or increasing with evidence of natural recruitment for a period of 15 years that includes the normal precipitation cycle.	Seed stored in Center for Plant Conservation (CPC) cooperating facility; seed germination and propagation techniques understood. Successful outplanting techniques developed. Life history research conducted and incorporated into recovery criteria. If declining trend documented, determine cause and reverse trend.
	Delist	No decline after downlisting for 10 years.	All potential habitat surveyed.
Arctostaphylos confertiflora Santa Rosa Island manzanita	Downlist	Maintain three populations on Santa Rosa Island that are stable or increasing with evidence of natural recruitment for a period of 30 years that includes the normal precipitation cycle.	Seed stored in CPC cooperating facilities; seed germination, propagation techniques, and fire ecology understood. Natural seed bank developed and maintained. Fire management plan developed. Protected from browsing to allow reproduction. Life history research conducted and incorporated into recovery criteria. If declining, determine cause and reverse trend
	Delist	No decline after downlisting for 10 years.	All potential habitat surveyed.
Berberis pinnata ssp. *insularis* Island barberry	Downlist	Discover or establish five populations per island (Santa Rosa and Santa Cruz), two to three populations on Anacapa Island; stable or increasing with evidence of natural recruitment for a period of 15 years that includes the normal precipitation cycle.	Seed stored in CPC cooperating facilities; seed germination and propagation techniques understood. Successful outplanting techniques developed. Life history research conducted. Causes of seedling mortality understood. Living collection maintained at CPC facility.

	Delist	Discover or outplant five additional populations per island. No decline after downlisting for 10 years. If declining, determine cause and reverse trend.	All potential habitat surveyed.
Castilleja mollis soft-leaved paintbrush	Downlist	Maintain the existing distribution with multiple colonies in each population on Santa Rosa Island. Maintain stable or increasing population trends with evidence of natural recruitment for a period of 15 years that includes the normal precipitation cycle. Damage from nonnative mammals significantly reduced.	Seed stored in CPC cooperating facilities; seed germination and propagation techniques understood. Successful outplanting techniques developed. Host plant and weed management plan developed and implemented. Life history research conducted. Hybridization with *Castilleja affinis* understood. If declining, determine cause and reverse trend.
	Delist	Expansion of individuals into potential habitat within population boundaries. No decline after downlisting for 10 years.	All potential habitat surveyed.
Dudleya nesiotica Santa Cruz Island dudleya	Delist	Maintain the existing population as stable with evidence of natural recruitment for a period of 20 years that includes the normal precipitation cycle.	Seed stored in CPC cooperating facilities; seed germination and propagation techniques understood. Weed competition understood and managed. Pig damage controlled. Life history research conducted.
Galium buxifolium island bedstraw	Downlist	Stabilize or increase populations on Santa Cruz and San Miguel Islands with evidence of natural recruitment for a period of 20 years that includes the normal precipitation cycle. Reintroduce plants to historic locations.	Seed stored in CPC cooperating facilities; seed germination and propagation techniques understood. Life history research conducted. Surveys of historic locations conducted. If declining, determine cause and reverse trend.

	Delist	Discover or establish five additional populations per island (San Miguel and Santa Cruz). No decline after downlisting for 10 years.	All potential habitat surveyed.
Gilia tenuiflora ssp *hoffmannii* Hoffmann's slender-flowered gilia	Downlist	Establish 10 populations on Santa Rosa Island that are stable or increasing for a period of 15 years that includes the normal precipitation cycle.	Seed stored in CPC cooperating facilities; seed germination and propagation techniques understood. Life history research conducted. Competitive effects of nonnative grasses understood. If declining, determine cause and reverse trend.
	Delist	Discover or establish five additional populations. No decline after downlisting for 10 years.	All potential habitat surveyed.
Helianthemum greenei island rush-rose	Delist	Maintain existing stable populations on Santa Cruz and Santa Catalina Islands for a period of 15 years that includes the normal precipitation cycle.	Seed stored in CPC cooperating facilities; seed germination and propagation techniques understood. Successful outplanting techniques developed. Life history research conducted. Experimental use of fire for population enhancement researched and applied.
Malacothamnus fasciculatus ssp. *nesiotica* Santa Cruz Island bushmallow	Downlist	Establish five viable populations on Santa Cruz Island. Maintain populations as stable or increasing with evidence of natural recruitment for a period of 15 years that includes the normal precipitation cycle.	Seed stored in CPC cooperating facilities; seed germination and propagation techniques understood. Successful outplanting techniques developed. Life history research conducted. Weed management plan developed and implemented. If declining, determine cause and reverse trend.

	Delist	Discover or establish five additional populations No decline after downlisting for 10 years.	All potential habitat surveyed.
Malacothrix indecora island malacothrix	Downlist	Maintain existing stable populations on San Miguel, Santa Cruz, and Santa Rosa Islands for a period of 15 years that includes the normal precipitation cycle.	Seed stored in CPC cooperating facilities; seed germination and propagation techniques understood. Successful outplanting techniques developed. Life history research conducted. Weed management plan developed and implemented. If declining, determine cause and reverse trend.
	Delist	No decline after downlisting for 10 years.	All potential habitat surveyed.
Malacothrix squalida Santa Cruz Island malacothrix	Downlist	Discover or establish 10 additional populations on Anacapa and Santa Cruz Islands. Maintain stable populations for a period of 15 years that includes the normal precipitation cycle.	Seed stored in CPC cooperating facilities; seed germination and propagation techniques understood. Successful outplanting techniques developed. Life history research conducted. Weed management plan developed and implemented. If declining, determine cause and reverse trend.
	Delist	No decline after downlisting for 10 years.	All potential habitat surveyed.
Phacelia insularis var. *insularis* island phacelia	Downlist	Discover or establish 10 populations per island (San Miguel and Santa Rosa); maintain stable populations for a period of 15 years that includes the normal precipitation cycle.	Seed stored in CPC cooperating facilities; seed germination and propagation techniques understood. Successful outplanting techniques developed. Life history research conducted. Weed management plan developed and implemented. If declining, determine cause and reverse trend.

	Delist	Discover or establish five additional populations per island. No decline after downlisting for 10 years.	All potential habitat surveyed.
Thysanocarpus conchuliferus Santa Cruz Island fringepod	Downlist	Establish or discover 10 populations on Santa Cruz Island; maintain stable populations for a period of 15 years that includes the normal precipitation cycle.	Seed stored in CPC cooperating facilities; seed germination and propagation techniques understood. Successful outplanting techniques developed. Life history research conducted. Pig damage controlled. If declining, determine cause and reverse trend.
	Delist	Discover or establish five additional populations on Santa Cruz Island. No decline after downlisting for 10 years.	All potential habitat surveyed.

C. STEPDOWN NARRATIVE

1. Protect existing populations from threats and manage habitat.

Protection against threats and managing habitat is essential to the recovery of these species. The goals and standards presented in the Conservation Strategy should be used to direct recovery efforts.

1.1 Eliminate threats from nonnative animals.

The effective elimination of habitat damage from nonnative animals is the most important management task required for the recovery of those species in this recovery plan that occur on islands with nonnative mammals.

1.1.1 Control elk and deer damage to plants on Santa Rosa Island.

As part of a lawsuit settlement and the adoption of the Natural Resource Management Plan for Santa Rosa Island, an adaptive management program is being implemented. The program will evaluate deer and elk damage to Santa Rosa Island manzanita and soft-leaved paintbrush. Herd size will be reduced to prevent continued damage to these species within a year of damage. If flowering and fruiting continue to decline through nonnative animal damage, the herd sizes are to be reduced as per the lawsuit settlement. All deer and elk are scheduled to be off Santa Rosa Island by the year 2011.

1.1.2 Remove pigs from Santa Cruz Island.

Develop and implement an island-wide pig removal plan to prevent the continuing habitat degradation on Santa Cruz Island. The National Park Service successfully removed pigs from Santa Rosa Island and should collaborate with The Nature Conservancy and other California island managers to develop methods that will expedite the elimination of pigs from all of Santa Cruz Island.

1.1.3 Control nonnative animals on Santa Catalina Island for island rush-rose.

A program to reduce the threat of nonnative animals on Santa Catalina Island is being developed and implemented. Collaboration with other California island managers is recommended to provide maximum efficiency in employing successful techniques to control nonnative animal damage to island habitats and listed species.

1.2 Minimize the threats from invasive, nonnative plants.

Removal and control of nonnative invasive plants is an important requirement to recover Hoffmann's rock-cress, soft-leaved paintbrush, Santa Cruz Island dudleya, Hoffmann's slender-flowered gilia, island malacothrix, island phacelia, Santa Cruz Island fringepod, and their habitats. The National Park Service has initiated an inventory of invasive plant locations on Santa Rosa Island. Monitoring should be conducted every 2 to 3 years,

expanded to the other islands, and followed by a removal and control program.

1.3 Manage occurrences and habitats.

Management of the listed plant species and their habitat will depend upon information gained from monitoring, threat analysis, and the evaluation of protection alternatives. It will be important to involve the expertise of land managers and species experts to develop conservation programs. Different management programs may be needed for each species. The management program selected will require periodic review to ensure that it is effective in protecting the species.

1.3.1 Develop and implement a plan to achieve the goals and standards established in the Conservation Strategy.

The goals and standards established in the Conservation Strategy provide for ecosystem-wide habitat restoration, which will benefit the habitat restoration process needed for the recovery of the species in this recovery plan. The need to improve habitat conditions on the islands will benefit the restoration of potential, unoccupied habitat for the species in this recovery plan and promote recovery. Within 1 year of the finalization of the Conservation Strategy, the implementation plan should be developed. Implementation of the plan should begin upon its completion.

1.3.2 Develop guidelines and implement management for each species.

Within 2 years of the finalization of this recovery plan, specific management practices should be developed for each species to ensure their conservation. This should include the preparation and implementation of management guidelines to address habitat restoration (e.g., increase shrub canopy cover of native shrubs for Hoffmann's rock-cress), control of invasive nonnative plant species, potential for reintroduction, compatible levels of recreational uses (e.g., trails down Lobo Canyon must avoid Santa Cruz Island malacothrix at the mouth of the canyon), and monitoring strategies.

1.3.3 Revise management guidelines based on information gathered from tasks 2, 3, and 4.

Information gathered from additional surveys, life history research, and monitoring data should be used to revise management of the species and their habitats to maximize their recovery.

2. Establish an inventory program for all species in the recovery plan.

Many areas of the islands are remote and have not been adequately or recently surveyed. Areas containing potential habitat need to be surveyed to determine whether undiscovered populations exist. If new populations are discovered, they will be assessed for potential threats and the needs for

protection evaluated. During the surveys, potential introduction sites will be identified. Survey historic locations to determine whether suitable habitat remains, if the species persists at the site, and/or if the sites remain suitable for repatriation. Suitability of historic sites for repatriation depends upon whether potential habitat exists, the presence and magnitude of the threats, our level of understanding about their life history (see task 3), and the imposed constraints on survival and recruitment in habitats altered by grazing. Surveys of historic sites were conducted on San Miguel and Santa Rosa Islands by the Biological Resources Division from 1996 to 1998, and were planned for an additional season. Conduct surveys on Santa Cruz Island and Anacapa Island.

3. Conduct biological and ecological research to define life history strategies and population dynamics to guide recovery/conservation efforts.

A better understanding of the population characteristics, and identification of factors that may be affecting those characteristics, is needed to develop appropriate management plans to recover the species in this recovery plan. Information regarding life history and the response of these plant species to management activities is generally needed in the following areas:

3.1 Seed production and dispersal mechanisms (to understand potential distribution).

3.2 Seed dormancy, seed germination, and seedling establishment with respect to soil conditions and competition from other plants.

3.3 Soil seed bank (viable seed condition in the soils of occupied habitat).

3.4 Effects of soil and vegetation disturbance (gaps in vegetation) on recruitment of seedlings.

3.5 Soil distribution of each listed species to assist in prioritizing surveys and potential introduction sites.

3.6 Microsite soil characteristics (pH, texture, hydrology, slope, etc.) of the listed species.

3.7 Experimental results on effects of removal of nonnative plant species.

3.8 Effects of vegetation management (burning, herbicide use, etc.) on mixed stands of nonnative and target species.

3.9 The relationship between substrate disturbance and invasion by nonnative plants that threaten listed species that require open habitat.

3.10 Metapopulation dynamics (how are the various sites interrelated).

3.11 Pollinators and vectors in reproduction.

3.12 The effects of fire management on the species and their requirements for fire.

4. Monitor effectiveness of reducing threats.

Wide spatial and temporal variability has been observed in populations of Santa Cruz Island malacothrix, island phacelia, Hoffmann's slender-flowered gilia, and others. Plot based monitoring of population characteristics is being done for soft-leaved paintbrush and Hoffmann's slender-flowered gilia. Monitoring should be conducted to document population dynamics and cycles to determine population trends for each species. This monitoring will help determine whether to downlist or delist the species that no longer have active, serious threats. Monitoring will also help to review the stability of the habitats on which the species depend. Recovery efforts should incorporate and apply the results from surveys, research activities, and monitoring in an adaptive management approach to effectively recover and conserve these species and the ecosystems of which they are a part.

4.1 Identify standards for monitoring decreased threats to listed plants. Identify standards to measure the success in reducing the levels of threats.

4.2 Monitor decreased threats to listed plants.
Annual monitoring should be conducted for each of the listed plants initially, reducing frequency to every other year after baseline information is established.

5. Preserve the genetic diversity of the species in this recovery plan.

Because the endangered plants occur in very few locations, seed banking and, for a few species, living collections are prudent to guard against chance catastrophic events.

5.1 Collect and store seed for the species in this recovery plan.

Maintain seed collections that are representative of the source populations. Detailed guidelines for seed collection have been published by the Center for Plant Conservation (1991). Rancho Santa Ana Botanic Gardens is the local seed storage facility for southern California; implement agreements to ensure long term storage and seed banking.

5.2 Maintain living collections of the long lived species.

Living collections should be maintained in Center for Plant Conservation gardens of long lived taxa with low genetic diversity (island barberry and Santa Cruz Island bushmallow). Greenhouse and garden facilities should be constructed on each island to maintain living collections and develop a propagation program as has been done on Santa Catalina, San Nicolas, and Santa Rosa Islands.

6. Develop, evaluate, and implement techniques to artificially enhance or introduce populations.

Restoration and reintroduction may be necessary to expand the current ranges of Hoffmann's rock-cress, island barberry, island bedstraw, Hoffmann's slender-flowered gilia, Santa Cruz Island bushmallow, Santa Cruz Island malacothrix, island malacothrix, island phacelia, and Santa Cruz Island fringepod to reduce the risk of extinction through random and natural events. Therefore, techniques need to be developed for artificial enhancement, repatriation, or introduction of populations for the species listed in this recovery plan. Artificially propagated plants or collected seeds can provide potential material for enhancement efforts in existing populations, repatriation of plants to former sites and/or introduction to new sites and to provide techniques to prevent extinction. Santa Barbara Botanic Garden and the Biological Resources Division have conducted preliminary work, which is to be continued and expanded, on germination and growth techniques for these species. Introduction experiments in appropriate habitat should measure the relevance of this technique for recovery.

6.1 Collect seed and/or cuttings for plants identified for introduction efforts.

Seed and cuttings, where appropriate, need to be collected and grown for future introduction programs.

6.2 Initiate enhancement, repatriation, or introduction where appropriate.

Outplant artificially propagated plants or collected seeds to enhance existing populations, provide repatriations of former sites, and/or introductions to new sites.

7. Develop a Channel Islands research coordinating committee for research and education.

7.1 Establish a Channel Islands coordinating committee. The National Park Service, The Nature Conservancy, the Santa Catalina Island Conservancy, and the two Navy Islands (San Nicolas and San Clemente) should increase communication and sharing between the Channel Islands resource managers and scientists to more effectively address similar issues and problems for recovery of listed species and their ecosystems.

7.2 The National Park Service, The Nature Conservancy, and the Santa Catalina Island Conservancy should expand their existing interpretive programs to include information about the uniqueness of the listed species, natural functioning ecosystems, and the importance of conservation efforts to recover them.

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IV. IMPLEMENTATION SCHEDULE

The Implementation Schedule is a guide for meeting the objectives discussed in Part II of this recovery plan. This schedule indicates task priorities, task numbers, brief task descriptions, duration of tasks, the responsible agencies, and lastly, estimated costs. These actions, when accomplished, should bring about the recovery of the species and protect their habitat. Priorities in column one of the following implementation schedule are assigned as follows:

Priority 1:	An action that must be taken to prevent extinction or to prevent the species from declining irreversibly in the foreseeable future.
Priority 2:	An action that must be taken to prevent a significant decline in the species' population/habitat quality or some other significant negative impact short of extinction.
Priority 3:	All other actions necessary to meet the recovery objective.

Key to Acronyms used in the Implementation Schedule:

FWS	U.S. Fish and Wildlife Service
NPS	National Park Service
TNC	The Nature Conservancy
BRD	Biological Resources Division, U.S. Geological Survey
SCIC	Santa Catalina Island Conservancy
RSA	Rancho Santa Ana Botanic Garden
SBBG	Santa Barbara Botanic Garden
DOD	Department of Defense
*	Lead responsible agency
ongoing	Indicates the task has been implemented and will continue until no longer necessary.
continuous	Indicates the task will be implemented on an annual basis once it was begun.

Implementation Schedule for the Thirteen Plant Taxa from the Northern Channel Islands Recovery Plan

PRIORITY #	TASK #	TASK DESCRIPTION	TASK DURATION (YRS)	RESPONSIBLE PARTY	TOTAL COST	COST ESTIMATES ($1,000)				
						FY 2001	FY 2002	FY 2003	FY 2004	FY 2005
1	1.1.1	Control elk and deer damage to plants on Santa Rosa Island.	10	NPS*, FWS	400	40	40	40	40	40
1	1.1.2	Remove the pigs from Santa Cruz Island.	8	NPS*, TNC	8,000	1,700	900	900	900	900
1	1.1.3	Control nonnative animals on Santa Catalina Island for island rush-rose.	10	SCIC*	6,000	1,500	500	500	500	500
1	1.2	Minimize the threats from invasive, nonnative plants.	Ongoing	NPS*, SCIC*, TNC*	8,000	200	200	200	200	200
1	1.3.1	Develop and implement a plan to achieve the goals and standards established in the Conservation Strategy.	10	NPS*, BRD* TNC*, FWS*	2,200	300	300	200	200	200
1	1.3.2	Develop guidelines and implement management for each species.	10	NPS*, SCIC*, TNC*, BRD, FWS	5,000	500	500	500	500	500
1	1.3.3	Revise management guidelines based on information gathered from tasks 2, 3, and 4.	Continuous	NPS*, SCIC*, TNC*, BRD*, SCIC*, FWS*	As needed	As needed	As needed	As needed	As needed	As needed
1	6.1	Collect seed and/or cuttings for reintroduction efforts.	5	SBBG*, RSA*, NPS, TNC, SCIC	395	195	50	50	50	50
1	6.2	Initiate enhancement, repatriation, or introductions where appropriate.	10	NPS*, TNC*, SCIC*, SBBG, RSA	2,000	200	200	200	200	200
Priority Task 1 Subtotal Cost:					31,995	4,635	2,690	2,590	2,590	2,590

Implementation Schedule for the Thirteen Plant Taxa from the Northern Channel Islands Recovery Plan

PRIORITY #	TASK #	TASK DESCRIPTION	TASK DURATION (YRS)	RESPONSIBLE PARTY	TOTAL COST	COST ESTIMATES ($1,000)				
						FY 2001	FY 2002	FY 2003	FY 2004	FY 2005
2	2	Establish and implement an inventory program for all species in the recovery plan.	10	NPS*, TNC*, SCIC*, BRD, FWS	1,000	100	100	100	100	100
2	3.1	Research on seed production and dispersal mechanisms.	5	BRD*, SBBG*, SCIC*, NPS, TNC, FWS	75	15	15	15	15	15
2	3.2	Research on seed dormancy, seed germination, and seedling establishment.	5	BRD*, SBBG*, SCIC*, NPS, TNC, FWS	75	15	15	15	15	15
2	3.3	Research on soil seed bank (viable seed condition in the soils of occupied habitat).	5	BRD*, SBBG*, SCIC*, NPS, TNC, FWS	75	15	15	15	15	15
2	3.4	Research on effects of soil and vegetation disturbance (gaps in vegetation) on recruitment of seedlings.	5	BRD*, SBBG*, SCIC*, NPS, TNC, FWS	75	15	15	15	15	15
2	3.5	Research on soil distribution of each listed species to assist in prioritizing surveys and potential introduction sites.	5	BRD*, SBBG*, SCIC*, NPS, TNC, FWS	75	15	15	15	15	15
2	3.6	Research on microsite soil characteristics (pH, texture, hydrology, slope, etc.) of the listed species.	5	BRD*, SBBG*, SCIC*, NPS, TNC, FWS	75	15	15	15	15	15

Implementation Schedule for the Thirteen Plant Taxa from the Northern Channel Islands Recovery Plan

PRIORITY #	TASK #	TASK DESCRIPTION	TASK DURATION (YRS)	RESPONSIBLE PARTY	TOTAL COST	COST ESTIMATES ($1,000)				
						FY 2001	FY 2002	FY 2003	FY 2004	FY 2005
2	3.7	Research on effects of experimental removal of nonnative plant species.	5	BRD*, SBBG*, SCIC*, NPS*, TNC*, FWS	75	15	15	15	15	15
2	3.8	Research on effects of vegetation management (burning, herbicide use, etc.) on mixed stands of nonnative and target species.	10	BRD*, SBBG*, SCIC*, NPS*, TNC*, FWS	150	15	15	15	15	15
2	3.9	Research on the relationship between substrate disturbance and invasion by nonnative plants that threaten listed species that require open habitat.	5	BRD*, SBBG*, SCIC*, NPS*, TNC*, FWS	75	15	15	15	15	15
2	3.10	Research on metapopulation dynamics (how are the various sites interrelated).	10	BRD*, SBBG*, SCIC*, NPS*, TNC*, FWS	150	15	15	15	15	15
2	3.11	Research on pollinators and vectors in reproduction.	5	BRD*, SBBG*, SCIC*, NPS*, TNC*, FWS	75	15	15	15	15	15
2	3.12	Research on fire management effects on the species and species requirements for fire.	10	BRD*, SBBG*, SCIC*, NPS*, TNC*, FWS	150	15	15	15	15	15
2	4.1	Identify standards for monitoring listed plants.	2	BRD*, NPS*, SBBG, TNC, FWS	20	10	10			
2	4.2	Monitor listed plants.	Ongoing	NPS*, TNC*, SCIC*, BRD, FWS	13,800	345	345	345	345	345

Implementation Schedule for the Thirteen Plant Taxa from the Northern Channel Islands Recovery Plan

PRIORITY #	TASK #	TASK DESCRIPTION	TASK DURATION (YRS)	RESPONSIBLE PARTY	TOTAL COST	COST ESTIMATES ($1,000)				
						FY 2001	FY 2002	FY 2003	FY 2004	FY 2005
2	5.1	Collect, store, and develop seed banking techniques for the species in this recovery plan.	Continuous	SBBG*, RSA*, NPS, TNC	1,955	200	45	45	45	45
2	5.2	Maintain living collections.	Continuous	SBBG*, RSA*	170	50	30	30	30	30
Priority Task 2 Subtotal Cost:					18,070	885	710	700	700	700
3	7.1	Establish coordinated resource management group	Continuous	NPS*, TNC*, SCIC*, DOD*	1,025	50	25	25	25	25
3	7.2	Develop and implement a public education program.	Continuous	NPS*, TNC*, SCIC*	830	50	20	20	20	20
Priority Task 3 Subtotal Cost:					1,855	100	45	45	45	45
TOTAL COST (assuming 40 years until recovery)					**51,920**	**5,920**	**4,045**	**3,935**	**3,935**	**3,935**

Appendix A

Summary of the Agency and Public Comments on the Draft Recovery Plan

We received two comment letters from two island experts as peer review. The comments were technical in nature and were incorporated into the final version. Both reviewers strongly emphasized the need to remove the threats of nonnative animals and plants.

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