



Cooperative National Park Resource Studies Unit

The University of California, Davis

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**ECOLOGICAL CONDITION AND PUBLIC USE OF THE
CABRILLO NATIONAL MONUMENT INTERTIDAL ZONE IN
1991**

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ABSTRACT

The National Park Service monitors natural resources and public use to provide public access and enjoyment of unimpaired tide pools in Cabrillo National Monument. With support from the Cabrillo Historical Association, marine biologists from the Service coordinated the efforts of 38 local scientists, students, and monument staff to determine the ecological health of intertidal organisms in the monument in 1991. Abundance and distributions of 18 index taxa were measured in 90 monitoring plots arrayed along a gradient of public use on the western shore of Point Loma during 23-26 MAR 91 and 3-5 NOV 91. Information from these plots, with 45 daily censuses of sea birds and visitors, was used to assess the condition of plants and animals characteristic of the monument's intertidal zones relative to visitor activities and general environmental conditions. Slightly fewer people and more seabirds may have visited monument tide pools in 1991 compared to 1990. Invertebrate predators, such as sea stars, and abalone are still remarkably absent from monument tide pools. Acorn and thatched barnacles increased slightly in 1991, while goose barnacles declined. Rockweed covered 51-74% of the rocks in the mid-tide zone. California mussel abundance continued to decline, and are now at only half of the 1990 level. Red algal turf and surf grass on flat surfaces subject to trampling remained unchanged between 1990 and 1991. Feather boa kelp abundance dropped dramatically in the spring of 1991, but recovered to 1990 levels by the fall. Non-native sargassum weed expanded its distribution in 1991. Owl limpet abundance declined 9% between spring and fall in 1991, and the sizes of the largest limpets dropped by more than 10 mm.

TABLE OF CONTENTS

ABSTRACT	i
TABLE OF CONTENTS	ii
LIST OF TABLES AND FIGURES	iii
INTRODUCTION	1
METHODS	1
Index Taxa	1
Ecological Monitoring	5
Photogrammetric Plots	5
Line-Transects	5
Band-Transects	5
Circular Plots	6
Timed Searches	6
Bird Censuses	6
RESULTS	6
Public use	6
Birds	6
Abalone and sea stars	8
Barnacle zone	8
Rockweed zone	8
Mussel zone	8
Algal turf zone	8
Surf grass zone	8
Feather boa kelp zone	9
Owl Limpets	9
DISCUSSION	9
LITERATURE CITED	12

LIST OF TABLES AND FIGURES

Tables

Table 1. Sampling techniques and index taxa used to monitor intertidal resources in Cabrillo National Monument, California.

Table 2. Participants in Cabrillo National Monument intertidal monitoring in 1991.

Table 3. Summary of public use and sea bird surveys in Cabrillo National Monument intertidal zone in 1991.

Table 4. Cover recorded in 50 x 75 cm photogrammetric plots during 1991.

Table 5. Abundance and distribution of goose barnacles, *Pollicipes polymerus*, in 1 x 10 m band transects during 1991.

Table 6. Size distribution within clumps of goose barnacles, *Pollicipes polymerus*, during 1991.

Table 7. Ground cover along 10 m-long line-intercept transects in 1991.

Table 8. Abundance and size distribution of owl limpets, *Lottia gigantea*, in 1 m radius plots during 1991.

Table 9. Summary of public use and condition of intertidal index taxa in Cabrillo National Monument, California during 1991.

Table 10. Summary of public use and condition of intertidal index taxa in Cabrillo National Monument, California 1990.

Figures

Figure 1. Rocky intertidal zones, showing public access and visitor use areas in Cabrillo National Monument, California.

Figure 2. Summary of 1991 visitor and bird censuses in Cabrillo National Monument, California.

Figure 3. Proportion of small, medium, and large individuals within clumps of goose barnacles, *Pollicipes polymerus*, at Cabrillo National Monument, California in 1991.

Figure 4. Size frequency distributions for owl limpets, *Lottia gigantea*, in Cabrillo National Monument, California.

INTRODUCTION

Trampling, specimen collecting, and general disturbance by visitors and pollution from afar affect the abundance and distribution of intertidal plant and animal populations in Cabrillo National Monument. These anthropogenic processes interact with natural population controls of competition, predation, and varying environmental conditions to create a dynamic ecological mosaic in time and space. Though the tide pools and associated intertidal habitats in Cabrillo National Monument are among the most pristine in San Diego County, they are also among the most accessible and show the effects of people exploring, discovering, and enjoying their wonders. The National Park Service is responsible for restoring these natural resources, for providing public access to them, and for protecting them unimpaired for the enjoyment of future generations.

These tidepools need to be restored and maintained while still providing enjoyment for the visiting public. Measures of resource conditions need to be established and monitored to evaluate restoration efforts. Monitoring is also needed to help develop strategies for ensuring maximum public access with acceptable low impacts to the fabric of this important biological community.

This report is the second in a series that will describe annual conditions of intertidal resources and characterize levels and distribution of public visitation. In subsequent years, the reports will also identify multi-year trends and patterns. The Cabrillo NM intertidal monitoring program was initiated in 1990 with funding from the Cabrillo Historical Association (CHA). A standar-

dized monitoring protocol was designed after resource inventories conducted by Zedler (1976), Stewart and Meyers (1980) and Stewart (1982) and a long-term monitoring program at Channel Islands National Park, California (Richards and Davis 1988). This protocol is defined in a handbook for Cabrillo NM (Davis and Engle, in prep).

METHODS

Index Taxa

Information about the population dynamics of a representative group of taxa is used to provide an index of resource conditions. For this study, species likely to be affected by trampling, harassment, and collecting are particularly important. Intertidal zonation is frequently characterized by distributions of dominant attached plants and sessile animals (Ricketts et al. 1985, Foster et al. 1988). These characteristic taxa may also serve as indicators of ecological conditions. The following section describes the characteristics of index taxa selected for monitoring in Cabrillo National Monument.

Algal Turf: Plants and animals covering flat surfaces are likely to be trampled in heavily used areas. The most widespread of these taxa, especially in the high tide zone, is a red algal turf composed of 40-60 species of attached and epiphytic plants (Stewart 1982). This turf assemblage is remarkably resistant to trampling, in part because it is adapted to a high level of natural disturbance, but at extreme levels of trampling can be expected to give way to bare rock.

Anemones: The aggregating anemone, *Anthopleura elegantissima*, is a conspicuous animal that attracts considerable visitor

attention and poking (Zedler 1978). On flat rock surfaces, this anemone tends to occupy small depressions or crevices. On vertical surfaces *A. elegantissima* frequently develops large continuous aggregations through asexual reproduction, with adjacent clones separated by small anemone-free corridors (Morris, Abbott and Haderlie 1980).

Rockweed: On slightly higher and somewhat wave-protected surfaces, the rockweed, *Pelvetia fastigiata*, is a common cover on both horizontal and vertical surfaces. It is a long-lived perennial whose thick thatch provides shelter and protection from desiccation for many animals (Ricketts et al. 1985). *Pelvetia* is tough and resilient, but will succumb to heavy trampling and may take several years to recover after trampling ceases.

Surf grass: An indicator of mean sea level, surf grass, *Phyllospadix* spp. serves as a nursery for juvenile California spiny lobster, *Panulirus interruptus*, and many other animals. Surf grass grows vegetatively from rhizomes and lives many years, but it is sensitive to both sewage discharge (Littler and Murray 1975) and oil pollution (Foster et al. 1988).

Feather boa kelp: Feather boa kelp, *Egregia menziesii*, is one of the largest intertidal plants and provides shelter for a wide variety of plants and animals. Limpets and giant black sea hares, *Aplysia vaccaria*, rely on this kelp for food. It is also sensitive to sewage discharge (Littler and Murray 1975).

Sargassum: Two species of sargassum weed occur in monument tide pools. The largest and most common, *Sargassum muticum*, is an alien, probably introduced on Japanese oysters imported to Puget Sound in the

1930's. First noticed in southern California in 1970 (Abbott and Hollenberg 1987), it has since spread rapidly throughout the region. It is a perennial plant with long branches, but dies back to a low stub in the summer and fall months. Its habitat requirements are similar to surf grass, and they are frequently mixed together in the lower intertidal zone and in tidepools.

Mussels: California mussels, *Mytilus californianus*, dominate mid and low intertidal rocks on exposed shores. They are capable of forming extensive beds that shelter the richest community of plants and animals in the intertidal zone, with over 100 species per square meter in dense patches (Kanter 1978). Mussels are often collected for food and bait. Individual beds may take a decade to recover from such collecting and impose long-lasting impacts on the entire intertidal community they support.

Owl limpets: Owl limpets, *Lottia gigantea*, are common in the high and middle intertidal zones on wave swept shores. They are the largest of the intertidal limpets. Each limpet maintains a territory of up to 1,000 cm² that it defends against competitors for space and food (Stimson 1973). By holding these territories, owl limpets create and maintain large areas of apparently bare rock and determine the physical structure of the community in these zones. Owl limpets live at least 10 to 15 years, and are collected for food, similar to abalone. Their removal would have far reaching impacts on intertidal communities.

Black abalone: Black abalone, *Haliotis cracherodii*, are the largest of the intertidal snails. Prized by people for their meat and shells for thousands of years, they have been decimated in southern California by harvest

and environmental stress. Once common in the monument, they are now virtually extinct. Black abalone feed on kelp that drifts ashore, and often stack several deep in areas where their densities may exceed 100 per square meter. They are long-lived, perhaps living 30-35 years, and may require a century to recover from their present condition, if they recover at all.

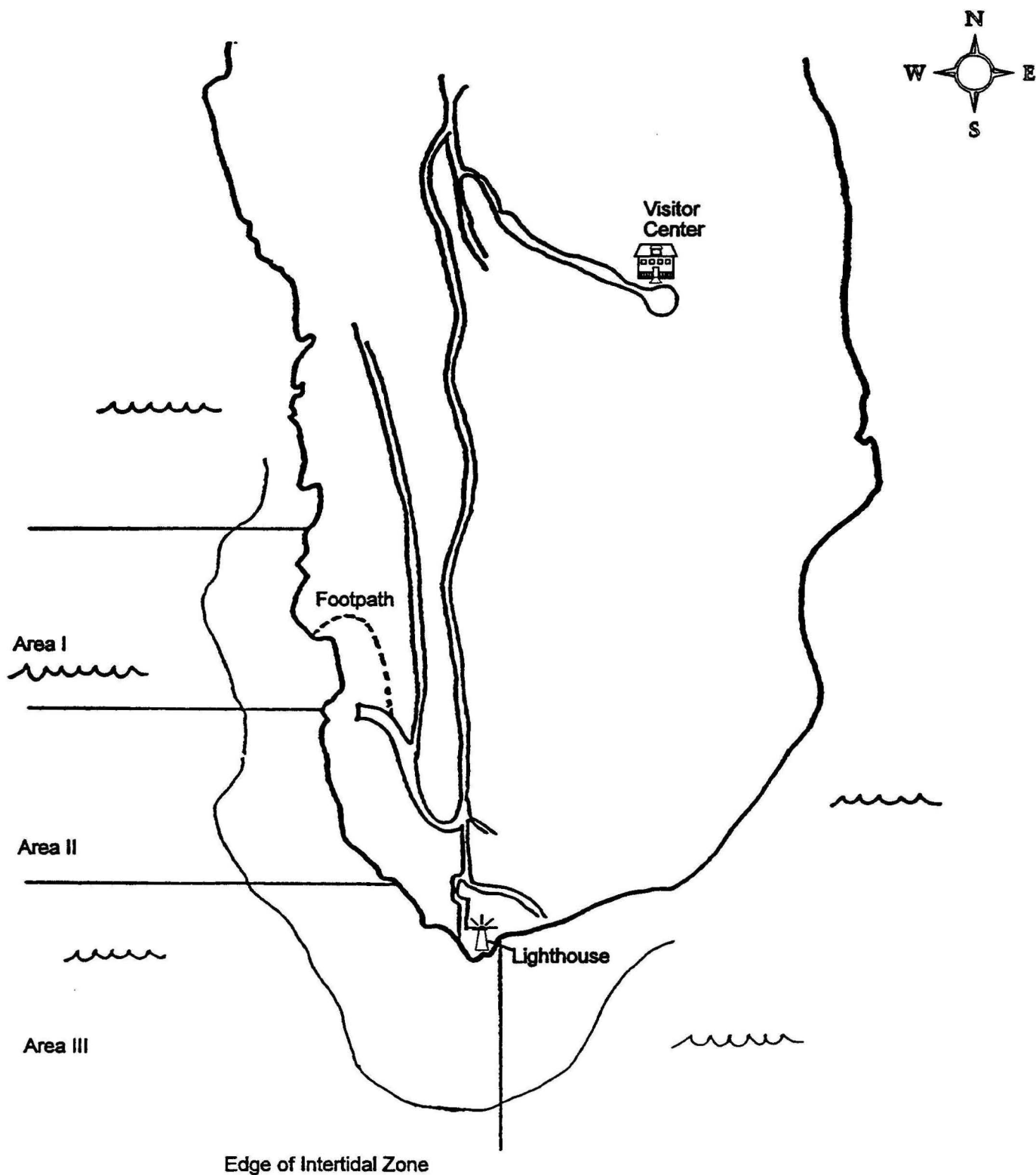
Sea stars: Ochre sea stars, *Pisaster ochraceus*, are keystone predators on mussels, other mollusks, and barnacles; that is they mediate competition among their prey species and thereby control community structure. When keystone predators are removed from intertidal systems, biodiversity declines as prey species are eliminated by competition. Ochre stars mysteriously disappeared from southern California in the late 1970's and are just now beginning to return. Since they live more than 20 years, it will take nearly that long to re-establish healthy adult populations again.

Barnacles: Barnacles are conspicuous competitors for space in rocky intertidal zones. The largest of the acorn-type barnacles, the pink thatched *Tetraclita rubescens*, occurs on exposed middle and low intertidal rocks where they may persist for 10-15 years. Small white acorn or buckshot barnacles, *Chthamalus* spp., are short-lived, maturing after only two months and surviving two years in the highest splash zone. Goose barnacles, *Pollicipes polymerus*, cluster in the high intertidal zone and mix with California mussels in the middle zone on exposed shores. Their edible stalks make them popular targets of human foragers. Another longlived species, goose barnacles live more than 20 years, and recovery from extensive collecting may be longer (Morris, Abbott, and Haderlie 1980).

Birds: A wide variety of wading birds, shore birds, and gulls also forage in intertidal communities, functioning as important predators and maintaining a diverse community. Commonly seen are great blue herons, great and snowy egrets, blackbellied plovers, willets, wandering tattlers, spotted sandpipers, marbled godwits, ruddy and black turnstones, and sanderlings. Several species of gull are also common, including western, California, Heermann's, herring, ring-billed, and mew gulls.

Public Use: The primary objective of this resource monitoring is to detect and measure both natural changes in plant and animal populations and those that are likely to be caused by human activities. Therefore, two kinds of information must be monitored: the parameters of populations most likely to be affected, and human activities. Public access to the monument's intertidal zone is largely restricted to a single point on the western coast of Point Loma, approximately 800 m north of the tip of the peninsula (Fig. 1). From this point, visitors can explore about 1 km of open ocean shoreline without crossing deep surge channels that extend to the base of steep cliffs or moving around the southern tip of the Point into San Diego Bay. At historic levels of visitation, this situation created a gradient of use, decreasing with distance from the access point (Zedler 1978). Based on this historic information and recent observations, the monument's western intertidal zone was stratified into three areas of use, each encompassing roughly 330 m of shoreline (Fig. 1). Area I, closest to the access point, receives the highest visitation. Area II, south of Grunion Beach to the Radio Tower, appears to receive slightly fewer visitors, and Area III, at the southwestern tip of the Point, receives the least.

Figure 1. Map showing public access and visitor use areas in Cabrillo National Monument, California.



The numbers of people in each of these three areas were recorded daily, when possible, within 30 minutes of the low tide, on the 118 days when low tide was less than 15 cm above mean sea level (MSL) during 1000 - 1600 hours (PST). These counts were used as an index of visitor use for each area and correlated with resource conditions.

Ecological Monitoring

Within each of the three visitor use areas, abundance and distribution of 18 species or collective taxa, bare substrate, and tar were measured during a series of daylight low tides in the spring and fall seasons. A variety of sampling techniques were employed to gather information about the population dynamics of these taxa. The following section describes each technique and its application. Table 1 summarizes the taxa and respective sampling techniques. Fixed ("permanent") plots and transects were established during February 1990 in a stratified random fashion to represent the range of tidal and biological zones in locations typical of each taxon, subject to physical constraints of plot or transect dimensions. Sketch maps and measurements from benchmarks and among plots were used to relocate obscure plots. Detailed information needed to relocate and survey plots are contained in a monitoring protocol handbook (Davis and Engle in prep.).

Photogrammetric Plots: Abundance and distribution of California mussels, *Mytilus californianus*, the barnacles, *Tetraclita rubescens* and *Chthamalus* spp., and rockweed, *Pelvetia fastigiata*, were measured from photographs made of 50 cm x 75 cm plots located on boulders. Fifteen plots were established and sampled in each of the

three visitor use areas: five each representing suitable mussel, rockweed, and barnacle habitats. The photoplot sampling protocol followed Richards and Davis (1988). Each plot was identified with a numbered brass tag in the upper left corner. The four corners of each plot were marked with small patches (2 cm diameter) of olive-green "Splash Zone" epoxy mixed to match the color of native rock. Photographs were made using a fixed quadrat camera frame with 35 mm color slide film. Slides were projected on a life-sized grid of 100 uniformly distributed points. The number of points occupied by mussels, barnacles, rockweed, tar, miscellaneous plants, miscellaneous animals, and bare rock on each photograph were recorded to determine percent cover of each taxon.

Line-Transects: Three strata of flat surfaces subject to trampling were sampled with replicate 10-meter line-intercept transects. Six transects were established in each visitor use area, two each at three elevations in high, middle, and low tidal zones, as characterized by distributions of red algal turf, surf grass (*Phyllospadix*), and feather boa kelp (*Egregia*). The abundance and distribution of these three taxa, *Sargassum muticum*, *Anthopleura elegantissima*, other biotic cover, tar, and bare substrata were recorded as distances along the transects to the nearest centimeter. These transects were marked with a numbered brass tag and three bronze bolts (7.5 cm length, 10 mm diameter) epoxied in holes drilled into bed rock at the ends and midpoint of each transect. A measuring tape calibrated in 2.0 mm intervals stretched between the end bolts was used to determine the distances each taxon occupied along the transect.

Band-Transects: The abundance and distri-

bution of goose barnacles (*Pollicipes*) were recorded in three band transects (1 m X 10 m) located on cliff faces or rip-rap at the base of the cliffs in each visitor use area. These transects were each marked with a numbered brass tag at the north end, and three bronze bolts (7.5 cm long, 10 mm diameter) epoxied in holes drilled into the rock at the ends and midpoint of each transect. The dimensions of each clump of *Pollicipes* within 0.5 m of the transect line were recorded, and the presence of small (<1 cm), medium sized (1-3 cm), and large (>3 cm) barnacles in each clump was noted.

Circular Plots: Owl limpet, *Lottia gigantea*, abundance and size frequency distributions were determined in six 1.0 m radius circular plots in each public use area: three plots were established on boulders and three on cliff faces or bedrock platforms. Each plot was marked with a numbered brass tag and a single bronze bolt (7.5 cm length, 10 mm diameter) epoxied in a hole drilled into the rock at the center of the plot. The numbers and sizes (maximum length in millimeters) of *Lottia Lottia gigantea* within 1.0 m of the bolts were recorded.

Timed Searches: Historically, black abalone, *Haliotis cracherodii*, and ochre stars, *Pisaster ochraceus*, were important components of the monument's intertidal system (Zedler 1978). Nevertheless, none were found during intensive searches of the entire study area in January and February, 1990 (Davis and Engle 1992). Timed searches (30 person-minutes) were conducted in each visitor use area for these species during routine monitoring.

Bird Censuses: Several shore and wading birds forage in the intertidal zone. Their

predation mediates competition and affects community structure. Gull, shore bird, and wading bird abundances were determined by census in each public use area daily during low tides when visitor censuses were conducted.

RESULTS

A total of 90 fixed plots or transects were sampled during 23-26 MAR 91 and again during 3-5 NOV 91. In addition to the authors, 38 people assisted in monitoring. They are listed with their local affiliations in Table 2.

Weather and tide conditions during both sampling periods were excellent. Air temperatures were 15-17C in the spring and 25-26C in the fall. Sea temperature in the spring was 15C, and 20C in the fall. Winds were light to moderate and low tides ranged from -3 cm to -24 cm MSL.

Public use

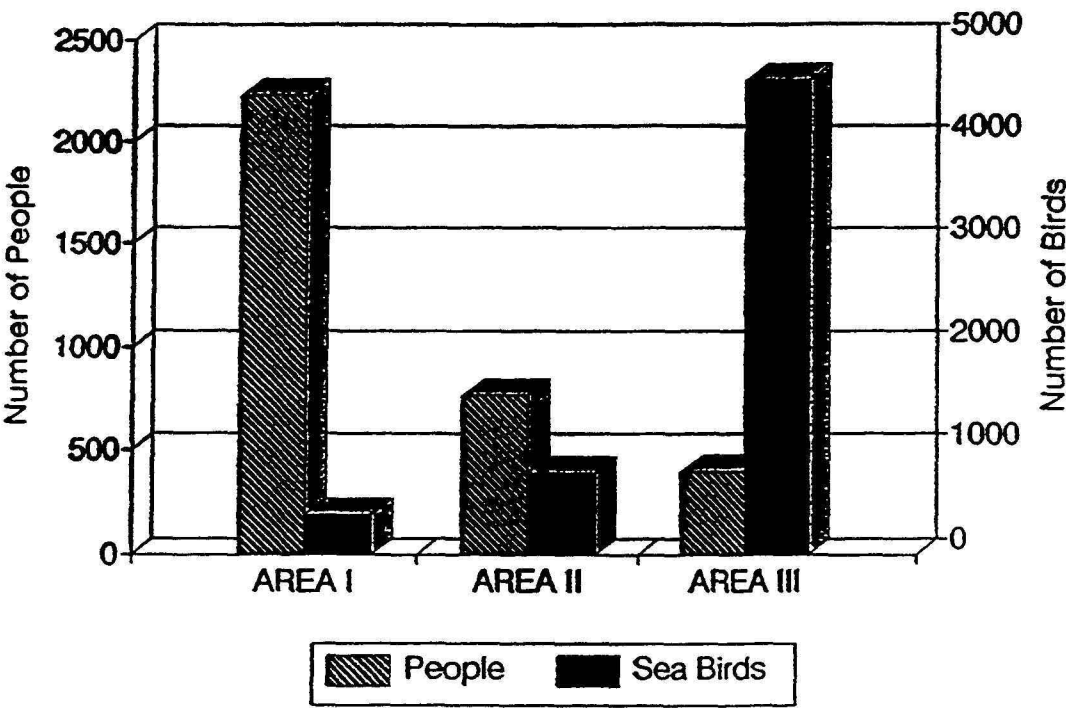
A total of 45 censuses were conducted in 1991, 37% of the possible days. Substantially more people were present on weekends and holidays (107) than on weekdays (21) (Table 3). The historical gradient of high use in Area I (mean 50 people), moderate use in Area II (17 people), and low use in Area III (9 people) was still present (Fig. 2).

Birds

Sea bird usage in the three areas showed a marked gradient opposite the gradient of public use (Table 3 & Fig. 2). The mean numbers of birds were 8, 17, and 102 for areas I, II, and III, respectively. Snowy egrets, great blue herons, marbled godwits,

Figure 2. Summary of 1991 visitor and bird censuses in Cabrillo National Monument, California.

Summary of Visitor and Bird Censuses in Cabrillo N M Intertidal Zone



sanderlings, and black turnstones were the most common wading and shore birds. Western and California gulls were the most frequently seen gulls.

Abalone and sea stars

Spring searches were conducted on 26 MAR 91 between 1155 and 1500 hours. Low tide was -24 cm MSL at 1300 PST. No live abalone were found. One green abalone shell, *Haliotis fulgens*, (130 mm) and two red abalone shells, *H. rufescens*, (130 and 172 mm) were found in area III. One giant spined sea star, *Pisaster giganteus*, (140 mm longest arm) was found in area III. No other *Pisaster* stars were found.

Fall searches were conducted on 3, 4, and 5 NOV 91 within 20 minutes of the low tide each day. The tides were -3 to -24 cm MSL. No abalone or *Pisaster* stars were found. Twelve small bat stars, *Patiria miniata*, (15-25 mm longest arm) were found under rocks in area II.

Barnacle zone

Abundance and distribution of acorn and thatched barnacles were recorded in photo-plots (Table 4), and goose barnacle clumps were measured and evaluated in band-transects (Tables 5 and 6). Acorn and thatched barnacles covered 33-54% of the highest photo-plots in the spring and 28-66% in the fall. Bare rock in the highest photo-plots averaged 41% in the spring and 24% in the fall. Algae covered 8% of the highest photoplots in the spring and 20% in the fall.

Goose barnacles occupied 1.4-6.4% of the transect areas in the spring and 1.5-7.0% in the fall (Table 5). The number of barnacle clumps in all three areas dropped from 562

to 447 between spring and fall, while mean clump size increased from 76 cm² to 83 cm². The occurrence of small barnacles in clumps increased slightly between spring and fall from 77% to 84% (Table 6).

Rockweed zone

Rockweed occupied 57-68% of the mid-level photoplots in the spring, and 75-79% in the fall (Table 4). Bare rock accounted for 13% of the cover in these plots during the spring, and 6% in the fall. Total algal cover in these plots varied from 75% in the spring to 91% in the fall.

Mussel zone

California mussels were rare in area I and very sparse in areas II and III. Mussels covered only 6-9% of the lowest photoplots in area I, 18-20% in area II, and 25-28% in area III (Table 4). Bare rock accounted for 41% of the cover in these plots in the spring and 34% in the fall. Algal cover in the lowest photo-plots increased from 22% in the spring to 33% in the fall.

Algal turf zone

Red algal turf covered 74-88% of the ground cover along the six highest transects in the spring and 71-83% in the fall (Table 7). Aggregating anemones occurred on all six of the high transects, but occupied only 1% to 2% of the area along the transects. On average, 9% of the ground was barren rock or sand along the highest transects in the spring and 11% in the fall.

Surf grass zone

Surf grass occupied 58-70% of the ground

along the six mid-level transects in the spring and 70-71% in the fall (Table 7). Bare substratum along the mid-level transects occupied 9% of the area in the spring and 3% in the fall. The alien sargassum weed was relatively uncommon, occurring along three of the six mid-level transects in the spring and only one in the fall.

Feather boa kelp zone

Feather boa kelp covered 11-22% of the ground along the six lowest transects in the spring and 25-54% in the fall (Table 7). Bare substratum was rare in the low intertidal zone, occupying 8% in the spring and 1% in the fall. Sargassum weed occurred along half of the low transects in the spring and two-thirds in the fall. At one site in area III, it covered 22% of the transect.

Owl Limpets

Owl limpets in the monument approach the maximum size for the species (9 cm) and are relatively abundant. The number of limpets per 3.1 m² plot ranged from 14 to 78 in the spring and from 17 to 71 in the fall. The total number of limpets dropped from 690 in the spring to 629 in the fall (Table 8). The 1991 cohort was relatively small except in area I (Fig. 3).

coefficients of variation made it difficult to detect small changes in visitation or bird usage. Invertebrate predators, such as sea stars, and abalone are still remarkably absent from monument tide pools. Acorn and thatched barnacles increased slightly in 1991, while goose barnacles declined. Rockweed covered 51-74% of the rocks in the mid-tide level in 1991, virtually identical to the overall coverage in 1990. California mussel abundance continued to decline, especially in the two zones of lowest use (II & III), where mussel cover was more than 50% in the spring of 1990 and fell steadily to half that by the fall of 1991. Red algal turf and surf grass on flat surfaces subject to trampling remained unchanged between 1990 and 1991. Feather boa kelp abundance dropped dramatically in the spring of 1991 (compared to 1990), but recovered to 1990 levels by the fall. Non-native sargassum weed expanded its distribution in 1991, from four of 18 study plots in 1990 to seven plots in 1991. A large cohort of juvenile owl limpets entered the population in the fall of 1990. They survived into the spring of 1991, but limpet abundance declined 9% between spring and fall in 1991, and the sizes of the largest limpets dropped by more than 10 mm.

DISCUSSION

Table 9 summarizes the abundance of human visitors, selected organisms, and substrate for spring and fall surveys in three visitor use areas of the monument in 1991. Fewer people and more seabirds may have visited monument tide pools in 1991 compared to 1990, but the small number of censuses (18 in 1990 and 45 in 1991) and subsequent high

Figure 3. Proportion of small, medium, and large individuals within clumps of goose barnacles, *Pollicipes polymerus*, at Cabrillo National Monument, California.

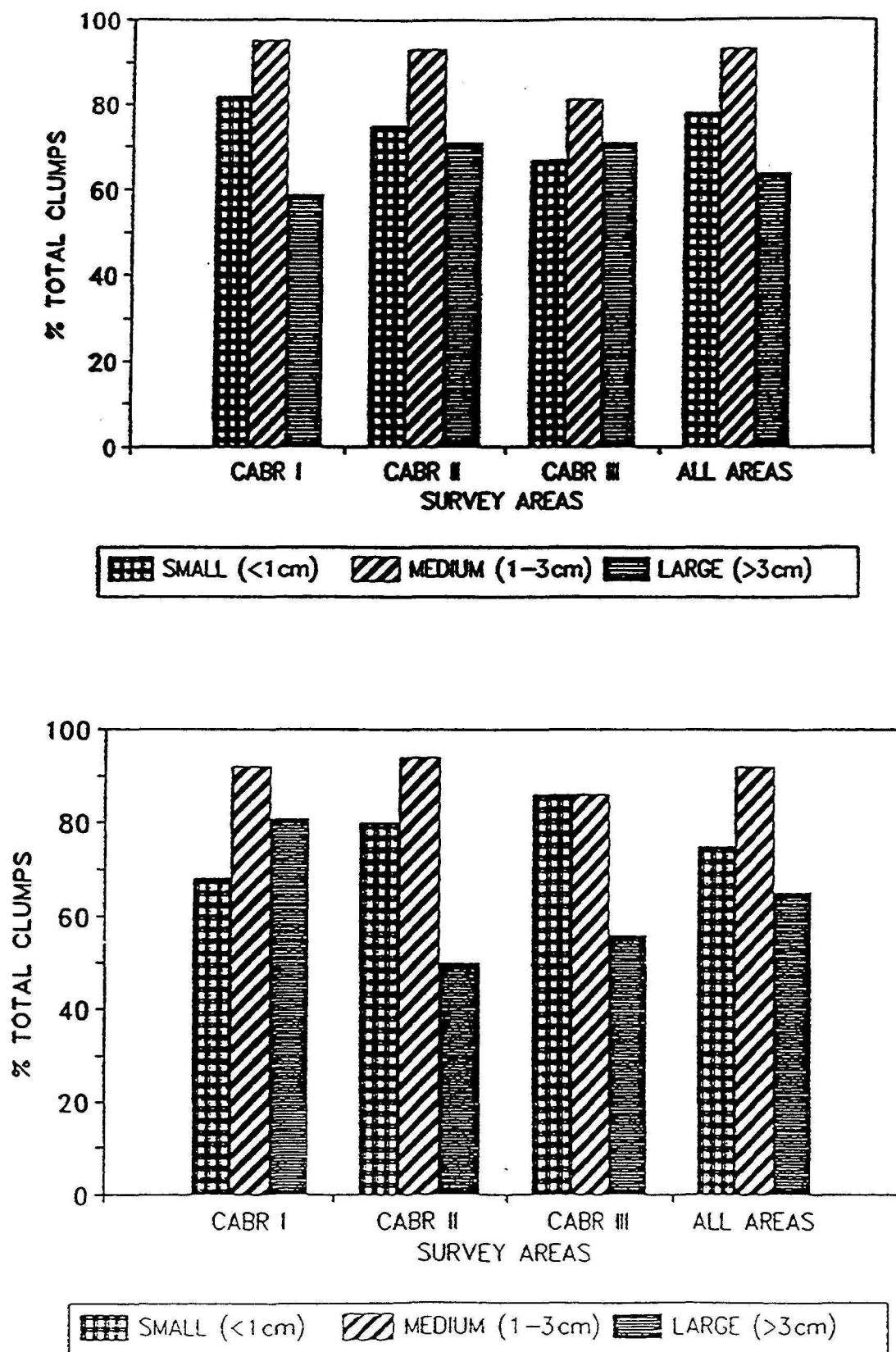
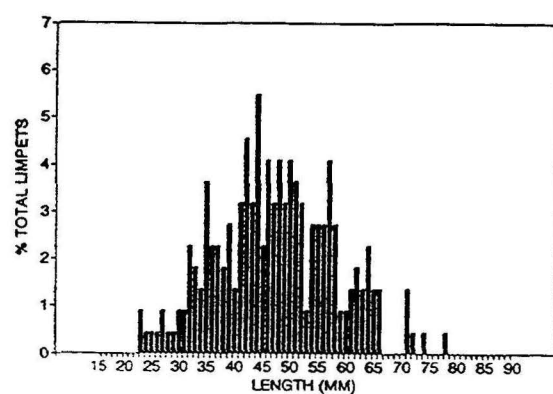
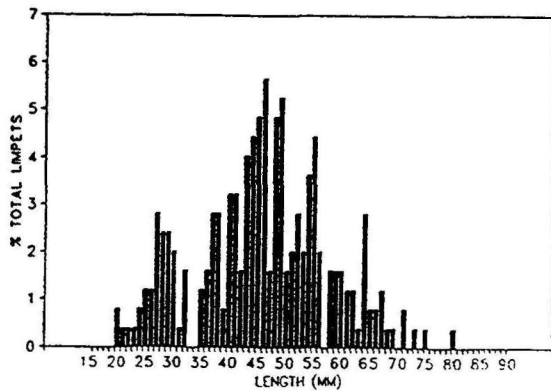
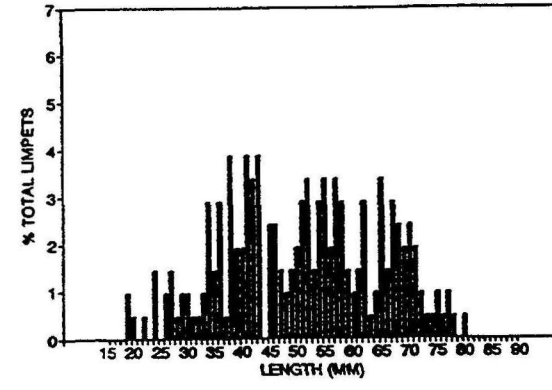
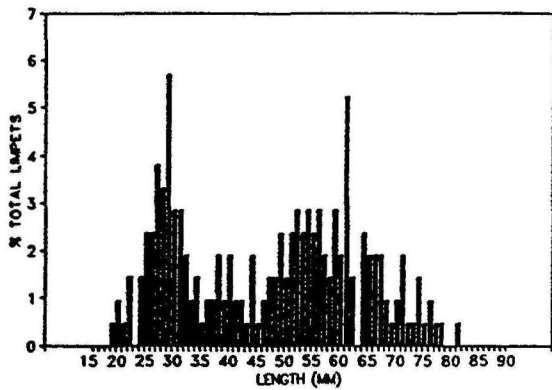
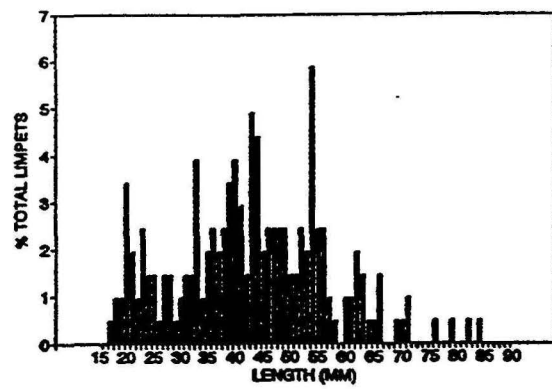
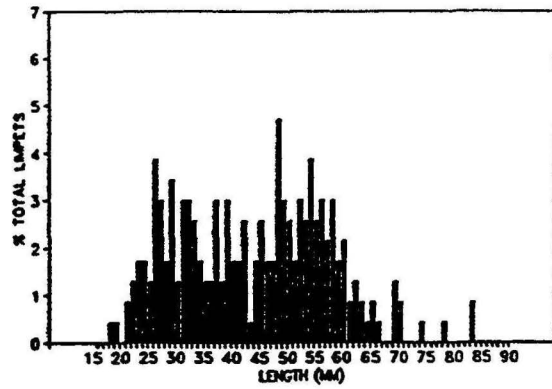


Figure 4. Size frequency distributions for owl limpets, *Lottia gigantea*, in Cabrillo National Monument, California, 1991.

SPRING

FALL



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Table 1. Sampling techniques and index taxa used to monitor intertidal resources in Cabrillo National Monument, California.

Line-intercept Transects (18, 10 m-long):

Boa Kelp, *Egregia menziesii*
Sargassum Weed, *Sargassum muticum*
Red Algal Turf, *Corallina* spp. et al.
Surf Grass, *Phyllospadix* spp.
Aggregating Anemone, *Anthopleura elegantissima*
Other Biota
Tar
Bare Substrate

Band Transects (9, 1 X 10 m):

Goose Barnacle, *Pollicipes polymerus*

Photoplots (45, 50 X 75 cm):

Rockweed, *Pelvetia fastigiata*
California Mussel, *Mytilus californianus*
Pink Thatched Barnacle, *Tetraclita rubescens*
Acorn Barnacle, *Chthamalus* spp.
Other Biota
Tar
Bare Substrate

Circular Plots (18, 1.0 m radius)

Owl Limpet, *Lottia gigantea*

Timed Search (90 person-minutes)

Black Abalone, *Haliotis cracherodi*
Ochre Sea Star, *Pisaster ochraceus*

Daily Census (when low tide < +15cm MSL between 0900-1600 hrs):

Visitors
Wading Birds
Shore Birds
Gulls

Table 2. Participants in Cabrillo National Monument intertidal monitoring zone in 1991.

Loana Adessi	SDSU
Marrissa Aguirre	SDSU
Ed Brown	CABR
Dan Cline	GCC
Gary E. Davis	UCD
Dorothy A. Davis	VIP
Ned Dukes	GCC
John M. Engle	TATMAN
Walt Gabler	CABR
Bob Gladden	VIP
Constance Grammlich	SDSU
Tom Gray	GCC
Melencio Guerero	GCC
Michael Hennick	VIP
Dan Ituarte	SDC
Lori Jackintell	SDSU
Fred Josetasky	GCC
Jeff Kepper	SDSU
Fred Kruse	GCC
Steve Lagos	SDC
Martin M. Lane	CABR
Roni Lloyd	GCC
Mark Long	GCC
Jason Miller	SDSU
Cindy Muehleman	GCC
Dot Norris	SDC
Elizabeth Osaska	GCC
David Quinn	CABR
Laura Rice	SDSU
Seth Seavey	GCC
Tracy Smith	CABR
Chris Stevens	GCC
Meleea VanPatten	GCC
Ron Velarde	SDC
Gina Velasu	GCC
James Wallace	GCC
Marybeth White	CABR
Joe Wilson	VIP
Dave Young	GCC
Shala Youngerman	GCC

CABR - Cabrillo National Monument Staff
GCC - Grossmont Community College
SDC - City of San Diego
SDSU - San Diego State University
TATEMAN - Tatman Foundation
UCD - University of Calif. Davis/National Park Service
VIP - Volunteer in Park

Table 3. Summary of public use and sea bird surveys in Cabrillo National Monument intertidal zone in 1991.

DATE	PEOPLE				BIRDS			
	AREA I	AREA II	AREA III	TOTAL	AREA I	AREA II	AREA III	TOTAL
JAN 1	23	150	73	246	35	8	64	107
JAN 9	3	0	0	3	15	20	27	62
JAN 10	18	10	2	30	10	7	47	64
JAN 11	0	24	4	28	9	23	167	199
JAN 12	93	30	11	134	6	6	38	50
JAN 13	151	23	16	190	0	11	33	44
JAN 14	8	41	7	56	34	27	191	252
JAN 15	10	32	3	45	15	34	145	194
JAN 16	18	5	0	23	11	7	42	60
JAN 17	35	0	1	36	12	24	537	573
JAN 25	0	6	7	13	6	2	199	207
JAN 26	114	17	10	141	1	0	224	225
JAN 27	125	7	14	146	0	4	244	248
JAN 28	12	25	2	39	13	33	108	154
JAN 29	25	8	17	50	6	15	25	46
JAN 30	13	2	4	19	5	11	24	40
JAN 31	35	4	4	43	5	10	161	176
FEB 7	11	0	1	12	6	13	35	54
FEB 8	43	2	0	45	20	22	243	285
FEB 9	99	15	6	120	13	13	235	261
FEB 10	98	33	8	139	0	15	29	44
FEB 11	90	12	4	106	25	50	156	231
FEB 13	40	2	0	42	3	19	28	50
FEB 21	22	1	1	24	8	3	85	96
FEB 22	8	0	0	8	12	21	29	62
FEB 24	48	97	80	225	6	42	170	218
MAR 2	59	0	0	59	9	7	13	29
MAR 9	67	5	6	78	3	1	65	69
MAR 10	53	5	1	59	6	40	66	112
MAR 16	82	20	7	109	0	7	35	42
MAR 17	75	23	10	108	4	2	55	61
MAR 23	22	0	0	22	10	22	42	74
MAR 24	74	30	18	122	9	2	95	106
MAR 28	78	6	15	99	7	0	47	54
MAR 31	81	8	1	90	3	10	89	102
APR 8	21	7	0	28	0	5	25	30
APR 10	27	0	0	27	2	8	62	72
APR 14	98	16	2	116	4	14	204	222
APR 21	51	20	30	101	3	4	51	58
SEP 2	60	11	3	74	3	79	14	96
OCT 20	75	6	0	81	6	33	19	58
NOV 3	80	10	8	98	5	51	7	63
NOV 4	22	18	16	56	4	8	54	66
NOV 5	26	32	2	60	4	35	238	277
NOV 7	35	2	6	43	21	13	137	171
TOTAL	2228	765	400	3393	379	781	4604	5768
N=45/ $\bar{x}$	50	17	9	75	8	17	102	128

Weekends (friday-saturday-sunday) n=23 $\bar{x}$ =107 s=61

Weekdays (monday-thursday) n=21 $\bar{x}$ =44 s=26

Table 4A. Cover recorded in 50 X 75 cm photogrammetric plots during Spring 1991.

CARR AREA I	BARNACLES (% COVER)						ROCKWEED (% COVER)						MUSSELS (% COVER)					
PHOTOPLOT #	<u>286</u>	<u>292</u>	<u>293</u>	<u>294</u>	<u>299</u>	<u>AVG</u>	<u>287</u>	<u>288</u>	<u>290</u>	<u>291</u>	<u>295</u>	<u>AVG</u>	<u>285</u>	<u>289</u>	<u>296</u>	<u>297</u>	<u>298</u>	<u>AVG</u>
# POINTS SCORED	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100
ACORN BARNACLE	33	4	0	14	13	13	0	0	0	0	0	0	0	0	3	0	0	1
THATCHED BARNACLES	23	26	10	23	18	20	0	0	0	0	0	0	1	9	0	0	0	2
TURFWEED	0	0	3	0	0	1	0	3	0	3	1	1	8	4	2	8	4	5
ROCKWEED	0	0	0	0	0	0	29	42	56	79	80	57	0	0	0	0	0	0
CALIFORNIA MUSSEL	0	0	0	0	0	0	0	0	0	0	0	0	7	2	11	5	6	6
OTHER PLANTS	0	13	1	42	0	11	22	42	18	12	14	22	17	51	9	24	56	31
OTHER ANIMALS	10	14	13	9	3	10	0	0	1	2	0	1	17	1	26	15	14	15
BARE SUBSTRATE	34	43	73	12	66	46	49	13	25	4	5	19	50	33	49	48	20	40

CARR AREA II	BARNACLES (% COVER)						ROCKWEED (% COVER)						MUSSELS (% COVER)					
PHOTOPLOT #	<u>247</u>	<u>248</u>	<u>256</u>	<u>259</u>	<u>260</u>	<u>AVG</u>	<u>249</u>	<u>251</u>	<u>252</u>	<u>258</u>	<u>265</u>	<u>AVG</u>	<u>245</u>	<u>246</u>	<u>253</u>	<u>254</u>	<u>255</u>	<u>AVG</u>
# POINTS SCORED	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100
ACORN BARNACLE	0	43	8	66	23	28	7	0	0	0	2	2	1	7	0	0	0	2
THATCHED BARNACLES	10	5	41	19	54	26	0	0	0	0	0	0	0	0	0	4	0	1
TURFWEED	0	0	0	0	0	0	0	0	0	0	0	0	0	3	37	0	10	10
ROCKWEED	0	5	0	0	0	1	66	62	71	75	68	68	0	0	0	0	0	0
CALIFORNIA MUSSEL	0	0	6	0	0	1	0	0	0	0	0	0	41	43	0	0	18	20
OTHER PLANTS	10	0	13	0	1	5	10	26	24	14	19	19	18	10	43	35	40	29
OTHER ANIMALS	2	0	4	3	1	2	0	0	0	0	1	0	1	5	4	10	2	4
BARE SUBSTRATE	78	47	28	12	21	37	17	12	5	11	10	11	39	32	16	51	30	34

CARR AREA III	BARNACLES (% COVER)						ROCKWEED (% COVER)						MUSSELS (% COVER)					
PHOTOPLOT #	<u>3</u>	<u>16</u>	<u>20</u>	<u>29</u>	<u>30</u>	<u>AVG</u>	<u>9</u>	<u>10</u>	<u>25</u>	<u>27</u>	<u>28</u>	<u>AVG</u>	<u>12</u>	<u>14</u>	<u>14</u>	<u>17</u>	<u>24</u>	<u>AVG</u>
# POINTS SCORED	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100
ACORN BARNACLE	13	9	9	33	47	22	12	3	6	9	1	6	4	2	9	9	4	6
THATCHED BARNACLES	38	33	11	25	22	26	3	2	0	0	0	1	0	4	13	0	0	3
TURFWEED	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
ROCKWEED	0	0	0	4	0	1	56	60	62	72	74	65	0	0	0	0	0	0
CALIFORNIA MUSSEL	0	0	0	0	0	0	0	0	0	0	0	0	37	24	27	33	20	28
OTHER PLANTS	13	10	1	0	6	6	5	25	28	1	21	16	7	10	1	2	13	7
OTHER ANIMALS	5	15	0	0	0	4	5	4	1	6	2	4	8	7	7	9	6	7
BARE SUBSTRATE	31	33	79	38	25	41	19	6	3	12	2	8	44	53	43	47	57	49

Table 4B. Cover recorded in 50 X 75 cm photogrammetric plots during Fall 1991.

CABR AREA I							BARNACLES (% COVER)						ROCKWEED (% COVER)						MUSSELS (% COVER)					
PHOTOPLOT #	286	292	293	294	299	AVG	287	288	290	291	295	AVG	285	289	296	297	298	AVG						
# POINTS SCORED	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100						
ACORN BARNACLE	29	0	0	29	15	0	0	0	0	0	0	0	0	0	0	0	0	0						
THATCHED BARNACLE	16	17	7	16	10	13	0	0	0	0	0	0	0	3	0	1	0	1						
TURFWEED	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0						
ROCKWEED	0	0	0	0	0	0	78	58	84	73	93	77	0	0	0	0	0	0						
CALIFORNIA MUSSEL	1	0	0	3	0	1	0	0	0	0	0	0	9	0	15	13	7	9						
OTHER PLANTS	3	40	18	63	0	25	5	33	3	27	7	15	36	68	19	35	39	39						
OTHER ANIMALS	13	9	11	15	3	10	0	0	0	0	0	0	14	3	20	16	15	14						
BARE SUBSTRATE	38	34	64	3	58	39	17	9	13	0	0	8	41	26	46	35	39	37						

CABR AREA II							BARNACLES (% COVER)						ROCKWEED (% COVER)						MUSSELS (% COVER)					
PHOTOPLOT #	247	248	256	259	260	AVG	249	251	252	258	265	AVG	245	246	253	254	255	AVG						
# POINTS SCORED	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100						
ACORN BARNACLE	4	45	14	30	21	23	0	0	0	3	0	1	0	0	0	0	4	1						
THATCHED BARNACLE	8	7	41	18	31	21	0	0	0	0	0	0	0	0	6	0	0	1						
TURFWEED	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0						
ROCKWEED	0	6	0	0	0	1	90	47	83	82	72	75	0	0	0	0	0	0						
CALIFORNIA MUSSEL	0	0	7	0	0	1	0	0	0	0	0	0	36	36	0	15	5	18						
OTHER PLANTS	68	12	8	18	27	27	5	53	17	8	11	19	54	37	47	70	53	52						
OTHER ANIMALS	0	2	21	28	4	11	0	0	0	0	0	0	2	4	5	3	2	3						
BARE SUBSTRATE	20	28	9	6	17	16	5	0	0	7	17	6	8	23	42	12	36	24						

CABR AREA III							BARNACLES (% COVER)						ROCKWEED (% COVER)						MUSSELS (% COVER)					
PHOTOPLOT #	3	16	20	29	30	AVG	9	10	25	27	28	AVG	12	14	15	17	24	AVG						
# POINTS SCORED	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100						
ACORN BARNACLE	25	53	32	52	48	42	3	0	0	3	0	1	15	10	34	13	15	17						
THATCHED BARNACLE	37	19	10	21	31	24	1	0	0	0	0	0	0	2	14	1	2	4						
TURFWEED	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0						
ROCKWEED	0	0	0	11	2	3	77	89	99	78	51	79	0	0	0	0	0	0						
CALIFORNIA MUSSEL	0	0	0	0	0	0	0	0	0	0	0	0	20	28	19	37	22	25						
OTHER PLANTS	8	12	4	2	1	5	2	5	1	2	32	8	13	3	5	3	15	8						
OTHER ANIMALS	9	10	5	5	12	8	8	6	0	11	15	8	8	10	4	3	1	5						
BARE SUBSTRATE	21	6	49	9	6	18	9	0	0	6	2	3	44	47	24	43	45	41						

Table 5A. Abundance (cm²) and distribution of goose barnacles, Pollicipes polymerus, in 1 x 10 m band transects during Spring 1991.

CLUMP NUM	CABR AREA I			CABR AREA II			CABR AREA III		
	276	278	281	273	274	275	22	23	269
1	3	113	39	13	3	20	113	225	1810
2	7	39	20	13	50	3	105	133	18
3	1	3	7	1	1	72	28	50	12
4	7	28	70	1	64	3	28	296	255
5	3	50	79	1	135	13	1	52	28
6	3	160	20	1	64	39	7	110	136
7	3	201	7	3	13	154	7	270	45
8	3	20	3	1	154	3	36	154	510
9	95	20	136	3	7	3	132	140	14
10	3	227	117	3	11	3	1	198	45
11	1	3	10	1	13	13	408	285	7
12	120	39	20	1	39	227	7	35	22
13	177	13	7	1	36	1	154	1	27
14	3	7	7	1	13	1	39	3	52
15	7	7	64	1	133	3	64	10	6
16	28	1	64	1	7	7	165	12	297
17	135	3	227	1	908	3	64	2	228
18	70	7	13	2	20	20	45	1	234
19	286	1	314	1	154	209	154		540
20	20	13	13	1	80	198	120		314
21	84	20	7	1	3	55	14		
22	95	3	3	64	1	79	715		
23	198	13	79	3	3	8	7		
24	13	55	39	3	50	10	13		
25	522	20	44	3	20	3	28		
26	39	3	28	28	1	13	1		
27	1	13	20	1	3	3	3		
28	3	20	420	180	3	8	7		
29	79	1	3	1	3	72	3		
30	252	7	3	1	3	20	3		
31	3	7	7	1	7	3	39		
32	98	13	1	1	7	1	28		
33	247	39	1	1	1	39	1		
34	113	28	3	3	1	20	1		
35	50	7	7	1	3	13	1		
36	3	24	7	408	231	20	3		
37	660	21	3	1	3	3	7		
38	64	20	13	3	1	28	7		
39	13	56	30	13	79	1	3		
40	1	3	13	95	84	3			
41	13	3	3	7	7				
42	1	50	1	1	374				
43	1	50	1	3	79				
44	3	210	10	3	104				
45	20	1	13	13	28				
46	13	3	20	1	79				

Table 5A (con't). Abundance (cm²) and distribution of goose barnacles, Pollicipes polymerus, in 1 x 10 m band transects during Spring 1991.

CLUMP	CABR AREA I			AREA II		CLUMP	CABR AREA I			AREA II	
NUM	276	278	281	273	275	NUM	276	278	281	273	275
47	3	3	20	147	20	47	3	3	20	147	20
48	113	1	13	3	79	48	113	1	13	3	79
49	133	1	1	48	28	49	133	1	1	48	28
50	28	1	13	79	91	50	28	1	13	79	91
51	204	79	20	13	50	51	204	79	20	13	50
52	64	39	3	20	20	52	64	39	3	20	20
53	35	64	7	13	1	53	35	64	7	13	1
54	133	3	13	36		54	133	3	13	36	
55	79	3	1	20		55	79	3	1	20	
56	39	13	3	3		56	39	13	3	3	
57	13	50	39	1		57	13	50	39	1	
58	13	50	79	39		58	13	50	79	39	
59	79	39	13	50		59	79	39	13	50	
60	3	28	3	20		60	3	28	3	20	
61	28	20	48	112		61	28	20	48	112	
62	240	3		1		62	240	3		1	
63	154	64		1		63	154	64		1	
64	13	3		1		64	13	3		1	
65	7	64		1		65	7	64		1	
66	7	20		1		66	7	20		1	
67	3	176		39		67	3	176		39	
68	13	79		3		68	13	79		3	
69	7	452		13		69	7	452		13	
70	79	7		7		70	79	7		7	
71	39	105		14		71	39	105		14	
72	28	50		7		72	28	50		7	
73	66	64		12		73	66	64		12	
74	64	95		3		74	64	95		3	
75	330	1		1		75	330	1		1	
76	50	4		13		76	50	4		13	
77	201	20		1		77	201	20		1	
78	64	50		13		78	64	50		13	
79	314	3		13		79	314	3		13	
80	227	13		3		80	227	13		3	
81		64		13		81		64		13	
82		50		39		82		50		39	
83		50		3		83		50		3	
84		79		13		84		79		13	
85		28		20		85		28		20	
86		161		28		86		161		28	
87		1		3		87		1		3	
88		105		1		88		105		1	
89		20		1		89		20		1	
90		136		18		90		136		18	
91		28		187		91		28		187	
92		13		198		92		13		198	

Table 5A (con't). Abundance (cm²) and distribution of goose barnacles, Pollicipes polymerus, in 1 x 10 m band transects during Spring 1991.

CLUMP	<u>CABR AREA I</u>			<u>CABR AREA II</u>			<u>CABR AREA III</u>		
NUM	<u>276</u>	<u>278</u>	<u>281</u>	<u>273</u>	<u>274</u>	<u>275</u>	<u>22</u>	<u>23</u>	<u>269</u>
139				3.1					
140				12.6					
141				39					

CLUMP	<u>CABR AREA I</u>			<u>CABR AREA II</u>			<u>CABR AREA III</u>		
NUM	<u>276</u>	<u>278</u>	<u>281</u>	<u>273</u>	<u>274</u>	<u>275</u>	<u>22</u>	<u>23</u>	<u>269</u>
SUM	6430	5190	2283	2677	3367	1393	2561	1977	4600
NUM	80	110	61	141	53	40	39	18	20
MIN	1	1	1	1	1	1	1	1	6
MAX	660	452	420	408	908	227	715	296	1810
AVG	80	47	37	19	64	35	66	110	230
SD	117	70	73	47	136	59	132	107	407

Table 5B. Abundance (cm²) and distribution of goose barnacles, Pollicipes polymerus, in 1 x 10 m transects during Fall 1991.

CLUMP NUM	CABR AREA I			CABR AREA II			CABR AREA III		
	<u>276</u>	<u>278</u>	<u>281</u>	<u>273</u>	<u>274</u>	<u>275</u>	<u>22</u>	<u>23</u>	<u>269</u>
1	4	143	64	3	7	50	79	243	1590
2	15	3	13	7	130	3	208	375	20
3	1	144	7	7	7	10	270	50	13
4	79	39	13	6	15	6	27	225	255
5	2	64	78	48	60	28	177	360	13
6	7	20	7	3	13	28	150	161	98
7	1	227	79	3	20	7	28	39	48
8	79	204	28	1	7	201	95	4	3
9	1	13	13	3	7	304	7	1	312
10	2	13	7	2	24	3	180	3	18
11	2	40	170	1	28	3	32	7	42
12	2	3	3	319	108	3	70	3	14
13	38	7	12	3	330	3	91	28	192
14	7	20	113	3	7	228	120		360
15	201	3	13	13	3	45	18		168
16	96	13	3	3	28	50	675		800
17	208	4	160	7	7	3	3		
18	120	32	20	108	7	50	13		
19	6	20	39	8	153	160	13		
20	126	13	79	3	14	7	1		
21	735	7	238	1	8	44	1		
22	6	39	12	2	20	7	1		
23	2	13	323	4	50	3	1		
24	153	30	7	3	1	15	1		
25	70	20	95	1	39	13	9		
26	2	13	39	1	57	1	1		
27	525	13	13	51	20	98	1		
28	95	18	72	3	578	3	20		
29	66	6	10	7	95	39	3		
30	595	4	462	36	3	35	1		
31	2	3	28	18	36	1	8		
32	3	3	40	28	3	28	1		
33	600	13	3	40	24	21	1		
34	15	13	8	24	227	4	39		
35	50	64	3	18	13		4		
36	255	48	3	18	99				
37	35	3	3	40	170				
38	252	3	3	12	3				
39	45	79	3	13	13				
40	12	3	20	55	66				
41	12	4	28	24	14				
42	6	7	50	24					
43	4	3	3	7					
44	1	40	20	16					
45	576	77	6	10					

Table 5B (con't). Abundance (cm²) and distribution of goose barnacles, Pollicipes polymerus, in 1 x 10 m transects during Fall 1991.

CLUMP	CABR AREA I			AREA II
NUM	<u>276</u>	<u>278</u>	<u>281</u>	<u>273</u>
46	294	1	3	8
47	4	1	50	3
48	2	3	18	8
49	1	150	68	3
50	1	3	3	3
51	12	1	13	8
52	8	133	3	8
53	121	24	3	171
54	10	128		3
55	2	300		3
56	24	50		1
57	55	64		4
58	500	20		18
59	100	60		150
60	40	3		10
61	133	13		1
62	60	50		7
63	28	28		28
64	63	28		32
65	20	50		6
66	12	113		3
67	4	1		10
68	48	108		20
69	12	126		4
70	220	3		3
71	54	7		9
72	6	119		20
73	8	84		20
74	30	90		20
75	2	13		20
76	12	13		5
77		13		13
78		600		113
79		255		3
80		90		54
81		7		3
82		24		13
83		105		3
84		40		3
85				4
86				12
87				52
88				3
89				24
90				24
91				11

Table 5B (con't). Abundance (cm²) and distribution of goose barnacles, Pollicipes polymerus, in 1 x 10 m transects during Fall 1991.

CLUMP	<u>CABR AREA I</u>			<u>CABR AREA II</u>			<u>CABR AREA III</u>		
NUM	276	278	281	273	274	275	22	23	269
92				6					
93				15					
94				24					
95				13					

CLUMP	<u>CABR AREA I</u>			<u>CABR AREA II</u>			<u>CABR AREA III</u>		
NUM	<u>276</u>	<u>278</u>	<u>281</u>	<u>273</u>	<u>274</u>	<u>275</u>	<u>22</u>	<u>23</u>	<u>269</u>
SUM	7000	4464	2571	2009	2513	1506	2345	1499	3945
NUM	76	84	53	95	41	34	35	13	16
MIN	1	1	3	1	1	1	1	1	3
MAX	735	600	462	319	578	304	675	375	1590
AVG	92	53	49	21	61	44	67	115	247
SD	162	86	85	42	107	72	127	141	414

Table 6. Size distribution within clumps of goose barnacles, Pollicipes polymerus, during 1991.

TRANSECT		SMALL (<1cm)		MEDIUM (1-3cm)		LARGE (>3cm)		TOTAL
AREA	NUMBER	NUM	%	NUM	%	NUM	%	NUM
I	276	67	84	72	90	64	80	80
	278	91	83	97	88	84	76	110
	281	45	74	51	84	43	70	61
ALL		203	81	220	88	191	76	251
AREA	273	100	71	108	77	59	42	141
II	274	44	83	40	75	39	74	53
	275	30	75	31	78	30	75	40
ALL		174	74	179	76	128	55	234
AREA	22	24	62	32	82	28	72	39
III	23	12	67	16	89	16	89	18
	269	18	90	20	100	19	95	20
ALL		54	70	68	88	63	82	77
ALL AREAS		431	77	467	83	382	68	562
AREA	276	66	89	63	85	60	81	74
I	278	72	86	73	87	61	73	84
	281	43	81	46	87	37	70	53
ALL		181	86	182	86	158	75	211
AREA	273	84	88	68	72	23	24	95
II	274	30	73	34	83	30	73	41
	275	27	79	25	74	26	76	34
ALL		141	83	127	75	79	46	170
AREA	22	30	86	25	71	20	57	35
III	23	11	85	8	62	8	62	13
	269	11	69	14	88	15	94	16
ALL		52	81	47	73	43	67	64
ALL AREAS		374	84	356	80	280	63	445
		SPRING 91		FALL 91				
CABR I		81	88	76	86	86	75	
CABR II		74	76	55	83	75	46	
CABR III		70	88	77	81	73	67	
ALL AREAS		77	83	68	84	80	63	

Table 7A. Ground cover (percent) along 10 m-long line-transects in Spring 1991.

CABR AREA I			HIGH ZONE		MID ZONE		LOW ZONE			
TAXA/TRANSECT	210		237	AVG	211	238	AVG	212	236	AVG
FEATHER BOA KELP	0		0	0	2	0	1	13	16	14
SARGASSUM WEED	0		0	0	0	0	0	0	0	0
RED ALGAL TURF	81		94	88	12	39	26	51	80	66
SURF GRASS	17		0	8	82	58	70	12	4	8
AGGREGATING ANEMONE	0		4	2	0	0	0	0	0	0
OTHER BIOTA	0		0	0	1	0	0	24	0	12
BARE SUBSTRATE	2		3	2	4	2	3	0	0	0
CABR AREA II			HIGH ZONE		MID ZONE		LOW ZONE			
TAXA/TRANSECT	244		270	AVG	267	271	AVG	268	272	AVG
FEATHER BOA KELP	0		0	0	4	17	10	16	6	11
SARGASSUM WEED	0		1	0	1	11	6	0	0	0
RED ALGAL TURF	92		56	74	8	13	10	74	53	64
SURF GRASS	0		7	4	84	40	62	9	39	24
AGGREGATING ANEMONE	1		0	0	0	0	0	0	0	0
OTHER BIOTA	0		3	2	3	12	8	0	0	0
BARE SUBSTRATE	7		33	20	0	7	4	0	3	2
CABR AREA III			HIGH ZONE		MID ZONE		LOW ZONE			
TAXA/TRANSECT	1		8	AVG	5	7	AVG	2	4	AVG
FEATHER BOA KELP	0		0	0	6	5	6	22	21	22
SARGASSUM WEED	2		0	1	0	1	0	6	22	14
RED ALGAL TURF	79		95	87	13	20	16	43	22	32
SURF GRASS	6		0	3	69	46	58	12	2	7
AGGREGATING ANEMONE	2		3	2	0	0	0	0	0	0
OTHER BIOTA	0		0	0	0	1	0	2	8	5
BARE SUBSTRATE	11		2	6	12	27	20	16	26	21

Table 7B. Ground cover (percent) along 10 m-long line-intercept transects in Fall 1991.

CABR AREA I		HIGH ZONE			MID ZONE			LOW ZONE		
TAXA/TRANSECT	210	237	AVG	211	238	AVG	212	236	AVG	
FEATHER BOA KELP	3	0	1	17	2	10	64	43	54	
SARGASSUM WEED	0	0	0	0	0	0	3	0	2	
RED ALGAL TURF	69	97	83	3	30	17	4	38	21	
SURF GRASS	28	0	14	75	67	71	19	19	19	
AGGREGATING ANEMONE	0	2	1	0	0	0	0	0	0	
OTHER BIOTA	0	0	0	0	0	0	9	0	4	
BARE SUBSTRATE	0	1	1	4	1	3	1	0	1	
CABR AREA II		HIGH ZONE			MID ZONE			LOW ZONE		
TAXA/TRANSECT	244	270	AVG	267	271	AVG	268	272	AVG	
FEATHER BOA KELP	2	0	1	4	30	17	31	27	29	
SARGASSUM WEED	0	2	1	0	0	0	13	0	6	
RED ALGAL TURF	63	79	71	2	14	8	24	21	23	
SURF GRASS	0	16	8	94	47	70	25	52	38	
AGGREGATING ANEMONE	1	0	1	0	0	0	0	1	0	
OTHER BIOTA	0	0	0	0	9	5	7	0	4	
BARE SUBSTRATE	34	4	19	0	0	0	0	0	0	
CABR AREA III		HIGH ZONE			MID ZONE			LOW ZONE		
TAXA/TRANSECT	1	8	AVG	5	7	AVG	2	4	AVG	
FEATHER BOA KELP	0	0	0	7	0	4	23	28	25	
SARGASSUM WEED	0	0	0	0	6	3	1	7	4	
RED ALGAL TURF	86	71	79	18	15	16	47	41	44	
SURF GRASS	11	0	6	74	66	70	17	11	14	
AGGREGATING ANEMONE	2	2	2	0	0	0	0	1	0	
OTHER BIOTA	0	0	0	0	0	0	10	11	11	
BARE SUBSTRATE	0	27	14	1	13	7	2	2	2	

Table 8A. Abundance and size (mm) distribution of owl limpets, Lottia gigantea, in 1 m radius plots during Spring 1991.

PLOT NUM	CABR AREA I						CABR AREA II						CABR AREA III					
	282	283	284	277	270	280	239	240	241	242	243	266	11	18	19	21	26	13
1	49	61	52	20	40	46	58	48	59	42	52	46	50	55	72	41	57	50
2	69	50	63	30	44	45	43	55	67	29	24	55	39	43	42	61	54	54
3	36	66	23	45	35	44	50	39	65	45	67	57	40	44	62	56	64	50
4	76	60	25	41	49	49	34	40	75	55	43	34	33	57	58	48	36	36
5	33	48	38	36	39	49	55	65	68	38	66	40	44	39	45	56	58	40
6	71	25	36	41	47	65	41	41	64	62	66	38	56	46	35	46	61	56
7	66	42	33	38	48	43	54	35	27	41	65	36	51	35	32	50	52	52
8	79	55	44	44	53	40	43	58	43	27	42	57	38	51	58	57	57	78
9	82	55	32	41	43	43	51	59	70	66	52	34	34	46	35	57	55	46
10	32	34	54	33	40	46	33	73	55	43	57	36	59	25	50	53	62	51
11	54	60	56	39	25	54	54	65	43	46	51	54	35	51	65	52	54	35
12	61	58	57	20	43	54	38	77	76	67	69	36	50	36	74	57	71	32
13	84	51	44	20	54	50	52	50	70	27	50	62	33	28	65	57	60	46
14	64	46	27	18	45	47	30	61	57	55	45	47	32	33	55	48	54	42
15	19	63	52	33	56	46	38	39	70	61	58	62	44	47	51	49	56	45
16	41	56	52	23	21	44	51	54	67	42	65	43	47	36	61	60	51	42
17	71	53	36	43	31	54	50	70	60	43	45	24	45	54	33	58	64	26
18	37		35	43	28	39	51	38	52	61	47	56	27	41	63	50	30	52
19	55		26	46	37	43	30	42	58	49	62	51	44	44	62	57	65	42
20	54		35	42	40	56	35	19	64	63	71	24	47	41	64	44	63	34
21	22		54	24	51	39	45	22	72	47	46	49	53	35	43	56		41
22	38		24	43	55	63	54	52	69		69	33	36	38	37			37
23	33		54	38	33	57	46		69		52	38	45	31	62			
24	62		47	30	23	54	32		75		53	36	55	46	37			
25	44		40	27	54	33			71		58	54	52	32	64			
26	70		50	40	40	33			74		42	41	44	44	71			
27	20		52	34	44	28			77		70	65	41	39	66			
28	48		29	31	38	55			71		48	57	42	42	59			
29	47		21	32		41			72		67	68	31	34	66			
30	20		35			37			62		45	31	66	30	71			
31	49		23			44			78		37	65	50	24				
32	66		39			43			68		34	58	29	42				
33	28		43			67			57		46	39						
34			41			42			40		45	40						
35			62			71			46		54	47						
36			40			26			68		47	48						
37			22			20			28		49	47						
38			27						68		48	49						
39			17						41		48	41						
40			20						29		49	49						
41			24						38		55	44						
42			42						36		38	43						
43			21						80		46	32						
44			51						56		43	44						
45			23						26		42	37						
46			48						55		42	39						

Table 8A (con't). Abundance and size (mm) distribution of owl limpets, Lottia gigantea, in 1 m radius plots during Spring 1991.

PLOT NUM	AREA I	CABR AREA II		
	<u>284</u>	<u>241</u>	<u>243</u>	<u>266</u>
47	19	59	47	27
48	47	40	44	52
49	39	53	43	49
50	62	41	48	44
51	62	34	23	48
52	37	35	51	55
53	18	36	43	52
54	20	56	43	49
55	36	52	41	57
56	52	60		42
57	48	41		35
58	53	56		39
59	31	57		37
60	56	34		38
61	54	41		35
62	53	49		58
63	39	19		51
64	21	39		48
65	45	62		46
66		53		50
67		51		58
68		39		64
69		42		63
70		38		23
71				48

PLOT NUM	CABR AREA I						CABR AREA II						CABR AREA III					
	<u>282</u>	<u>283</u>	<u>284</u>	<u>277</u>	<u>270</u>	<u>280</u>	<u>239</u>	<u>240</u>	<u>241</u>	<u>242</u>	<u>243</u>	<u>266</u>	<u>11</u>	<u>18</u>	<u>19</u>	<u>21</u>	<u>26</u>	<u>13</u>
NUM	33	17	65	29	28	32	24	22	37	21	32	70	5	71	30	21	20	22
MIN (mm)	19	25	17	18	21	28	30	19	20	27	24	19	23	23	32	41	30	26
MAX (mm)	84	66	63	46	56	65	58	77	78	67	71	80	66	64	74	61	71	78
AVG (mm)	51	52	39	34	41	46	45	50	62	48	54	46	44	43	55	53	56	45
SD	19	11	13	9	10	8	9	15	15	12	12	13	8	9	13	5	9	11

Table 8B. Abundance and size (mm) distribution of owl limpets, *Lottia gigantea*, in 1 m radius plots during 1991.

PLOT NUM	CABR AREA I						CABR AREA II						CABR AREA III					
	282	283	284	277	279	280	239	240	241	242	243	266	11	18	19	21	26	13
1	69	57	50	42	53	48	38	67	74	31	29	30	49	44	67	53	64	39
2	58	54	62	25	58	53	39	50	72	31	32	51	52	48	69	59	63	51
3	65	50	42	24	40	49	56	28	67	61	39	54	45	27	68	52	65	32
4	26	32	49	21	25	46	51	66	65	30	30	40	37	42	62	37	54	56
5	74	44	55	37	53	42	25	31	56	62	52	29	45	35	28	46	28	46
6	60	51	52	31	53	39	27	29	73	44	61	55	46	37	71	49	64	41
7	56	52	56	35	47	54	55	52	35	70	51	46	49	27	58	53	54	49
8	33	59	35	61	35	58	29	59	61	31	47	42	48	51	55	59	64	44
9	53	57	62	42	29	26	44	34	65	49	27	50	54	44	47	55	45	28
10	70	54	22	41	33	51	53	49	48	57	31	20	36	54	42	56	59	44
11	56	30	58	40	49	36	54	27	57	52	61	26	53	45	67	49	59	27
12	83	51	32	39	26	34	26	71	41	29	52	19	35	38	26	50	55	52
13	33	37	58	27	49	29	27	78	53	55	64	52	43	42	27	55	55	64
14	54	37	45	37	52	40	40	71	71	37	66	21	38	28	49	48	61	44
15	78	63	66	23	23	41	56	64	75		27	43	62	41	62	56	71	46
16	22	52	57	28	52	19	44	61	64		45	55	45	40	54	58	50	48
17	38	41	26	39	28	44	38	30	59		29	24	46	36	73	27	52	47
18	27	54	48	18	52	37	54	25	69		55	28	45	25	67	29	60	46
19	69		39	41	29	59	44	36	61		58	26	22	43	64	43	54	52
20	59		46	27	50	60	22	54	66		38	28	37	38	66	46	61	24
21	83		26	43	53	63	20	49	65		40	47	26	44	32	49	60	40
22	55		31	32	27	33	22	61	33		53	52	47	41	65	40	60	28
23	56		37	36	25	29	50	46	64		48	32	58	25	61	41	30	29
24	70		45	46	48	26	29		66		59	58	51	24	54	48		45
25	55		51	37	54	48	24		74		29	61	54	43	44	55		31
26	48		60	24	31	32	25		68		59	60	52	44	38	66		40
27	45		47	39	27	30	51		62		58	32	48	48	30	64		58
28	64		44	26	55	49	22		53		24	64	41	50		55		55
29	62		48	34		47	61		28			61	32	48				80
30	55		31	21		45	47		76			28	47	46				43
31	32		32	22		56	56		70			30	41	45				75
32	34		39	38		57	29		71			26	44	51				
33	59		23	26		47	31		59			54	39	40				
34	56		42	48		40	48		76			81	49	37				
35	61		48	42		48			74			54	23	45				
36	55		45	32		29						77	20	49				
37	65		49	38		28						60	48	43				
38	29		48	27		27						27	64	29				
39	45		30	24		52						29	48	26				
40				50		31						49	45	52				
41				69		33						36	46	48				
42				57		56						26	55	55				
43				50		58						67	49	56				
44				29		28						34	40	49				
45				50		31						60	44	56				
46				26		48						40	51	45				

Table 8B (con't). Abundance and size (mm) distribution of owl limpets, Lottia gigantea, in 1 m radius plots during 1991.

PLOT NUM	<u>CABR AREA I</u>		<u>AREA II</u>	<u>AREA III</u>	
	<u>277</u>	<u>280</u>	<u>266</u>	<u>11</u>	<u>18</u>
47	23	39	68	41	29
48	34	54	67	46	20
49	60	49	61	54	30
50	54	60	57	44	21
51	46	44	59	36	40
52	54	58	29	46	55
53	31	36	29	38	46
54	33		60	43	36
55	24		62	43	50
56	29		56	38	43
57			49	48	40
58			38	41	37
59			32	37	46
60			28	35	45
61			57		53
62			27		46
63			56		29
64			25		32
65			42		38
66			53		30
67			33		53
68			41		43
69			34		60
70			28		29
71			30		25
72			65		30
73			51		49
74			27		49
75			37		27
76			25		42
77					28
78					27

PLOT NUM	<u>CABR AREA I</u>						<u>CABRE AREA II</u>						<u>CABR AREA III</u>					
	<u>282</u>	<u>283</u>	<u>284</u>	<u>277</u>	<u>279</u>	<u>280</u>	<u>239</u>	<u>240</u>	<u>241</u>	<u>242</u>	<u>243</u>	<u>266</u>	<u>11</u>	<u>18</u>	<u>19</u>	<u>21</u>	<u>26</u>	<u>13</u>
NUM	39	18	56	39	28	53	34	23	35	14	28	76	60	78	27	28	23	31
MIN (mm)	22	30	22	18	23	19	20	25	28	29	24	19	20	20	26	27	28	24
MAX (mm)	83	63	69	61	58	63	61	78	76	70	66	81	64	60	73	66	71	80
AVG (mm)	54	49	44	34	41	43	39	49	62	46	45	44	44	40	54	50	56	45
SD	16	10	12	9	12	11	13	17	12	14	13	15	9	10	15	9	10	13

Table 9. Summary of public use and condition of intertidal index taxa in Cabrillo National Monument, California in 1991.

	AREA I		AREA II		AREA III		All Areas	
	Spring	Fall	Spring	Fall	Spring	Fall	Spring	Fall
Owl Limpet (number)	39	34	35	34	41	36	38	35
<i>Lottia gigantea</i> (size-mm)	48	43	47	51	46	47	47	47
Goose Barnacle <i>Pollicipes polymerus</i>	5%	5%	2%	2%	3%	3%	3%	3%
Featherboa Kelp <i>Egregia menziesii</i>	14%	54%	11%	29%	22%	25%	16%	36%
Surf Grass <i>Phyllospadix</i> spp.	70%	71%	62%	70%	58%	70%	63%	70%
Red Algal Turf <i>Corallina</i> spp. et al.	88%	83%	74%	71%	87%	79%	83%	78%
Sargassum Weed <i>Sargassum muticum</i>	0	2%	0	6%	14%	4%	5%	4%
Aggregating Anemone <i>Anthopleura elegantissima</i>	2%	1%	0	1%	2%	2%	1%	1%
Bare Substratum (All Line Transects)	2%	2%	9%	6%	16%	8%	9%	5%
Bare Rock (All Photoplots)	35%	28%	27%	15%	33%	21%	32%	25%
California Mussel <i>Mytilus californianus</i>	6%	9%	20%	18%	28%	25%	18%	17%
Rockweed <i>Pelvetia fastigata</i>	57%	77%	68%	75%	65%	79%	63%	77%
Thatched Barnacle <i>Tetraclita rubescens</i>	20%	13%	26%	21%	26%	24%	24%	19%
Visitors (Index: mean/census)	50	50	18	13	9	6	77	69
Seabirds (Index: mean/census)	9	7	14	36	78	106	101	149

Table 10. Summary of public use and condition of intertidal index taxa in Cabrillo National Monument, California in 1990.

	AREA I		AREA II		AREA III		All Areas	
	Spring	Fall	Spring	Fall	Spring	Fall	Spring	Fall
Owl Limpet $\bar{x}$ #	34	40	27	34	39	42	33	38
<i>Lottia gigantea</i> $\bar{x}$ size	48	46	53	52	46	47	49	48
Goose Barnacle ^b <i>Pollicipes polymerus</i>	5%	5%	4%	3%	3%	7%	4%	5%
Featherboa Kelp ^b <i>Egregia menziesii</i>	44%	31%	55%	42%	54%	36%	51%	36%
Surf Grass ^b <i>Phyllospadix</i> spp.	53%	72%	40%	69%	60%	72%	51%	71%
Red Algal Turf ^b <i>Corallina</i> spp. et al.	87%	15%	73%	75%	90%	80%	83%	79%
Sargassum Weed ^b <i>Sargassum muticum</i>	0	0	6%	0	3%	2%	1%	<1%
Aggregating Anemone ^b <i>Anthopleura elegantissima</i>	2%	1%	1%	1%	2%	15%	25%	1%
Bare Substratum ^b (All Line Transects)	7%	6%	10%	8%	6%	9%	8%	8%
Bare Rock ^b (All Photoplots)	33%	30%	27%	18%	95%	25%	30%	24%
California Mussel ^b <i>Mytilus californianus</i>	16%	9%	55%	30%	47%	34%	39%	24%
Rockweed ^b <i>Pelvetia fastigata</i>	16%	95%	55%	05%	75%	34%	39%	24%
Thatched Barnacle ^b <i>Tetraclita rubescens</i>	20%	16%	30%	17%	22%	95%	24%	21%
Visitors ^a (Index: mean/census)	80	73	24	30	6	18	110	121
Seabirds ^a (Index: mean/census)	5	8	14	9	67	35	86	52

^a = mean number in fixed plots ^b = percent cover in fixed plots

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