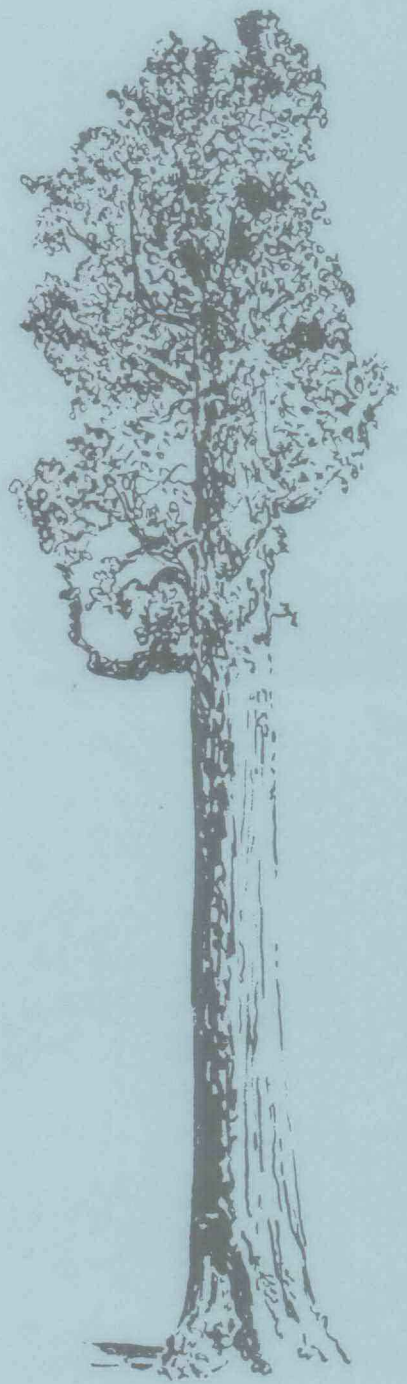

# Cooperative National Park

## RESOURCES STUDIES UNIT

Technical Report No. 42

PLANT COMMUNITIES OF SANTA ROSA ISLAND, CHANNEL ISLANDS NATIONAL PARK

BY Ronilee A. Clark, William L. Halvorson, Andell A. Sawdo and Karen C. Danielsen

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**COOPERATIVE NATIONAL PARK RESOURCES STUDIES UNIT**

University of California - National Park Service

The National Park Service and the University of California signed a Master Memorandum of Understanding on May 4, 1979, that provided for the establishment and operation of the Cooperative National Park Resources Studies Unit as an affiliate of the Institute of Ecology on the Davis Campus. On October 1, 1981, the Master Memorandum of Understanding was superseded by a Cooperative Agreement between the National Park Service and the University of California. This Unit is dedicated to development and facilitation of ecological, environmental and sociological programs of research and study in the interest of use, conservation, and management of natural areas and other components of the National Park System in California.

Unit personnel conduct research and assist National Park Service personnel in developing and coordinating research to provide information relevant to resource management in park areas. They provide direct support to N.P.S. resource managers in planning, conducting and monitoring resource management activities. They also support the broader goals of education and increasing the public awareness of the role of National Parks and similar natural area preserves as part of our national natural heritage.

D-43

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Technical Report No. 42

# PLANT COMMUNITIES OF SANTA ROSA ISLAND, CHANNEL ISLANDS NATIONAL PARK

BY Ronilee A. Clark, William L. Halvorson, Andell A. Sawdo and Karen C. Danielsen

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October 1990

Final Report to National Park Service

**ABSTRACT**

A survey of the plant communities on Santa Rosa Island, Channel Islands National Park, was conducted from January through July 1988. Vegetation data were collected at 296 sites using a releve technique. The plant communities described include: grassland, coastal marsh, caliche scrub, coastal sage scrub, lupine scrub, baccharis scrub, coastal bluff scrub, coastal dune scrub, mixed chaparral, mixed woodland, torrey pine woodland, closed-cone pine woodland, island oak woodland, riparian woodland, and riparian herbaceous vegetation. The areal extent of each community was mapped on USGS 7.5' topographic maps, and digitized for GIS manipulation.

The description of the communities presented here provides the first quantitative analysis of the vegetation of Santa Rosa Island, and provides a baseline against which future comparisons of the condition of vegetation resources can be made. Santa Rosa Island has a grazing history that spans nearly 150 years. Presently an active cattle ranch, and populations of introduced elk, deer, and pigs still occur. Grassland, coastal sage scrub, and mixed chaparral are the prominent vegetation types on the island, covering over 90% of the total area. The remainder of the plant communities each account for less than 1% of the total area. The extent of grassland and the residual nature of the scrub and woodland plant communities clearly demonstrate the effects of long-term grazing. A number of insular endemic plants

occur on the island, some are apparently quite limited in distribution and were not encountered in this vegetation study. Management of the island to preserve viable populations of these endemics, and to allow for the restoration of natural plant assemblages will require the removal of alien herbivores, and a complex active restoration scheme. A long-term commitment by NPS managers of both monies and personnel are necessary to achieve these goals. The success of this endeavour will be a great accomplishment in ecosystem restoration.

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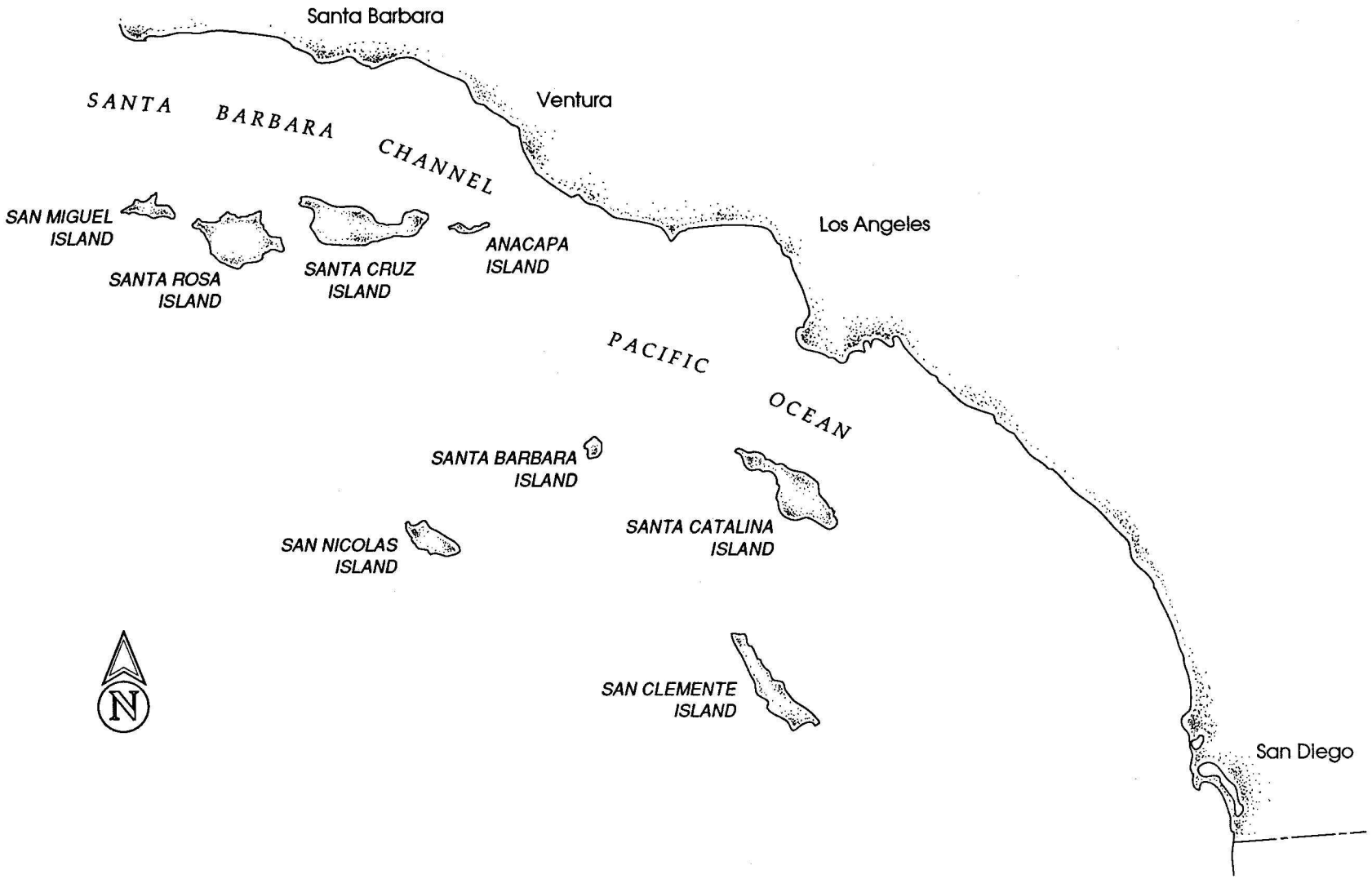
## INTRODUCTION

Santa Rosa Island is one of the eight Channel Islands off the coast of southern California (Figure 1) and one of five islands within the boundary of Channel Islands National Park. Santa Rosa Island was acquired by the National Park Service (NPS) in December 1986, and soon thereafter, a preliminary investigation of the vegetation of the island was initiated in anticipation of future management needs. Although the NPS now manages the island, the previous land owners have exercised their option of maintaining, through a special use permit, an established cattle ranch, and elk and deer hunting operation. Under this option, NPS management is affected by the presence of these operations.

Historical records suggest that ranching has been a part of Santa Rosa Island for more than 150 years (Appendix A). This land use is not unique to Santa Rosa Island as each island in the Channel Islands group has been affected by ranching and/or farming operations. Pressure exerted by grazing animals in combination with periods of drought has caused severe damage to insular communities, in some cases resulting in the extinction of native plant and animal species and extensive soil erosion (Philbrick 1967, Halvorson, et al. 1988). Detailed quantitative accounts of the pre-contact vegetation are poor although most descriptions suggest that the vegetation of the islands has undergone dramatic changes over the past century.

Figure 1. Santa Rosa Island and vicinity. The eight islands of the Channel Islands are represented as well as the adjacent mainland area. From Clark, 1989.


Santa Barbara
SANTA BARBARA CHANNEL
Ventura
Los Angeles
SAN MIGUEL ISLAND
SANTA ROSA ISLAND
SANTA CRUZ ISLAND
ANACAPA ISLAND
PACIFIC OCEAN
SANTA BARBARA ISLAND
SANTA CATALINA ISLAND
SAN NICOLAS ISLAND
SAN CLEMENTE ISLAND
N
San Diego

The study reported herein was undertaken to provide data describing the present status of the vegetation resources on Santa Rosa Island. The specific goals of the research were to: 1) define the plant community types by describing their species composition and habitat characteristics, 2) map the distribution and extent of the plant communities, and 3) provide the baseline data necessary to allow future comparisons, making it possible to evaluate the condition of the vegetation resources through time.

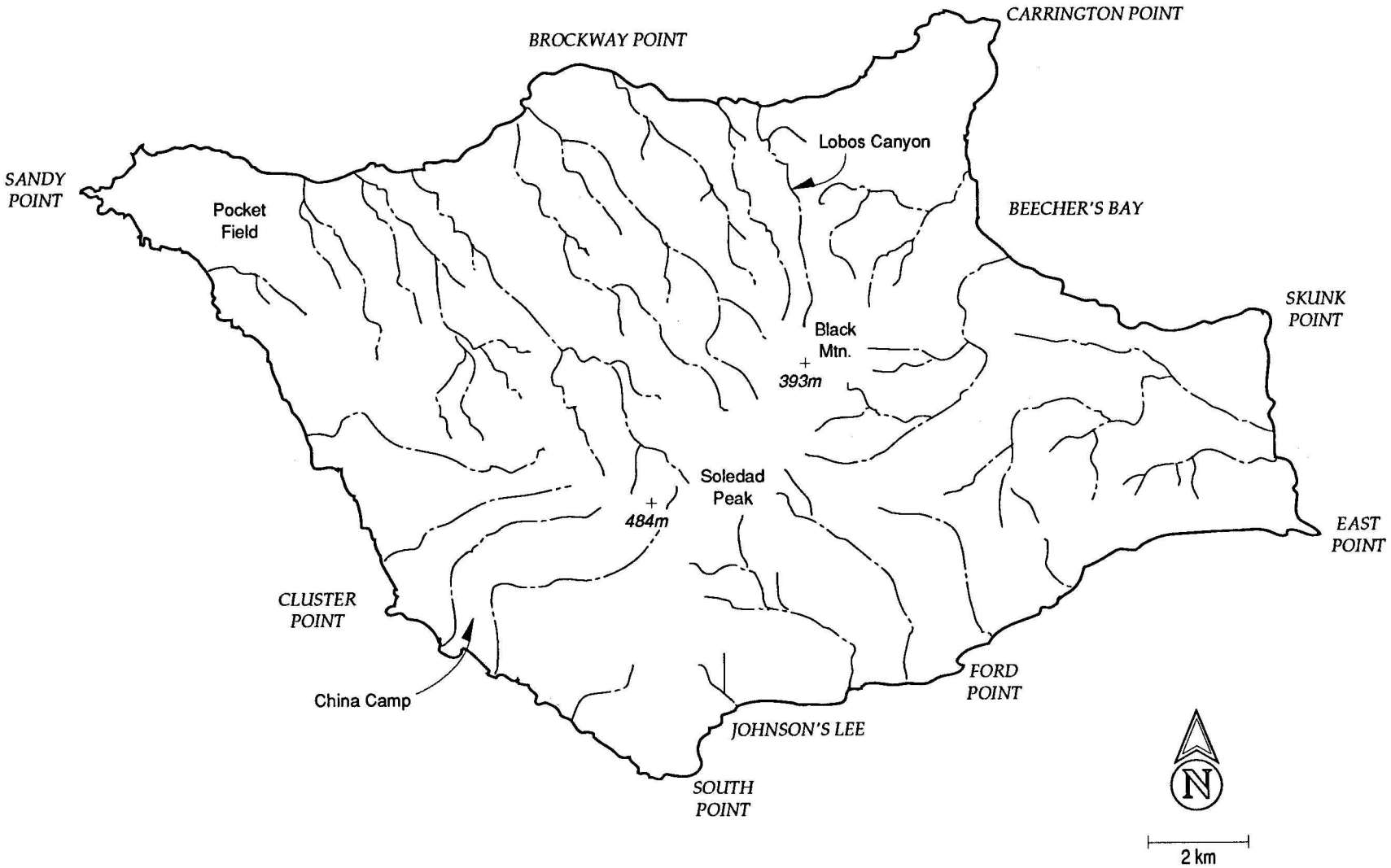
Santa Rosa Island lies 72 km west of Ventura, and 48 km southwest of Santa Barbara, California. It is approximately 21,449 hectares in size; 23 km long (e to w) and 16 km wide. The climate of Santa Rosa Island is a maritime-mediterranean type, with cool moist winters, and warm dry summers. The annual rainfall is approximately 30 cm, and typically occurs during the months of November through March, although infrequent summer storms, and summer fog bring some measurable precipitation. Wind is a common climatic component on Santa Rosa Island. Winds typically blow out of the northwest with an average speed of 10 to 15 knots per hour, and winds of up to 40 knots per hour are not uncommon. Long-term temperature data are not available for Santa Rosa, or any of the other Channel Islands, however, comparisons made of temperature data from adjacent mainland areas and recent data from the island suggest a mean annual temperature of approximately 15.5°C, with highs of 27°C occurring from July through October and lows of 6°C during January through March. Lightning storms are infrequent on the Channel Islands with the

result that natural fires are not a common occurrence. Only one small (<.1 hectare) natural fire has occurred on Santa rosa Island during the past 10 years.

**Physical Setting**

The topography of Santa Rosa Island is dominated by a central highlands region with Soledad Peak, the highest point on the island, reaching 484 m, and Black Mountain at 393 m elevation (Figure 2). From this central ridge, lateral ridges extend in all directions and the main canyons of the island originate here. The northern side of the island has an extensive marine terrace rising gently from the steep sea bluffs towards the central highlands region, at an elevation ranging from 76 m to 152 m. This terrace is cut by a series of canyons, many of which are wide enough to have well developed stream terraces. The south slope of the island has shorter, steeper, and more narrow canyons extending from the central highlands region to the ocean. This south-facing slope lacks the marine terrace present on the northern side of the island. The coastline of Santa Rosa Island is dominated by rocky intertidal areas, with well developed sandy beaches and dunes on the north-eastern and south-western shores. There is a small tidal marsh on the eastern portion of the island. The topographic diversity of Santa Rosa Island creates a great diversity of microclimates and habitat types - ultimately affecting the development of vegetation on the island.

Figure 2. Topography of Santa Rosa Island. The main geographic locations of the island are shown.


CARRINGTON POINT
BROCKWAY POINT
Lobos Canyon
SANDY POINT
Pocket Field
BEECHER'S BAY
SKUNK POINT
Black Mtn.
393m
Soledad Peak
484m
EAST POINT
CLUSTER POINT
China Camp
FORD POINT
JOHNSON'S LEE
SOUTH POINT
N
2 km

Santa Rosa Island is divided geologically by the Santa Rosa fault, which runs east-west through the center of the island. On the northern side of the fault, the geology is composed of well-developed terrace deposits of mid-tertiary marine clastics and volcaniclastics. The geology of the southern portion of the island is more complex, resulting from fracturing and complex faulting of tertiary sandstones and shales, and mid-tertiary clastics and volcaniclastics with volcanic intrusions (Weaver 1969). The major geologic formations on the island, their approximate ages, and locations are discussed in Appendix B.

A preliminary overview of the soils of Santa Rosa Island (Fenn 1983) showed that soil textures range from fine sandy loam to clay loam, with the clay content of many areas being high enough that the soils exhibit shrink-swell characteristics. On gentle grass covered slopes, these soils are generally thick and dark brown in color with a relatively high organic matter content. On steep slopes, soils are thin and much lighter in color. Soils of extremely high organic content occur within the marsh on the east end of the island. Sandy soils are associated with the dunes in the Sandy Point, Cluster Point, and Skunk Point regions of the island. In the vicinity of Pocket Field at the western end of the island, the ground is so windswept that most of the soil has been removed and the ground is covered with caliche (a calcium carbonate hardpan).

**Historical Aspects of Santa Rosa Island**

The Chumash (or Canalino) Indians inhabited Santa Rosa

Island from approximately 10,000 years before present to 1812 (see Appendix A for a detailed account of the history of the island). Indian population estimates on Santa Rosa and Santa Cruz islands range from 1,800 to 6,000 people, at any given time (Holland 1962, Orr 1968). The use of plants by the indians is documented by artifacts such as mats, twine, bags, nets, and baskets, however, the source of these materials (insular vs. mainland) remains unclear (Landberg 1965, Orr 1968, Timbrook 1985). Further, though plants were utilized by the indians, the affect of this use upon the island's natural vegetation is not known.

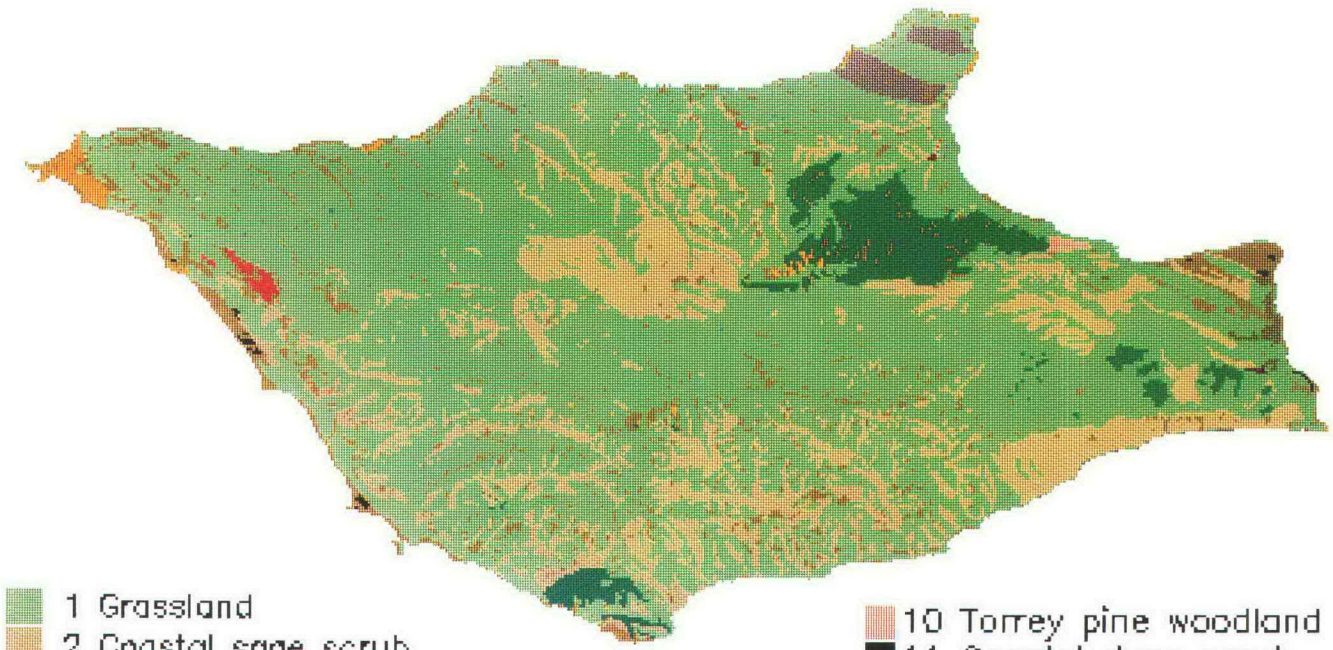
The first settlement of Santa Rosa Island by Europeans occurred during 1844, when a cattle and sheep ranch was established (Holland 1962). From that time to the present, the island has been managed as a ranch, with fluctuating numbers of sheep, cattle, and other alien herbivores. Apparently, the heaviest impact from ranching came during the late 1800's when a herd of more than 100,000 sheep were on the island.

## METHODS

An initial study, using aerial photographs, field reconnaissance, and a nested plot sampling technique was conducted during February and March 1988 in order to: 1) delineate the plant communities of Santa Rosa Island, and 2) determine the appropriate size, number, and location of sample stands to be used in a descriptive investigation of the island's plant communities. Fifteen plant community types were recognized as a result of this preliminary analysis, and included: grassland, coastal marsh, caliche scrub, coastal sage scrub, lupine scrub, baccharis scrub, coastal bluff scrub, coastal dune scrub, mixed chaparral, mixed woodland, torrey pine woodland, closed-cone pine woodland, island oak woodland, riparian woodland, and riparian herbaceous vegetation. The boundaries of these communities were mapped on USGS 1:24,000 topographic maps. They were then digitized for cover analyses and graphical display using Erdas software (Figure 3).

In the present research, plant communities were described using a releve, or sample-stand technique, as outlined in Mueller-Dombois and Ellenberg (1974). The appropriate releve size for each community type was determined by a species-area curve using data gathered in an initial survey. The area represented by the point on this curve at which an increase of 10% of the sampling area yielded an increase equal-to or less-than 5% of the total number of plant species recorded in each community was chosen to represent the needed releve size. This

Figure 3. Plant communities of Santa Rosa Island, 1989.


1 Grassland
2 Coastal sage scrub
3 Bare ground
4 Mixed chaparral
5 Baccharis scrub
6 Lupine scrub
7 Coastal bluff scrub
8 Coastal marsh
9 Caliche scrub
10 Torrey pine woodland
11 Coastal dune scrub
12 Mixed woodland
13 Island oak woodland
14 Pond
15 Closed-cone pine woodland
16 Riparian woodland
17 Eucalyptus
18 Cypress

method indicated appropriate releve sampling sizes as follows: 2 x 2 m ($4m^2$) for herbaceous communities, 5 x 4 m ($20m^2$) for lupine scrub, 5 x 8 m ($40m^2$) for other shrubs, and 10 x 25 m ($250m^2$) for tree layers (Table 1).

The specific sites sampled were chosen to represent the range of variation in habitats occupied by, and the geographic spread for, each plant community on the island (Figure 3). Vegetation data were collected during the period 1 April to 15 July 1988. The plant taxa within each releve were identified (nomenclature follows Munz 1974, and Anon. 1987), and assigned a cover, density, and distribution rating using the criteria presented in Table 2. Habitat data collected at each site included the degree of slope, slope aspect, elevation, and a qualitative assessment of soil type and the effects of grazing.

The frequency of occurrence of each plant taxon within the plant community was calculated (Appendix C). These frequency data are used to compare the abundance of taxa within each community. Further, the number of plant communities in which each taxon occurred was determined. The cover, density and distribution data for each taxon were used to calculate an importance value for each releve sampled, and a mean importance value for the taxa within each community. The importance value data were used to compare the contribution of individual taxa and alien and rare taxa within the communities.

TABLE 1. The size and number of releves sampled within each plant community on Santa Rosa Island, 1988.

| Community | Releve | | | |
|---|---|---|---|---|
| | 4 m² | 20 m² | 40 m² | 250 m² |
| Grassland | 83 | | | |
| Coastal marsh | 7 | | | |
| Caliche scrub | | | 5 | |
| Coastal sage scrub | | | 32 | |
| Lupine scrub | | 6 | | |
| Baccharis scrub | | | 15 | |
| Coastal bluff scrub | 6 | | | |
| Coastal dune scrub | 6 | | | |
| Mixed chaparral | | | 27 | |
| Mixed woodland | | | | 15 |
| Torrey pine woodland | | | | 6 |
| Closed-cone pine woodland | | | | 4 |
| Island oak woodland | | | | 9 |
| Riparian woodland | | | | 2 |
| Riparian herbaceous vegetation | 6 | | | |

TABLE 2. Criteria used in rating the plant taxa occurring within the releves sampled.

| | |
|---|---|
| cover rating: | 1 = 0 - 10% |
| | 2 = 11 - 25% |
| | 3 = 26 - 50% |
| | 4 = 51 - 75% |
| | 5 = 76 - 100% |
| density rating: | 1 = one |
| | 2 = uncommon |
| | 3 = common |
| | 4 = many |
| | 5 = dominant |
| distribution rating: | 1 = solitary |
| | 2 = densely clumped |
| | 3 = moderately clumped |
| | 4 = loosely clumped |
| | 5 = evenly dispersed |

## RESULTS

Prior to this study, 490 plant taxa were known to occur on Santa Rosa Island (Anon. 1987). In this vegetation survey, 227 (46%) of these were encountered (Appendix D). In addition, one species was found which had not been previously recorded as occurring on the island (not new to the Park, having been previously recorded on other islands). Of these 228 plants, 53 or 23% are alien taxa to the Santa Rosa Island flora. This is comparable to the entire flora of the island and the park (Anon. 1987). Thirty-eight taxa are insular endemic plants, and five of these are found only on Santa Rosa Island (Table 3). Two plants are formally listed by the State of California, Mahonia pinnata s. insularis as endangered, and Galium buxifolium as rare. No plants are formally listed by the U. S. Fish and Wildlife Service under the Endangered Species Act, however, the two above and 14 others are candidates for listing (Table 4). One additional taxon (Pinus torreyana s. insularis) is listed by the California Native Plant Society (CNPS) as rare or endangered in California (List 1B, Smith and Berg 1988). Thirteen of these endemic and/or listed plants were encountered in this study, some showing rather wide habitat affinities. The remaining 25 endemic taxa were not encountered. The reasons for their omission is likely two-fold: 1) the range occupied by some plants, and 2) a narrow range or low population numbers resulting from the grazing and browsing pressures of alien herbivores on the island.

A look at the number of plant communities in which each

Table 3. Insular endemic plants that occur on Santa Rosa Island. The island distribution is given for each plant, and for those taxa encountered in this research, the plant community distribution is also given.

Endemics occurring within the sampled releves- during 1988 vegetation sampling on SRI.

| PLANT TAXON | INSULAR DISTRIBUTION | COMMUNITY DIST. ON SRI |
|---|---|---|
| Arctostaphylos confertiflora | SRI | MC,MW,PT,CCP |
| Astragalus miguelensis | SMI,SRI SCI,AI | CAS,CB |
| Castilleja mollis | SRI | CAS |
| Dudleya greenei | SMI,SRI,SCI | G,CSS,MC,MW |
| Eriogonum arborescens | SRI,SCI,AI | CSS |
| Eriogonum grande s. rubescens | SMI,SRI,SCI,AI? | RW,CB |
| Heuchera maxima | SRI,SCI,AI | MW |
| Lotus dendroideus v. dendroideus | SRI,SCI,AI | CSS,MC,MW,PT |
| Lyonothamnus floribundus s. asplenifolius | SRI,SCI,SCL | MW |
| Malacothrix saxatilis v. implicata | SMI,SRI,SCI,AI | CSS |
| Mimulus flemingii | SRI,SCI,AI | CSS,MC,MW,PT, CCP,QT,RW |
| Pinus torreyana s. insularis | SRI | PT |
| Quercus tomentella | SRI,SCI,AI,SCA, SCL,GU | MW,CCP,QT |

Endemics that did not occur within any of the sampled plots during the 1988 vegetation study on SRI.

| | |
|---|---|
| Arabis hoffmannii | SRI,SCI |
| Arctostaphylos insularis | SRI?, SCI |
| Arctostaphylos tomentosa s. insulicola | SRI,SCI |
| Calystegia macrostegia s. macrostegia | SMI,SRI,SCI,AI |
| Castilleja hololeuca | SMI,SRI,SCI,AI |
| Ceanothus arboreus v. glaber | SRI |
| Ceanothus megacarpus s. insularis | SMI!,SRI,SCI,AI |
| Dendromecon rigida s. harfordii | SRI,SCI |
| Dudleya blochmaniae s. insularis | SRI |
| Dudleya candelabrum | SRI,SCI |
| Eschscholzia ramosa | SRI,SCI,SBI,SCA,SCL,GU |
| Galium angustifolium s. foliosum | SRI,SCI,AI |
| G. buxifolium | SMI,SRI,SCI |
| G. californicum s. miguelense | SMI,SRI |
| G. nuttallii s. insulare | SRI,SCI |

Table 3, cont.

| | |
|---|---|
| Gilia tenuiflora s. hoffmannii | SRI |
| Haplopappus detonsus | SRI,SCI,AI |
| Helianthemum greenei | SMI,SRI,SCI,SCL |
| Jepsonia malvifolia | SRI,SCI,SCA,SCL,SNI,GU |
| Lavatera assurgentiflora s. assurgentiflora | SMI,SRI,SCI,AI |
| Mahonia pinnata s. insularis | SRI,SCI,AI |
| Phacelia insularis v. insularis | SMI,SRI |
| Rhamnus pirifolia | SMI!,SRI,SCI |
| Solanum clokeyi | SRI,SCI |
| Thysanocarpus laciniatus v. ramosus | SRI,SCI |

**KEY**

ISLANDS

| | |
|---|---|
| SMI | San Miguel |
| SRI | Santa Rosa |
| SCI | Santa Cruz |
| AI | Anacapa |
| SBI | Santa Barbara |
| SCA | Santa Catalina |
| SCL | San Clemente |
| SNI | San Nicolas |
| GU | Guadalupe |

PLANT COMMUNITIES

| | |
|---|---|
| G | Grassland |
| CAS | Caliche scrub |
| CSS | Coastal sage scrub |
| CB | Coastal bluff |
| MC | Mixed chaparral |
| MW | Mixed woodland |
| PT | Torrey pine woodland |
| CCP | Closed cone pine woodland |
| QT | Island oak woodland |
| RW | Riparian woodland |

! following an island abbreviation indicates a natural extirpation (verses a purposeful removal) of the plant from that island.
? following an island abbreviation indicates a questionable location for the plant (a location appearing in a published document, but not verified by a collection specimen).

Table 4. Listing status of the rare plant taxa on Santa Rosa Island.

| PLANT TAXON | INSULAR DISTRIBUTION | LISTING STATUS |
|---|---|---|
| Arabis hoffmannii | SRI,SCI | C-1*,1B |
| Arctostaphylos confertiflora | SRI | C-2,1B |
| Castilleja hololeuca | SMI,SRI,SCI,AI | C-2,1B |
| Castilleja mollis | SRI | C-2,1B |
| Dudleya blochmaniae s. insularis | SRI | C-2,1B |
| Dudleya candelabrum | SRI,SCI | C-2,1B |
| Erysimum insulare | SMI,SRI,SCI,AI | C-2 |
| Galium buxifolium | SMI,SRI,SCI | C-2,CR,1B |
| Gilia tenuiflora s. hoffmannii | SRI | C-2,1B |
| Helianthemum greenei | SMI,SRI,SCI,SCL | C-2,1B |
| Heuchera maxima | SRI,SCI,AI | C-2,1B |
| Lyonothamnus floribundus s. asplenifolius | SRI,SCI,SCL | C-2,1B |
| Mahonia pinnata s. insularis | SRI,SCI,AI | C-2,CE,1B |
| Orobanche parishii s. brachyloba | SMI,SRI,SCI,SNI,SCA | C-2,1B |
| Phacelia insularis v. insularis | SMI,SRI | C-2 |
| Salvia brandegei | SRI | C-2,1B |

**KEY**

C-1* Candidate, Category 1, USFWS (*=believed to be extinct)
C-2 Candidate, Category 2, USFWS
CR California State Listed, Rare, CDFG
CE California State Listed, Endangered, CDFG
1B California Native Plant Society, Endangered or Rare in California and elsewhere

taxon occurred provides some insight into the wide range of ecological tolerances of some taxa, and the apparent narrow range of suitable habitats for others. Nineteen plant taxa were found in at least seven of the 15 plant communities recognized for Santa Rosa Island (Table 5). Eleven of these taxa are alien forbs and grasses, that are characteristic of over-grazed sites, while seven are native plants. The one native shrub that was widespread, Baccharis pilularis s. consanguinea is a weedy plant that typically occupies recently disturbed and/or heavily grazed sites. Thus, it is not surprising to find this species widespread on Santa Rosa Island. The presence of natives on this list of widespread plants, provides hope that the native vegetation is still present in sufficient numbers, and with a wide enough geographic distribution to allow recovery through time, given the removal of alien animals. A total of 71 taxa were found in only one plant community on the island (Table 6). Eight of these are alien forbs and grasses, and 63 are native plants. The limited distribution of these plants, as mentioned above with regard to endemic plants, is likely the result of natural ecological limitations as well as disturbance-induced reductions in geographic range and total numbers of individuals.

The three most abundant plant communities on Santa Rosa Island were grassland, coastal sage scrub, and mixed chaparral. Grassland covered over half of the total vegetated area (67.5%), coastal sage 18.4%, and mixed chaparral 4.8%. The remaining plant communities each accounted for <1% of the total vegetated

Table 5. Plant taxa that occurred in at least seven of the fifteen plant communities on Santa Rosa Island. Plants that are alien to the California flora are indicated with an *. The life form (annual grass [ag], perennial grass [pg], annual herb [ah], perennial herb [ph], and shrub [s]) of each taxon is also indicated.

| Plant Taxa | Number of Plant Communities | Life Form |
|---|---|---|
| * Bromus diandrus | 13 | ag |
| * Hordeum murinum s. leporinum | 12 | ag |
| * Sonchus oleraceous | 11 | ah |
| Baccharis pilularis s. consanguinea | 10 | s |
| * Bromus mollis | 10 | ag |
| Distichlis spicata | 10 | pg |
| * Silene gallica | 10 | ah |
| * Vulpia bromoides | 9 | ag |
| * Avena barbata | 9 | ag |
| * Medicago polymorpha v. polymorpha | 9 | ah |
| * Hypochoeris glabra | 9 | ah |
| Bromus carinatus | 9 | pg |
| Achillea millefolium | 9 | ph |
| Gnaphalium purpureum | 8 | ah |
| * Bromus rubens | 8 | ag |
| Corethrogyne filaginifolia v. robusta | 8 | ph |
| Hordeum californicum | 8 | pg |
| Daucus pusillus | 7 | ah |
| * Erodium cicutarium | 7 | ah |

Table 6. Plant taxa occurring in only one plant community on Santa Rosa Island during 1988 vegetation sampling. Plant taxa considered alien to the island flora are indicated with an *.

---

**Coastal sage scrub**

Adiantum jordanii
Astragalus curtipes
Calochortus catalinae
Cleome isomeris
Coreopsis gigantea
Eriogonum arborescens
Grindelia robusta v. robusta
Linaria canadensis v. texana
Lotus saluginosus s. saluginosus
Malacothrix saxatilis v. implicata
Muhlenbergia microsperma
Oligomeris linifolia
Opuntia prolifera
Phacelia viscida
Toxicodendron diversilobum
Zauschneria californica s. californica

**Grassland**

Achyrachaena mollis
Bowlesia incana
*Brassica geniculata
Calandrinia ciliata v. menziesii
Carex subbracteata
Delphinium parryi s. parryi
Lepidium lasiocarpum v. lasiocarpum
Lotus hamatus
Platystemon californicus
Suadea californica
Trifolium amplectens v. amplectens

**Mixed woodland**

Comarostaphylos diversifolia v. planifolia
Erigeron sanctarum
Heuchera maxima
*Lactuca serriola v. serriola
Lyonothamnus floribundus s. asplenifolius
Prunus ilicifolia s. lyonii
Quercus agrifolia v. agrifolia
*Spergula arvensis

Table 6, cont.

**Riparian herbaceous vegetation**
Juncus phaeocephalus v. phaeocephalus
Juncus xiphioides
Mimulus guttatus
*Polygonum arenastrum
Scirpus cernuus v. californicus

**Mixed chaparral**
Arctostaphylos tomentosa s. insulicola
Chorizanthe wheeleri
Crassula erecta
Elymus glaucus s. glaucus
Helianthemum scoparium
Orobanche bulbosa
Pellaea mucronata s. mucronata

**Riparian woodland**
Chenopodium ambrosioides v. ambrosioides
*Chenopodium murale
Populus trichocarpa
Salix lasiolepis v. lasiolepis
Scirpus americanus v. monophyllus

**Baccharis scrub**
Chenopodium berlandieri v. sinuatum
*Marrubium vulgare
*Polygonum aviculare
Rumex salicifolius
Zigadenus fremontii

**Torrey pine woodland**
Ceanothus arboreus v. glaber
Pinus torreyana s. insularis
Rhus integrifolia

**Caliche scrub**
Castilleja mollis
Lepidium nitidum v. nitidum

Table 6, cont.

**Coastal bluff scrub**
Lasthenia glabrata s. coulteri
Poa douglasii

**Coastal dune scrub**
Abronia maritima
*Cakile maritima s. maritima

**Island oak woodland**
Dryopteris arguta
Phacelia cicutaria v. hispida

**Coastal marsh**
Jaumea carnosa

**Closed-cone pine woodland**
Pinus remorata

**Lupine scrub**
Lupinus arboreus

Table 7. Extent of each plant community, and bare ground on Santa Rosa Island as a percentage of the total area.

| Community | Area of Island (%) |
|---|---|
| Grassland | 67.53 |
| Coastal marsh | 0.29 |
| Caliche scrub | 0.16 |
| Coastal sage scrub | 18.37 |
| Lupine scrub | 0.81 |
| Baccharis scrub | 0.04* |
| Coastal bluff scrub | 0.43 |
| Coastal dune scrub | 0.16 |
| Mixed chaparral | 4.84 |
| Mixed woodland | 0.09 |
| Torrey pine woodland | 0.16 |
| Closed-cone pine woodland | 0.01 |
| Island oak woodland | 0.08 |
| Riparian woodland | 0.01 |
| Riparian herbaceous vegetation | <.01 |
| Bare ground | 6.9 |

* The Baccharis scrub plant community is under-represented by these data due to the inability to distinguish the baccharis scrub from coastal sage scrub community on aerial photographs. The data for these two communities are being reevaluated using recent (1988), high resolution aerial photos.

area (Table 7). Bare ground, including open sand dunes and eroding interior slopes, covered 6.9% of the island.

The more widespread plant communities occurred over a wide range of geographic and topographic situations, and this diversity is reflected in the relative number of plant taxa observed in the communities. The coastal sage scrub, grassland, and mixed chaparral support the highest number of plant taxa (Table 8). Interestingly, some of the more restricted communities (e.g. mixed woodland, and torrey pine woodland) also support a relatively high number of plants.

In 14 of the 15 plant communities on the island, the number of native plants exceeds that of alien taxa, with the coastal marsh community being the only exception. Although numerically the native plants dominate in the grassland, caliche scrub, Baccharis scrub, and riparian herbaceous vegetation, the relative importance value of the alien plants exceeds that of the native taxa. In these communities, alien species are dense, widespread and dominate the landscape.

**Community Descriptions**

A discussion of the findings of this research by plant community follows. Appendix C provides data on the frequency of occurrence and the relative importance values of plant taxa within each community.

**Grassland.** The grassland community (Figure 4) is abundant on Santa Rosa Island, and occurs on sites ranging from the ridges of the central highlands region to the lowest reaches of the

Table 8. The total number of plant taxa observed in each plant community, and their origin (native vs.alien). The relative importance value (RIV) for the native and alien taxa are given in parentheses.

| Community | Total Species | Native Species | (RIV) | Alien Species | (RIV) |
|---|---|---|---|---|---|
| Grassland | 94 | 63 | (25.2) | 31 | (74.8) |
| Coastal marsh | 15 | 6 | (75.2) | 9 | (24.8) |
| Caliche scrub | 44 | 25 | (44.4) | 19 | (55.6) |
| Coastal sage scrub | 103 | 77 | (54.0) | 26 | (46.0) |
| Lupine scrub | 27 | 20 | (74.4) | 7 | (25.6) |
| Baccharis scrub | 74 | 44 | (37.2) | 30 | (62.8) |
| Coastal bluff scrub | 24 | 17 | (65.1) | 7 | (34.8) |
| Coastal dune scrub | 15 | 9 | (74.0) | 6 | (26.0) |
| Mixed chaparral | 81 | 63 | (72.9) | 18 | (27.3) |
| Mixed woodland | 67 | 51 | (71.5) | 17 | (27.2) |
| Torrey pine woodland | 62 | 47 | (72.5) | 15 | (27.5) |
| Closed-cone pine woodland | 32 | 23 | (71.0) | 9 | (29.0) |
| Island oak woodland | 17 | 11 | (77.7) | 6 | (22.3) |
| Riparian woodland | 44 | 26 | (54.9) | 18 | (44.2) |
| Riparian herbaceous vegetation | 19 | 11 | (45.3) | 8 | (54.7) |

canyons. Although the dominant plant taxa varied with terrain and soil-type, the most common taxa throughout were alien annual grasses including: Bromus diandrus, Bromus mollis, Avena fatua, Avena barbata, Hordeum murinum s. leporinum, Vulpia bromoides, and alien, annual forbs including: Medicago polymorpha, Silene gallica, Erodium cicutarium, Erodium moschatum, Hypochoeris glabra, Malva parviflora and Sonchus oleraceous. Structurally, Avena barbata, A. fatua, and Bromus diandrus formed an upper canopy that reached a height of 30 to 40 cm, with a dense understory at a height of 12 to 25 cm that included: Hordeum murinum s. leporinum, Bromus mollis, B. rubens, Distichlis spicata v. stolonifera, Vulpia bromoides, V. myuros, and many of the herbaceous forbs. Invasive alien plants present within the grassland community included: Centaurea melitensis, Silybum marianum, and Xanthium spinosum.

The native perennial grass, Stipa pulchra, was abundant at grassland sites at higher elevations on southeast-facing slopes of the central highlands region, the southern canyons, and at the southeastern portion of the island where the grassland and coastal sage scrub plant communities meet. Common grass associates included the annual aliens: Bromus spp., Avena spp., Hordeum murinum s. leporinum, Medicago polymorpha, and Silene gallica.

The dominant plants in grasslands near the coastal strand and coastal bluff, were primarily native taxa and included: Hordeum californicum, Distichlis spicata v. stolonifera, and

salt-tolerant forbs. The abundance of Distchlis spicata v. stolonifera in the grassland decreased at inland sites, except in isolated areas where the sand content of the soil was high. The texture of soils in the grassland community ranged from predominantly clay loam to sandy clay loam.

**Coastal marsh.** The marsh community (Figure 5) is best developed on the east side of the island, at the mouth of Old Ranch House Canyon, and extending northward toward Skunk Point. One additional, small marsh is present at the mouth of Arlington Canyon. Plant taxa present at these sites included: Distichlis spicata v. stolonifera, Salicornia virginica, Frankenia salina, Cressa truxillensis, Hordeum murinum s. leporinum, Bromus diandrus, and Jaumea carnosa. Distichlis spicata v. stolonifera formed a loose, ground cover into which the S. virginica interweaved, forming a matrix that either F. salina or J. carnosa penetrated. Soil moisture and organic matter were higher than the adjacent areas and soil texture was clay loam.

**Caliche scrub.** The caliche scrub plant community (Figure 6) occurs in the southern portion of pocket field, at the northwest portion of the island. Caliche formations are common on the soil surface in pocket field, distinguishing this from all other areas on Santa Rosa Island. The area is relatively flat except for shallow erosion gullies, and the raised areas of caliche. The vegetation is low-growing due to the almost constant northwesterly winds. The dominant species were the nearly prostrate Haplopappus venetus v. sedoides, and Astragalus

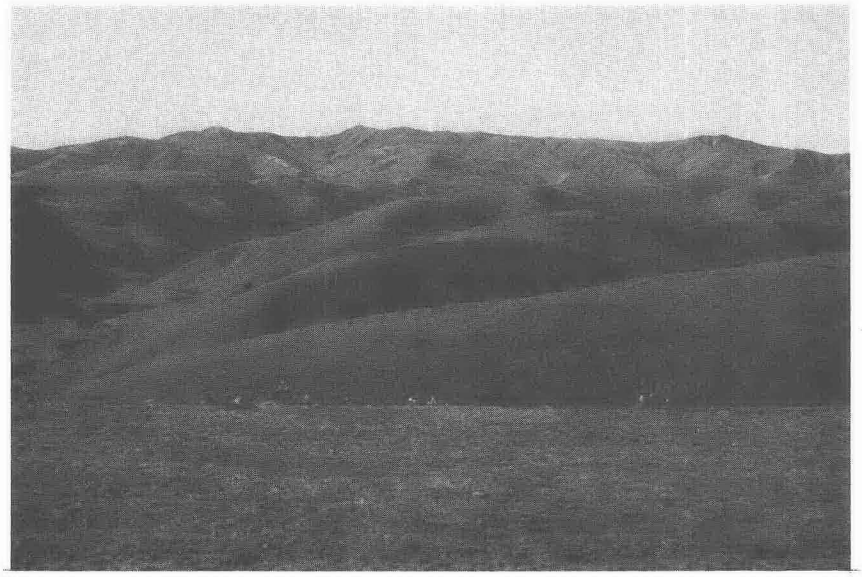


Figure 4. Grassland on Santa Rosa Island.

Figure 5. Coastal marsh on Santa Rosa Island.

miguelensis at a height of 25 to 50 cm. Associated species were generally shorter in stature (12 to 20 cm), with a patchy distribution. These included the native taxa: Atriplex californica, Artemisia californica, Baccharis pilularis s. consanguinea, Sisyrinchium bellum, Daucus pusillus, and Spergularia macrotheca, and alien forbs and grasses including: Medicago polymorpha, Erodium cicutarium, Sonchus asper, Avena barbata, Bromus mollis, B. rubens, and Melilotus indicus.

**Coastal sage scrub.** The coastal sage scrub plant community (Figure 7) is abundant on Santa Rosa Island occurring primarily on southeast to southwest-facing slopes, and at elevations ranging from 15 m on coastal slopes to 213-244 m at inland sites. The dominant shrubs were Artemisia californica and Baccharis pilularis s. consanguinea. Other native shrubs that were recorded within the coastal sage scrub, but with low frequency and cover include Salvia brandegei, in protected drainages, Heteromeles arbutifolia at scattered sites, and Cleome isomeris in the canyons at lower elevations. The dominant herbs and grasses are primarily of alien origin and included: Avena barbata, Bromus mollis, B. rubens, B. diandrus, Atriplex semibaccata, Silene gallica, Medicago polymorpha, and Vulpia bromoides. The native, perennial grasses Stipa pulchra, and Stipa diegoensis, occurred with a relatively high frequency and cover, but were found primarily at the base of established shrubs where they received protection from grazing animals.

The structure of this plant community varied with exposure.

Figure 6. Caliche scrub on Santa Rosa Island.

Figure 7. Coastal sage scrub on Santa Rosa Island

Sites on southern aspects and more level slopes were quite open, with introduced annual grasses and forbs in the areas between shrubs. In contrast, sites on western and eastern aspects or on steeper slopes where grazing was more restricted, the canopy was more dense. At these latter sites, alien annual grasses were less abundant, and the diversity of native forbs higher. The soils characteristic of sites supporting the coastal sage scrub were clay loam in texture.

**Lupine scrub.** The lupine scrub plant community (Figure 8) occurs only near Carrington Point at the northeastern portion of the island. Two species of lupine dominated this community: Lupinus albifrons and Lupinus arboreus. These taxa are spatially separated with Lupinus albifrons occurring on the eastern and western sides of the stand and L. arboreus in the center. L. albifrons was found growing closer to the sea where it is more fully exposed to the prevailing northwesterly winds and sea spray, while L. arboreus was found at more protected sites away from the ocean. Lupinus albifrons occurred on unconsolidated sandy soils, while L. arboreus occurred on soils that have a greater loam content. The lupine shrubs formed a canopy at a height of 50 - 63 cm over a patchy understory of forbs and grasses that included: Chenopodium californicum, Amsinckia intermedia, Phacelia ramosissima, Abronia umbellata, Elymus triticoides, Bromus diandrus, Hordeum murinum s. leporinum, and Distichlis spicata v. stolonifera.

**Baccharis scrub.** The baccharis scrub plant community

Figure 8. Lupine scrub on Santa Rosa Island.

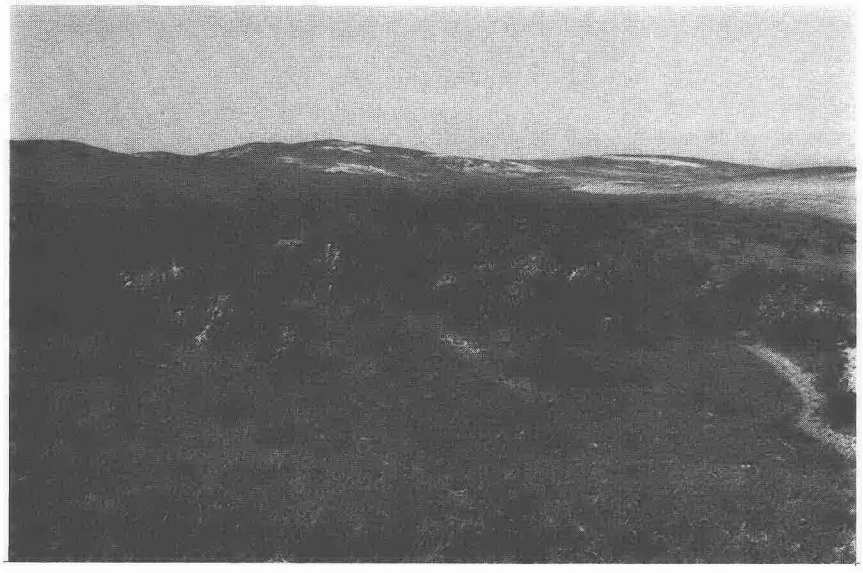


Figure 9. Baccharis scrub on Santa Rosa Island.

(Figure 9) occurs at scattered sites on the island, primarily at mid to lower elevations. The dominant plant taxa found were: Baccharis pilularis s. consanguinea, Bromus diandrus, B. mollis, Hordeum murinum ssp.leporinum, Avena fatua, A. barbata, Medicago polymorpha, Silene gallica, Vulpia bromoides, Distichlis spicata v. stolonifera, Sonchus oleraceous, and Atriplex semibaccata. The vertical structure of the baccharis community was quite variable from site to site. Shrubs in areas exposed to high winds, and in the open grassland were typically less than 0.5 m tall, while at more protected sites among the coastal sage, in canyon bottoms and north-facing slopes, shrubs reached a height of 1 to 1.5 m. The soil textures at sites supporting baccharis scrub ranged from loam to sandy clay loam in texture.

**Coastal bluff scrub.** The coastal bluff scrub plant community (Figure 10) is best developed adjacent to Sandy Point, at the northwestern portion of the island. A number of smaller isolated sites occur along the northern and western coastlines. This is an intermediate community between the grassland and coastal dune scrub, both in geographic position and floristic composition. The vegetation was low-growing (12 to 20 cm), and irregularly distributed, with much bare ground. The dominant plant taxa included: Camissonia cheiranthifolia, Carpobrotus aequilateralis, Haplopappus venetus, Astragalus miguelensis Hordeum californicum, and Atriplex californica. The soil of the coastal bluff was sandy to sandy loam in texture, and highly erodible with extensive bare areas.

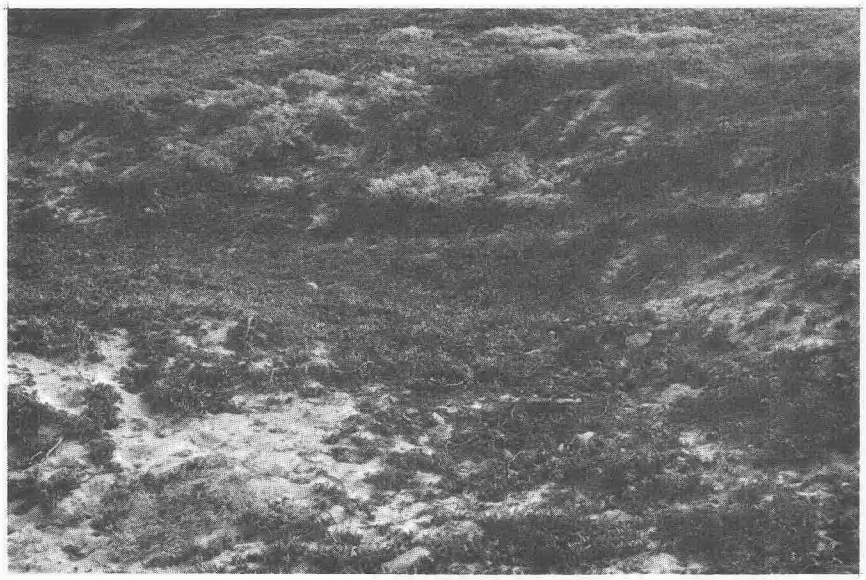


Figure 10. Coastal bluff scrub on Santa Rosa Island.

Figure 11. Coastal dune scrub on Santa Rosa Island.

**Coastal dune scrub.** There are two areas that support the coastal dune community (Figure 11). The far western end of the island, and Sandy Point, at the eastern tip of Beecher's Bay. The floristic composition of this community varied with exposure and geographic position on the dunes. The western side of the island is exposed to high winds, therefore the dunes are steep, with high ridges and low valleys between. The dune area on the eastern, more protected end of the island, is gently sloping with few peaks and valleys. The foredunes were dominated by a dense growth of Abronia maritima and Cakile maritima v. maritima reaching a height of approximately 5 to 15 cm, while the vegetation of the backdunes was more irregularly distributed with Ambrosia chamissonis, Cakile maritima, and Hordeum murinum s. leporinum as dominants.

With increased protection and distance from the ocean, the flora of the dune community was more diverse, and included: Ambrosia chamissonis, Hordeum murinum s. leporinum, Distichlis spicata v. stolonifera, Cakile maritima v. maritima, Camissonia cheiranthifolia, Sonchus oleraceous, and Mesembryanthemum crystallinum. The soils were sand with isolated pockets of sandy loam.

**Mixed chaparral.** The mixed chaparral community (Figure 12) is best developed on the slopes of Black Mountain, but also occurs near South Point, and at the upper regions of Old Ranch House Canyon. The floristic composition of the mixed chaparral community varied with aspect and steepness of the slope. A

nearly prostrate Adenostoma fasciculatum v. fasciculatum (20 to 30 cm) occurred along the ridgetops in nearly monotypic stands. On west and east-facing slopes A. fasciculatum v. fasciculatum and Quercus dumosa were codominants. Both were found in a prostrate and upright form, with growth form varying with exposure. The primary plant associates included: Galium nuttalii s. insulare, Mimulus flemingii, Eriophyllum confertiflorum, Carex globosa, Vulpia bromoides, Bromus rubens, Filago californica, and Silene gallica. The soils were clay loam in texture.

**Mixed woodland.** The mixed woodland community (Figure 13) occurs primarily in the larger canyons, at elevations ranging from 76 to 152 m. The tree species that occurred within the mixed woodland included: Quercus agrifolia, Q. tomentella, Prunus ilicifolia s. lyonii, and Lyonothamnus floribundus s. asplenifolius. Arborescent shrubs included Heteromeles arbutifolia, and Quercus dumosa. The composition of tree species varied between sites, and usually only one of the above listed species was dominant. The woodlands are utilized extensively as cover for alien herbivores, therefore there was little understory development and litter was absent from the soil surface. Herbaceous plants that did occur as an understory were primarily alien weedy taxa and included: Avena barbata, Silene gallica, Bromus diandrus, Hypochoeris glabra, Daucus pusillus, Vulpia bromoides, and Bromus mollis. Scattered seedlings of Artemisia californica or Baccharis pilularis s. consanguinea were found,

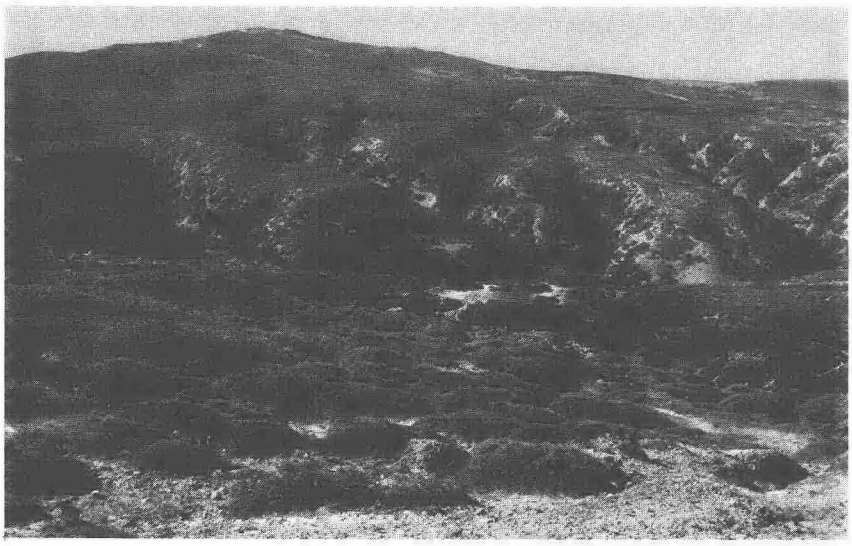


Figure 12. Mixed chaparral on Santa Rosa Island.

Figure 13. Mixed woodland on Santa Rosa Island.

but few survived to a mature age. The soils of the mixed woodland community were loam to clay loam in texture.

**Torrey pine woodland.** The torrey pine community (Figure 14) occurs only on the east side of the island. The main stand is located on a north-facing sea-slope at the eastern end of Beecher's Bay, and a smaller stand occurs to the southeast of this site, in Box Canyon. Plants typical of the mixed chaparral and grassland communities were often components of the torrey pine woodland, and therefore this community ranged from monotypic assemblages of Pinus torreyana with a litter understory, to more open stands that resembled the mixed woodland community. Shrub species that occurred in association with torrey pine included: an arborescent form of Quercus dumosa, and Heteromeles arbutifolia, Rhus integrifolia, Arctostaphylos confertiflora, Adenostoma fasciculatum v. fasciculatum, Ceanothus arboreus, Mimulus flemingii, Artemisia californica and Baccharis pilularis s. consanguinea. The herbaceous cover included: Pityogramma triangularis, Carex globosa, Bromus diandrus, Melica imperfecta, Silene laciniata, Bromus rubens, Agrostis diegoensis, Avena barbata, and Gnaphalium purpureum. The soils characteristic of the torrey pine community were loam to sandy clay loam in texture.

**Closed-cone pine woodland.** The closed-cone pine plant community (Figure 15) is best developed on the northeastern side of Black Mountain, at elevations ranging from 213 to 274 m. In addition, a small group of 7 Pinus remorata occurs within the

Figure 14. Torrey pine woodland on Santa Rosa Island.

Figure 15. Closed-cone pine woodland on Santa Rosa Island.

main torrey pine stand, and solitary trees occur on a south-facing slope near Carrington Point, and on Soledad Peak. There is some taxonomic confusion regarding the trees occurring within these stands, with some taxonomists recognizing 2 species, Pinus muricata and P. remorata, while others only variations of P. remorata. All plants were called P. remorata in this work.

The development of a vegetative understory in the closed-cone pine community varied among sites. At those sites where the pines formed a nearly continuous overstory, litter was present, but little herbaceous understory had developed. Shrubs and herbs were present, and irregularly distributed in the less-dense pine stands. Plant associates included: Adenostoma fasciculatum v. fasciculatum, Carex globosa, Mimulus flemingii, Luzula subsessilis, Silene gallica, Hypochoeris glabra, and Gnaphalium purpureum. The soils in the closed cone pine woodland were sandy clay loam in texture.

**Island oak woodland.** The island oak plant community (Figure 16) occurs near Soledad Peak, and on the northwest-facing slopes of Black Mountain. Seventeen monotypic groves were found, ranging in size from less than 10 individual stems to groves of several hundred individual stems. Stems are used here to define trees due to the clonal nature of oaks and the resultant difficulty of identifying 'individual' plants. The groves on Soledad Peak are, in general, small and geographically distinct. They occur at elevations ranging from 274 to 412 m, and on slopes exceeding 20°. No measurable understory or litter cover was

found beneath the tree canopy at these sites. The only tree species that occurred in these groves was Quercus tomentella, the island oak. The Black Mountain groves occur at slightly lower elevations, ranging from 244 to 274 m. These groves supported an understory of arborescent individuals of Heteromeles arbutifolia, and associated herbaceous species that included: Silene gallica, Hypochoeris glabra, Avena barbata, Vulpia bromoides, Sonchus oleraceus, and Gnaphalium purpureum.

**Riparian woodland.** The riparian woodland community (Figure 17) exists as one grove of Populus trichocarpa, clusters of Salix lasiolepis var. lasiolepis, and scattered individuals of Sambucus mexicana along a perennial stream in Lobos Canyon. Small stands of S. lasiolepis were also found in moist areas of other large canyons. The soil texture in these areas was sandy loam.

**Riparian herbaceous vegetation.** The herbaceous riparian plant community occurs in the bottoms of the larger canyons where soil moisture is high. Water sources vary from perennial flowing streams to vernal seeps. Distichlis spicata v. stolonifera formed a thick ground cover with a maximum height of 10 to 20 cm. Associated plant taxa included: Polypogon monspeliensis, Agrostis stolonifera v. major, and Cotula coronopifolia, each considered alien to the island flora. In general, the cover of these associated taxa increased with increasing moisture levels. In narrow canyons, the herbaceous riparian vegetation is interspersed with the typical grassland or sage-baccharis plant community types. The soils of these moist areas are a clay loam.

Figure 16. Island oak woodland on Santa Rosa Island.

Figure 17. Riparian woodland on Santa Rosa Island.

## DISCUSSION

The vegetation of Santa Rosa Island is more open than the other large Channel Islands due to the relatively large expanse of grassland. Grassland accounts for over 65% of the total area on Santa Rosa, the total amount of woodland on the island is only 0.35%, and the rest of the island is either covered by low growing shrubs (25.2%) or is devoid of vegetation due to erosion or blowing sand (6.9%)

The plant communities on Santa Rosa Island are similar to those documented for other islands within the Channel Islands group (Minnich 1980). Annual grassland, dominated by alien European species, is generally the major component of the vegetation cover. Persistent populations of native perennial grasses, and woodland and scrub communities are highly fragmented, and often depauperate. This fragmentation, large numbers of alien species, and highly restricted distributions of native species is believed to be caused by long-term grazing and browsing by introduced animals which has occurred on all of the Channel Islands.

The specific effects of overgrazing upon vegetation on Santa Cruz and Santa Catalina Islands, documented by comparisons of sites that are heavily grazed by sheep and goats, and supporting populations of feral pigs with protected and recovering sites included: 1) a decrease in the density and cover of vegetation, 2) a decline in the species richness of plant communities, 3) a decline in the understory development in woodland communities, 4)

a decline in the reproduction of woody and herbaceous plants, 5) a decrease in the accumulation of litter, directly effecting the development and stability of soil, 6) increased erosion, 7) an arborescent growth-form in chaparral plants, especially evident in long-lived taxa (e.g. Heteromeles, Quercus, and Rhus), and 8) an alteration of the natural fire regime due to the continual 'harvest' of flammable fuels (Minnich 1980). Similar detrimental effects apply to Santa Rosa Island where cattle, and populations of deer, elk and feral pigs impact the vegetation.

Although it is clear that grazing has affected the structure of the woodland and scrub plant communities, creating more open, fragmented stands, paleontological evidence suggests that the woodland communities on Santa Rosa Island retreated to the highlands region of the island as a result of climatic warming several thousand years ago (Orr 1968, Minnich 1980). Therefore, grazing has probably not significantly altered the geographic range of the woodland communities. Closed-cone pine stands on Santa Cruz and Santa Catalina Islands occur primarily at sites exposed to summer fog, suggesting this species may depend upon summer moisture to ameliorate drought stress (Minnich 1980). On Santa Rosa Island, the closed cone pine community occupies sites at elevations within the zone affected by the summer marine layer that typically occurs between 300-500 m elevation (Minnich 1980). In fact, most of the sites supporting woodland communities are relatively cool and moist. For instance, sites supporting the oak woodland, mixed woodland, and Torrey pine communities on

Santa Rosa Island are also within the summer fog zone or within canyons where moisture concentrates and temperatures remain mild.

The woodland communities on Santa Rosa Island are regularly visited by alien herbivores which forage and disturb the soil surface, causing the characteristic depauperate woody and herbaceous understory, little litter accumulation and surface soil erosion. Three woodland plants that appear to be in immediate jeopardy, as a result of herbivore use, are the island oak (Quercus tomentella), Santa Cruz Island pine (Pinus remorata), and Santa Cruz Island ironwood (Lyonothamnus floribundus s. asplenifolius). Soil erosion is so extensive at the base of island oak trees that the survival of plants, at least at some sites, is threatened. Further, no reproduction of island oak has been documented in recent years. Soil erosion is apparently the cause of felled mature Pinus remorata individuals, and while some reproduction has occurred within this community, the long-term survival of the community may be in jeopardy. Recent observations of dead and extensively browsed ironwood trees raises concern for the survival of this taxa as well. Some populations of ironwood are in rocky ravines where soil erosion and litter accumulation are not concerns, however trees are being browsed so severely, with bark as well as twigs and leaves being removed, that some individuals are dying. It must be an immediate concern of the NPS to preserve these woodland plants. Each is an insular endemic, and the maintenance of viable populations on Santa Rosa Island is critical to the existence of

these taxa. Fencing of woodland groves should be a high priority resource issue.

The most widely distributed shrub community, coastal sage scrub, is particularly vulnerable to the long-term effects of grazing. This "soft chaparral" is composed of plants that are typically low-growing (<1.5 m in height) and succulent enough to be extensively browsed during the summer drought when grass forage is less abundant. Susceptible taxa include many of the endemic, and noticeably rare plants including: Eriogonum spp., Galium spp., Malacothrix saxitilis v. implicata, Ceanothus spp., and also the abundant and widespread Artemisia californica. In addition to the loss of biomass from direct browsing, many of the native species of this community suffer reproduction impairment under heavy grazing, causing these taxa to be unable to maintain populations through periods of prolonged grazing. An analysis of individual releves from the coastal sage scrub community reveals a strong inversion relationship between animal disturbance and species diversity and shrub canopy cover. As grazing and browsing pressure increases,the integrity of the community is reduced through decreasing species diversity, increasing importance of alien species, and increasing bare ground and open space between shrubs (Halvorson and Ingram, in prep).

**Trends Of Vegetation Change**

Some of the trends of vegetation change that might be expected with the removal of cattle and other herbivores from Santa Rosa Island include: 1) an invasion of grassland by

chaparral plants, Baccharis pilularis s. consanguinea, and plants typical of the coastal sage scrub community, 2) a conversion of grassland from one dominated by alien annual taxa to a grassland that supports a greater percentage of native perennial grasses and forbs, and 3) the development of denser scrub and woodland stands that have an increased species diversity.

Numerous studies of succession in grassland areas protected from grazing have been conducted throughout California (White 1967, Heady 1988, Bartolome and Gemmill 1981, Lathrop and Gogan 1985). Although the study sites addressed in these works are in northern California, the general trends observed can be expected to also occur on Santa Rosa Island. These studies have shown a variety of results, but the more common successional pattern in grassland is as mentioned above, a rapid invasion by 'soft-chaparral' type plants, including Baccharis pilularis s. consangiunea, Artemisia californica, and Eriogonum spp. The particular species invading will depend upon the adjacent vegetation type, for the adjacent vegetation provides the seed source for invasion. The succession of a depauperate chaparral-grassland site on Santa Catalina Island, upon removal of alien herbivores, was characterized by a rapid invasion by coastal sage scrub such that within a 20 year period grassland plants were present only as a component of the more dominant sage scrub vegetation (Minnich 1980). Later succession at this site was characterized by the slow establishment of more-woody plants including Heteromeles arbutifolia and Rhus spp. A scenario

similar to this can be expected for much of Santa Rosa Island. However, grassland is likely to remain a common vegetative community on the island through time. Observations on San Miguel Island in recent years (approximately 30 years following the major removal of herbivores) shows the grassland zone converting to a low scrub vegetation on exposed sites and in areas of relatively low soil fertility, while in the heavier clay-loam type soils the grassland has persisted, and is increasingly dominated by perennial taxa (predominantly, the native bunchgrass Stipa pulchra and herbaceous forbs [vegetation monitoring data in NPS files]). A similar increase in the abundance of Stipa pulchra has been observed on San Clemente Island following the removal of feral sheep (Beauchamp 1987).

**Floristics**

In addition to the three endemic tree taxa mentioned above, many other endemic plants are reduced in distribution and numbers. Arctostaphylos confertiflora, an insular endemic, occurs in very low numbers, and most individuals observed suffer from severe browsing. Arabis hoffmannii was believed to be extinct on Santa Cruz Island until recently, and following the removal of sheep from that island, several extant populations have been observed (S. Junak, pers. comm. 1989). This plant was not encountered in the present research on Santa Rosa Island, and it is unknown if individuals of Arabis hoffmannii occur on the island any longer.

Our vegetation monitoring program has already shown that

insular endemic plants have increased both in geographic distribution and population numbers following removal of alien herbivores on San Miguel and Santa Barbara Islands. These include: Calystegia macrostegia ssp. macrostegia, Castilleja hololeuca, Dudleya greenei, Galium californicum s. miguelense, Eriogonum giganteum s. compactum, Eriophyllum nevinii, and Artemisia californica s. insularis.

Many other native species, such as Coreopsis gigantea, are found only in isolated locations on canyon walls and rock outcrops out of the reach of herbivores. The reduction in numbers of native species is, in many locations accompanied by an increase of alien plant species which are more adapted to disturbance. It is expected that with a reduction in grazing on the island, all native species, including the most restricted endemics, will recover and become more numerous and more widely distributed.

**Recommendation**

The removal of all alien herbivores is a necessary task for protection of the vegetation resources on Santa Rosa Island. The specific trends in vegetation that will occur on the island will depend upon the timing of removal and the sequence of removal of the introduced animals. Each of the alien herbivore groups pose serious threats to the stability of plant communities, and the negative impacts of deer and elk upon the woodland and scrub communities must not be discounted.

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## APPENDIX A

Human Occupation

Vast changes in island ecosystems have resulted from the settlement of Santa Rosa Island through time. Pre-European insular people, recognized as the Canalino, or present-day Chumash Indians, inhabited Santa Rosa Island approximately 10,000+ years ago. Population counts of the Canalino (Holland 1962) have varied from 6,000 during prolific times to 1,800 in 1805 on Santa Cruz and Santa Rosa islands (Orr 1968). Seafood appears to have been their staple foodstuff although the diet was undoubtedly supplemented by botanical resources. The seasonal fluctuation in food availability was, most likely, the primary determinant of food items consumed. The utilization of natural resources is documented by artifacts of mats, twine, bags, nets, baskets, canoes, and shelters, however, the location of botanical source materials remains undocumented (Landberg 1965, Orr 1968, Timbrook 1985). Although plants were utilized by the indians, the exact impact this use had upon the botanical communities of the island will never be known.

It is not clear why the insular people left Santa Rosa Island, although a number of factors likely contributed, including: 1) an 1807 measles outbreak diminished population numbers, and 2) an 1812 earthquake (Orr 1968). There is no evidence that these people left as a result of depleted resources. By 1835, when George Nidever began hunting for sea

otter along the coast of Santa Rosa Island, there were no longer Canalinos communities on the islands (Holland 1962).

European influence began with short, exploratory visits Juan Rodriguez Cabrillo in approximately 1542, followed in 1595 by Sebastian Rodriguez Cermerro, and in 1602 by Sebastian Vizcaino (Orr 1968 and Holland 1962). In the early 1800's, Aleutian hunters began harvesting marine mammals, including sea otters, in the waters around the Channel Islands (Holland 1962). Hunting expeditions continued on a regular basis until around 1841.

The first settlement of Santa Rosa Island by European man occurred during 1844 by Alphaus B. Thompson, marking the beginning of a long history of grazing by introduced animals (Table A-1). Thompson brought with him 270 head of cattle, 51 ewes, 2 rams, and 9 horses (Holland 1962). In 1852, brood mares, hogs, and rabbits were added to the alien island fauna. Alphaus B. Thompson and John C. Jones were co-owners of Santa Rosa Island until Thompson's death in 1857 (Holland 1962). In 1858, the More family bought out Thompson and Jones and, in subsequent years, ownership changed within the More family. Ownership changes usually meant changes in livestock numbers. In 1860, 1,000 head of cattle, 2,000 head of sheep, and 100 horses were present on the island (Holland 1962), and by 1874, the sheep herd had grown to 60,000 animals. In 1876, the market for sheep crashed, and it is thought that up to 1,200 sheep a day were slaughtered for their skin and tallow. Despite this setback, approximately 20 years later in 1894, the sheep counts were again recorded to be

close to 60,000 animals. In the late 1890's the sheep herd reached its maximum of 125,000 head of sheep on Santa Rosa Island.

The 1900 tax account revealed the animal head count to be 150 goats, 20 hogs, 180 horses, and 10,000 sheep (Holland 1962). In 1902, the Vail and Vickers Cattle Company purchased the island from the More family, gradually began removing the sheep, and converted to a cattle operation. Santa Rosa Island received other types of introduced animals in 1914 and 1929, when the Vail and Vickers Cattle Company brought in Canadian elk and Rocky Mountain mule deer for private hunting.

In 1958, the U.S. Air Force developed a radar station on the island. Approximately 200 Air Force personnel and 30 civilians were housed on the island. Construction included a major facility at Johnson's Lee, near South Point, and small scattered facilities in the vicinity of Soledad Peak. A paved road ran between Johnson's Lee and Soledad Peak. Though in disrepair, this still is the only paved road on the island. The station remained active for 10 years.

In 1986, Santa Rosa Island was purchased by the Federal Government, and is managed by the National Park Service as a part of Channel Islands National Park. However, the cattle ranching and hunting operations continue.

TABLE A-1. The history of grazing on Santa Rosa Island (1844-1988).

| YEAR | CATTLE | SHEEP | HORSES | PIGS | ELK | DEER | GOATS |
|---|---|---|---|---|---|---|---|
| 1844 | 270 | 53 | 9 | | | | |
| 1852 | 3,000 | | Introduced | | | | |
| 1857 | 8,000 | | | | | | |
| 1860 | 1,000 | 2,300 | 235 | | | | |
| 1874 | 60,000 | | | | | | |
| 1894 | 60,000 | | | | | | |
| 1900 | | 10,000 | 180 | 20 | | | 150 |
| 1902 | | | | | | | Removed |
| 1914 | | | | | Introduced | | |
| 1929 | | | | | | Introduced | |
| 1940 | | Removed | | | | | |
| 1988 | 6,000 | 0 | 120 | 5,000 | 900 | 1,500 | 0 |

## APPENDIX B

The principal geologic formations present on Santa Rosa Island are presented in Table B-1 (Weaver 1969). Following is a brief discussion of each formation:

- The South Point formation is a sandstone sequence with interbeds of shale. It is exposed from South Point to Ford Point along the southern coast, and from South Point west and northwest as isolated blocks to Sandy Point. It is also found in some canyons on the north side of the island.

- The Cozy Dell formation is mudstone and shale, found in a narrow band of outcrop from just east of Ford Point to just northeast of China Camp.

- The Sespe formation is composed of siltstone and sandstone with interbedded shale. It is exposed in fault blocks in the southern, western, and west central regions, with a very thick deposit in the Cluster Point area.

- The Vaqueros formation is coarse-grained clastic sandstones and siltstones, found in a large outcropping near and on the crest of the Soledad Anticline in the central highlands.

- The Rincon formation, composed of fine grained mudstones, is the most widely exposed formation and is found in every region of the island.

- The San Miguel Volcanics formation is a tuffaceous sandstone, exposed from Soledad Peak to Black Mountain, then southeast to East Point. It is also found at Sandy Point in the west and Brockway Point in the north.

- The Monterey formation is siliceous shale, sandstone, and conglomerate. It is found at Brockway Point and Carrington Point on the north coast and from there to Black Mountain. On the east side, it is found from Skunk Point to East Point.

TABLE B-1. The geological time frame associated with formations present on Santa Rosa Island.

| PERIODS | EPOCH | FORMATIONS |
|---|---|---|
| QUATERNARY | | |
| | Recent<br>(10,000-present) | |
| | Pleistocene<br>(1,000,000-10,000) | |
| | | Monterey |
| TERTIARY | | |
| | Miocene<br>(25,000,000-10,000,000) | |
| | | San Miquel volcanics<br>Rincon shale<br>Vaqueros sandstone |
| | Oligocene<br>(40,000,000-25,000,000) | |
| | | Sespe<br>Cozy Dell |
| | Eocene<br>(60,000,000-40,000,000) | |
| | | South Point sandstone |

## APPENDIX C

Frequency data for the plants observed within each plant community

TABLE C.1. Santa Rosa Island Grassland (83 releves sampled)
(* denotes alien species)

| SPECIES | FREQUENCY (%) | IMPORTANCE VALUE MEAN | S.D | RELATIVE % |
|---|---|---|---|---|
| *Hordeum murinum leporinum | 85.5 | 7.9 | 4.3 | 10.0 |
| *Bromus diandrus | 78.3 | 7.6 | 5.0 | 9.6 |
| *Medicago polymorpha polymorpha | 68.7 | 4.9 | 3.7 | 6.2 |
| *Bromus mollis | 59.0 | 6.0 | 5.4 | 7.5 |
| *Avena fatua | 53.0 | 5.0 | 5.1 | 6.3 |
| *Silene gallica | 48.2 | 3.4 | 3.6 | 4.3 |
| *Avena barbata | 41.0 | 3.9 | 4.9 | 5.0 |
| *Vulpia bromoides | 41.0 | 3.8 | 5.0 | 4.8 |
| *Erodium cicutarium | 39.8 | 2.5 | 3.3 | 3.2 |
| *Erodium moschatum | 38.6 | 2.5 | 3.3 | 3.1 |
| *Hypochoeris glabra | 32.5 | 2.2 | 3.3 | 2.7 |
| Amsinckia intermedia | 31.3 | 1.9 | 3.1 | 2.4 |
| Distichlis spicata stolonifera | 30.1 | 2.9 | 4.6 | 3.6 |
| *Sonchus oleraceus | 30.1 | 1.9 | 3.1 | 2.4 |
| *Malva parviflora | 25.3 | 1.4 | 2.6 | 1.7 |
| Lupinus bicolor | 22.9 | 1.6 | 3.1 | 2.0 |
| *Atriplex semibaccata | 21.7 | 1.5 | 3.1 | 1.9 |
| Layia platyglossa | 21.7 | 1.4 | 2.8 | 1.7 |
| Stipa pulchra | 18.1 | 1.5 | 3.6 | 1.9 |
| Trifolium tridentatum | 14.5 | 0.7 | 2.0 | 0.9 |
| *Melilotus indicus | 12.0 | 0.6 | 1.7 | 0.7 |
| *Vulpia myuros hirsuta | 9.6 | 0.9 | 2.8 | 1.1 |
| Lasthenia californica | 9.6 | 0.8 | 2.4 | 1.0 |
| Sidalcea malviflora | 9.6 | 0.6 | 2.0 | 0.8 |
| Hordeum californicum | 8.4 | 0.6 | 2.0 | 0.7 |
| *Bromus rubens | 7.2 | 0.5 | 1.8 | 0.6 |
| Viola pedunculata | 7.2 | 0.5 | 1.8 | 0.6 |
| Sisyrinchium bellum | 7.2 | 0.4 | 1.5 | 0.5 |
| *Sonchus asper | 7.2 | 0.4 | 1.6 | 0.5 |
| Dichelostemma pulchella | 7.2 | 0.3 | 1.2 | 0.4 |
| Ranunculus californicus | 6.0 | 0.4 | 1.5 | 0.5 |
| *Silybum marianum | 4.8 | 0.6 | 2.0 | 0.8 |
| *Geranium dissectum | 4.8 | 0.4 | 1.8 | 0.5 |
| Corethrogyne filaginifolia robusta | 4.8 | 0.3 | 1.4 | 0.4 |
| Elymus triticoides | 4.8 | 0.3 | 1.6 | 0.4 |
| Lomatium caruifolium | 4.8 | 0.3 | 1.6 | 0.4 |
| *Medicago polymorpha brevispina | 4.8 | 0.3 | 1.2 | 0.3 |
| Pterostegia drymarioides | 4.8 | 0.3 | 1.6 | 0.4 |
| Gnaphalium purpureum | 4.8 | 0.2 | 1.2 | 0.3 |
| Achyrachaena mollis | 3.6 | 0.3 | 1.3 | 0.3 |
| Clarkia davyi | 3.6 | 0.3 | 1.4 | 0.4 |
| *Anagallis arvensis | 3.6 | 0.2 | 1.0 | 0.2 |
| Bromus carinatus | 3.6 | 0.2 | 1.0 | 0.2 |
| *Centaurea melitensis | 3.6 | 0.2 | 1.1 | 0.3 |
| Delphinium parryi | 3.6 | 0.2 | 1.1 | 0.3 |
| Haplopappus squarrosus | 3.6 | 0.2 | 1.2 | 0.3 |

Table C.1. cont...

| | | | | |
|---|---|---|---|---|
| Sanicula arguta | 3.6 | 0.2 | 1.2 | 0.3 |
| Trifolium gracilentum | 3.6 | 0.2 | 1.1 | 0.3 |
| Cardionema ramosissimum | 2.4 | 0.2 | 1.1 | 0.2 |
| Daucus pusillus | 2.4 | 0.2 | 1.1 | 0.2 |
| *Erodium botrys | 2.4 | 0.2 | 1.3 | 0.3 |
| Spergularia macrotheca | 2.4 | 0.2 | 1.0 | 0.2 |
| Vicia americana | 2.4 | 0.2 | 1.0 | 0.2 |
| Baccharis pilularis consanguinea | 2.4 | 0.1 | 0.6 | 0.1 |
| Brassica geniculata | 2.4 | 0.1 | 0.5 | 0.1 |
| *Cerastium glomeratum | 2.4 | 0.1 | 0.6 | 0.1 |
| Claytonia perfoliata | 2.4 | 0.1 | 0.7 | 0.1 |
| Cryptantha clevelandii | 2.4 | 0.1 | 0.8 | 0.2 |
| Eschscholzia californica | 2.4 | 0.1 | 0.8 | 0.2 |
| *Lamarckia aurea | 2.4 | 0.1 | 0.9 | 0.2 |
| Lepidium lasiocarpum | 2.4 | 0.1 | 0.8 | 0.2 |
| *Lolium multiflorum | 2.4 | 0.1 | 0.8 | 0.2 |
| Microseris linearifolia | 2.4 | 0.1 | 0.8 | 0.2 |
| Trifolium microcephalum | 2.4 | 0.1 | 0.6 | 0.1 |
| *Xanthium spinosum | 2.4 | 0.1 | 0.8 | 0.2 |
| Achillea millefolium | 1.2 | 0.1 | 0.8 | 0.1 |
| Camissonia cheiranthifolia | 1.2 | 0.1 | 0.8 | 0.1 |
| Carex subbracteata | 1.2 | 0.1 | 0.9 | 0.1 |
| Chenopodium californicum | 1.2 | 0.1 | 0.9 | 0.1 |
| *Convolvulus arvensis | 1.2 | 0.1 | 0.8 | 0.1 |
| *Cynodon dactylon | 1.2 | 0.1 | 0.9 | 0.1 |
| Eremocarpus setigerus | 1.2 | 0.1 | 0.7 | 0.1 |
| Filago californica | 1.2 | 0.1 | 1.0 | 0.1 |
| Frankenia salina | 1.2 | 0.1 | 0.8 | 0.1 |
| Lotus hamatus | 1.2 | 0.1 | 0.8 | 0.1 |
| Lupinus albifrons | 1.2 | 0.1 | 0.5 | 0.1 |
| Lupinus succulentus | 1.2 | 0.1 | 0.9 | 0.1 |
| Melica imperfecta | 1.2 | 0.1 | 0.7 | 0.1 |
| *Mesembryanthemum crystallinum | 1.2 | 0.1 | 0.9 | 0.1 |
| Orthocarpus purpurascens | 1.2 | 0.1 | 0.7 | 0.1 |
| Phacelia ramosissima | 1.2 | 0.1 | 0.8 | 0.1 |
| Platystemon californicus | 1.2 | 0.1 | 0.7 | 0.1 |
| Suaeda californica | 1.2 | 0.1 | 0.8 | 0.1 |
| Trifolium amplectens | 1.2 | 0.1 | 0.8 | 0.1 |
| Abronia umbellata | 1.2 | 0.04 | 0.3 | 0.04 |
| Bowlesia incana | 1.2 | 0.04 | 0.3 | 0.04 |
| Calandrinia ciliata | 1.2 | 0.04 | 0.3 | 0.04 |
| Cirsium occidentale | 1.2 | 0.04 | 0.3 | 0.04 |
| Dudleya greenei | 1.2 | 0.04 | 0.3 | 0.04 |
| Opuntia littoralis | 1.2 | 0.04 | 0.3 | 0.04 |
| Plantago erecta | 1.2 | 0.04 | 0.3 | 0.04 |
| Pityogramma triangularis | 1.2 | 0.04 | 0.3 | 0.04 |
| Silene laciniata v. major | 1.2 | 0.04 | 0.3 | 0.04 |
| Solanum douglasii | 1.2 | 0.04 | 0.3 | 0.04 |

TABLE C.2. Santa Rosa Island Coastal Marsh (7 releves sampled)
(* denotes alien species)

| SPECIES | FREQUENCY (%) | IMPORTANCE VALUE MEAN | S.D. | RELATIVE % |
|---|---|---|---|---|
| Distichlis spicata stolonifera | 100.0 | 11.3 | 2.6 | 20.8 |
| Salicornia virginica | 100.0 | 11.0 | 2.6 | 20.3 |
| Frankenia salina | 85.7 | 9.0 | 4.3 | 16.6 |
| Cressa truxillensis | 42.9 | 3.6 | 4.1 | 6.6 |
| *Hordeum murinum leporinum | 42.9 | 3.3 | 4.0 | 6.1 |
| *Bromus diandrus | 42.9 | 2.6 | 3.3 | 4.7 |
| Jaumea carnosa | 28.6 | 3.7 | 6.0 | 6.9 |
| Hordeum californicum | 28.6 | 2.1 | 3.4 | 4.0 |
| *Medicago polymorpha polymorpha | 28.6 | 2.0 | 3.2 | 3.7 |
| *Parapholis incurva | 14.3 | 1.1 | 2.8 | 2.1 |
| *Bromus mollis | 14.3 | 1.0 | 1.8 | 1.3 |
| *Melilotus indicus | 14.3 | 1.0 | 2.4 | 1.8 |
| *Monerma cylindrica | 14.3 | 1.0 | 2.4 | 1.8 |
| *Sonchus oleraceus | 14.3 | 1.0 | 2.4 | 1.8 |
| *Polypogon monspeliensis | 14.3 | 0.7 | 1.8 | 1.3 |

TABLE C.3. Santa Rosa Island Caliche Scrub (5 releves sampled)
(* denotes alien species)

| SPECIES | FREQUENCY (%) | IMPORTANCE VALUE MEAN | S.D. | RELATIVE % |
|---|---|---|---|---|
| Haplopappus venetus | 100.0 | 9.4 | 0.5 | 5.2 |
| *Sonchus asper | 100.0 | 9.0 | 0.0 | 5.0 |
| Astragalus miguelensis | 100.0 | 8.4 | 0.5 | 4.7 |
| *Anagallis arvensis | 100.0 | 8.2 | 0.7 | 4.6 |
| Daucus pusillus | 100.0 | 7.8 | 0.7 | 4.3 |
| *Erodium cicutarium | 100.0 | 7.4 | 0.5 | 4.1 |
| *Medicago polymorpha polymorpha | 100.0 | 7.2 | 1.3 | 4.0 |
| Sisyrinchium bellum | 100.0 | 7.2 | 2.4 | 4.0 |
| *Avena barbata | 80.0 | 6.8 | 3.7 | 3.8 |
| *Bromus mollis | 80.0 | 6.8 | 3.5 | 3.8 |
| *Silene gallica | 80.0 | 6.8 | 3.5 | 3.8 |
| *Melilotus indicus | 80.0 | 6.6 | 3.4 | 3.7 |
| *Parapholis incurva | 80.0 | 6.4 | 4.0 | 3.6 |
| *Bromus rubens | 80.0 | 6.2 | 3.4 | 3.4 |
| Hordeum californicum | 80.0 | 6.0 | 3.3 | 3.3 |
| Spergularia macrotheca | 80.0 | 6.0 | 3.0 | 3.3 |
| *Atriplex semibaccata | 80.0 | 5.8 | 2.9 | 3.2 |
| *Vulpia bromoides | 80.0 | 5.8 | 3.4 | 3.2 |
| *Atriplex californica | 80.0 | 4.6 | 2.7 | 2.6 |
| *Centaurea melitensis | 80.0 | 3.4 | 2.6 | 1.9 |
| *Bromus diandrus | 60.0 | 5.8 | 4.8 | 3.2 |
| Orthocarpus purpurascens | 60.0 | 4.8 | 3.9 | 2.7 |
| *Hordeum murinum leporinum | 40.0 | 3.2 | 4.0 | 1.8 |
| Gnaphalium chilense | 40.0 | 2.8 | 3.4 | 1.6 |
| *Mesembryanthemum crystallinum | 40.0 | 2.8 | 3.4 | 1.6 |
| Cirsium occidentale | 40.0 | 2.0 | 2.6 | 1.1 |
| Artemisia californica | 20.0 | 2.0 | 4.0 | 1.1 |
| Filago californica | 20.0 | 1.6 | 3.2 | 0.9 |
| Juncus mexicanus | 20.0 | 1.6 | 3.2 | 0.9 |
| Achillea millefolium | 20.0 | 1.4 | 2.8 | 0.8 |
| Amblyopappus pusillus | 20.0 | 1.4 | 2.8 | 0.8 |
| Baccharis pilularis consanguinea | 20.0 | 1.4 | 2.8 | 0.8 |
| Corethrogyne filaginifolia robusta | 20.0 | 1.4 | 2.8 | 0.8 |
| Distichlis spicata stolonifera | 20.0 | 1.4 | 2.8 | 0.8 |
| Elymus triticoides | 20.0 | 1.4 | 2.8 | 0.8 |
| Lepidium nitidum | 20.0 | 1.4 | 2.8 | 0.8 |
| *Sonchus oleraceus | 20.0 | 1.4 | 2.8 | 0.8 |
| Castilleja mollis | 20.0 | 1.2 | 2.4 | 0.7 |
| Galium nuttallii | 20.0 | 1.2 | 2.4 | 0.7 |
| Pterostegia drymarioides | 20.0 | 1.2 | 2.4 | 0.7 |
| *Carpobrotus aequilateralis | 20.0 | 1.0 | 2.0 | 0.6 |
| Gnaphalium bicolor | 20.0 | 0.6 | 1.2 | 0.3 |
| Layia platyglossa | 20.0 | 0.6 | 1.2 | 0.3 |
| *Malva parviflora | 20.0 | 0.6 | 1.2 | 0.3 |

TABLE C.4. Santa Rosa Island Coastal Sage Scrub (32 releves sampled)
(* denotes alien species)

| SPECIES | FREQUENCY (%) | IMPORTANCE VALUE MEAN | S.D. | RELATIVE % |
|---|---|---|---|---|
| Artemisia californica | 100.0 | 11.9 | 1.6 | 9.1 |
| *Avena barbata | 93.8 | 7.8 | 2.6 | 6.0 |
| Baccharis pilularis | 84.4 | 6.7 | 3.9 | 5.1 |
| *Bromus mollis | 81.2 | 7.3 | 3.9 | 5.5 |
| *Bromus rubens | 78.1 | 6.3 | 3.8 | 4.8 |
| *Silene gallica | 65.6 | 4.5 | 3.6 | 3.4 |
| *Atriplex semibaccata | 65.6 | 4.2 | 3.3 | 3.2 |
| Stipa pulchra | 62.5 | 5.5 | 4.5 | 4.1 |
| *Bromus diandrus | 62.5 | 5.2 | 4.3 | 3.9 |
| *Medicago polymorpha polymorpha | 56.2 | 3.4 | 3.5 | 2.6 |
| *Vulpia bromoides | 50.0 | 3.5 | 3.7 | 2.7 |
| Stipa diegoensis | 43.8 | 3.8 | 4.5 | 2.9 |
| *Avena fatua | 37.5 | 3.0 | 4.0 | 2.3 |
| Daucus pusillus | 37.5 | 2.6 | 3.4 | 1.9 |
| Achillea millefolium | 34.4 | 2.4 | 3.5 | 1.8 |
| Pityogramma triangularis | 34.4 | 2.4 | 3.6 | 1.8 |
| *Sonchus oleraceus | 34.4 | 2.2 | 3.1 | 1.6 |
| *Lamarckia aurea | 31.2 | 1.8 | 2.8 | 1.3 |
| Pellaea andromedifolia | 31.2 | 1.7 | 2.8 | 1.3 |
| Astragalus curtipes | 25.0 | 1.8 | 3.4 | 1.4 |
| *Hordeum murinum leporinum | 25.0 | 1.6 | 2.8 | 1.2 |
| *Melilotus indicus | 25.0 | 1.4 | 2.8 | 1.1 |
| Bromus carinatus | 21.9 | 1.8 | 3.5 | 1.4 |
| Gnaphalium microcephalum | 21.9 | 1.6 | 3.1 | 1.2 |
| *Anagallis arvensis | 21.9 | 1.5 | 2.9 | 1.2 |
| *Erodium cicutarium | 21.9 | 1.5 | 2.9 | 1.2 |
| Gnaphalium californicum | 21.9 | 1.4 | 2.7 | 1.1 |
| Pterostegia drymarioides | 21.9 | 1.4 | 2.8 | 1.1 |
| Haplopappus squarrosus | 21.9 | 1.2 | 2.4 | 0.9 |
| Galium nuttallii | 18.8 | 1.2 | 2.7 | 0.9 |
| Sanicula arguta | 18.8 | 1.2 | 2.6 | 0.9 |
| *Hypochoeris glabra | 18.8 | 1.1 | 2.4 | 0.8 |
| Trifolium tridentatum | 18.8 | 1.0 | 2.3 | 0.8 |
| Marah macrocarpa | 18.8 | 0.8 | 1.9 | 0.6 |
| Gnaphalium purpureum | 15.6 | 1.0 | 2.4 | 0.8 |
| Gnaphalium chilense | 15.6 | 0.9 | 2.2 | 0.7 |
| Vicia americana | 15.6 | 0.9 | 2.2 | 0.7 |
| Dichelostemma pulchella | 15.6 | 0.8 | 1.9 | 0.6 |
| *Malva parviflora | 15.6 | 0.6 | 1.5 | 0.4 |
| Melica imperfecta | 12.5 | 0.8 | 2.2 | 0.6 |
| Sisyrinchium bellum | 12.5 | 0.8 | 2.0 | 0.6 |
| Corethrogyne filaginifolia robusta | 12.5 | 0.7 | 2.0 | 0.5 |
| Lupinus succulentus | 12.5 | 0.7 | 2.0 | 0.5 |
| *Erodium moschatum | 12.5 | 0.6 | 1.7 | 0.4 |
| Haplopappus venetus | 12.5 | 0.6 | 1.7 | 0.4 |
| *Sonchus asper | 12.5 | 0.6 | 1.6 | 0.4 |
| *Convolvulus arvensis | 12.5 | 0.4 | 1.0 | 0.3 |

Table C.4., cont...

| SPECIES | FREQUENCY (%) | IMPORTANCE VALUE MEAN | S.D. | RELATIVE % |
|---|---|---|---|---|
| Antirrhinum nuttallianum | 9.4 | 0.6 | 2.0 | 0.5 |
| *Gastridium ventricosum | 9.4 | 0.6 | 1.9 | 0.4 |
| Gnaphalium bicolor | 9.4 | 0.6 | 1.9 | 0.4 |
| *Chenopodium murale | 9.4 | 0.5 | 1.5 | 0.4 |
| Cirsium occidentale | 9.4 | 0.5 | 1.6 | 0.4 |
| *Vulpia myuros hirsuta | 9.4 | 0.5 | 1.5 | 0.4 |
| Dichondra occidentalis | 9.4 | 0.4 | 1.4 | 0.3 |
| Opuntia littoralis | 9.4 | 0.4 | 1.2 | 0.3 |
| Lotus dendroideus | 6.2 | 0.5 | 1.9 | 0.4 |
| Lotus strigosus | 6.2 | 0.5 | 1.8 | 0.4 |
| Poa scabrella | 6.2 | 0.5 | 1.9 | 0.4 |
| Vicia ludoviciana | 6.2 | 0.5 | 1.8 | 0.4 |
| Zauschneria californica | 6.2 | 0.5 | 1.8 | 0.4 |
| Distichlis spicata stolonifera | 6.2 | 0.4 | 1.6 | 0.3 |
| Linaria texana | 6.2 | 0.4 | 1.6 | 0.3 |
| Solanum douglasii | 6.2 | 0.4 | 1.6 | 0.3 |
| Adiantum jordanii | 6.2 | 0.3 | 1.5 | 0.3 |
| Heteromeles arbutifolia | 6.2 | 0.3 | 1.3 | 0.2 |
| Lotus salsuginosus | 6.2 | 0.3 | 1.3 | 0.2 |
| Ranunculus californicus | 6.2 | 0.3 | 1.5 | 0.3 |
| Salvia brandegei | 6.2 | 0.3 | 1.5 | 0.3 |
| Selaginella bigelovii | 6.2 | 0.3 | 1.3 | 0.2 |
| Cardionema ramosissimum | 6.2 | 0.2 | 1.0 | 0.2 |
| Cleome isomeris | 6.2 | 0.2 | 0.7 | 0.1 |
| Eriogonum arborescens | 6.2 | 0.2 | 0.7 | 0.1 |
| Phacelia viscida | 6.2 | 0.2 | 0.8 | 0.1 |
| Amblyopappus pusillus | 3.1 | 0.2 | 1.2 | 0.2 |
| Cerastium glomeratum | 3.1 | 0.2 | 1.2 | 0.2 |
| Chenopodium californicum | 3.1 | 0.2 | 1.0 | 0.1 |
| Corethrogyne filaginifolia virgata | 3.1 | 0.2 | 1.2 | 0.2 |
| Cryptantha clevelandii | 3.1 | 0.2 | 1.2 | 0.2 |
| Dudleya greenei | 3.1 | 0.2 | 1.2 | 0.2 |
| Eriogonum grande | 3.1 | 0.2 | 1.2 | 0.2 |
| *Geranium dissectum | 3.1 | 0.2 | 1.2 | 0.2 |
| Hordeum californicum | 3.1 | 0.2 | 0.9 | 0.1 |
| Microseris linearifolia | 3.1 | 0.2 | 1.2 | 0.2 |
| Muhlenbergia microsperma | 3.1 | 0.2 | 1.2 | 0.2 |
| Perezia microcephala | 3.1 | 0.2 | 1.0 | 0.1 |
| *Polypogon interruptus | 3.1 | 0.2 | 1.2 | 0.2 |
| Spergularia marina | 3.1 | 0.2 | 1.0 | 0.1 |
| Agoseris grandiflora | 3.1 | 0.1 | 0.5 | 0.1 |
| Calochortus catalinae | 3.1 | 0.1 | 0.5 | 0.1 |
| Camissonia micrantha | 3.1 | 0.1 | 0.5 | 0.1 |
| *Chenopodium album | 3.1 | 0.1 | 0.9 | 0.1 |
| Coreopsis gigantea | 3.1 | 0.1 | 0.5 | 0.1 |
| Elymus triticoides | 3.1 | 0.1 | 0.9 | 0.1 |
| Eriophyllum confertiflorum | 3.1 | 0.1 | 0.9 | 0.1 |
| Grindelia robusta | 3.1 | 0.1 | 0.5 | 0.1 |

Table C.4., cont...

| SPECIES | FREQUENCY (%) | IMPORTANCE VALUE MEAN | S.D. | RELATIVE % |
|---|---|---|---|---|
| Layia platyglossa | 3.1 | 0.1 | 0.9 | 0.1 |
| Malacothrix saxatilis | 3.1 | 0.1 | 0.5 | 0.1 |
| *Medicago polymorpha bervispina | 3.1 | 0.1 | 0.5 | 0.1 |
| Mimulus flemingii | 3.1 | 0.1 | 0.5 | 0.1 |
| Oligomeris linifolia | 3.1 | 0.1 | 0.9 | 0.1 |
| Opuntia prolifera | 3.1 | 0.1 | 0.5 | 0.1 |
| Toxicodendron diversilobum | 3.1 | 0.1 | 0.5 | 0.1 |
| Trifolium gracilentum | 3.1 | 0.1 | 0.9 | 0.1 |
| Trifolium microcephalum | 3.1 | 0.1 | 0.9 | 0.1 |

TABLE C.5. Santa Rosa Island Lupine Scrub (6 releves sampled)
(* denotes alien species)

| SPECIES | FREQUENCY (%) | IMPORTANCE VALUE MEAN | S.D. | RELATIVE % |
|---|---|---|---|---|
| *Bromus diandrus | 100.0 | 10.2 | 2.5 | 13.9 |
| Elymus triticoides | 100.0 | 8.0 | 1.7 | 11.0 |
| Chenopodium californicum | 100.0 | 6.7 | 2.1 | 9.1 |
| Distichlis spicata stolonifera | 83.3 | 7.5 | 3.5 | 10.3 |
| Lupinus albifrons | 66.7 | 8.0 | 5.7 | 11.0 |
| Amsinckia intermedia | 50.0 | 2.7 | 2.9 | 3.7 |
| *Hordeum murinum leporinum | 50.0 | 2.7 | 2.7 | 3.7 |
| Lupinus arboreus | 33.3 | 3.8 | 5.5 | 5.3 |
| Phacelia ramosissima | 33.3 | 3.0 | 4.3 | 4.1 |
| Abronia umbellata | 33.3 | 2.7 | 3.8 | 3.7 |
| *Malva parviflora | 33.3 | 2.0 | 2.9 | 2.7 |
| Viola pedunculata | 33.3 | 1.8 | 2.6 | 2.5 |
| Camissonia cheiranthifolia | 33.3 | 1.7 | 2.6 | 2.3 |
| Amsinckia spectabilis | 33.3 | 1.0 | 1.4 | 1.4 |
| Carex tumulicola | 16.7 | 1.3 | 3.0 | 1.8 |
| Cirsium occidentale | 16.7 | 1.2 | 2.6 | 1.6 |
| *Erodium moschatum | 16.7 | 1.2 | 2.6 | 1.6 |
| Eschscholzia californica | 16.7 | 1.2 | 2.6 | 1.6 |
| *Sonchus asper | 16.7 | 1.2 | 2.6 | 1.6 |
| Carex pansa | 16.7 | 1.0 | 2.2 | 1.4 |
| *Mesembryanthemum crystallinum | 16.7 | 1.0 | 2.2 | 1.4 |
| Dichelostemma pulchella | 16.7 | 0.8 | 1.9 | 1.1 |
| Atriplex californica | 16.7 | 0.5 | 1.1 | 0.7 |
| Cryptantha clevelandii | 16.7 | 0.5 | 1.1 | 0.7 |
| Marah macrocarpa | 16.7 | 0.5 | 1.1 | 0.7 |
| Ranunculus californicus | 16.7 | 0.5 | 1.1 | 0.7 |
| *Stellaria media | 16.7 | 0.5 | 1.1 | 0.7 |

TABLE C.6. Santa Rosa Island Baccharis Scrub (15 releves sampled)
(* denotes alien species)

| SPECIES | FREQUENCY (%) | IMPORTANCE VALUE MEAN | S.D. | RELATIVE % |
|---|---|---|---|---|
| Baccharis pilularis consanguinea | 100.0 | 12.4 | 1.5 | 9.0 |
| *Bromus diandrus | 100.0 | 9.2 | 1.9 | 6.7 |
| *Bromus mollis | 93.3 | 8.6 | 3.5 | 6.3 |
| *Hordeum murinum leporinum | 93.3 | 6.1 | 2.4 | 4.5 |
| *Avena fatua | 86.7 | 8.7 | 3.7 | 6.3 |
| *Medicago polymorpha polymorpha | 86.7 | 6.8 | 2.8 | 4.9 |
| *Silene gallica | 73.3 | 5.7 | 3.6 | 4.1 |
| *Vulpia bromoides | 66.7 | 6.1 | 4.6 | 4.5 |
| *Avena barbata | 66.7 | 5.1 | 4.0 | 3.7 |
| Distichlis spicata | 60.0 | 4.9 | 4.2 | 3.6 |
| *Sonchus oleraceus | 60.0 | 4.1 | 3.5 | 3.0 |
| *Atriplex semibaccata | 60.0 | 4.0 | 3.4 | 2.9 |
| *Hypochoeris glabra | 46.7 | 3.0 | 3.5 | 2.2 |
| *Erodium moschatum | 46.7 | 2.0 | 2.4 | 1.5 |
| *Malva parviflora | 40.0 | 2.6 | 3.4 | 1.9 |
| Gnaphalium purpureum | 33.3 | 2.4 | 3.4 | 1.7 |
| Frankenia salina | 33.3 | 2.3 | 3.5 | 1.7 |
| *Anagallis arvensis | 33.3 | 1.7 | 2.7 | 1.3 |
| Ranunculus californicus | 26.7 | 2.0 | 3.3 | 1.5 |
| Bromus carinatus | 26.7 | 1.8 | 3.2 | 1.3 |
| *Sonchus asper | 26.7 | 1.7 | 2.9 | 1.2 |
| Gnaphalium chilense | 26.7 | 1.6 | 2.8 | 1.2 |
| *Erodium cicutarium | 26.7 | 1.5 | 2.7 | 1.1 |
| Sidalcea malviflora | 26.7 | 1.5 | 2.7 | 1.1 |
| Gnaphalium microcephalum | 20.0 | 1.5 | 3.0 | 1.1 |
| Sanicula arguta | 20.0 | 1.5 | 3.1 | 1.1 |
| Achillea millefolium | 20.0 | 1.3 | 2.6 | 0.9 |
| *Geranium dissectum | 20.0 | 1.3 | 2.9 | 1.0 |
| Hordeum californicum | 20.0 | 1.3 | 2.6 | 0.9 |
| Juncus mexicanus | 20.0 | 1.3 | 2.6 | 0.9 |
| *Marrubium vulgare | 20.0 | 1.3 | 2.7 | 1.0 |
| Trifolium tridentatum | 13.3 | 1.1 | 2.7 | 0.8 |
| Artemisia californica | 20.0 | 1.0 | 2.4 | 0.7 |
| *Melilotus indicus | 20.0 | 1.0 | 2.0 | 0.7 |
| Stipa pulchra | 20.0 | 1.0 | 2.1 | 0.7 |
| Lupinus bicolor | 13.3 | 1.0 | 2.7 | 0.7 |
| *Cynodon dactylon | 13.3 | 0.9 | 2.5 | 0.7 |
| *Bromus rubens | 13.3 | 0.8 | 2.0 | 0.6 |
| *Stellaria media | 13.3 | 0.8 | 2.1 | 0.6 |
| Carex tumulicola | 13.3 | 0.7 | 1.7 | 0.5 |
| Dichelostemma pulchella | 13.3 | 0.7 | 1.9 | 0.5 |
| Stachys bullata | 13.3 | 0.7 | 1.9 | 0.5 |
| Lomatium caruifolium | 13.3 | 0.6 | 1.6 | 0.4 |
| Sisyrinchium bellum | 13.3 | 0.5 | 1.4 | 0.4 |
| Trifolium gracilentum | 13.3 | 0.5 | 1.4 | 0.4 |
| *Polygonum aviculare | 13.3 | 0.4 | 1.0 | 0.3 |

Table C.6., cont...

| SPECIES | FREQUENCY (%) | IMPORTANCE VALUE MEAN | S.D. | RELATIVE % |
|---|---|---|---|---|
| Agoseris grandiflora | 6.7 | 0.5 | 1.7 | 0.3 |
| Bloomeria crocea | 6.7 | 0.5 | 1.7 | 0.3 |
| *Centaurea melitensis | 6.7 | 0.5 | 1.7 | 0.3 |
| Chenopodium berlandieri | 6.7 | 0.5 | 1.7 | 0.3 |
| Corethrogyne filaginifolia robusta | 6.7 | 0.5 | 1.7 | 0.3 |
| *Galium aparine | 6.7 | 0.5 | 2.0 | 0.4 |
| Gnaphalium californicum | 6.7 | 0.5 | 1.7 | 0.3 |
| *Rumex crispus | 6.7 | 0.5 | 1.7 | 0.3 |
| *Silybum marianum | 6.7 | 0.5 | 1.7 | 0.3 |
| Solanum douglasii | 6.7 | 0.5 | 1.7 | 0.3 |
| Spergularia macrotheca | 6.7 | 0.5 | 1.7 | 0.3 |
| Trifolium microcephalum | 6.7 | 0.5 | 1.7 | 0.3 |
| Vicia americana | 6.7 | 0.5 | 1.7 | 0.3 |
| Elymus triticoides | 6.7 | 0.4 | 1.5 | 0.3 |
| Carex pansa | 6.7 | 0.3 | 1.2 | 0.2 |
| Chenopodium californicum | 6.7 | 0.3 | 1.2 | 0.2 |
| *Gastridium ventricosum | 6.7 | 0.3 | 1.2 | 0.2 |
| *Monerma cylindrica | 6.7 | 0.3 | 1.2 | 0.2 |
| Rumex salicifolius | 6.7 | 0.3 | 1.2 | 0.2 |
| Salicornia virginica | 6.7 | 0.3 | 1.2 | 0.2 |
| Spergularia marina | 6.7 | 0.3 | 1.2 | 0.2 |
| Viola pedunculata | 6.7 | 0.3 | 1.2 | 0.2 |
| Agrostis diegoensis | 6.7 | 0.2 | 0.7 | 0.1 |
| Cardionema ramosissimum | 6.7 | 0.2 | 0.7 | 0.1 |
| *Erodium botrys | 6.7 | 0.2 | 0.7 | 0.1 |
| Haplopappus venetus | 6.7 | 0.2 | 0.7 | 0.1 |
| Heteromeles arbutifolia | 6.7 | 0.2 | 0.7 | 0.1 |
| Zigadenus fremontii | 6.7 | 0.2 | 0.7 | 0.1 |

TABLE C.7. Santa Rosa Island Coastal Bluff Scrub (6 releves sampled)
(* denotes alien species)

| SPECIES | FREQUENCY (%) | IMPORTANCE VALUE MEAN | S.D. | RELATIVE % |
|---|---|---|---|---|
| Haplopappus venetus | 100.0 | 9.6 | 0.7 | 12.1 |
| *Carpobrotus aequilateralis | 100.0 | 9.5 | 1.3 | 11.9 |
| Camissonia cheiranthifolia | 100.0 | 7.5 | 2.1 | 9.4 |
| Lasthenia glabrata | 66.7 | 5.7 | 4.0 | 7.1 |
| Astragalus miguelensis | 66.7 | 5.0 | 3.6 | 6.3 |
| Atriplex californica | 66.7 | 5.0 | 3.7 | 6.3 |
| *Medicago polymorpha polymorpha | 66.7 | 4.5 | 3.2 | 5.6 |
| *Sonchus oleraceus | 66.7 | 4.3 | 3.5 | 5.4 |
| Hordeum californicum | 50.0 | 3.8 | 3.8 | 4.8 |
| *Melilotus indicus | 50.0 | 3.5 | 3.5 | 4.4 |
| Poa douglasii | 33.3 | 2.6 | 3.8 | 3.3 |
| *Erodium cicutarium | 33.3 | 2.5 | 3.6 | 3.1 |
| *Mesembryanthemum crystallinum | 33.3 | 2.3 | 3.3 | 2.9 |
| Abronia umbellata | 33.3 | 1.7 | 2.6 | 2.1 |
| Cryptantha clevelandii | 33.3 | 1.7 | 2.6 | 2.1 |
| Cirsium occidentale | 33.3 | 1.5 | 2.3 | 1.9 |
| Ambrosia chamissonis | 16.7 | 1.7 | 3.7 | 2.1 |
| Daucus pusillus | 16.7 | 1.3 | 3.0 | 1.7 |
| Eriogonum grande rubescens | 16.7 | 1.3 | 3.0 | 1.7 |
| Distichlis spicata stolonifera | 16.7 | 1.2 | 2.6 | 1.5 |
| *Hordeum murinum leporinum | 16.7 | 1.2 | 2.6 | 1.5 |
| Eschscholzia californica | 16.7 | 1.2 | 2.6 | 1.5 |
| Lupinus albifrons | 16.7 | 0.5 | 1.1 | 0.6 |
| Orobanche parishii brachyloba | 16.7 | 0.5 | 1.1 | 0.6 |

TABLE C.8. Santa Rosa Island Coastal Dune Scrub (6 releves sampled)
(*denotes alien species)

| SPECIES | FREQUENCY (%) | IMPORTANCE VALUE MEAN | S.D. | RELATIVE % |
|---|---|---|---|---|
| Ambrosia chamissonis | 83.3 | 7.7 | 3.7 | 20.1 |
| Distichlis spicata stolonifera | 66.7 | 4.8 | 3.4 | 12.7 |
| *Hordeum murinum leporinum | 66.7 | 4.2 | 3.0 | 10.9 |
| Cakile maritima | 50.0 | 4.8 | 5.0 | 12.7 |
| Camissonia cheiranthifolia | 50.0 | 3.0 | 3.4 | 7.9 |
| Abronia umbellata | 33.3 | 2.8 | 4.0 | 7.4 |
| *Sonchus oleraceus | 33.3 | 1.7 | 2.6 | 4.4 |
| Abronia maritima | 16.7 | 2.5 | 5.6 | 6.6 |
| *Mesembryanthemum crystallinum | 16.7 | 1.5 | 3.4 | 3.9 |
| *Bromus diandrus | 16.7 | 1.3 | 3.0 | 4.8 |
| Amsinckia intermedia | 16.7 | 1.2 | 2.6 | 3.1 |
| Camissonia micrantha | 16.7 | 0.8 | 1.9 | 2.2 |
| *Carpobrotus aequilateralis | 16.7 | 0.8 | 1.9 | 2.2 |
| Amsinckia spectabilis | 16.7 | 0.5 | 1.1 | 1.3 |
| *Erodium cicutarium | 16.7 | 0.5 | 1.1 | 1.3 |

TABLE C.9. Santa Rosa Island Mixed Chaparral (27 releves sampled)
(* denotes alien species)

| SPECIES | FREQUENCY (%) | IMPORTANCE VALUE MEAN | S.D. | RELATIVE % |
|---|---|---|---|---|
| Galium nuttallii | 85.2 | 6.6 | 2.9 | 5.5 |
| Adenostoma fasciculatum | 81.5 | 9.6 | 5.3 | 8.0 |
| *Vulpia bromoides | 77.8 | 6.6 | 3.6 | 5.5 |
| Mimulus flemingii | 77.8 | 6.0 | 3.7 | 5.0 |
| Quercus dumosa | 66.7 | 6.6 | 5.5 | 5.5 |
| *Bromus rubens | 66.7 | 4.9 | 3.6 | 4.1 |
| *Silene gallica | 59.3 | 4.7 | 3.9 | 3.9 |
| Filago californica | 59.3 | 4.0 | 3.6 | 3.3 |
| Eriophyllum confertiflorum | 51.9 | 3.4 | 3.5 | 2.9 |
| *Avena barbata | 48.1 | 3.3 | 3.7 | 2.8 |
| *Hypochoeris glabra | 48.1 | 3.0 | 3.3 | 2.5 |
| *Bromus mollis | 44.4 | 3.0 | 3.5 | 2.5 |
| Baccharis pilularis | 44.4 | 2.9 | 3.5 | 2.4 |
| Plantago erecta | 40.7 | 3.3 | 4.2 | 2.8 |
| Selaginella bigelovii | 40.7 | 3.3 | 4.1 | 2.8 |
| Achillea millefolium | 40.7 | 2.6 | 3.2 | 2.2 |
| Carex globosa | 37.0 | 2.8 | 3.8 | 2.3 |
| *Bromus diandrus | 33.3 | 2.6 | 3.8 | 2.1 |
| Lotus dendroideus | 33.3 | 2.0 | 3.1 | 1.7 |
| Bromus carinatus | 29.6 | 2.1 | 3.2 | 1.7 |
| Trifolium tridentatum | 29.6 | 1.2 | 2.0 | 1.0 |
| Gnaphalium purpureum | 25.9 | 1.7 | 2.9 | 1.4 |
| Lasthenia californica | 25.9 | 1.7 | 3.1 | 1.5 |
| Gnaphalium chilense | 25.9 | 1.5 | 2.7 | 1.2 |
| Daucus pusillus | 25.9 | 1.1 | 2.1 | 0.9 |
| Melica imperfecta | 22.2 | 1.8 | 3.4 | 1.5 |
| Gnaphalium microcephalum | 22.2 | 1.1 | 2.3 | 0.9 |
| Stipa pulchra | 18.5 | 1.6 | 3.4 | 1.4 |
| Pityogramma triangularis | 18.5 | 1.2 | 2.5 | 1.0 |
| Lotus strigosus | 18.5 | 1.2 | 2.6 | 1.0 |
| Pterostegia drymarioides | 18.5 | 1.1 | 2.4 | 1.0 |
| *Cynodon dactylon | 14.8 | 1.3 | 3.1 | 1.1 |
| Poa scabrella | 14.8 | 1.0 | 2.4 | 0.8 |
| Artemisia californica | 14.8 | 0.9 | 2.1 | 0.7 |
| Chenopodium californicum | 14.8 | 0.9 | 2.1 | 0.7 |
| Silene laciniata | 14.8 | 0.9 | 2.3 | 0.7 |
| Dichondra occidentalis | 14.8 | 0.8 | 1.9 | 0.7 |
| Dudleya greenei | 14.8 | 0.8 | 2.0 | 0.7 |
| Salvia brandegei | 14.8 | 0.8 | 2.1 | 0.7 |
| Vicia americana | 14.8 | 0.4 | 1.8 | 0.6 |
| Corethrogyne filaginifolia robusta | 11.1 | 0.7 | 2.0 | 0.6 |
| *Medicago polymorpha polymorpha | 11.1 | 0.7 | 2.0 | 0.6 |
| Trifolium gracilentum | 11.1 | 0.7 | 1.9 | 0.6 |
| Dodecatheon clevelandii | 11.1 | 0.6 | 1.8 | 0.5 |
| Galium angustifolium | 11.1 | 0.6 | 1.8 | 0.5 |

Table C.9., cont...

| SPECIES | FREQUENCY (%) | IMPORTANCE VALUE MEAN | S.D. | RELATIVE % |
|---|---|---|---|---|
| Heteromeles arbutifolia | 11.1 | 0.4 | 1.3 | 0.4 |
| Gnaphalium bicolor | 7.4 | 0.6 | 2.0 | 0.5 |
| Luzula subsessilis | 7.4 | 0.6 | 2.1 | 0.5 |
| *Erodium cicutarium | 7.4 | 0.5 | 1.8 | 0.4 |
| *Vulpia myuros hirsuta | 7.4 | 0.5 | 1.8 | 0.4 |
| Navarretia atractyloides | 7.4 | 0.4 | 1.6 | 0.3 |
| Vaccinium ovatum | 7.4 | 0.4 | 1.4 | 0.3 |
| *Lamarckia aurea | 7.4 | 0.3 | 1.1 | 0.2 |
| Lupinus bicolor | 7.4 | 0.3 | 1.2 | 0.3 |
| Corethrogyne filaginifolia virgata | 7.4 | 0.2 | 0.8 | 0.2 |
| Piperia elegans | 7.4 | 0.2 | 0.8 | 0.2 |
| Arctostaphylos tomentosa | 3.7 | 0.5 | 2.5 | 0.4 |
| Cheilanthes clevelandii | 3.7 | 0.3 | 1.3 | 0.2 |
| Chorizanthe wheeleri | 3.7 | 0.3 | 1.3 | 0.2 |
| Elymus glaucus | 3.7 | 0.3 | 1.3 | 0.2 |
| *Hordeum murinum leporinum | 3.7 | 0.3 | 1.5 | 0.2 |
| Pellaea andromedifolia | 3.7 | 0.3 | 1.3 | 0.2 |
| Polypodium californicum | 3.7 | 0.3 | 1.3 | 0.2 |
| *Sonchus oleraceus | 3.7 | 0.3 | 1.3 | 0.2 |
| Stachys bullata | 3.7 | 0.3 | 1.3 | 0.2 |
| *Stellaria media | 3.7 | 0.3 | 1.7 | 0.3 |
| Trifolium microcephalum | 3.7 | 0.3 | 1.5 | 0.2 |
| *Urtica urens | 3.7 | 0.3 | 1.5 | 0.2 |
| Cardionema ramosissimum | 3.7 | 0.2 | 1.3 | 0.2 |
| Crassula erecta | 3.7 | 0.2 | 0.9 | 0.2 |
| Helianthemum scoparium | 3.7 | 0.2 | 0.9 | 0.2 |
| Hieraceum argutum | 3.7 | 0.2 | 0.9 | 0.2 |
| Layia platyglossa | 3.7 | 0.2 | 0.9 | 0.2 |
| Pellaea mucronata | 3.7 | 0.2 | 0.9 | 0.2 |
| *Torilis nodosa | 3.7 | 0.2 | 1.1 | 0.2 |
| Agrostis diegoensis | 3.7 | 0.1 | 0.7 | 0.1 |
| Antirrhinum nuttallianum | 3.7 | 0.1 | 0.6 | 0.1 |
| Arctostaphylos confertiflora | 3.7 | 0.1 | 0.6 | 0.1 |
| *Galium aparine | 3.7 | 0.1 | 0.6 | 0.1 |
| Orobanche bulbosa | 3.7 | 0.1 | 0.6 | 0.1 |
| Opuntia littoralis | 3.7 | 0.1 | 0.6 | 0.1 |

TABLE C.10. Santa Rosa Island Mixed Woodland (15 releves sampled)
(* denotes alien species)

| SPECIES | FREQUENCY (%) | IMPORTANCE VALUE MEAN | S.D. | RELATIVE % |
|---|---|---|---|---|
| *Bromus diandrus | 86.7 | 7.5 | 3.3 | 7.1 |
| Heteromeles arbutifolia | 73.3 | 7.9 | 5.1 | 7.5 |
| Baccharis pilularis consanguinea | 66.7 | 4.2 | 3.4 | 4.0 |
| Mimulus flemingii | 60.0 | 4.0 | 3.5 | 3.8 |
| *Silene gallica | 53.3 | 3.7 | 3.5 | 3.5 |
| Bromus carinatus | 53.3 | 3.3 | 3.1 | 3.2 |
| Quercus tomentella | 46.7 | 5.0 | 5.8 | 4.8 |
| Carex globosa | 46.7 | 3.5 | 3.8 | 3.3 |
| *Stellaria media | 46.7 | 3.4 | 3.8 | 3.3 |
| *Avena barbata | 40.0 | 3.0 | 3.7 | 2.9 |
| Melica imperfecta | 40.0 | 2.4 | 2.9 | 2.3 |
| Gnaphalium purpureum | 40.0 | 2.3 | 2.9 | 2.2 |
| Polypodium californicum | 40.0 | 2.3 | 2.7 | 2.2 |
| Quercus agrifolia | 33.3 | 3.5 | 5.1 | 3.3 |
| Pterostegia drymarioides | 33.3 | 2.5 | 3.7 | 2.4 |
| *Hordeum murinum leporinum | 33.3 | 2.3 | 3.3 | 2.2 |
| Pityogramma triangularis | 33.3 | 2.1 | 2.9 | 2.0 |
| *Hypochoeris glabra | 26.7 | 1.8 | 3.0 | 1.7 |
| *Bromus rubens | 26.7 | 1.7 | 2.9 | 1.7 |
| Daucus pusillus | 26.7 | 1.7 | 2.8 | 1.6 |
| Galium nuttallii | 26.7 | 1.6 | 2.7 | 1.5 |
| Heuchera maxima | 26.7 | 1.5 | 2.4 | 1.4 |
| Lyonothamnus floribundus asplenifolius | 20.0 | 3.0 | 6.0 | 2.9 |
| Agrostis diegoensis | 20.0 | 1.5 | 3.2 | 1.5 |
| *Avena fatua | 20.0 | 1.4 | 2.8 | 1.3 |
| Comarostophylos diversifolia planifolia | 20.0 | 1.3 | 2.6 | 1.2 |
| Luzula subsessilis | 20.0 | 1.3 | 2.5 | 1.2 |
| Stachys bullata | 20.0 | 1.2 | 2.4 | 1.1 |
| Dryopteris arguta | 20.0 | 0.9 | 1.9 | 0.9 |
| Quercus dumosa | 13.3 | 1.1 | 2.9 | 1.1 |
| Toxicodendron diversilobum | 13.3 | 1.1 | 2.8 | 1.0 |
| *Vulpia bromoides | 13.3 | 1.0 | 2.6 | 1.0 |
| *Bromus mollis | 13.3 | 0.9 | 2.4 | 0.9 |
| Selaginella bigelovii | 13.3 | 0.9 | 2.4 | 0.9 |
| *Sonchus oleraceus | 13.3 | 0.9 | 2.4 | 0.9 |
| Achillea millefolium | 13.3 | 0.8 | 2.0 | 0.8 |
| Chenopodium californicum | 13.3 | 0.8 | 1.0 | 0.8 |
| *Chenopodium murale | 13.3 | 0.8 | 2.0 | 0.8 |
| Gnaphalium microcephalum | 13.3 | 0.8 | 2.0 | 0.8 |
| Navarretia atractyloides | 13.3 | 0.8 | 2.0 | 0.8 |
| Silene laciniata | 13.3 | 0.8 | 2.0 | 0.8 |
| Solanum douglasii | 13.3 | 0.8 | 2.0 | 0.8 |
| Dudleya greenei | 13.3 | 0.7 | 1.9 | 0.7 |
| Lotus dendroideus | 13.3 | 0.7 | 1.9 | 0.7 |
| *Silybum marianum | 13.3 | 0.6 | 1.6 | 0.6 |

Table C.10., cont...

| | | | | |
|---|---|---|---|---|
| Claytonia perfoliata | 6.7 | 0.7 | 2.5 | 0.6 |
| Prunus ilicifolia lyonii | 6.7 | 0.7 | 2.5 | 0.6 |
| Cerastium glomeratum | 6.7 | 0.5 | 2.0 | 0.5 |
| Adiantum jordanii | 6.7 | 0.4 | 1.5 | 0.4 |
| Cheilanthes clevelandii | 6.7 | 0.4 | 1.5 | 0.4 |
| Corethrogyne filaginifolia virgata | 6.7 | 0.4 | 1.5 | 0.4 |
| Dodecatheon clevelandii | 6.7 | 0.4 | 1.5 | 0.4 |
| Eriophyllum confertiflorum | 6.7 | 0.4 | 1.5 | 0.4 |
| Filago californica | 6.7 | 0.4 | 1.5 | 0.4 |
| *Gastridium ventricosum | 6.7 | 0.4 | 1.5 | 0.4 |
| *Geranium dissectum | 6.7 | 0.4 | 1.5 | 0.4 |
| Gnaphalium chilense | 6.7 | 0.4 | 1.5 | 0.4 |
| Marah macrocarpus | 6.7 | 0.4 | 1.5 | 0.4 |
| Parietaria hespera | 6.7 | 0.4 | 1.5 | 0.4 |
| Phacelia cicutaria | 6.7 | 0.4 | 1.5 | 0.4 |
| Rubus ursinus | 6.7 | 0.4 | 1.5 | 0.4 |
| Stipa diegoensis | 6.7 | 0.4 | 1.5 | 0.4 |
| *Urtica urens | 6.7 | 0.4 | 1.5 | 0.4 |
| Zigadenus fremontii | 6.7 | 0.4 | 1.5 | 0.4 |
| Arctostaphylos confertiflora | 6.7 | 0.3 | 1.0 | 0.3 |
| Centaurea melitensis | 6.7 | 0.3 | 1.2 | 0.3 |
| Salvia brandegei | 6.7 | 0.2 | 0.7 | 0.2 |

Table C.11. Santa Rosa Island Torrey Pine Woodland (6 releves sampled)
(* denotes alien species)

| SPECIES | FREQUENCY (%) | IMPORTANCE VALUE MEAN | S.D. | RELATIVE % |
|---|---|---|---|---|
| Pinus torreyana | 100.0 | 12.7 | 1.2 | 7.5 |
| *Bromus diandrus | 100.0 | 8.3 | 1.6 | 4.9 |
| *Silene gallica | 100.0 | 6.5 | 1.0 | 3.8 |
| *Bromus rubens | 83.3 | 5.5 | 2.5 | 3.3 |
| Mimulus flemingii | 83.3 | 5.3 | 2.5 | 3.2 |
| Antirrhinum nuttallianum | 83.3 | 4.8 | 2.2 | 2.9 |
| Gnaphalium purpureum | 66.7 | 5.5 | 2.6 | 3.3 |
| *Avena barbata | 66.7 | 5.3 | 3.9 | 3.2 |
| *Vulpia bromoides | 66.7 | 5.3 | 3.9 | 3.2 |
| Stipa pulchra | 66.7 | 4.2 | 3.0 | 2.5 |
| Silene laciniata | 66.7 | 4.0 | 2.9 | 2.4 |
| Achillea millefolium | 66.7 | 3.8 | 2.7 | 2.3 |
| Baccharis pilularis consanguinea | 66.7 | 3.8 | 2.7 | 2.3 |
| Heteromeles arbutifolia | 66.7 | 3.5 | 2.7 | 2.1 |
| Carex globosa | 50.0 | 4.3 | 4.3 | 2.6 |
| Galium nuttallii | 50.0 | 3.5 | 3.5 | 2.1 |
| *Hypochoeris glabra | 50.0 | 3.5 | 3.5 | 2.1 |
| Agrostis diegoensis | 50.0 | 3.3 | 3.4 | 2.0 |
| Gnaphalium microcephalum | 50.0 | 3.3 | 3.4 | 2.0 |
| Layia platyglossa campestris | 50.0 | 3.3 | 3.4 | 2.0 |
| Melica imperfecta | 50.0 | 3.3 | 3.4 | 2.0 |
| Gnaphalium chilense | 50.0 | 3.2 | 3.2 | 1.9 |
| Luzula subsessilis | 50.0 | 3.2 | 3.2 | 1.9 |
| Lotus dendroideus | 50.0 | 3.0 | 3.0 | 1.8 |
| Pityogramma triangularis | 50.0 | 3.0 | 3.0 | 1.8 |
| Trifolium tridentatum | 50.0 | 3.0 | 3.0 | 1.8 |
| Quercus dumosa | 50.0 | 2.8 | 2.9 | 1.7 |
| *Avena fatua | 33.3 | 3.2 | 4.5 | 1.9 |
| Pterostegia drymarioides | 33.3 | 2.3 | 3.3 | 1.4 |
| Spergularia macrotheca | 33.3 | 2.3 | 3.3 | 1.4 |
| *Stellaria media | 33.3 | 2.3 | 3.4 | 1.4 |
| Eriophyllum confertiflorum | 33.3 | 2.2 | 3.1 | 1.3 |
| Filago californica | 33.3 | 2.2 | 3.1 | 1.3 |
| Bromus carinatus | 33.3 | 2.0 | 2.8 | 1.2 |
| Corethrogyne filaginifolia robusta | 33.3 | 2.0 | 2.8 | 1.2 |
| Hieraceum argutum argutum | 33.3 | 2.0 | 2.8 | 1.2 |
| Stipa diegoensis | 33.3 | 1.8 | 2.6 | 1.1 |
| *Hordeum murinum s. leporinum | 16.7 | 1.3 | 3.0 | 0.8 |
| *Sonchus oleraceus | 16.7 | 1.3 | 3.0 | 0.8 |
| Achyrachaena mollis | 16.7 | 1.2 | 2.6 | 0.7 |
| Plantago erecta erecta | 16.7 | 1.2 | 2.6 | 0.7 |
| Adiantum jordanii | 16.7 | 1.0 | 2.2 | 0.6 |
| Allium lacunosum v. lacunosum | 16.7 | 1.0 | 2.2 | 0.6 |
| Arctostaphylos confertiflora | 16.7 | 1.0 | 2.2 | 0.6 |
| *Atriplex semibaccata | 16.7 | 1.0 | 2.2 | 0.6 |

Table C.11., cont...

| | | | | |
|---|---|---|---|---|
| Calochortus albus | 16.7 | 1.0 | 2.2 | 0.6 |
| Cirsium occidentale | 16.7 | 1.0 | 2.2 | 0.6 |
| Comarostaphylos diversifolia planifolia | 16.7 | 1.0 | 2.2 | 0.6 |
| Elymus triticoides | 16.7 | 1.0 | 2.2 | 0.6 |
| *Gastridium ventricosum | 16.7 | 1.0 | 2.2 | 0.6 |
| Koeleria macrantha | 16.7 | 1.0 | 2.2 | 0.6 |
| Lasthenia californica | 16.7 | 1.0 | 2.2 | 0.6 |
| *Marrubium vulgare | 16.7 | 1.0 | 2.2 | 0.6 |
| Polypodium californicum | 16.7 | 1.0 | 2.2 | 0.6 |
| Stachys bullata | 16.7 | 1.0 | 2.2 | 0.6 |
| Vicia americana | 16.7 | 1.0 | 2.2 | 0.6 |
| Vicia ludoviciana | 16.7 | 1.0 | 2.2 | 0.6 |
| Clarkia davyi | 16.7 | 0.8 | 1.9 | 0.5 |
| Hordeum californicum | 16.7 | 0.8 | 1.9 | 0.5 |
| *Medicago polymorpha polymorpha | 16.7 | 0.8 | 1.9 | 0.5 |
| Navarretia atractyloides | 16.7 | 0.8 | 1.9 | 0.5 |
| *Sonchus asper | 16.7 | 0.8 | 1.9 | 0.5 |

TABLE C.12. Santa Rosa Island Closed-Cone Pine Woodland
(* denotes alien species) (4 releves sampled)

| SPECIES | FREQUENCY (%) | IMPORTANCE VALUE MEAN | S.D. | RELATIVE % |
|---|---|---|---|---|
| Pinus remorata | 100.0 | 13.8 | 1.3 | 13.5 |
| *Avena barbata | 100.0 | 8.3 | 0.8 | 8.1 |
| Carex globosa | 100.0 | 8.0 | 0.7 | 7.8 |
| Mimulus flemingii | 100.0 | 7.8 | 0.4 | 7.6 |
| *Vulpia bromoides | 100.0 | 6.3 | 3.8 | 6.1 |
| Luzula subsessilis | 100.0 | 6.0 | 0.0 | 5.9 |
| Gnaphalium purpureum | 75.0 | 4.5 | 2.6 | 4.4 |
| Vaccinium ovatum | 50.0 | 3.5 | 3.5 | 3.4 |
| Baccharis pilularis consanguinea | 50.0 | 3.3 | 3.3 | 3.2 |
| *Hypochoeris glabra | 50.0 | 3.3 | 3.3 | 3.2 |
| *Silene gallica | 50.0 | 3.3 | 3.3 | 3.2 |
| Corethrogyne filaginifolia virgata | 50.0 | 3.0 | 3.0 | 2.9 |
| *Bromus diandrus | 25.0 | 2.5 | 4.3 | 2.4 |
| *Bromus mollis | 25.0 | 2.0 | 3.5 | 2.0 |
| Plantago erecta erecta | 25.0 | 2.0 | 3.5 | 2.0 |
| Gallium nuttallii insulare | 25.0 | 1.8 | 3.0 | 1.7 |
| Achillea millefolium | 25.0 | 1.5 | 2.6 | 1.5 |
| Arctostaphylos confertiflora | 25.0 | 1.5 | 2.6 | 1.5 |
| Bromus carinatus | 25.0 | 1.5 | 2.6 | 1.5 |
| Cardionema ramosissima | 25.0 | 1.5 | 2.6 | 1.5 |
| Corethrogyne filaginifolia robusta | 25.0 | 1.5 | 2.6 | 1.5 |
| Eriophyllum confertiflorum | 25.0 | 1.5 | 2.6 | 1.5 |
| *Erodium botrys | 25.0 | 1.5 | 2.6 | 1.5 |
| Gnaphalium chilense | 25.0 | 1.5 | 2.6 | 1.5 |
| Heteromeles arbutifolia | 25.0 | 1.5 | 2.6 | 1.5 |
| Hieraceum argutum argutum | 25.0 | 1.5 | 2.6 | 1.5 |
| Melica imperfecta | 25.0 | 1.5 | 2.6 | 1.5 |
| Polypodium californicum | 25.0 | 1.5 | 2.6 | 1.5 |
| *Polypogon monospeliensus | 25.0 | 1.5 | 2.6 | 1.5 |
| Quercus dumosa | 25.0 | 1.5 | 2.6 | 1.5 |
| *Spergularia villosa | 25.0 | 1.5 | 2.6 | 1.5 |
| Quercus tomentella | 25.0 | 0.8 | 1.3 | 0.7 |

TABLE C.13. Santa Rosa Island Island Oak Woodland (9 releves sampled)
(* denotes alien species)

| SPECIES | FREQUENCY | IMPORTANCE VALUE | | |
|---|---|---|---|---|
| | (%) | MEAN | S.D. | RELATIVE % |
| Quercus tomentella | 100.0 | 13.0 | 1.4 | 45.7 |
| Agrostis diegoensis | 22.2 | 1.4 | 2.7 | 5.1 |
| Mimulus flemingii | 22.2 | 1.4 | 2.7 | 5.1 |
| *Hordeum murinum leporinum | 22.2 | 1.3 | 2.5 | 4.7 |
| Melica imperfecta | 22.2 | 1.3 | 2.5 | 4.7 |
| *Stellaria media | 22.2 | 1.3 | 2.5 | 4.7 |
| Carex globosa | 22.2 | 1.2 | 2.3 | 4.3 |
| *Hypochoeris glabra | 22.2 | 1.2 | 2.3 | 4.3 |
| *Silene gallica | 22.2 | 1.2 | 2.3 | 4.3 |
| Dryopteris arguta | 11.1 | 0.8 | 2.2 | 2.7 |
| Bromus carinatus | 11.1 | 0.7 | 1.9 | 2.3 |
| Galium nuttallii | 11.1 | 0.7 | 1.9 | 2.3 |
| Heteromeles arbutifolia | 11.1 | 0.7 | 1.9 | 2.3 |
| *Sonchus oleraceus | 11.1 | 0.7 | 1.9 | 2.3 |
| *Bromus diandrus | 11.1 | 0.6 | 1.6 | 2.0 |
| Plantago erecta erecta | 11.1 | 0.6 | 1.6 | 2.0 |
| Stachys bullata | 11.1 | 0.3 | 0.9 | 1.2 |

TABLE C.14. Santa Rosa Island Riparian Woodland (2 releves)
(* denotes alien species)

| SPECIES | FREQUENCY (%) | IMPORTANCE VALUE MEAN | S.D. | RELATIVE % |
|---|---|---|---|---|
| *Bromus diandrus | 100.0 | 9.0 | 2.0 | 5.5 |
| *Agrostis semiverticillata | 100.0 | 7.5 | 1.5 | 4.5 |
| Baccharis pilularis consanguinea | 100.0 | 6.5 | 0.5 | 3.9 |
| *Silene gallica | 100.0 | 6.5 | 0.5 | 3.9 |
| *Stellaria media | 100.0 | 6.5 | 0.5 | 3.9 |
| Populus tricocarpa | 50.0 | 7.5 | 7.5 | 4.5 |
| Salix lasiolepis lasiolepis | 50.0 | 7.0 | 7.0 | 4.2 |
| Claytonia perfoliata | 50.0 | 4.5 | 4.5 | 2.7 |
| Marah macrocarpus | 50.0 | 4.5 | 4.5 | 2.7 |
| *Polypogon interruptus | 50.0 | 4.5 | 4.5 | 2.7 |
| *Polypogon monospeliensis | 50.0 | 4.5 | 4.5 | 2.7 |
| Eleocharis macrostachya | 50.0 | 4.0 | 4.0 | 2.4 |
| *Galium aparine | 50.0 | 4.0 | 4.0 | 2.4 |
| Juncus mexicana | 50.0 | 3.5 | 3.5 | 2.1 |
| Agrostis diegoensis | 50.0 | 3.0 | 3.0 | 1.8 |
| *Anagallis arvensis | 50.0 | 3.0 | 3.0 | 1.8 |
| Bromus carinatus | 50.0 | 3.0 | 3.0 | 1.8 |
| *Bromus mollis | 50.0 | 3.0 | 3.0 | 1.8 |
| Corethrogyne filaginifolia robusta | 50.0 | 3.0 | 3.0 | 1.8 |
| *Cynodon dactylon | 50.0 | 3.0 | 3.0 | 1.8 |
| Daucus pusillus | 50.0 | 3.0 | 3.0 | 1.8 |
| Distichlis spicata stolonifera | 50.0 | 3.0 | 3.0 | 1.8 |
| *Geranium dissectum | 50.0 | 3.0 | 3.0 | 1.8 |
| Gnaphalium chilense | 50.0 | 3.0 | 3.0 | 1.8 |
| Gnaphalium purpureum | 50.0 | 3.0 | 3.0 | 1.8 |
| Heteromeles arbutifolia | 50.0 | 3.0 | 3.0 | 1.8 |
| Mimulus flemingii | 50.0 | 3.0 | 3.0 | 1.8 |
| Pityogramma triangularis | 50.0 | 3.0 | 3.0 | 1.8 |
| Pterostegia drymarioides | 50.0 | 3.0 | 3.0 | 1.8 |
| Solanum douglasii | 50.0 | 3.0 | 3.0 | 1.8 |
| Stachys bullata | 50.0 | 3.0 | 3.0 | 1.8 |
| *Urtica urens | 50.0 | 3.0 | 3.0 | 1.8 |
| *Vulpia bromoides | 50.0 | 3.0 | 3.0 | 1.8 |
| *Xanthium spinosum | 50.0 | 3.0 | 3.0 | 1.8 |
| Achillea millefolium | 50.0 | 2.5 | 2.5 | 1.5 |
| Artemisia californica | 50.0 | 2.5 | 2.5 | 1.5 |
| *Cotula coronopifolia | 50.0 | 2.5 | 2.5 | 1.5 |
| Eriogonum grande rubescens | 50.0 | 2.5 | 2.5 | 1.5 |
| *Hypochoeris glabra | 50.0 | 2.5 | 2.5 | 1.5 |
| Juncus bufonius | 50.0 | 2.5 | 2.5 | 1.5 |
| Lotus strigosus | 50.0 | 2.5 | 2.5 | 1.5 |
| *Malva parviflora | 50.0 | 2.5 | 2.5 | 1.5 |
| *Medicago polymorpha | 50.0 | 2.5 | 2.5 | 1.5 |
| Trifolium tridentatum | 50.0 | 2.5 | 2.5 | 1.5 |

TABLE C.15. Santa Rosa Island Riparian Herbaceous Vegetation
(* denotes alien species) (6 releves sampled)

| SPECIES | FREQUENCY (%) | IMPORTANCE VALUE MEAN | S.D. | RELATIVE % |
|---|---|---|---|---|
| Distichlis spicata stolonifera | 100.0 | 10.7 | 2.7 | 16.8 |
| *Agrostis semiverticillata | 100.0 | 10.0 | 1.0 | 15.8 |
| *Cotula coronopifolia | 100.0 | 8.7 | 1.4 | 13.7 |
| *Polypogon monspeliensis | 100.0 | 7.7 | 1.5 | 12.1 |
| Juncus mexicanus | 50.0 | 5.5 | 5.5 | 8.7 |
| Mimulus guttatus | 50.0 | 4.8 | 4.9 | 7.6 |
| *Polypogon interruptus | 33.3 | 3.0 | 4.2 | 4.7 |
| *Rumex crispus | 33.3 | 2.5 | 3.5 | 3.9 |
| *Polygonum arenastrum | 33.3 | 1.5 | 2.3 | 2.4 |
| Juncus xiphioides | 16.7 | 1.8 | 4.1 | 2.9 |
| Juncus phaeocephalus | 16.7 | 1.5 | 3.4 | 2.4 |
| Gnaphalium microcephalum | 16.7 | 1.2 | 2.6 | 1.8 |
| *Bromus mollis | 16.7 | 0.8 | 1.9 | 1.3 |
| Hordeum californicum | 16.7 | 0.8 | 1.9 | 1.3 |
| Juncus bufonius | 16.7 | 0.8 | 1.9 | 1.3 |
| *Avena barbata | 16.7 | 0.5 | 1.1 | 0.8 |
| Baccharis pilularis consanguinea | 16.7 | 0.5 | 1.1 | 0.8 |
| Frankenia salina | 16.7 | 0.5 | 1.1 | 0.8 |
| Scirpus cernuus | 16.7 | 0.5 | 1.1 | 0.8 |

# APPENDIX D

List of all plants encountered
in this vegetation study of Santa Rosa Island.

| FAMILY | TAXA | AUTHOR | COMMON NAME |
|---|---|---|---|
| AIZOACEAE | | | |
| | *Carpobrotus aequilateralis | N.E.Brown | sea-fig |
| | *Mesembryanthemum crystallinum | (L.) Rotm. | ice-plant |
| ALLIACEAE | | | |
| | Bloomeria crocea v. crocea | (Torr.) Cov. | golden stars |
| | Dichelostemma pulchella | (Salisb.) Heller | blue dicks |
| ANACARDIACEAE | | | |
| | Rhus integrifolia | (Nutt.) Benth.& Hook. | lemonade berry |
| | Toxicodendron diversilobum | (T.& G.) Greene | poison oak |
| APIACAEA | | | |
| | Bowlesia incana | R.& P. | bowlesia |
| | Daucus pusillus | Michx. | rattlesnake weed |
| | Lomatium caruifolium | (H.& A.)Coult.& Rose | caraway-leaved |
| | Sanicula arguta | Greene ex Coult.& Rose | snakeroot |
| | *Torilis nodosa | (L.) Gaertn. | knotted hedge parsley |
| ASPIDIACEAE | | | |
| | Dryopteris arguta | (Kaulf.) Watt. | coastal wood-fern |
| ASTERACEAE | | | |
| | Achillea millefolium | L. | yarrow |
| | Achyrachaena mollis | Schauer | blow-wives |
| | Acourtia microcephala | (DC.) Gray | sacapellote |
| | Agoseris grandiflora | (Nutt.) Greene | |
| | Amblyopappus pusillus | H.& A. | pineapple weed |
| | Ambrosia chamissonis | | beachbur |
| | Artemisia californica | Less. | |
| | v. californica | (Rydb.) Munz | coastal sagebrush |
| | Baccharis pilularis | | |
| | s. consanguinea | (DC.) C.B. Wolf | coyote brush |
| | *Centaurea melitensis | L. | star thistle |
| | Cirsium occidentale | (Nutt.) Jeps. | western thistle |
| | Coreopsis gigantea | (Kell.) Hall | giant coreopsis |
| | Corethrogyne filaginifolia | | |
| | v. robusta | Greene | cudweed aster |
| | Corethrogyne filaginifolia | | |
| | v. virgata | (Benth.) Gray | |
| | *Cotula coronopifolia | L. | brass buttons |
| | Erigeron sanctarum | Wats. | saint's daisy |
| | Eriophyllum confertiflorum | (DC.) Gray | golden yarrow |
| | Filago californica | Nutt. | California filago |
| | Gnaphalium bicolor | Bioletti | bicolored everlasting |
| | Gnaphalium californicum | DC. | green everlasting |
| | Gnaphalium chilense | Spreng. | cotton-batting |
| | Gnaphalium microcephalum | Nutt. | white everlasting |
| | Gnaphalium purpureum | L. | purple cudweed |

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|---|---|
| Grindelia robusta v. robusta Nutt. | gum-plant |
| Haplopappus squarrosus H.& A. s. grindeliodes (DC.) | sawtooth goldenbrush |
| Haplopappus venetus (HBK) Blake. s. sedoides (Greene) Munz | prostrate goldenbrush |
| Hieraceum argutum s. argutum Nutt. | hawkweed |
| *Hypochoeris glabra L. | smooth cat's ear |
| Jaumea carnosa (Less.) Gray | |
| *Lactuca serriola v. serriola L. | wild lettuce |
| Lasthenia californica DC. ex Lindley | goldfield |
| Lasthenia glabrata Lindl. s. coulteri (Gray) Ornduff | goldfield |
| Layia platyglossa (F.& M.) Gray s. campestris Keck. | tidytips |
| Malacothrix saxatilis (Nutt.) T. & G. v. implicata (Eastw) Hall | cliff aster |
| Microseris linearifolia (DC.) Sch.-Bip. | |
| !*Senecio vulgaris L. | common groundsel |
| *Silybum marianum (L.) Gaertn | milk thistle |
| *Sonchus asper (L.) Hill | prickly sow thistle |
| *Sonchus oleraceus L. | common sow thistle |
| *Xanthium spinosum L. | spiny clotbur |

BORAGINACEAE

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|---|---|
| Amsinckia intermedia F.& M. | common fiddleneck |
| Amsinckia spectabilis F.& M. | beach fiddleneck |
| Cryptantha clevelandii v. clevelandii Greene | |

BRASSICACEAE

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|---|---|
| *Brassica geniculata (Desf.) J. Ball | short-podded mustard |
| *Cakile maritima s. maritima Scop. | sea rocket |
| Caulanthus lasiophyllus (Hook. & Arn.) Payson | California mustard |
| Lepidium lasiocarpum v. lasiocarpum Nutt. | sand peppergrass |
| Lepidium nitidum v. nitidum | shining peppergrass |

CACTACEAE

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|---|---|
| Opuntia littoralis v. littoralis (Engelm.) Ckll. | prickly pear |
| Opuntia prolifera Engelm. | coastal cholla |

CALOCHORTACEAE

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| Calachortus albus v. albus Dougl. ex. Benth. | fairy lanterns |
| Calochortus catalinae | Catalina mariposa |

CAPPARACEAE

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|---|---|
| Cleome isomeris Greene | bladderpod |

CARYOPHYLLACEAE

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|---|---|
| Cardionema ramosissimum (Weinm.) Nels. & Muchr. | sandmat |
| *Cerastium glomeratum Thuill. | mouse-ear chickweed |
| *Silene gallica L. | |
| Silene laciniata s. major Hitchc. & Maguire | Indian pink |
| *Spergula arvensis | corn spurrey |

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|---|---|
| Spergularia macrotheca v. macrotheca (Hornem.) Heynh | sand spurrey |
| Spergularia marina (L.) Griseb | salt marsh spurrey |
| *Stellaria media (L.) Vill | common chickweed |
| **CHENOPODIACEAE** | |
| Atriplex californica Moq. in | California saltbrush |
| *Atriplex semibaccata R. Br. | Australian saltbrush |
| *Chenopodium ambrosioides v. ambrosioides L. | Mexican-Tea |
| Chenopodium berlandieri v. sinuatum Moq. (J.Murr.) Wahl. | |
| Chenopodium californicum (Wats.) Wats. | soaproot |
| *Chenopodium murale L. | nettle-leaf goosefoot |
| Salicornia virginica L. | pickleweed |
| Suaeda californica Wats. | sea blite |
| **CISTACEAE** | |
| Helianthemum scoparium v. scoparium Nutt. | rushrose |
| **CONVOLVULACEAE** | |
| *Convolvulus arvensis L. | bindweed |
| Cressa truxillensis v. vallicola (Heller) Munz | alkali weed |
| Dichondra occidentalis House | western dichcondra |
| **CRASSULACEAE** | |
| Crassula erecta (H.& H.) Berger | pygmy weed |
| Dudleya greenei Rose | Greene's live-forever |
| **CUCURBITACEAE** | |
| Marah macrocarpus (Greene) Greene | wild cucumber |
| **CYPERACEAE** | |
| Carex globosa Boott | round-fruited sedge |
| Carex pansa Bailey | sand dune sedge |
| Carex subbracteata Mkze. | |
| Carex tumulicola Mkze. | foothill sedge |
| Scirpus americanus v. monophyllus Pers. | three square bullrush |
| Scirpus ceruus v. californicus (Torr.) Beetle | low clubrush |
| **ERICACEAE** | |
| Arctostaphylos confertiflora Eastw. | SRI manzanita |
| Arctostaphylos tomentosa (Pursh.) Lindl. s. insulicola Wells. | |
| Comarostaphylis diversifolia (Parry) Greene v. planifolia Jeps. | summer-holly |
| Vaccinium ovatum Pursh. | California huckleberry |
| **EUPHORBIACEAE** | |
| Eremocarpus setigerus (Hook) Benth. | dove weed |

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| FABACEAE | |
| Astragalus curtipes Gray | SLO locoweed |
| Astragalus miguelensis Greene | SMI locoweed |
| Lotus dendroideus v. dendroideus v. dendroideus (E. Greene) E. Greene | island deerweed |
| Lotus hamatus Greene | small flowered lotus |
| Lotus salsuginosus s. salsuginosus Greene | coastal lotus |
| Lotus strigosus s. strigosus (Nutt.) Greene | Bishop's lotus |
| Lupinus albifrons v. albifrons Benth. | silver lupine |
| Lupinus arboreus Sims. | coastal bush lupine |
| Lupinus bicolor s. microphyllus (Wats.) D. Dunn | dove lupine |
| Lupinus succulentus Dougl. ex Koch. | succulent lupine |
| *Medicago polymorpha L. v. brevispina (Benth.) Heyn. | bur-clover |
| *Medicago polymorpha v. polymorpha L. | spiny bur-clover |
| *Melilotus indicus (L.) All. | sweet clover |
| Trifolium amplectens v. amplectens T.& G. | |
| Trifolium gracilentum T.& G. | pin point clover |
| Trifolium microcephalum Pursh | small headed clover |
| Trifolium tridentatum v. tridentatum Lindle | tomcat clover |
| Vicia americana Muhl. ex Willd. | American vetch |
| Vicia ludoviciana s. ludoviciana Nutt. | slender vetch |
| FAGACEAE | |
| Quercus agrifolia v. agrifolia Nee. | coast live oak |
| Quercus dumosa Nutt. | scrub oak |
| Quercus tomentella Engelm. | island oak |
| FRANKENIACEAE | |
| Frankenia salina (Molina) I. M. Johnston | frankenia |
| GERANIACEAE | |
| *Erodium botrys (Cav.) Bertol. | broad-leaf filaree |
| *Erodium cicutarium (L.) L'Her. | redstem filaree |
| *Erodium moschatum (L.) L'Her. | whitestem filaree |
| *Geranium dissectum L. | cutleaf geranium |
| HYDROPHYLLACEAE | |
| Phacelia cicutaria v. hispida (Gray) J.T. Howell | caterpillar phacelia |
| Phacelia ramosissima Dougl. ex Lehm. | |
| Phacelia viscida (Benth.) Torr. | sticky phacelia |
| IRIDACEAE | |
| Sisyrinchium bellum Wats. | blue-eyed grass |

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| **JUNCACEAE** | |
| Juncus bufonius L. | toadrush |
| Juncus mexicanus Willd. | Mexican rush |
| Juncus phaeocephalus v. phaeocephalus Engelm. | brown headed rush |
| Juncus xiphioides E. Mey. | iris-leaved rush |
| Luzula subsessilis (Wats.) Buch. | common wood rush |
| **LAMIACEAE** | |
| *Marrubium vulgare L. | horehound |
| Salvia brandegei Munz. | SRI sage |
| Stachys bullata Benth. | wood-mint |
| **MALVACEAE** | |
| *Malva parviflora L. | cheeseweed |
| Sidalcea malviflora (DC.) Gray ex Benth. | checker bloom |
| **MELANTHACEAE** | |
| Zigadenus fremontii Torr. | chaparral zygadene |
| **NYCTAGINACEAE** | |
| Abronia maritima Nutt. ex Wats. | sticky sand-verbena |
| Abronia umbellata Lam. | beach sand-verbena |
| **ONAGRACEAE** | |
| Camissonia cheiranthifolia (Hornem. ex Spreng.) Raimann in Engl. & Prantl. s. cheiranthifolia | beach primrose |
| Camissonia micrantha Raven. | small primrose |
| Clarkia davyi (Jepson) Lewis & Lewis | |
| Zauschneria californica Presl. s. californica | California fuchsia |
| **ORCHIDACEAE** | |
| Piperia elegans (Lindl.) Boland | elegant rein orchid |
| **OROBANCHACEAE** | |
| Orobanche bulbosa (Gray) G. Beck. | chaparral broomrape |
| Orobanche parishii (Jeps.) Heckard s. brachyloba | short lobed broomrape |
| **PAPAVERACEAE** | |
| Eschscholzia californica Cham. | California poppy |
| Platystemon californicus (Greene) Munz | cream cups |
| **PINACEAE** | |
| Pinus remorata Mason. | SCI pine |
| Pinus torreyana Parry ex. Carr. | Torrey pine |
| **PLANTAGINACEAE** | |
| Plantago erecta s. erecta Morris | California plantain |

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| **POACEAE** | |
| Agrostis diegoensis Vasey | thin grass |
| *Agrostis semiverticillata (Forsk) C. Chr. | water bent |
| *Avena barbata Brot. | slender wild oats |
| *Avena fatua L. | wild oats |
| Bromus carinatus H.& A. | California brome |
| *Bromus diandrus Roth | ripgut brome |
| *Bromus mollis L. | soft chess brome |
| *Bromus rubens L. | red brome |
| *Cynodon dactylon (L.) Pers. | bermuda grass |
| Distichlis spicata v. spicata (L.) Greene | salt grass |
| Elymus glaucus s. glaucus Buckl. | western rye |
| Elymus triticoides Buckl. | alkali rye |
| *Gastridium ventricosum (Gouan) Schinz & Thell | nit grass |
| Hordeum californicum Covas & Steb. | meadow barley |
| *Hordeum murinum s. leporinum Link | |
| Koeleria macrantha (Ledeb.) Spreng. | June grass |
| *Lamarckia aurea (L.) Moench | goldentop |
| *Lolium perenne L. s. multiflorum (Lam.) Husnot. | Italian ryegrass |
| Melica imperfecta L. | coast range melica |
| *Monerma cylindrica Trin. | |
| Muhlenbergia microsperma (DC.) Kunth | |
| *Parapholis incurva (L.) C.E. Hubb | sickle grass |
| Poa douglasii Nees | maritime bluegrass |
| Poa scabrella (Thurb.) Benth. | |
| Polypogon interruptus HBK | |
| *Polypogon monspeliensis (L.) Desf. | rabbitsfoot grass |
| Stipa diegoensis Swall | |
| Stipa pulchra Hitchc. | purple needlegrass |
| *Vulpia bromoides (L.) S. F. Gray | brome fescue |
| *Vulpia myuros v. hirsuta Hackel | foxtail fescue |
| **POLEMONIACEAE** | |
| Gilia clivorum (Jeps.) V. Grant | |
| Navarretia atractyloides (Benth.) H.& A. | |
| **POLYGONACEAE** | |
| Chorizanthe wheeleri Wats. | Wheeler's spineflower |
| Eriogonum arborescens Greene | SCI buckwheat |
| Eriogonum grande s. rubescens (Greene) Munz | red buckwheat |
| *Polygonum arenastrum Bor. | common knotweed |
| *Polygonum aviculare L. | |
| Pterostegia drymarioides F.& M. | fairy mist |
| *Rumex crispus L. | curly dock |
| Rumex salicifolius Weinm. | willow dock |
| **POLYPODIACEAE** | |
| Polypodium californicum Kaulf | California polypody |

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| **PORTULACACEAE** | |
| Calandrinia ciliata (R. & P.) DC. v. menziesii (Hook.) Macbr. | redmaids |
| Claytonia perfoliata v. perfoliata Donn. | miner's lettuce |
| **PRIMULACEAE** | |
| *Anagalis arvensis L. | scarlet pimpernal |
| Dodecatheon clevelandii Greene s. insulare H.J. Thomps. | shooting star |
| **PTERIDACEAE** | |
| Adiantum jordani K. Mull. | California maidenhair |
| Cheilanthes clevelandii D.C. Eat. | Cleveland's lip fern |
| Pellaea andromedifolia (Kaulf.) Feevar. v. pubescens D.C. Eat. | coffee fern |
| Pellaea mucronata s. mucronata (D.C. Eat.) D.C. Eat.) | bird's foot fern |
| Pityogramma triangularis v. triangularis (Kaulf.) Maxon | gold-back fern |
| **RANUNCULACEAE** | |
| Delphinium parryi s. parryi Gray | larkspur |
| Ranunculus californicus v. californicus Benth. | California buttercup |
| **RESEDACEAE** | |
| Oligomeris linifolia (Vahl) Macbr. | |
| **RHAMNCEAE** | |
| Ceanothus arboreus Greene v. glaber Jeps. | California lilac |
| **ROSACEAE** | |
| Adenostoma fasciculatum v. fasciculatum H.& A. | chamise/greasewood |
| Heteromeles arbutifolia M. Roem. | toyon |
| Lyonothamnus floribundus Gray s. asplenifolius (Greene) Raven | SCI ironwood |
| Prunus ilicifolia (Nutt.) Walp. s. lyonii | island cherry |
| **RUBIACEAE** | |
| Galium angustifolium Nutt. | narrow-leaved bedstraw |
| *Galium aparine L. | cleavers |
| Galium nuttallii Gray s. insulare Ferris | bedstraw |
| **SALICACEAE** | |
| Populus trichocarpa T.& G. | black cottonwood |
| Salix lasiolepis v. lasiolepis Benth. | arroyo willow |
| **SCROPHLARIACEAE** | |
| Antirrhinum nuttallianum Benth. in DC. | snapdragon |
| Castilleja affinis s. affinis H.& A. | Indian paintbrush |

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| Castilleja mollis Penn. | soft-leaved paintbrush |
| Linaria texana (Scheele) | toadflax |
| Mimulus flemingii Munz. | island monkeyflower |
| Mimulus guttatus Fisch. ex DC. | common monkeyflower |
| Orthocarpus purpurascens Benth. v. pallidus Keck. | owl's clover |
| **SELAGINELLACEAE** | |
| Selaginella bigelovii Underw. | club moss |
| **SOLANACEAE** | |
| Solanum douglasii Dunal in DC. | Douglas' nightshade |
| **URTICACEAE** | |
| *Urtica urens L. | dwarf nettle |
| **VIOLACEAE** | |
| Viola pedunculata T.& G. | johnny-jump-up |

! = newly reported for Santa Rosa Island

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