ALIEN PLANTS AT CHANNEL ISLANDS NATIONAL PARK

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ABSTRACT

Alien plant species are an important part of the biota of Channel Islands National Park. The Park plant list consists of 334 species; of these, 23.6% are considered to be alien to the southern California flora. However, alien species are much more important than floristics indicate; the vegetation of the islands is dominated by alien species. The primary cause is anthropogenic disturbance, not simply the introduction of species. In most cases, the original vegetation of the Channel Islands had a large component of shrubs and trees, whereas the alien plant communities on the Islands today are primarily herbaceous. In recovery from disturbance, native shrubs often return to dominate the landscape; the alien species, though not completely eliminated, are reduced in numbers of individuals and to subordinance rather than dominance. A few alien plant species on the Islands are quite aggressive. Without active control and management, these species can outcompete the natives and gain control. These are the species of most interest, given limited Park natural resources support.

INTRODUCTION

Alien plants (see terminology of Smith 1985) have been important in the flora of the Channel Islands (Fig. 1) since the early influence of European man in the late 1700s. A recent compilation of all available information on the flora of the Channel Islands (Wallace 1985) shows a total of 848 plant species present on nine islands (the eight California Channel Islands and Guadalupe Island, Mexico). Of the 848 species, 621 (73.2%) are considered native, 227 (26.8%) alien. Endemics constitute 16.2% of the total flora and 22.1% of the native flora. On the five islands (Anacapa (West, Middle, and East), Santa Barbara, and San Miguel) managed by Channel Islands National Park in 1986, there are 334 species, of which 79 (23.6%) are alien and 33 (9.9%) endemic (Appendix A). Management of the resources of Channel Islands National Park includes both the control of alien species and the encouragement of rare and endemic species. Management of the area

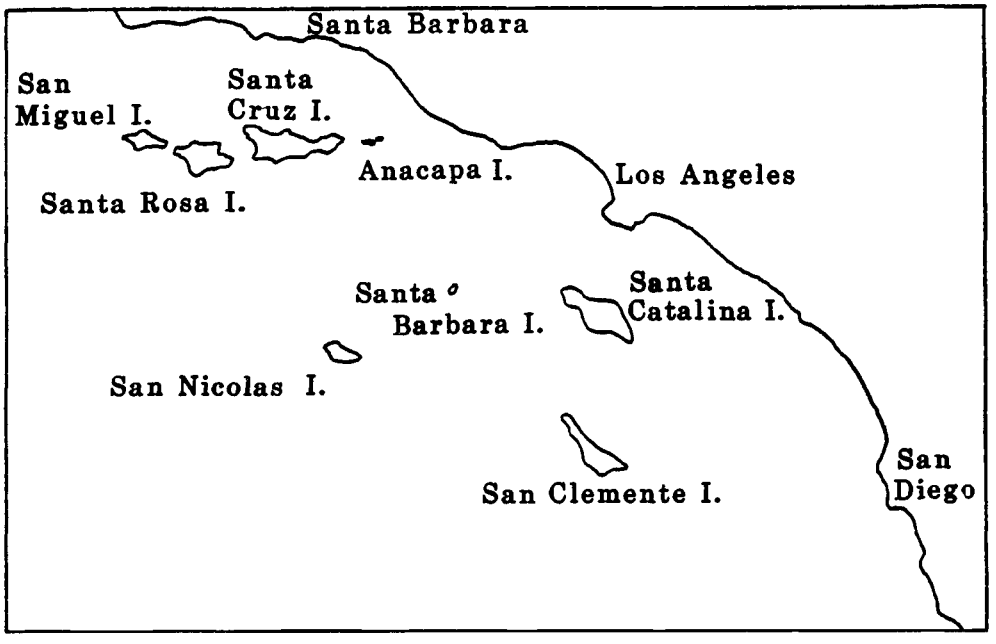

Figure 1. Channel Islands National Park as of 1986 (Anacapa West, Middle, and East; Santa Barbara; and San Miguel).

takes into consideration community integrity rather than simply the preservation of species populations.*

PHYSICAL FEATURES

With an area of approximately 640 a (260 ha), Santa Barbara Island is the smallest of the Channel Islands. It is located 38 mi (61 km) southwest of Los Angeles and 24 mi (39 km) west of Santa Catalina Island. Anacapa (690 a or 280 ha) is located about 12 mi (19 km) south of the mainland at Ventura. These islands are primarily of Miocene volcanic origin, with some small areas of Miocene sedimentary material (Kemnitzer 1933; Emery 1960; Vedder and Howell 1976). Quaternary sedimentary deposits of both marine and nonmarine origin cover the volcanic bedrock over most of Santa Barbara Island (Lipps *et al.* 1968; Johnson, 1979). Various joints, faults, and fractures are seen in sea cliffs about Anacapa, and where these intersect the sea, caves have formed (Scholl 1960; Valentine and Lipps 1963; Lipps 1964; Johnson 1979). Both islands are characterized by steep, rocky sea slopes.

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*A recent (1988) list includes information for the five islands within Park boundaries. This list is available from the author and includes 802 species, of which 195 (24.3%) are alien and 85 (10.6%) are endemic.

San Miguel Island encompasses an area of approximately 9,885 a or 4,000 ha and is the westernmost of the northern Channel Islands. It lies about 28 mi (45 km) south of Point Conception and 62 mi (100 km) west-northwest of Ventura. This island is composed primarily of Cretaceous and early- to mid-Tertiary conglomerates, sandstones, siltstones, shales, and volcanics. For the most part, bedrock is covered by sand. Structurally, the island represents the northern flank of a folded and faulted anticline, whose axis trends northwest-southeast (Weaver and Doerner 1969; Weaver *et al.* 1969; Johnson 1979). Topographically, San Miguel is dominated by two rounded peaks with relatively gentle slopes leading to the sea. Prominent marine terraces are present, as are a number of large canyons and extensive beaches.

A reconnaissance soil survey of the Islands was conducted by Johnson (1979). He found three types of soils: 1) Entisol soils have formed in recent calcareous sands and in the steep, highly erodible areas around the perimeter of each island. These soils show very little profile development. 2) Vertisol soils, characterized by a high level of expandable clays that swell when wet and shrink when dry, creating deep cracks in the soil surface, occur in areas with deep deposits. Over time, this shrink-swell motion churns the soil into a fairly uniform, nonhorizonated profile with similar properties throughout. 3) Mollisol soils, characterized by a high clay content, a high base concentration, and a dark surface horizon containing a modest to high organic matter content, are usually found in the central portions of each island. These soils also show shrink-swell properties and form cracks when dry.

Specific weather/climate characteristics of the Islands are relatively undefined due to the lack of adequate records. The National Park Service has had automated, real-time reporting weather stations in operation since November 1985. From these data, together with information from other islands, nearby mainland stations, and a few records available from earlier periods, it is possible to gain a general picture of the weather. The Channel Islands lie in the Dry-summer Subtropical climatic region, commonly called the Mediterranean (Trewartha 1954). Rainfall generally comes only in the winter months, leaving the months of April through October rain free. Annual rainfall appears to be in the range of 50-65 in. (204-254 mm) for Santa Barbara, 40-50 in. (152-203 mm) for Anacapa, and 76-90 in. (300-355 mm) for San Miguel. In the scale reported by Dunkle (1950), this puts Santa Barbara Island in the arid maritime climatic zone, to the north of the desert maritime; San Miguel in the semi-humid maritime to the north and west; and Anacapa on the boundary between the two. Island temperatures are generally mild year-round due to the marine influence, and they show small diurnal and seasonal fluctuations. Mean annual temperatures are 60.8 F (16.0 C) for Santa Barbara and 56.6 F (13.7 C) for San Miguel, compared to 61.5 F (16.4 C) for Long Beach on the mainland.

Santa Barbara Island is far less windy than either San Miguel or Anacapa because it is protected from the strong northwesterly winds, which sweep down past Point Conception, and the Santa Ana winds, which come off the mainland. The winds on Santa Barbara and Anacapa are usually of low velocity except for those periods when the jet stream shifts south, causing

strong westerly winds. San Miguel Island experiences wind nearly year-round, with brief lulls coming on the heels of passing storm fronts. Winds commonly blow out of the northwest at 12-19 mi/hr (20-30 km/hr), with storm periods bringing winds of 25-28 mi/hr (40-45 km/hr).

Cloudiness is also seasonal, with the winter season having cloudy, stormy weather interspersed with generally clear skies. The summer is characterized by a layer of fog (marine layer) that hangs offshore and generally covers the Islands, except for a variable amount of time at midday, when it burns off above land surfaces. San Miguel Island has the most consistently foggy weather (Dunkle 1950; Weissman and Rentz 1977; National Park Service, unpub. data).

VEGETATION COMMUNITIES OF CHANNEL ISLANDS NATIONAL PARK

The vegetation of the Channel Islands is Mediterranean in nature, ranging from grassland and scrubland through chaparral to woodland communities. The islands currently managed by the National Park Service -- Anacapa, Santa Barbara, and San Miguel -- all have low community diversity. Santa Barbara has no tree species, and Anacapa and San Miguel have a few trees in deeper canyons. Sea cliff and island grassland communities cover the largest areas of the islands, with perennial iceplant, coastal sage scrub, and coreopsis scrub communities forming patches of various sizes within the other two. Alien species dominate both the island grassland and perennial iceplant communities.

Native Shrublands

The native shrublands of the islands are varied and found to be more important on islands that have had the most amount of time to recover from ranching disturbance (Figs. 2-4). The more important shrub communities are described below.

Sea Cliffs. Due to the form of Santa Barbara and Anacapa Islands, with steep slopes from the sea to 245 ft (75 m), the sea cliff community is very important on these islands. The community is actually dominated by bare rock and soil, but it supports a number of species that are more or less restricted to cliffs. This is in part due to the fact that the slopes have been inaccessible to humans and domestic and feral herbivores; thus they have been refugia during periods of intense use. The widely scattered shrubs and succulents are all low growing (less than 1.6 ft or 0.5 m). Some of the rarer species found here are: *Eriogonum giganteum* var. *compactum*, *Eriophyllum nevinii*, and *Dudleya traskiae*, which are all island endemics. *Dudleya traskiae*, in fact, is restricted to Santa Barbara and is on the Federal list of endangered species. This is by far the least impacted of all communities on the Islands.

The sea cliff community on Anacapa Island is almost entirely restricted to the north-facing slopes, which catch most of the prevailing northwest winds. This community is dominated by bare rock and, as at Santa Barbara, is composed of a rather large number of species, none of which dominate the

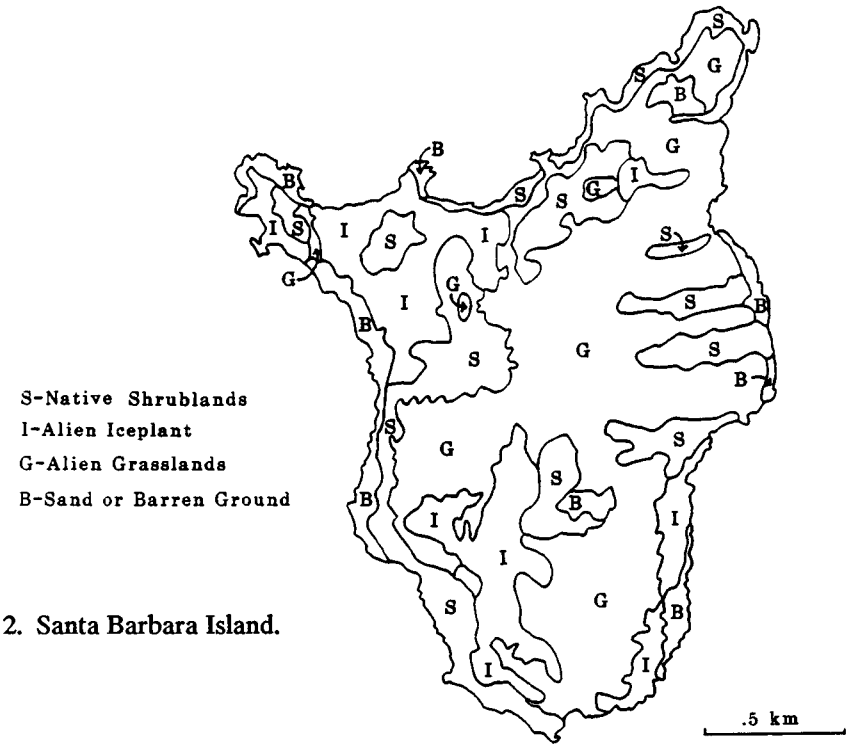


Figure 2. Santa Barbara Island.

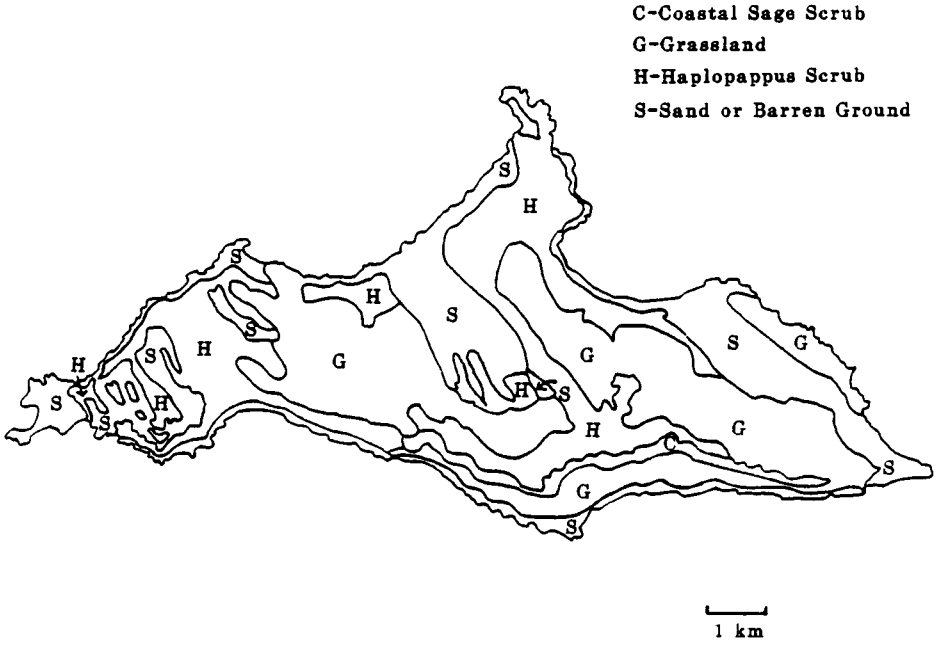


Figure 3. San Miguel Island.

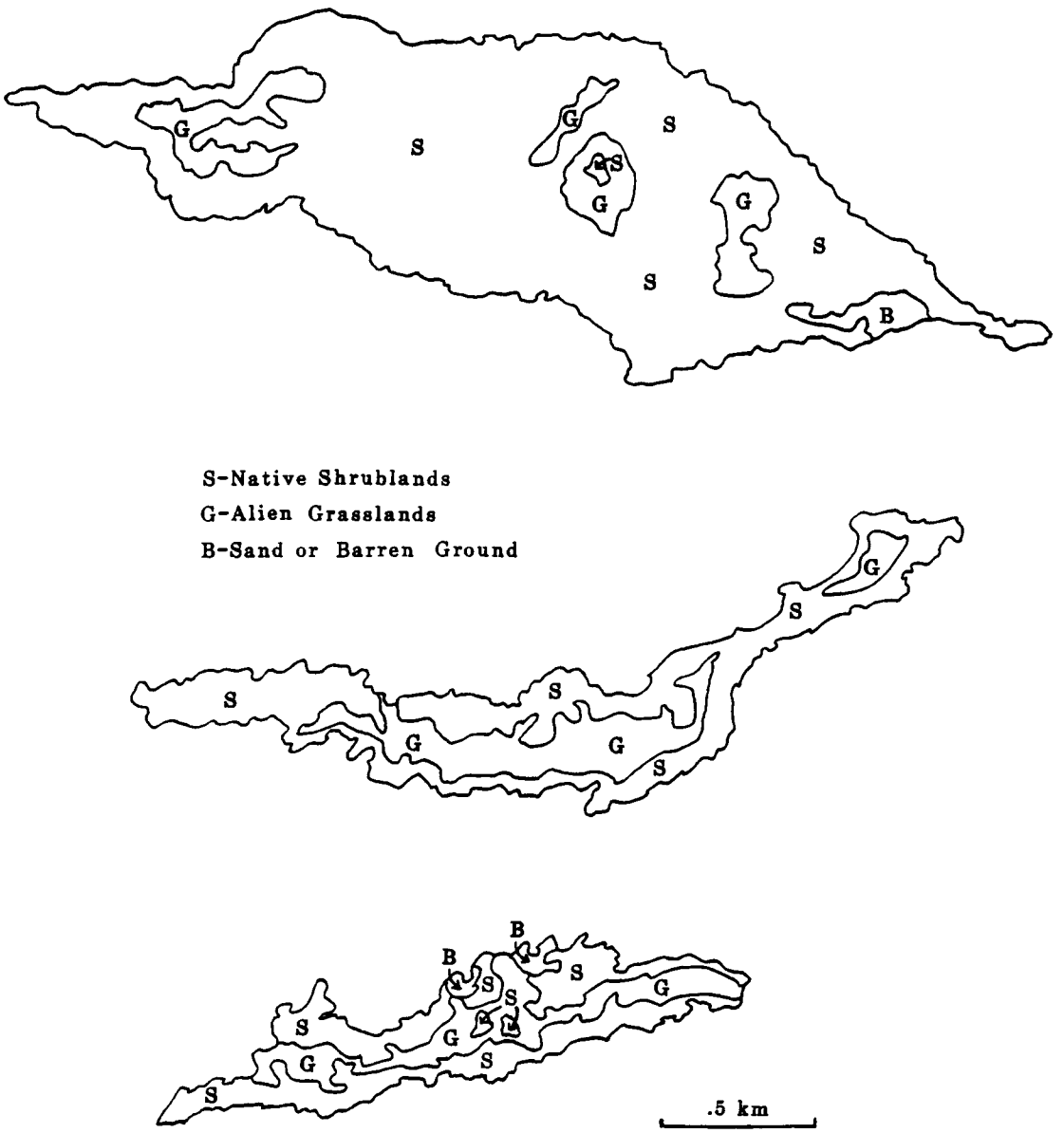


Figure 4. Anacapa Island (East, Middle, and West -- top to bottom).

landscape and most of which are also found on the island itself in other communities. Representative species include: *Dudleya caespitosa, Eriogonum grande* var. *grande, Malacothrix implicata, Eriophyllum* sp., *Haplopappus* sp., and various annual grasses.

On San Miguel Island, sandy beaches alternate with rocky headlands with their sea cliffs, which, though not as imposing as at Anacapa, are important to the island vegetation. As on the other islands, this community is widely scattered and dominated by species that are also found in other communities. Important species are: *Achillea millefolium, Artemisia californica, Coreopsis gigantea, Erigeron glaucus, Eriogonum grande* ssp. *rubescens, Galium buxifolium, Lotus dendroideus* var. *veatchii, Malacothrix saxatilis* var. *implicata*, and *Marah macrocarpus.*

Coreopsis Scrub. Giant coreopsis (*Coreopsis gigantea*) is one of the most picturesque species on the islands. It is a semi-succulent shrub that can attain heights of 8.2 ft (2.5 m). It is drought deciduous, with the dried leaves being persistent over the summer. Bright sunflower-like flowers follow the new leaves during the rainy period. *Coreopsis* once covered large portions of gentle island slopes, but because of its semi-succulent nature, it was reduced by farming, grazing, and fire to a few refugia on steep slopes and in canyons. These populations are now expanding to once again cover a major portion of each island. The physiognomy of this scrub community is of a tall shrub canopy, often closed enough to prohibit any understory. Newly developing stands have an understory of the grassland into which the species is expanding. There are no important associated shrub species. Herbaceous associates are: *Calystegia macrostegia* ssp. *amplissima, Marah macrocarpus, Pterostegia drymarioides*, and other shade-tolerant species.

Coastal Sage Scrub. This community is restricted in distribution to the southern and western slopes of the Islands and, except for San Miguel (see Fig. 4), to relatively small scattered patches. It is characterized by coastal sage, *Artemisia californica* var. *insularis*. Important associates are *Dudleya caespitosa, Encelia californica, Eriogonum arborescens, Opuntia oricola, O. prolifera, Haplopappus detonsus, Salvia mellifera, Lotus dendroideus* var. *veatchii, Bromus rubens, Calystegia macrostegia* var. *macrostegia, Haplopappus venetus*, and *Malacothrix saxatilis* var. *implicata.*

Maritime Cactus Scrub. Occurring only on Santa Barbara Island, this community is dominated by prickly pear, *Opuntia littoralis*, and cholla, *Opuntia prolifera*. Other important associates are *Amblyopappus pusillus, Marah macrocarpus, Perityle emoryi, Encelia californica*, and *Dudleya traskiae.*

Sea Blight Scrub. Also occurring only on Santa Barbara, this community is dominated by the shrub *Suaeda californica.* This is generally an open community with large bare or grass-covered spaces between the scattered shrubs. The alien grass *Hordeum glaucum* is the most common herbaceous species in the community. Other associated species are

Frankenia grandifolia, Spergularia macrotheca, and the alien iceplants *Mesembryanthemum crystallinum* and *M. nodiflorum.*

Boxthorn Scrub. Another community only associated with Santa Barbara, this is scattered in warmer microhabitats around the islands such as on south-facing slopes and is often associated with the maritime cactus scrub community. It is dominated by boxthorn, *Lycium californicum.* Where these half-meter tall shrubs are widely scattered, the spaces are filled with grasses from the grassland community. Often, however, they group together to form a dense canopy, which excludes most other species. The Federally listed threatened island night lizard, *Xantusia riversiana,* is frequently found inhabiting this community.

Haplopappus Scrub. The second-most abundant plant community on San Miguel Island (Fig. 4) is a low (<1.5 ft or <0.5 m) shrub community dominated by *Haplopappus venetus.* This community occurs on poorly developed soils that are either thin and rocky or sandy. It is unclear whether this is a climax community on these poorer soils, or a long-term seral stage which will give way to either a grassland community or a chaparral community with improving microenvironmental conditions. It is believed that this is such a widespread community on the island because of the vast disturbance the island has undergone. There is no comparable community on any other of the Channel Islands. Important associates are *Achillea millefolium, Astragalus miguelensis, Atriplex californica, Baccharis pilularis, Carpobrotus aequilaterus, Dudleya greenei, Eriogonum grande* ssp. *rubescens, Erysimum insulare,* and *Malacothrix incana.*

Island Chaparral. On West Anacapa Island in the larger canyons on the northern side of the island, there exist a few scattered stands of what appear to be relicts of a once more widely distributed chaparral community. These are stands with one or more of the following: toyon, *Heteromeles arbutifolia*; island bigpod ceanothus, *Ceanothus megacarpus* ssp. *insularis*; and Catalina cherry, *Prunus ilicifolia* ssp. *lyonii.* These stands are only a shadow of what one sees in the chaparral of the larger islands and the mainland. On San Miguel Island, this community was extirpated by grazing and by ranchers using the wood for fires. Occasionally one can find a large piece of wood lying on the surface as a reminder of the past, woodier, island. The largest patches are of shrub lupine, *Lupinus albifrons* and *L. arboreus.* These usually exist as an introduction to the grassland and therefore have a typical grassland assemblage of understory species. The other important species, lemonade berry (*Rhus intergrifolia*), is primarily found scattered along the sea slopes on the northern side of the island and has not yet begun to form a distinct community.

Native Woodlands

Island Woodland. This community type is represented by two small stands of island oak, *Quercus tomentella,* in Oak Canyon, on the northern side of West Anacapa Island. The understory of the community is rather sparse and made up mostly of native perennials such as *Penstemon cordifolia, Silene laciniata,* and *Lilium humboldtii,* rather than grasses.

Riparian

San Miguel Island has running water in a number of the larger canyons, and with such has developed a recognizable riparian community at some locations. Species that are important here are willows (*Salix lasiolepis*), *Coreopsis gigantea*, *Baccharis pilularis*, and *Typha domingensis*. These stands are widely scattered and only a minor part of the vegetation. For instance, willows occur in only four isolated locations.

Alien Communities

Perennial Iceplant. A community dominated by perennial, sea fig type iceplants of the genera *Carpobrotus* and *Malephora* covers extensive areas on the southern side of East Anacapa Island and on the upland, unstable sand areas of San Miguel. This community is a primary stabilizer and as such plays an important role in the restoration of island vegetation. Once established, the perennial iceplant community provides a more protected microhabitat into which other species colonize. This iceplant forms a low (<12 in. or <30 cm), tangled mat of vines. Associated species are *Astragalus miguelensis, Malacothrix incana, M. succulenta, Poa douglasii*, and *Distichlis spicata*.

Island Grassland. The most abundant vegetation type on most of the Channel Islands is grassland dominated by wild oats, *Avena fatua*. This community has an overstory (at about 3 ft or 1 m) of wild oats with a diverse understory of a number of alien brome grasses (*Bromus* spp.), other grass species, and a number of forbs such as *Erodium, Amsinckia*, and *Dichelostemma*. In response to protection, shrubs are rapidly invading this community. They include *Coreopsis gigantea, Atriplex semibaccata, Lycium californicum, Artemisia californica*, and *Baccharis pilularis*. Intermixed in this oat field are occasional patches dominated by the native bunchgrass, *Stipa pulchra*, and in depressions or wetter areas, patches dominated by saltgrass, *Distichlis spicata*, or by *Juncus* spp.

The Anacapa Island grassland is richer in native perennial grasses and forbs than that on Santa Barbara and San Miguel Islands, indicating that there has been less disturbance. It is also structurally distinct in that native perennials are also present, particularly *Dudleya caespitosa* and *Grindelia latifolia*. Common associates in this community are *Achillea millefolium, Calystegia macrostegia* ssp. *macrostegia, Castilleja affinis, Dichelostemma pulchellum, Lasthenia chrysostoma*, and *Marah macrocarpus*. Common alien species include *Erodium cicutarium, Sonchus oleraceus, Medicago polymorpha*, and *Atriplex semibaccata*.

A second type of alien grassland is a barley-dominated grassland. This is characterized by *Hordeum glaucum* as a canopy at about 1 ft (0.3 m), with many fewer associated herbaceous species than in the wild oats grassland. This is only widely scattered on the Islands, and the area covered is not extensive.

Annual Iceplant. On Santa Barbara Island (Fig. 2), crystalline iceplant, *Mesembryanthemum crystallinum*, forms large, dense patches and

accumulates salt to the extent that all other species are generally excluded. A common associate is another annual iceplant, *Mesembryanthemum nodiflorum*. This is a serious management problem because only periodically are salt-tolerant shrubs such as *Suaeda californica* able to establish, if they can overtop the iceplant rapidly enough to overcome the shading effects. Otherwise, the iceplant leads to the extirpation of other plants from the area and then to erosion problems.

On Anacapa and San Miguel Islands, the annual iceplants form only a few large patches associated with erosion surfaces. Otherwise the species are restricted to narrow bands around small eroded areas and to a narrow strip along the top of sea cliffs.

ALIEN SPECIES

The influx of alien species to California started with the arrival of Europeans. In southern California, this was during the Mission Period (1769-1848) when exploration gave way to settlement. Adobe bricks used to build the earliest Spanish missions have been found to contain seeds of *Erodium cicutarium, Hordeum leporinum, Lolium perenne,* and *Sonchus asper* (Hendry 1931). Plants brought in for use as livestock forage included *Avena fatua, A. barbata,* and *Medicago polymorpha.* One story has it that Father Serra and other priests scattered seeds of wild mustard (*Brassica rapa* and *B. nigra*) along El Camino Real so that a trail of gold would guide travelers from mission to mission (Hochberg *et al.* 1979).

Following an initial period of alien plant increase, the native grasslands underwent major changes (beginning in the 1850s) as the cattle industry began to build up in California (Burcham 1956; Robbins 1970). The native grassland, originally dominated by perennial bunch grasses such as *Stipa pulchra,* came to be dominated by alien annual grasses. Adding to the problems of alien plants dominating native vegetation, especially in grassland areas, was the flood of miners coming into the State, bringing all sorts of seeds, bulbs, and cuttings; an eleven-year drought; and the development of farming starting in the 1880s (Hochberg *et al.* 1979).

In general, established weed populations on the mainland were the stock from which the islands were invaded later. Propagules were transported both on the winds and by explorers and ranchers. Human activities on the Islands became intense enough to start causing dramatic changes to the vegetation in the late 1800s and early 1900s, as reflected in the increase of weedy species on the Channel Islands at this time (Table 1). Sheep ranching began on San Miguel Island in 1850 and continued until 1948; sheep ranching on Anacapa did not begin until 1902 and stopped in 1937; goats (*Capra hircus*) were reported on Santa Barbara in 1849, but active farming and ranching occurred only between 1915 and 1922 (Farnham 1849; Hochberg *et al.* 1979). In addition, the U.S. military was active on the islands during and after WW II. A history of alien species on Santa Barbara is presented in Appendix B as an indication of site qualities and time scale of introductions on the Channel Islands.

Table 1. Approximate date of first report for selected weedy species on the California mainland and Santa Barbara, Anacapa, and San Miguel Islands.*

Species	MAIN	SBI	AI	SMI
Atriplex semibaccata	1901	1931	1932	1932
Avena fatua	1800	1939	1939	1887
Brassica nigra	1800	1939	----	----
Brassica rapa	1800	----	----	1887
Bromus diandrus	1862	1939	1939	1930
Centaurea melitensis	1797	1963	----	1887
Chenopodium murale	1797	1901	1932	1887
Conyza canadensis	1876	1978	1978	1973
Erechtites glomerata	1970	----	----	1984
Erodium cicutarium	1769	1939	1890	1887
Erodium moschatum	1856	1931	1962	1887
Larmarckia aurea	1875	1939	1959	1932
Lolium perenne	1775	1978	----	----
Malva parviflora	1791	1897	1962	1887
Medicago polymorpha	1800	1931	1932	1932
Mesembryanthemum crystallinum	1900	1897	1930	1887
Mesembryanthemum nodiflorum	1900	1932	1942	1932
Polypogon monspeliensis	1870	1939	1971	1890
Silene gallica	1837	1939	1940	1887
Silybum marianum	1854	1968	----	----
Sonchus oleraceus	1870	1931	1929	1927
Stellaria media	1870	----	----	1932
Torilis nodosa	1800	----	----	1930
Xanthium spinosum	1870	1931	----	1930

*based on Hochberg *et al.* 1979.

Main = Mainland, SBI = Santa Barbara Island, AI = Anacapa Island, SMI = San Miguel Island.

Species introductions have slowed since the National Park Service started protecting these islands, but they have not stopped. We continue to experience invasions, both from seeds blown across the Santa Barbara Channel and from seeds introduced with human activities (e.g., on planes and helicopters, with supplies, or on clothing and boots of visitors). At present, alien species range from a high of 29.9% on Santa Barbara to a low of 19.8% of the flora on Anacapa (Table 2). These figures are reflective of the amount of damage that has been caused by past overgrazing and the length of time that has transpired since grazing was last permitted.

Table 2. Percentage of native and alien species at Channel Islands National Park.

Island	Total (n)	Natives (n)	Natives (%)	Endemics* (n)	Endemics* (%)	Aliens (n)	Aliens (%)
Anacapa	222	178	80.2	18	8.1	44	19.8
Santa Barbara	107	75	70.1	13	12.1	32	29.9
San Miguel	233	174	75.1	13	5.6	58	24.9
All Three Islands	334	255	76.4	33	9.9	79	23.6

* = endemic to one or more of the Channel Islands.

Almost all alien species on the Islands are herbaceous (74 species); only two alien species are trees (see Appendix A). Four individuals from the southwestern U.S. desert, fan palm, *Washingtonia filifera*, were planted on the beach at Cuyler Harbor on San Miguel, the only location of this species in the Park; no reproduction is evident. Middle Anacapa Island has a grove of blue gum, *Eucalyptus globulus*, planted by sheep ranchers in the early 1920s. This native of Australia is commonly planted in southern California for shade and protection from wind. The eucalyptus has created an alien microhabitat and with it a somewhat unusual community of insects and birds, not as yet well studied. The species is not spreading from its planted location. The only other alien woody species on the Islands are the subshrubs Australian saltbush (*Atriplex semibaccata*) and nightshade (*Solanum nodiflorum*), which will be discussed later, and the suffrutescent perennial horehound (*Marrubium vulgare*).

Alien Plants of African Origin

Alien plants in Channel Islands National Park come from three regions of the world: Africa, Australia, and Europe. The African contingent is represented by a group of five species.

Authorities disagree about when and how the sea fig *Carpobrotus aequilaterus*, a perennial species, arrived on the shores of southern California. Since no clear data are available as to when it arrived, there is no agreement as to whether or not it should be considered native. This species is a vine and one of the most important dune-stabilizing plants on San Miguel Island, where it covers vast areas of sand dune and disturbed soil. It is also an important member of the shrub community inhabiting the tops of sea cliffs on East Anacapa Island.

Another perennial sea fig vine, *Malephora crocea*, is found only on East Anacapa. It was brought to the Island by U.S. Coast Guard personnel manning a lighthouse station there in the 1940s. The plant was used for erosion control and has not since spread to other islands.

The Hottentot fig (*Carpobrotus edulis*) is also only found on East Anacapa at this time. It is not known how this perennial vine was introduced to the Island; it only occurs as a few isolated patches among other perennial iceplants and appears to be slowly spreading at this time.

Crystalline iceplant (*Mesembryanthemum crystallinum*) covers extensive areas on Santa Barbara Island and scattered smaller areas on Anacapa and San Miguel. This annual species readily enters disturbed areas and became a dominant feature of the vegetation of Santa Barbara Island in the 1950s, when European rabbits (*Oryctolagus cuniculus*) and fire destroyed the native shrub cover. Crystalline iceplant forms large dense patches that both shade out other species and accumulate salt, which enters the soil profile upon the death of the plants (Vivrette and Muller 1977). Salt accumulation is a major resource problem on Santa Barbara Island. Another crystalline iceplant, *Mesembryanthemum nodiflorum*, similar to *M. crystallinum* but with smaller leaves, is found in the same situations but does not have as intense an impact because of smaller leaf area and generally lower density.

Alien Plants of Australian and New Zealand Origin

Alien species from Australia and New Zealand include one tree species, which has been planted, one shrub, and two herbs, one of which is particularly aggressive.

Blue gum (*Eucalyptus globulus*), a large tree, was planted in a grove on Middle Anacapa to provide protection for sheep ranchers. It is likewise planted on many of the larger Channel Islands. To date it has not been a problem for the Islands in that it has not spread from these groves.

Australian saltbush (*Atriplex semibaccata*) is a prostrate shrub, which is found in many habitats on the islands, especially disturbed areas and grasslands. In the grasslands it tends to produce a microhabitat that is favorable for grass species, causing a more lush growth around the perimeter of the shrub patch. This may be due to an amelioration of light and surface water conditions. The shrubs may be actually improving the moisture and nutrient content by bringing water and chemicals from deep in the soil profile. In any case, the species does have a dramatic affect on island grassland communities.

The herbaceous New Zealand spinach (*Tetragonia expansa*) occurs widely scattered along coastal areas of the islands and in some disturbed sites. It is not considered a problem species.

Australasian fireweed (*Erechtites glomerata*) is an aggressive composite that found its way to San Miguel Island in 1984 after having spread down the coast from the San Francisco area, where it was first reported in 1970 (Robbins 1970). It is invasive in established fields,

does not need disturbance to become established, and very quickly dominates grasslands and fields. Fireweed is considered one of the most serious plant pests in Channel Islands National Park, and Park personnel are working quickly to keep it in check.

Alien Plants of European Origin

The great majority (87%) of the alien species in the Park (69 of the 79) are introductions from Europe. These are primarily herbaceous (21 species of grasses and 48 forbs). Many of the forbs are cosmopolitan garden and field weeds which thrive on some sort of disturbance. Those species that have the ability to invade and dominate for varying amounts of time and which are important to the ecology of Channel Islands National Park are listed below.

Grasses. 1) Wild oats (*Avena fatua*) and 2) slender oats (*A. barbata*), both annual species, were introduced to California at the time the cattle industry began (see Table 1). They now dominate much of the California grassland and, in that sense, the island grasslands merely reflect the general pattern throughout the State. Both are allelopathic, restricting the germination and growth of forbs in the vicinity (Tinnin and Muller 1971, 1972). By this and other means, oats maintain dominance over the grasslands for many years. 3) Soft chess (*Bromus mollis*), an annual grass, inhabits disturbed areas and also tends to dominate the understory in the wild oat grassland. 4) Red brome (*Bromus rubens*) is also widely distributed in the western United States and tends to replace natives and dominate drier slopes. 5) Foxtail (*Hordeum glaucum*), another annual, was noted as a nuisance in California as early as 1890 (Robbins 1970). On the Channel Islands it is a common associate of sea blight (*Suaeda californica*) in the native shrubland community, often being a co-dominant with this salt-tolerant shrub.

Forbs. 1) Yellow star thistle, or tocalote (*Centaurea melitensis*, an annual weed, inhabits areas of disturbance and has the ability to persist in shrublands and some grassland habitats. It is not a major problem at this time in the Channel Islands but has been slowly spreading over the past few years. 2) Pigweed (*Chenopodium murale*), a common annual weed, is often found scattered in disturbed areas, such as around campgrounds and along trails. It also forms large patches where there has been widespread destruction of vegetative cover through fire, overgrazing, etc. These large patches persist for many years and may even be the center of further dissemination of the population. 3) Red-stemmed filaree (*Erodium cicutarium*) is the most common and widespread of the filarees. Fremont found it already very dense in some areas on his 1844 exploration to southern California (Robbins 1970). On the Channel Islands (Table 1) it is found as an understory plant in the grassland and in scattered patches in disturbed areas. 4) Another filaree, *Erodium moschatum*, is also an important understory species in the island grasslands and is occasionally found as scattered patches in other habitats. 5) Cheese weed (*Malva parviflora*) is very similar to pigweed in its impact on the vegetation of the islands. 6) Bur clover (*Medicago polymorpha*) and 7) yellow sweet clover (*Melilotus indica*) were introduced to California during the Mission Period (1769-1848) and have

been encouraged by ranchers ever since due to their forage value and the fact that they are nitrogen fixers. These annuals are found scattered throughout grasslands as understory plants and in disturbed areas. 8) Annual sowthistle (*Sonchus oleraceus*) is found scattered in areas of more disturbance. While individuals may be found throughout many plant communities, it is rare to find this annual weed clumped in large patches away from areas that have not been recently disturbed.

MANAGEMENT OF ALIEN SPECIES

Trees

The management strategy for the few groves of alien trees on the Channel Islands (fan palm and eucalyptus) has been determined from their importance in the history of the Islands. As important cultural features, they are managed for preservation. Since they are not extending their ranges, this appears to have only a minimal impact on native plant communities.

Shrubs

The three alien shrub species are all restricted in distribution. The control of these aliens is of low priority compared to the more important herbaceous species, and they are managed only on an *ad hoc* basis. In fact, as mentioned earlier, Australian saltbush has a somewhat beneficial impact, in that it tends to increase the growth of grasses when growing in association with them.

Herbaceous Plants

Perennial Iceplants. Perennial iceplants are not the subject of a control program at this time, because of their importance in erosion control and the fact that they tend to act as pioneer species that decline in importance with time and community development. Research is being conducted on sand dune stabilization on San Miguel Island to determine if any action can be taken which would speed the reduction of the dominance of *Carpobrotus aequilaterus* and improve stabilization of the dunes by a native plant community.

Annual Iceplants. These are a matter of great concern for Park managers. At present, research is being conducted to determine the best management strategy for the removal of the *Mesembryanthemum crystallinum* mat and replacement with species from the perennial native shrub community, such as *Suaeda californica.* Techniques will be designed to reduce the barren ground that is available for the crystalline iceplant to invade and to stop the spread of any existing patches. To date, mechanical methods of removal and revegetation have proven to be slow going and only minimally effective.

Annual Grasses and Forbs. In general, the native vegetation of Channel Islands National Park is dominated by perennial shrub communities. The major management strategy for the Park, therefore, is to protect and encourage native species and species assemblages. The islands in the Park have all experienced drastic native species reduction due to human misuse. This has led to the situation where the species list shows 23% alien

species, but the vegetation shows anywhere from 25-70% alien species-dominated communities (primarily annual grasslands). Beginning with the time that each island came under the protection of the National Park Service and all grazers were removed, the vegetation has been recovering. Each island recovers at its own pace depending upon the length and intensity of past land use. With recovery, those species that are found principally in disturbance situations begin to diminish in importance.

A few species, however, are aggressive and require active management. Park personnel are currently working at removal of these species by mechanical means. We do not use fire or biological control because of a decision to not introduce anything new to the island ecosystems, whether it be fire, which has not had a role in vegetation development, or biological control agents, which were never part of these systems. The Park staff is also wary of the use of chemicals and has thus far chosen not to implement any herbicide programs, although a study was initiated in 1987 to test the feasibility of herbicide use on certain species. It has been necessary to use a rather large cadre of volunteers in order to accomplish control. Because of this we have chosen to work on one or two species per island at a time, for instance, *Erechtites glomerata* on San Miguel (Halvorson and Koske 1987) and *Centaurea melitensis* on Santa Barbara Island. Our technique is to hit any extant population hard with a large crew, after which resource management specialists and rangers periodically watch the area and remove any recruits. This technique has been successful in dealing with *Erechtites glomerata*, a species with a fairly restrictive distribution. The record of dealing with this species after its discovery in the spring of 1984 was as follows: 1) The species first discovered in Spring 1984. 2) Reconnaissance and mapping were completed in August 1984. 3) Park staff decided in October 1984 to carry out the eradication. 4) 200 worker days were required to remove the weed from 170 a (69 ha) in 1985. 5) 120 worker days were required to remove the weed from 123 a (50 ha) in 1986. 6) 19 worker days were required to remove the weed from 123 a (50 ha) in 1987. Park staff now spend only a few days during the spring removing any new *Erechtites* individuals originating from the remaining seed bank. For a number of years we will only be able to say that we have this one "under control," as we do not know how long the seed bank will remain viable.

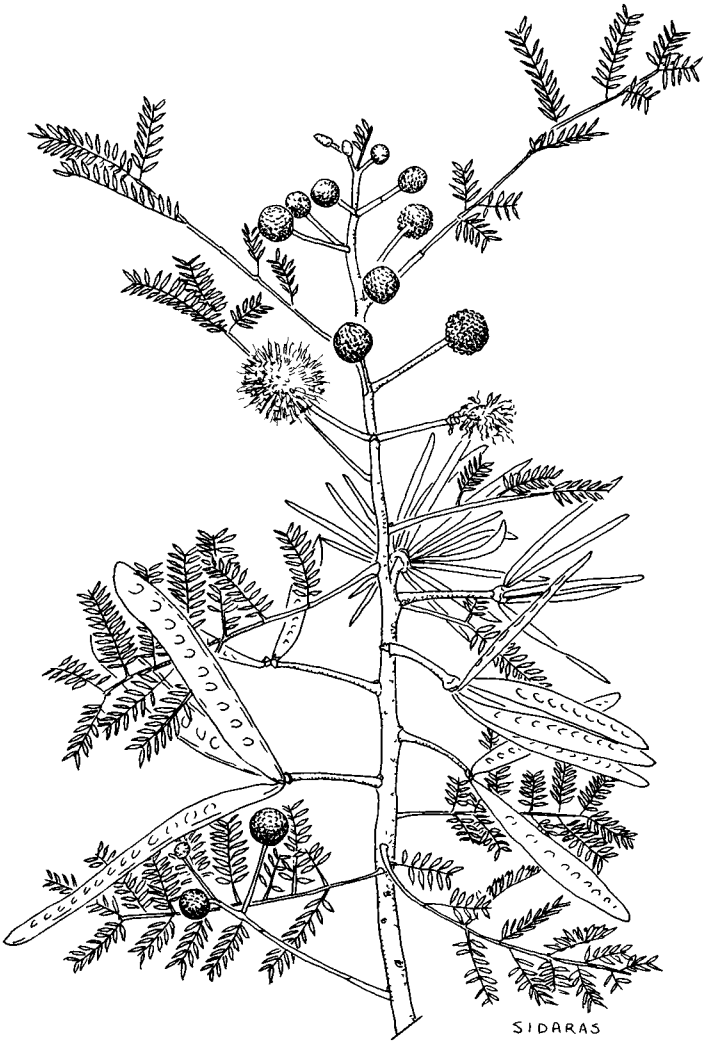
CONCLUSIONS

Channel Islands National Park has a serious problem with alien plant species. Twenty-three percent of the plants on the Park list are introduced, but this is not a good indication of the impact of these species. In the Park, 25-70% of the vegetation cover is composed of plant communities that are dominated by alien plants. The most important of these communities in terms of area is a grassland dominated by alien annual grasses (primarily wild oats). Alien plant communities were largely caused by clearing, farming, fire, and grazing. Park personnel have begun to remove these disturbances from Santa Barbara, Anacapa, and San Miguel Islands. Native plant communities are now recovering, extending their

ranges and thereby decreasing the coverage of the alien species. Management of introduced species seeks first to protect and encourage native species and second to mechanically remove alien species, population by population. Alien species that are aggressive and have restricted distributions are eliminated first. In time, it is planned to concentrate on less aggressive species with wider distributions.

ACKNOWLEDGMENTS

Many people have contributed to the information on which this report is based. Santa Barbara Botanical Garden continues to help the Park with species collections and identifications; in particular I would like to thank Steve Junak and Ralph Philbrick of that organization. I would also like to thank Charles Drost and Steve Veirs for information from their field work, and Ronie Clark for her field assistance and review of early drafts of the report.



Appendix A. Status and distribution of plants of Channel Islands National Park.*

Taxon	Status	Island
AIZOACEAE		
Carpobrotus aequilaterus (Haw.) N.E.Br.	I	AM
Carpobrotus edulis (L.) Bolus	I	A
Malephora crocea (Jacq.) Schwant.	I	A
Mesembryanthemum crystallinum L.	I	ABM
Mesembryanthemum nodiflorum L.	I	ABM
Tetragonia tetragonioides (Pall.) O. Kuntze	I	AM
AMARYLLIDACEAE		
Allium praecox Bdg.	N	M
Brodiaea jolonensis Eastw.	N	M
Dichelostemma pulchellum (Salisb.) Heller	N	ABM
ANACARDIACEAE		
Toxicodendron diversilobum Greene	N	AM
Rhus integrifolia (Nutt.) Benth. & Hook.	N	AM
APIACEAE		
Apiastrum angustifolium Nutt. in T. & G.	N	ABM
Berula erecta (Huds.) Cov.	N	AM
Daucus pusillus Michx.	N	ABM
Lomatium caruifolium (H. & A.) Coult. & Rose	N	M
Sanicula arguta Greene ex Coult. & Rose	N	AM
Torilis nodosa (L.) Gaertn.	I	M
ARACEAE		
Zantedeschia aethiopica (L.) Spreng.	I	M
ARECACEAE		
Washingtonia sp.	I	M
ASPIDIACEAE		
Dryopteris arguta (Kaulf.) Watt	N	A
ASTERACEAE		
Achillea millefolium L.	N	ABM
Agroseris grandiflora (Nutt.) Greene	N	M
Amblyopappus pusillus H. & A.	N	ABM
Ambrosia chamissonis bipinnatisecta (Less.) Wiggins & Stockw.	N	AM
Ambrosia chamissonis chamissonis (Less.) Greene	N	M

*(Status: I = Alien, E = Insular Endemic, N = Native, R = Extirpated. Islands: A = Anacapa, B = Santa Barbara, M = San Miguel).

Appendix A, continued.

Appendix A, continued.

Taxon	Status	Island
ASTERACEAE (Cont)		
Artemisia californica californica Less.	N	AM
Artemisia californica insularis (Rydb.) Munz	N,E	B
Baccharis douglasii DC.	N	AM
Baccharis glutinosa Pers.	N	A
Baccharis pilularis DC. *consanguinea* (DC.) C.B. Wolf	N	ABM
Brickellia californica (T. & G.) Gray	N	A
Centaurea melitensis L.	I	BM
Cirsium occidentale (Nutt.) Jeps.	N	M
Conyza bonariensis (L.) Cronq.	I	AB
Conyza canadensis (L.) Cronq.	I	ABM
Coreopsis gigantea (Kell.) Hall	N	ABM
Corethrogyne filaginifolia (H. & A.) Nutt.	N	AM
Cotula coronopifolia L.	I	AM
Erechtites glomerata (Poir.) DC.	I	M
Erigeron foliosus Nutt. *foliosus* Nutt.	N	M
Erigeron foliosus Nutt. *stenophyllus* (Nutt.) Gray	N	AM
Erigeron glaucus Ker.	N	AM
Erigeron sanctarum Wats.	N	A
Eriophyllum confertiflorum (DC.) Gray	N	AM
Eriophyllum nevinii Gray	N,E	B
Eriophyllum staechadifolium Lag.	N	AM
Filago californica Nutt.	N	ABM
Gnaphalium beneolens A. Davids.	N	A
Gnaphalium bicolor Bioletti.	N	AB
Gnaphalium californicum DC.	N	AB
Gnaphalium chilense Spreng.	N	AM
Gnaphalium luteo-album L.	I	M
Gnaphalium microcephalum Nutt.	N	A
Gnaphalium purpureum L.	N	A
Grindelia latifolia Kell.	N	AM
Haplopappus canus (Gray) Blake	N,E	A
Haplopappus detonsus (Greene) Raven	N,E	A
Haplopappus ericoides (Less.) H. & A.	N	M
Haplopappus squarrosus H. & A.	N	A
Haplopappus venetus (HBK) Blake *sedoides* (Greene) Munz	N	AM
Haplopappus venetus (HBK.) Blake *vernonioides* (Nutt.) Hall	N	AM
Hemizonia clementina Bdg.	N,E	AB

*(Status: I = Alien, E = Insular Endemic, N = Native, R = Extirpated. Islands: A = Anacapa, B = Santa Barbara, M = San Miguel).

Taxon	Status	Island
ASTERACEAE (Cont)		
Hemizonia fasciculata (DC.) T. & G.	N	BM
Hypochoeris sp.	I	A
Jaumea carnosa (Less.) Gray	N	M
Lactuca serriola L. *integrata* Gren. & Godr.	I	M
Lasthenia chrysostoma (F. & M.) Greene	N	ABM
Layia platyglossa (F. & M.) Gray	N	M
Malacothrix foliosa Gray	N,E	ABM
Malacothrix incana (Nutt.) T. & G.	N	M
Malacothrix indecora Greene	N,E	M
Malacothrix saxatilis implicata (Eastw.) Hall	N,E	AM
Malacothrix saxatilis tenuifolia (Nutt.) Gray	N	A
Malacothrix squalida Greene	N	A
Malacothrix succulenta Elmer	N	M
Microseris douglasii (DC.) Sch. Bip. *tenella* (Gray) Chamb.	N	M
Microseris elegans Greene ex Gray	N	M
Microseris linearifolia (Nutt.) Sch. Bip.	N	AB
Perityle emoryi Torr. in Emory	N	AB
Rafinesquia californica Nutt.	N	AB
Senecio vulgaris L.	I	AM
Silybum marianum (L.) Gaertn.	I,R	B
Solidago sp.	N	A
Sonchus asper (L.) Hill	I	AM
Sonchus oleraceus L.	I	ABM
Sonchus tenerrimus L.	I	AB
Stephanomeria virgata Benth.	N	M
Xanthium spinosum L.	I	BM
BERBERIDACEAE		
Berberis pinnata Lag. *insularis* Munz	N,E	A
BORAGINACEAE		
Amsinckia intermedia F. & M.	N	ABM
Amsinckia spectabilis F. & M.	N	ABM
Cryptantha clevelandii Greene	N	ABM
Cryptantha maritima (Greene) Greene	N	B
Cryptantha muricata jonesii (Gray) Jtn.	N	A
Heliotropium curassavicum L. *oculatum* (Heller) Thorne	I	AM
Plagiobothrys californicus californicus (Gray) Greene	N	AM

Appendix A, continued.

Appendix A, continued.

Taxon	Status	Island
Plagiobothrys californicus (Gray) Greene *gracilis* Jtn.	N	A
BRASSICACEAE		
Brassica geniculata (Desf.) J. Ball	I	M
Brassica nigra (L.) Koch in Rohling	I,R	B
Brassica rapa L. *sylvestris* (L.) Janchen	I	M
Cakile edentula californica (Heller) Hult.	N	M
Cakile maritima Scop.	I	AM
Capsella bursa-pastoris (L.) Medic.	I	M
Cardamine californica (Nutt.) Greene	N	AM
Descurainia pinnata menziesii (DC.) Detl.	N	A
Dithyrea californica maritima (A. Davids.) A. Davids. ex Rob.	N	M
Erysimum insulare Greene	N	AM
Hutchinsia procumbens (L.) Desv.	N	ABM
Lepidium nitidum Nutt. *nitidum*	N	AB
Lepidium oblongum Small *insulare*	I	AM
Lepidium strictum (Wats.) Rattan	I	A
Nasturtium officinale R. Br.	I	M
Thelypodium lasiophyllum (H. & A.) Greene	N	ABM
CACTACEAE		
Opuntia ficus-indica (L.) Mill.	I	A
Opuntia littoralis (Engelm.) Ckll.	N	ABM
Opuntia oricola Philbrick	N	ABM
Opuntia prolifera Engelm.	N	ABM
CARYOPHYLLACEAE		
Cardionema ramosissimum (Weinm.) Nels. & Macbr.	N	M
Cersatium glomeratum Thuill.	I	M
Sagina decumbens (Ell.) T&G *occidentalis* Wats. Crow	N	M
Silene antirrhina L.	N	M
Silene gallica L.	I	ABM
Silene laciniata Cav. *major* Hitchc. & Maguire	N	AM
Silene multinervia Wats.	N	A
Spergularia macrotheca (Hornem.) Heynh.	N	ABM
Stellaria media (L.) Vill.	I	AM
CHENOPODIACEAE		
Aphanisma blitoides Nutt. ex Moq. in DC.	N	B
Atriplex californica Moq. in DC.	N	ABM

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Taxon	Status	Island
Atriplex coulteri (Moq.) D. Dietr.	N	AM
Atriplex lentiformis breweri (Wats.) Hall. & Clem.	N	A
Atriplex leucophylla (Moq. in DC.) D. Dietr.	N	M
Atriplex pacifica Nels.	N	AB
Atriplex patula L. *hastata* (L.) Hall & Clem.	I	M
Atriplex semibaccata R. Br.	I	ABM
Beta vulgaris L.	I,R	M
Chenopodium californicum (Wats.) Wats.	N	ABM
Chenopodium murale L.	I	ABM
Monolepis nuttalliana (Schult.) Greene	N	BM
Salicornia subterminalis Parish	N	M
Salicornia virginica L.	N	M
Suaeda californica Wats.	N	ABM
CISTACEAE		
Helianthemum greenei Rob.	N,E	AM
CONVOLVULACEAE		
Calystegia macrostegia amplissima Brummitt	N,E	B
Calystegia macrostegia macrostegia (Greene) Brummitt	N,E	AM
Calystegia soldanella (L.) R. Br.	N	M
Cressa truxillensis HBK. *vallicola* (Heller) Munz	N	AM
Dichondra occidentalis House	N	M
CRASSULACEAE		
Crassula erecta (H. & A.) Berger	N	ABM
Dudleya caespitosa (Haw.) Britt. & Rose	N	A
Dudleya greenei Rose	N,E	M
Dudleya traskiae (Rose) Moran	N,E	B
CUCURBITACEAE		
Marah macrocarpus (Greene) Greene	N	ABM
CUSCUTACEAE		
Cuscuta salina Engelm. *salina*	N	AM
CYPERACEAE		
Scirpus cernuus Vahl *californicus* (Torr.) Thorne	N	M
ERICACEAE		
Comarostaphylos diversifolia Greene *planifolia* Jeps.	N	A

Appendix A, continued.

Appendix A, continued.

Taxon	Status	Island
FABACEAE		
Astragalus curtipes Gray	N	M
Astragalus didymocarpus H. & A.	N	AM
Astragalus miguelensis Greene	N,E	ABM
Astragalus traskiae Eastw.	N,E	B
Astragalus trichopodus Gray *leucopis* (T. & G.) Thorne	N	A
Lathyrus laetiflorus Greene *barbarae* (White) C.L. Hitchc.	N	A
Lotus argophyllus ornithopus (Greene) Raven	N,E	B
Lotus dendroideus (Greene) Greene *dendroideus*	N	A
Lotus dendroideus veatchii (Greene) Isley	N	M
Lotus salsuginosus Greene	N	AM
Lotus strigosus (Nutt. in T. & G.) Greene	N	A
Lotus subpinnatus Lag.	N	A
Lupinus albifrons Benth.	N	AM
Lupinus arboreus Sims	N	M
Lupinus bicolor Lindl.	N	AM
Lupinus bicolor Lindl. *umbellatus* (Greene) D. Dunn	N	A
Lupinus chamissonis Eschs.	N	M
Lupinus succulentus Dougl. ex Koch	N	AM
Lupinus truncatus Nutt. ex H. & A.	N	A
Medicago polymorpha L. *brevispina* (Benth.) Heyn.	I	M
Medicago polymorpha L. *polymorpha* L.	I	ABM
Medicago sativa L.	I	M
Melilotus indica (L.) All.	I	ABM
Trifolium amplectens T. & G.	N	AM
Trifolium barbigerum Torr.	N	M
Trifolium fucatum Lindl.	N	M
Trifolium gracilentum T. & G.	N	AM
Trifolium microcephalum Pursh	N	M
Trifolium palmeri Wats.	N,E	B
Trifolium tridentatum Lindl.	N	ABM
Vicia americana Muhl. ex Willd.	N	M
Vicia exigua Nutt. in T. & G.	N	AM
FAGACEAE		
Quercus tomentella Engelm.	N,E	A

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Taxon	Status	Island
FRANKENIACEAE		
Frankenia grandifolia Cham. & Schlecht.	N	AM
GERANIACEAE		
Erodium cicutarium (L.) L'Her.	I	ABM
Erodium moschatum (L.) L'Her.	I	ABM
HYDROPHYLLACEAE		
Eucrypta chrysanthemifolia (Benth.) Greene	N	ABM
Nemophila pedunculata Dougl. ex Benth.	N	M
Phacelia cicutaria hispida (Gray) J.T.Howell	N	A
Phacelia distans Benth.	N	ABM
Phacelia insularis Munz *insularis*	N,E	M
Phacelia viscida (Benth.) Torr.	N	AM
Pholistoma auritum (Lindl.) Lilja ex Lind.	N	B
Pholistoma racemosum (Nutt.) Const.	N	B
IRIDACEAE		
Chasmanthe aethiopica (L.) N.E.Br.	I	M
Sisyrinchium bellum Wats.	N	M
JUNCACEAE		
Juncus balticus Willd.	N	M
Juncus bufonius L.	N	AM
Juncus mexicanus Willd.	N	M
LAMIACEAE		
Marrubium vulgare L.	I	M
LILIACEAE		
Lilium humboldtii Roezl & Leichtl.	N	A
Zigadenus fremontii Torr.	N	A
MALVACEAE		
Lavatera assurgentiflora Kell.	N,E	AM
Lavatera cretica L.	I	A
Malva parviflora L.	I	ABM
Sidalcea malvaeflora (DC.) Gray ex Benth.	N	M
MORACEAE		
Ficus carica L.	I,R	M

Appendix A, continued.

Appendix A, continued.

Taxon	Status	Island
MYRTACEAE		
Eucalyptus globulus Labill.	I	A
NYCTAGINACEAE		
Abronia latifolia Eschs.	N	M
Abronia maritima Nutt. ex Wats.	N	AM
Abronia umbellata Lam.	N	M
Mirabilis californica Gray *californica* Gray	N	AB
ONAGRACEAE		
Camissonia cheiranthifolia cheiranthifolia Raven	N	BM
Camissonia micrantha (Hornem. ex Spreng.) Raven	N	M
Clarkia epilobioides (Nutt.) Nels. & Macbr.	N	A
Epilobium adenocaulon Hausskn.	N	M
Zauschneria californica Presl	N	AM
Zauschneria cana Greene	N	A
OROBANCHACEAE		
Orobanche fasciculata Nutt.	N	M
Orobanche parishii (Jeps.) Heckard *brachyloba* Heck.	N	M
PAPAVERACEAE		
Eschscholzia californica Cham.	N	M
Eschscholzia ramosa (Greene) Greene	N,E	AB
Platystemon californicus Benth.	N	AM
Platystemon californicus Benth. *ciliatus* Dunkle	N,E	B
Stylomecon heterophylla (Benth.) G. Tayl.	N	ABM
PLANTAGINACEAE		
Plantago bigelovii Gray	N	M
Plantago erecta erecta Morris	N	A
Plantago hirtella HBK.	N	M
Plantago insularis Eastw.	N	A
Plantago ovata Forsk.	I	B
POACEAE		
Agropyron repens (L.) Beauv.	I	M
Agrostis semiverticillata (Forsk.) C. Chr.	I	A
Avena barbata Brot.	I	ABM

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Taxon	Status	Island
Avena fatua L.	I	ABM
Bromus arizonicus (Shear) Steb.	N	B
Bromus carinatus H. & A.	N	A
Bromus diandrus Roth	I	ABM
Bromus madritensis L.	I	A
Bromus maritimus (Piper) Hitchc.	N	AM
Bromus mollis L.	I	ABM
Bromus pseudolaevipes Wagnon	N	A
Bromus rubens L.	I	ABM
Bromus trinii E. Desv. in Gray	N	ABM
Cortaderia selloana (Schult.) Asch. & Graebn.	I	M
Cynodon dactylon (L.) Pers.	I	A
Distichlis spicata (L.) Greene *stolonifera* Beetle	N	AM
Elymus condensatus Presl	N	AM
Elymus pacificus Gould	N	M
Hordeum californicum Covas & Steb.	N	AM
Hordeum glaucum Steud.	I	AB
Hordeum pusillum Nutt.	N	AB
Hordeum leporinum Link.	I	AM
Lamarckia aurea (L.) Moench	I	ABM
Lolium perenne L.	I,R	B
Melica imperfecta Trin.	N	ABM
Muhlenbergia microsperma (DC.) Kunth	N	AB
Parapholis incurva (L.) C.E.Hubb.	I	BM
Pennisetum clandestinum Hochst. ex Chiov.	I	M
Phalaris minor Retz.	I	ABM
Poa annua L.	I	M
Poa douglasii Nees	N	M
Poa scabrella (Thurb.) Benth. ex Vasey	N	A
Polypogon interruptus HBK.	I	M
Polypogon monspeliensis (L.) Desf.	I	BM
Stipa lepida Hitchc.	N	AM
Stipa pulchra Hitchc.	N	ABM
Vulpia dertonensis Volk.	I	AM
Vulpia megalura Rydb.	N	ABM
Vulpia octoflora (Walt.) Rydb.	N	ABM
Vulpia pacifica Rydb.	N	A
POLEMONIACEAE		
Gilia angelensis V. Grant	N	A

Appendix A, continued.

Appendix A, continued.

Taxon	Status	Island
POLEMONIACEAE, (Cont)		
Gilia clivorum (Jeps.) V. Grant	N	AM
Gilia nevinii Gray	N,E	A
Linanthus androcaceus micranthus (Steud.) Mason	N	M
POLYGONACEAE		
Eriogonum arborescens Greene	N,E	A
Eriogonum giganteum Wats. *compactum* (Dunkle) Munz	N,E	B
Eriogonum grande Greene *grande*	N	A
Eriogonum grande Greene *rubescens* (Greene) Munz	N,E	AM
Pterostegia drymarioides F. & M.	N	ABM
Rumex crispus L.	I	AM
Rumex fueginus Phil.	N	M
Rumex salicifolius Weinm.	N	M
POLYPODIACEAE		
Polypodium californicum Kaulf.	N	AB
PORTULACACEAE		
Calandrinia ciliata (R. & P.) DC. *menziesii* (Hook.) Macbr.	N	ABM
Calandrinia maritima Nutt.	N	AB
Claytonia perfoliata Donn	N	ABM
PRIMULACEAE		
Anagallis arvensis L.	I	AM
Dodecatheon clevelandii Greene *insulare* H.J.Thomps.	N	A
PTERIDACEAE		
Adiantum jordanii C. Muell.	N	A
Pellaea andromedaefolia (Kaulf.) Fee	N	A
Pellaea mucronata (D.C.Eat.) D.C.Eat.	N	A
Pityrogramma triangularis (Kaulf.) Maxon	N	A
RANUNCULACEAE		
Delphinium parryi Gray	N	AM
Ranunculus californicus Benth.	N	M

*(Status: I = Alien, E = Insular Endemic, N = Native, R = Extirpated. Islands: A = Anacapa, B = Santa Barbara, M = San Miguel).

Taxon	Status	Island
RESEDACEAE		
Oligomeris linifolia (Vahl) Macbr.	N	ABM
RHAMNACEAE		
Ceanothus megacarpus Nutt. *insularis* (Eastw.) Raven	N,E,R	AM
Rhamnus pirifolia Greene	N,E	M
ROSACEAE		
Heteromeles arbutifolia (Ait.) M. Roem.	N	AM
Potentilla agedii Wormski *grandis* (Rydb.) J.T.Howell	N	M
Prunus lyonii (Eastw.) Sarg.	N	A
Rubus ursinus Cham. & Schlecht.	N	AM
RUBIACEAE		
Galium angustifolium Nutt. *foliosum* Hilend & Howell	N,E	A
Galium aparine L.	I	ABM
Galium buxifolium Greene	N,E	M
Galium californicum H. & A. *miguelense* (Greene) Jeps.	N,E	M
SALICACEAE		
Salix lasiolepis Benth.	N	M
SAXIFRAGACEAE		
Heuchera maxima Greene	N,E	A
Ribes malvaceum Sm.	N	A
SCROPHULARIACEAE		
Antirrhinum nuttallianum Benth. in DC.	N	AM
Castilleja affinis H. & A.	N	AM
Castilleja hololeuca Greene	N,E	AM
Linaria texana Scheele	N	AM
Mimulus flemingii Munz	N	A
Orthocarpus densiflorus Benth.	N	M
Orthocarpus purpurascens Benth.	N	M
Keckiella cordifolia (Benth.) Straw.	N	A
Scrophularia villosa Penn. in Millsp. & Nutt.	N	A

Appendix A, continued.

Appendix A, continued.

Taxon	Status	Island
SELAGINELLACEAE		
Selaginella bigelovii Underw.	N	A
SOLANACEAE		
Lycium californicum Nutt.	N	ABM
Lycopersicum esculentum Mill.	I,R	BM
Solanum douglasii Dunal in DC.	N	AM
TYPHACEAE		
Typha domingensis Pers.	N	M
URTICACEAE		
Hesperocnide tenella Torr.	N	B
Parietaria hespera Hinton	N	AB
Urtica dioica L. *holosericea* (Nutt.) Thorne	N	A
Urtica urens L.	I	M
VERBENACEAE		
Verbena lasiostachys Link.	N	M
ZOSTERACEAE		
Phyllospadix scouleri Hook.	N	AB
Phyllospadix torreyi Wats.	N	ABM
Zostera marina L.	N	A

*(Status: I = Alien, E = Insular Endemic, N = Native, R = Extirpated. Islands: A = Anacapa, B = Santa Barbara, M = San Miguel).

Appendix B.

History of alien species on Santa Barbara Island.

To help in understanding how alien species came to gain such control in the vegetation of the Channel Islands, the following brief history of Santa Barbara Island is presented. The information, unless otherwise noted, is from Philbrick (1972).

1848 The island became part of the United States in the Treaty of Guadalupe Hildago (Weinman 1978) and was said to be densely populated with goats (Farnham 1849).

1852 The island was first surveyed and the report stated that "the whole surface is covered with a deep and apparently good soil, containing much lime, very light and ashy, and averaging four or five feet deep. It seems difficult to account for its uniformity of composition and depth, except on the supposition that it was to a great degree, formed from the decomposition of animal remains" (National Park Service, unpub. data).

1889 A Coast and Geodetic Survey report states that "there is not a drop of water on the island; no grass, but plenty of prickly pear and shrubs" (Weinman 1978).

1896 Feral house cats were introduced by a passing freighter. Several ground-nesting bird populations were subsequently destroyed (Weinman 1978).

1915 Alvin Hyder and his family moved to the island. The Hyders enlisted the aid of as many as 15 other people to assist in the homesteading pursuits. Eleven structures and three small reservoirs were built. Tillable portions of the island were burned each year and then plowed with a mold board plow. *Coreopsis* was pulled by hand and crystalline ice plant (*Mesembryanthemum*) was cut, dried and burned. Five acres (2 hectares) of potatoes were planted on the western slopes of the island and 150 acres (60.7 ha) of barley were cultivated on the eastern slope.

1918 The entire island was burned by the Hyders. Sometime during the early part of their stay they released 1,200 Belgian hares to raise for meat and pelts. The hares were eventually killed by the resident cats and eagles. Four hogs brought to the island died from eating poisoned rabbits or cats.

1922 The Hyders left the island with 12 goats, 300 sheep, four horses, and the family dogs. The island was described as covered with foxtail, iceplant, and jungles of coreopsis. Feral house cats were abundant (Weinman 1978).

1928 Hyder used the island to fatten 250 sheep for market after failing to get his lease renewed (Weinman 1978).

1938 F.D. Roosevelt designated Channel Island National Monument, which included Santa Barbara Island.

1942 New Zealand red rabbits were introduced by the Navy for meat and sport of the men stationed on coast watch duty.

Appendix B, continued.

Appendix B, continued.

History of alien species on Santa Barbara Island.

1949 Field notes of P.C. Orr stated that the whole eastern side of the island was covered with a dense forest of coreopsis (National Park Service, unpub. data).

1950 Lowell Sumner reported that a "jungle" of *Coreopsis* existed that was head high. He also expressed a concern that the National Park Service was actively exterminating the cats on the island because of their effect on the populations of ground nesting seabirds. He felt that the cats were also keeping rabbit numbers in check.

1958 Lowell Sumner reported that with a rise in the rabbit population, the coreopsis jungle had a stricken aspect. Many were girdled and felled by rabbits and "bare ground showed everywhere through a shriveled carpet of vegetation" (Sumner 1958).

1959 Lowell Sumner reported that acres of boxthorn and island sagebrush had been exterminated and a reduction of the coreopsis stands resulted in the extinction of the Santa Barbara song sparrow (Sumner 1959).

1959 The eastern two thirds of the island was accidentally burned.

1979 The National Park Service decided on an intensive rabbit removal program (National Park Service, unpub. data).

1981 The last of the rabbits was exterminated on the island (National Park Service, unpub. data).

1985 Halvorson, Drost, and Fowler reported on the recovery of a number of shrub species including coreopsis, island sagebrush, boxthorn, and seablight (National Park Service, unpub. data).

This pattern of alternating periods of heavy impact and recovery is evident on Anacapa and San Miguel Islands as well. On all islands, the number of reports is scanty and the changes in species composition and importance are not adequately documented. Further, grazing started on the islands before any biological inventories were accomplished; therefore it is impossible to reconstruct any sort of pristine condition. As far as our understanding of the biology of the islands is concerned, we have always had an impacted system.

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