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**ECOLOGICAL CONDITION AND PUBLIC USE OF THE
CABRILLO NATIONAL MONUMENT INTERTIDAL
ZONE IN 1990**

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Association

for

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ABSTRACT

The tide pools in Cabrillo NM are among the most pristine and accessible in San Diego county. Unfortunately, they are showing the adverse effects of thousands of people exploring, discovering, and enjoying their wonders. In 1990, to ensure continued public access and enjoyment of unimpaired tide pools, the National Park Service initiated an ecological restoration and monitoring program with support from the Cabrillo Historical Association. The initial phase of research will continue through 1995.

Marine biologists from the National Park Service established 90 long-term monitoring plots during February and November, 1990. They were assisted by 37 volunteers and members of the Cabrillo NM staff. The plots are arrayed along a gradient of public use on the western shore of Point Loma. These plots, with censuses of birds, abalone, sea stars, and visitors, will be used to assess the condition of plants and animals characteristic of the monument's intertidal zones relative to visitor activities.

Some aspects of the monument's intertidal zone appear to have deteriorated since it was last evaluated 13-14 years ago by Dr. Joy Zedler from San Diego State University. Unfortunately, without fixed plots from early surveys and a continuous record of resource conditions, it is virtually impossible to differentiate between normal year-to-year variations in populations and dangerous long-term trends caused by human activities. For example, the maximum number of people in the monument's intertidal zone at a single moment appears to have doubled from 160 in the mid-1970's to 325 in 1990. However, it is difficult to directly compare current resource conditions with those documented by Zedler in the mid-1970's, and virtually impossible to attribute the cause of change to any human activity or environmental conditions. Red algal turf, that covered 90-95% of the flat rock surfaces

in the 1970's, only occupied 80% of similar rocks in 1990. In 1977 experiments showed that 200-300 steps on turf reduced algal cover from 95% to 80%. But, without a series of simultaneous observations documenting the loss of algal cover and a corresponding increase in public use, it is not possible to say with certainty that increased trampling caused the apparent algal decline. Similarly, a decline in rock weed that covered 86% of the boulders in 1976, but only 62% in 1990, does not prove that rockweed is being damaged by public use. Trends can not be identified from just two observations, even if exactly the same plots were measured. On the other hand, California mussels have clearly declined, with no apparent recruitment for several years. The surviving large older individuals are rapidly disappearing. Black abalones and sea stars, once common in this area are now virtually absent. Public use also prevents most wading and shore birds from foraging in the intertidal zone during low tide.

The condition of monument tide pools is difficult to assess with only a single year's observation, but the low or declining abundances of ecologically important taxa such as abalones, mussels, sea stars, and shore birds is cause for serious concern. Now, with fixed plots and an established monitoring protocol, we have a tool for regularly measuring the health of the intertidal ecosystem and for facilitating the restoration efforts for these fascinating biological communities.

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INTRODUCTION

Intertidal resources in Cabrillo National Monument are dynamic. They change constantly in response to natural environmental conditions and to many human activities. Trampling, specimen collecting, general disturbance, and pollution all take their toll. 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 they show signs of serious impact from people exploring, discovering, and enjoying their wonders. The National Park Service is responsible for these natural resources, for providing public access to them, and for protecting them unimpaired for the enjoyment of future generations.

The 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 first 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 standardized 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

Although hundreds of intertidal species are commonly found in the monument, not all of them should be monitored. Information about the population dynamics of a representative group of taxa should provide an accurate index of resource conditions. For this study, those 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). These characteristic taxa may also serve as indicators of ecological conditions.

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 trampling can be expected to give way to bare rock. 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).

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.

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, *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).

There are two species of sargassum weed 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.

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, R. G. 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, *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, *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.

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 (Paine 1966). 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 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 long-lived species, goose barnacles live more than 20 years, and recovery from extensive collecting may be longer (Morris, Abbott, and Haderlie 1980).

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, black-bellied 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.

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 Use Areas

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

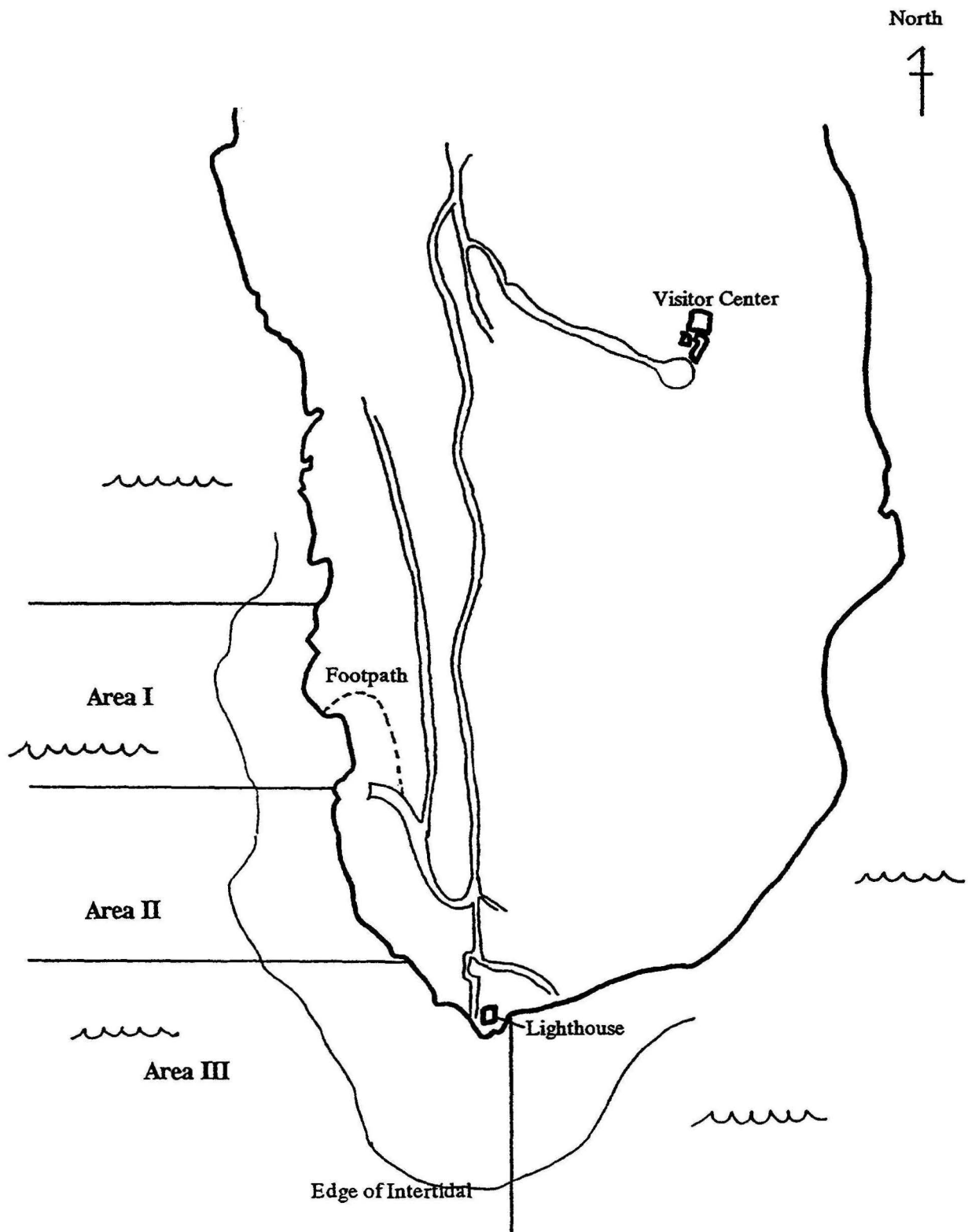


Figure 1. Public Access and Visitor Use Areas in Cabrillo National Monument, California.

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, page 5). 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.

Visitor Censuses

The numbers of people in each of these three areas were recorded daily, when possible, within 30 minutes of the low tide, when the low tide was less than 15 cm above mean sea level (MSL) during 1000 - 1600 hours (PST). About 120 days met these conditions in 1990; however, only a small portion of these days could be sampled this year. These counts will be 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 biologic 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.).

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. Timed searches (30 person-minutes) were conducted in each visitor use area for these two 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.

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 stereo

Table 1. Intertidal natural resources and monitoring techniques in Cabrillo National Monument, California.

Technique/Taxa	Dimensions	Number Per Area	Total Sample
Line Transect	10 m (1.0 cm)	6	18
Boa Kelp			
<i>Egregia menziesii</i>			
Sargassum Weed			
<i>Sargassum muticum</i>			
Red Algal Turf			
<i>Corallina</i> spp. et al.			
Surf Grass			
<i>Phyllospadix</i> spp.			
Aggregating Anemone			
<i>Anthopleura elegantissima</i>			
Other Biota			
Tar			
Bare Substrate			
Band Transect	2 X 10 m	3	9
Goose Barnacle			
<i>Pollicipes polymerus</i>			
Photoplot	50 X 75 cm	5	45
Rockweed			
<i>Pelvetia fastigiata</i>			
California Mussel			
<i>Mytilus californianus</i>			
Pink Thatched Barnacle			
<i>Tetraclita rubescens</i>			
Acorn Barnacle			
<i>Chthamalus</i> spp.			
Other Biota			
Tar			
Bare Substrate			
Circular Plot	1.0 m radius	6	18
Owl Limpet			
<i>Lottia gigantea</i>			
Timed Search	30 person-minutes	1	3
Black Abalone			
<i>Haliotis cracherodi</i>			
Ochre Starfish			
<i>Pisaster ochraceus</i>			
Daily Census (day time tide <0.5 ft)			
	Area-wide	120	360
Visitors			
Wading Birds			
Shore Birds			
Gulls			

mounted strobes and 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 the middle to lowtidal 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 distribution 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 gigantea* within 1.0 m of the bolts were recorded.

RESULTS

Sampling Efforts

A total of 90 fixed plots and transects were established during 4-7 FEB 90, 30 in each of the three public use areas (Fig. 1). Sketch maps were prepared to show locations of each plot and prominent physical features in each area. Distances and bearings among the plots were measured and used to adjust the sketch maps. Monitoring was initiated during 8-10 FEB 90, and the fall sample was taken during 28 NOV - 1 DEC 90. In addition to the authors, 37 people assisted in establishing plots and monitoring (Table 2). Weather and tide conditions during the sampling periods were excellent, with air temperatures of 17-19°C, light to moderate winds, and tides from +9 cm to -55 cm MSL. Daily observations are shown in Table 3, with the results of the visitor censuses.

Public Use and Bird Censuses

Only two censuses for people and birds were conducted during the first sampling period, but 16 were completed in the fall of 1990 (Table 3). The historical gradient of diminishing public use from Area I to Area III was clear (Fig. 2). The mean numbers of people in each Area during all 18 censuses were 73, 30, and 17 for Areas I, II, and III, respectively. Public use was substantially higher on weekends and holidays, often by an order of magnitude.

Wading and shore bird usage in the three Areas also showed a marked gradient, but opposite the gradient of public use (Table 4 & Fig. 2). The mean numbers of birds were 8, 10, and 38 for Areas I, II, and III, respectively. Gull numbers also showed a similar trend, with mean counts of 3, 6, and 65 for Areas I, II and III. Snowy egrets, marbled godwits, sanderlings, and black turnstones were the most common wading and shore birds, while western and California gulls were the most frequently seen gulls.

Timed Searches

Spring searches were conducted on 10 FEB 90, between 1330 and 1700 hours. Low tide was -30 cm MSL at 1556 PST. One green abalone, *Haliotis fulgens*, (148 mm) was found in Area I. One giant spined sea star, *Pisaster giganteus*, (45 mm) and three bat stars, *Patiria miniata*, (35-58 mm) were located in Area II. In Area III, 12 bat stars (28-61 mm) were discovered.

The fall searches were conducted on 1 DEC 90 from 1305 to 1530 hours, during which time the tide fell to -54 cm MSL at 1450 hours PST. One pink abalone (201 mm) and one giant spined sea star (50 mm) were discovered in Area I during 45 minutes of search. Six bat stars (10-63 mm) were located during 30 minutes in Area II, and 18 bat stars (7-23 mm) were found during 50 minutes in Area III.

Photogrammetric Plots

The abundance and distribution of acorn and thatched barnacles, rockweed, California mussels, and bare rock recorded in photo-plots are reported in Table 5. Acorn and thatched barnacles covered on average 22% to 42% of the highest photo-plots in the spring and slightly more (29% to 55%) in the fall. Rockweed did not exhibit much seasonal variation, occupying 59% to 84% of the mid-level photoplots. California mussels were rare in Area I (9% to 16% cover) and very patchy in Areas II and III, where they covered 30-55% of the lowest photo-plots. The abundance of California mussels declined in 14 of the 15 mussel plots between the spring and fall sampling periods, dropping overall from 39% to 24% in mean cover. Bare rock in all of the photo plots averaged 30% in the spring and 24% in the fall.

Table 2. Participants in Cabrillo National Monument Intertidal Monitoring Project, 1990.

PARTICIPANTS	SPRING	FALL
Loana Addressi, SDSU		X
Sonya Bednarski, CABR	X	
Bob Beyer, CABR		X
Ed Brown, CABR		X
Mike Caprio, GCC		X
David Claypool, GCC		X
Gary Davis, UCD	X	X
Claude Edwards, CABR	X	
John Engle, Tatman Foundation	X	X
Walt Gabler, CABR		X
Cquvator Gatson, CABR	X	
Robert Gladden, VIP	X	X
Scott Gooding, VIP	X	
Constance Gramlich, SDSU		X
Charles Hammer, GCC		X
Aidé Hillman, CABR	X	X
Lori Jackintell, VIP	X	
Barry Joyce, CABR	X	
Dave Kushner, CHIS	X	X
Martin Lane, VIP		X
Michael Lee, CABR	X	
Sandy Miller, GCC		X
Debra Mulvaney, GCC		X
Peo Nilsson, VIP	X	
Howard Overton, CABR	X	
Marion Pandes, GCC		X
Julie Presnell, GCC		X
Bob Randall, CABR		X
Kylene Rawley, GCC		X
Daniel Richards, CHIS	X	
Edmond Roberts, CABR	X	
David Quinn, CABR	X	
Sam Santana, CABR		X
Tracey Smith, CABR	X	
Timothy Stebbins, VIP	X	
Roberta Van Gundy, VIP	X	X
Brian Vignati, CABR		X
Samantha Weber, CABR		X
Bill Zepf, VIP	X	

CABR = Cabrillo NM Staff
 CHIS = Channel Islands NP Staff
 GCC = Grossmont Community College
 SDSU = San Diego State University
 UCD = University California, Davis/National Park Service
 VIP = Volunteer In Park

Table 3. Summary of Public Use Surveys of Cabrillo National Monument Intertidal Zone Within 30 Minutes of Low Tide in 1990.

SPRING 1990 DATE	DAY OF WEEK	LOW TIDE TIME	TIDE HT (cm)	CLOUD COVER (%)	AIR TEMP (C)	WIND COND (BS)^	WAVE HT (m)	PEOPLE COUNTS							
								AREA I		AREA II		AREA III		ALL	
								#	%	#	%	#	%	#	
02/08	TH	1459	-46	10	17	3 W	1	53	73	20	27	0	0	73	
02/10	SA	1558	-30	0	18	3 NW	2	107	72	29	20	12	8	148	

FALL 1990 DATE	DAY OF WEEK	LOW TIDE TIME	TIDE HT (cm)	CLOUD COVER (%)	AIR TEMP (C)	WIND COND (BS)^	WAVE HT (m)	PEOPLE COUNTS							
								AREA I		AREA II		AREA III		ALL	
								#	%	#	%	#	%	#	
11/28	WE	1230	+9	0	21	2 NW	1	4	40	6	60	0	0	0	
11/29	TH	1315	-18	5	19	2 N	<1	9	53	4	24	4	24	17	
11/30	FR	1403	-40	0	21	2 W	<1	36	42	33	39	16	19	85	
12/01	SA	1449	-55	10	22	3 N	1	172	58	92	31	34	11	298	
12/02	SU	1537	-61	0	—	0 NW	1	250	69	75	21	39	11	364	
12/11	TU	1122	+55	30	—	2 W	1	27	30	56	62	8	9	91	
12/12	WE	1307	+6	30	—	0 W	1	16	89	2	11	0	0	18	
12/13	TH	1345	-6	50	—	2 NW	1	5	71	0	0	2	29	7	
12/14	FR	1421	-15	30	12	2 W	1	17	89	2	11	0	0	19	
12/15	SA	1453	-21	50	15	1 W	1	98	100	0	0	0	0	98	
12/17	MO	1556	-24	—	—	—	1	2	50	1	25	1	25	4	
12/18	TU	1630	-21	1	—	1 W	1	1	33	0	0	2	67	3	
12/27	TH	1221	-3	90	16	1 E	1	41	93	3	7	0	0	44	
12/28	FR	1313	-27	20	15	2 W	>1	159	85	14	8	13	7	186	
12/30	SU	1446	-61	0	18	1 W	1	297	79	0	0	81	21	378	
12/31	MO	1529	-67	100	23	- NW	1	28	9	200	63	87	28	315	

= BEAUFORT SCALE

Summary

		PEOPLE COUNTS							
		AREA I		AREA II		AREA III		ALL	
		#	%	#	%	#	%	#	
Spring, 1990	MIN	53	72	20	20	0	0	73	
	MAX	107	73	29	27	12	8	148	
	MEAN	80	72	24	22	6	5	110	
	STD	38		6		8		53	
Fall, 1990	MIN	1	9	0	0	0	0	3	
	MAX	297	100	200	63	87	67	378	
	MEAN	73	60	30	25	18	15	121	
	STD	95		54		28		139	

Figure 2A.

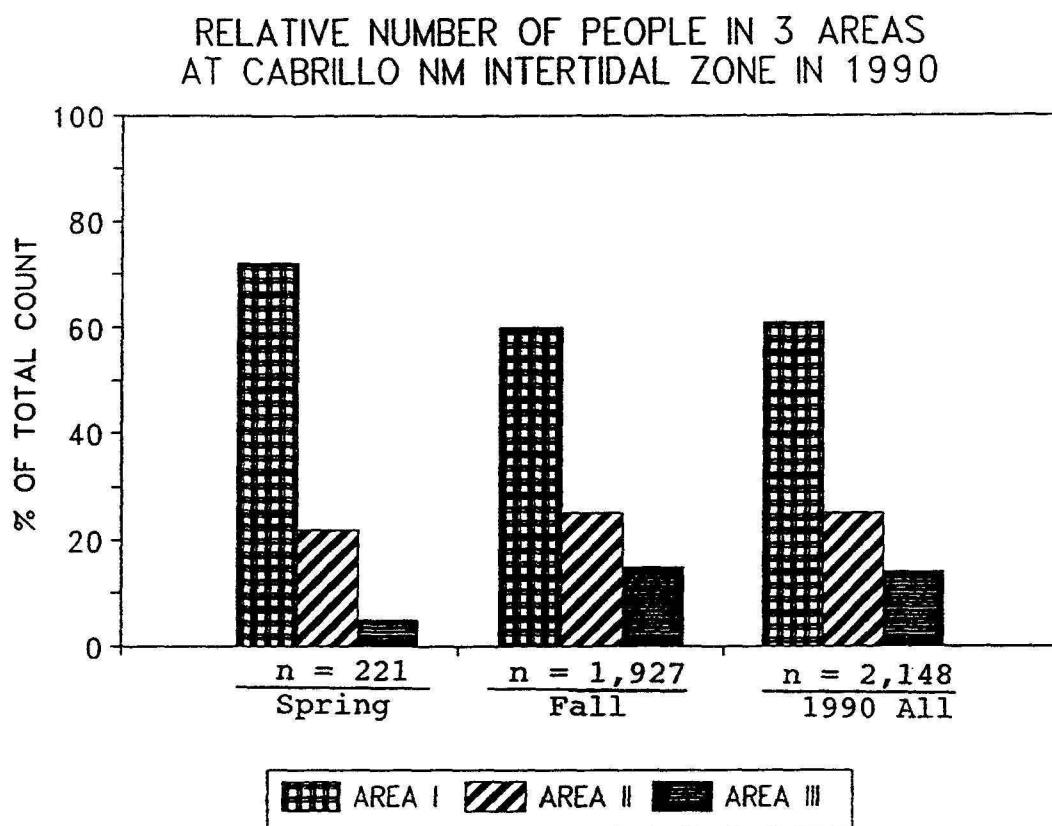


Figure 2B.

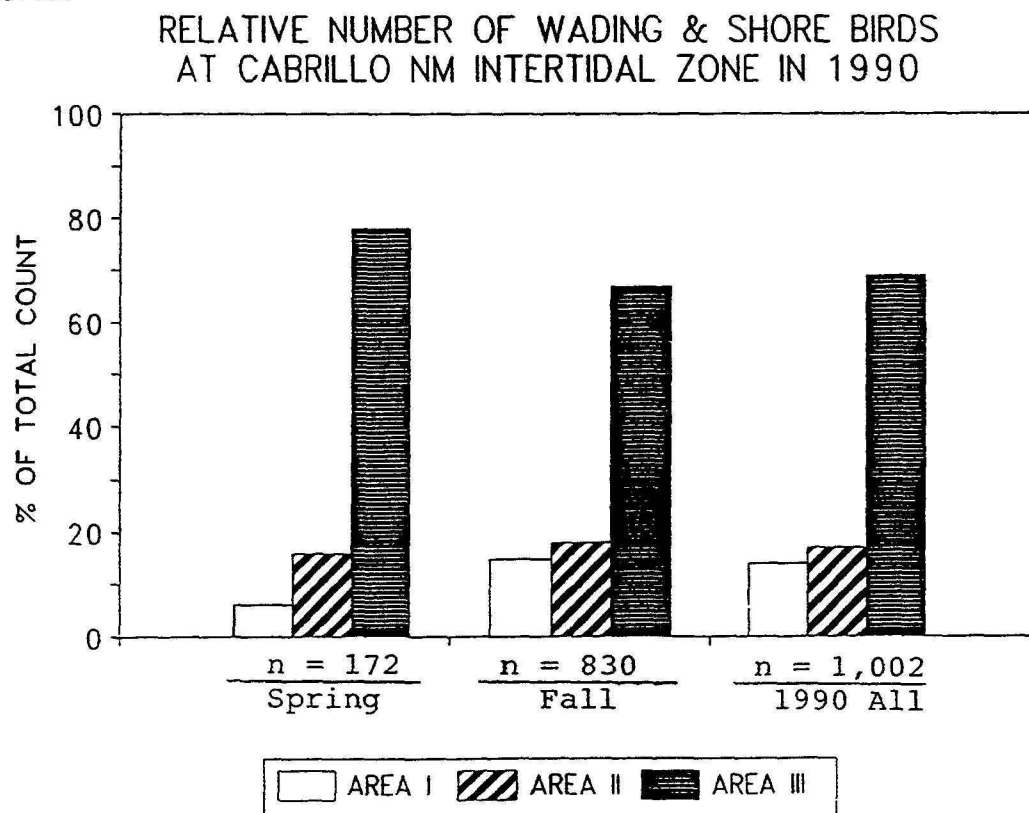


Table 4. Abundance and Distribution of Wading and Shore Birds and Gulls at Low Tide in Cabrillo National Monument, California, in 1990.

SPRING		CABR Area I					CABR Area II					CABR Area III					Total
1990	Wade	Shore	Gull	W+S	W+S	Wade	Shore	Gull	W+S	W+S	Wade	Shore	Gull	W+S	W+S	W+S	
Date	(W)	(S)	(G)	#	%	(W)	(S)	(G)	#	%	(W)	(S)	(G)	#	%	#	
02/08	6	4	-	10	8	3	11	-	14	11	15	92	-	107	82	131	
02/10	0	1	0	1	2	6	7	11	13	32	9	18	14	27	66	41	

FALL		CABR Area I					CABR Area II					CABR Area III					Total
1990	Wade	Shore	Gull	W+S	W+S	Wade	Shore	Gull	W+S	W+S	Wade	Shore	Gull	W+S	W+S	W+S	
Date	(W)	(S)	(G)	#	%	(W)	(S)	(G)	#	%	(W)	(S)	(G)	#	%	#	
11/28	2	3	3	5	17	2	19	5	21	70	0	4	0	4	13	30	
11/29	5	5	1	10	12	1	14	4	15	8	9	51	200	60	71	85	
11/30	1	4	17	15	29	5	10	15	15	29	3	19	22	22	42	52	
12/01	0	0	2	0	0	0	0	4	0	0	0	56	7	56	100	56	
12/02	0	2	1	2	6	0	0	8	0	0	6	27	100	33	94	35	
12/11	0	10	1	10	26	1	2	7	3	8	8	17	37	25	66	38	
2/12	0	3	4	3	3	0	19	3	19	21	8	61	16	69	76	91	
12/13	1	24	5	25	28	2	2	3	4	5	9	50	13	59	67	88	
12/14	3	7	2	10	15	1	1	9	2	3	6	48	306	54	82	66	
12/15	0	0	0	0	0	2	3	6	5	16	8	19	36	27	84	32	
12/17	5	7	5	12	32	2	10	4	12	32	6	7	25	13	35	37	
12/18	8	19	2	27	30	6	24	8	30	33	13	20	74	33	37	90	
12/27	0	6	0	6	13	0	11	3	11	24	5	23	15	28	62	45	
12/28	0	0	3	0	0	1	6	2	7	6	10	27	13	37	84	44	
12/30	0	0	2	0	0	0	0	5	0	0	4	15	210	19	100	19	
12/31	0	1	3	1	5	0	2	6	2	9	1	18	17	19	86	22	

Summary

SPRING		CABR Area I					CABR Area II					CABR Area III					Total
1990	Wade	Shore	Gull	W+S	W+S	Wade	Shore	Gull	W+S	W+S	Wade	Shore	Gull	W+S	W+S	W+S	
	(W)	(S)	(G)	#	%	(W)	(S)	(G)	#	%	(W)	(S)	(G)	#	%	#	
MIN	0	1	0	1	2	3	7	11	13	11	9	18	14	27	66	41	
MAX	6	4	0	10	8	6	11	11	14	32	15	92	14	107	82	131	
MEAN	3	3	0	5	6	5	9	6	14	16	12	55	7	67	78	86	
ST DEV	4	2	0	6	-	2	3	8	1	-	4	52	10	57	-	64	

FALL		CABR Area I					CABR Area II					CABR Area III					Total
1990	Wade	Shore	Gull	W+S	W+S	Wade	Shore	Gull	W+S	W+S	Wade	Shore	Gull	W+S	W+S	W+S	
	(W)	(S)	(G)	#	%	(W)	(S)	(G)	#	%	(W)	(S)	(G)	#	%	#	
MIN	0	0	0	0	0	0	0	2	0	0	0	4	0	4	13	19	
MAX	8	24	17	27	32	6	24	15	30	70	13	61	306	69	100	91	
MEAN	2	6	3	8	15	1	8	6	9	18	6	29	68	35	67	52	
ST DEV	2	7	4	9	2	8	3	9	4	18	91	19	25				

Table 5A. Abundance and Distribution of Cover Recorded in 50 x 70 cm Photogrammetric Plots in Spring, 1990.

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		92	97	98	79	100	-	73	89	97	81	100	-	88	80	100	100	96	-
Acorn Barnacle		5	2	0	0	4	2	0	0	0	0	0	0	0	0	0	0	0	0
Thatched Barnacle		11	26	7	37	21	20	0	0	0	0	0	0	0	8	0	0	0	2
Turfweed		0	2	2	0	0	1	0	3	0	0	0	1	0	1	1	0	4	1
Rockweed		0	0	0	0	0	0	27	60	48	72	88	59	10	13	17	23	16	16
California Mussel		0	0	0	1	0	0	0	0	0	0	0	0	10	13	17	23	16	16
Other Plants		0	22	14	32	0	14	19	31	22	12	10	19	36	36	10	27	29	28
Other Animals		28	13	19	22	15	20	0	0	3	7	0	2	24	0	28	13	19	17
Bare Substrate		55	35	57	9	60	43	53	6	27	9	2	19	30	43	44	37	32	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		97	91	100	100	100	-	100	100	100	100	100	-	100	100	87	90	80	-
Acorn Barnacle		0	25	4	29	0	12	2	0	0	0	0	0	1	0	10	1	0	2
Thatched Barnacle		15	12	43	29	52	30	0	0	0	0	0	0	0	0	6	3	0	2
Turfweed		0	0	0	0	0	0	0	0	0	0	0	0	0	2	3	0	0	1
Rockweed		0	3	0	0	0	1	72	71	72	69	73	71	0	0	0	0	0	0
California Mussel		0	1	9	0	0	2	0	0	0	0	0	0	65	74	46	18	74	55
Other Plants		26	0	4	0	2	6	7	25	19	12	5	14	21	13	18	11	0	13
Other Animals		0	2	9	4	10	5	0	0	0	7	12		0	1	1	16	0	4
Bare Substrate		59	56	31	38	36	44	19	4	9	12	21	13	13	10	15	51	26	23

CABR Area III		Barnacles (% Cover)						Rockweed (% Cover)						Mussels (% Cover)					
Photoplot #		3	16	20	29	80	AVG	9	10	25	27	28	AVG	12	14	15	17	24	AVG
# Points Scored		74	78	100	97	100	-	100	100	100	100	100	-	91	99	98	100	100	-
Acorn Barnacle		11	14	0	13	29	13	6	0	1	1	0	2	3	4	8	8	2	5
Thatched Barnacle		22	15	18	30	25	22	1	0	0	0	0	0	3	2	12	4	5	5
Turfweed		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Rockweed		0	0	4	3	0	1	77	90	92	76	84	84	0	0	0	0	0	0
California Mussel		0	0	0	0	0	0	0	0	0	0	0	0	64	40	39	55	39	47
Other Plants		22	14	0	1	6	9	0	0	6	1	10	3	0	1	0	1	0	0
Other Animals		13	12	2	1	20	10	9	3	0	14	3	6	6	4	5	0	7	4
Bare Substrate		32	45	76	52	20	45	7	7	1	8	3	5	24	49	36	32	47	38

Table 5B. Abundance and Distribution of Cover Recorded in 50 x 75 cm Photogrammetric Plots in Fall, 1990.

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	-
Acorn Barnacle	39	0	0	0	24	13	0	0	0	0	0	0	0	0	0	0	0	0
Thatched Barnacle	18	17	5	18	21	16	0	0	0	0	0	0	1	2	0	0	0	1
Turfweed	0	0	0	0	0	0	0	10	4	0	0	3	0	2	0	0	2	1
Rockweed	0	0	0	0	0	0	44	45	69	70	82	62	0	0	0	0	0	0
California Mussel	0	0	0	3	0	1	0	0	0	0	0	0	6	2	17	14	7	9
Other Plants	9	42	15	67	3	27	18	37	22	12	13	20	36	64	8	28	51	37
Other Animals	3	11	15	0	0	6	0	0	0	0	0	0	23	1	33	15	9	16
Bare Substrate	31	30	65	12	52	38	38	8	5	18	5	15	34	29	42	43	31	36

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	-
Acorn Barnacle	1	44	8	49	26	26	4	0	0	0	4	2	0	0	0	2	0	0
Thatched Barnacle	9	7	39	12	18	17	0	0	0	1	0	0	0	0	2	3	0	1
Turfweed	0	0	0	0	0	0	0	0	2	1	0	1	0	0	6	0	2	2
Rockweed	0	4	4	0	0	2	73	62	66	77	80	72	0	0	0	0	0	0
California Mussel	0	0	7	0	0	1	0	0	0	0	0	0	44	53	17	6	31	30
Other Plants	59	19	25	7	25	27	4	37	28	13	5	17	36	28	57	43	47	42
Other Animals	2	1	1	12	5	4	0	0	0	0	0	0	2	3	1	4	3	3
Bare Substrate	29	25	16	20	26	23	19	1	4	18	11	9	18	16	17	42	17	22

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	-
Acorn Barnacle	17	11	14	44	42	26	9	1	2	3	2	3	11	3	7	17	2	8
Thatched Barnacle	52	34	10	19	32	29	5	1	0	0	0	1	1	1	11	2	4	4
Turfweed	2	0	0	0	3	1	0	0	0	0	0	0	3	0	0	3	3	2
Rockweed	0	0	0	5	3	2	64	79	90	66	69	74	0	0	0	0	0	0
California Mussel	0	1	0	0	0	0	0	0	0	0	0	0	36	30	32	44	28	34
Other Plants	9	25	6	1	3	9	3	1	8	3	12	5	9	8	7	8	8	8
Other Animals	6	4	6	1	0	3	3	18	0	15	17	11	2	10	2	3	3	4
Bare Substrate	14	25	64	30	17	30	16	0	0	13	0	6	38	48	41	23	52	40

Line-Transects

In 1990, red algal turf averaged 73% to 90% of the ground cover along the six highest transects in the three Areas. Surf grass occupied 40% to 72% along the six mid-level transects, and boa kelp covered 31% to 55% of the ground along the six lowest transects (Table 6). With all three areas combined, surf grass increased from 51% to 71% between spring and fall, boa kelp decreased from 51% to 36%, and red algal turf remained essentially unchanged. The alien sargassum weed, *Sargassum muticum*, was relatively rare. It appeared along 2% to 9% of the four mid-level transects in Areas II and III in the spring, but only at 5% on one mid-level transect in Area III in the fall. Aggregating anemones occurred on all six of the high transects, but occupied only 1% to 2% of the area. On average, 6% to 10% of the ground was barren rock or sand along the transects at all levels.

Band-Transects

Goose barnacles were relatively abundant in the study area. During 1990, they occupied from 7.8 m² to 21.7 m² of the 30 m² transects in each Area (Table 7). Between spring and fall, the number of clumps in Area III dropped from 73 to 36, while the size of individual clumps increased by a factor of six and the total area occupied by goose barnacles nearly tripled. The abundance of goose barnacles in the other two Areas remained essentially unchanged. The size structures of the goose barnacle populations in the three Areas showed some variation (Table 8 and Figure 3). Most goose barnacle clumps contained medium-sized individuals, while small and large barnacles, respectively, were found less frequently in the clumps.

Circular Plots

Owl limpets in the monument approach the maximum size for the species (9 cm) and are relatively abundant. Mean densities in the 3.1 m² plots ranged from 27 to 42. Numbers

of limpets increased slightly in all three Areas between spring and fall, while the mean size remained essentially unchanged (Table 9). The size frequency distributions revealed an influx of 15-30 mm sized recruits in the fall samples (Fig. 4).

Table 6A. Abundance and Distribution of Ground Cover Along 10 m Line-Intercept Transects in Spring, 1990.

CABR Area I	Line Transects (% Cover)								
	High Zone			Mid Zone			Low Zone		
	210	237	AVG	211	238	AVG	212	236	AVG
Feather Boa Kelp	7	0	3	20	0	10	43	44	44
Sargassum Weed	0	0	0	0	0	0	0	0	0
Red Algal Turf	78	96	87	13	36	25	31	36	34
Surf Grass	10	0	5	50	56	53	9	11	10
Aggregating Anemone	0	3	2	0	0	0	1	0	0
Other Biota	1	0	0	2	0	1	11	0	5
Bare Substrate	4	1	3	15	8	11	5	9	7

CABR Area II	Line Transects (% Cover)								
	High Zone			Mid Zone			Low Zone		
	244	270	AVG	267	271	AVG	268	272	AVG
Feather Boa Kelp	0	12	6	17	23	20	76	34	55
Sargassum Weed	0	0	0	2	9	6	0	0	0
Red Algal Turf	86	59	73	5	48	26	22	35	28
Surf Grass	0	5	2	64	16	40	1	21	11
Aggregating Anemone	1	0	1	0	0	0	0	0	0
Other Biota	0	0	0	0	2	1	0	1	1
Bare Substrate	13	24	18	12	2	7	1	9	5

CABR Area III	Line Transects (% Cover)								
	High Zone			Mid Zone			Low Zone		
	1	8	AVG	5	7	AVG	2	4	AVG
Feather Boa Kelp	0	0	0	3	0	2	47	61	54
Sargassum Weed	0	0	0	3	3	3	0	0	0
Red Algal Turf	86	94	90	22	28	25	35	33	34
Surf Grass	7	0	4	66	54	60	8	0	4
Aggregating Anemone	3	2	2	0	0	0	0	0	0
Other Biota	0	0	0	0	2	1	3	0	2
Bare Substrate	4	4	4	6	13	9	7	6	6

Table 6B. Abundance and Distribution of Ground Cover Along 10 m Line-Intercept Transects in Fall, 1990.

CABR Area I	Line Transects (% Cover)								
	High Zone			Mid Zone			Low Zone		
	210	237	AVG	211	238	AVG	212	236	AVG
Transect/Taxa									
Feather Boa Kelp	0	0	0	1	0	1	29	33	31
Sargassum Weed	0	0	0	0	0	0	0	0	0
Red Algal Turf	67	96	81	8	38	23	22	51	36
Surf Grass	28	0	14	88	57	72	27	4	16
Aggregating Anemone	1	1	1	0	0	0	0	0	0
Other Biota	0	0	0	0	0	0	15	1	8
Bare Substrate	4	3	4	3	5	4	7	11	9

CABR Area II	Line Transects (% Cover)								
	High Zone			Mid Zone			Low Zone		
	244	270	AVG	267	271	AVG	268	272	AVG
Transect/Taxa									
Feather Boa Kelp	0	6	3	1	14	8	52	32	42
Sargassum Weed	0	0	0	0	0	0	0	0	0
Red Algal Turf	79	71	75	16	17	16	30	34	32
Surf Grass	2	7	5	78	61	69	13	21	17
Aggregating Anemone	1	0	1	0	0	0	0	6	3
Other Biota	0	0	0	0	3	2	4	2	3
Bare Substrate	18	16	17	5	5	5	1	5	3

CABR Area III	Line Transects (% Cover)								
	High Zone			Mid Zone			Low Zone		
	1	8	AVG	5	7	AVG	2	4	AVG
Transect/Taxa									
Feather Boa Kelp	0	0	0	7	0	4	28	44	36
Sargassum Weed	0	0	0	0	5	2	0	0	0
Red Algal Turf	76	84	80	14	17	15	45	49	47
Surf Grass	8	0	4	76	67	72	14	0	7
Aggregating Anemone	1	1	1	0	0	0	0	0	0
Other Biota	1	0	1	0	0	0	3	3	3
Bare Substrate	14	15	14	3	11	7	10	4	7

Table 7A. Abundance and Distribution of Goose Barnacles in 1 x 10 m Band Transects During Spring, 1990.

Area CM ²	CABR Area I Transects					CABR Area II Transects					CABR Area III Transects				
	276	278	281	All	%	273	274	275	All	%	22	23	269	All	%
5	35	39	19	93	30	8	3	12	3	17	18	0	0	18	25
10	9	16	11	36	12	11	5	10	26	19	6	1	1	8	11
15	8	17	8	33	11	11	2	8	21	15	5	0	1	6	8
20	12	8	10	30	10	3	2	3	8	6	2	1	2	5	7
25	0	3	2	5	2	2	1	2	5	4	0	0	0	0	0
30	6	8	2	16	5	2	2	4	8	6	4	0	1	5	7
35	0	2	0	2	1	0	0	0	0	0	0	0	0	0	0
40	3	6	1	10	3	1	1	1	3	2	1	1	2	4	5
45	1	2	2	5	2	0	1	2	3	2	0	0	0	0	0
50	0	2	0	2	1	0	1	1	2	1	0	0	1	1	1
55	2	3	2	7	2	1	1	0	2	1	1	0	0	1	1
60	0	0	0	0	0	1	0	0	1	1	0	0	0	0	0
65	4	3	3	10	3	2	0	0	2	1	0	0	0	0	0
70	1	0	0	1	<1	1	1	0	2	1	0	0	0	0	0
75	0	2	0	2	1	2	0	0	2	1	0	0	0	0	0
80	2	1	2	5	2	3	2	0	5	4	1	0	0	1	1
85	0	3	1	4	1	0	0	0	0	0	0	0	0	0	0
90	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
95	4	1	0	5	2	0	1	0	1	1	1	0	0	1	1
100	0	0	0	0	0	0	1	0	1	1	0	0	0	0	0
105	2	0	0	2	1	0	0	0	0	0	0	0	0	0	0
110	0	1	0	1	<1	0	0	0	0	0	0	0	1	1	1
115	1	1	0	2	1	2	0	0	2	1	1	1	0	2	3
120	1	0	0	1	<1	0	1	0	1	1	0	1	0	1	1
125	0	0	0	0	0	1	0	0	1	1	0	0	0	0	0
130	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
135	1	2	1	4	1	0	1	0	1	1	1	0	0	1	1
140	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
145	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
150	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
155	3	3	0	6	2	0	0	0	0	0	0	1	0	1	1
160	0	1	0	1	<1	0	0	0	0	0	0	1	0	1	1
165	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
170	1	0	0	1	<1	0	0	0	0	0	0	0	0	0	0
175	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
180	1	1	1	3	1	0	2	2	4	3	0	1	1	2	3
185	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
190	1	0	0	1	<1	0	1	0	1	1	0	0	0	0	0
195	1	0	0	1	<1	0	0	0	0	0	1	0	0	1	1
200	0	1	0	1	<1	0	0	0	0	0	1	0	0	1	1
205	2	0	0	2	1	1	1	0	2	1	0	0	0	0	0
210	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
215	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
220	0	0	0	0	0	0	1	0	1	1	0	0	0	0	0
225	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
230	2	0	1	3	1	0	0	0	0	0	0	0	0	0	0
235	0	0	0	0	0	0	0	1	1	1	0	0	0	0	0
240	0	0	0	0	0	0	1	0	1	1	0	0	0	0	0
245	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
250	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
255	0	1	1	2	1	0	0	0	0	0	0	0	0	0	0
260	1	0	0	1	<1	0	0	0	0	0	0	0	0	0	0
265	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
270	0	0	0	0	0	0	0	0	0	0	0	1	0	1	1

Table 7A (continued). Abundance and Distribution of Goose Barnacles in 1 x 10 m Band Transects During Spring, 1990.

Area CM ⁻²	CABR Area I Transects					CABR Area II Transects					CABR Area III Transects				
	276	278	281	All	%	273	274	275	All	%	22	23	269	All	%
275	1	0	0	1	<1	0	0	0	0	0	0	0	0	0	0
280	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
285	0	1	1	2	1	0	0	0	0	0	0	0	0	0	0
290	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
295	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
300	0	1	0	1	<1	0	0	0	0	0	0	0	0	0	0
305	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
310	0	0	0	0	0	0	0	0	0	0	1	0	0	1	1
315	0	0	1	1	<1	0	0	1	1	1	0	1	0	1	1
320	0	0	0	0	0	0	0	1	1	1	0	0	0	0	0
325	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
330	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
335	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
340	1	0	0	1	<1	0	0	0	0	0	0	0	0	0	0
345	0	0	0	0	0	0	1	0	1	1	0	0	0	0	0
350	1	0	1	2	1	0	0	0	0	0	1	0	0	1	1
355	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
360	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
365	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
370	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
375	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
380	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
385	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
390	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
395	0	0	1	1	<1	0	0	0	0	0	0	0	0	0	0
400	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
405	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
410	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
415	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
420	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
425	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
430	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
435	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1
440	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
445	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
450	1	0	0	1	<1	1	0	0	1	1	0	0	0	0	0
455	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1
460	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
465	1	0	0	1	<1	0	0	0	0	0	0	0	0	0	0
470	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1
475	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
480	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
485	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
490	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
495	0	1	0	1	<1	0	1	0	1	1	0	0	1	1	1
500	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
500	2	0	0	2	1	0	3	0	3	2	2	0	1	3	4
# Clumps	111	130	71	312	-	53	37	48	138	-	47	10	16	73	-
Area Size	7745	5080	3306	16131	-	2130	6568	1816	10514	-	3185	1373	3320	7778	-
Min Size	1	1	1	1	-	1	3	1	1	-	1	7	7	1	-
Max Size	707	491	392	707	-	450	1385	319	1385	-	714	314	616	714	-
Mean	70	39	47	52	-	40	178	38	76	-	68	137	201	107	-
St. Dev.	120	69	86	94	-	70	320	75	186	-	149	101	216	168	-
% Cover	8%	5%	3%	5%	-	2%	7%	2%	4%	-	3%	1%	3%	3%	-

Table 7B. Abundance and Distribution of Goose Barnacles in 1 x 10 m Band Transects During Fall, 1990.

Area CM ²	CABR Area I Transects					CABR Area II Transects					CABR Area III Transects				
	276	278	281	All	%	273	274	275	All	%	22	23	269	All	%
5	5	2	12	19	10	23	12	4	39	23	0	0	0	0	0
10	9	9	9	27	14	14	2	1	17	10	1	0	1	2	6
15	4	9	7	20	11	17	2	5	24	14	1	0	0	1	3
20	1	2	8	11	6	10	2	4	6	9	0	0	3	3	8
25	0	2	0	2	1	2	0	0	2	1	0	0	1	1	3
30	7	4	9	20	11	7	4	2	13	8	0	0	0	0	0
35	0	1	0	1	1	1	1	0	2	1	0	0	0	0	0
40	2	1	2	5	3	2	3	4	9	5	1	0	0	1	3
45	0	1	0	1	1	2	1	0	3	2	0	0	0	0	0
50	0	0	0	0	0	1	0	1	2	1	0	0	1	1	3
55	7	4	1	12	6	2	3	1	6	4	1	0	0	1	3
60	0	0	0	0	0	0	0	1	1	1	0	0	0	0	0
65	3	3	1	7	4	0	5	0	5	3	0	0	0	0	0
70	0	0	0	0	0	1	0	0	1	1	0	0	0	0	0
75	0	4	0	4	2	1	1	0	2	1	0	0	0	0	0
80	2	4	2	8	4	1	2	1	4	2	0	0	0	0	0
85	0	1	0	1	1	0	1	0	1	1	0	0	0	0	0
90	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
95	5	1	1	7	4	1	3	0	4	2	0	0	0	0	0
100	1	0	0	1	1	0	1	0	1	1	0	0	0	0	0
105	0	1	1	2	1	0	0	0	0	0	0	0	0	0	0
110	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
115	2	1	1	4	2	3	1	0	4	2	0	0	0	0	0
120	1	0	0	1	1	1	1	0	2	1	0	0	0	0	0
125	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
130	0	0	0	0	0	0	1	0	1	1	0	0	0	0	0
135	4	1	0	5	3	0	1	0	1	1	1	0	0	1	3
140	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
145	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
150	0	1	0	1	1	1	0	0	1	1	1	0	0	1	3
155	0	0	0	0	0	0	1	0	1	1	0	0	0	0	0
160	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
165	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
170	1	1	0	2	1	0	0	0	0	0	0	0	0	0	0
175	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
180	1	2	1	4	2	1	0	1	2	1	1	0	0	1	3
185	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
190	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
195	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
200	0	1	0	1	1	0	0	0	0	0	0	0	0	0	0
205	1	0	0	1	1	0	1	0	1	1	0	0	0	0	0
210	0	0	1	1	1	0	0	0	0	0	0	0	0	0	0
215	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
220	0	0	0	0	0	0	0	1	1	1	0	0	0	0	0
225	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
230	1	0	1	2	1	0	0	1	1	1	0	0	0	0	0
235	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
240	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
245	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
250	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
255	2	0	0	2	1	0	1	0	1	1	1	0	0	1	3
260	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
265	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
270	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Table 7B (continued). Abundance and Distribution of Goose Barnacles in 1 x 10 m Band Transects During Fall, 1990.

Area CM ²	CABR Area I Transects					CABR Area II Transects					CABR Area III Transects				
	276	278	281	All	%	273	274	275	All	%	22	23	269	All	%
275	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
280	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
285	1	0	0	1	1	0	0	0	0	0	1	0	0	1	3
290	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
295	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
300	0	1	0	1	1	0	0	0	0	0	0	0	0	0	0
305	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
310	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
315	2	0	0	2	1	0	0	1	1	1	0	1	0	1	3
320	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
325	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
330	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
335	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
340	0	0	0	0	0	0	0	0	0	0	1	0	0	1	3
345	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
350	0	0	1	1	1	0	0	0	0	0	0	0	0	0	0
355	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
360	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
365	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
370	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
375	1	0	0	1	1	0	0	0	0	0	0	0	0	0	0
380	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
385	0	1	0	1	1	0	0	0	0	0	0	0	0	0	0
390	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
395	1	0	0	1	1	0	0	0	0	0	0	0	0	0	0
400	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
405	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
410	0	0	0	0	0	1	0	0	1	1	0	0	0	0	0
415	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
420	0	0	0	0	0	0	0	0	0	0	1	0	1	2	6
425	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
430	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
435	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
440	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
445	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
450	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
455	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
460	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
465	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
470	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
475	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
480	1	0	0	1	1	0	0	0	0	0	0	0	0	0	0
485	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
490	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
495	1	1	0	2	1	0	0	0	0	0	0	0	0	0	0
500	0	0	0	0	0	0	0	0	0	0	1	0	0	1	3
>500	2	1	1	4	2	0	1	0	1	1	3	7	6	16	44
# Clumps	68	60	59	187	-	92	51	28	171	-	15	8	13	36	-
Area Sum	8211	4599	2806	15615	-	2681	3640	1551	7872	-	6908	7360	7431	21699	-
Min Size	1	2	1	1	-	1	1	3	1	-	8	314	8	8	-
Max Size	900	525	589	900	-	408	962	314	962	-	3318	2827	2827	3318	-
Mean	121	77	48	84	-	29	71	55	46	-	461	920	572	603	-
St Dev	173	108	95	135	-	52	138	79	92	-	817	803	795	803	-
% Cover	8%	5%	3%	5%	-	3%	4%	2%	3%	-	7%	7%	7%	7%	-

Table 8. Size Distribution Within Clumps of Goose Barnacles in 1 x 10 m Band Transects During 1990.

CABR Area	SPRING Band #	Small (<u><1 cm</u>)		Medium (<u>1-3 cm</u>)		Large (<u>>3 cm</u>)		Total #
		#	%	#	%	#	%	
I	276	87	78	106	96	65	59	111
	278	112	86	125	96	61	47	130
	281	57	80	65	92	58	82	71
	All	256	82	296	95	184	59	312
II	273	40	75	50	94	40	75	53
	274	23	62	33	89	26	70	37
	275	41	85	46	96	32	67	48
	All	104	75	129	93	98	71	138
III	22	36	77	40	85	28	60	47
	23	3	30	7	70	9	90	10
	269	10	63	12	75	15	94	16
	All	49	67	59	81	52	71	73
All Areas		409	78	484	93	334	64	523
CABR Area	FALL Band #	Small (<u><1 cm</u>)		Medium (<u>1-3 cm</u>)		Large (<u>>3 cm</u>)		Total #
		#	%	#	%	#	%	
I	276	48	71	63	93	59	87	68
	278	34	57	51	85	56	93	60
	281	45	76	58	98	37	63	59
	All	127	68	172	92	152	81	187
II	273	80	87	92	100	25	27	92
	274	45	88	47	92	34	67	51
	275	12	43	22	79	27	96	28
	All	137	80	161	94	86	50	171
III	22	11	73	11	73	7	47	15
	23	8	100	8	100	5	63	8
	269	12	92	12	92	8	62	13
	All	31	86	31	86	20	56	36
All Areas		296	75	364	92	258	65	394

Figure 3A.

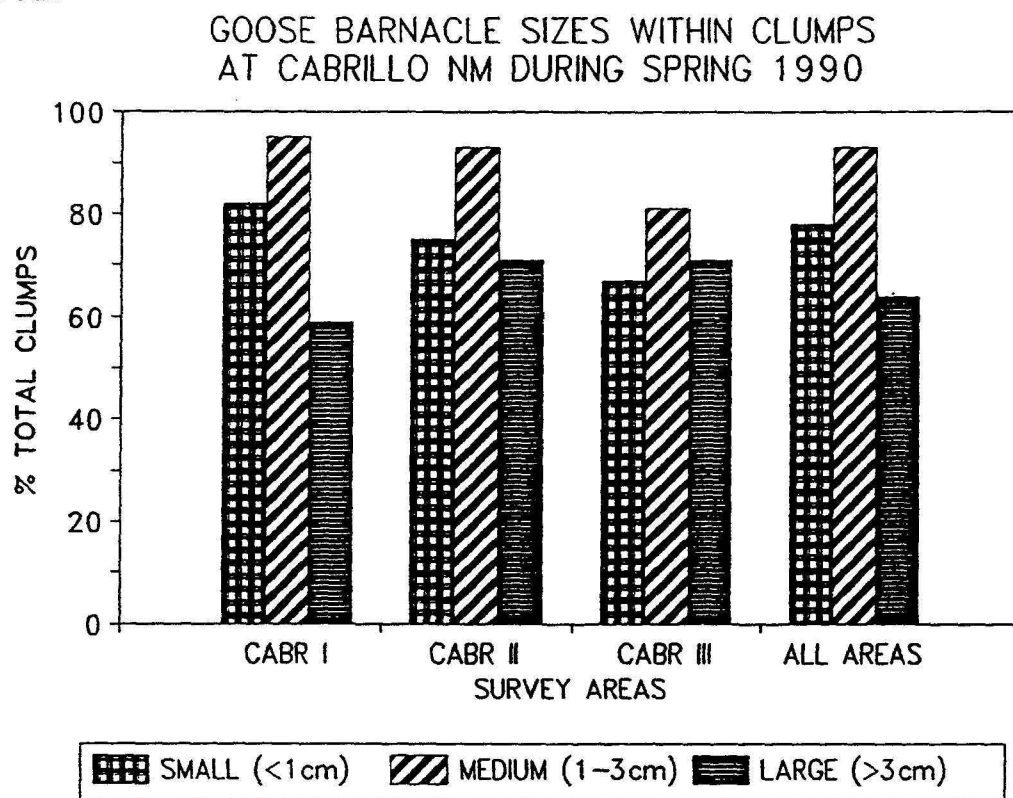


Figure 3B.

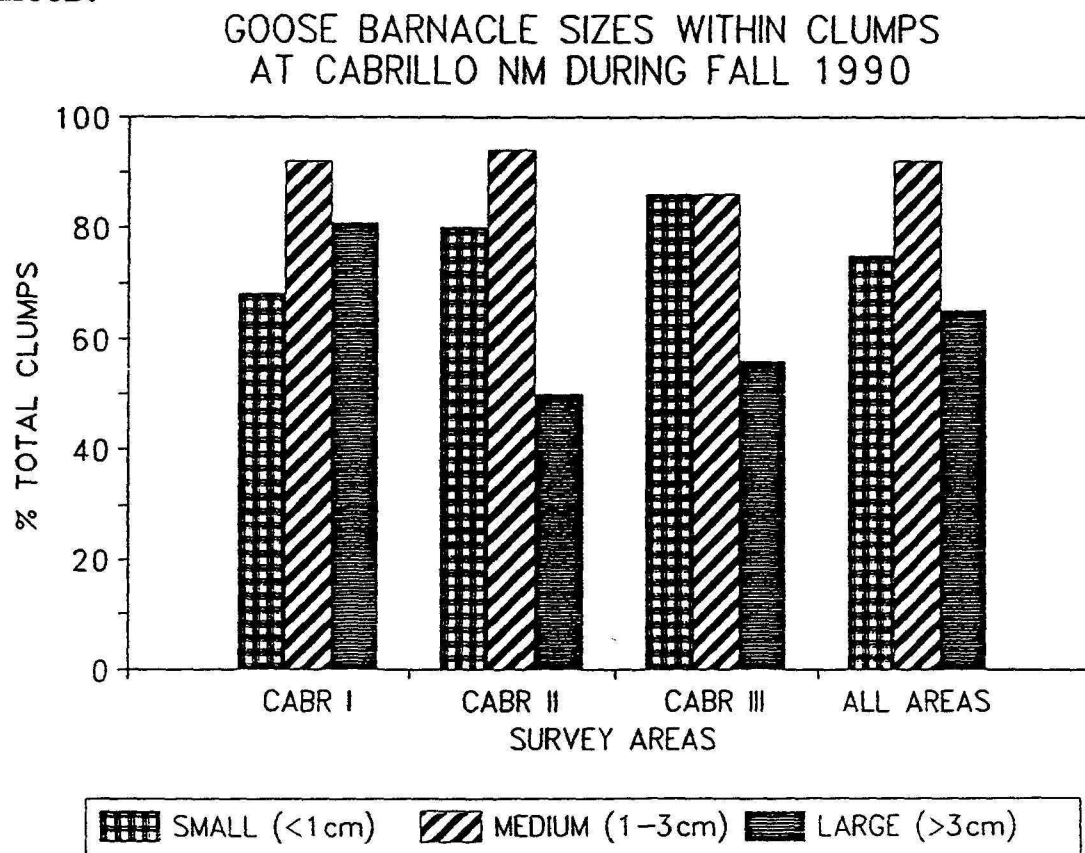


Table 9A. Abundance and Distribution of Owl Limpets in 1 m Radius Plots During Spring, 1990.

Length (mm)	Area I Plots (# of Limpets)								Area II Plots (# of Limpets)								Area III Plots (# of Limpets)							
	Boulder			Cliff					Boulder			Cliff					Boulder			Cliff				
	282	283	284	277	279	280	All	%	239	240	241	242	243	266	All	%	11	18	19	21	26	13	All	%
15	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
16	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	1
17	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
18	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
19	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
20	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
21	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
22	0	0	1	0	0	0	1	<1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
23	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
24	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
25	0	0	0	0	0	0	0	0	1	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0
26	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	1	<1
27	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	3	1	0	0	0	5	2
28	0	0	0	0	0	1	1	<1	0	0	0	0	0	0	0	0	0	2	0	0	0	0	2	1
29	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
30	0	0	1	0	0	0	1	<1	0	0	0	0	0	0	0	0	1	2	0	1	0	0	4	2
31	0	0	0	0	0	0	0	0	2	0	0	0	0	0	2	1	1	2	0	0	0	0	3	1
32	0	0	1	0	0	1	2	1	1	0	0	1	0	0	2	1	1	0	0	0	0	0	1	<1
33	1	0	2	0	0	1	4	2	0	0	0	0	1	1	2	1	4	3	1	1	1	0	10	4
34	1	0	2	0	0	2	5	2	0	1	1	0	0	0	2	1	0	3	0	0	0	0	3	1
35	0	0	1	0	0	0	1	<1	0	0	1	0	1	1	3	2	2	2	1	0	0	1	6	3
36	0	0	3	1	0	0	4	2	0	0	0	0	0	0	0	0	1	2	0	0	0	1	4	2
37	1	0	1	0	1	1	4	2	1	0	0	0	0	0	1	1	2	4	1	2	0	1	10	4
38	1	0	1	0	0	2	4	2	1	0	0	0	0	0	1	1	1	5	0	0	0	1	7	3
39	0	1	0	1	0	2	4	2	1	0	2	0	0	0	3	2	2	2	0	0	2	2	8	3
40	0	1	6	0	4	1	12	6	3	0	0	1	0	0	4	2	3	2	0	0	0	3	8	3
41	1	2	0	0	3	4	10	5	0	0	0	0	1	1	2	1	1	4	1	1	0	1	8	3
42	0	0	3	1	1	2	7	3	1	0	2	0	0	1	4	2	2	4	0	1	0	0	7	3
43	2	0	3	0	1	1	7	3	1	0	0	0	0	1	2	1	0	4	0	1	0	1	6	3
44	0	0	1	0	1	2	4	2	0	1	0	0	0	0	1	1	1	5	1	0	0	1	8	3
45	0	1	4	2	0	1	8	4	0	1	1	0	2	4	8	5	2	2	0	1	0	0	5	2
46	1	3	2	0	2	3	11	5	0	0	1	0	2	4	7	4	4	2	0	1	0	2	9	4
47	0	1	1	0	4	5	11	5	1	1	1	0	0	5	8	5	3	3	0	2	0	1	9	4
48	1	2	2	1	1	6	13	6	1	2	1	0	2	2	8	5	7	7	0	0	0	1	15	6
49	0	1	0	2	1	1	5	2	1	0	0	0	1	2	4	2	3	5	1	3	0	2	14	6
50	0	2	2	1	0	2	7	3	1	0	1	0	2	1	5	3	2	5	0	1	0	0	8	3
51	2	2	1	0	2	1	8	4	0	0	1	1	2	2	6	4	2	1	0	1	0	0	4	2
52	0	1	3	0	0	3	7	3	2	0	1	0	1	2	6	4	2	3	0	3	2	0	10	4
53	0	0	0	0	1	4	5	2	1	0	1	1	1	1	5	3	2	0	1	2	1	1	7	3
54	0	0	1	2	2	0	5	2	0	1	0	1	2	0	4	2	1	1	0	0	1	0	3	1
55	1	2	0	2	1	1	7	3	3	0	1	1	0	1	6	4	1	1	0	0	2	2	6	3
56	2	2	1	0	0	1	6	3	0	0	0	2	1	3	6	4	0	1	1	3	1	0	6	3
57	0	1	1	1	1	1	5	2	2	1	2	0	0	3	8	5	0	0	1	1	0	1	3	1
58	1	0	2	1	2	0	6	3	0	3	0	0	0	2	5	3	1	0	2	1	0	0	4	2
59	1	0	0	1	0	0	2	1	1	0	0	0	3	0	4	2	0	0	1	0	1	1	3	1
60	1	2	2	0	0	2	7	3	0	0	0	1	0	2	3	2	1	0	0	0	1	0	2	1
61	1	0	1	0	0	2	4	2	0	0	1	0	0	2	3	2	1	0	0	0	2	1	4	2
62	0	0	1	0	0	0	1	<1	0	0	2	0	0	0	2	1	0	0	0	0	2	0	2	1
63	1	0	2	0	0	0	3	1	0	0	0	0	0	1	1	1	0	0	1	0	3	0	4	2
64	0	0	0	0	0	1	1	<1	1	1	2	0	0	0	4	2	1	0	3	1	2	0	7	3
65	0	0	0	0	0	0	0	0	0	0	1	0	0	0	1	1	0	0	1	0	0	0	1	<1
66	1	0	0	0	0	0	1	<1	0	2	1	1	0	0	4	2	0	0	0	1	0	0	1	<1
67	0	0	1	0	0	0	1	<1	0	0	2	0	0	0	2	1	0	0	1	0	1	0	2	1

Table 9A (continued). Abundance and Distribution of Owl Limpets in 1 m Radius Plots During Spring, 1990.

Length (mm)	Area I Plots (# Of Limpets)								Area II Plots (# Of Limpets)								Area III Plots (# Of Limpets)							
	Boulder				Cliff				Boulder				Cliff				Boulder				Cliff			
	282	283	284	277	279	280	All	%	239	240	241	242	243	266	All	%	11	18	19	21	26	13	All	%
68	0	1	0	0	0	0	1	<1	0	0	0	0	0	3	3	2	0	0	0	0	0	0	0	0
69	1	0	0	0	0	0	1	<1	0	1	1	0	0	0	2	1	0	0	0	1	0	0	1	<1
70	2	0	1	0	0	0	3	1	0	0	1	1	0	1	3	2	0	0	0	0	0	0	0	0
71	0	0	0	0	0	0	0	0	0	0	2	0	0	0	2	1	0	0	0	0	0	0	0	0
72	0	0	0	0	0	0	0	0	0	0	1	0	0	0	1	1	0	0	0	1	0	0	1	<1
73	0	0	0	0	0	0	0	0	0	0	3	0	0	0	3	2	0	0	0	0	0	0	0	0
74	1	0	0	0	0	0	1	<1	0	0	1	0	0	1	2	1	0	0	0	0	1	0	1	<1
75	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
76	1	0	0	0	0	0	1	<1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
77	0	0	0	0	0	0	0	0	0	0	1	0	0	0	1	1	0	0	0	0	0	0	0	0
78	0	0	0	0	0	0	0	0	0	1	0	0	0	1	2	1	0	0	0	0	0	0	0	0
79	1	0	0	0	0	0	1	<1	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	<1
80	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
81	1	0	0	0	0	0	1	<1	0	1	0	0	0	0	1	1	0	0	0	0	0	0	0	0
82	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	<1
83	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
84	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
85	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
86	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
87	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	0	0	0	0	0	0	0	0
88	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
89	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
90	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Summary																								
Total #	27	25	54	16	28	54	204		26	17	36	11	22	49	161		56	82	19	30	23	26	236	
Min Size	33	39	22	36	37	28	22		25	34	34	32	33	33	25		27	16	27	30	33	35	16	
Max Size	81	68	70	59	58	64	81		64	81	77	70	59	87	87		64	56	67	72	74	82	82	
Length in (mm)	56	50	46	50	47	47	48		46	57	58	54	49	54	53		45	41	52	50	57	48	46	
St Dev	14	7	10	7	6	8	10		10	12	13	11	7	11	11		8	8	12	10	10	12	11	

Table 9B. Abundance and Distribution of Owl Limpets in 1 m Radius During Fall, 1990.

Length (mm)	Area I Plots (# Of Limpets)								Area II Plots (# Of Limpets)								Area III Plots (# Of Limpets)													
	Boulder				Cliff				All	%	Boulder				Cliff				All	%	Boulder				Cliff				All	%
	282	283	284	277	279	280	239	240			241	242	243	266	11	18	19	21			26	13								
15	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0		
16	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0		
17	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0		
18	0	0	0	0	0	1	1	<1	1	0	0	0	0	0	1	<1	0	0	0	0	0	0	0	0	0	0	0	0		
19	0	0	1	1	0	0	2	1	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	1	<1				
20	0	0	0	1	0	0	1	<1	1	1	0	0	0	0	2	1	1	2	0	0	0	0	0	0	3	1				
21	0	0	0	2	0	0	2	1	1	1	0	0	0	0	2	1	0	0	1	0	0	0	0	0	1	<1				
22	0	0	2	1	1	1	5	2	0	1	0	0	0	0	1	<1	1	0	0	0	0	0	0	0	1	<1				
23	1	0	1	0	2	0	4	2	0	2	0	0	0	3	5	2	1	1	0	0	0	0	0	0	2	1				
24	0	0	1	2	0	2	5	2	2	0	0	0	0	1	3	1	0	0	0	0	0	0	1	1	<1					
25	1	0	4	0	0	3	8	3	1	0	0	1	0	1	3	1	0	3	0	0	0	0	1	4	2					
26	0	1	4	1	0	1	7	3	3	0	1	1	0	1	6	3	0	1	1	0	0	1	1	3	1					
27	1	0	4	0	0	0	5	2	0	1	0	1	0	1	3	1	0	2	0	0	1	1	4	2						
28	0	0	2	3	1	1	7	3	2	0	0	2	0	1	5	2	0	1	0	0	0	0	0	1	4	<1				
29	0	0	0	1	0	2	3	1	0	0	0	0	1	0	1	<1	1	1	1	0	0	1	4	2						
30	0	0	0	0	0	2	2	1	0	0	0	0	0	0	0	0	0	0	0	0	0	2	2	1						
31	0	0	1	1	0	0	2	1	0	0	0	0	1	0	1	<1	1	0	1	0	0	0	2	1						
32	1	0	0	1	0	0	2	1	0	1	0	0	1	1	3	1	0	0	0	0	0	0	0	0						
33	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	1	2	1						
34	0	2	0	0	0	2	4	2	0	0	0	0	1	1	2	1	0	0	0	0	0	0	0	0						
35	0	0	0	2	1	1	4	2	1	0	0	1	0	0	2	1	2	0	0	0	0	0	2	1						
36	0	0	0	2	0	0	2	1	0	0	0	0	0	0	0	0	3	2	1	0	0	0	6	2						
37	0	0	0	2	0	1	3	1	2	1	0	0	0	1	4	2	2	1	0	1	0	0	4	2						
38	1	0	1	1	0	0	3	1	0	0	0	0	0	2	2	1	2	3	1	1	0	0	7	3						
39	0	1	1	3	0	0	5	2	1	0	0	0	0	0	1	<1	3	0	0	1	0	1	5	2						
40	1	0	1	1	0	0	3	1	1	0	0	0	0	1	2	1	2	4	0	0	0	0	6	2						
41	0	0	0	2	0	1	3	1	1	0	0	0	1	1	3	1	3	3	0	1	0	0	7	3						
42	0	0	0	4	0	4	8	3	0	0	0	0	0	2	2	1	1	6	2	0	0	3	12	5						
43	0	0	1	2	0	1	4	2	1	0	0	0	0	0	1	<1	3	5	0	0	0	1	9	4						
44	1	1	1	1	0	2	6	2	1	0	0	0	0	0	1	<1	1	5	0	2	0	4	12	5						
45	0	0	2	2	0	2	6	2	1	0	0	0	0	0	1	<1	3	5	0	1	0	3	12	5						
46	0	0	2	1	0	0	3	1	1	2	1	0	1	1	6	3	5	1	1	0	0	0	7	3						
47	0	0	3	1	1	1	6	2	0	0	0	0	0	2	2	1	7	3	0	1	0	1	12	5						
48	1	0	3	3	0	2	9	4	0	0	0	1	0	2	3	1	2	5	0	2	0	2	11	4						
49	0	1	5	0	2	1	9	4	1	0	0	1	0	0	2	1	2	3	0	2	0	0	7	3						
50	0	1	3	0	0	2	6	2	1	1	1	0	0	2	5	2	3	5	1	0	0	1	10	4						
51	1	1	0	0	1	2	5	2	2	1	1	0	1	1	6	3	1	1	0	3	2	1	8	3						
52	0	1	1	0	3	3	8	3	1	0	1	0	1	4	7	3	2	1	1	0	0	1	5	2						
53	1	2	1	0	2	3	9	4	0	0	0	0	0	3	3	1	0	2	0	1	3	0	6	2						
54	0	2	1	0	2	3	8	3	1	1	0	1	1	1	5	2	3	2	1	1	1	0	8	3						
55	1	1	2	0	2	3	9	4	3	1	0	0	2	3	9	4	1	3	0	2	0	0	6	2						
56	2	1	2	0	1	3	9	4	1	0	1	0	1	1	4	2	0	2	2	1	1	2	8	3						
57	3	1	2	0	1	1	8	3	2	0	0	1	1	0	4	2	0	2	0	2	1	0	5	2						
58	1	1	2	0	0	4	8	3	0	0	3	1	3	3	10	3	0	0	0	1	0	0	1	<1						
59	2	1	1	0	1	1	6	2	0	1	2	1	0	2	6	1	1	1	0	3	1	0	5	2						
60	1	0	0	0	0	0	1	<1	0	0	1	0	1	0	2	2	2	0	0	0	2	0	4	2						
61	3	0	1	0	1	2	7	3	0	0	0	0	2	2	4	3	0	0	3	0	1	0	4	2						
62	3	0	0	0	0	0	3	1	1	1	1	0	1	3	7	3	0	0	0	0	1	0	1	<1						
63	1	0	1	1	0	1	4	2	0	1	2	1	1	2	7	3	0	0	0	0	2	0	2	1						
64	1	1	1	0	0	1	4	2	0	0	2	1	1	3	7	2	1	0	1	1	0	0	3	1						
65	2	0	0	0	0	0	2	1	0	1	0	0	2	1	4	3	0	0	1	1	1	0	3	1						
66	1	0	0	0	0	0	1	<1	0	0	2	0	2	2	6	3	0	0	1	1	1	0	3	1						

Table 9B (continued). Abundance and Distribution of Owl Limpets in 1 m Radius During Fall, 1990.

Length (mm)	Area I Plots (#Of Limpets)								Area II Plots (# Of Limpets)								Area III Plots (# Of Limpets)							
	Boulder			Cliff			All	%	Boulder			Cliff			All	%	Boulder			Cliff			All	%
	282	283	284	277	279	280			239	240	241	242	243	266			11	18	19	21	26	13		
67	0	0	1	0	0	0	1	<1	0	2	1	0	1	0	4	2	0	0	2	0	1	1	4	2
68	0	0	0	0	0	0	0	0	0	0	1	1	0	1	3	1	0	0	2	0	0	0	2	1
69	1	0	0	0	0	0	1	<1	0	0	3	2	1	3	9	4	0	0	1	0	0	0	1	<1
70	1	0	0	0	0	0	1	<1	0	0	1	0	0	0	1	<1	0	0	0	0	0	0	0	0
71	1	0	0	0	0	0	1	<1	0	2	2	0	0	0	4	2	0	0	0	1	0	0	1	<1
72	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1	<1	0	0	2	0	1	0	3	1
73	0	0	0	0	0	0	0	0	0	0	1	0	0	0	1	<1	0	0	1	0	0	0	1	<1
74	1	0	0	0	0	0	1	<1	0	0	3	0	0	1	4	2	0	0	0	0	0	0	0	0
75	1	0	0	0	0	0	1	<1	0	0	3	0	0	0	3	1	0	0	0	0	0	0	0	0
76	1	0	0	0	0	0	1	<1	0	0	1	0	0	1	2	1	0	0	0	0	0	1	1	<1
77	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
78	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
79	0	0	0	0	0	0	0	0	0	1	0	0	0	0	1	<1	0	0	0	0	0	0	0	0
80	1	0	0	0	0	0	1	<1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
81	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	<1
82	0	0	0	0	0	0	0	0	0	1	0	0	0	0	1	<1	0	0	0	0	0	0	0	0
83	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	<1	0	0	0	0	0	0	0	0
84	1	0	0	0	0	0	1	<1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
85	1	0	0	0	0	0	1	<1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
86	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
87	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
88	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
89	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
90	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Summary																								
Total #	40	19	59	42	22	60	242	34	24	35	17	29	62	201	62	76	28	29	22	32	249			
Min Size	23	26	19	19	22	18	18	18	20	26	25	29	23	18	19	20	21	37	27	24	19			
Max Size	85	64	67	63	61	64	85	62	82	76	69	72	83	83	65	60	73	71	72	81	81			
Length in (mm)	58	50	42	37	47	45	46	41	50	64	49	55	52	52	44	43	54	52	58	45	47			
St Dev	15	10	13	10	12	12	14	13	20	10	17	12	15	16	9	9	15	8	9	14	12			

Figure 4A.

Owl Limpet Length Frequency Distribution
For Area I During Spring 1990

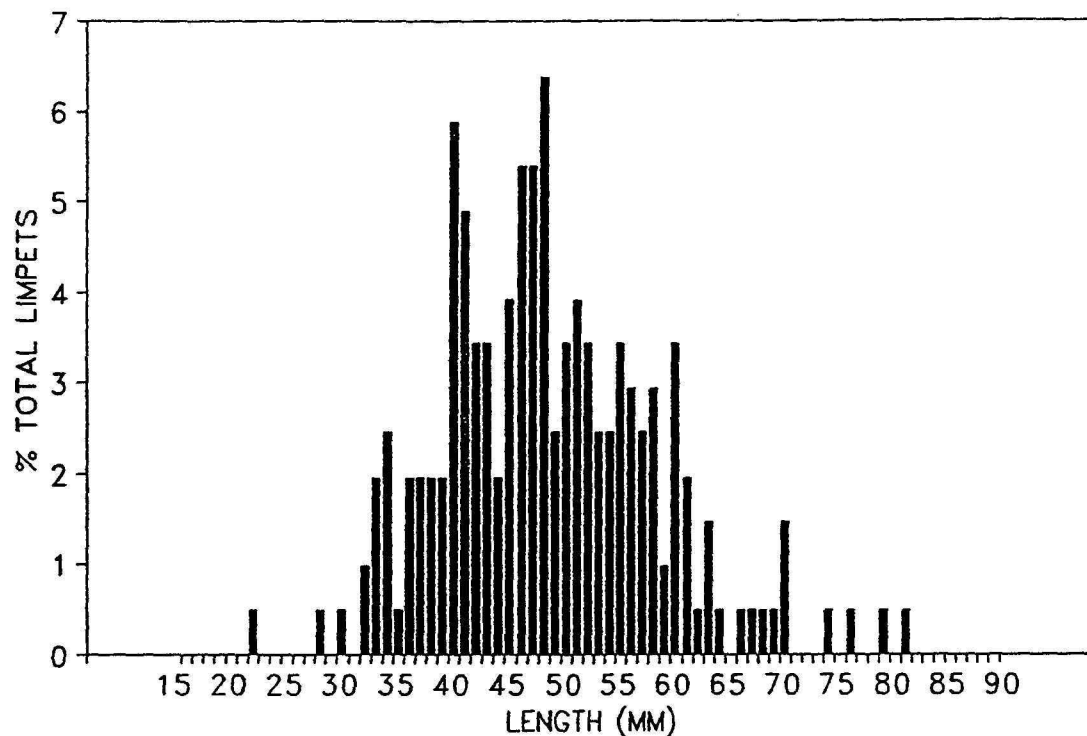


Figure 4B.

Owl Limpet Length Frequency Distribution
For Area II During Spring 1990

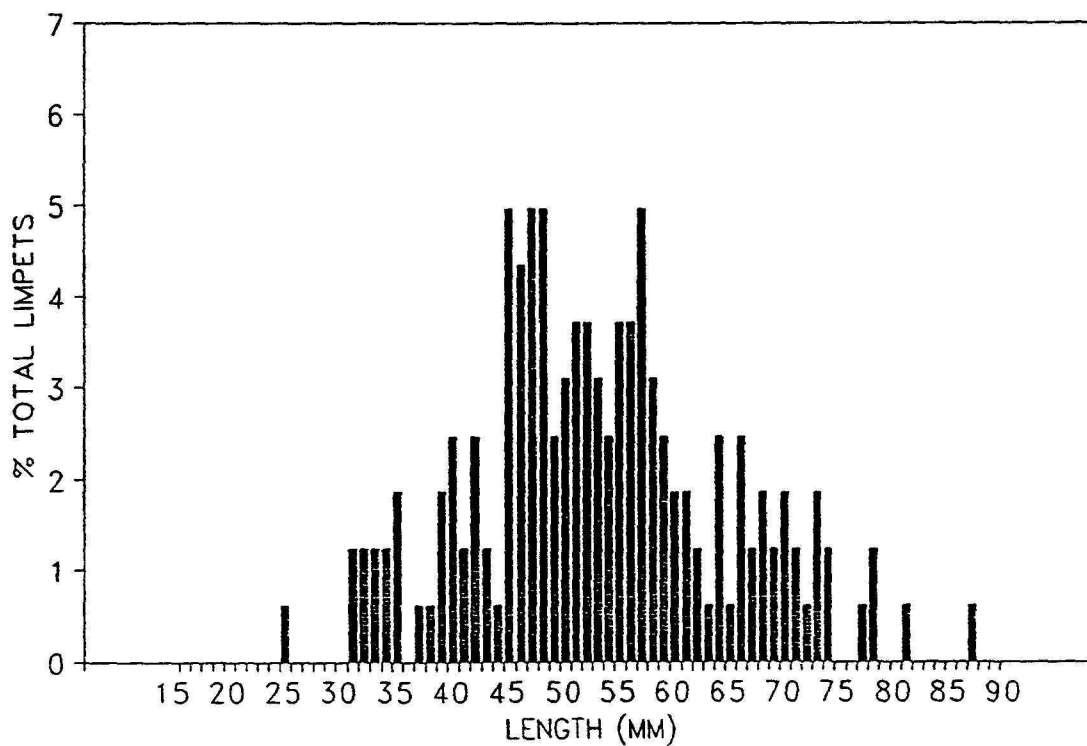


Figure 4C.

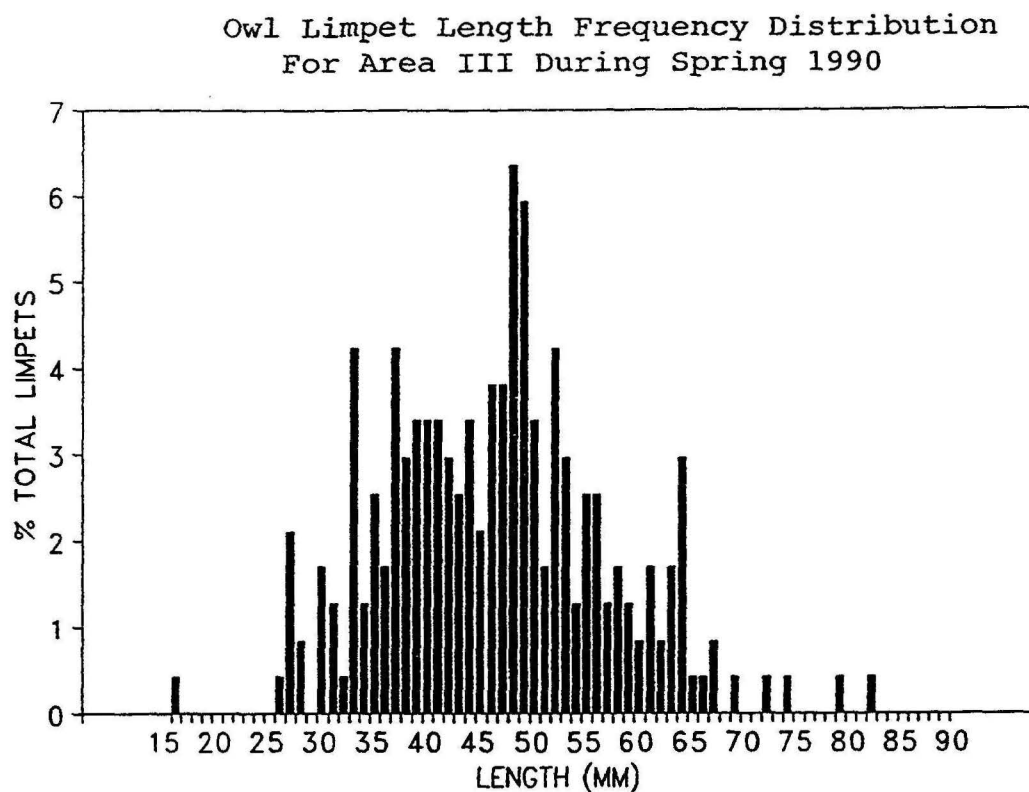


Figure 4D.

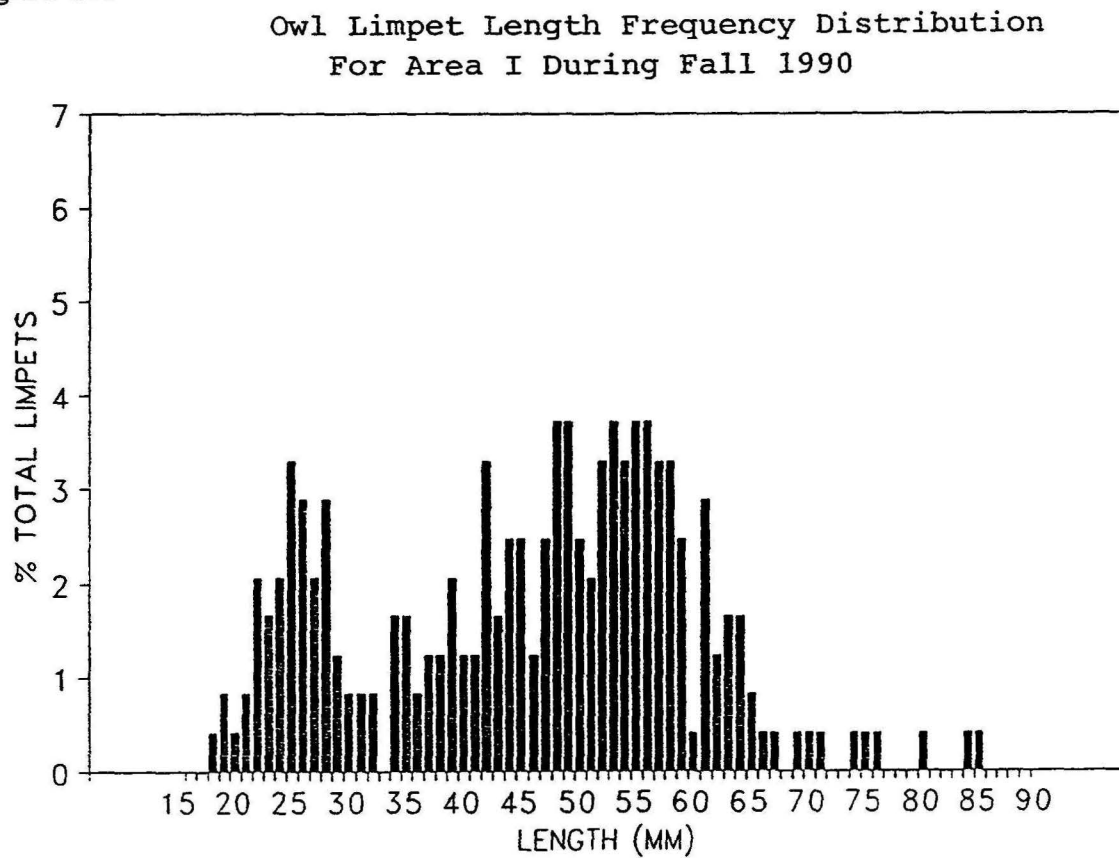


Figure 4E.

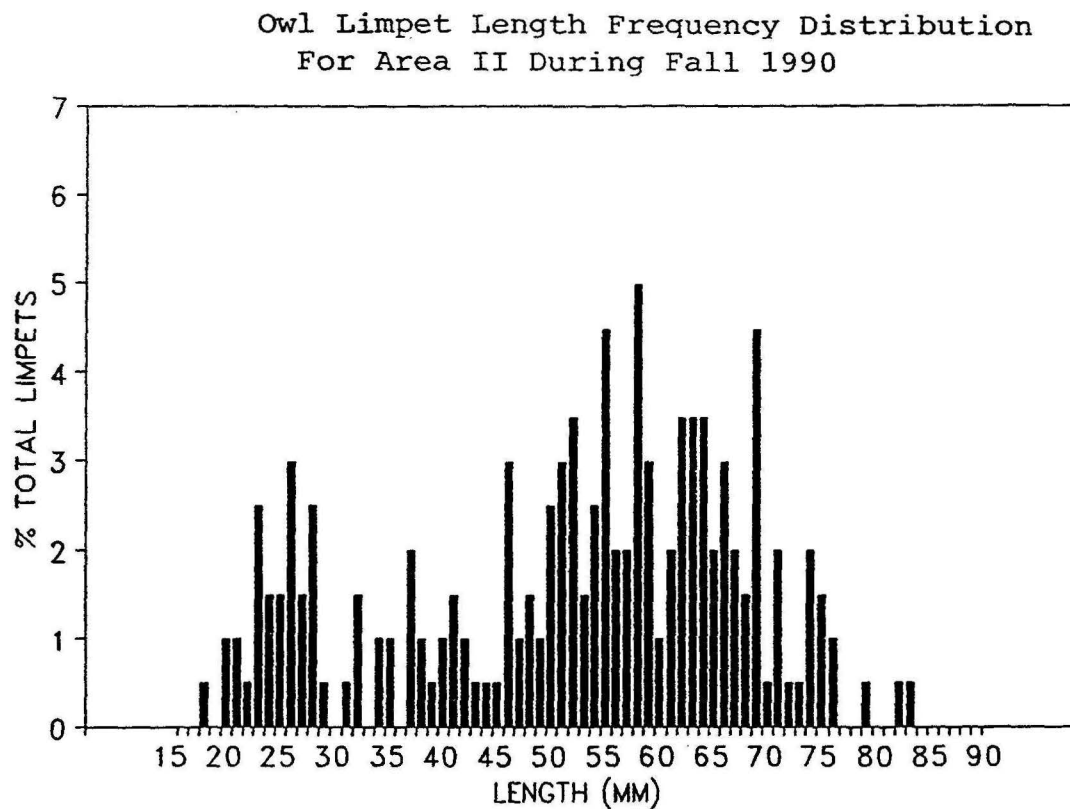
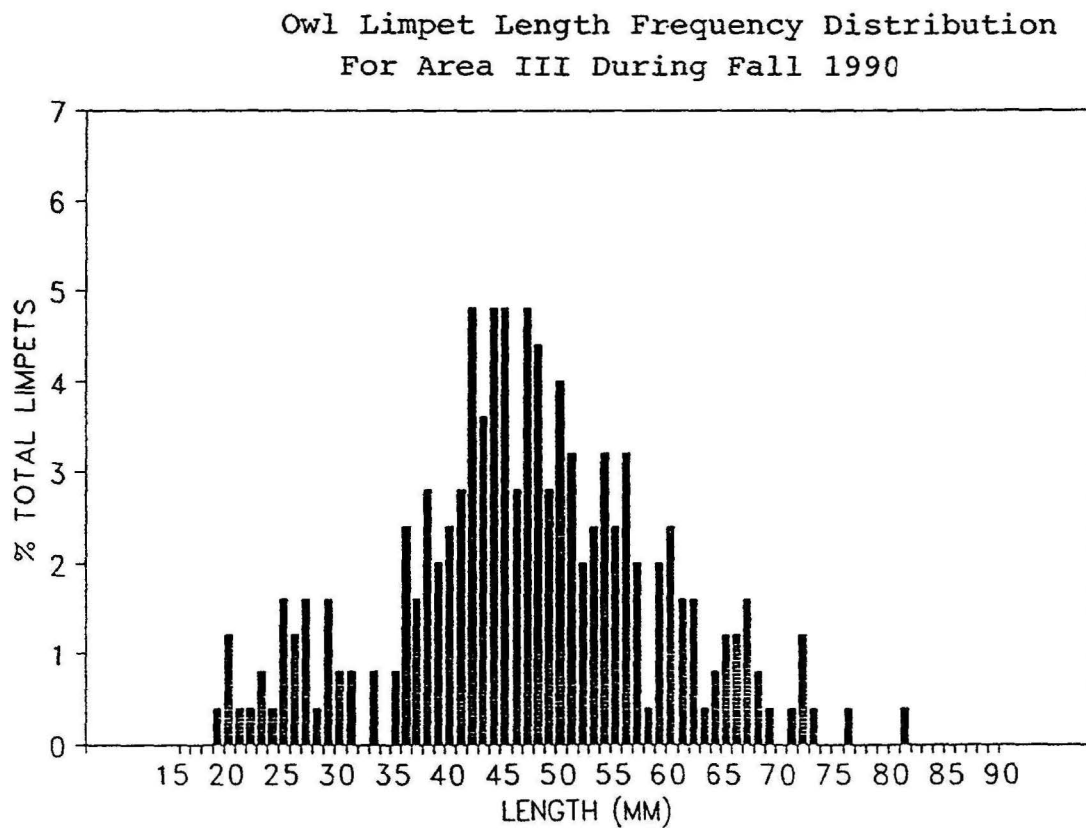


Figure 4F.



DISCUSSION

Table 10 summarizes abundance of human visitors, selected organisms, and substrate for spring and fall surveys in Areas I, II, and III. Where equivalent data exist, general comparisons with surveys by Zedler (1976, 1978) 13-14 years ago may provide insight into public use and resource conditions. Without fixed plots from the early surveys, it is not possible to make reliable direct comparisons, and with only two observations (1976-77 and 1990) it is not possible to identify trends in resource conditions. For example, even though the maximum number of people at any one time in the area adjacent to the access point (Areas I & II) appears to have more than doubled from 160 in the late 1970's to 325 in 1990, it is not possible to correlate this apparent increase with resource conditions beyond qualitative observations. It is clear that abalone, sea stars, and mussels that were commonly found in this area during the mid-1970's were either missing or greatly diminished in 1990, and that most wading and shore birds avoided people and were unable to effectively forage in Areas I & II during much of the low tide in 1990.

Several components of the monument's intertidal community are clearly stressed, but others seem to be holding up to public use rather well. Red algal turf covered 90% to 95% of the flat, mid-level, rocks in the late 1970's and was experimentally reduced to 1990 levels of 79% to 83% only after stepping on plots 200 to 300 times. The seasonal increases in surf grass cover observed in 1990 were consistent with earlier observations, but in 1990 the fall cover reached only 69% to 72%, whereas in 1976 it was 95% in Area II. Spring rockweed cover on boulders in Area I was the same in 1976 and 1990 (58% to 59%), but the 1990 fall peak of 62% fell far short of 1976's 86%. California mussels were very abundant on boulders throughout the monument in the late 1970's, occurring in mean densities of 220 to 568 m⁻². In 1990,

California mussels were rare, patchy, the highest mean densities in Area I & II photoplots were only 35-75 m⁻², and they were nearly all old large individuals. Even more disturbing was the 38% decline in mussel abundance during 1990 alone. Fragile sand castle worms, *Phragmatopoma californica*, common in 1976, were virtually absent in the spring, but common under rockweed thatch in the fall during 1990. Owl limpets appear to have increased in both abundance and maximum size between 1977 and 1990, while mean sizes remained essentially the same (50 vs 48 mm). Continued seasonal and annual monitoring is needed to determine whether these apparent changes were the result of cumulative human effects or were just chance variation. Clearly, the current low or declining abundances of ecologically important taxa such as abalones, mussels, sea stars, and shore birds is cause for serious concern.

Table 10. Summary of Public Use of Selected Intertidal Taxa in Cabrillo National Monument, California during 1990.

Taxa	Area I		Area II		Area III		All Areas	
	Spring	Fall	Spring	Fall	Spring	Fall	Spring	Fall
Owl Limpets ^a $\bar{x}$ #	34	40	27	34	39	42	33	38
$\bar{x}$ size	48	46	53	52	46	47	49	48
<i>Lottia gigantea</i>								
Goose Barnacles ^b <i>Pollicipes polymerus</i>	5%	5%	4%	3%	3%	7%	4%	5%
Boa 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%	81%	73%	75%	90%	80%	83%	79%
Sargassum Weed ^b <i>Sargassum muticum</i>	0%	0%	6%	0%	3%	2%	1%	<1%
Anemone ^b <i>Anthopleura elegantissima</i>	2%	1%	1%	1%	2%	15	25	1%
Bare Substrate ^b (All Line Transects)	7%	6%	10%	8%	6%	9%	8%	8%
Bare Rock ^b (All Photo Plots)	33%	30%	27%	18%	29%	25%	30%	24%
Mussel ^b <i>Mytilus californianus</i>	16%	9%	55%	30%	47%	34%	39%	24%
Rock Weed ^b <i>Pelvetia fastigata</i>	16%	9%	55%	30%	47%	34%	39%	24%
Barnacle ^b <i>Tetraclita rubescens</i>	20%	16%	30%	17%	22%	29%	24%	21%
Visitors ^a (Relative Abundance Index)	80	73	24	30	6	18	110	121
Birds ^a (Wading and Shore)	5	8	14	9	67	35	86	52

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

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