THE MARINE ENVIRONMENT IN THE VICINITY OF DIABLO COVE WITH SPECIAL REFERENCE TO ABALONES AND BONY FISHES

RESOURCES AGENCY
CALIFORNIA
DEPARTMENT
FISH & GAME

by

Richard T. Burge and Steven A. Schultz

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ABSTRACT

Diablo Cove, a future warm water discharge site, is located about midpoint of a 13 mile long rocky shoreside reef in central California. The reef, physically isolated from other similar coastal areas, supports important kelp bed communities of nonmigratory vertebrates and invertebrates that must be constantly monitored to ensure they are protected.

This 2 year study is a base line inventory done in the vicinity of Diablo Cove with major emphasis on abalones, including their food chain, and bony fishes. Data was obtained on the life history and annual canopy development of the kelp *Nereocystis* and all macroalgae were cataloged. Seasonal collections of fishes were made to document those species indigenous to the system and to obtain life history information on the common forms.

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ERRATA: After Page 322, the remaining pages should read Page 323 to Page 423.

On Page 88, line 7, "6 - 10mm" should read " 6 - 10cm".

ACKNOWLEDGMENTS

This study was established through Research Contract No. S-1902 between the Pacific Gas and Electric Company and the State of California, Resources Agency. Under this contract, the Department of Fish and Game agreed to conduct a pre-operational marine environmental study at Diablo Canyon, San Luis Obispo County, to establish a base line inventory of the marine biota with special reference to abalone, including its food chain, and to bony fish.

It was only with the help of many Department divers, vessel operators, and others that the seasonal fish collections were possible. The following assisted in one or more of these operations: Jack Ames, Glen Bickford, Kenneth Boettcher, James Bybee, Dale Clifton, William Craig, James Dixon, John Duffy, Earl Ebert, John Fitch, John Geibel, Russel Goodrich, Daniel Gotshall, James Hardwick, Robert Hardy, Arthur Haseltine, Bobby Horacek, Wayne Klein, Robert Lea, Kenneth Mais, Howard Martin, Clifford Matthews, Michael Mazorovich, William McGuire, Daniel Miller, Melvin Odemar, Daniel Odenweller, Gordon Richardson, Thomas Riley, Bruce Sanford, Alex Strachan, Hugh Thomas, Charles Turner, Paul Wild, Kenneth Wilson, and Daryl Yount. Robert Lavenberg and Camm Swift, Los Angeles County Museum, and James Adams and Brian Waters, Pacific Gas and Electric, also assisted in these collections.

Jack Ames, Dale Clifton, John Duffy, Earl Ebert, Robert Hardy, Bobby Horacek, Melvin Odemar and Ken Wilson gave occasional diving assistance during subtidal surveys.

Earl Ebert helped in the original survey planning, in setting the permanent stations and in making preliminary surveys including plant and animal identifications in 1969. Ebert furnished much of the data on *Nereocystis*, especially that from Point Estero. James Adams also helped in the tiring task of cementing permanent intertidal station markers.

Those assisting in transplanting abalones included Glen Bickford, Dale Clifton, James Dixon, Russel Goodrich, Wayne Klein, Howard Martin, Thomas Riley, Hugh Thomas, California Department Fish and Game; James Adams, Edward Colson, Joel Knee, Vince Kosorack, Donald Price, Roland Richardson, Russel Theberge, John Warrick, Brian Waters, Pacific Gas and Electric Company; Ernest Porter, Gerald Lopez, Dean Tyler, and several other commercial abalone divers; and many professors and students from California Polytechnic College.

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Mostly, we would like to thank John Fitch, Robert Lavenberg, Camm Swift, and Shirley Sparling for helping us during field and laboratory work. Shirley Sparling checked and identified most of the specimens in our marine algae reference collection and gave us added confidence to work in this field.

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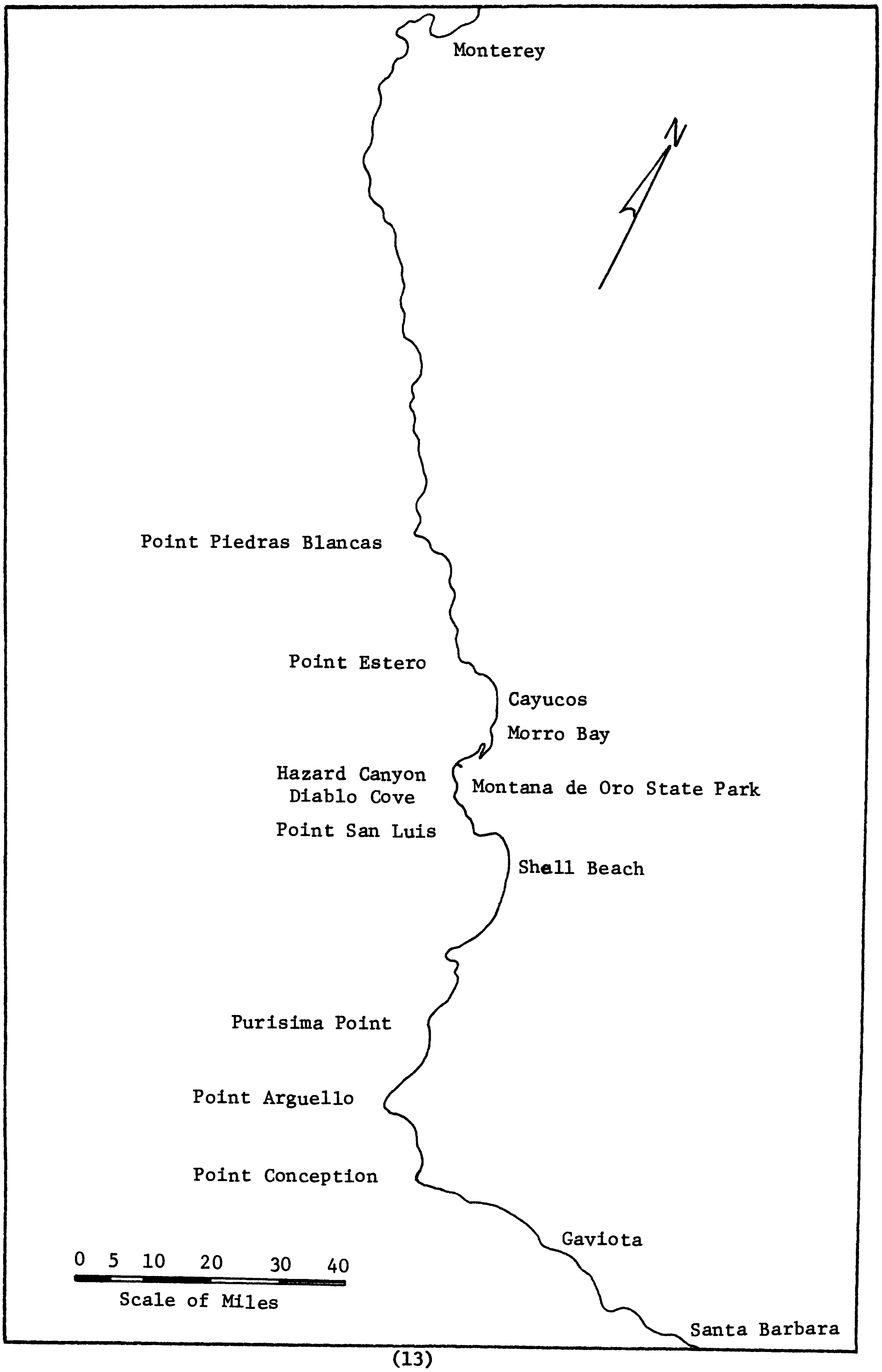
Lavenberg and Camm Swift also helped during the fish collection, spent many laboratory hours working on the fishes, and supplied the data from SEARCHER trawl stations off Diablo Canyon. Robson Collins, Robert Lea, Herbert Fry, and Shirley Sparling edited the manuscript.

INTRODUCTION

Diablo Cove (120° 51' 23"W Longitude, 35° 12' 44"N Latitude) is located about midway on a 13 mile rocky shoreside reef that extends from Hazard Canyon to Point San Luis, San Luis Obispo County. The reef is physically isolated from other rocky habitat by long expanses of sandy beaches. To the north of Hazard Canyon the nearest significant rocky area is above Cayucos, about 10 miles distant. South of Point San Luis only a few small rocky areas such as Shell Beach and Point Sal interrupt a long sandy stretch to Purisima Point -- a distance of some 30 miles (Figure 1).

The reef supports important communities of vertebrates and invertebrates each integrally dependent upon the other and upon the dense stands of canopy forming kelps and lower growing algae. Inhabitants of the adjacent sandy bottom areas are entirely independent from this fauna. The Diablo Cove reef communities must therefore self perpetuate; they must recruit from within rather than from nearby coastal areas. Damage to or extermination of such a reef fauna would result in extremely slow recovery due to the reef's isolation and the nonmigratory behavior of the indigenous species. If such destruction were to occur, only a few stray fishes and unknown numbers of larvae and spores would reach the area during any given year to form a nucleus for the gradual rebuilding of the community. For these reasons it is imperative to protect the existing fauna and to monitor constantly the areas adjoining Diablo Cove.

Figure 1. California shoreline from Monterey to Santa Barbara with special reference to Diablo Cove and other important land marks.



Investigations of the extensive Indian middens in the Diablo Cove area have shown the continued importance of this shoreside reef in man's economy for more than 7,000 years. Today it supports an abalone fishery of prime importance to sport divers and to commercial fishermen from Morro Bay and Avila. In fact the area between Hazard Canyon and Point San Luis is now the only major contributor to Morro Bay and Avila commercial red abalone landings. Some sport fishing for abalones and rockfishes exists at Montana de Oro State Park and at Pt. San Luis, but access is restricted by land to most of the area. Only a few sportfishermen in private or party boats presently utilize the remaining area. As local communities and tourism increase, the importance of the reef to the local sportfisheries should markedly increase.

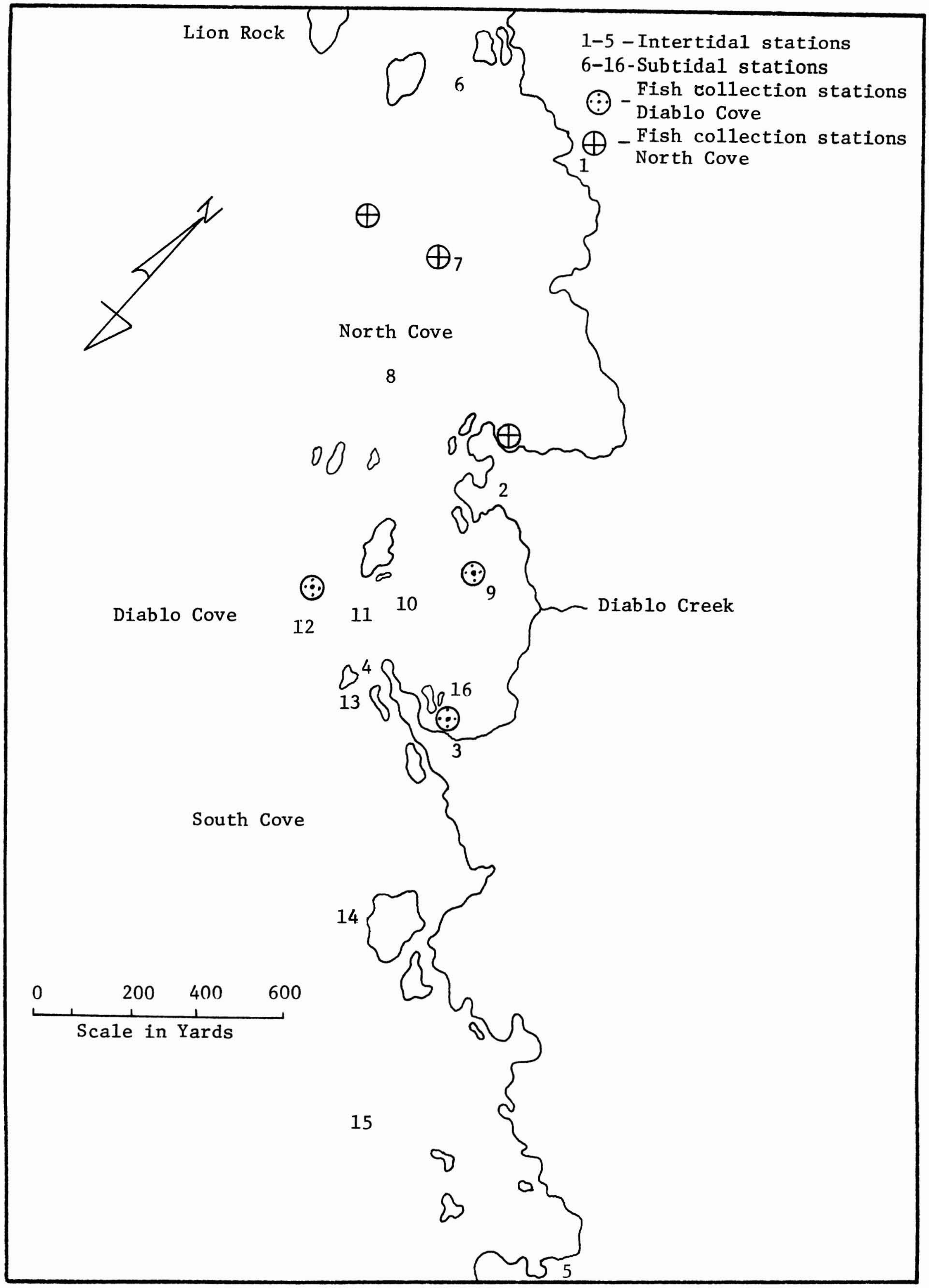
Permanent intertidal and subtidal stations were selected as the initial phase of this study. These stations were essential to establish a base line to document seasonal, annual, and spatial biotic variations inherent to this specific marine system. Surveys at these stations were conducted during three periods of 1970 and 1971: (1) February-March, to document the reduction in marine flora during the winter and to determine if fish and invertebrate populations declined or moved from or about the area during this period, (ii) June-July, to record the early summer algae bloom, (iii) September-October, to document the peak bull kelp, *Nereocystis luetkeana,* canopy and to note any southern migrant fish that may frequent the area during the fall warmer water period.

Additional seasonal collections of fishes were made to document those species typical to the nearshore area and to obtain life history information on the more common forms. Many nocturnal forms and crevice or gravel dwellers that were not observed during subtidal diving surveys were collected.

Physical data such as station makeup, surface and bottom temperature, and water clarity were recorded for each survey date. Daily surface water temperatures were also taken by a continuous recording themograph suspended in the mouth of Diablo Cove. Additional reconnaissance within the Diablo Canyon study area (Figure 2) allowed a brief description of the geological formations and related biological findings at permanent stations to the total system.

Information available at the date of this report on the effects of a warm water discharge into a temperate, nearshore, rocky marine environment is not sufficient to judge what changes in the biota or life history patterns may occur in the Diablo Canyon area. The information obtained from this preoperational survey along with that furnished by North (1966), Cayot and North (1968, 1969), Adams et. al. (1972), and Ebert (1966) may assist the Resources Agency, the Central Coast Water Quality Board, and other regulatory agencies in their evaluation of the heated water discharge into Diablo Cove.

Figure 2. Diablo Canyon study area including location of permanent intertidal and subtidal stations and fish collection sites.



METHODS AND MATERIALS

We established five permanent intertidal and 11 permanent subtidal stations in the study area. The five intertidal stations consisted of 11 transects and 22 quadrats which were located by cementing small building blocks to the substrate. Transect (2 m wide) and quadrat (1/4 m^2 in area) positions were set by placing epoxy putty in chiseled depressions. Two stations were located inside Diablo Cove on sheltered rocky beaches. A third was located along the wave pounded south point. Control stations were positioned approximately one mile north and one mile south of the cove (Figure 2).

At the intertidal stations we counted abalones and noted their food items (marine algae) and associates. Abalone associates include competitors (e.g., sea urchins, *Strongylocentrotus* spp.) and predators (e.g., rock crabs, *Cancer antennarius*). When it was not feasible to make actual counts, as with most species of algae, relative abundance was estimated. A photographic record in color was made during each survey of the 1/4 m^2 quadrats.

The 11 permanent subtidal stations were constructed by cementing 5 foot lengths of 3/4 inch polypropylene rope to the substrate at 10 or 15 m intervals to delineate 30 x 2m transects. Four of these stations were positioned along a line bisecting the cove in progressive depths of 20, 35, 50, and 70 feet. A shallow station in 10 feet of water was set in the south corner (Station 16) of the cove rather than along the line of the four deeper stations to avoid proposed construction activities. Six control stations were set in bull kelp beds outside Diablo Cove, three to the north and three to the south at intervals of about 1/3 mile, to measure the seasonal abundance of this important marine alga (Figure 2).

Diving operations at these 11 subtidal stations were conducted from the Department's research vessel Mollusk. The data recorded during seasonal diving surveys included: (i) counts of abalones and their associates, (ii) relative abundance estimates of marine algae, (iii) bony fish (actual counts were made when possible, large numbers of fish in schools were estimated), and (iv) physical information such as surface and bottom water temperatures, estimated water clarity, and such general bottom characteristics as depth, type, and relief.

Seasonal fish collections were made during May and September 1970 and January 1971 to identify and enumerate the many small bottom, crevice, and gravel dwellers that are not normally seen during diving surveys. Three stations were occupied during each survey at 0-10 (shore), 20, and 70 foot depths (Figure 2).

One additional fish collection at similar depths was made in North Cove to determine what difference, if any, might occur in species composition and density outside Diablo Cove.

Divers treated approximately 4,000 square feet at each fish collection station with 3 to 5 gallons of "Chem-fish Collector", waited for the chemical to take effect, and then retrieved all fish available with nets and collecting bags. Many of the larger fishes and many of those in the midwater column were not seriously affected by the treatment or were able to escape the area when the chemical was first spread.

General observations and diving counts of *Nereocystis* during the first year indicated that annual distribution and abundance is variable. To document further this important kelp, the canopy was surveyed with a 20x spotting scope during peak sporophyte development each October. Actual counts of sporophytes were made within the cove while the relative abundance and positions of the larger beds were mapped for the total study area.

DESCRIPTION OF STUDY AREA

The shoreline between Hazard Canyon and Point San Luis is characterized by sheer, wave eroded cliffs, jutting headlands, and massive offshore rocks and reefs. The tidal zone is generally narrow and may terminate abruptly where protection from wave shock is minimal and deposition is reduced or absent. These topographical features form a highly irregular coastline, providing many different exposed and protected habitats that may extend or control the abundance and composition of marine plants and animals.

Diablo Cove is the largest indentation in this area, and occupies about 32 acres. Protection derived from offshore rocks and bounding points offers relatively calm conditions inside the cove in comparison to the surrounding area. The tidal zone along the entire inside perimeter of the cove is wider than normal, consisting of beveling layers of bedrock and large strewn boulders continuous to 10 or 15 foot depths. These formations provide numerous protective crevices and ledges for abalones and other sedentary marine invertebrates and cryptic fishes.

The subtidal cove bottom is traversed by rocky reefs that generally parallel the shoreline in 15 to 40 foot depths. Wave eroded materials are deposited between the reefs. Boulders, gravel, and coarse sand gradually grade to finer materials at greater depths.

Massive submerged reefs and large boulders form much of the subtidal bottoms adjacent to Diablo Cove. The structure of these reefs may form pinnacles and emergent rocks, or a lower relief of ridges, ledges, crevices and flats. This substrate provides good habitat for abalones and hard stable surfaces for the attachment and development of canopy forming kelps and shorter growing seaweeds.

RESULTS OF INTERTIDAL SURVEYS

Abalone Distribution and Abundance

Black abalones, *Haliotis cracherodii*, were one of the most common and conspicuous animals found in the intertidal throughout the study area. Because the substrate makeup affords excellent habitat, and access is restricted, the population in most areas is substantial. In the low tidal zone (0 to about -2.0 feet mllw), exposed only at minus low tides, a transition to red abalones, *H. rufescens*, begins although blacks remain dominant.

Counts of abalones varied considerably at permanent intertidal transects during seasonal surveys. This variation reflected several factors including: (i) abundance of marine algae, e.g., *Iridaea flaccida*, which blankets the substrate during some periods; (ii) differences in tidal and ocean conditions and; (iii) the number of biologists conducting each survey.

The highest total count during 1970 was made during the winter (1,045 black abalones, 8 transects) while the lowest count (714 black abalones, 10 transects) was made during the summer, reflecting mostly the masking effect of a dense algal cover (Table 1). One extreme low count was recorded at Station 2 during the summer when only one biologist and and one photographer were working. This strongly suggests the need for at least two biologists (plus photographer, etc.) to conduct these diversified quantitative surveys since the short low tidal period limits the time available and accomplishments of each individual.

TABLE 1. Abundance of Black Abalones, *Haliotis cracherodii*, Red Abalones, *H. rufescens*, Rock Crabs, *Cancer antennarius*, and Sunflower Stars, *Pycnopodia helianthoides*, at Intertidal Transects During 1970.

Transect	Number of Surveys	Counts of Black Abalones			Mean No. of Black Abalones	Counts of Red Abalones			Mean No. of Red Abalones	Counts of Rock Crabs			Mean No. of Rock Crabs	Counts of Sunflower Stars			Mean No. of Sunflower Stars
		*W	S	F		W	S	F		W	S	F		W	S	F	
1A	3	223	124	127	158	0	0	0	0	0	0	0	0	0	0	0	0
1B	3	292	285	387	321	0	0	0	0	0	0	0	0	0	0	0	0
2A	3	274	81	189	181	3	3	1	2.3	0	0	0	0	0	0	1	.3
2B	3	95	64	69	76	0	2	5	2.3	0	0	0	0	0	1	1	.7
3A	3	25	11	20	19	0	0	2	.6	0	1	0	.3	0	2	1	1.0
3B	3	40	34	41	38	0	6	0	2.0	0	0	0	0	0	1	0	.3
4A	3	56	61	51	56	0	0	0	0	0	0	1	.3	0	0	0	0
4B	2	-	21	55	38	-	0	0	0	-	0	0	0	-	0	0	0
4C	3	40	11	34	28	0	0	0	0	0	0	0	0	0	0	0	0
5A	1	-	22	-	22	-	0	-	0	-	0	-	0	-	1	-	.3
Totals		1,045	714	973	937	3	11	8	7.2	0	1	1	.6	0	5	3	2.6

*W = Winter survey
S = Summer survey
F = Fall survey

During 1971, transect counts increased but the differences between seasonal surveys decreased markedly (Table 2). The winter counts were slightly higher but the range between seasonal surveys was unexpectedly low considering the many physical and biological variables in counting conditions. The average count for every station was higher than in 1970. The higher means of the 1971 stations and the decreased seasonal range suggest that surveyors were more familiar and efficient than in the previous year and that the 1971 station means closely approached the countable population.

Red abalone counts were highest each summer, suggesting that to make accurate measurements of densities of this species in the intertidal one must depend on both calm ocean conditions and extreme low tides.

The highest abalone counts are also considerably below their actual abundance levels as most juveniles and many adults are cryptic, living under boulders and deep in crevices during daylight hours. An unknown percentage of the population is therefore not available to practical sampling methods. Only visible abalones were counted during these surveys, since to prevent alteration and destruction of the habitat and associated flora and fauna, boulders and bedrock were never turned or broken. However, these counts can be used as a standard if the same stations are resurveyed using the same sampling techniques.

The higher 1971 counts of black abalones (937 total of seasonal means for all transects in 1970 compared to 1,247 in 1971) presumably represents increased efficiency and familiarity of the area by the surveyors rather than an increasing abalone population or annual variation. This difference may well be representative of sampling error from increased efficiency attributable to any long term quantitative investigation in an unknown marine environment.

TABLE 2. Abundance of Black Abalones, *Haliotis cracherodii*, Red Abalones, *H. rufescens*, Rock Crabs, *Cancer antennarius*, and Sunflower Stars, *Pycnopodia helianthoides*, at Intertidal Transects During 1971.

Transect	Number of Surveys	Counts of Black Abalones			Mean No. of Black Abalones	Counts of Red Abalones			Mean No. of Red Abalones	Counts of Rock Crabs			Mean No. of Rock Crabs	Counts of Sunflower Stars			Mean No. of Sunflower Stars
		*W	S	F		W	S	F		W	S	F		W	S	F	
1A	3	186	243	214	214	0	0	0	0	0	1	1	.7	0	0	0	0
1B	3	419	372	343	378	0	0	0	0	0	0	0	0	0	0	0	0
2A	3	247	272	281	267	2	4	2	2.7	0	0	0	0	0	0	2	.7
2B	3	118	122	100	113	3	7	1	3.6	0	0	1	.3	1	1	2	1.3
3A	3	22	7	37	22	2	2	3	2.3	0	0	3	1.0	0	0	2	.7
3B	3	45	39	54	46	6	8	8	7.3	0	1	5	2.0	0	1	3	1.3
4A	3	69	87	65	74	0	0	0	0	3	2	0	1.7	0	0	0	0
4B	3	85	22	59	55	0	0	0	0	0	0	0	0	0	0	0	0
4C	3	47	36	48	44	0	0	0	0	0	2	0	.7	0	0	0	0
5A	2	-	38	30	34	0	-	0	0	0	-	0	0	0	-	0	0
Totals		1238	1238	1231	1247	13	21	14	15.9	3	6	10	6.4	1	2	9	4.0

*W = Winter survey
S = Summer survey
F = Fall survey

The highest density of black abalones was always recorded inside Lion Rock at control Station 1, about 1 mile north of Diablo Cove. The highest transect (28 x 2m) count here of 419 black abalones (7.48/m^2) was made in February, 1971. The average density for the station during the study period was 7.05 black abalones/m^2. A permanent 1/4 m^2 quadrat monitored at this station (1Ab) contained a 2 year average of 13 black abalones. The seasonal photographs of this quadrat indicated the same adult black abalones were always present and remained in relatively the same positions throughout the study period.

Densities of black abalones inside Diablo Cove were generally lower, as revealed by both transect counts and casual observations. However, a sizable population was observed throughout the northern section of the cove which is represented by Station 2. There, from 81 to 281 blacks were counted along two transects (30 x 2m and 33 x 2m) with an average density of 2.72/m^2 during the study period.

Lower counts of blacks ranging from 7 to 54 (.50/m^2) were recorded along two transects (30 x 2m and 38 x 2m) at Station 3, which appeared representative of the southern section of the cove. Station 4, selected to represent exposed sea conditions for the cove, yielded higher counts than Station 3. The range in transect (11 x 2m, 13 x 2m, 19 x 2m) counts at Station 4 was 11 to 87 and the average density was 1.72 blacks/m^2.

Juvenile black abalones, 1/4 - 1/2 inch in length, were often observed living with purple urchins, *Strongylocentrotus purpuratus*, in their depressions. Fifteen juveniles were recorded from quadrat 1Aa during the fall of 1970 while only one was present during the following winter. Juvenile abalones of other species are found in similar associations with the red urchin, *Strongylocentrotus franciscanus*. Red abalones are often seen deep in crevices lined by red urchins. Threaded abalones, *Haliotis kamtschatkana assimilis*, and red abalones are occasionally found living under red urchin tests. The reasons for these associations are not established, but the urchin (and its depression in this situation) obviously provides protection and may provide bits of food for the very small abalones. Other invertebrates such as limpets (*Acmaea mitra, Collisella pelta*), chitons (*Tonicella lineata, Nuttallina californica*) and anemones (*Anthopleura elegantissima*) were also associated with (or without) urchins in these depressions.

Red abalones were observed only inside Diablo Cove at wave protected Stations 2 and 3, and only in low tide zone positions. Reds were generally under large boulders or overhanging ledges in shaded or submerged places. The highest count of 21 (.57/m^2) red abalones from the low zones at these two stations was made during the summer of 1971. The lowest count of only three reds (.08 m^2) was made during the first survey in the winter of 1970. This difference reflects both increased familiarity and efficiency of the surveyors and the calmer ocean conditions that existed during the summer of 1971.

Abalone Predators - Composition and Abundance

Only a few known predators of adult abalone were observed in the intertidal and their numbers were usually low. Turbulence during rougher ocean conditions and extreme tidal exchanges may restrict a majority of the soft bodied or swimming types of predators from this region.

A few rock crabs, *Cancer antennarius*, were observed during most surveys, generally inside the cove at protected stations. A high of 10 rock crabs was counted during the fall of 1971, while none was observed during the 1970 winter survey. Juvenile rock crabs, both *C. antennarius* and *C. productus*, were common under rocks in the mid and low tide zones inside Diablo Cove.

Sunflower stars, *Pycnopodia helianthoides*, were also occasionally observed inside Diablo Cove. A high of nine *Pycnopodia* was counted during the fall of 1971 while low counts were recorded during the winter of 1970 (0) and 1971 (1). A large 2 foot specimen was observed feeding on a black abalone during October 1970 at Station 3. The seasonal difference in abundance of both rock crabs and sunflower stars indicates that these predators move on shore during the calmer oceanic periods of summer and fall, presumably to feed on invertebrates including abalones.

Cabezon, *Scorpaenichthys marmoratus*, were observed in less than 10 foot depths during reconnaissance dives and occasionally at the shallow 5 to 10 foot diving station (Station 16). Large numbers of both adult and juvenile cabezon were taken on seasonal fish collections at the shore 0-10 foot station; a high of 38 cabezon, mostly juveniles, was taken during the January 1971 collection. These records indicate that cabezon are quite capable of foraging throughout the intertidal whenever inundated.

Abalone Competitors - Composition and Abundance

Algivores appeared in balance with expected community structures throughout the study area. The black turban, *Tegula funebralis*, was possibly the most abundant and ubiquitous algivore in the intertidal. They were most abundant in the mid and high intertidal zones* in protected cove areas, but were also occasionally recorded (usually as sparse) in the low intertidal and in exposed areas. A high zone 1/4 m^2 quadrat

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* See Appendix I for a definition of the intertidal zones of this study.

(3Ad) during 1970 yielded counts of 168 *T. funebralis* in the winter, 49 in the summer, and 40 in the fall. Counts from a mid zone quadrat (2Bb) in 1971 ranged through 0 in the winter, 26 in the summer, and 10 in the fall. These differences, and similar data from other permanent intertidal quadrats, indicate considerable movement of the species and suggest a migration during winter months with a percentage of the population moving to higher intertidal regions. Large numbers of *T. funebralis* were often observed in high tide pools during winter months in areas where drift algae (as *Nereocystis, Pterygophora,* etc.) accumulated.

The brown turban, *Tegula brunnea*, was generally found sparse in all low tidal zone areas and was recorded on diving surveys to 30 foot depths. The red turban, *Astraea gibberosa*, and the costate top snail, *Calliostoma ligatum*, were occasionally seen but were nowhere considered numerous. Other algivores that we counted seasonally at the 1/4 m^2 quadrats included many species of limpets that were often quite numerous in the mid and high zones such as *Collisella digitalis, C. pelta, C. scabra*, and *Notoacmaea scutum*, and several species of chitons including *Nuttallina californica* and *Tonicella lineata*. The conspicuous chiton, *Stenoplax conspicua*, was common under boulders in the mid and low tidal zones in the cove, but was rarely recorded from a permanent quadrat due to its cryptic nature.

Purple sea urchins were burrowed into flat, exposed surfaces in the mid and low zones at Stations 1 and 4, but were rarely recorded or observed in protected cove areas. Counts at high density quadrats averaged 20 to 51 per 1/4m^2 for the 2 years (Table 3). Seasonal variation in counts of purple urchins was depicted from these data, indicating a drop in the observable population level from the winter to summer. Total counts for all four quadrats for both years averaged 139 during the winter, 115

TABLE 3. Counts of Purple Sea Urchins, *Strongylocentrotus purpuratus*, From Four Wave Exposed Quadrats at Intertidal Stations 1 and 4 During 1970 and 1971.

Season	Quadrat 1Aa	 1Ab	 1Ba	 4Aa	Total
Winter 1970	46	28	33	21	128
Summer 1970	39	15	47	15	116
Fall 1970	61	31	38	20	150
Winter 1971	59	33	33	25	150
Summer 1971	48	17	36	14	115
Fall 1971	54	31	37	24	146
Average	51.16	25.8	37.3	19.8	

Seasonal Totals	139 Winter
	115 Summer
	148 Fall

during the summer, and 148 during the fall. Recruits from spring or summer spawns apparently do not reach visible size (of about 1/8 to 3/16 inches) until the fall survey periods. Annual variation for the 2 years was not apparent with totals of 150 for four quadrats in the fall of 1970 and 146 in the fall of 1971.

Abundance levels of the aggregate anemone, *Anthopleura elegantissima*, and the solitary anemone, *A. xanthogrammica*, were relatively low and neither species appeared to be actively displacing either black or red abalones. However, changes in environmental conditions that enhance the reproductive, settling or survival rate of either or both anemones might place them in direct competition with abalones for space. Data for the two species are therefore presented for quadrats where each occurred (Table 4).

In many areas, as at Stations 1 or 4, the aggregate anemone was found in purple urchin depressions. In other areas, as at Stations 2 and 3, a few anemones in small to large clusters were observed in sandy areas or on flat bedrock. In the high zone at Station 4, aggregate anemones were quite common in clusters on bedrock and sandwiched between California sea mussels, *Mytilus californianus*.

The solitary anemone was found attached to rocky substrate in shaded areas and in tide pools. They were sparsely distributed in the lower zone of most transects.

Intertidal Marine Plants*: Composition, Distribution, Variation, and Relative Abundance

One hundred eleven species of intertidal marine algae and two flowering plants were observed in the Diablo Canyon study area. Only

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* The scientific names of marine algae in this report primarily follow those presented by Gilbert M. Smith, 1969, in "Marine Algae of the Monterey Peninsula, Second Edition."

TABLE 4. Counts of Solitary Anemones, *Anthopleura xanthogrammica*, and Aggregate Anemones, *A. elegantissima*, at Quadrats Where They Most Frequently Occurred During 1970 and 1971.

Season	Quadrats 1Aa	1Ab	1Ac	1Ba	2Bc	4Aa	4Ba	4Ca
Winter 1970	4	*(10)		4	7	3	1	**C
Summer 1970	7	(7)	3		7	2		A
Fall 1970	8	(5)			2	4		A
Winter 1971	7	(6)	1		1			C
Summer 1971	11	(6)	1		2	2	1	C
Fall 1971	6	(6)			3	3		A

* Those counts listed in parenthesis (N) are *A. xanthogrammica*, all other counts are *A. elegantissima*.

** See Appendix I for explanation of abundance symbols.

those species that were fairly obvious within transects and quadrats were identified. Many of the smaller, concealed, or prostrate forms were omitted as they were considered of minor importance as food for abalones and other marine algivores. Also, only conspicuous stages of plants were recorded. Reconnaissance in the intertidal of other sections of the cove allowed us to relate assemblages of adjoining areas to those at permanent stations and to note a few plants and animals that were not recorded elsewhere.

Many similarities and many differences occurred in the floral assemblages growing in the various intertidal zones and contrasting sea exposures. Some plants appeared to require wave exposed, rough, breaking areas while others could not tolerate these conditions and were found only in protected cove areas. Many plants were restricted to the lower zones by air exposure and dessication during low tide while a few showed a preference to exposure or were ubiquitous.

The data on algal distribution and abundance that we recorded during seasonal surveys became voluminous and difficult to interpret and condense. This problem was compounded because abundance estimates were relative; it was usually impossible to count the numbers of each alga because thousands of some existed along each transect. Therefore, relative abundance estimates were condensed to numerical values from transect data for each exposure and each zone to provide a more meaningful descriptions of the plant cover for the various areas (Tables 5,6 and 7). Plants that occurred often and were dense enough to be considered important to the Diablo Cove system (generally common and abundant forms) or displayed significant seasonal variation, are discussed in relation to the intertidal zones in which they existed.

TABLE 5. Numerical Values* for Intertidal Plants Observed at Diablo Cove in the Low Tidal Zone During 1970 and 1971.**

PLANT	Protected Cove Areas (Stations #2 & 3)						Exposed Cove Areas (Station #4)					
	1970			1971			1970			1971		
	**W	S	F	W	S	F	W	S	F	W	S	F
CHLOROPHYTA												
Bryopsis corticulans						.2						
Codium setchellii			.2		.2							
Spongomorpha coalita	*** .2	1.7				.2						
Ulva lactuca		1.5	2.2	.2	.2	.5						
PHAEOPHYTA												
Alaria marginata								.3	.3		.7	.3
Cystoseira osmundacea		1.2		.2	1	.2						
Desmarestia herbacea						.2						
Dictyoneurum californicum		1.2		.2	.8	.8	4	5	5	2	5	4.3
Egregia menziesii		1	.5	.2	.2	.5	.5	2	.7	.7	.7	.3
Laminaria setchellii		1		.2	.5	.5	2	2	2	2	2	2.3
Nereocystis luetkeana					.2							

TABLE 5 - Contd.

PLANT	Protected Cove Areas (Stations #2 & 3)						Exposed Cove Areas (Station #4)					
	170			1971			1970			1971		
	**W	S	F	W	S	F	W	S	F	W	S	F
RHODOPHYTA												
Agardhiella tenera	.8	1.5	.5	1	1.2	1.2						
*Articulated corallines	3	3.5	3.5	4	2	3.5	5	4.3	3	3.6	3	1.7
Botryoglossum farlowianum	.5	1	1	.8	2.2	1.8	.5	2	3	.3	2.7	2.3
Callithamnion pikeanum	.5	1	.2	.5	.5	.2						
Callophyllis violacea		1.5	.5	.2	1	.8					.3	.3
Callophyllis pinnata						.2						
Ceramium eatonianum			.2	.2	.5							
*Crustose corallines	4	3.5	4	4.5	4.5	4	4	5	2.7	5	3	3.7
Cryptopleura lobulifera	.2	2	1.5		2	1	3	1.7	.3	1	2	
Endocladia muricata				.2						.3		
Erythrophyllum delesserioides		.2	.5		.5	.5	.5	2	2.3	1	3.2	1.7
Farlowia compressa											.3	
Gastroclonium coulteri	3	3.5	4	1.5	3	3	2		1		1.3	.3
Gelidium coulteri				.2	.5				.3			

TABLE 5 - Contd.

PLANT	Protected Cove Areas (Stations #2 & 3)						Exposed Cove Areas (Station #4)					
	1970			1971			1970			1971		
	**W	S	F	W	S	F	W	S	F	W	S	F
RHODOPHYTA-Contd.												
Gelidium robustum										.3	.3	
Gigartina canaliculata	2	1.2	2.5	3.8	1	2			.3			.7
**Gigartina corymbifera* (group)	2	2	2	2	2	3	3	5	3.7	3	2.7	3.3
**Gigartina cristata* (group)	1.8	1	1.8	.8		.2			1	.3		
Halosaccion glandiforme		1.5	1		1	.7						
Hymenena flabelligera									1.7			1.7
Iridaea flaccida	4	4.2	4	3	3	2.5	1		1	.3		1
Iridaea heterocarpum	.2	.5	.2	.2		.7				.7		
Iridaea splendens	.7	1.2	.2	1.5	1.5	1.5	1	3	2	1.7	2.3	2.3
Laurencia spectabilis	.5	.2	.7	.5		1						
Laurencia blinksii					.2							
Microcladia borealis					.2	.2		2.3	1	.7	1	1
Microcladia coulteri	1.5	2.5	4.5	2	4	3	1.3	.3	4.3	1	3	3
Petrocelis franciscana	.8	2.5		.8	.5	1.2						

TABLE 5 - Contd.

PLANT	Protected Cove Areas (Station #2 & 3)						Exposed Cove Areas (Station #4)					
	1970			1971			1970			1971		
	**W	S	F	W	S	F	W	S	F	W	S	F
RHODOPHYTA-Contd.												
Pikea californica					.2							
Plocamium coccineum		.7					1	1				
Polysiphonia paniculata		.2		.2	.2	.2						
Porphyra perforata	.2	.5	1	.2								
Porphyrella gardneri									.3	.3		
Prionitis australis										.7		
Prionitis lanceolata	3	2	1	3	2	3	3	1	3	3	3	2.3
Ptilota hypnoides											.3	
Pterosiphonia baileyi											.3	.3
Schizymenia pacifica					.2							
Smithora naiadum		.7	1.7	1.2	1.5	3.0						

TABLE 5 - Contd.

PLANT	Protected Cove Areas (Station #2 & 3)						Exposed Cove Areas (Station #4)					
	1970			1971			1970			1971		
	**W	S	F	W	S	F	W	S	F	W	S	F
SPERMATOPHYTA												
*_Phyllospadix scouleri_	3.5	4	2.5	4.5	5	3.5						

* See Appendix I

** W = Winter survey, S = Summer survey, F = Fall survey

*** Numerical values were averaged for each season from transect data on a scale of 0 to 5 by assigning the rates of 1 for sparse, 3 for common, and 5 if abundant. A cumulative rating of 5 indicates near 100% cover, 3 about 60% cover, and 1 about 20% cover. Some interpretation was included for periods when a transect was not surveyed and from quadrat data.

TABLE 6. Numerical Values of Intertidal Plants Observed at Diablo Cove in the Mid Tidal Zone During 1970 and 1971.

PLANT	Protected Cove Areas (Stations #2 & 3)						Exposed Cove Areas (Station #4)					
	1970			1971			1970			1971		
	**W	S	F	W	S	F	W	S	F	W	S	F
CHLOROPHYTA												
Bryopis corticulans					.2						.3	
Cladophora trichotoma	*** .2		.2		.2							
Codium setchellii		.2	.2	.2	.2	.2						
Spongomorpha coalita		.5	.2		.7							
Ulva lactuca	.2	1	3		.5	1.2					.3	
PHAEOPHYTA												
Alaria marginata								.3	.7			.7
Egregia menziesii	.2	.5	.5	.2	.2	.2	.7	1.3	1.3	1	1.7	3.7
Fucus distichus			.2			.2				1		
Hesperophycus harveyanus				.2								
Laminaria setchellii					.2			1.3				
Pelvetia fastigiata		.5	.5	.2	1	.2		.3	.3		.3	

TABLE 6 - Contd.

PLANT	Protected Cove Areas (Stations #2 & 3)						Exposed Cove Areas (Station #4)					
	1970			1971			1970			1971		
	**W	S	F	W	S	F	W	S	F	W	S	F
RHODOPHYTA												
Agardhiella tenera	.2	.2		.2	.2			.3				
*Articulated corallines	1.2	2.2	1.7	2.2	.7	2.2	5	3	4.3	5	2.7	5
Botryoglossum farlowianum								1.3				
Callithamnion pikeanum	1	1.2	.5	.5	1.5	.2		1		.3	1	
Callophyllis violacea								.3	.3		.7	.3
Ceramium eatonianum			.2								.3	.3
*Crustose corallines	2.2	3	2	2.5	1.5	3	2.5	3.7	5	2	3.7	4.3
Cryptopleura lobulifera	.5	2.2	1		.5	1	1.3	1	1.7	1	1	1.7
Erythrophyllum delesserioides								1.3	.3	.3		
Endocladia muricata	1.2	.7	1.5	1	.5		2	3	.7	.3	.3	
Gastroclonium coulteri	1.5	2.2	1.2	.7	2	1.2	3	3	2.7	1.3	2	.3
Gelidium coulteri	.2		.5	.5	.5	.7			.3	.7	.3	.3
Gigartina canaliculata	1	3.5	1.2	1.7	2.5	1.5	3.7	2.3	3	3	3	3
**Gigartina corymbifera* (group)	.2	.7	.2	.5	.7	.2	.7	1	.7	.7	1.7	.7

TABLE 6 - Contd.

PLANT	Protected Cove Areas (Stations #2 & 3)						Exposed Cove Areas (Station #4)					
	1970			1971			1970			1971		
	**W	S	F	W	S	F	W	S	F	W	S	F
RHODOPHYTA-Contd.												
**Gigartina cristata* (group)	2.2	4	4.5	4	3.5	4.5	3	2.3	1.7	1.3	1.7	.7
Gigartina leptorhynchos	.2	.5										
Halosaccion glandiforme		.7	.5	.2	1	.7						
Hymenena flabelligera											.3	.3
Iridaea flaccida	2.2	5	4.5	4.5	5	4	3	5	4.3	3	5	5
Iridaea heterocarpum	1	1.5	.7	.5	1	.7			.3	.6	1	1
Iridaea splendens	.2	1.5			.5			2.7	.3		.7	
Laurencia blinksii					.2				.3			.3
Laurencia spectabilis	.2		.7	.2		.2	1.3	.3				
Microcladia borealis					.2		.7	1.7		.7	3	1
Microcladia coulteri			3.7		.1	1.5		1.7	1	.3	.3	.3
Petrocelis franciscana	3.2	4.5	4	4	3.7	4	3	3.7	1.7	1.7	.3	.3
Plocamium coccineum		.2					.7	.3	.7			
Polysiphonia paniculata			1								.7	.7
Porphyra perforata		2.2	2.5		.7	1.2		1	.3		1	

TABLE 6 - Contd.

PLANT	Protected Cove Areas (Stations #2 & 3)						Exposed Cove Areas (Station #4)					
	1970			1971			1970			1971		
	**W	S	F	W	S	F	W	S	F	W	S	F
RHODOPHYTA-Contd.												
Prionitis lanceolata	.5	1.2	.2	.5	.7	1	.3	1.7	1	1	.3	.7
Ptilota densa			.2									
Rhodoglossum affine						.2						
Rhodoglossum parvum						.2						
Smithora naiadum			.7			.5						
SPERMATOPHYTA												
Phyllospadix scouleri	1.2	1.2	1	.7	.7	1						

* See Appendix I

** W = Winter survey, S = Summer survey, F = Fall survey

*** Numerical values were averaged for each season from transect data on a scale of 0 to 5 by assigning the rates of 1 for sparse, 3 for common, and 5 if abundant. A cumulative rating of 5 indicates near 100% cover, 3 about 60% cover, and 1 about 20% cover. Some interpretation was included for periods when a transect was not surveyed and from quadrat data.

TABLE 7. **Numerical Values of Intertidal Plants Observed at Diablo Cove in the High Tidal Zone During 1970 and 1971.**

PLANT	Protected Cove Areas (Stations #2 & 3)						Exposed Cove Areas (Station #4)					
	1970			1971			1970			1971		
	**W	S	F	W	S	F	W	S	F	W	S	F
CHLOROPHYTA												
Cladophora trichotoma	*** .2	.2	.5	.2		.2		1			1	1
Ulva lactuca		.2				.2					1	
Ulva sp.								1	1			
PHAEOPHYTA												
Fucus distichus	.5	.7	.5	1	.5	.5						
Hesperophycus harveyanus	.5	.5	.2	.2	.2							
Heterochordaria abietina								1	1		3	1
Pelvetia fastigiata	3	2.5	2.5	1.5	2.5	2						
RHODOPHYTA												
*Articulated corallines	.2	.7					1	1	1		3	
Callithamnion pikeanum		.2									3	
*Crustose corallines	1.2	1.2	1	1.2	1.2	2	5	3	5	3	3	3

TABLE 7 - Contd.

PLANT	Protected Cove Areas (Stations #2 & 3)						Exposed Cove Areas (Station #4)					
	1970			1971			1970			1971		
	**W	S	F	W	S	F	W	S	F	W	S	F
RHODOPHYTA - Contd.												
Endocladia muricata	4	4	2.2	2.7	3	3	3	3	3	1	1	1
**Gigartina cristata* (group)	4.5	4	5	4.5	4.5	4.5			1			1
Gigartina canaliculata	.2				.2							
Iridaea flaccida	1	1.5	2	1	1	1.5	1	1	1			
Iridaea heterocarpum	.5		.5									
Petrocelis franciscana	4.5	4.5	5	4	3.2	4	1	1	3		1	3
Porphyra perforata		1	.7		.7	.7		3	1		3	1
Prionitis andersonii								1				

* See Appendix I

** W = Winter survey, S = Summer survey, F = Fall survey

*** Numerical values were averaged for each season from transect data on a scale of 0 to 5 by assigning the rates of 1 for sparse, 3 for common, and 5 if abundant. A cumulative rating of 5 indicates near 100% cover, 3 about 60% cover, and 1 about 20% cover. Some interpretation was included for periods when a transect was not surveyed and from quadrat data.

Low Zone Plants

The most abundant and ubiquitous intertidal alga was the foliose red alga, *Iridaea flaccida*, which blanketed most exposed surfaces in the mid and low zones. *I. flaccida*, was found at all sea exposures, all tidal zones, and during all seasonal surveys. Dessication during fall afternoon low tides and abrasive ocean conditions during the winter reduced the *Iridaea* cover substantially but short new blades were usually observed beneath the older cover during these periods. *I. flaccida* was densest in both mid and low protected zones where it was usually recorded as abundant. It appeared to be partially replaced in the low protected zone during 1971 by *I. splendens* which was considered sparse to common throughout. In low exposed areas *I. flaccida* was uncommon, and was absent during both summers when *I. splendens* became common (Table 5).

Articulated and crustose corallines* comprised a substantial portion of the benthic cover but their abundance was partially masked by the luxuriant growth of larger forms. *Corallina* and *Calliarthron* comprised the majority of the articulated forms while *Lithothamnion* and *Lithophyllum* outranked the other crustose genera; however, because it requires microscopic examination of reproductive structures to identify crustose forms, it was impossible to assess the density of species.

Gastroclonium coulteri was considered abundant during 1970 and common during 1971. Dessication was apparent at some stations during October surveys and this factor possibly contributed to the seasonal low that was recorded each winter.

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* See Appendix I

*Gigartina corymbifera** and *G. canaliculata* were most abundant in the low zone but *G. canaliculata* was also quite common in the mid zone. *G. corymbifera* was common in both exposed and protected areas but *G. canaliculata* was important only in the protected cove area. *G. canaliculata* displayed seasonal lows in the low zone each summer, possibly due to masking by other species, as it did reach a seasonal peak in the mid zone during this period. *G. corymbifera* displayed little seasonal change in abundance but did reach a summer high in exposed areas during 1970.

Microcladia coulteri, an epiphytic red alga, reached highest abundance levels during summer and fall months when its hosts *Iridaea flaccida, Gigartina corymbifera,* and *Prionitis lanceolata* were also numerous. *M. coulteri* was of greatest importance (usually common) in protected areas but was also common during the fall of 1970 in open exposures.

Several species of *Prionitis* were found in the study area but only *P. lanceolata* was important. *P. lanceolata* was common in the low zone in both exposures and in several cases displayed a seasonal low during the summer, possibly due to masking rather than a decline of the species.

Hymenena flabelligera, Callophyllis violacea and *Botryoglossum farlowianum*, all foliose reds, occurred in low wet or submerged areas. *Hymenena* was observed only during the fall in exposed areas while *Botryoglossum* was common in both exposures during both summer and fall. *Callophyllis* was recorded as sparse to common only in wet protected areas during the summer and fall.

Halosaccion glandiforme, a low growing saccate red, was observed in both the low and mid zones but only in protected cove areas. Except

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* See Appendix I

for one sighting during the 1971 winter survey, *Halosaccion* was found only during summer and fall months as a sparse to common form.

Erythrophyllum delesserioides was found mainly in the low zone in exposed habitat but was occasionally seen in low protected and in mid exposed areas. Transect and quadrat data both suggest the species is an annual, as new plants first appeared during the spring and summer, diminished somewhat during the fall, and nearly disappeared during the winter.

Agardhiella tenera, a rather delicate red, was usually restricted to wet or submerged areas inside Diablo Cove. It was also occasionally recorded in protected mid zone areas and once was seen during 1970 along a wave exposed transect in a deep tide pool.

Several species of brown kelps were regularly observed in the low zone. *Dictyoneurum californicum* was always found in 3 to 4 foot deep tide pools at Station 4 and was numerous there during the summer and fall. Feather boa kelp, *Egregia menziesii*, and palm kelp, *Laminaria setchellii*, were also present at Station 4. Palm kelp formed a dense bed on a submerged shelf (1 to 3 foot deep at low tide) off transect 4C and was abundant there throughout the 2 year study period.

Egregia, Laminaria, Dictyoneurum, and *Cystoseira osmundacea*, all perennial brown algae, were also present in very low, wet areas inside Diablo Cove, an extension of their shallow subtidal beds. Branches and vesicles of *Cystoseira* were conspicuous during the summer while only basal blades were present during the winter. The highest densities of these brown algae inside the cove were observed during extreme low tides (-1.5 and lower) in the spring or summer and it is possible they may be completely missed intertidally during lesser lows (-0.5 and higher). The sampling technique does not, therefore, accurately document the presence or abundance of these four species.

Spongomorpha coalita, a green alga, appeared in both the mid and low zones on several occasions. It was common in low protected areas during 1970 but absent from these areas during the summer of 1971. It also occurred sparsely in mid exposed areas during both summers.

Surf grasses, *Phyllospadix scouleri* and *P. torreyi**, the only spermatophytes observed in the study area, were abundant throughout the protected low zone but never recorded from transects in exposed habitat. *Phyllospadix* possibly occupied more rocky habitat than any other genus in low protected areas. A seasonal low during the fall was depicted from both transect and quadrat data and from quadrat photographs. A small epiphytic red alga, *Smithora naiadum*, was present on some *Phyllospadix* blades throughout the year but usually appeared during the summer, becoming a common form by the fall. *Melobesia mediocris*, a minute crustose coralline, was also usually present on *Phyllospadix* blades.

Mid Zone Plants

Iridaea flaccida dominated the mid zone cover (as in the low zone) and reached its peak abundance here. *I. flaccida* was normally recorded as abundant in both protected and wave exposed areas but displayed a winter low each year. *Iridaea heterocarpum* was generally recorded as sparse throughout (Table 6).

Articulated and crustose corallines occurred here but were generally less numerous than in the low zone. Both were considered common in protected areas and common to abundant in exposed areas. As in the low zone, their abundance was masked by larger forms such as *Iridaea*. The

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* See Appendix I

recorded seasonal variation for both groups, often reduced during the summer, likely is due to this factor.

Gigartina cristata (along with *G. papillata* and *G. agardhii**) occurred in all tidal zones but was numerous only in the mid and high zones. *G. cristata* was common in mid zone exposed areas but was rarely seen in low and high zone open sea exposures. *G. cristata* and *Iridaea flaccida* dominated the algal cover in mid zone cove areas.

Cryptopleura lobulifera, a short red alga (1-2 inches tall, usually larger subtidally but apparently dwarfed by intertidal exposure) was only tentatively identified and possibly should be combined with our *Cryptopleura* group (Appendix I). However, because this alga was distinguished in the field from others that were placed in the *Cryptopleura* grouping, it can be discussed separately. *C. lobulifera* occurred as a sparse to common form in both the mid and low zones in both exposures. It often formed dense, localized mats on flat rocky surfaces. The species was not observed inside Diablo Cove during the 1971 winter and was observed sparsely along only one transect there during the 1970 winter.

Porphyra perforata reached a peak in the summer and fall of 1970 when it was considered common inside the cove. Only two sparse sightings were made during winter months, both in the low zone of the cove in 1970.

*Petrocelis franciscana**, a crustose red alga, was usually abundant inside the cove and was near ubiquitous with the one exception that it was never observed in low exposed areas. *Petrocelis* covered many of the boulders and bedrock in the mid and high zones and dominated many high zone areas.

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* See Appendix I

The brown strap kelp, *Alaria marginata*, was sparse at exposed cove transects. However, it was a common to abundant species during the summer in several exposed areas including portions of North Cove, along the South Cove jetties and south at (control) Station 5. At quadrat 4Aa during 1970, 31 stipes were counted during the summer and 27 during the fall. The old plants were gone by the winter but new blades 1 to 2 inches in length were beginning to appear. The highest quadrat counts of *Alaria* were made at Station 5; 147 stipes at quadrat 5Aa and 94 at quadrat 5Ab during the summer of 1970 and 64 and 173 respectively during the summer of 1971. Although *Alaria* is a perennial, it appears that most plants do not survive more than one year at Diablo Cove.

The green sea lettuce, *Ulva lactuca*, was found in all areas, but was important only in low and mid zone protected cove exposures. During the fall of 1970, *U. lactuca* was common throughout the study area, partially replacing *Iridaea*.

Several other plants that were discussed as low zone inhabitants were also found here. These included *Egregia menziesii* which was common during the fall of 1971 at exposed stations, *Gastroclonium coulteri*, generally common throughout, *Gigartina canaliculata*, common throughout, *Prionitis lanceolata*, generally sparse, and *Phyllospadix scouleri*, sparse to common in wet protected areas. Other algae considered an integral part of the mid zone algal cover were *Microcladia coulteri*, *Microcladia borealis*, *Iridaea splendens*, *Endocladia muricata*, *Callithamnion pikeanum* and *Halosaccion glandiforme*.

High Zone Plants

The high zone cover, including that of *Iridaea*, was markedly reduced in comparison to the low and mid zone cover. Eighteen species were recorded here compared to 46 in the mid zone and 51 in the low zone. Only four species were regularly recorded as common or abundant (*Endocladia muricata, Gigartina cristata, Pelvetia fastigiata,* and *Petrocelis franciscana*) and only two additional species (*Iridaea flaccida* and crustose corallines) were considered integral forms (Table 7).

Fucus distichus and *Hesperophycus harveyanus* occurred sparsely in protected cove areas while *Heterochordaria abietina* occurred sparsely in exposed areas. *Pelvetia fastigiata* was recorded regularly from mid and high zone protected areas but was common only in the high zone. In some areas, as near Station 2, dense mats of *Pelvetia* were seen during reconnaissance surveys.

Endocladia muricata occurred throughout, it was usually sparse in the mid zone and common to abundant in the protected high zone. Higher densities were recorded along most transects during 1971. This species was considered common in exposed areas of the mid zone during the summer of 1970 and then declined and was rarely observed here during the remaining surveys.

RESULTS OF SUBTIDAL SURVEYS

Abalone Distribution and Abundance

The transition from black to red abalones in the lower reaches of the intertidal is nearly complete at 2 to 5 foot depths. An occasional black abalone was seen deeper. The shallow 0 to 20 foot depths along most of the inside perimeter of Diablo Cove afford excellent habitat and supports a large population of red abalones. The bottom, confluent with the shoreline, is composed of large strewn boulders and rocky ledges providing numerous protective niches for cryptic animals. Currents deposit kelps and seaweeds in this region as they are ripped up or sluffed from the substrate during winter months.

Station 16 was established to monitor the red abalone population in this shallow region of Diablo Cove. The station was located along the southern perimeter of the cove rather than off Diablo Creek to avoid projected construction activities. Similar beds of red abalones were observed during reconnaissance dives throughout this shallow perimeter. Dense beds were located off the Coffer Dam, off Diablo Creek and along the northern cove edge. Low concentrations of red abalones were also observed in this shallow water zone.

Certain factors typical to the shallow cove waters reduced the accuracy of diver observations at Station 16 during most surveys. The surge here was stronger than normally encountered at deeper stations, and it was not possible to dive here or at many other shallow stations during the winter due to rough water conditions. Dense kelp beds (*Pterygophora*, *Laminaria*, and *Cystoseira*) during the summer restricted diver mobility and confused direction at times. Extra effort was therefore expended to maintain accurate counts of red abalones. Additional counts were often made if the first results were questionable.

The average for four seasonal counts at Station 16 was 77.25 red abalones per transect of 60 m^2, or a red abalone/m^2 density of 1.29. Counts ranged from a low of 57 during the fall of 1970 to a high 90 in the fall of 1971. The annual average increased from 65 in 1970 to 89.5 in 1971, while both counts of 1971 were higher than either of 1970. Increased efficiency and familiarity, as with intertidal surveys, may be partially responsible although the data strongly suggest an increased population during 1971 (Tables 8 and 9).

TABLE 8. Abundance of Red Abalones, *Haliotis rufescens*, Rock Crabs, *Cancer antennarius*, Sunflower Stars, *Pycnopodia helianthoides*, Cabezon, *Scorpaenichthys marmoratus*, and Red Sea Urchins, *Strongylocentrotus franciscanus*, at 11 Subtidal Diving Stations During 1970.

Stat. No.	No. of Surveys	No. of Red Abalones			Mean No. Red Abalones	No. of Rock Crabs			Mean No. Rock Crabs	No. of Sunflower Stars			Mean No. Sun Stars	No. of Cabezon			Mean No. of Cabezon	No. of Red Sea Urchins			Mean No. Red Sea Urchins
		W	S	F		W	S	F		W	S	F		W	S	F		W	S	F	
6	3	2	1	1	1.3	0	1	0	0.3	1	4	0	1.7	2	2	1	1.7	270	340	243	284
7	3	5	5	1	3.7	0	0	0	0	2	2	2	2.0	2	1	0	1.0	192	125	247	188
8	2	4	-	2	2.0	0	-	4	2.0	0	-	2	1.0	2	-	0	1.0	131	-	167	149
9	3	0	2	0	0.7	0	0	0	0	0	0	3	1.0	0	1	1	0.7	282	333	274	296
10	3	0	0	0	0	1	0	0	0.3	2	5	1	2.7	0	0	0	0	57	87	91	78
11	3	1	0	0	0.3	0	0	0	0	0	1	1	0.7	0	0	0	0	116	80	79	92
12	3	0	0	0	0	0	0	0	0	1	0	0	0.3	0	0	0	0	38	36	50	41
13	1	-	-	0	0	-	-	2	2.0	-	-	2	2.0	-	-	2	2.0	-	-	152	152
14	1	-	-	1	1.0	-	-	1	1.0	-	-	0	0	-	-	0	0	-	-	53	53
15	2	11	-	7	9.0	6	-	1	3.5	0	-	0	0	0	-	0	0	**P	-	206	206
16	2	-	73	57	65.0	-	0	2	1.0	-	1	0	0.5	-	1	0	0.5	-	97	61	79
Total of Means					83.3				10.1				11.9				6.9				1618
Seasonal Totals		23	81	69		7	1	10		6	13	11		6	5	4		1086	1098	1623	
Corrected Seasonal* Totals		89	93	69		11	9.5	10		8.5	16	11		8.5	8	4		1576	1658	1623	

*Seasonal Totals were corrected by including the station's annual average rather than "0" for periods when a station was not occupied.

**See Appendix I

TABLE 9. Abundance of Red Abalones, *Haliotis rufescens*, Rock Crabs, *Cancer antennarius*, Sunflower Stars, *Pycnopodia helianthoides*, Cabezon, *Scorpaenichthys marmoratus*, and Red Sea Urchins, *Strongylocentrotus franciscanus*, at 11 Subtidal Stations During 1971.

Stat. No.	No. of Surveys	No. of Red Abalones			Mean No. Red Abalones	No. of Rock Crabs			Mean No. Rock Crabs	No. of Sunflower Stars			Mean No. Sunflower Stars	**No. of Cabezon**			**Mean No. of Cabezon**	No. of Red Sea Urchins			Mean No. Red Sea Urchins
		W	S	F		W	S	F		W	S	F		W	S	F		W	S	F	
6	3	0	0	0	0	1	0	0	0.3	3	1	1	1.7	3	1	3	2.3	203	346	232	260
7	3	5	7	3	5.0	3	1	0	1.3	1	4	4	3.0	0	0	1	0.3	293	342	191	275
8	3	0	0	5	1.7	0	1	4	1.7	1	0	3	1.3	2	1	2	1.7	187	265	321	258
9	3	0	0	1	0.3	1	0	0	.3	6	3	4	4.3	0	0	1	0.3	359	345	361	355
10	3	0	0	0	0	0	0	0	0	4	1	5	3.3	0	0	0	0	116	107	105	109
11	3	0	0	0	0	0	0	0	0	1	0	2	1.0	1	0	0	0.3	107	99	47	84
12	3	0	0	0	0	0	0	0	0	1	0	0	0.3	1	0	0	0.3	35	20	37	31
13	1	-	-	1	1.0	-	-	2	2.0	-	-	1	1.0	-	-	1	1.0	-	-	82	82
14	2	-	0	0	0	-	1	1	1.0	-	1	2	1.5	-	1	1	1.0	-	17	99	58
15	3	0	12	6	6.0	2	1	1	1.3	1	0	3	1.3	2	0	0	.7	317	227	212	252
16	2	-	89	90	89.5	-	1	2	1.5	-	5	2	3.5	-	1	0	.5	-	78	157	118
Total of Means					103.5				9.4				22.2				8.4				1882
Seasonal Totals		5	108	106		7	5	10		18	15	27		9	4	9		1617	1846	1844	
Corrected Seasonal* Totals		96	109	106		12	7	10		24	16	27		12	5	9		1875	1928	1844	

*Seasonal Totals were corrected by including a station's annual average rather than "0" for periods when a station was not occupied.

As depth increases inside Diablo Cove, abalone habitat generally declines in quality. Reefs rising from 15 to 40 foot depths do provide protective crevices and ledges, but much of the central cove bottom is composed of low relief bedrock, and smaller boulders, cobble and fines in assorted mixtures. Only an occasional red abalone was observed at the 20, 35, 50, and 70 foot stations (Stations 9, 10, 11, and 12 respectively), reflecting abalone densities at these depths for the central region of Diablo Cove.

Several other localized beds of red abalones were observed inside Diablo Cove. In 10 to 40 foot depths adjoining the cove's south point the bottom consisted of deep crevices and ledges and high relief rocky projections. A dense cover of kelps and numerous red abalones were found here. Ebert (1966: Transect 1, Station 1) counted 27 red abalones along a 100 x 15 foot transect in this area. Another red abalone bed was located in the lee and north of Diablo Rock, but urchins had grazed this area extensively.

Flat abalones, *Haliotis walallensis*, and threaded abalones, *H. kamtschatkana assimilis*, were occasionally observed in the central region of Diablo Cove but were nowhere common.

The largest population of red abalones in the Diablo Canyon study area exists in North Cove. This bed is roughly bounded on the south by the northern point of Diablo Cove, on the north by Station 7, and extends from the shallows to outside Station 8. Both extensive shoaling areas and dense beds of *Nereocystis* exist here (Figures 4 and 5) and substantial numbers of red abalones were observed during reconnaissance dives from the intertidal to 40 foot depths. The massive and highly irregular rocky reef structures provide excellent abalone habitat and hard surfaces for kelp and seaweed attachment.

Counts of red abalones at three permanent control stations to the north of Diablo (Stations 6, 7, 8) were low and did not reflect true abalone densities which have been observed in this area. These stations were selected in surface bull kelp beds and did not fall in good abalone areas. Red abalone/60m^2 counts at these stations ranged from 0 to 7, averaging only .04/m^2 during the study.

Possibly the second best abalone population existed in South Diablo Cove. This cove was selected by Pacific Gas and Electric Company (P.G.&E.) for an intake site of ocean water that will cool reactor water. Prior to intake structure construction activities, most of the red abalones were removed from the cove and planted in nearby areas (Table 13). In all 7,328 red abalones and 5,354 black abalones were transplanted between June 14, 1969, and May 11, 1972. Assuming the South Cove benthos covers 23 acres, the average density of red abalones that could be efficiently removed was .0787/m^2.

With the exception of South Cove, areas to the south of Diablo Cove, encompassed by the study limits, had few abalones. Good numbers do exist along the shoreline in 0 to 15 foot depths and on a few offshore reefs. However, much of the bottom is composed of rather flat rock and sediments without protective crevices. Control stations to the south (Stations 13, 14, 15) were placed, as were the north control stations, in kelp beds. Our red abalone counts reflect the patchiness and densities of the area. At Stations 13 and 14, both located on nearshore reefs, counts ranged from 0 to 1 and averaged just .0067/m^2. Red abalone counts at Station 15, a shallow offshore reef, ranged from 0 to 12 and averaged .12/m^2.

Abalone Predators - Composition, Distribution and Abundance

Several cabezon were recorded during each seasonal diving survey, mostly in shallow reef areas throughout the study area. These observations are supported by the seasonal fish collections in which most cabezon were taken at the shore (0-10 feet) and 20 foot stations in Diablo Cove and North Cove (Appendicies XXXIV and XXXV). Totals for the four fish collections were 81 at the shore stations, 136 at the 20 foot stations, and 13 at the deeper (60-70 ft.) stations. While most of the juveniles were taken in shallow water all but two of the 13 specimens from the deepest stations were adults.

A 346 mm 2 year old female (837 g) from the shore station in May, 1970, had ingested a black abalone while a 525 mm female (7 1/4 lb) had abalone (unidentifiable) remains in its stomach. Items found in other cabezon stomachs included several mollusks (*Tegula* sp., *Octopus* sp., and chitons) and crustaceans (*Pugettia* spp., *Cancer* sp., and numerous unidentifiable crab remains).

Cabezon were also observed feeding on red abalones during two dives. A large cabezon (about 6 lb) was seen eating the foot from the shell of a large red abalone at station 14 while another similar observation was made near Station 6 where a replaced red abalone was quickly knocked off the substrate by a smaller cabezon (about 4 lb).

O'Connel (1953) found abalones to be an important food item of the cabezon in the Monterey area but only flat and pinto abalones had been ingested by the specimens he examined.

Counts of cabezon during seasonal diving surveys were low and only adults were seen. Actual counts averaged 11.2 cabezon per season (for all diving transects surveyed) during 1970 and 8.1 during 1971 (Tables 18 and 19).

One of three kelp greenlings, *Hexagrammos decagrammus*, over 300 mm Sl taken in shallow water during the May 1970 fish collection had a small abalone in its stomach. Wolf-eels, *Annarhichthys ocellatus*, also are known to occasionally feed on abalones (Fitch, 1973).

During each seasonal survey several sunflower stars were recorded. The highest seasonal counts were made during the fall surveys (11 in 1970, 27 in 1971) while the highest single count at one station (6) was made in September, 1971 in 20 foot depths inside the Diablo Cove (Station 9). Shallow water stations, namely Stations 7, 9, 10, and 16 ranged in depth from 5 to 35 feet continually produced the highest counts while at deeper stations, namely 11 and 12 in 50 and 70 foot depths respectively, counts were usually lowest. Sunflower star counts averaged only 1.02 per 60 m^2 transect in 1970 and 2.02 in 1971.

Only occasionally were rock crabs, *Cancer antennarius* and *C. productus*, observed and most were on reef stations outside Diablo Cove. Six were counted at the most southerly station (15) during the 1970 winter. At Station 8, four were recorded each fall, although they were not observed here during either winter survey. Rock crabs appear inactive during daylight hours, remaining confined to rocky crevices and other cryptic habitats. Those seen along transects were often in crevices in areas of abundant algal growth that further masked their presence. As with abalones and other cryptic animals, counts of rock crabs should be considered minimal.

Many other sea stars, crabs, octopi, and fishes were present in the Diablo study area that are known or potential predators on abalones and other mollusks. Two sea stars, *Pisaster ochraceous*, and *Orthasterias koehleri*, have recently been documented as feeding on adult red abalones in northern California (J. DeMartini, California State University, Humboldt, pers. commun.). Both are sparsely present in the Diablo system. Two other sea stars present, *Pisaster giganteus* and *P. brevispinus* are likely predators, especially on juveniles, as they are known to feed heavily on other mollusks. Bat stars, *Patiria miniata*, were observed feeding on fresh rock crab remains, and are another potential predator. Because none of these sea stars have been observed feeding on abalones in the Diablo system or in central California, their take of adult abalones, if it exists, is presently considered low. It is also possible that any carnivorous sea star may feed heavily on juvenile abalones.

The observation of large numbers of small rock crabs as well as many other decapod crustaceans in the intertidal, both exposed, in seaweeds and under rocks, suggests a high predation rate on juvenile abalones in shallow water by these forms.

Within its present California habitat, the southern sea otter, *Enhydra lutris nereis*, feeds on many nearshore invertebrates including abalones, red and purple sea urchins, rock crabs, gaper clams, *Tresus nuttallii*, and sea mussels (Ebert, 1968a). Their diet has been observed to include 63 (Ebert, 1968a) to 88% (Vandevere, 1969) abalones in newly invaded areas where abalones were abundant.

The food requirements of a sea otter are high. In Alaska, sea otters in captivity have been found to require 20 to 35% of their body weight in food each day (Stulken and Kirkpatrick, 1955; Kenyon, 1969). Two California sea otters in captivity at Stanford Research Institute required 25% of their body weight each day (Richard Hubbard, DVM, pers. commun.). Four

California otters weighing a total of 148 pounds at capture were placed in pens at Sea World in December 1972. After 2 months of acclimation these otters were being fed 60-70 pounds daily (with little apparent waste) of clam meat and crabs (P. Wild, California Department of Fish and Game, pers. commun.). Using the average weight of 57 pounds for 20 sea otters captured near Cambria in 1969, the average animal in the wild in California may consume 11.4 to 19.9 pounds of food daily.

During 1968 a large team of California Department of Fish and Game (CDF&G) divers conducted an extensive sea otter-abalone habitat survey between Monterey and Morro Bay (Ebert, 1968b). A significant depletion of abalones and other sedentary invertebrates was found in all areas where otters had foraged. Immediately south of the otter's range at Point Estero, red abalones were flourishing. By early 1970, sea otters were foraging heavily on the Point Estero beds and in 1972, otters moved south in large numbers to the rocky reefs between Point Estero and Cayucos. Recent habitat surveys at Pt. Estero and Cayucos Point have revealed that red abalone, red sea urchin, and rock crab populations are now greatly reduced in these areas (unpublished data, Burge, Schultz and Ebert).

The present range of the sea otter in California is from Santa Cruz to Avila Beach with substantial concentration between Point Buchon and Seaside (P. Wild, CDF&G, pers. commun.). The highest count of sea otters in California, 1060, was made in January, 1972, with 1059 observed between Point Estero and Seaside (Wilson, 1972). During a shore census on December 11, 1972 (P. Wild, CDF&G, pers. commun.), 277 sea otters were counted between Cambria and Cayucos of which 207 were seen between Cayucos Point and Cayucos. In January, 1973, at least 57 sea otters were observed at Montana de Oro, several miles south of Morro Bay. On April 5, 1973, 137 sea otters were observed in the vicinity of Point Buchon (Paul Wild, CDF&G, pers. commun.). On April 23, 1973, 4 feeding sea otters were sighted at Lion Rock (Tommy Toleman, Caretaker, Fields Ranch, pers. commun.), approximately 200 yards from Station 6. We observed 3 sea otters on April 24, 1973, foraging in Windmill Cove, approximately 1 mile north of Lion Rock.

These recent movements of sea otters suggest that large numbers likely will invade the Diablo Canyon area this year (1973). It can be predicted that when this occurs the densities of many of the invertebrates surveyed during this study (red and black abalones, sea urchins, rock crabs, etc.) will be significantly reduced. Beds of *Nereocystis* and lower growing red and brown algae can be expected to increase following the decline of algivores. It will be extremely difficult to discern between the effects of the Pacific Gas and Electric warm water discharge and changes resulting from foraging by sea otters.

Abalone Competitors - Composition, Distribution and Abundance

Red sea urchins reached highest densities in the study area inside Diablo Cove in 20 foot depths (Station 9) and then declined as depth increased. The highest counts, averaging 325 per transect, were made at Station 9 in 15 to 20 foot depths and the lowest counts, averaging 36, were made at Station 12 in 70 to 75 foot depths. Surge and turbulence appear to limit red urchin numbers in shallower waters. At Station 16 in the shallow 5 to 10 foot depths of Diablo Cove, the average was 82. Reconnaissance dives along the shallow 0 to 15 foot depth of the cove

Red urchins were so abundant inside Diablo Cove in 15 to 50 foot depths that they appeared out of balance and were altering the expected biotic assemblages to the extent of partially or completely replacing other algivores including abalones. Urchins are known to compete directly with abalones for habitat and food, and, with the exception of the reef crowns and the shallower depths where the urchin apparently cannot cope with increased surge, they have browsed many areas inside Diablo Cove to barren rock. *Nereocystis* sporophytes, along with such other kelps as *Pterygophora*, often settled and grew on upper portions of station markers (polypropylene rope) that urchins could not reach. These observations suggest that red urchins often browse the small *Nereocystis* sporophytes and stipes of other brown and red algae in these areas before the plants can complete development. Juvenile *Nereocystis* sporophytes (6 inches to 2 feet tall) seen on reef crowns at Station 9 were often missing blades or portions of blades during the summer. These various observations indicate that urchins have substantially reduced *Nereocystis* and seaweed production inside Diablo Cove.

The near destruction of a giant kelp, *Macrocystis pyrifera*, bed at Station 7 by red urchins was documented during the 2 year study. As the urchin density increased at Station 7, a decrease in giant kelp stipes (from several bundles) followed (Table 10).

It was evident in February and again in June of 1971, both from associated counts and visual observations, that red urchins were slowly reducing the *Macrocystis* bed by moving up on the holdfast and feeding on stipes and sporophylls. Several plants (bundles) were barren of stipes and sporophylls in January of 1971 when our total stipe count first

TABLE 10. **Counts of Giant Kelp, *Macrocystis pyrifera,* and Red Urchins, *Strongylocentrotus franciscanus,* At Station 7 During the Study Period, 1970-71.**

Year	Season	Red Urchins	Giant Kelp Stipes
1970	Winter	192	526
	Summer	125	467
	Fall	247	847
1971	Winter	293	378
	Summer	342	200
	Fall	191	118

decreased, from a high of 847 in the fall of 1970 to 378 in January of 1971. Many small urchins (approximately 25% of the 342 seen in June) increased the total urchin count in June while the stipe count again decreased. By September, 1971, both the number of urchins (191) and the number of stipes (118) had decreased.

Marine Algae of Diablo Cove

Shallow Water Zone

Many areas inside Diablo Cove are partially protected from the prevailing near-shore ocean turbulence. These areas normally remain calm through the summer and fall or early winter until the first Pacific storm. Along the shallow 0 to 15 foot cove perimeter a dense kelp canopy begins to form in the spring with new plants continually being added during the summer. The first major oceanic disturbance usually marks the initial decline of the canopy. A few stipes of several species, however, persist throughout the winter.

Diving Station 16 was monitored to represent this shallow zone. Rough water prevented occupying the station during both winters, but observations in the intertidal and deeper subtidal, and of the surface canopy here, furnished a reasonable picture of the floral cover during this season.

A total of 36 plant species occurred here with 16 considered regular or integral forms. Although kelps dominated both the surface and benthic canopies, several reds were also important. A few red algae were shallow water extensions of forms dominant in the intertidal, while others occurred only sparsely or occasionally (Table 11).

TABLE 11. Subtidal Marine Plants Observed in Diablo Cove During 1970 and 1971.

PLANT	Shallow Water Zone (Station 16)						15 to 20 Foot Zone (Station 9)						25 to 50 Foot Zone (Station 11)					
	1970			1971			1970			1971			1970			1971		
	W	S	F	W	S	F	W	S	F	W	S	F	W	S	F	W	S	F
CHLOROPHYTA																		
Halicystis ovalis						S		S			S							
Spongomorpha coalita											S							
Ulva sp.					S						S						S	
CHRYSOPHYTA																		
Biddulphia sp.											A							
PHAEOPHYTA	NOT SURVEYED			NOT SURVEYED														
Coilodesme californica					S													
Cystoseira osmundacea		A	A		C	C						S						
Desmarestia herbacea		S	C		S	S		C	C	S	C	S		S			S	
Desmarestia munda		C	S		S	S		S	S		S	S						
Dictyoneurum californicum		P	C		C	C	S	C	C	S	S	C						
Egregia menziesii					S													
Laminaria setchellii		S	S		S	S												
Nereocystis luetkeana		10			6	1	1	2			11							
Pterygophora californica		A	C		A	C												

TABLE 11 - Contd.

PLANT	Shallow Water Zone (Station 16) 1970 W	S	F	1971 W	S	F	15 to 20 Foot Zone (Station 9) 1970 W	S	F	1971 W	S	F	25 to 50 Foot Zone (Station 11) 1970 W	S	F	1971 W	S	F
RHODOPHYTA																		
*Articulated corallines		A	A		A	A	C	C	C	C	C	C	S	S	C	A	S	S
Botryoglossum farlowianum		A	A		A	A	S	C	S	S	S	S						
Callophyllis flabellulata											S	S				S	S	
Callophyllis obtusifolia					S							S						
Callophyllis pinnata		S	S		S	S				S	S	S						
Callophyllis violacea						S					S							
*Crustose corallines	NOT SURVEYED	C	A	NOT SURVEYED	A	A	A	A	A	A	A	A	A	A	A	A	A	A
Erythrophyllum delesserioides											S							
Gelidium purpurascens					S													
Gelidium robustum					S	S												
**Gigartina californica* (group)		S	S		S	S			S		S							
Hymenena flabelligera								S				S						
Iridaea splendens					S						S							
Laurencia spectabilis		S	S		S													

TABLE 11 - Contd.

PLANT	Shallow Water Zone						15 to 20 Foot Zone						25 to 50 Foot Zone					
	(Station 16)						(Station 9)						(Station 11)					
	1970			1971			1970			1971			1970			1971		
	W	S	F	W	S	F	W	S	F	W	S	F	W	S	F	W	S	F
RHODOPHYTA - Cont.																		
Microcladia borealis					S	S												
Microcladia coulteri		S	C		S	S					S	S						
Opuntiella californica		S						S	S	S	S			S				
Petrocelis franciscana					S													
Pikea californica		S			S													
Polyneura latissima					S			S			S						S	
Polysiphonia paniculata	NOT SURVEYED	S		NOT SURVEYED	S			S	S	S	C	S					S	
Prionitis australis										S								
Prionitis lanceolata			S		S					S	S							
Pseudogloiophloea confusa					S							S					S	
Pterochondria woodii			P			P												
Pterosiphonia baileyi					S													
Ptilota densa		S			S	S				S	S	S						
Rhodoglossum roseum											S							

TABLE 11 - Contd.

PLANT	Shallow Water Zone (Station 16)						15 to 20 Foot Zone (Station 9)						25 to 50 Foot Zone (Station 11)					
	1970			1971			1970			1971			1970			1971		
	W	S	F	W	S	F	W	S	F	W	S	F	W	S	F	W	S	F
RHODOPHYTA - Contd.																		
Rhodymenia spp.											S							
Schizymenia epiphytica	NOT SURVEYED			NOT SURVEYED			S		C	S	S	S			S	S	S	S
Smithora naiadum		S	C		S	S												
SPERMATOPHYTA																		
Phyllospadix scouleri		C	C		S	C												

*See Appendix I

The important brown algae and kelps of this shallow zone include *Cystoseira osmundacea*, *Egregia menziesii*, and *Nereocystis luetkeana* which formed the surface canopy. *Dictyoneurum californicum*, *Laminaria setchellii*, *Pterygophora californica*, *Desmarestia herbacea* and *D. munda* composed much of the bottom cover. In many areas the *Laminaria* and *Pterygophora* beds shaded the bottom, which effectively limited the growth of other species.

Cystoseira was recorded at Station 16 as the dominant canopy forming species. However, surface observations and reconnaissance dives throughout the shallow zone depicted *Nereocystis* and *Egregia* as equally important in this zone. Branches and vessicles of *Cystoseira* normally lasted only through the fall while *Nereocystis* and *Egregia* broke up more slowly with a few stipes persisting throughout the winter. The entire canopy of *Nereocystis*, an annual, eventually disappeared although a few sporophytes normally endured through the following spring.

Articulated corallines, namely *Calliarthron* spp., and such crustose corallines as *Lithothamnion* and *Polyporolithon* were abundant. Several foliose reds such as *Botryoglossum farlowianum*, *Callophyllis pinnata*, *Gigartina corymbifera*, and the epiphytic red, *Microcladia coulteri*, were recurrent and important here. *Botryoglossum* dominated the foliose red algae and was observed growing on most stable, well lighted surfaces.

Surf grasses and their red epiphytes *Smithora naiadum* and *Melobesia mediochris* were usually common forms, normally occurring to about 5 foot depths. Surf grasses were observed much deeper, down to 10 or 15 foot depths, in some areas near the north point of the cove where the shoreline plunges directly to these depths.

Occasionally a few intertidal forms penetrated the shallow subtidal and were incidentally recorded at Station 16 or on reef crowns at Station 9.

These included *Ulva* sp., *Petrocelis franciscana, Callophyllis violacea, Iridaea splendens, Spongomorpha coalita, Microclodia borealis*, and *Pterosiphonia baileyi. Iridaea* and *Spongomorpha* were recorded to 18 feet during the 1971 Summer at Station 9 while *Ulva* was recorded to 30 feet at Station 10.

Mid Cove Reef Zone

The algal cover, both of surface canopy and benthic forms, noticeably decreased with depth past 15 to 20 feet due to the abundance of grazing red urchins and the lack of stable substrate in some areas. Exceptions were the reef crowns that had reduced numbers of urchins. Station 9 crossed several submerged reefs that were typical of the 15 to 40 foot zone inside Diablo Cove.

A total of 31 species of algae including one benthic diatom was recorded at Station 9. Only 11 species were considered regular or important to this zone. Many more foliose reds may have been common here if not for the urchin population.

Brown algae were noticeably restricted to the reef crowns and included *Nereocystis leutkeana, Dictyoneurum californicum, Desmarestia herbacea* and *Desmarestia munda. Dictyoneurum* was generally restricted to 10 foot depths and shallower.

Juvenile *Nereocystis* sporophytes were present at Station 9 each summer but failed to survive until the fall, presumably due to urchin grazing. However, the annual variation in density and distribution of *Nereocystis* was considerable. During November 1969, 24 *Nereocystis* sporophytes were present at Station 9. Surface observations of the kelp canopy during September of 1972 indicated an even higher abundance of *Nereocystis* than in 1969 (see section of *Nereocystis* Abundance and Distribution).

Desmarestia herbacea showed marked seasonal variation. The species was usually common in shallow, partially protected depths, during the summer. In the fall the color of *D. herbacea* was changing from normal light olive to light yellow and most plants were beginning to deteriorate and slough blades. During February only small plants, 1 to 2 inches were seen. These were just beginning to develop on shallow reefs in well lighted areas.

The seasonal pattern of *D. munda* was similar but not as distinct as that of *D. herbacea.* The fall deterioration was not always observed in *D. munda* and large adult plants were occasionally observed during the winter.

Articulated corallines, mostly *Calliarthron cheilosporioides,* and such crustose corallines as *Lithothamnion* were abundant. Many reds were present but only *Bothryoglossum farlowianum, Opuntiella californica, Polysiphonia paniculata, Schizymenia epiphytica,* and *Callophyllis pinnata* were regular or of sufficient densities to be considered integral to the zone.

A centric chain forming diatom, *Biddulphia* sp., strung from most rocky surfaces during the 1971 summer. It was observed at four shallow stations during this period but was abundant only inside Diablo Cove.

Deeper Water Zone

With increasing depths the algal cover and species composition markedly decreased inside Diablo Cove. Similar composition and abundance were recorded at stations in 35, 50, and 70 foot depths. At Station 11 in 50 foot depths in the mouth of Diablo Cove, only 11 species were recorded. Of these 11, only the red corallines were commonly present.

Brown algae such as *Desmarestia* and *Pterygophora* and foliose reds such as *Callophyllis flabellulata* and *Schizymenia epiphytica* were occasionally observed as being sparse forms. Prostrate red corallines, namely *Lithothamnion*, dominated this zone.

One notable exception to this zonation was the bottom adjacent to and inside the cove's south point. Wave protection and deposition here was minimal. A dense bed of *Peterygophora* and *Laminaria* existed in 10 to 30 foot depths. Small scattered beds of *Nereocystis* also emerged here each summer.

Marine Algae of the Reef Systems
Outside Diablo Cove

The algal cover of the reefs outside Diablo Cove remained similar in species composition to that of Diablo Cove but the cover (density) and spatial (as depth) distribution increased significantly. Reduced urchin densities and more expansive and irregular reef systems provided excellent attachment surfaces for *Nereocystis* and benthic seaweeds.

The nearshore shallow water flora in wave protected areas was similar in composition and density to the shallow zone of Diablo Cove. *Cystoseira*, *Nereocystis*, *Macrocystis* and *Egregia* formed dense surface canopies during the same seasons while *Pterygophora*, *Laminaria*, *Dictyoneurum*, and *Desmarestia* remained important to the benthic cover.

While foliose and coralline reds were common in shallow areas, their composition and cover increased with depth, reaching peak abundance in 15 to 30 foot depths. Dense mats of *Botryoglossum farlowianum, Callophyllis pinnata, Hymenena flabelligera* and *Calliarthron* covered the reefs in these depths. Other recurrent but not as abundant reds included *Callophyllis* *flabellulata, Gelidium robustum, Gigartina californica, Microcladia coulteri, Opuntiella californica, Polyneura latissima, Ptilota densa, Rhodymenia pacifica,* and *Schizymenia epiphytica.* Crustose corallines were common throughout.

Dense surface canopies of *Nereocystis* developed over most reefs in depths to 40 feet during the summer. Benthic beds of *Laminaria* and *Pterygophora* were numerous throughout the 15 to 30 foot depths although *Pterygophora* remained common much deeper.

At greater depths available light rather than grazing by urchins limited the algal growth. At Station 12 in 70 to 75 foot depths only a few foliose reds such as *Callophyllis flabellulata*, *Polyneura latissima*, *Rhodymenia pacifica*, *Schizymenia pacifica*, and *Halymenia* sp. were occasionally seen, and these were never common. Juvenile *Nereocystis* sporophytes were seen during the summer at depths to 75 feet but these failed to reach the surface or complete their development. An occasional *Desmarestia* or *Pterygophora* plant was also observed in these depths.
As in the deeper zone of Diablo Cove, crustose corallines dominated depths greater than 50 feet, covering most rocky surfaces.

Two reds that were not observed elsewhere, *Botryocladia pseudodichotoma* and *Stenogramme interrupta*, were observed very sparsely in 90 to 100 foot depths. *Polyneura, Opuntiella, Rhodymenia, Schizymenia*, and *Lithothamnion* were also seen at 100 feet.

In general, the important algal production, of abundant kelps and foliose reds, is limited to depths shallower than 50 feet throughout the Diablo system.

Nereocystis Studies

Distribution and Abundance

Nereocystis luetkeana, the dominant canopy forming alga in the Diablo Canyon area, is common along the California coast from Point Conception northward. It has a recorded range from Point Conception, California, to Shumagin Island, Alaska. Dense and extensive stands occur in central California near Morro Bay from Point Estero to Cambria and from Hazard Canyon (near Point Buchon) to Point San Luis. *Nereocystis* is the predominant food item for red abalones north of Point Conception (Cox, 1962). However, other members of the phaeophyta such as *Macrocystis*, *Alaria*, *Costaria*, *Egregia*, and *Postelsia* are also important abalone foods in central and northern California, especially in areas where *Nereocystis* does not exist. *Nereocystis* appears to be the dominant and preferred abalone food item in areas where extensive beds develop annually. Field observations of abalone food habits at Point Estero have shown it is utilized whenever available.

In the Morro Bay region the bathymetric range of *Nereocystis* is from the intertidal to depths of 80 feet. In the Diablo study area, however, few beds were seen outside 40 foot depths. Between Point Estero and Cambria, the densest stands normally occur from the 15 to the 60 foot depth contours although it is not unusual to find large beds shallower, and to 70 feet.

Significant variations in the annual distribution and density of *Nereocystis* beds have been noted recently in the Morro Bay area. Beds that exist seasonally for many years often temporarily disappear for a year or more. Because *Nereocystis* is an annual, it is possible that gametophytes are occasionally swept from certain areas by currents. However, such other factors as substrate quality, sedimentation, light penetration, intensive grazing, and water temperature appear most important in regulating sporophyte development and distribution.

A major decline in the Point Estero *Nereocystis* beds recently occurred. Unusual heavy rains and runoff during the 1968-69 winter caused turbid waters during the late winter and spring of 1969. Commercial abalone diving operations were hampered by the dirty ocean waters and few red abalones were landed from the Morro Bay area during March, April or May (February closed season) of 1969 in comparison to records from previous years. Sporophyte growth was not observed until mid-July, nearly 3 months later than usual, and the fall density of the *Nereocystis* beds was estimated at less than one-fourth that of 1968 or 1970.

Quite probably water clarity strongly influences the year to year variability in *Nereocystis* density, distribution and development. However, no other data are available for previous periods. Long term monitoring is therefore needed to record normal temporal and spatial distribution and variations of the major *Nereocystis* beds.

Two years of quantitative monitoring (1970-71) and two additional years of casual observations (1969, 1972) of *Nereocystis* beds were made at Diablo. Seasonal monitoring at permanent stations of *Nereocystis* beds proved inadequate due to variable gametophyte settling patterns and because the area encompassed by each station was small in comparison to the bed size. Some Stations as 13 and 14 were established in dense beds in 1969 that failed to emerge during 1970-71.

Further assessment of the *Nereocystis* canopy was made using a 20x spotting scope each October, the period considered a peak for sporophyte development preceding winter break-up. Actual counts of individual plants were made within Diablo Cove (Figures 3 and 4) while the distribution and relative densities were mapped for the remaining study area (Figures 5-8). Lack of time and the distance offshore of many beds made counting prohibitive outside the cove.

The total *Nereocystis* stipe count for Diablo Cove during 1970 (3,925 stipes) and 1971 (5,154 stipes) (Figures 3 and 4), appeared much lower than either the 1969 or 1972 peak canopies when large kelp beds flourished off Diablo Creek in 10 to 25 foot depths and along the south point and nearby wash rocks. The 1969 Diablo Cove canopy was estimated at about twice these figures while the September 1972 canopy appeared to be 3 to 4 times as great. Using total plant weights developed by Foreman (1970) for his Class 8 plants (emergent plants with immature sori) the 1971 production of *Nereocystis* inside Diablo Cove was about 45,000 pounds.

The largest and densest *Nereocystis* beds in the Diablo study area were continually observed offshore in North Cove (Figures 5 and 6) which corresponds with observations made by North (1966) during 1966. Here an irregular rocky bottom and partial wave protection provided by Lion Rock affords excellent conditions for sporophyte development. Smaller *Nereocystis* beds were scattered throughout North Cove in areas where rocky reefs exist.

To the south of Diablo, *Nereocystis* beds were normally confined to a narrow band along the shoreline except for a few small isolated patches over nearshore pinnacles and reefs. Sizable beds were observed in 1969 in the vicinity of Stations 13 and 14 and covering a large reef system inside Station 15. These beds failed to appear in significant densities during 1970 and 1971 (Figures 7 and 8). After South Cove jetty construction

Figure 3. Distribution and counts of *Nereocystis luetkeana* plants in Diablo Cove on 20 October 1970.

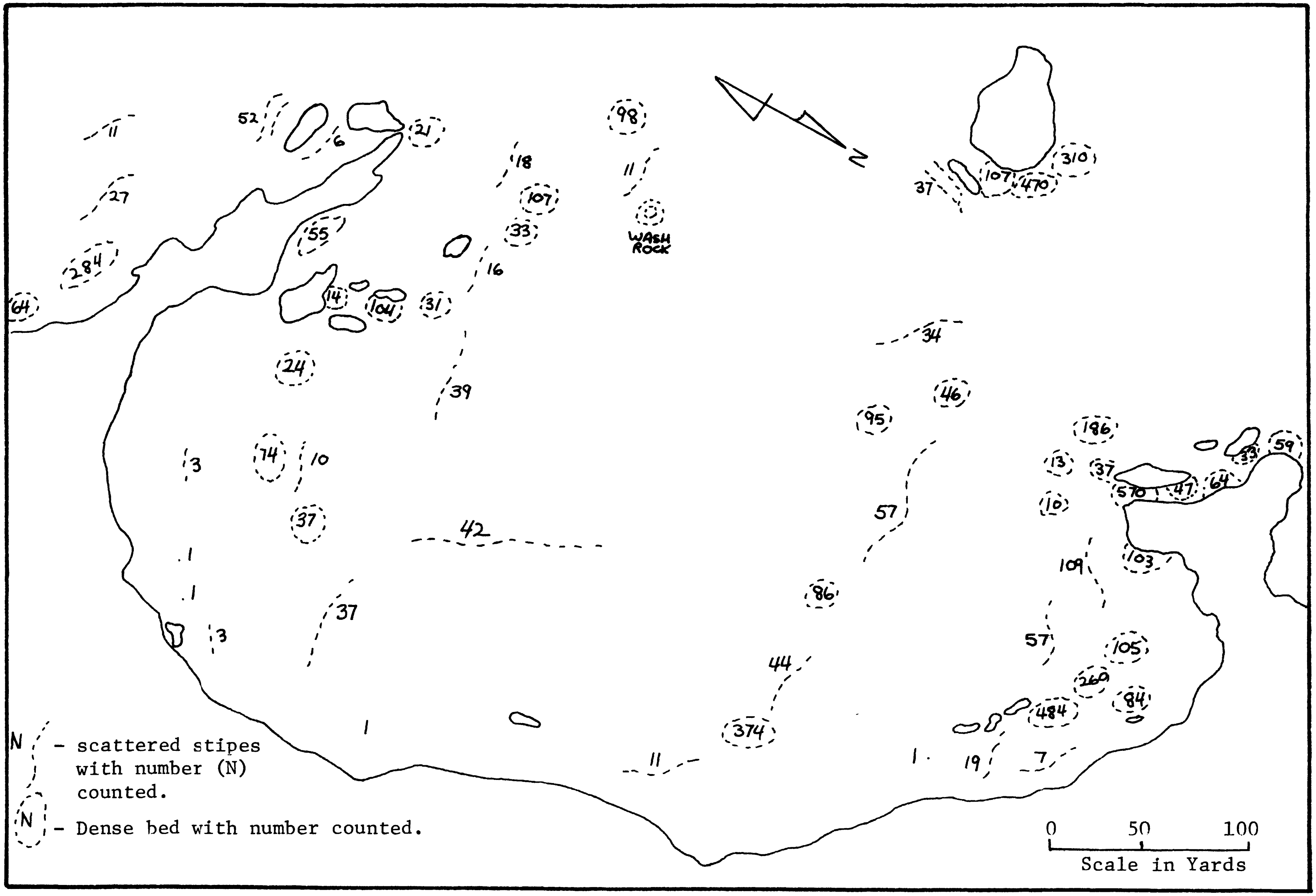


Figure 4. Distribution and counts of *Nereocystis luetkeana* in Diablo Cove on 1 October 1971.

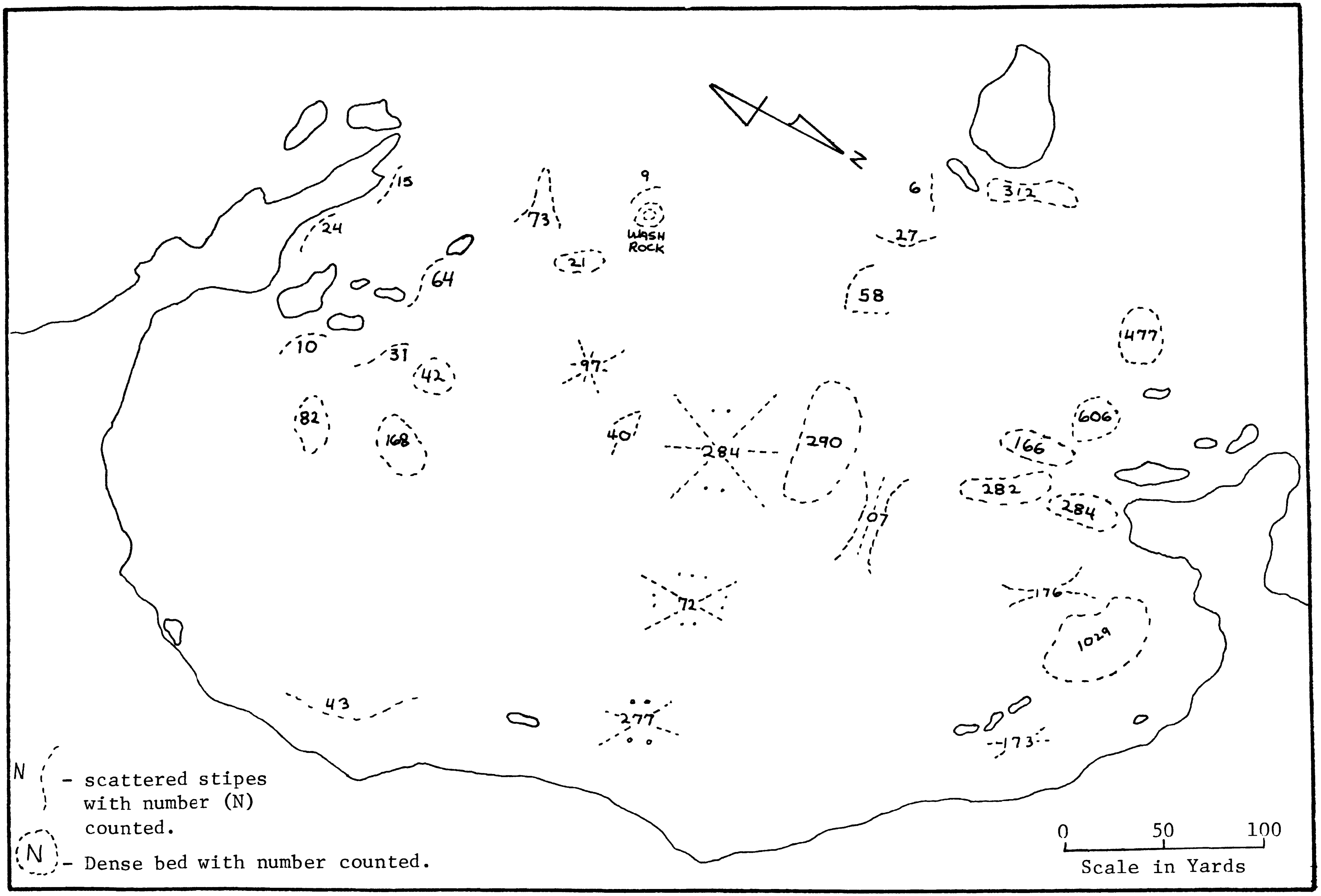


Figure 5. Relative densities and distribution of *Nereocystis* from the north point of Diablo Cove to Lion Rock on 20 October 1970.

Figure 6. Relative densities and distribution of *Nereocystis* from the north point of Diablo Cove to Lion Rock on 1 October 1971.

Figure 7. Relative densities and distribution of *Nereocystis* from the south point of Diablo Cove to intertidal station 5 on 20 October 1970.

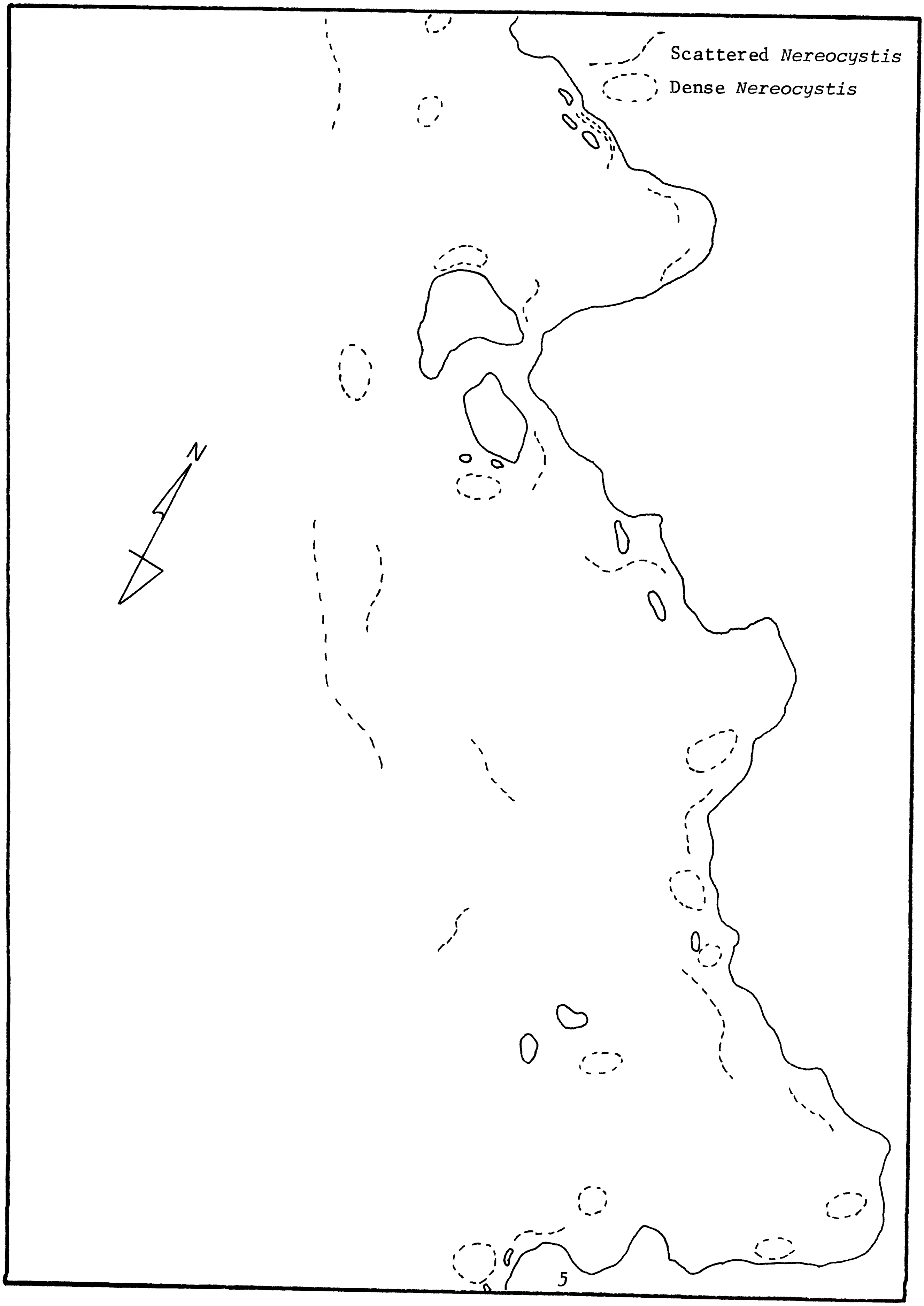
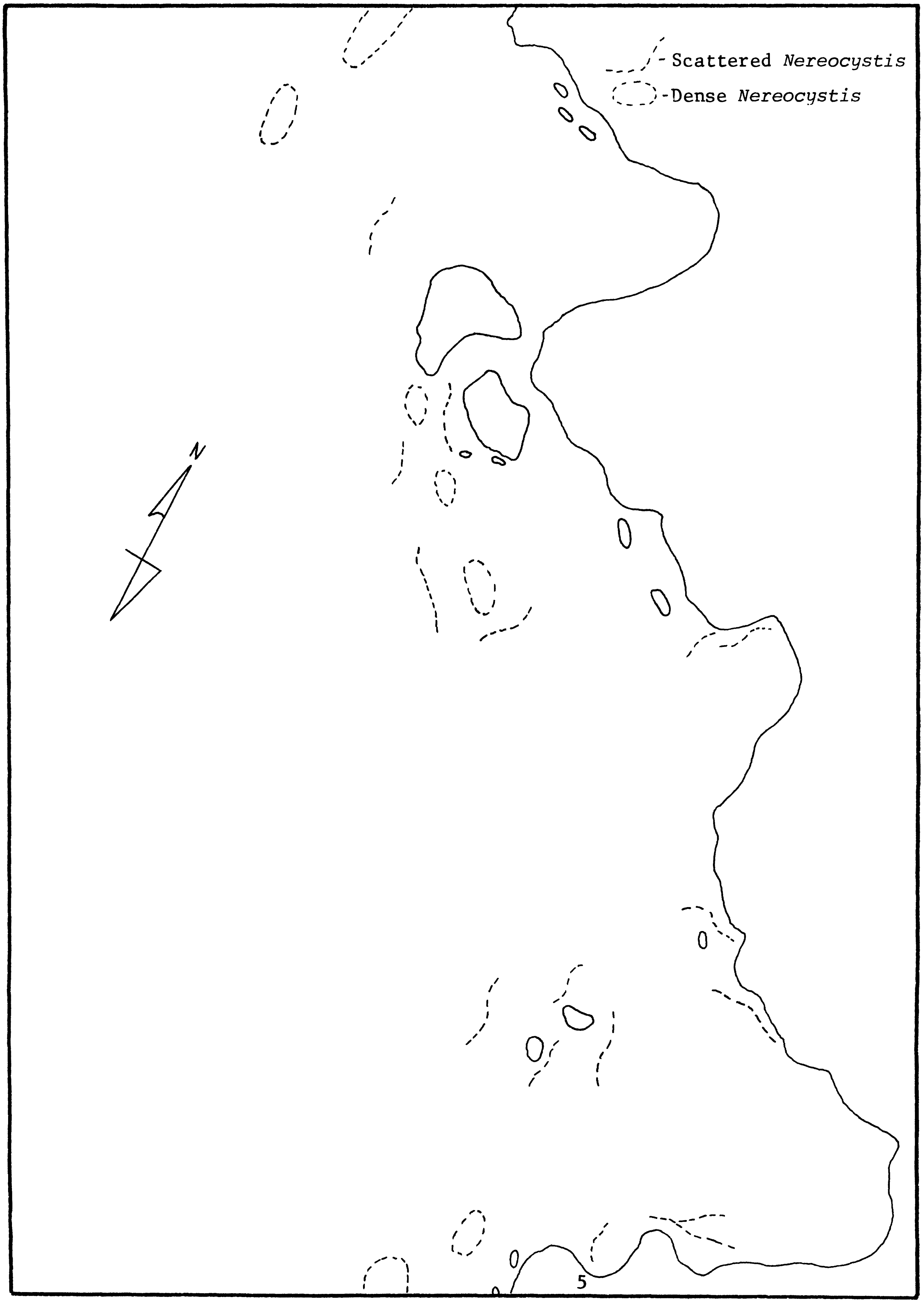


Figure 8. Relative densities and distribution of *Nereocystis* from the south point of Diablo Cove to intertidal station 5 and 1 October 1971.



was completed, dense beds grew in the jetty entrance and along the outside tribars.

Life History

The onset of the *Nereocystis* sporophyte generation in Central California is normally first observed in mid spring, about late March or early April. At this time, approximately 1 to 5% of the previous year's canopy (mostly late developing plants) usually remain. If a dense canopy remains, as during 1971 above Point Estero, the old plants may retard new sporophyte generation and growth by shading the bottom. By June it is usually difficult to find a remaining old plant.

Old sporophytes during the spring are heavily burdened with epiphytes, both invertebrates and algae, and the blades are frequently reduced and ragged or absent. Foreman (1970) observed old sporophytes at Salt Point to undergo a regeneration of new blades that became reproductive. Regeneration has not been observed near Morro Bay. However, an occasional old plant was observed with mature sori as late as May and a few old ragged plants were observed to last at least through July.

The mortality rate is extremely high in the developing sporophyte generation as sporophytes commonly attach on unstable surfaces such as cobble which will not support subsequent growth. Small rock, debris, incrusting invertebrates and benthic seaweeds are soon separated from stable substrates by the buoyant pull of the young plants. Algivores including red sea urchins and abalones graze heavily upon sporophytes during this early growth period when the stipe is short and the entire plant is accessible.

Tons of rock are lifted and transported by the developing kelp bed. This action begins after the pneumatocyst forms and at a short stipe length of only 2 to 4 feet. It continues throughout the year. Divers often encounter cobble and large boulders weighing up to 15 pounds or more suspended in the water column by *Nereocystis* plants. Even large abalones have been observed suspended in this manner. Undoubtedly, this action has a significant impact upon the stability of nearshore rocky communities. Foreman (1970) found that Salt Point *Nereocystis* beds were thinned by the loss of plants that drifted ashore in this manner and were there destroyed by wave action. The fate of such plants is not as certain in the Morro Bay area. The vast and dense stands above Point Estero possibly precludes many plants reaching the shore except those along the shoreward fringe of beds. Mature plants are later observed in spiral tangles, and a few of these are attached to "floated" rock and held stationary by others. In the Diablo area most "floaters" probably reach the shore and are destroyed because the beds here are generally restricted to a narrower nearshore band.

The first sporophytes of the season normally reach the surface by May. Those growing in shallow water appear first. Sorus development initiates prior to the plants reaching the surface. Mature sori may be observed as early as June. Several sori develop on each blade; the most distal are the oldest and first to mature. Preceding zoospore release, mature sori break free from the blade and drift to the ocean floor. Zoospore release then commences and is usually completed within an hour (Nicholson, 1970).

New plants initiate at least through August, and sori develop and mature through March of the following year. These conditions may account for the overlap of annual sporophyte generations. Peak bed development (density) and maturation of the sori typically occur in September near Morro Bay. At this time, sori are frequently seen accumulated in seafloor gullies surrounded by buff colored "clouds" of swarming zoospores.

Epiphytes and encrusting, grazing, and boring invertebrates become obvious as the plants reach the surface. First to appear are hydroids, an ectoproct *Membranipora membranacea*, and a green algae, *Enteromorpha* sp. Algal epiphytes in time become dominant, of these, filamentous reds, *Antithamnion* spp., are most abundant. *Porphyra nereocystis*, a foliose red, also becomes a prominent form.

Algivorous gastropods graze steadily upward on the elongating kelp stipes. Common are the trochid snails, *Calliostoma ligatum, C. annulatum,* and *Tegula montereyi.*

A host of bony fishes utilize the kelp bed canopy and stipe regions, both for protection and as a harbor for food items. The developing kelp bed appears particularly important to adult and juvenile rockfishes. Notable were the blue rockfish, *Sebastes mystinus* and olive rockfish, *S. flavidus*, that utilize the entire water column and derive both shelter and indirect food sources here.

The first Pacific winter storm, usually in October or November, starts the kelp bed decline. In these months the availability of *Nereocystis* to abalones is maximal and the seafloor is littered with kelp stipes. Beds may break up completely from a few severe storms or may decline more slowly throughout the fall, winter, and spring months. This latter condition, more normal, provides a continuous rain of high quality food to benthic algivores. Abalones near Morro Bay are in prime condition during these months and may add most of their annual growth during this period.

Nereocystis Growth

Nereocystis growth studies were conducted a few miles north of Point Estero in 40 to 50 foot depths. A permanent sea floor station was established there in 1967 by Earl Ebert to study red abalone ecology, including life history studies of *Nereocystis*. One-half inch steel cable and concrete blocks defined the rectangular station perimeter that measured 50 by 150 feet. Rather than attach a surface buoy, the station was located by triangulation from shore markers.

Kelp markers were constructed using 1/8 inch polyvinyl tubing, numbered plastic tags (1/2 x 1 inch pieces) and stainless steel wire. To minimize injury from chaffing, the wire was first passed through the soft tubing and then looped around the plant stipe. Length measurements were made by two divers utilizing a reel-wound tape measure. Kelp length was recorded as the distance from the holdfast base to the distal end of the pneumatocyst, and was measured to the nearest centimeter. Growth studies were made in 1967 and 1968.

In 1967 *Nereocystis* sporophyte development initiated during early April. On April 27 ten plants averaging 9.5 cm total length and ranging from 6 to 20 cm were tagged. Many of these perished by June 25 so an additional 13 of the smaller plants available in the study area were tagged. This second group ranged from 25 to 114 cm with a mean stipe length of 55 cm (Appendix XXX, Table 12).

Mortality rates at first were high. Eight, or 35% of the total tagged, were missing before 30 days had elapsed. An additional five (combined

TABLE 12. Average Daily Growth Rates of *Nereocystis* at Point Estero During 1967 and 1968.

		1967 Group I	1967 Group II	1968 Combined
Date tagged		April 27	June 25	May 7
Mean length at tagging in cm		9.5	54.7	104.87
Range in length at tagging in cm		6-20	18-114	27-182
Average Daily Growth in cm	May	8.18		24.70
	June	17.5	10.03	15.74
	July	12.59	18.87	8.52
	August	2.61	11.15	1.99
	September	-.33		.64

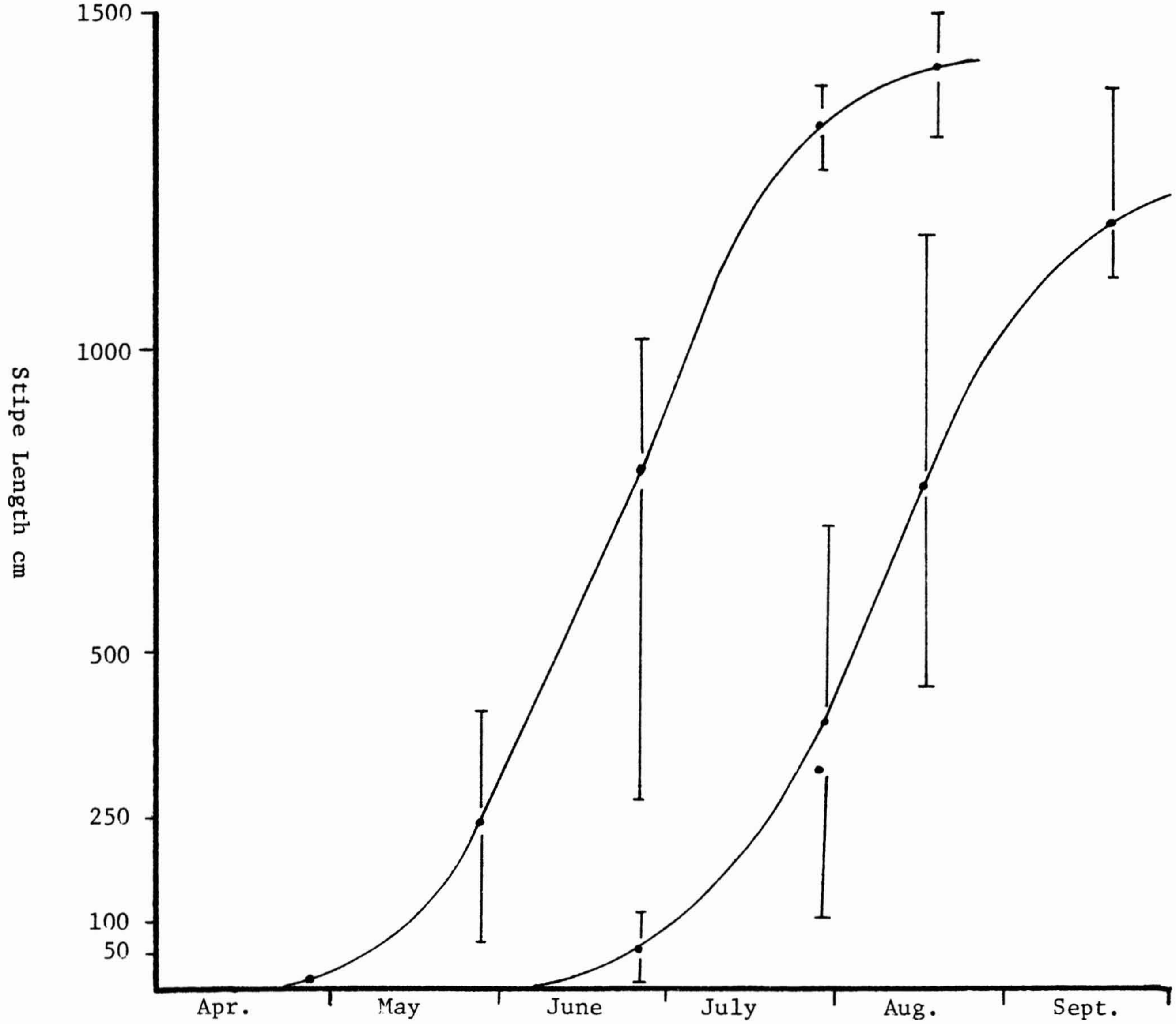
total of 57%) did not survive for 90 days. Nicholson (1970) found a mortality rate of 48% amongst intertidal plants at Monterey. Foreman (1970) observed higher mortality rates of juvenile subtidal plants at Salt Point which agrees with subjective subtidal observations at Point Estero and Diablo. Only plants that were firmly attached to proper substrates were tagged for our studies at Point Estero; had plants been tagged at random a much higher mortality rate would have likely ensued.

Growth rates for both tagged groups of 1967 averaged 13.05 cm/day during the first 3 months. The growth rate accelerated in the mid water column and then slowed as the plants neared the surface. After reaching the surface, growth of the stipes retarded and eventually ceased (Figure 9).

Developing kelp sporophytes of 1968 were first noted on March 22. These ranged in length to 10 cm. Tags were not affixed until May 7; at that time a few plants were estimated to be 5 m long but the average was considerably less. Twenty plants were tagged but only nine were useful in growth determinations (Appendix XXXI). The others either perished or their growth was anomalous due to blade loss or shading by the developing canopy. Plants which were naturally or experimentally debladed grew slowly compared to normal plants and eventually perished. Nicholson (1970) suggested that blades produce materials necessary for sporophyte growth and found that plants ceased development and did not mature or grow after blades were removed.

Kelp stipes elongated more rapidly in 1968 than 1967 and the bed density also appeared appreciably greater. Plants grew at a rate of 16.32 cm/day during the first 3 months, which appears similar to 1967 (Table 12). However, plants grew more rapidly during May after their initial start, and reached the surface much earlier. Hence, the apparent similarity to

Figure 9. Growth rate of two groups of *Nereocystis luetkeana* at Point Estero in 1967. Mean length and length range are included for each measuring date.



1967 although growth rate was markedly faster in 1968. After nearing or reaching the surface, growth again slowed and eventually ceased (Figure 10).

Data from both years suggest that initial growth is slower than during subsequent months. As plants cannot develop or grow without blades (Nicholson, 1970), early blade formation including the pneumatocyst must be of primary importance. Plants at Point Estero were first recognizable as *Nereocystis* at 6 to 10 mm total length when a vertical line marked the origin of the first blade division. The primary blade was somewhat longer than the stipe at this point. At about 12-15 cm the first blade splitting occurred and lines marking the second divisions were evident. A slight swelling of the stipe at the base of the primary blade marked the location and appearance of the pneumatocyst. At 9 to 15 cm stipe length (about 15 to 25 cm total length), the stipe length first exceeded blade length, the pneumatocyst was prominent and ranged from 7 to over 20 mm diameter, the primary blade division was completed, and several additional longitudinal lines marked areas of further blade divisions.

At this point, stipe elongation continued more rapidly than blade development. Fast developing plants grew at the rates of over 28 cm/day after reaching over 100 cm stipe length (after the initial slower growth).

Temperature and water clarity were the only physical parameters recorded, relative to kelp development, during the two year study. Seafloor temperatures at the study area ranged from 10.5 C to 14.9 C while sea surface temperatures ranged from 10.5 C to 15.9 C (Figures 11 and 12, Appendicies XXXII and XXXIII). Sporophyte development was first seen each spring as seafloor temperatures declined to yearly lows following fall and winter maxima. In 1967 the sporophyte generation initiated at a seafloor temperature of 10.0 C; in 1968 the temperature was 11.2 C when growth first

Figure 10. Growth rate of *Nereocystis luetkeana* at Point Estero in 1968. Mean length and length range are included for each measuring date.

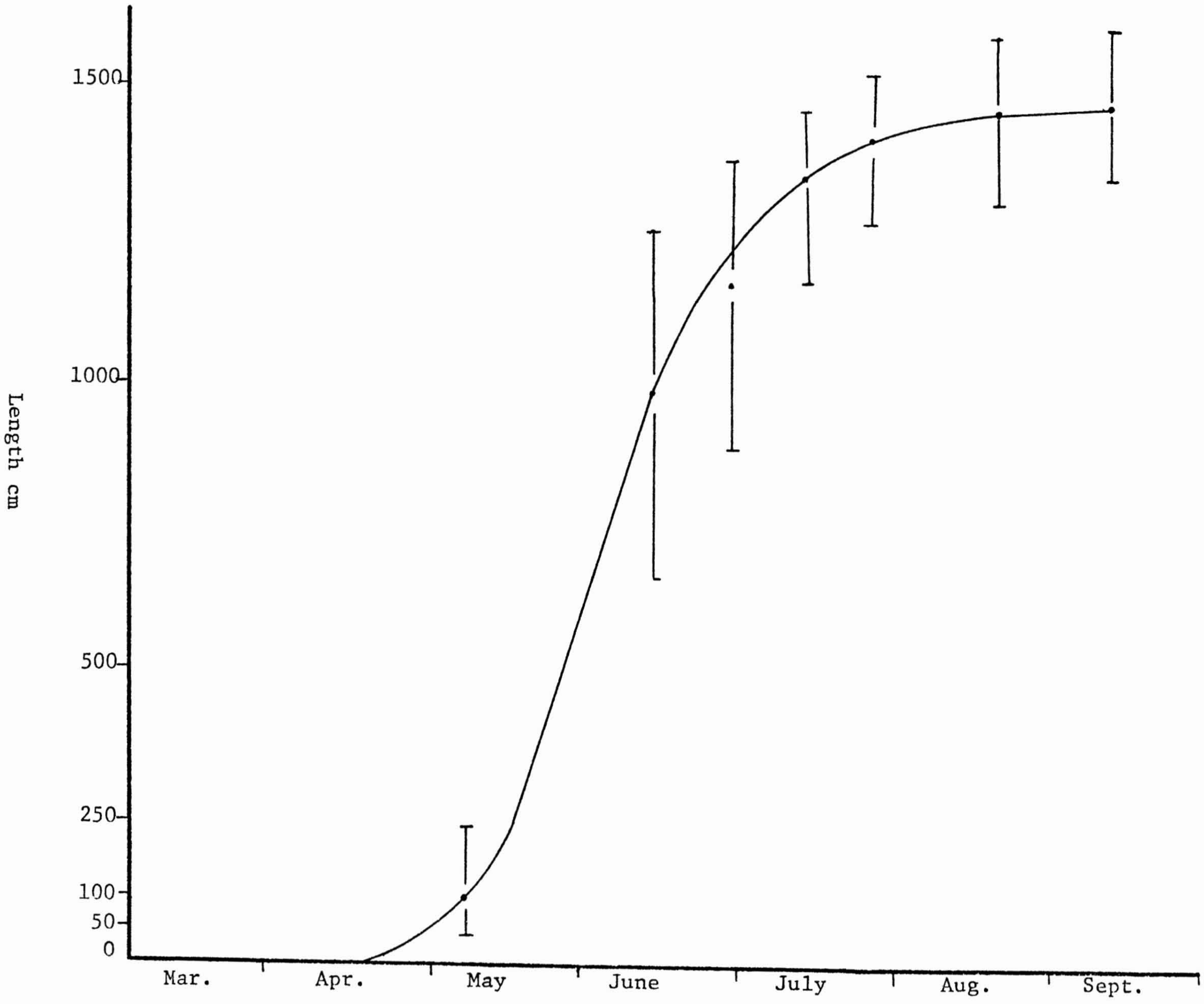


Figure 11. Average monthly surface and bottom water temperatures at Point Estero during 1967.

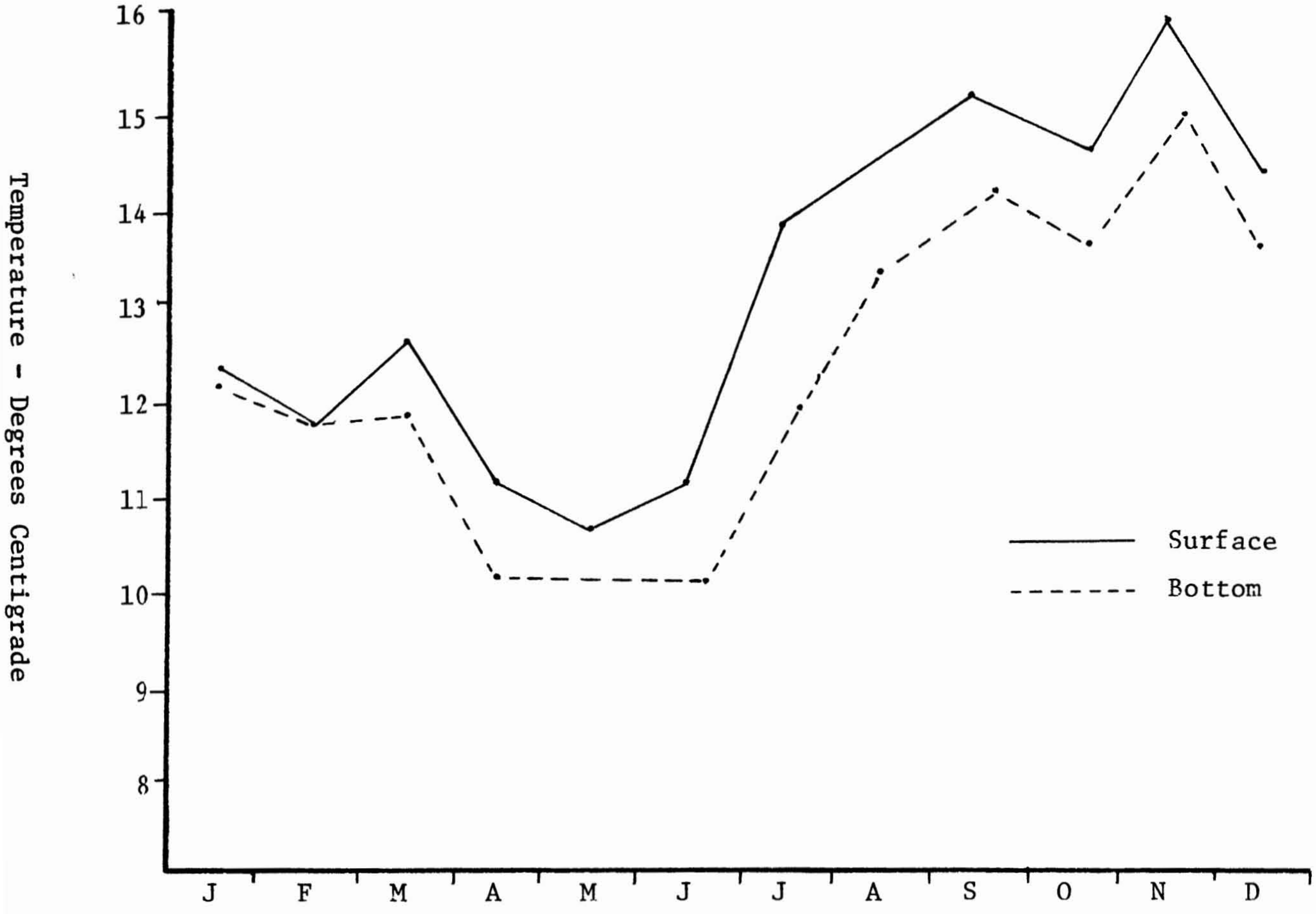
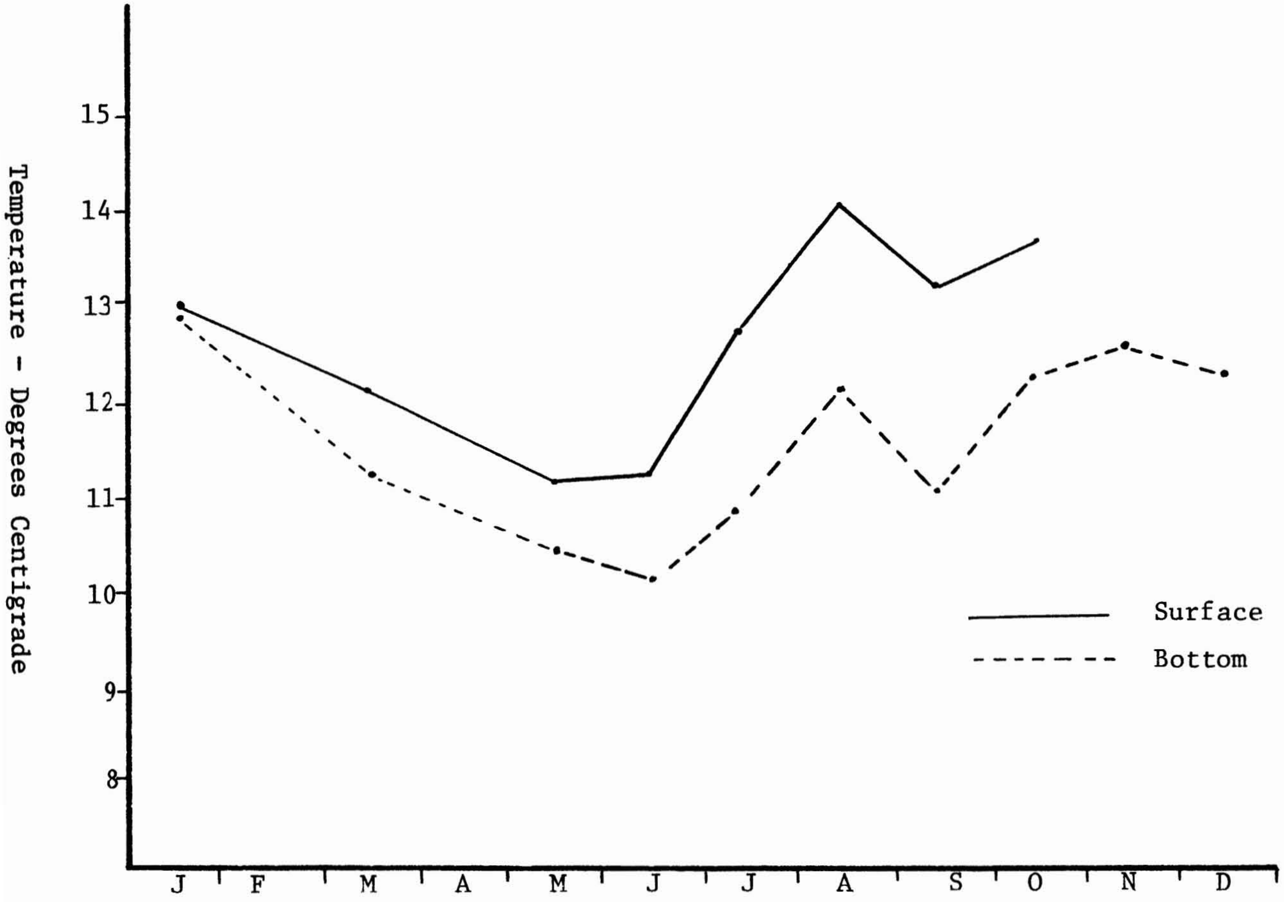


Figure 12. Average monthly surface and bottom water temperatures at Point Estero during 1968.



started. Few new sporophytes were seen after bottom temperatures rose above 12 C in August. In laboratory culture, Vadas (1972) obtained both gametophyte maturation and sporophyte development at 5, 10, and 15 C but not at 20 C. He suggested the temperature limits to be 2 or 3 C above 15 C and below 5 C.

The estimated water clarity at Point Estero during 1967 and 1968 varied from 12 to 35 feet on the bottom and 8 to 28 feet at the surface. During initial sporophyte generation in March through May, the clarity ranged from 12 to 30 feet.

Lower water clarity resulting in reduced light penetration is suggested as responsible for inhibiting sporophyte generation until July in 1969. Clarity measured at Diablo during the spring that year was 4-12 feet and was considered much less at Point Estero during the same period although measurements were not taken. Vadas (1972) found light intensity to be the most important factor inducing sexuality. Both growth and reproduction were inhibited or significantly delayed at 161 lux while maturation occurred rapidly at 1076 and 2152 lux at 5, 10, and 15 C. These data furnish good evidence that dirty water conditions can inhibit sporophyte development and may even prevent growth and canopy development.

ABALONE TRANSPLANTS

To avoid or minimize adverse effects of construction activities, abalone transplants were conducted at several sites during 1969-72. A total of 30 transplants was made from jetty, haul road, and intake sites in South Cove and the discharge site in Diablo Cove. Personnel from CDF&G, PG&E, and students and professors from California Polytechnic College, participated in the shoreline transplants. Sport and commercial divers assisted many of the subtidal operations.

TABLE 13. Abalones Transplanted from the Diablo Cove Study Area During 1969 to 1972.

DATE	Red Abalone	Black Abalone	*Other Species	Total Abalone	Removed From	Transplanted To
6/14/69	483	8	26	517	South Cove	Point Buschon Shell Beach
6/15/69	53		6	59	South Cove	Point Buschon Humboldt Bay
6/16/69		500		500	South Cove	Morro Bay jetty Humboldt Bay
6/20/69	688		23	711	South Cove	Montana De Oro
7/10/69	121			121	South Cove	Montana De Oro
9/4/69	273			273	South Cove	Montana De Oro
9/5/69	1,253			1,253	South Cove	Montana De Oro
9/8/69	1,148			1,148	South Cove	Montana De Oro
9/9/69	1,320			1,320	South Cove	Montana De Oro
9/11/69		200		200	South Cove	Humboldt Bay
2/28/70		766		766	South Cove	Montana De Oro
3/1/70	1	828		829	South Cove	Montana De Oro
3/2/70		528		528	South Cove	Montana De Oro
3/3/70		857		857	South Cove	Montana De Oro
3/18/70		471		471	South Cove	Montana De Oro
3/19/70	23	627		650	South Cove	Montana De Oro
3/20/70	39	248		287	South Cove	Montana De Oro
5/22/70	88	192		280	Diablo Cove	Montana De Oro
5/23/70		866		866	Diablo Cove	Shell Beach
5/24/70	274			274	South Cove	Montana De Oro
5/24/70		682		682	Diablo Cove	Shell Beach

In all 15,396 abalones were removed including 7,473 red abalones, 7,865 black abalones, 53 threaded abalones, and 5 flat abalones (Table 13). All were replanted outside of the Diablo Canyon area primarily at Montana De Oro State Park and Shell Beach. A few black abalones were planted on the outside of the North-West Morro Bay entrance channel jetty. Several subtidal transplants of red abalones were made to the Pecho Rock area. Additionally, some red abalones were transported to Department research laboratories where they were used as spawning stocks or in other experiments.

It was originally assumed the transplanted animals would be beneficial to the abalone resources at the planting sites by increasing existing low stock sizes and providing additional spawn and recruitment to immediate and adjoining areas. However, many of the legal sport size abalones planted in the intertidal were immediately removed by shore pickers. Both the Shell Beach and State Park areas were heavily picked which prompted at least one newspaper article (Telegram Tribune, San Luis Obispo County) titled "Abalone 'grabbin' at Palisades". In some cases black abalones planted in the intertidal were removed by sportsmen on the same tide as they were transplanted. It is questionable if the intertidal black abalone transplants benefited the resource; apparently they provided only temporary recreational benefits to a limited number of sportsmen.

Abalones transplanted subtidally were also taken, but at a much slower rate. Of the 721 red abalones planted with tags off Shell Beach during May, 1972, 14 have been removed by sport divers and seven by commercial divers. An additional five empty shells with tags which washed up on shore or were found by divers have been returned.

TABLE 13 - Contd.

DATE	Red Abalone	Black Abalone	Other* Species	Total Abalone	Removed From	Transplanted To
5/25/70	51	373		424	Diablo Cove	Shell Beach
5/26/70	415		2	417	South Cove	Montana De Oro
6/24/70	6	398		404	Diablo Cove	Shell Beach
11/17/71	81	234		315	S. Cove Inside Cofferdam	C D F/G Research Labs.
11/18/71	150	87	1	238	S. Cove Inside Cofferdam	C D F/G Research Labs.
3/16/72	76			76	Inside E. Breakwater S. Cove	C D F/G Research Labs.
4/3/72	190			190	Inside E. Breakwater S. Cove	C D F/G Research Labs.
5/9/72	506			506	Inside E. Breakwater S. Cove	Shell Beach
5/11/72	234			234	Inside E. Breakwater S. Cove	Shell Beach
TOTALS	7,473	7,865	58	15,396		

* Combined flat and threaded abalones

Transplanting mortality rates were not measured, but we suspect they were significant. Fresh shells were occasionally seen in the intertidal immediately following transplants. Abalones may die during or following transplants from several factors including handling, improper planting and/or tumbling in the surf during rough ocean periods, and cuts sustained when removed by pickers. Cuts are especially serious as the animal may bleed to death or be weakened and become vulnerable to predators. Animals may also die several months following cutting and this may not be observed or attributed to the transplants.

During these transplants, when time and personnel were available, measurements of length and width were taken. On two occasions red abalones were also weighed.

BLACK ABALONE POPULATION STRUCTURE AND MORPHOMETRICS

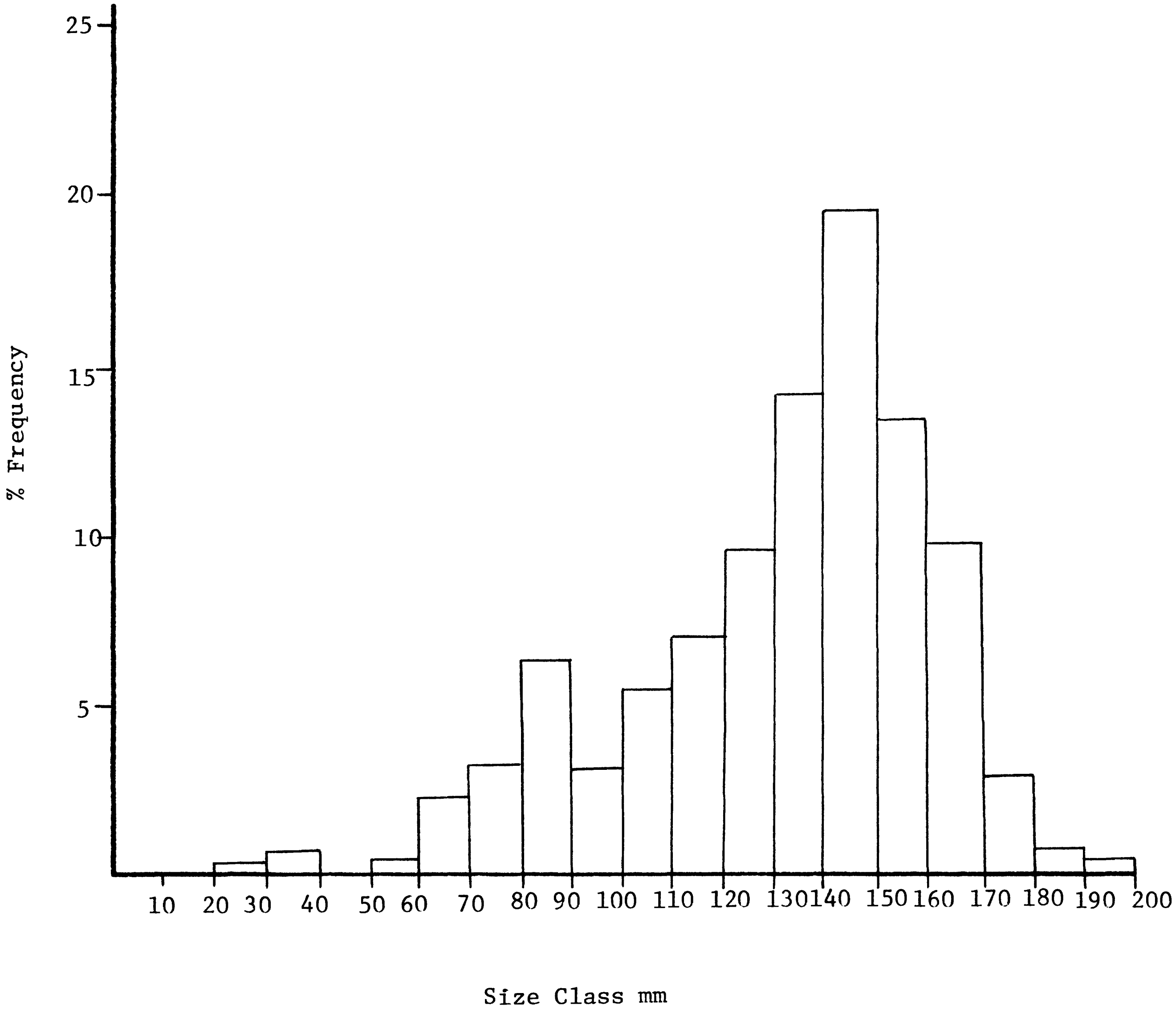
In all 2,511 black abalones from five transplants were removed from the Diablo Cove intertidal at the planned discharge structure site. Length and width measurements were obtained for 438 of these (Table 14, Appendix XXV). Filled burlap bags of abalones were randomly sampled as individual pickers left the intertidal and brought abalones to transporting vehicles.

The length measurements were divided into 10 mm size classes for analysis (Table 14, Figure 13). Over 61% of the sample at 131 mm or larger (5.16 inches) were close to the minimum sport legal size of five inches. At 141 mm or greater 47% were over 5 1/2 inches, the minimum commercial size limit in southern California. Nearly 27% reached 6 inches at 151 mm (5.94 inches).

TABLE 14. Length-Width Relationship for 438 Black Abalones, *Haliotis cracherodii*, removed from Diablo Cove Discharge Site During 1970.

Length Size Class mm	Number Measured	Width Range mm	Width Mean mm	Percent of Total
21-30	1		19.0	.2
31-40	3	25-29	27.3	.7
41-50	-	-	-	-
51-60	2	39-39	39.0	.5
61-70	10	44-53	48.0	2.3
71-80	15	40-62	54.3	3.4
81-90	28	60-75	64.2	6.4
91-100	14	68-81	74.8	3.2
101-110	24	75-88	81.8	5.5
111-120	31	79-105	91.1	7.1
121-130	42	88-111	99.2	9.6
131-140	62	96-128	108.6	14.2
141-150	86	105-138	118.7	19.6
151-160	59	115-140	127.7	13.5
161-170	43	121-152	134.9	9.8
171-180	13	135-151	144.2	3.0
181-190	3	143-150	147.0	.7
191-200	2	149-159	154.0	.5
TOTAL	438			100.2

Figure 13. Length frequency distribution of 438 black abalones, *Haliotis cracherodii*, removed from the Diablo Cove discharge site during 1970.



The high percentage of sport legals is typical of virgin or little utilized stocks. Many of the abalones appeared old, exhibiting the deep bowl shaped shell characteristic of abalones competing for space and food. Many shells were heavily eroded with parts or all of the prismatic layer missing and had only the inside nacreous layer left. In some cases erosion was extreme and a muscle scar was visible in nacre on the outside of the shell. This condition existed to the greatest degree in South Cove.

The largest black abalone removed measured 192 mm in length and was 159 mm wide. The smallest was 27 mm long and 19 mm wide.

The low number of blacks smaller than 100 mm (only 16.7% of the total) was not unusual for these conditions. If abalones of these smaller size classes were visible and removable, the numbers salvaged would be far greater. However, small black abalones are cryptic, as are reds, living under boulders, in deep crevices, in urchin depressions, etc. They are seldom available for removal, and may be missed or left by pickers when larger abalones are present. Thus, the size class structures presented, do not reflect actual numbers or percentages of the smaller abalones at Diablo.

Width increased with length in a straight line relationship (Figure 14). A 100 mm long black abalone averaged 78.3 mm in width; a 150 mm long black abalone averaged 123.2 mm in width.

In South Cove, 5,354 black abalones were removed during 12 transplants. These were from the intake site and from the haul road area that followed the shoreline to an offshore reef where the east breakwater commenced. Only 199 of these were measured (Table 15, Appendix XXVI). These 199 came from the intake site only, and followed an earlier transplant which probably accounts for the smaller size class distribution,

Figure 14. Length-width relationship for 438 black abalones, *Haliotis cracherodii*, removed from the Diablo Cove discharge site during 1970 and 199 black abalones removed from the South Cove intake site in 1969.

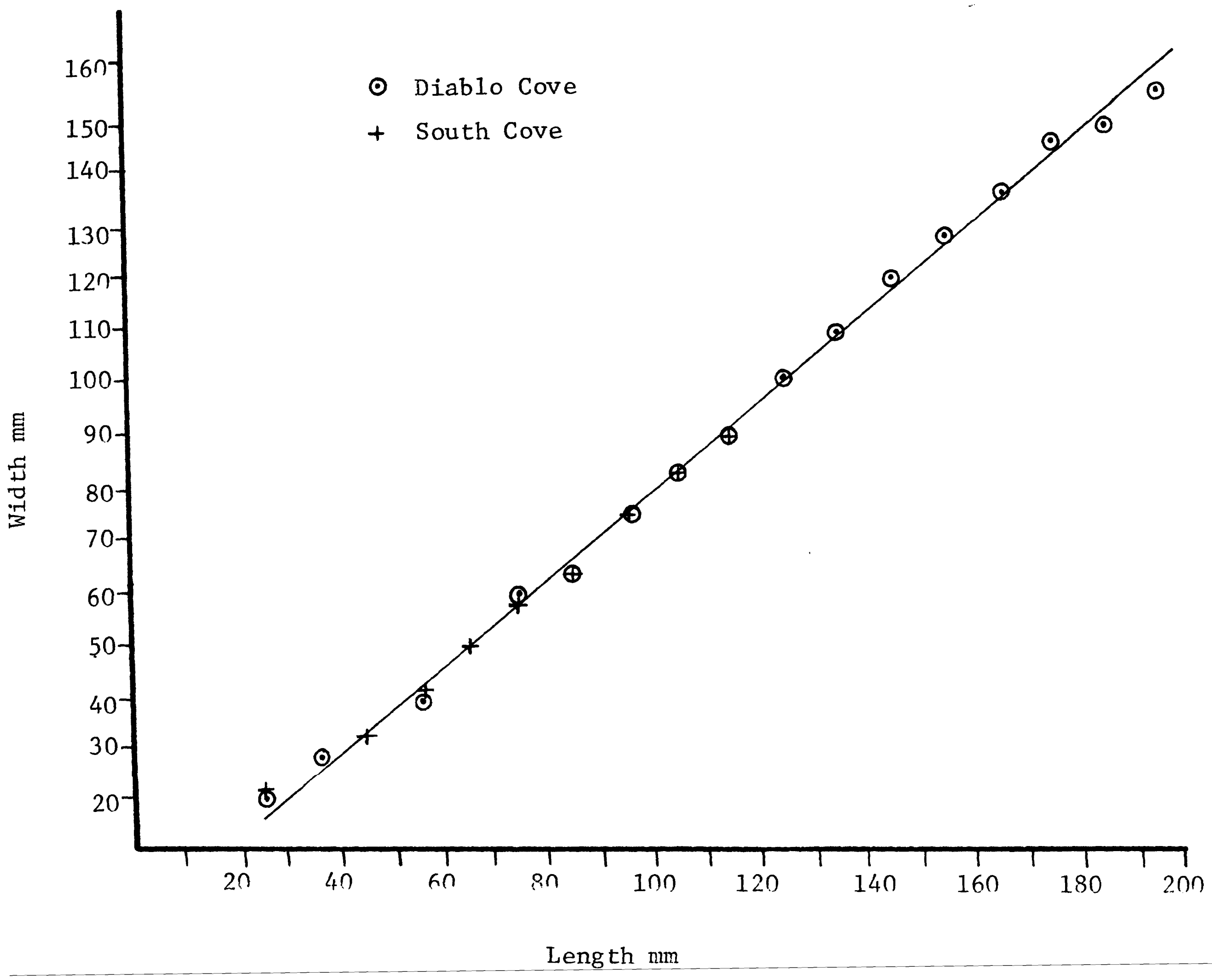


TABLE 15. **Length-Width Relationship for 199 Black Abalones, *Haliotis cracherodii*, removed from the Intake Site South Diablo Cove in September, 1969.**

Length Size Class mm	Number Measured	Width Range mm	Width Mean mm	Percent of Total
21-30	1	--	21.00	0.50
31-40	0	--	--	--
41-50	12	30-37	32.50	6.03
51-60	27	37-45	41.26	13.57
61-70	32	43-58	48.87	16.08
71-80	32	51-63	56.90	16.08
81-90	39	58-75	65.41	19.60
91-100	33	68-82	74.15	16.58
101-110	16	75-90	82.25	8.04
111-120	7	84-99	91.00	3.52
TOTAL	199			100.00

assuming the larger abalones had been picked earlier. The data for length-width are presented in Figure 14 but size class frequencies were not plotted as they do not represent normal population structures.

RED ABALONE POPULATION STRUCTURE AND MORPHOMETRICS

Of 7,328 red abalones removed from South Cove during 18 transplants, 981 were measured for length (Table 17). An additional 721 were taken from inside the East Breakwater during May 1972, and were sampled for length, width and weight (Table 16). The 981 reds were measured aboard commercial abalone boats and partyboats under less than ideal ocean and working conditions, but the 721 removed from South Cove were picked by CDF&G and PG&E biologists and all were brought aboard the R/V Mollusk where good conditions were available to take length and weight measurements. These abalones were tagged with stainless steel wire looped through the two anterior respiratory holes with a numbered 0.5 x 0.5 inch monel plate attached. They were then transported to a Shell Beach CDF&G study area and replanted under a *Macrocystis* canopy in 15 to 20 foot depths. These red abalones will be periodically monitored for growth and weight gains.

The length measurements from all red abalones from South Cove were separated into 20 mm increments for further analysis (Tables 16 and 17, Appendix XXVII). The two groups did not vary greatly in size class structure. Of the 1,702 measured, 51.3% were 180 mm and greater (the minimum sport legal size is 7 inches or 178 mm) while 9.1% were 200 mm and greater (the minimum commercial length size is 7 3/4 inches or 197 mm). The high percentage of sport legals and the percentage available to commercial harvest compare closely to our unpublished data from red abalone surveys at Point Estero (Figure 15).

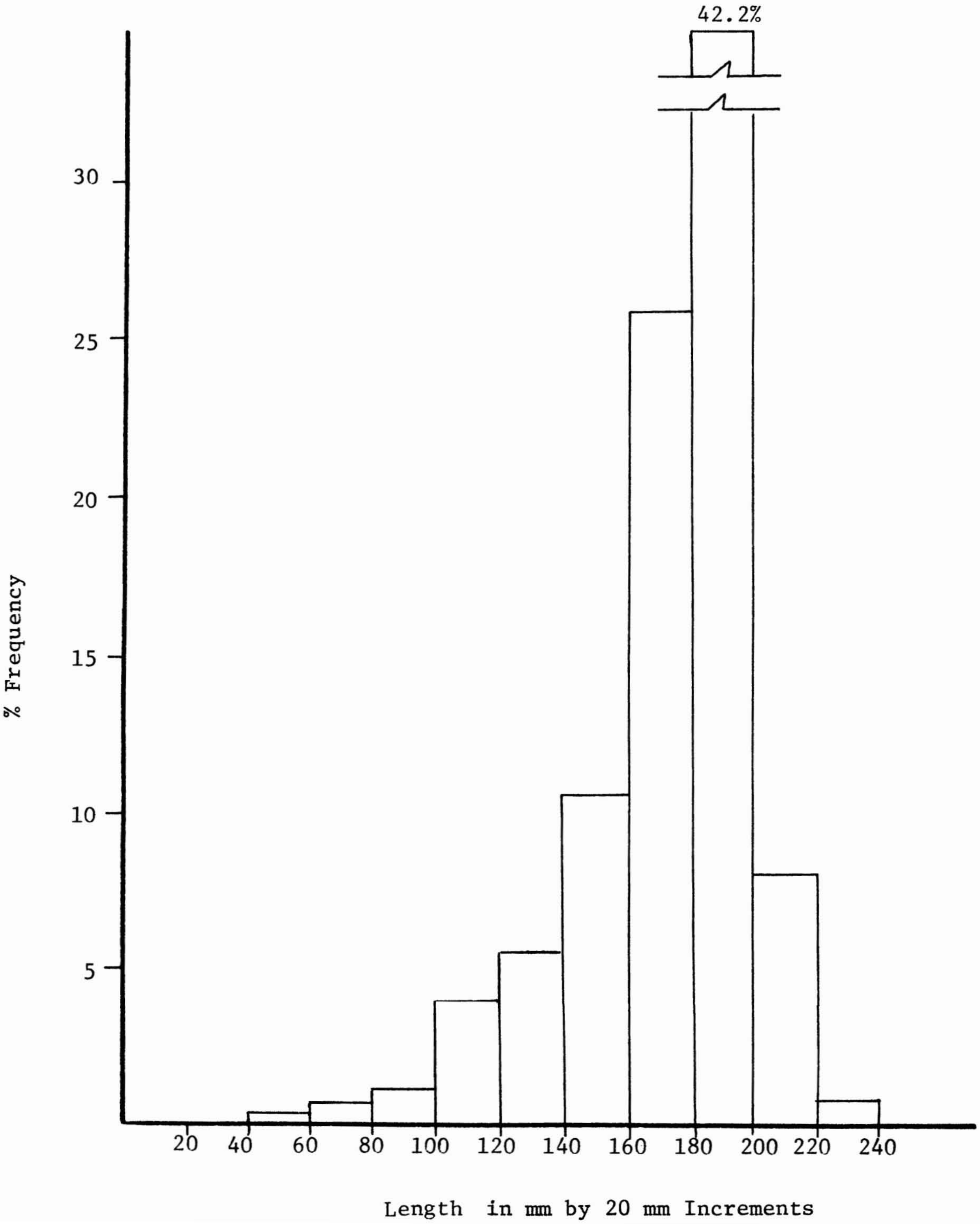
TABLE 16. Length-Width and Length-Weight Relationships for 721 Red Abalones, *Haliotis rufescens*, Removed From Inside the East Breakwater During May, 1972.

Length Size Class mm	Number Measured	Percent of Total	Width Range mm	Width Mean mm	Number Weighed	Percent of Total	Weight Range (g)	Weight Mean (g)
61-80	6	0.8	45.0-59.0	53.6	6	1.1	30-75	53.3
81-100	4	0.6	58.5-71.0	64.5	4	0.7	55-105	81.3
101-120	22	3.0	75.0-94.0	82.8	17	3.1	100-275	181.5
121-140	37	5.0	90.0-117	100.1	31	5.7	180-420	308.1
141-160	98	13.6	104.0-132	116.7	72	13.2	340-850	533.2
161-180	208	28.8	114.0-146.5	134.3	152	27.9	490-1300	841.6
181-200	280	38.8	132.0-173.0	148.0	212	38.9	700-2075	1183.6
201-220	62	8.6	147.0-173.0	161.73	48	8.8	1160-1920	1595.5
221-240	4	0.6	150.5-179.0	165.9	3	0.5	1750-1985	1845.0
TOTAL	721	99.8			545	99.9		

TABLE 17. Length Frequencies for 1,702 Red Abalones, *Haliotis rufescens*, Removed From South Cove.

Length Size Class mm	South Cove Number	South Cove Percent	Inside East Breakwater Number	Inside East Breakwater Percent	Total	Percent of Total
41-60	7	.7			7	0.4
61-80	7	.7	6	.8	13	0.8
81-100	17	1.7	4	.6	21	1.2
101-120	46	4.7	22	3.1	68	4.0
121-140	58	5.9	37	5.1	95	5.6
141-160	83	8.5	98	13.6	181	10.6
161-180	235	24.0	208	28.8	443	26.0
181-200	439	44.8	280	38.8	719	42.2
201-220	79	8.1	62	8.6	141	8.2
221-240	9	.9	4	.6	13	0.8
241-260	1	.1			1	0.1
TOTAL	981	100.1	721	100.0	1,702	99.9

Figure 15. **Length frequency distribution of 1,702 red abalones, *Haliotis rufescens*, removed from South Cove during 1969-1972.**



The few small abalones taken (less than 160 mm) also compares favorably with our data from Point Estero. Juvenile red abalones are highly cryptic, as are blacks, and live deep in crevices and under boulders. In this habitat, they receive considerable protection from their many predators. Had it been possible to turn large boulders and open deep crevices, the number of juveniles taken would have increased substantially.

Although growth rates for red abalones are imperfectly known recent data from Point Estero and Shell Beach (unpublished data, CDF&G Abalone Project Files) indicates red abalones are growing at less than 1 inch per year. Assuming that most abalones are sexually mature at 4 to 5 inches (we have observed spawning in animals as small as 69 mm), red abalones at Diablo will spawn three to four times or more before harvest.

Width increased with length in a straight line relationship (Figure 16). A marked deviation from the plotted line occurred in the 221 to 240 mm increment but too few animals were available for sampling in this size class to determine if the point was valid. Otherwise, the size class means closely fit the suggested drawn line. A 100 mm long red abalone averaged 73.4 mm in width. Sport legal abalones at 180 mm length averaged 141.1 mm width and a commercial legal at 200 mm averaged 154.6 mm width (Figure 16).

The length-weight relationship of 545 red abalones from South Cove was curvilinear (Figure 17). The drawn curve appears to become linear at about 160 mm length and 700 g weight. Minimum sport size red abalones at 180 mm averaged 1012.6 g and minimum commercial size at 200 mm averaged 1389.5 g. The 48 red abalones of commercial size and larger in the 201 to 220 mm size class averaged 1596 g (3.52 lb).

Figure 16. Length-width relationship for 721 red abalones, *Haliotis rufescens*, removed from South Cove inside the east jetty.

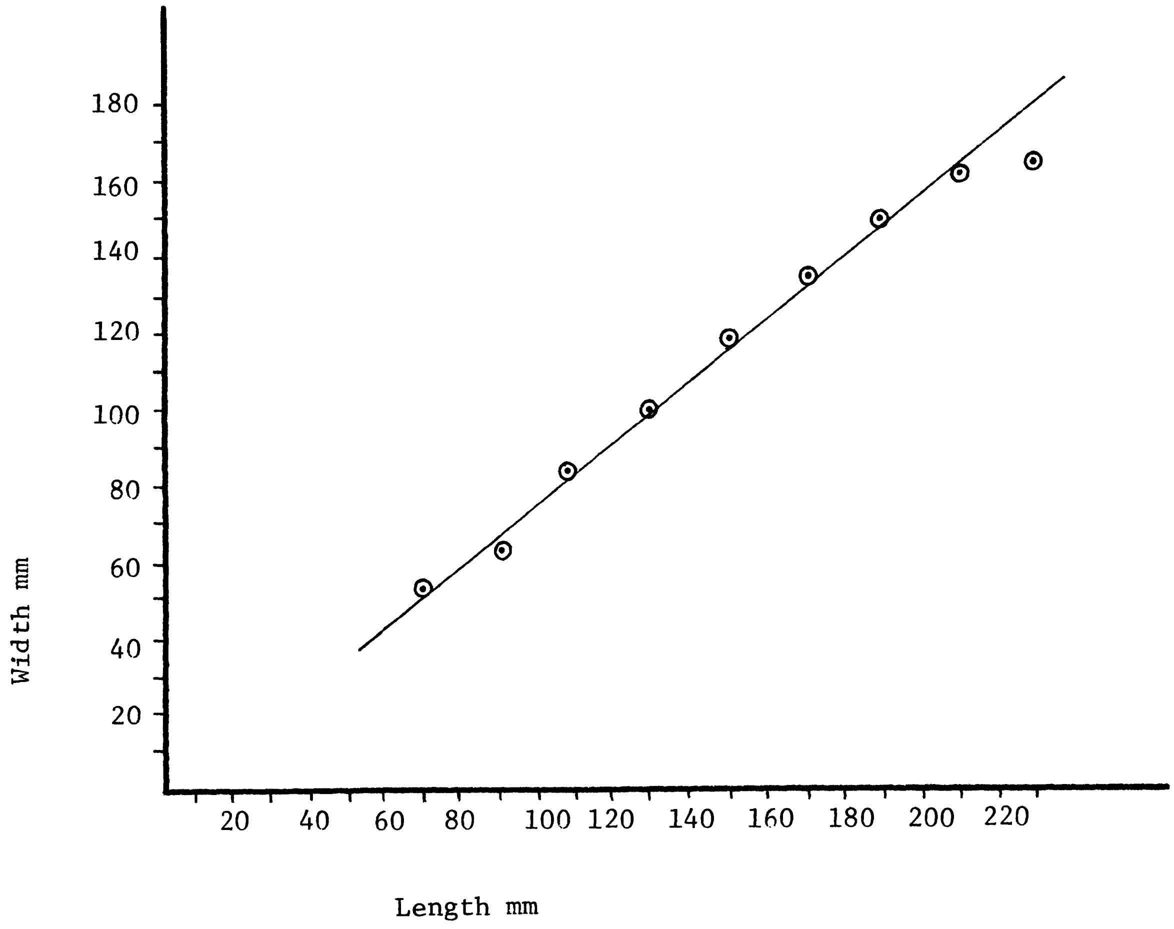
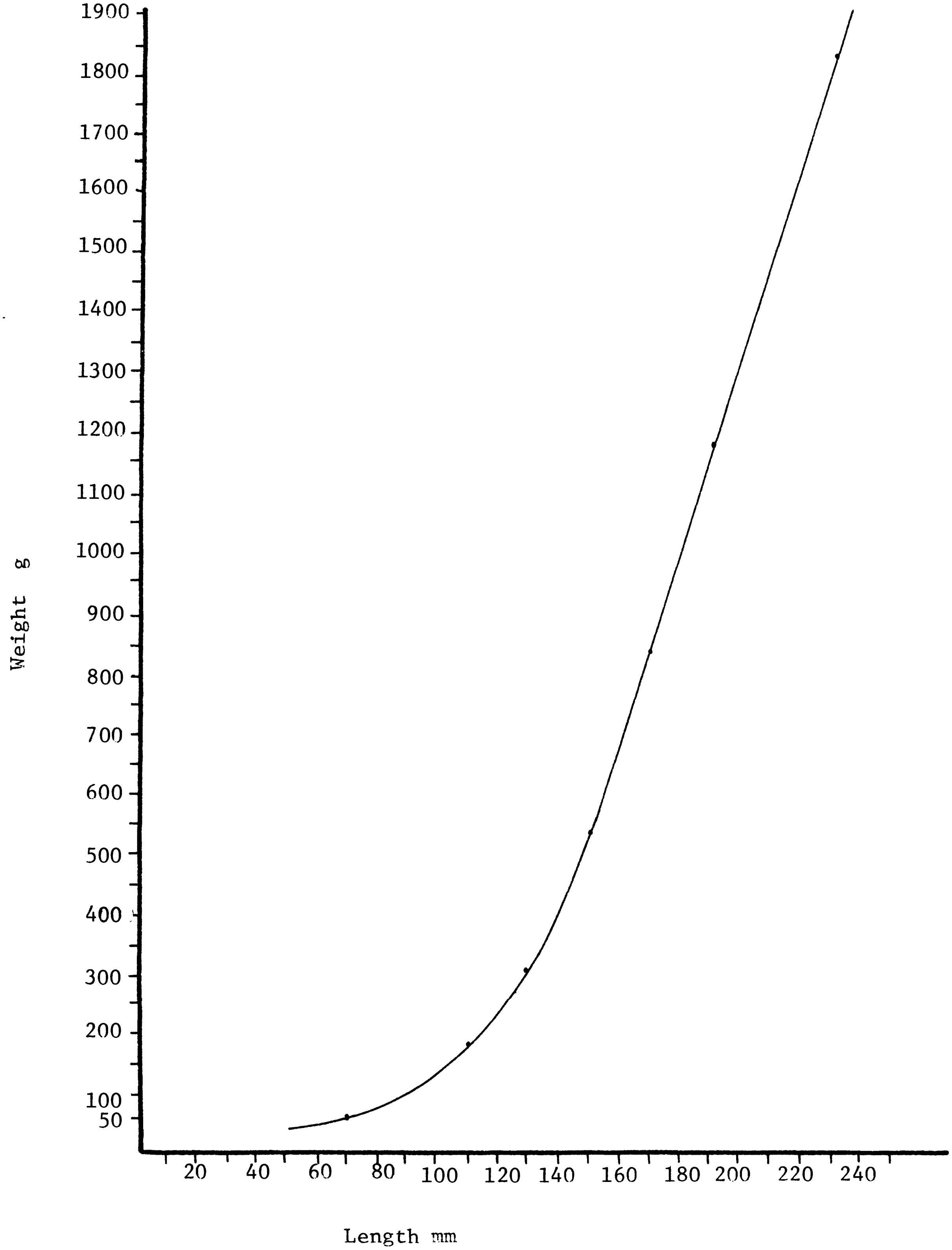


Figure 17. Length-weight relationship for 545 red abalones, *Haliotis rufescens*, removed from South Cove inside the east breakwater during May, 1972.



The length-weight relationship was developed from the following formula.

$$W = AL^{b}$$

where: W = weight

L = length

and

A and b are constants

$A = .000011571$

$b = 3.509796904$

with a correlation coefficient of

.999

The width-weight relationship was developed from the following formula.

$$W_{1} = AW_{2}^{b}$$

where: W_{1} = weight

W_{2} = width

and

A and b are constants

$A = .000011116$

$b = 3.234748563$

with a correlation coefficient of

.999

Both length-weight and width-weight relationships were calculated using mid-length for size classes (the mid-length for the 81-100 mm size class would then be 90.5 mm) and the calculated average weight and width for each class.

RESULTS OF FISH STUDIES

The location of Diablo Cove, as discussed in the introduction to this report, is in the middle of an isolated 13 mile long reef with long expanses of sand to the north and south.

The isolation of this reef becomes increasingly important when we consider the non-migratory behavior patterns of the indigenous fish populations. If activities by man should in any way adversely affect these resident fish populations, or their complex food chain, recruitment from outside this unique area would be extremely slow. An example of the permanence of "reef" fishes is seen in the recoveries from thousands of blue rock fish tagged between the Channel Islands and San Francisco (D. Miller, CDF&G, pers. commun.). Blue rockfish rarely moved more than a mile but would roam between reefs within a 1 mile distance. In a subsequent study in kelp beds, there was no movement of blue rockfish between kelp beds and little movement within a bed.

Until now, man has had little affect upon the fin fish populations of this area. There have never been waste discharges into this area and fishing has been minimal, at best. From Point San Luis north to Coon Creek, a distance of about 11 miles, public access to the shoreline for sport fishing has been (and is) denied by land owners. From Coon Creek to Hazard Canyon, about 2 miles, is state park property, Montana de Oro. However, even in this accessible area shore fishing is partially limited by the walking distance involved and steep precipitous cliffs.

In all, four major collections were made: three at Diablo Cove and one in the North Cove. Those at Diablo Cove were made seasonally (summer, fall, and winter) and at three depths (0 to 10, 20, and 70 feet, Figure 2).

The North Cove collection was made in summer (July) and also entailed three depths: 0 to 10, 25, and 60 feet. This collection was to act as a control for the study area as well as to yield data for a desalter impact statement.

Each collection station encompassed approximately 3,000 - 4,000 square feet. This area was marked by a 250 foot weighted poly propylene line. The configuration of the area varied and surface area was not computed. The ichthyocide also drifted at some stations increasing the area affected.

At each collecting site, divers placed an ichthyocide in plastic bags, entered the water, and simultaneously ringed the collection site releasing the chemical over the total area. Care was taken to push the ichthyocide into crevices and dense benthic algal stands to reach those fishes occupying that habitat. As fishes were affected (time varied due to water temperatures) divers collected them with dip nets.

During the first collection in Diablo Cove many specimens were ingested by the sea gulls which flocked to the collecting site. Skiffs were employed during subsequent collections to compete with the sea gulls for floating specimens.

At the shallow stations (shore and 20-25 feet) divers were not limited by bottom time, so more man hours were expended in the water collecting specimens. However, at the 60 to 70 foot stations the opposite was true. At these deep stations diving teams alternated to collect the fishes efficiently as they were affected by the chemicals used (Table 18).

Sport fishing boats occasionally utilize the Diablo area. The two most popular areas are Pecho Rock, by boats launched at Avila, and Hazard Canyon, by boats launched at Morro Bay. Fishing activity along this portion of the coast will undoubtedly increase.

During the 2 year study in the Diablo Canyon area two methods were employed to access quantitatively and qualitatively the fishes indigenous to that area.

One method entailed actual seasonal counts of fishes occupying the benthos and the mid-water column encompassed by a 30 x 2 m transect at 11 permanent subtidal stations. Estimates were made where large schools occurred by counting a segment of the school and then expanding it into a total number. Quantitatively, large schools of fishes that were counted did not always fall within the 30 x 2 m transect. Counts of benthic dwelling fishes were restricted to the sampling area.

To minimize the number of fishes fleeing due to diver's presence, as one diver layed the transect the other made fish counts. Both divers then made counts during the survey (including estimates of fish schools) and compared counts at its termination. We always had good agreement in numbers counted and estimated except for those fishes fleeing the area during the initial count. In this instance the highest number was recorded.

The second method was to collect fishes by use of an ichthyocide. These collections were made in order to obtain fishes indigenous to the Diablo Canyon area which were not observed by divers, determine the relative abundance of the various fish species by depth, and acquire life parameters for the species inhabiting the area including age, length, weight, sexual maturity, and food habits.

TABLE 18. The Number of Personnel Involved, Diving Man Hours Expended and Ichthyocide Used For Each Fish Collection.

	Number Personnel	Man Hrs. Diving	Amount of Ichthyocide (Gal.)	Number Specimens	Vessels
Diablo Cove					
May 20, 1970					
Depths					
Shore	12	20	3.5	189	skiff
20 Feet	7	12	2.5	171	Rainbow
70 Feet	9	8	2.5	363	Mollusk
September 23-24, 1971					
Depths					
Shore	11	28	4.0	1,599	
20 Feet	11	16	3.0	325	Mollusk & skiff
70 Feet	11	10.5	3.0	972	Mollusk & skiff
January 25-26, 1971					
Depths					
Shore	11	10.5	3.5	643	
20 Feet	12	16	3.0	268	Mollusk & skiff
70 Feet	12	8	3.0	372	Mollusk & skiff
North Cove					
July 6-7, 1971					
Depths					
Shore	9	24.0	5.0	897	
25 Feet	7	24.0	5.0	3,462	Mollusk, Rainbow and skiff
60 Feet	10	18.0	5.0	1,210	Mollusk, Rainbow and skiff

Processing of the specimens was completed at the CDF&G Laboratory, Long Beach, California. As time permitted, age, length, weight, sexual maturity, and food habits were established for many of the fishes. However, due to the number of specimens collected, only groups and representative sizes were usually examined.

Subtidal Fish Counts

During the subtidal surveys nine families of fishes were observed representing 15 genera and 24 species (Cottidae unid., and juvenile rockfishes, *Sebastes* spp. are considered here to each represent a single species each while in fact each may represent several species).

In 1970, 6,687 of the 8,442 fishes counted were juvenile rockfishes (Table 19). In 1971, 32,502 fish were counted and 23,641 of these were juvenile rockfishes (Table 20). This variation is believed to be due to increased water visibility, calmer ocean conditions, and increased familiarity with the fishes and their habitats during the 1971 surveys.

Adult scorpaenids accounted for 84.5% of the adult fishes counted in 1970 (an average of 57 per transect surveyed) and 93.6% in 1971 (an average of 178 per transect surveyed). Blue rockfish, *Sebastes mystinus*, alone accounted for 74.1% of the total in 1970 and 91.4% in 1971.

In 1970, seasonal fish counts (exclusive of juvenile rockfish) varied considerably. The winter and summer counts were quite similar (355 and 301, respectively) but the fall counts involved 1,099 individuals. Counts of juvenile rockfish remained constant for the fall and summer totaling 3,080 and 3,133 respectively. A very low figure of 474 was recorded for the winter, with 200 of these on one station. This may again be attributed to poor visibility which averaged 10.8 feet (Appendix XXIII) during the

TABLE 19. Summary of Fishes Counted by Season, at *11 Permanent Subtidal Transects (30 m x 2 m) Surveyed in 1970.

SPECIES	No. of Individuals Observed by Season				No. Transects Fish Occurred on by Season*			Range for All Transects Surveyed			***Rank for 1970	Percent of Total
	**W	S	F	YR	W	S	F	W	S	F		
Anarrhichthys ocellatus	1	1	-	2	1	1	-	0-1	0-1	-	18	0.1
Aulorhynchus flavidus	-	P	-	P	-	1	-	-	-	-	-	-
Coryphopterus nicholsi	13	32	17	62	6	6	7	0-4	0-15	0-4	4	3.5
Cottidae unidentified	1	3	6	10	1	2	5	0-1	0-2	0-2	13	0.6
Damalichthys vacca	1	6	1	8	1	4	1	0-1	0-2	0-1	15	0.5
Embiotoca jacksoni	-	1	8	9	-	1	5	-	0-1	0-2	14	0.5
Embiotoca lateralis	5	10	1	16	4	5	1	0-2	0-5	0-1	9	0.9
Hexagrammos decagrammus	1	5	6	12	1	4	5	0-1	0-2	0-2	12	0.7
Ophiodon elongatus	5	6	3	14	3	4	3	0-3	0-2	0-1	10	0.8
Oxyjulis californica	-	-	40	40	-	-	1	-	-	0-40	5	2.3
Oxylebius pictus	20	35	27	82	6	7	8	0-5	0-10	0-6	3	4.7
Pimelometopon pulchrum	-	-	1	1	-	-	1	-	-	0-1	19	-
Scorpaenichthys marmoratus	8	5	4	17	4	4	3	0-2	0-2	0-2	8	1.0
Sebastes atrovirens	2	10	1	13	1	3	1	0-2	0-7	0-1	11	0.7
Sebastes carnatus	-	4	-	4	-	2	-	-	0-2	-	16	0.2

TABLE 19 - Contd.

SPECIES	No. of Individuals Observed by Season				No. Transects Fish Occurred on by Season*			Range for All Transects Surveyed			***Rank for 1970	Percent of Total
	**W	S	F	YR	W	S	F	W	S	F		
Sebastes chrysomelas	4	16	6	26	4	5	4	0-1	0-5	0-3	7	1.5
Sebastes melanops	-	23	12	35	-	1	1	-	0-23	0-12	6	2.0
Sebastes miniatus	-	-	4	4	-	-	3	-	-	0-2	16	0.2
Sebastes mystinus	289	136	874	1299	5	5	10	0-150	0-100	0-500	1	74.0
Sebastes serranoides	5	8	88	101	3	2	4	0-3	0-5	0-50	2	5.8
SUB TOTALS ADULTS	355	301	1099	1755	35	52	54	0-200	40-2000	13-500		
Sebastes spp. (juveniles)	474	3080	3133	6687	7	7	11					
TOTALS	829	3381	4232	8442	8	7	11					

* Due to inclement ocean conditions, the following number of transects were actually surveyed:

winter - 8
summer - 7
fall - 11
Annual 26

** W = winter, S = summer, F = fall

*** *Sebastes* spp. (juveniles) are not included.

P = Present but not counted.

TABLE 20. Summary of Fishes Counted by Season, at *11 Permanent Subtidal Transects (30 m x 2 m) Surveyed in 1971.

SPECIES	No. of Individuals Observed by Season				No. Transects Fish Occurred on by Season*			Range for All Transects Surveyed			***Rank for 1971	Percent of Total
	**W	S	F	YR	W	S	F	W	S	F		
Aulorhynchus flavidus	6	-	-	6	2	-	-	0-4	-	-	18	0.07
Cebidichthys violaceus	-	1	-	1	-	1	-	-	0-1	-	21	0.01
Citharichthys stigmaeus	9	-	-	9	1	-	-	0-9	-	-	16	0.10
Coryphopterus nicholsi	39	29	29	97	7	8	6	0-11	0-11	0-13	3	1.09
Cottidae unidentified	22	18	45	85	7	7	10	0-7	0-8	0-11	4	0.96
Damalichthys vacca	10	10	31	51	3	6	4	0-5	0-3	0-22	6	0.58
Embiotoca jacksoni	8	20	20	48	4	6	7	0-2	0-6	0-4	8	0.54
Embiotoca lateralis	10	6	9	25	5	4	3	0-4	0-2	0-4	12	0.28
Hexagrammos decagrammus	10	12	20	42	6	7	8	0-2	0-3	0-3	9	0.47
Ophiodon elongatus	5	12	11	28	5	6	5	0-1	0-4	0-6	11	0.32
Oxyjulis californica	-	-	8	8	-	-	3	-	-	0-4	17	0.09
Oxylebius pictus	41	46	59	146	8	10	9	2-8	0-8	0-11	2	1.65
Scorpaenichthys marmoratus	9	4	8	21	5	4	6	0-3	0-1	0-2	13	0.24
Sebastes atrovirens	4	9	6	19	3	3	3	0-2	0-5	0-3	14	0.21
Sebastes carnatus	5	1	5	11	4	1	4	0-2	0-1	0-2	15	0.12

TABLE 20 - Contd.

SPECIES	No. of Individuals Observed by Season				No. Transects Fish Occurred on by Season*			Range for All Transects Surveyed			***Rank for 1971	Percent of Total
	**W	S	F	YR	W	S	F	W	S	F		
Sebastes caurinus-vexillaris	1	4	-	5	1	2	-	0-1	0-3	-	19	0.06
Sebastes chrysomelas	18	17	16	51	6	8	8	0-7	0-5	0-4	6	0.58
Sebastes melanops	-	23	14	37	-	6	3	-	0-12	0-10	10	0.42
Sebastes miniatus	1	-	1	2	1	-	1	0-1	-	0-1	20	0.02
Sebastes mystinus	2521	3430	2146	8097	6	9	9	0 2000	0 2000	0 1000	1	91.37
Sebastes serranoides	17	41	14	72	5	5	6	0-7	0-33	0-3	5	0.81
SUB-TOTALS	2736	3683	2442	8861								
Sebastes spp. (juveniles)	2564	11550	9527	23641	8	10	11	14 600	100 2000	27 3000		
TOTALS	5300	15233	11969	32502	8	10	11					

* Due to inclement ocean conditions, the following number of transects were actually surveyed:

winter	8
summer	10
fall	11
Annual	29

** W = winter, S = summer, F = fall

*** *Sebastes* spp. (juveniles) are not included.

winter surveys. Such visibility is adequate to make counts of fishes occupying the benthos, but not for viewing rockfish schools that may hover above the diver out of this visibility range.

In 1971, the winter survey yielded 2,736 fish exclusive of juvenile rockfish and the fall survey 2,452. The summer counts of 3,683 were highest. Visibility during the winter averaged 36.3 feet. During six of the eight winter surveys bottom visibility averaged 45 feet (Appendix XXIV). This may account for a good winter count.

Juvenile rockfish counts during the 1971 surveys were highest in the summer when 11,550 were counted for an average of 1,155 fish per transect. The fall counts of 9,327 were comparable, averaging 866 fish per transect, but the winter count of 2,564 was low and averaged only 321 fish per transect.

Other fish considered abundant during subtidal surveys include the painted greenling, blackeye goby and unidentified cottids (i.e., those cottids which were impossible to identify underwater by sight). Although many kinds of sculpins were probably involved, we feel that most were *Artedius corallinus*. These three "fishes" were ranked 2nd, 3rd, and 4th in numbers for the 2 year study and were found at more transects than any other fishes, including the number one ranked fish, blue rockfish.

Fishes we commonly observe include the olive rockfish, black-and-yellow rockfish, pile perch, black perch, kelp greenling, black rockfish, lingcod and cabezon.

The numbers and species composition of fishes counted on any given transect will vary in relation to the habitat types found on that transect. Such habitat differences would include depth, exposure to wave shock, amount and species of algae, substrate, and relationships with other biotic assemblages. These differences vary between transects and within a single transect. When considering numbers and species in Tables 19 and 20, an evaluation of the habitat offered by the transects surveyed also must be made.

Fish Collections

During the three seasonal fish collections within Diablo Cove, 24 families of fishes representing 47 genera and 77 species were collected (Appendix XXXIV). The single North Cove collection in July yielded 20 families representing 48 genera and 72 species (Appendix XXXV). In all, 4,902 specimens were taken at Diablo Cove, and 5,538 in the North Cove.

At Diablo Cove the most specimens were taken in the fall with the highest number coming from the shore station. However, of 1,599 individuals collected at the shore station in the fall, 1,094 (68%) were of three species: the rockweed gunnel, *Xerepes fucorum*, the black prickleback, *Xiphister atropurpureus*, and the rock prickleback, *Xiphister mucosus*.

In the North Cove July collection, the 25 foot station contributed 62% of the total take. The varying habitats at this station, including a rocky reef with many crevices covered by a dense algal flora with a large *Macrocystis* bed, and partially surrounded by sand probably accounted for the increased numbers and species collected. At this station, 61% of the specimens were of three species, the speckled sanddab, *Citharichthys stigmaeus*, the tubesnout, *Aulorhynchus flavidus*, and the blue rockfish.

The increase in numbers of fishes at the single North Cove collection may also be attributed to use of a greater quantity of ichthyocide (about 5 gallons per station as compared to 2.5 to 4.0 per station in Diablo Cove), and the *Macrocystis* bed at the 25-foot station (accounting for 62% of the specimens collected at the three stations).

Large fish are not as susceptible to the ichthyocide as small fish, and as smaller fish were affected, larger predator fish moved in to feed until they were affected or speared by divers, time permitting. The stomachs of these predators, when examined, added to the collection both quantitatively and qualitatively because the freshly ingested specimens they contained were usually in good condition.

Many of the fish stomachs were empty. This is typical in that many fishes regurgitate part or all of their stomach contents when affected by an ichthyocide. Juvenile rockfishes were by far the most commonly encountered food item in the stomachs examined.

In addition to fish, mollusks, crustaceans, and polychaets were important food items. The scope of this study did not document the relative abundance of some food items however, i.e. *Octopus* spp., shrimps, amphipods and in-fauna such as polychaets. The importance of marine algae in the food chain was emphasized by the food habits of the monkeyfaced prickleback, *Cebidichthys violaceus*, high cockscomb, *Anoplarchus purpurescens*, black prickleback, and rock prickleback. All four of these species had ingested large quantities of algae, primarily reds. Whether these fishes benefit directly from the algae or from microorganisms present on the algae is not known at this time.

The importance of juvenile rockfish cannot be over emphasized. Not only are they necessary to perpetuate healthy adult rockfish populations, but are also a major food item for predator fishes. The nearshore rocky marine environment, such as is found at Diablo Cove, is important as a nursery area for nearshore resident fishes and some deeper water forms.

Juveniles from resident and semiresident nearshore species were numerous, e.g., 98% of all blue rockfish, and 96% of all olive rockfish, *Sebastes serranoides*, collected in North Cove were juveniles. Also, in the North Cove 398 of the 954 speckled sanddabs were young of the year. In the kelp at the 25 foot station in North Cove 91 of 106 cabezon were young of the year. At that same station 18 of 25 kelp greenlings were juveniles. The collected brown Irish lords, *Hemilepidotus spinosus*, which are rocky crevice dwellers, were also primarily juveniles with 51 of 61 taken in the North Cove ranging from 32-53 mm SL.

During routine subtidal surveys, juvenile rockfish comprised 74% of all fishes counted.

The number of juvenile rockfish found in our collections from deeper water forms, with few or no adults present, indicates the area is important as a nursery area for several additional fishes, i.e., widow rockfish, *Sebastes entomelas,* yellowtail rockfish, *S. flavidus,* chilipepper, *S. goodei,* canary rockfish, *S. pinninger,* copper rockfish, *S. caurinus* and the bocaccio, *S. paucispinis,* were primarily juveniles. In all, these six species contributed 647 specimens of which 97% (628) were juveniles with most taken at the shore and 20 to 25 foot stations. The 115 northern anchovies, *Engraulis mordax* collected in Diablo Cove were all juveniles.

Species Accounts

The following species accounts include all fishes collected and/or observed in the Diablo Canyon study area. Scientific and common names and geographic and depth ranges plus maximum size limits for the fishes were taken from Miller and Lea (1972).

The discussions of fishes collected are based on three seasonal collections at Diablo Cove and one collection in the North Cove.

The discussions of fishes counted during routine subtidal seasonal surveys are based on the following number of surveyed transects: winter - 8; summer - 7; fall - 11 for a total of 26 in 1970, and winter - 8; summer - 10; and fall - 11 for a total of 29 surveyed transects in 1971.

Scyliorhinidae

Cephaloscyllium ventriosum (Garman) - Swell shark

Swell sharks were observed on two occasions during reconnaissance dives in the Diablo area. Two individuals were seen in the fall of 1971 in a protected rocky habitat inside Lion Rock, and one in Diablo Cove in the summer of 1971, again in protected rocky habitat near shore (15 foot depth) in the vicinity of the discharge site. All were estimated at 3 feet in length.

Lengths up to 3.3 feet have been reported. The swell shark has an antitropical discontinuous distribution from Chili to Monterey Bay, including Gulf of California and Guadalupe Island in depths from shore to 1,380 feet.

Platyrhinidae

Platyrhinoidis triseriata (Jordan and Gilbert) - Thornback

One specimen was collected in shallow water (0-10 feet) inside Diablo Cove during the summer. At 660 mm total length (TL), this female thornback weighed 5.1 pounds; its stomach contained remains of one squid.

This species commonly occurs off southern California and Baja California ranging from 1.5 miles SSE of Thurloe Head, Baja California, to San Francisco, at depths to 150 feet. Lengths up to 3 feet have been reported.

Engraulidae

Engraulis mordax (Girard) - Northern anchovy

In the winter at Diablo Cove 115 were collected at the shore station. All were juveniles (39 - 53 mm standard length: SL).

This species, by far is the most abundant fish in California waters ranging from Cape San Lucas, Baja California, to Queen Charlotte Islands, British Columbia. Lengths to 9 inches (228.5 mm) have been reported but a 7 inch fish is unusual.

Based upon recovered fish remains, primarily otoliths or earstones, from an Indian midden at Diablo Cove, Fitch (1973) found the northern anchovy to be the second most abundant fish (juvenile rockfish were first) at that site. Fitch felt that the otoliths arrived at the midden site via stomachs of predatory species harvested by the Indians because many otoliths showed signs of erosion from digestive action and because the Indians during that period apparently lacked the fishing tools for harvesting this species.

The northern anchovy is one of the most heavily preyed upon "bait" fish in the marine environment.

Gobiesocidae

Gobiesox maeandricus (Girard) - Northern clingfish

The northern clingfish normally lives on or under various algae. In giant kelp cutting operations at Monterey Bay, this species was the second most abundant of eight kinds of fishes collected with the kelp. In these operations only the kelp canopy is removed to a maximum depth of 4 feet. So the clingfish were in the uppermost fronds in 40 to 60 feet of water. (D. Miller, CDF&G, pers. commun.).

This species also occupies the low intertidal zone attaching to low growing algae and the substrate.

Seventy-eight specimens of northern clingfish were collected in Diablo Cove: 67 at the shore station, 11 at 20 feet, and none at 70 feet. Seasonally, the fall collection accounted for 73 of the 78 fishes while none was taken in the winter. Ten additional northern clingfish were collected in North Cove, nine at the shore station, and one at 25 feet. The 88 fishes ranged from 19.0 to 111.5 mm SL. Ages were determined for five specimens which at 111.5, 79, 75, 68 and 37 mm SL were 4, 3, 3, 3 and 1 year old respectively.

During fish collections involving ichthyocides, predatory fishes such as the lingcod, rockfishes, cabezon and kelp greenlings fed on clingfishes that were affected by the chemical. We suspect that northern clingfish is a forage item for these fishes at other times also. Fitch (1973), found otoliths of three northern clingfish in the Diablo Cove Indian midden which he believed arrived through the stomachs of predator fishes.

The northern clingfish ranges from Guadalupe Island and the mainland of Baja California (on drift kelp) to Mud Bay Revillagigedo Island, Alaska, occurring commonly throughout most of its range except found rare south of Point Conception. Lengths to 6.5 inches (165 mm) have been reported.

Rimicola muscarum (Meek and Pierson) - Kelp clingfish

As this species' common name implies, it occurs in and around kelp canopies. During the fish collections the kelp clingfish was found only at 25 feet in North Cove. That station encompassed a *Macrocystis* bed. The two specimens taken measured 33 and 39.5 mm SL.

Lengths to 2.34 inches (59 mm) have been recorded. This clingfish occurs uncommonly from Point Banda, Baja California, to Goose Island, British Columbia.

Brotulidae

Brosmophycis marginata (Ayres) - Red brotula

The red brotula was relatively abundant in North Cove with 40 specimens taken at 25 feet and 42 at 60 feet. They may be considered common in Diablo Cove at 70 feet where 50 specimens were taken in about equal numbers during the three sampling periods. Within Diablo Cove only five were found at 20 feet, and none was collected at the shallow stations. These 137 red brotulas ranged from 55 to 310 mm TL. Of those aged, the oldest at 261 mm TL was 10 years old, with 4 specimens ranging from 57-62 mm TL taken in July in the 0 age group. Additional age-length-weight data are included in Table 21.

Females examined from the Diablo Cove 70 foot May collection were distended with "uneyed" red eggs. Similarly a 248 mm SL female in the North Cove July collection at 60 feet, contained eggs easily extruded with slight pressure.

Stomach contents for those examined consisted of small unidentified fish and crabs.

Additionally, 95 of the 137 red brotulas were measured and weighed. A summary of these by 30 mm increments is included in Table 22.

The red brotula ranges from Ensenada Bay, Baja California, to Petersburg, Alaska, with a depth range of 10 to 840 feet.

This bright red fish was never observed during routine subtidal surveys, but due to its rocky cryptic type habitat and nocturnal behavior, would probably only be found by icthyocide collecting or night diving.

TABLE 21. Length-Weight by Age for 49 Red Brotulas, *Brosmophycis marginata*, Collected at Diablo Cove and the North Cove During 1970-71.

Age Group	Number Sampled	Length Range (SL mm)	Length Mean (SL mm)	Number Weighed	Weight Range (g)	Weight Mean (g)
0	4	57-62	59.1	4	1.0-1.5	1.3
1	11	55-110	91.6	10	2.0-7.0	4.7
2	12	73-173	92.1	3	2.0-27	11.7
3	7	100-211	131.6	3	12.0-66	31.3
4	7	152-205	172.6	4	23.0-50	37.3
5	3	223-248	238.7	1	88.0	88.0
6	2	178-237	207.5	1	118.0	118.0
7	1	285	285.0			
9	1	280	280.0	1	204.0	204.0
10	1	261	261.0	1	144.0	144.0

TABLE 22. Length (by 30 mm increments) - Weight Summary for 95 Red Brotulas, *Brosmophycis marginata*, Collected in Diablo Cove and North Cove During 1970-71.

Size Class (mm)	Number Sampled	Length Mean (TL mm)	Number Weighed	Weight Range By Size Class (g)	Weight Mean (g)
31-60	4	57.4	3	1.0-1.5	1.3
61-90	17	78.6	8	1.3-5.0	3.0
91-120	21	100.3	17	5.5-9.5	7.1
121-150	10	133.1	9	13.0-20.0	15.6
151-180	15	166.1	12	23.0-44.0	33.0
181-210	3	198.7	2	50.0-58.0	54.0
211-240	7	227.3	7	66.0-118.0	89.2
241-270	9	255.9	7	108.5-154.0	135.1
271-300	8	278.4	7	145.0-204.0	171.3
301-300	1	310.0	1	210.0	210.0

Ophidiidae

Chilara taylori (Girard) - Spotted cusk-eel

This species was abundant in the North Cove 25 and 60 foot stations with 46 and 109 specimens taken respectively. During the three seasonal collections within Diablo Cove, only 30 spotted cusk-eels were taken, all from the 70 foot station. No specimens were taken in shallow water. Individuals ranged from 40 to 267 mm TL. Age was determined for 16 cusk-eels (Table 23).

The largest individual has been recorded at 14.25 inches. They often burrow tail first in sand and live there in mucus lined holes. During the collections most specimens were taken on the sandy flats half out of their burrows. This species ranges in depth from 4 to over 800 feet and commonly occurs from San Cristobal Bay, Baja California, to Northern Oregon.

Atherinidae

Atherinops affinis (Ayres) - Topsmelt

This species ranges from Gulf of California to 4 miles west of Sooke Harbour, Vancouver Island, British Columbia, and attains a length of 14.4 inches.

Living on or near the surface, the topsmelt commonly occurs in bays, sloughs and kelp beds.

Six topsmlet (86 - 132 mm SL) were taken at the shore station during the winter at Diablo Cove.

Topsmelt are probably a prime forage fish for many predatory species including pelicans, marine mammals, and larger fishes. Fitch (1973) found 13 otoliths in the Diablo Cove Indian midden sample. He felt that these

TABLE 23. Age-Length-Weight Data for 16 Spotted Cusk-eels, *Otophidium taylori*, Collected in Diablo and North Cove 1970-71.

Age Group	Number Sampled	Length Range (TL mm)	Length Mean (TL mm)	Number Weighed	Weight Range (g)	Weight Mean (g)
1	8	86-102	93.6	3	2.0-2.5	2.2
2	4	120-147.5	134.4	4	4.5-12.0	8.2
3	2	146-176.0	161.0	1	20.5	20.5
*4	2	152-187	169.5	1	26.5	26.5

*Otoliths were difficult to read - age may vary.

topsmelt arrived in the midden via predators harvested by the Indians in that the otoliths showed digestive erosion.

Gasterosteidae

Aulorhynchus flavidus Gill - Tubesnout

The tubesnout ranges from Point Rompiente, Baja California, to Sitka, Alaska.

Only three tubesnouts were collected within Diablo Cove in shallow water: one in the summer and two in the fall; but 724 tubesnouts accounted for 21% of the fishes collected at the 25 foot station in North Cove. While spreading the ichthyocide, divers noted a large school of tubesnouts passing through the area which would probably account for the large number taken.

Total lengths of the collected specimens ranged from 54 to 177 mm. Aging was very difficult requiring polarized light and anise oil to bring out cocentric growth rings in the otoliths. The oldest specimen, taken at North Cove, 177 mm TL, was set at 9 years and matches or exceeds the previous recorded size. The smallest specimen aged, at 139 mm TL, was 5 years old. Females from the North Cove (July) collection were ripe with eggs protruding from the vents of most. Mature eggs measured 1.4 by 1.2 mm with about 400 eggs of this size in both ovaries of one specimen. More and larger eggs were noted in some individuals.

Stomach contents consisted of tiny stalk-eyed crustaceans in those specimens examined.

This species was observed three times during routine subtidal surveys. One sighting of several specimens was made inside Diablo Cove at Station 16 (10 ft.) during the summer 1970. Two additional sightings were made in North Cove area at Stations 7 and 8 with two and four individuals sighted respectively during our 1971 winter survey. All were observed in protected areas.

Syngnathidae

Syngnathus sp. - Pipefish

Two unidentified pipefish were collected. Both were taken during the summer (May) within Diablo Cove at the shallow station (0-10 ft.). They measured 167 and 211 mm TL.

Girellidae

Girella nigricans (Ayres) - Opaleye

The opaleye ranges from Cape San Lucas, Baja California, to San Francisco. A record individual was 25.38 inches (645 mm) long and weighed 13.46 pounds (6105 g). Occurring from the intertidal to depths of 95 feet, this species is most common south of Point Conception.

One collected at the shore station in Diablo Cove in May was 188 mm SL and weighed 300 g; it appeared to be 2 years old.

Embiotocidae

Cymatogaster aggregata Gibbons - Shiner surfperch

The shiner surfperch ranges from San Quintin Bay, Baja California, to Port Wrangel, Alaska.

This species was found only in North Cove, with all 18 specimens taken at the shallow water station. Most commonly found in less than 50 feet, occurrences to 480 feet have been recorded. Among the 18 specimens there were only two males. Sizes ranged from 89 to 139 mm TL at 10 and 30 g weight respectively.

Small aggregations of this embiotocid were observed by divers in the surf area in Diablo Cove on several occasions.

Damalichthys vacca (Girard) - Pile surfperch

This species ranges from Guadalupe Island to Port Wrangel, Alaska. There were 26 pile surfperch collected at Diablo Cove: 23 at the shore station, and three at 70 feet. Most were taken in the fall, with one collected in the winter. Six others were collected in North Cove: four at 25 feet and one each at the 60 foot and shore stations. These 32 fish ranged from 59 to 284 mm SL. The 284 mm specimen was a female weighing 755 grams and aged at 9 years. The youngest aged at 71 mm SL was a young of the year. Additional age-length-weight data are included in Table 24. Stomachs of those specimens examined contained small crustaceans.

The pile surfperch occurs most commonly in shallow water over both rocky and sandy substrate as well as around pilings and kelp, in depths from shallow water to 150 feet.

During routine subtidal surveys, the pile surfperch was seldom found in deep water, with only three recorded at 50 feet or deeper in the fall and summer of 1971. Most were counted in protected areas with only occasional sightings made at the surging reefs south of Diablo Cove. The greatest number counted at any single station was 22 (Station 16) during the fall of 1971. During 1970 only eight pile surfperch were seen at six of the 26 surveyed stations. Most (6) were observed in the summer. However, in 1971, 51 were counted at 13 stations with 31 being seen in the fall (the 22 counted at Station 16 substantially increased this number).

This species averaged 1.04 fish per transect surveyed for 1970-71 and ranked 8th of 23 species counted.

TABLE 24. Age-Length-Weight Data for 17 Pile Surfperch, *Damalichthys vacca*, Collected in Diablo and North Cove 1970-71.

Age Group	Number Sampled	Length Range (SL mm)	Length Mean (SL mm)	Number Weighed	Weight Range (g)	Weight Mean (g)
0	1	71	71.0			
2	3	152-171	164.3	3	120-181	155.0
4	7	195-223	209.7	7	275-430	343.6
5	4	228-241	233.2	4	370-585	457.5
9	2	268-284	276.0	2	385-755	570.0

Otoliths and teeth of the pile surfperch were found by Fitch (1973) in the Indian middens at Diablo Cove. With the development of hooks, the pile surfperch contributed more heavily to the Indian's diet.

Embiotoca jacksoni Agassiz - Black surfperch

The black surfperch ranges from Point Abreojos, Baja California, to Fort Bragg, California, and is found offshore at Guadalupe Island.

Eleven specimens were taken during the three seasonal collections in Diablo Cove. Of eight taken in shallow water (0-10 ft.), six were taken in September, all juveniles, 53 - 61 mm SL. Eight additional black surfperch were taken in the North Cove July collection. All were adults with six of the eight collected at 25 feet.

These 16 fish ranged from 53 to 326 mm TL. The largest, a male, weighed 658 g. The oldest at 9 years measured 318 mm TL (Table 25). Lengths to 14 inches have been reported.

This species is found from the surface to depths of 130 feet. During diving surveys only three black surfperch were observed at 50 feet or deeper. Again this embiotocid was generally seen in the calmer protected waters, but 33% of the 1971 count was made at the surging reefs south of Diablo Cove (Stations 13, 14 and 15).

A considerable variation existed in numbers counted seasonally and annually. In 1970, nine were counted at six stations: one in the summer, eight in the fall, with none in the winter. In 1971, 48 were observed at 17 stations: eight in the winter, 20 in the summer, and 20 in the fall, with a high count of six at one station.

This species ranked 9th of the 23 counted fishes and averaged 1.07 fish per surveyed transect for the 2 year study.

TABLE 25. Age-Length-Weight Data for 11 Black Surfperch, *Embiotoca jacksoni*, Collected at Diablo and North Cove 1970-71.

Age Group	Number Sampled	Length Range (TL mm)	Length Mean (TL mm)	Number Weighed	Weight Range (g)	Weight Mean (g)
3	1	201	201.0	1	161	161
4	1	241	241.0	1	295	295
5	2	263-266	264.5	2	370-420	395
6	3	265-298	280.0	3	382-610	484
7	1	277	277.0	1	495	495
8	2	258-284	271.0	2	385-490	437.5
9	1	318	318.0	1	630	630

Embiotoca lateralis Agassiz - Striped surfperch

This embiotocid ranges from Point Cabras, Baja California, to Port Wrangel, Alaska, attaining lengths to 15 inches.

Only 14 striped surfperch were taken during the three collections at Diablo Cove. Most (8) were from the shallow station (0-10 ft.) with only two collected at the deep station. Twenty-five others were taken in the North Cove July collection: 11 at the shore station, and 14 at the 25 foot station of which 10 were young of the year, 74-82 mm TL.

These 39 fish ranged from 74 to 332 mm TL, and were from 0 to 8 years old (Table 26). One female examined from the Diablo Cove summer (May) shore collection, at 300 mm TL and 640 g, was ready to bear young.

During our diving surveys only one striped surfperch was seen in waters deeper than 40 feet. This sighting was made in the summer of 1970 at 70 feet. This observation and 2 specimens taken at 70 feet represent a depth range extension for this species. Occasional sightings were made at the exposed Station 15 (one in 1970 and six in 1971), with the remaining counts made in protected areas.

Annual counts varied from 16 noted at 10 stations in 1970 to 25 at 12 stations in 1971. Most (10) were observed in the summer in 1970, but in 1971, ten and nine were counted in the winter and fall respectively. The striped surfperch ranked 13th among 23 species sighted subtidally.

The embiotocids occupied the mid-water column and were usually leary of divers, so counts during poor visibility periods were minimal at best.

Relative abundance of the striped surfperch and other collected embiotocids in the Diablo Canyon area is not reflected by the ichthyocide collections. Their larger size and behavioral patterns of occupying the mid-water column and surface waters makes them much less vulnerable than the benthic dwellers.

TABLE 26. Age-Length-Weight Data for 33 Striped Surfperch, *Embiotoca lateralis*, Collected at Diablo and North Cove 1970-71.

Age Group	Number Sampled	Length Range (TL mm)	Length Mean (TL mm)	Number Weighed	Weight Range (g)	Weight Mean (g)
0	11	74-107	79.5	6	5-18	7.8
1	3	127-146	136.0	3	36-52	45.0
2	7	172-214	191.9	6	90-165	128.6
3	1	202	202.0	1	162	162.0
4	2	245.5-270	257.8	2	272-372	322.0
5	1	268	268.0	1	373	373.0
6	2	259-280	269.5	2	275-404	339.5
7	4	295-325	307.3	4	518-640	566.5
8	2	295-332	313.5	2	560-566	563.0

Fitch (1973) reported that the Indians probably caught striped surfperch and other embiotocids by hook and line. Although many of the otoliths he found in a Diablo Cove midden were worn and could only be identified as embiotocids, the six surfperch species from the SLO-2 midden at Diablo Canyon demonstrated the contribution of this group to the Indian's diet.

Hyperprosopon argenteum Gibbons - Walleye surfperch

The walleye surfperch ranges from Point Rosarito, Baja California, to Vancouver Island, British Columbia, and is found offshore at Guadalupe Island. It inhabits depths from surface to 60 feet and attains lengths to 12 inches.

Only 2 specimens were collected in the summer at the shore stations: one in Diablo Cove and one in North Cove, measuring 114 and 106 mm SL respectively.

This embiotocids' otoliths also occurred in the Indian midden at Diablo Cove. Fitch (1972) felt that it contributed to the Indian's diet, with some having been caught by hook and line and others brought to the midden in stomachs of predator species.

Hypsurus caryi (Agassiz) - Rainbow surfperch

The rainbow surfperch ranges from Rio Santo Tomas, Baja California, to Cape Mendocino, attaining lengths to 12 inches. They inhabit depths from surface to 130 feet.

Only three specimens were taken during the summer collections, all at the shore stations. Two were collected in North Cove, a male and a female, 124 and 128 mm TL, weighing 30 and 31 g respectively. A single specimen taken within Diablo Cove was 111 mm TL and weighed 23 g. All were 1 year old fish.

Micrometrus aurora (Jordan and Gilbert) - Reef surfperch

This species ranges from Point Baja, Baja California, to Tomales Bay, occurring in the rocky intertidal and subtidal zones, and to depths of 20 feet. The record size is 7.1 inches in length.

Although anglers occasionally catch reef surfperch with pieces of marine invertebrates for bait, they are believed to be algivores feeding in the tidal zone during daily tidal fluctuations (Fitch, 1973).

The reef surfperch was collected only at the shore stations (0-10 ft.). Of 22 collected in Diablo Cove, 17 were taken in the fall (September). Four others were taken in the North Cove July collections, all females. Sizes of collected individuals ranged from 35-138 mm SL. Five specimens were aged from Diablo Cove: one, 42 mm SL, was 0; two, 65 mm and 106 mm SL, were 1 year old; and 2, 115 and 138 mm SL, were 2. The smaller 2 year old collected in the summer was pregnant.

Although reef surfperch were not recorded during seasonal surveys at diving stations, they were occasionally observed by divers in Diablo Cove.

Micrometrus minimus (Gibbons) - Dwarf surfperch

Only one 65 mm SL dwarf surfperch was taken at Diablo Cove. This single specimen is not representative of the numbers which commonly occur from Cedros Island, Baja California, to Bodega Bay. Found in the tide pools to 30 feet deep, the dwarf surfperch reportedly attains lengths to 6.25 inches (158.8 mm).

Rhacochilus toxotes Agassiz - Rubberlip surfperch

This species ranges from Thurloe Head, Baja California, to Russian Gulch State Beach, Mendocino County, and is found offshore at Guadalupe Island, occurring from shallow surface waters into depths of 150 feet.

The rubberlip surfperch was collected only in North Cove at the 25 foot station during the single summer collection. The two males taken measured 405 and 410 mm TL. The smaller rubberlip surfperch weighed 1,110 grams and was 8 years old; the larger weighed 1,135 grams and was 9. The reported record size for this species is 18.5 inches (470 mm).

A single embiotocid observed at Station 8 during a routine subtidal survey in the fall of 1970 was tentatively identified as a rubberlip surfperch.

Labridae

Oxyjulis californica (Günther) - Senorita

The senorita ranges from Cedros Island, Baja California, to Sausalito at depths from the surface to 180 feet.

During the three seasonal collections in Diablo Cove 49 senoritas were taken and two were taken at the single North Cove collection.

Of the 49 from Diablo Cove, 30 were taken at the shore station, 12 at 20 feet, and 6 at 70 feet. Most (29) were from the summer collections. The two in North Cove were from 25 feet.

Sizes ranged from 58-199 mm TL and ages from 1 to 6 years. The senorita attains a length of 10 inches. Ages were determined for 10 specimens. One 58 mm TL specimen was 1 year old; one 99 mm TL was 2 years old; three (131-153 mm TL) averaging 144 mm were 3 years old; two (155-165 mm TL) averaging 194.5 mm were 6 years old.

Females taken at the shore station in the summer contained ripening eggs. Stomachs from this collection contained crustaceans, except one which contained ladybird beetles (*Coccinellidae*).

At no time were senoritas observed in Diablo Cove during routine subtidal surveys. In North Cove, however, a school of about 40 senoritas was seen swimming in the midwater column at Station 8 in 1970, four others at the same station in 1971, and two each were observed on Stations 13 and 15--the surging reefs south of Diablo Cove.

We have observed large schools (~1,000) of senoritas off Point Estero during abalone surveys in the fall.

Fitch (1973) found senorita jaws and fused pharyngeals in Indian midden SLO-2 at Diablo Canyon. He believed that due to the tooth arrangement of this species the Indians were not capable of catching them by hook and line and that this wrasse was probably trapped. The senorita was also preyed upon by cormorants and predator fishes which were taken by the Indians, and may have reached the midden via the stomachs of these food items.

Pimelometopon pulchrum (Ayres) - California sheephead

One male sheephead about 2 feet long was observed at Station 8 in the fall of 1970. Lengths to 3 feet and weights up to 36.25 pounds have been reported. This species ranges from Cape San Lucas, Baja California, to Monterey from surface to 180 feet deep and is common in Southern California but uncommon north of Point Conception.

Bathymasteridae

Rathbunnela hypoplecta (Gilbert) - Rough ronquil

During the four major fish collections, 159 *Rathbunella* were taken.

In our previous reports these were listed as *Rathbunella alleni* (130), *R. hypoplecta* (15), and *Rathbunella sp.* (14). These identifications were based on canine teeth differences. At this time we feel that these canine differences (long vs. short) are not adequate for species separation and until a more definitive study of this group is made, all specimens will be considered as being *R. hypoplecta*. The 159 specimens of *Rathbunella* were preserved for future examination at Los Angeles County Museum of Natural History.

Ronquils range from Northern Baja California to the Pacific Northwest, attain lengths of 8.5 inches, and are found in the intertidal to depths of several hundred feet.

In Diablo Cove, 130 *Rathbunella* were collected: 128 at 70 feet, and two at 20 feet. Most were taken in the fall (53) and winter (48). These 130 specimens ranged from 37 to 153 mm TL. In North Cove, 29 were taken at the 60 foot station. These ranged from 67.5 to 156 mm TL. Ages for a selected sample from both areas ranged from 1 to 5 years (Table 27).

Female ronquils taken at Diablo Cove in May contained ripening eggs. Stomachs from those examined contained nudbranchs.

Clinidae

Gibbonsia elegans (Cooper) - Spotted kelpfish

The spotted kelpfish ranges from Magdalena Bay, Baja California, to Point Piedras Blancas and offshore to Guadalupe Island.

Twenty-five spotted kelpfish were taken at Diablo Cove and five in North Cove. All but one were collected at depths shallower than 20 feet.

Twenty-one of the Diablo Cove specimens ranged from 44 to 79 mm SL, while five from North Cove ranged from 59.5 to 97 mm SL. Lengths to 6.2

TABLE 27. Age-Length-Weight Data for 48 Ronquils, *Rathbunella hypoplecta*, Collected in Diablo and North Cove 1970-71.

Age Group	Number Sampled	Length Range (TL mm)	Length Mean (TL mm)	Number Weighed	Weight Range (g)	Weight Mean (g)
1	2	79-82	80.5	2	3.5-4.5	4.0
2	13	90-122	103.2	4	5.5-16	11.0
3	11	92-132	120.3	10	9.5-20	15.3
4	13	112-155.5	127.1	7	15.5-26	19.2
5	9	116-156	142.8	6	27.0-34	30.9

inches (157 mm) have been recorded. This species occurs in depths from the surface to 185 feet.

Gibbonsia metzi Hubbs - Striped kelpfish

This species ranges from Point Rompiente, Baja California, to Vancouver Island, British Columbia.

Thirty-two striped kelpfish were taken in Diablo Cove: 30 from the shallow station, and two at 20 feet somewhat equally divided between the fall and winter collections. None was collected in the summer at Diablo Cove, but 22 were collected in the summer in North Cove: 20 at the shore station and two at 25 feet.

Of seven females examined in the fall, six contained fairly well developed ovaries. Total lengths ranged from 87.5 to 242 mm for all specimens collected. This species had been previously reported to attain a length of 9.25 inches (236 mm). Our largest specimen at 9 1/2 inches is 1/4 inch longer than the previously reported maximum size. Ages ranged from 2 to 8 years (Table 28).

Gibbonsia monteryensis Hubbs - Crevice kelpfish

This species is commonly found from Rio Santo Tomas, Baja California, to British Columbia.

The crevice kelpfish was common to abundant in the shore (0-10 ft.) collections. Of the 216 specimens from Diablo Cove, 162 were taken inshore 53 at 20 feet, and one at 70 feet. Most (59%) were collected in the fall (September). In North Cove, 26 crevice kelpfish were collected at the shore station, and 30 were taken at 25 feet. Previous records have listed this species occurring in depths from surface to 22 feet.

TABLE 28. Age-Length-Weight Data for 18 Striped Kelpfish, *Gibbonsia metzi*, Collected in Diablo and North Cove 1971.

Age Group	Number Sampled	Length Range (TL mm)	Length Mean (TL mm)	Weight Range (g)	Weight Mean (g)
2	5	168-190	180.6	50.0-79.0	66.6
3	7	171-208	193.1	47.5-110.0	85.1
4	5	202-242	223.8	82.0-167.0	128.6
8	1	231	231.0	121.0	121.0

Sizes ranged from 26 to 97 mm SL. Maximum reported length is 4.44 inches (113 mm). Of those aged, nine ranging from 60-97 mm SL (averaging 81.89 mm) were 2 years old; one, 78 mm SL, was 3 years old.

Females examined from the Diablo Cove summer (May) collection contained well developed eggs which could be extruded with slight pressure.

Cebidichthyidae

Cebidichthys violaceus (Girard) - Monkeyface-eel

The monkeyface-eel ranges from San Quintin Bay, Baja California, to Crescent City, but is quite rare south of Point Conception.

This species was collected only at the shallow stations (0-10 ft.) at Diablo Cove and North Cove. Although the monkeyface-eel has been recorded from 80 feet, it commonly occupies the rocky intertidal zone. Of the 23 individuals from the three seasonal collections in Diablo Cove, only one was taken during the summer, 12 in the fall, and 10 in the winter. The July (summer) collection in the North Cove produced only two.

Standard lengths ranged from 28 to 635 mm. The youngest specimen aged was 4 years old; it measured 318 mm SL. The largest specimen, a male weighing 2,459 g, was 14 years old (Table 29). The smallest was 28 mm SL taken in the fall, while the smallest taken in January were in the 50 mm size group. We suspect these were all young of the year.

Three large females (averaging 541.33 mm SL) taken in September contained spent ovaries, while a single female collected in January was full of eggs. Additionally, a large female (578 mm SL), from the North Cove July collection, contained undeveloped small eggs. This seasonal variation, plus the presence of young of the year in the fall, suggests a late summer spawning for the species.

TABLE 29. Age-Length-Weight Data for 12 Monkeyface-eels, *Cebidichthys violaceus,* Collected at Diablo and North Cove 1970-71.

Age Group	Number Sampled	Length Range (SL mm)	Length Mean (SL mm)	Number Weighed	Weight Range (g)	Weight Mean (g)
4	1	318	318.0	1	304	304
5	1	433	433.0	1	782	782
6	2	455-478	466.5	2	882-998	940
7	1	465	465.0	1	985	985
8	3	430-532	482.7	2	1235-1632	1433.5
11	1	525	525.0	1	1808	1808.0
13	1	534	534.0	1	1305	1305.0
14	2	486-635	560.5	2	2120-2459	2289.5

Stomach contents of the monkeyface-eel indicated that they are active algivores. All six stomachs examined contained red algae. *Microcladia coulteri* occurred in five stomachs, *Gigartina californica* (or *G. corymbifera*) occurred in three, *Prionitis lanceolata* occurred in three, *Iridaea* sp. occurred in two, and *Schizymenia* sp., *Smithora* sp., (*epiphytic on Phyllospadix*), *Callophyllis* sp. and a green alga *Ulva* sp. occurred in one stomach. One shrimp, *Spirontocaris* sp., was found. These food items indicated feeding in the tidal zone by this species.

One monkeyface-eel was sighted during the subtidal transect surveys. The observation was made in the summer under a boulder at the protected shallow Station 16 in Diablo Cove while counting red abalones at that station. This species is not normally observed because of its cryptic habits - hiding deep in crevices and under boulders.

Fitch (1973) found this stichaeid's otoliths in the Diablo Canyon SLO-2 Indian midden. He believed that the Indians caught them by hook and line or by hand as the receding tide exposed them in tide pools.

Stichaeidae

Anoplarchus purpurescens Gill - High cockscomb

This stichaeid ranges from Santa Rosa Island to The Pribilof Islands, Bering Sea, occurring intertidally to 100 feet.

The high cockscomb was taken almost entirely along the shoreline. Of the 71 specimens collected (55 in Diablo Cove, 16 in North Cove), 69 were taken at the shore stations and two were at 20 feet (Diablo Cove). These 71 fish ranged from 40 to 126.5 mm TL. This species attains a length of 7.75 inches (197 mm). Four specimens (90-112 mm TL) averaging 105.5 mm were 2 years old; 2 (107.5-124.0 mm TL) averaging 115.75 mm were

3; three (114.5-120 mm TL) averaging 117.5 mm were 4; and one specimen 126.5 mm TL was 5 years old.

Stomachs examined from North Cove specimens contained mainly unidentified algae.

Chirolophis nugator (Jordan and Williams) - Mosshead warbonnet

The mosshead warbonnet occurs in depths from the intertidal to 264 feet, ranging from Cuyler Harbor, San Miguel Island, to Kodiak Island, Alaska.

In the Diablo Cove fish collections, the 57 specimens were nearly equally divided between the 20 and 70 foot stations. No mosshead warbonnets were taken at the shore stations. Most were taken in the fall. In North Cove, they also occurred only at the 25 and 60 foot stations, with 72 of the 78 being taken at 25 feet. Although many were collected at Diablo, this species is not generally considered common within its range.

Sizes ranged from 33.5 to 133 mm TL. The largest recorded specimen is 5.62 inches (143 mm). Ages ranged from 0 to 5 years (Table 30).

Kasatkia sp.

The exact generic placement of this fish is not known at this time due to very obscure key characteristics and the unavailability of the type material for comparison. Other investigators have tentatively placed our specimens in the geneus *Askoldia*. One key characteristic is the variation of the presence to non-presence of pelvic fins and girdle. Through x-rays, a pelvic girdle was found present. The specimens collected are new to science and the tentative identification will be further examined.

TABLE 30. Age-Length-Weight Data for 33 Mosshead Warbonnets, *Chirolophis nugator*, Collected in Diablo and North Cove 1970-71.

Age Group	Number Sampled	Length Range (TL mm)	Length Mean (TL mm)	Number Weighed	Weight Range (g)	Weight Mean (g)
0	1	33.5	33.5			
1	8	81-104	87.8	8	3.5-7.0	4.9
2	14	85-125	105.9	10	7.5-20.0	12.3
3	6	112-125	118.8	5	12.0-13.0	12.4
4	3	110-130	123.0	3	12.0-16.0	14.5
5	1	133	133.0	1	18.0	18.0

All seven specimens were collected at the 20 foot station in Diablo Cove. Six were taken in September; one in January. Four of these specimens ranged from 74-85 mm SL, averaging 80.75 mm, and ranged in weight from 3-4.5 g, averaging 3.63 g. Two of the seven were removed from rockfish stomachs.

The otoliths were very dense and generally unreadable. One fish (74 mm SL) was aged at 3 years.

Plagiogrammus hopkinsi Bean - Crisscross prickleback

This species occurs intertidally to depths of 70 feet, ranging from San Nicolas Island to Pacific Grove.

In Diablo Cove the crisscross prickleback occurred most frequently at the 20 foot station in the winter. During the three collections, seven were taken at 70 feet matching the existing depth record and 25 at the 20 foot station. In North Cove five were taken at 25 feet and one at 60 feet.

Sizes ranged from 55 to 147 mm SL. Lengths to 7.75 inches (197 mm) have been recorded.

Ages ranged from 0 to 7 years (Table 31).

One female examined from the Diablo Cove fall shore collection at 105 mm SL contained spent ovaries.

Stomachs contained pistol shrimp, euphausiid shrimp, and chiton plates.

Stichaeopsis sp. - Masked prickleback

This prickleback is new to science. It ranges from Point Arguello to Monterey and is considered uncommon. Lengths up to 12.75 inches (324mm) have been recorded. Typically a shallow water form it occurs in the intertidal and to 70 feet.

TABLE 31. Age-Length-Weight Data for a Selected Sample of Crosscross pricklebacks, *Plagiogrammus hopkinsi*, Collected at Diablo and North Cove 1970-71.

Age Group	Number Sampled	Length Range (SL mm)	Length Mean (SL mm)	Number Weighed	Weight Range (g)	Weight Mean (g)
0	1	55	55			
2	5	59-82	70.6	3	6-8	7.0
3	6	72-105	93.0	5	8-17	13.8
4	1	132	132.0	1	30	30.0
5	5	116-130	121.6	4	20.5-28.5	23.3
6	3	117-141	127.7	1	35.5	35.5
7	1	143	143.0			

Two masked pricklebacks were taken at Diablo Cove in September; one at 20 feet (29 mm SL), and one at 70 feet (230 mm SL) weighing 137 g and aged at 4 years. In North Cove, five were taken: one at the shore station (119 mm SL) weighing 14 g and 1 year old, one at 25 feet (247 mm SL) aged at 5 (±1 year), and three at 60 feet of which two were 4 years old (235 and 250 mm SL) and one was 6 (237 mm SL).

Xiphister atropurpureus (Kittlitz) - Black prickleback

This fish along with the rock prickleback, *X. mucosus*, seemed to be affected first by the ichthyocide with many specimens appearing on the surface only minutes after application.

This species ranges from 1 mile south of Point China, south of Rio Santo Tomas, Baja California, to Kodiak Island, Alaska, but it is not common south of Point Conception.

The black prickleback was very abundant in the shore collections. In Diablo Cove, all but one of 392 specimens were taken at the shore station, the exception being taken at the 20 foot station. The fall collection accounted for 248 specimens (63%) as compared to 113 in the winter and 30 in the summer. In the North Cove July collection, 163 were taken at the shore station and three at the 25 foot station. Previous records list the depth range from intertidal to 20 feet.

Sizes ranged from 40 to 268 mm TL and ages ranged from 1 year old for an 83 mm TL specimen to 12 or 13 years old for a 262 mm TL specimen (Table 32). Lengths by 20 mm increments and weights for 186 black pricklebacks are included in Table 33.

Females contained ripening to ripe ovaries in the Diablo Cove winter collection. Females of comparable size contained small to only

TABLE 32. Age-Length-Weight Data for 44 Black Pricklebacks, *Xiphister atropurpureus*, Collected at Diablo and North Cove 1970-72.

Age Group	Number Sampled	Length Range (TL mm)	Length Mean (TL mm)	Number Weighed	Weight Range (g)	Weight Mean (g)
1	1	83	83.0			
2	3	105-106	105.3			
3	5	123-153	133.6	3	6.5-18.7	11.1
4	13	138-204	165.4	12	10.0-33.2	18.1
5	8	161-204	186.1	8	17.0-36.0	27.5
6	5	190-231	209.8	5	33.0-62.0	45.6
7	1	233	233.0	1	53.5	53.5
8	5	181-248	228.0	5	25.0-76.0	58.4
9	1	251	251.0	1	71.0	71.0
10	1	243	243.0	1	72.0	72.0
12 or 13	1	262	262.0	1	80.5	80.5

TABLE 33. Length (by 20 mm increments) -Weights for 186 Black Pricklebacks, *Xiphister atropurpureus*, Collected in Diablo and North Cove 1970-71.

Class Interval 20 mm TL	Number Sampled	Length Mean (TL mm)	Number Weighed	Weight Range (g)	Weight Mean (g)
51-70	6	61.6	4	.25-2.0	1.1
71-90	3	85.0	1	2.0	2.0
91-110	5	98.5	3	3.0-3.50	3.3
111-130	4	123.0	3	5.25-8.0	6.6
131-150	4	142.5	4	10.0-13.0	11.4
151-170	18	160.8	18	13.0-19.5	17.2
171-190	31	181.1	31	18.0-37.0	25.1
191-210	31	201.4	31	27.0-43.0	35.7
211-230	33	219.5	33	36.0-60.0	45.6
231-250	31	238.6	31	41.0-76.0	58.6
251-270	19	258.5	19	57.5-84.0	74.4
271-290	1	290.0	1	83.0	83.0

slightly enlarged ovaries in the North Cove July collection, suggesting a late winter or early spring spawning.

Of the stomachs examined, all were empty except for one piece of a thin red alga. It is suspected that the black prickleback is an active algivore which also feeds on small invertebrates and fishes. Its feeding habits probably compare with those of the rock prickleback, *X. mucosus*. An additional 50 stomachs have been preserved for future examination.

Xiphister mucosus (Girard) - Rock prickleback

This prickleback ranges from the Point Arguello boat station to Port San Juan, Alaska, occurring intertidally and to 60 feet.

The rock prickleback during our collections was found exclusively at the shore stations (0-10 ft.). In Diablo Cove 372 were collected, 361 during the fall and 11 in the winter. No specimens were collected in the summer. However, in the North Cove summer collection 169 were taken. We have no explanation for the abundance of this species in the North Cove during the summer in contrast with its absence at Diablo Cove during the same period.

Sizes ranges from 22 mm SL to 586 mm TL, a new size record for the species. Ages for a selected sample ranged from 1 to 11 years (Table 34).

Females collected in Diablo Cove during the winter contained ripe to easily extruded eggs. One female, 448 mm SL and weighing 472 grams contained ovaries weighing 48 g. Most examined from the Diablo Cove fall collection were immature although some were beginning to mature.

TABLE 34. **Age-Length-Weight Data for 89 Rock Pricklebacks, *Xiphister mucosus*, Collected in Diablo and North Cove 1970-71.**

Age Group	Number Sampled	Length Range (TL mm)	Length Mean (TL mm)	Weight Range (g)	Weight Mean (g)
1	3	152-204	171.6	18.0-31.5	23.5
2	9	165-231	184.4	15.0-63.0	28.9
3	13	218-276	249.7	35.5-109	75.4
4	11	259-357	297.0	84.0-205	135.6
5	8	304-387	343.3	132.0-277	207.6
6	15	335-407	378.3	193.0-425	295.6
7	13	395-506	426.1	332.0-585.0	414.4
8	4	438-468	452.3	398.0-590.0	489.0
9	4	431-445	437.8	426.0-542.0	471.5
10	6	430-515	462.8	470.0-801.0	606.0
11	3	488-520	502.7	620-845	755.7

The rock prickleback feeds almost exclusively on algae. Stomachs examined from the Diablo Cove January collection primarily contained red algae, *Microcladia coulteri*, *Gelidium* sp., *Botryoglossum farlowianum*, *Iridaea* sp. and *Gigartina californica* (or *G. corymbifera*). Additionally, 2 rockweed gunnels, *Xerepes fucorum*, 81 and 76 mm TL were removed from the stomachs of two specimens 460 mm and 357 mm total length respectively. One shrimp (*Spirontocaris* sp.) and a colonial bryozoan were found in separate stomachs. The rock prickleback is believed to feed intertidally, moving in and out with the tidal fluctuations. Fifty additional stomachs were preserved for further examination.

Otoliths from this species taken from the Diablo Canyon SLO-2 Indian midden demonstrated its contribution to their diet during that period (Fitch, 1973). He believed that the Indians caught this prickleback during low tide periods by turning exposed rocks, while some could have been caught by traps and hook and line.

Pholidae

Apodichthys flavidus Girard - Penpoint gunnel

The penpoint gunnel ranges from Santa Barbara Island to Kodiak Island, Alaska, and is common in appropriate habitat within this range.

Thirty-nine of the collected 54 penpoint gunnels in Diablo Cove were taken in the fall at the shore station. One was taken at 20 feet in the fall. In the North Cove July collection, only two individuals were taken, both at 25 feet.

Sizes ranged from 29 to 316 mm SL. The record is 18 inches (457 mm). Ages of seven individuals were: one, 1 year old was 131 mm TL; four, 2 year olds averaged 236.5 mm TL; one, 5 year old was 333 mm TL; and one, 6 year old was 305 mm TL.

The ovaries of three large females examined during September were spent.

Pholis schultzi Hubbs - Red gunnel

This species was listed in our earlier reports as *Lumpenopsis* sp. Through superficial examination, the collected specimens appeared not to have ribs. However, through x-rays it was determined that ribs were present. The red gunnel has been collected by Boyd Walker, UCLA, at San Simeon on several occasions. The collection of this species extends the geographic range south to Diablo Cove. The northern range is Vancouver Island, British Columbia.

The red gunnel was taken only in the North Cove July collection: 12 at the 25 foot station and one at 60 feet. Those from the 25 foot station ranged from 33 to 91 mm SL with one, 84.5 mm aged at 1 year old and one at 91 mm SL aged at 2. The single specimen from 60 feet was 75.5 mm SL and 2 years old.

Xererpes fucorum (Jordan and Gilbert) - Rockweed gunnel

This gunnel is commonly found from the intertidal zone to a depth of 30 feet, ranging from Point Escarpada, Baja California, to Vancouver Island, British Columbia.

The rockweed gunnel was the most abundant fish in the shoreline collections. At Diablo Cove, 604 specimens were taken at the shoreline (0-10 ft.) station; 485 of these during the fall collection. Only 10 were taken at the 20 foot station during the three collections, and none was taken deeper. In North Cove, 319 were taken at the shore station, and one at 25 feet.

Individuals ranged from 30-151 mm TL. A 9 inch (229 mm) fish is the record size. Ages, lengths and weights for 11 specimens included: two 1 year olds (90.5, 94.5 mm TL) averaging 92.5 mm and 2.25 g; three 2 year olds (119.5 - 144 mm TL) averaging 130.33 mm and 7.92 g; five 3 year olds (127 - 151 mm TL) averaging 143 mm TL and 8.9 g; and one 4 year old was 137.5 mm TL and weighed 8.5 g. Most stomachs examined from the North Cove collection contained gammarid amphipods.

Anarhichadidae

Anarrhichthys ocellatus Ayres - Wolf-eel

The wolf-eel ranges from Imperial Beach, San Diego County, to Kodiak Island, Alaska, and the Sea of Japan, attaining a length of 6 feet 8 inches. It ranges in depth from the intertidal to 400 feet.

A wolf-eel was observed at subtidal Station 6 in North Cove in 1970 during the winter and summer surveys. It was thought that the two sightings were of the same wolf-eel in that it was in the same crevice both times. The size was estimated at 3 feet.

Previous studies show the most common items found in wolf-eel stomachs are crab remains with occasional sea urchin fragments, small snails, pieces of fish and abalones (Fitch, 1973). The wolf-eel apparently lacks predators, so the abundance of its teeth in the Diablo Canyon SLO-2 Indian midden is strong evidence that the Indians used traps during their earliest occupation of that site. This species would not have been easy for the Indians to catch with hook and line.

Scytalinidae

Scytalina cerdale Jordan and Gilbert - Graveldiver

This species is rare in collections although it occurs from the intertidal zone to 25 feet (depth extension from our collection) between Diablo Cove and the Bering Sea.

Twenty-three graveldivers were collected: 17 (39 - 65 mm SL) at the shore station within Diablo Cove during September, and six at the 25 foot station in North Cove during July. These specimens represent a southern range extension for the species.

Many of the 17 graveldivers collected in Diablo Cove were dug from coarse sand and did not appear to be as affected by the ichthyocide as other species. Many were actively burrowing in the sand when collected.

The Diablo Cove specimens ranged from 39 to 65 mm SL and most were believed to be young of the year. The six from North Cove ranged from 53 to 69 mm SL with the largest specimen aged at 3 years. The largest reported graveldiver is 6 inches (152 mm).

Ammodytidae

Ammodytes hexapterus Pallas - Pacific sand lance

The Pacific sand lance ranges from Balboa Island, Orange County to the Bering Sea, Arctic Alaska, and to the Sea of Japan and attains a length of 8 inches (203 mm).

Only one Pacific sand lance was taken during the four collections. It was from the 60 ft. station in North Cove, and was 155 mm TL, weighed 8.25 g and was 4 years old.

This individual increases the previous depth range from 30 to 60 feet.

Gobiidae

Coryphopterus nicholsi (Bean) - Blackeye goby

The blackeye goby ranges from South of Point Rompiente, Baja

California, to Skidegate Channel, Queen Charlotte Islands, British Columbia.

During the fish collections this common benthic dweller was taken in greatest numbers at the deep stations. In Diablo Cove, 118 specimens were collected: 89 at 70 feet, 28 at 20 feet, and one at the shore station. They were most abundant in the fall collection. In the North Cove summer collection, 57 of the 83 specimens were from the 60 foot station, and 26 from the 25 foot station.

Sizes ranged from 34 to 109 mm TL. The record size is 6 inches (152 mm). Four specimens (34-52 mm TL) averaging 42.5 mm were age 0; 2 (48, 65 mm TL) averaging 56.5 mm were 1 year old; two (79, 88 mm TL) averaging 83.5 mm were 2 years old; and three (88 - 98 mm TL) averaging 93.7 mm were 3.

During subtidal surveys, more blackeye gobies were seen in shallow water than deep; the reverse of the distribution pattern indicated by the ichthyocide collections. The highest transect counts occurred at Station 6 where a sand-mud bottom occurred between two large pinnacles. At this station, 15 were seen during the summer and the average for the six surveys was 9.67.

Sixty-two were counted at 19 stations in 1970 as compared to 97 at 21 stations in 1971. This goby with its black eyes and black tipped dorsal, contrasting with its "white" body makes it easy to see and count. Most often this goby is associated with the painted greenling, "perched" on rocks and shows little fear of divers.

The blackeye goby was only observed in calm waters. The overall transect average for the species was 2.89, ranking 4th among the 23 fish species observed, and excluding juvenile rockfish, this goby was the 3rd most frequently observed fish. Counts during each season were similar.

Lethops connectens Hubbs - Kelp goby

The kelp goby has been recorded from the intertidal to 60 feet, ranging from Cape Colnett, Baja California, to Carmel.

Only two kelp gobies were taken: one in North Cove in the summer at 60 feet, matching the depth record and one in Diablo Cove during the winter at 20 feet.

The North Cove specimen was 62 mm TL, weighed 1.5 g and was 3 years old. At 62 mm (2.44 inches) this fish is close to the record of 2.5 inches.

Lythrypnus dalli (Gilbert) - Bluebanded goby

A single bluebanded goby was seen near Diablo Rock during the summer of 1969.

This goby ranges from the Gulf of California to Morro Bay and offshore to Guadalupe Island; it is very rare north of Point Conception.

Recorded from the intertidal to 210 feet, the largest known was 2.25 inches (57 mm) long.

Lythrypnus zebra (Gilbert) - Zebra goby

One zebra goby 35 mm TL and 2 years of age was collected in North Cove at 25 feet in the summer. This finding is a northern range extension. The southern range is Clarion Island, Mexico.

Typhlogobius californiensis Steindachner - Blind goby

This goby ranges from Magdalena Bay, Baja California, to the cove north of San Simeon Point occupying the intertidal zone to 25 feet.

Two blind gobies (63 and 67 mm TL) were taken near intertidal Station 3 (from about the mid tide zone) in Diablo Cove (Figure 1) during a low tide in October 1970. Both specimens were collected from a seawater filled depression left in a sand and cobble substrate after turning a large boulder. A single ghost shrimp, *Callianassa affinis*, the associated host which provides the burrow lives commensally with the blind goby, and provides its food, (MacGinitie, 1939) was collected from the same depression. A length of 3.25 inches (82 mm) is the record size for the blind goby.

Liparididae

Liparis florae (Jordan and Starks) - Tidepool snailfish

The tidepool snailfish ranges from 1 mile south of the lighthouse, Point Conception to the Bering Sea.

This snailfish was found only within Diablo Cove at the shallower stations. In all, 17 specimens were collected. During the fall, six specimens ranging from 87 to 110 mm SL were taken at the shore station, and nine individuals 80 to 103 mm SL were taken at 20 feet. Two additional specimens were collected in the winter at 20 feet.

Previous records list this species' depth range as intertidal only. A length of 7.2 inches (183 mm) is the largest recorded.

Liparis mucosus Ayres - Slimy snailfish

The slimy snailfish ranges from Playa Maria Bay, Baja California, to Vancouver Island, British Columbia. This liparid has been recorded in depths from the intertidal to 50 feet. The record size is 2.87 inches (73 mm).

In Diablo Cove ten slimy snailfish were taken. Eight (28 - 43 mm SL) were collected at the 20 foot station equally divided between the fall and winter collections, and two (30 - 44 mm SL) at the shore station in the fall.

In previous reports 5 of these 10 liparids were listed as slipskin snailfish, *L. fucensis* which represented a southern range extension. The initial identification of *L. fucensis* has been changed to *L. mucosus*, (D. Miller and B. Lea, CDF&G pers. commun.).

Liparis spp. - Snailfishes

Forty-six liparids were collected that were not identified: 32 in North Cove (15-54 mm TL), and 14 in Diablo Cove (21-57 mm SL). Two specimens collected in May and September at the 20 foot station in Diablo Cove and four taken at 25 feet in North Cove did not fit the description of any presently known species off our coast. The one taken in May was a fully mature female (ovaries filled with ripe eggs) at 58 mm TL and 2 years of age. Thirty-seven of these unidentified snailfishes were taken at the 20 and 25 foot stations. All specimens have been stored at Los Angeles County Museum of Natural History for further examination.

Snailfishes occurring along the California coast are uncommon with the exception of the tidepool snailfish which is considered common.

Scorpaenidae

Sebastes atrovirens (Jordan and Gilbert) - Kelp rockfish

The kelp rockfish ranges from Point San Pablo, Baja California, to Timber Cove, Sonoma County. Found in depths to 150 feet, it is a shallow water species commonly occurring in 35 feet or less.

Only seven were collected in Diablo Cove, six in the winter and one in the fall. All were taken at the 20 foot station. In North Cove in the summer, kelp rockfish were fairly common at the 25 foot station where 11 were collected. This station was in a *Macrocystis* bed, possibly accounting for the larger numbers taken as kelp is this species' preferred habitat. One individual was taken at 60 feet.

All kelp rockfish collected were adults ranging from 221-370 mm TL. The record size is 16.75 inches (425 mm). Ages ranged from 3-15 years (Table 35).

All six kelp rockfish from the Diablo Cove winter collection appeared to be approaching their spawning period. One female, 361 mm TL weighing 906 g, contained ovaries weighing 41 g. One 370 mm TL female from the fall collection was spent.

Seven of nine stomachs examined were empty. This is a common occurrence when collecting fishes with ichthyocide as many will regurgitate their food as they are affected by the chemical. Two stomachs contained fishes ingested during the collecting: one slimy snailfish, *Liparis mucosus*, and seven juvenile rockfish.

During routine subtidal summer surveys, most kelp rockfish were observed in protected areas associated with kelp. Stations 7 and 16 accounted for half of the sightings of this species during the 2 year study. The dense algal cover at these two stations probably accounted for their presence. The numbers observed at Station 7 correlated well with findings during the fish collections at that station. No specimens were observed at depths greater than 30 feet. The kelp rockfish observed at Station 15, a surging reef, were in the shelter of a dense bed of palm kelp, *Laminaria setchellii*.

TABLE 35. **Age-Length-Weight Data for a Selected Sample of the Kelp Rockfish, *Sebastes atrovirens*, Collected at Diablo and North Cove 1971.**

Age Group	Number Sampled	Length Range (TL mm)	Length Mean (TL mm)	Weight Range (g)	Weight Mean (g)
3	2	221-225	223.0	178-209	193.5
5	1	263	263.0	368	368.0
7	1	345	345.0	761	761.0
8	2	335-340	337.5	810-864	837.0
9	1	368	368.0	889	889.0
*12	1	370	370.0	1003	1003.0
*15	1	370	370.0	997	997.0

* otoliths dense - age may vary ±1 year.

Seasonal patterns for 1970 were: two in the winter, 10 in the summer and one in the fall. The 10 were recorded at three stations. In 1971, seasonal patterns were: four in the winter, nine in the summer and six in the fall, with each seasonal count made at three stations.

Sebastes carnatus (Jordan and Gilbert) - Gopher rockfish

The gopher rockfish ranges from San Rogue, Baja California, to Eureka. A typical shallow water species, it has been recorded to a depth of 180 feet.

In Diablo Cove this fish was found only at the deep station (70 ft.). The 49 individuals taken were seasonally distributed as follows: winter - 12; summer - 23; and fall - 12. Lengths ranged from 42-233 mm SL. In North Cove 84 specimens were collected: 59 at the 25 foot station and 25 at the 70 foot station. Lengths of these 84 fish ranged from 54-274 mm SL. The record size is 15.6 inches (396 mm). Specimens collected at Diablo Cove in the winter included gravid females and ripe males. Among those examined in the summer were one ripe and one spent female, suggesting a late winter-early summer spawning. Ages ranged from 1-13 years (Table 36).

Ten of 35 stomachs examined were empty, the remaining 25 contained primarily crustaceans and fishes (Table 37).

The volume of stomach contents is not reliable under the collecting procedures (ichthocides) used in this study because this predator rockfish picks up small affected fishes during the collection, and as it in turn is affected by the ichthocide, it often regurgitates all food items in its stomach.

Coloration is the only valid way for divers to distinguish between black-and-yellow rockfish and gopher rockfish underwater. This posed a

TABLE 36. **Age-Length-Weight Data for 49 Gopher Rockfish, *Sebastes carnatus*, Collected at Diablo and North Cove 1970-71.**

Age Group	Number Sampled	Length Range (SL mm)	Length Mean (SL mm)	Weight Range (g)	Weight Mean (g)
1	4	55-91	78.8	7-27	19.3
2	8	94-121	108.9	25-68	49.9
3	15	125-151	136.5	67-144	98.7
4	5	158-182	166.0	124-274	189.2
5	4	185-205	194.5	249-339	295.5
6	2	195-213	204.0	307-311	309.0
7	1	212	212.0	422	422.0
8	5	206-232	223.2	405-577	507.8
*9-11	3	225-231	228.0	548-583	566.0
*12-13	2	230-233	231.5	575-638	606.5

* Concentric growth rings in older specimens are very close together making 1 year distinctions very difficult without elaborate preparation of otoliths.

TABLE 37. Stomach Contents of 25 Gopher Rockfish, *Sebastes carnatus*, Collected at Diablo and North Cove 1971.

Food Item	No. of Stomachs Found in	Total No. Items	% of Total
Crustaceans			
Crabs - unidentified	7	10	21.74
Shrimp (*Callianassa* sp.)	3	9	19.57
Cancer sp.	2	3	6.52
Pugettia producta	1	1	2.17
Fishes			
Digested fish - unidentified	11	15	32.61
Sebastes spp.	2	2	4.35
Artedius sp.	1	1	2.17
Mollusks			
Octopus sp.	3	3	6.52
Squid	1	1	2.17
Echinoderm			
Brittle star	1	1	2.17
		46	99.99

problem at our deeper stations, or where turbidity and water clairty masked the true coloration of the fish. During the 1970 diving surveys more black-and-yellow rockfish were recorded at the deep stations than gopher rockfish, while in 1971 the opposite was true. Misidentification between the two species under these conditions undoubtedly existed.

Four gopher rockfish were observed at two stations in the summer during 1970 surveys, while 11 were observed at nine transects in 1971. For the 2 year study, an average of five were counted during each season. The species ranked 16th among the 23 species observed.

Sebastes caurinus-vexillaris complex - Copper-whitebelly rockfish

There are no positive key differences between these two species. The copper is reported to range from Monterey to Kenai Pennisula, Alaska, and the whitebelly from San Benito Islands, Baja California, to Crescent City. Size records are 22.5 inches (572 mm) for the copper and 20 inches (508 mm) for the whitebelly. Both fishes have been recorded at depths from the surface to 600 feet.

This "species" was found only in Diablo Cove. Sixty specimens were collected: 58 juveniles ranging from 28.5 to 40.5 mm TL at the 70 foot station in the summer, and two additional specimens, a juvenile, 33 mm SL, and an adult, 204 mm SL, at 20 feet in the fall. The adult weighed 232 g and was 4 years old. It had two recently ingested juvenile blue rockfish in its stomach.

During routine subtidal surveys, 5 were observed at 2 stations in 1971. One was counted at Station 6 in both the winter and summer, and 3 at Station 7 in the summer.

Sebastes chrysomelas (Jordan and Gilbert) - Black-and-yellow rockfish

The black-and-yellow rockfish ranges from Natividad Island, Baja California, to Eureka.

In Diablo Cove this benthic dweller was commonly found in the shoreline area to 20 feet. It has been recorded to 120 feet. In Diablo Cove during the fish collections, 58 were taken in the shore area, 59 at 20 feet, and one in deeper water (70 ft.). Similar numbers were recorded during each season's sampling. In North Cove, 12 were taken at the shore station and 11 at 25 feet.

Individuals ranged from 30 to 260 mm SL in the fall, 46 to 260 mm SL in the summer and 63 to 264 mm SL in the winter. The record length for this species is 15.25 inches (388 mm). Age varied from 0 to 14 or 15 years (Table 38).

Adults collected in January included both gravid females and ripe males. One female, 228 mm SL weighing 574 g, contained ovaries weighing 48 g. Most females collected in the summer (May) were spawned out, but one-third of the examined specimens were still ripe.

Stomachs contained primarily crustaceans including both crabs and shrimp. Four stomachs containing crustaceans also contained fish with other rockfishes most often encountered. Most of the fish had been eaten after having been affected by the ichthyocide. Three of 16 stomachs were empty. During subtidal surveys at Station 9 in the summer, one large (about 9 inches) black-and-yellow rockfish was observed eating a smaller (about 3 inches) black-and-yellow rockfish.

During routine subtidal surveys, the black-and-yellow rockfish ranked 6th by numbers among 23 species observed, but was the 4th most frequently encountered at all transects during the 2 year period. Equal numbers were

TABLE 38. Age-Length-Weight Data for 52 Black-and-Yellow Rockfish, *Sebastes chrysomelas*, Collected at Diablo and North Cove 1970-71.

Age Group	Number Sampled	Length Range (SL mm)	Length Mean (SL mm)	Number Weighed	Weight Range (g)	Weight Mean (g)
0	1	63	63.0			
1	1	60	60.0			
2	11	90-132	107.4	8	30-85	43.9
3	13	115.5-167	140.7	9	58-142	91.2
4	5	153-170	161.2	4	133-210	171.8
5	3	195-200	198.0	3	276-307	292.3
6	2	195-206	200.5	1	275	275.0
7	3	202-212	206.3	3	347-444	401.0
8	3	215-218	216.7	3	422-513	468.7
9	2	220-228	224.0	2	473-574	523.5
*10	3	211-260	232.0	2	372-529	450.0
*11	1	221	221.0	1	498	498.0
12	2	232-248	240.0	2	569-679	624.0
14	1	230	230.0	1	512	512.0
*15	1	252	252.0	1	680	680.0

* Age may vary due to difficulty in reading otoliths of older fish.

tallied in the winter and fall surveys with a slightly higher count in the summer for the 2 year period. Twice as many black-and-yellows were observed in 1971 as in 1970. We attribute this to better visibility in 1971 and greater familiarity with this species' cryptic habits. Many occupied the same crevices at each station throughout the year.

As discussed under the gopher rockfish, identification problems existed with these two species. The fish collections supported the premise that the gopher rockfish occupied deeper water than the nearshore black-and-yellow in the Diablo Cove area.

Sebastes entomelas (Jordan and Gilbert) - Widow rockfish

The widow rockfish ranges from Todos Santos Bay, Baja California, to Kodiak Island, Alaska.

This species was only found at Diablo Cove at 70 feet during the fall. The 28 specimens taken were all juveniles 41 to 78 mm SL. The largest recorded is 21 inches (534 mm). Adult widow rockfish are deep water species, and the presence of juveniles at the 70 foot station suggests the use of shallow, nearshore habitat as a nursery ground.

Sebastes flavidus (Ayres) - Yellowtail rockfish

This rockfish ranges from San Diego to Kodiak Island, Alaska, and is found in depths from the surface to 900 feet.

Although the yellowtail rockfish typically inhabits deeper water than our collection stations encompassed, one adult, 382 mm TL, was collected in North Cove at 25 feet, and 16 others, including 14 juveniles, were collected at the 60 and 70 foot stations.

Individuals ranged from 49 to 378 mm TL. The largest recorded yellowtail rockfish is 26 inches (660 mm). Nine of these 17 specimens were aged: four ranging from 104 to 123 mm TL, averaging 113.5 mm were 1 year old; two 145 and 154 mm TL were 2; one 208 mm TL was 3; one 340 mm TL was 4; and the largest at 378 mm TL was 6 years old.

It was almost impossible for us to distinguish between yellowtail rockfish and olive rockfish during subtidal surveys. Minor coloration differences, and anal fin ray counts sometimes will distinguish the two species but these do not work on moving fish in surging water. Because of this, we combined yellowtail and olive rockfish counts during our subtidal surveys. However, because of the depth preference between the two species and because most at Diablo were seen in shallow water, we suspect most were olives.

Sebastes goodei (Eigenmann and Eigenmann) - Chilipepper

This rockfish ranges from Magdalena Bay, Baja California, to 40 miles SW of Cape Scott on the NW coast of Vancouver Island, British Columbia.

Although the chilipepper also is typically a deep water species, ranging to 1,080 feet, juveniles were taken in the summer collections: one at Diablo Cove from 70 feet measured 57.5 mm TL, 11 in North Cove from 25 feet ranged from 72-85 mm TL, and four in North Cove at 60 feet ranged from 63.5 to 70.5 mm TL. The chilipepper attains a length of 22 inches (560 mm).

Sebastes melanops Girard - Black rockfish

This species ranges from Paradise Cove to Amchitka Island, Alaska. It is found most commonly in shallow water, but depths to 300 feet have been reported.

The black rockfish was abundant during the fall collections in Diablo Cove. At 70 feet, 123 were taken which ranged from 44 to 156 mm SL;

13 collected at 20 feet ranged from 50-282 mm SL; and three juveniles taken along the shore were 49 to 93 mm SL. The record length has been reported at 23.75 inches (603 mm). Few were taken in the summer and winter collections at Diablo Cove. At North Cove in the summer, four adults 232 to 237 mm TL were collected.

Ages ranged from 0 at 114 mm TL to 6 years at 343 mm TL (Table 39).

In the Diablo Cove winter collection, the four specimens taken at 20 feet were all spent males (average TL 252.5 mm). One of these had eaten a rockweed gunnel which had been affected by the ichthyocide, but the other three were empty.

During routine subtidal surveys, black rockfish were occasionally observed on the benthos associated with the black-and-yellow rockfish and in the mid-water column associated with schools of blue and olive rockfish. The largest numbers were always counted in the mid-water column.

Annual counts were very similar. However, the number of transects the black rockfish were observed on in 1970-71 varied considerably. Thirty-five were counted on two transects (23 at Station 9 in Diablo Cove and 12 at Station 8 in North Cove) in 1970 as compared to 37 at 9 transects in 1971. The highest counts in 1971 were made within Diablo Cove; however, the highest count for a single transect that year was 12 at Station 15. During both years, summer surveys accounted for about twice as many black rockfish as fall. None was observed during the winter surveys on transects, although a few individuals were seen during reconnaissance dives. This species ranked 7th of 23 counted fishes.

TABLE 39. Age-Length-Weight Data for a Selected Sample of Black Rockfish, *Sebastes melanops*, Collected at Diablo and North Cove 1970-71.

Age Group	Number Sampled	Length Range (TL mm)	Length Mean (TL mm)	Weight Range (g)	Weight Mean (g)
0	1	114	114	16	16
1	4	84-149	120.8	9-52	30.8
2	1	190	190	119	119
3	3	237-274	253	232-396	296.6
4	2	300-324	312	507-663	585
6	2	340-346	343	715-790	752.5

Sebastes miniatus (Jordan and Gilbert) - Vermilion rockfish

This rockfish ranges from San Benito Islands, Baja California, to Vancouver Island, British Columbia, and has been taken at a record depth of 660 feet.

Only one vermilion was collected in Diablo Cove. This fish, a female, taken at the 20 foot station, measured 478 mm TL, and was 16 years old. It had ingested 12 small fish from the collection. The record size is 30 inches (762 mm).

Three vermilion rockfish were collected in North Cove, two at 25 feet and one at 60 feet. They measured 492, 449, and 375 mm TL, and weighed 2500, 1485 and 1200 g respectively. The largest one's stomach contained 18 small fish which had been affected by the collecting ichthyocide.

Four vermilions were counted at three transects in 1970 during the fall. Two were observed on two transects, one in the winter and one in the fall during 1971. The presence of this rockfish in the summer was verified by the fish collection in North Cove.

This species was always observed in or about deep rocky crevices. We always saw more individuals during surveys and reconnaissance dives just off Station 15, where large boulders (automobile size) adjacent to the transect formed deep crevices and caverns, than at any other subtidal station.

Sebastes mystinus (Jordan and Gilbert) - Blue rockfish

The blue rockfish ranges from Point Santo Tomas, Baja California, to the Bering Sea. A common shallow water form, typically occurring in waters less than 150 feet, it has been recorded to a depth of 300 feet.

This rockfish was the second most abundant collected fish at Diablo

Cove and North Cove. At Diablo Cove, 542 were taken during three collections: 381 in the fall, 83 in the summer, and 78 in the winter. Of the 381 taken in the fall, 308 were from 70 feet, with individuals ranging from 41 to 140 mm SL. At the shore station in the fall, all were juveniles 55-79 mm SL, but at the 70 foot station, sizes ranged from 53 to 270 mm SL. The blue rockfish in the summer collection ranged from 39-237 mm SL. Blue rockfish are reported to attain a length of 21 inches (533 mm).

In the North Cove July collection (three stations), the blue rockfish was the most abundant species collected at a single station with 833 taken at 25 feet. Of these 833, 815 were 40-78 mm SL and were young of the year (1 year old fish had a mean standard length of 100.2 - Table 40). In all, 98% of the blue rockfish collected in North Cove were young of the year, which probably reflected the time of year this collection was made, the habitat (a *Macrocystis* bed at the 25 foot station), the susceptability of the juveniles to the collecting chemical, and the ability of the adults to escape the chemical.

With the exception of juvenile rockfish, adult blue rockfish counts far exceeded any other species observed at subtidal transects. In 1970, 1,299 were counted at 20 transects (26 transects were surveyed that year). In 1971, however, 8,097 were counted at 24 transects (29 were surveyed in 1971). The increased visibility and calmer ocean conditions in 1971 probably accounted for this difference.

Seasonally, the highest counts in 1970 were made in the fall (874 of the 1,299) while in 1971 the highest count was made in the summer (3,430 of the 8,097). The high counts during each season in 1971 demonstrated the abundant presence of this species throughout the year.

TABLE 40. Age-Length-Weight Data for a Selected Sample of Blue Rockfish, *Sebastes mystinus*, Collected at Diablo and North Cove 1970-71.

Age Group	Number Sampled	Length Range (SL mm)	Length Mean (SL mm)	Number Weighed	Weight Range (g)	Weight Mean (g)
1	13	86-112	100.2	11	20-50	35.2
2	12	127-164	144.7	10	57-135	89.3
3	3	166-211	184.3	2	140-200	184.3
4	3	191-199	195.0	3	235-250	241.7
6	1	237	237.0	1	470	470.0
8	1	270	270.0	1	760	760.0

Highest counts were consistently made at reef pinnacle areas outside Diablo Cove, primarily at Stations 6 and 15 where schools of 1,000 to 2,000 individuals were often seen. Schools containing up to 1,000 fish were seen inside Diablo Cove in the fall at Station 9.

To estimate numbers of blue rockfish per school was very difficult. At times these schools were so dense they seemed to cast a shadow over the transect. Portions of these schools often extended beyond our vision, even on good visibility days. Estimates under these conditions were minimal at best.

This rockfish averaged 210 per transect surveyed in the summer, 176 per transect in the winter, and 137 per transect in the fall for a 2 year average of 171 per transect which amounted to 74.1 percent of all fishes counted (excluding unidentified juvenile rockfish).

Sebastes nebulosus Ayres - China rockfish

The China rockfish is typically a common shallow-water inhabitant recorded from 36 to 420 feet. Five specimens were taken during the four collections: four at Diablo Cove and one in North Cove, all at the deep stations. Those taken at Diablo Cove represent a southern range extension for the species along the mainland coast. The northern range is SE Alaska. We also collected this species (two individuals) by hook and line off Hazard Canyon, about 3 miles north of Diablo Cove.

Three specimens collected at Diablo Cove during the summer and fall at 2 years of age ranged from 113-138 mm TL (128 mm average), and weighed from 29-54 g (average 41.5 g). The fourth China rockfish from Diablo Cove, collected in January, was a gravid female at 322 mm TL and a weight of 908 g; its stomach contained one digested squid. This species reportedly attains a length of 17 inches (432 mm).

The single fish taken in North Cove was 78.5 mm TL, weighed 7.5 g, and was 1 year old.

Sebastes paucispinis Ayres - Bocaccio

This rockfish ranges from Point Blanca, Baja California, to Kruzof Island and Kodiak Island, Alaska, to depths of 1,050 feet.

The bocaccio was collected only in North Cove during the summer. It was abundant at the 25 foot station (103 specimens ranging from 59-109 mm TL), common at 60 feet (29 specimens ranging from 65-115 mm TL), and sparse at the shore station (five ranged from 64-85.5 mm TL). The record size is 36 inches (915 mm).

Sebastes pinniger (Gill) - Canary rockfish

The canary rockfish ranges from Cape Colnett, Baja California, to 17 miles west of Cape San Bartolome, Alaska, and to a depth of 900 feet.

This rockfish was abundant at the 25 and 60 foot stations in North Cove during the summer (198 and 178 specimens respectively). Of these 376 fish, 369 were young of the year ranging from 43 to 87 mm TL. Six of the other seven specimens were 1 year olds, ranging from 108-138 mm TL (average 121 mm), and in weight from 19-44.5 g (average 29 g). The seventh was 2 years old, 167 mm TL and 76 g.

In Diablo Cove only 17 specimens were taken during four collections with all but one from the deep station. Twelve collected in the summer and fall ranged from 43 to 89 mm SL, and two of these, (73 and 89 mm SL) were 1 year old. Of five collected in the winter, two (75 and 80 mm SL) were age 0, one at 125 mm SL was 1, and two (170 and 180 mm SL) were 2. Lengths to 30 inches have been reported for this species.

Sebastes rastrelliger (Jordan and Gilbert) - Grass rockfish

The grass rockfish ranges from Playa Maria Bay, Baja California, to Yaguina Bay, Oregon. Found in depths to 150 feet, it attains a length of 22 inches (493 mm).

This rockfish was relatively uncommon throughout the collections. Nine were taken in Diablo Cove during three collections, and five others in North Cove. All 14 were taken in shallow water (0-10 ft.), and ranged from 101-358 mm SL. Ages ranged from 2 to about 14 (Table 41).

One specimen 277 mm SL had eaten a crab and a top snail, *Tegula* sp. Grass rockfish and the kelp rockfish were not differentiated during our routine subtidal surveys; both were recorded as kelp rockfish and are discussed under that species.

Sebastes serranoides (Eigenmann and Eigenmann) - Olive rockfish

The olive rockfish ranges from San Benito Islands, Baja California, to Redding Rock, Del Norte County, and to a depth of 480 feet.

In Diablo Cove during September, 12 of 13 specimens from the shore and 20 foot stations were young of the year ranging from 65-83 mm SL. The other olive rockfish was collected at 70 feet and was 152 mm SL, weighed 93 g, and was 1 year old. During January, 12 olive rockfish were collected. One of these at 164 mm SL, 117 g, and one year of age, had eaten four northern anchovies, all about 2 inches in length. No olive rockfish were taken in Diablo Cove in May.

In North Cove, 123 olive rockfish were taken in the July collection. Of the 69 from the 25 foot station, 65 were age 0 (30-67 mm SL); three were 1 year (87-118 mm TL; average 106 mm), and one was 10 (340 mm SL). At the shore and 60 foot stations, the 15 and 39 specimens collected

TABLE 41. Age-Length-Weight Data for 14 Grass Rockfish, *Sebastes rastrelliger*, Collected at Diablo and North Cove 1970-71.

Age Group	Number Sampled	Length Range (SL mm)	Length Mean (SL mm)	Weight Range (g)	Weight Mean (g)
2	1	101	101.0	34	34.0
3	3	112-162	142.3	52-151	106.7
*4	1	176	176.0	194	194.0
5	1	258	258.0	595	595.0
6	1	316	316.0		
*7	2	277-284	280.5	730-740	735.0
*8	1	330	330.0	1175	1175.0
*14	1	358	358.0	1536	1536.0

* Age could vary ±1 year due to difficulty in interpreting otolith annuli for large fish.

ranged from 33 to 55.5 mm SL except for one which was 113 mm SL and 1 year old. The stomach of the 340 mm fish from the 20 foot July station contained nine rockfish (about 2 inches) from the collection. The record size for an olive rockfish is 24 inches (610 mm).

During routine subtidal surveys olive rockfish ranked 3rd numerically of 23 counted species. In the 1970 surveys, most olive rockfish were observed in the fall. Of the 88 counted in the fall, 85 were at two transects on the surging reefs south of Diablo Cove (Stations 13 and 15). In the 1971 surveys, most were counted in the summer with 33 of the 41 occurring on the outside reef (Station 15). Where olive rockfish were abundant, their numbers were difficult to assess due to their schooling behavior. Olive rockfish often schooled with blues in the midwater column and were so scattered among the more abundant blues, it was impossible to make accurate counts. When this occurred our counts for olives were minimal at best.

For the 2 year study, our highest average counts (4.66 fish per surveyed transect) were made in the fall.

Sebastes spp. - Unidentified juvenile rockfish

Five unidentified juvenile rockfish (24-46 mm SL) were taken during the summer and fall collections. One was taken at North Cove and 4 at Diablo Cove. These specimens were not identified due to their small size and/or their poor condition.

During routine subtidal surveys no attempt was made to identify juvenile rockfishes to species. As a group, juvenile rockfishes were the most abundant fish recorded. Totals were much higher for 1971 (23,641) than 1970 (6,687), which in part reflected better ocean conditions in 1971. Our highest counts of juveniles generally correlated with high counts of blue rockfish, but large numbers of juveniles were also observed where few adults were present. The largest schools of juvenile rockfishes (2,000-3,000) were observed at the shallower stations associated with the reef-pinnacle formations in a thigmotaxic behavior pattern. Large schools usually were in the mid-water column, with scattered more sparse groups on the bottom.

Highest counts were made during the fall in 1970 and in the summer in 1971, a pattern identical to that of adult blue rockfish. We mention this because we believe that most juveniles, over 80%, were blue rockfish. The lowest count, 474 in the winter of 1970, probably reflects poor visibility and rough ocean conditions. For the 2 year study, juvenile rockfishes averaged 190 in the winter, 861 in the summer, and 575 in the fall per transect surveyed. Transect counts varied from 0 to 200 in 1970 and from 27 to 3,500 in 1971. The importance of juvenile rockfish cannot be overemphasized; not only are they necessary in order to perpetrate healthy adult rockfish populations, but they are a choice prey for nearshore predators.

Of the 14 shallow water rockfishes that attain a respectable size (2 to 5 pounds or more) that could occur at Diablo Cove within 200 yards of the shore, all but one (*S. auriculatus*) was collected at one or more of the three depths sampled. Also, juveniles of several deep water rockfish were taken in these collections.

Fitch (1973) found that many of the rockfish otoliths found in the SLO-2 Indian midden were from juveniles and that almost every otolith showed signs of erosion from predator digestion.

Hexagramidae

Hexagrammos decagrammus (Pallas) - Kelp greenling

Ranging from La Jolla to the Aleutian Islands, Alaska, this hexagramid has been recorded from the intertidal to 150 feet deep. It is most commonly found in less than 50 feet associated with dense algae.

In Diablo Cove, 30 were taken during the three collections: 14 in the winter, eight in the summer, and eight in the fall. Seventeen of the 30 were from the shore station. Lengths ranged from 59 to 392 mm TL. In North Cove no kelp greenlings were found at the shore station. Twenty-three were found at the 25 foot station and two at 70 feet. Of these 25 specimens, 18 were young of the year and four were 1 year old. Lengths ranged from 64 to 380 mm TL. The record size is 21 inches (533 mm). Ages ranged from 0 to 9 years for those specimens aged (Table 42).

An examination of stomach contents indicated kelp greenlings are voracious eaters. Their diet appeared to consist primarily of small crustaceans (crabs and shrimps), but such other items as *Octopus* sp., brittle star fragments , small fish, fish eggs, urchin eggs, chitons, polychaetes, algae, small snails, and small abalones (unidentifiable) were found in their stomachs.

During routine subtidal surveys this fish, when observed, was always along the bottom in protected areas generally associated with dense algal cover. In 1970, 12 were counted at 10 stations, while in 1971, 42 were observed at 21 stations. The highest counts in both years were made during the fall. Overall, the kelp greenling ranked 10th of the 23 counted fishes.

TABLE 42. Age-Length-Weight Data for 17 Kelp Greenlings, *Hexagrammos decagrammus*, Collected at Diablo and North Cove 1970-71.

Age Group	Number Sampled	Length Range (TL mm)	Length Mean (TL mm)	Number Weighed	Weight Range (g)	Weight Mean (g)
0	4	98-136	105.0	4	9-29	14.9
1	5	136-208	180.2	4	33-122	75.8
2	1	285	285.0	1	343	343.0
3	1	313	313.0	1	420	420.0
4	1	320	320.0	1	487	487.0
5	3	332-356	342.0	3	645-708	669.7
6	1	350	350.0	1	889	889.0
7	1	354	354.0	1	655	655.0
8	1	375	375.0	1	860	860.0
9	1	360	360.0	1	798	798.0

Ophiodon elongatus Girard - Lingcod

The lingcod ranges from Point San Carlos, Baja California, to Kodiak Island, Alaska.

This species ranges in depth by age: post larval (to 3") are pelagic nearshore and offshore, while juveniles range from shallow water (along the shore) to water several hundred feet deep; adults have been recorded from as deep as 1400 feet (Miller and Lea, 1972). Lengths to 52 inches and weight to 54 pounds have been recorded in California (D. Miller, CDF&G Pers. Commun.).

Few lingcod were collected with the ichthyocide. In Diablo Cove, only one was taken in May, three in September, and seven in January. Of the seven taken in January, six were from the deep station and most were speared as they came in to feed on the affected smaller fish. Five were collected in the North Cove, four at 20 feet and one at 60 feet.

These 16 fish ranged from 420 to 875 mm TL. Two lingcod, 313 and 301 mm TL, were aged at 1 year, and one at 420 mm TL was 2 years old.

Females examined from the January collection contained ripe eggs, whereas the 875 mm TL female lingcod weighing 8,136 g taken in May was completely spawned out.

Stomachs frequently contained recently ingested fishes. As the ichthyocide affected smaller fishes the predacious "lings" moved in for easy feeding. Large "lings" were then speared as time permitted during the collection. The most common stomach contents were octopus beaks and other digested octopus parts. One "ling", 475 mm TL, had eaten 15 juvenile yellowtail rockfish, 13 juvenile blue rockfish, and two bonehead sculpin, *Artedius notospilotus*. Another, 491 mm TL had ingested a blue rockfish 200 mm TL.

During routine subtidal surveys 14 were observed at 26 transects in 1970, and 28 at 29 transects in 1971. Most were seen during the summer with the winter second in 1970, and fall second in 1971. The lingcod was usually observed near rocky crevices in protected areas. General perusal dives revealed a greater abundance of lingcod than was indicated by the surveys.

Man and large sea lions are about the only noteworthy lingcod predators. In the SLO-2 Diablo Cove Indian midden, Fitch (1973) found a tooth from a lingcod at a depth in the midden suggesting it was caught by hook-and-line. Two otoliths from deeper sampled increments probably came from lingcod that had been trapped by Indians or eaten by a sea lion.

Oxylebius pictus (Gill) - Painted greenling

The painted greenling ranges from Point San Carlos, Baja California, to Queen Charlotte Island, British Columbia, and to depths of 160 feet. A length of 10 inches has been reported but 6 inchers are rare.

During three collections in Diablo Cove, 330 were taken: 25 at the shore station, 89 at 20 feet, and 216 at 70 feet. The summer and fall collections accounted for 258 of the specimens somewhat equally divided between the two seasons.

In July at the North Cove, most (106) were taken at 25 feet. One was found at the shore station and 87 at 60 feet.

Lengths for all painted greenlings taken ranged from 39 - 173 mm TL, representing ages from 0 to 8 years (Table 43).

Those females examined in May and September contained developing and mature eggs. Crustaceans were the predominant food found in their stomachs, polychaetes were also important.

TABLE 43. Age-Length-Weight Data for a Selected Sample of Painted Greenlings, *Oxylebius pictus*, Collected at Diablo and North Cove, 1970-71.

Age Group	Number Sampled	Length Range (TL mm)	Length Mean (TL mm)	Number Weighed	Weight Range (g)	Weight Mean (g)
0	6	53.5-89.0	70.4	6	1.75-10	4.8
1	8	81.5-113.0	97.2	7	8.50-22	12.2
2	10	98.0-133.0	120.2	7	12.00-35	23.6
3	8	173.0-152.0	145.0	6	43.00-55	46.2
4	5	140.0-151.0	145.2	5	34.00-50	41.2
5	1	156	156.0	1	47	47.0
7	1	172	172.0			
8	1	173	173.0	1	70	70.0

This fish (excluding juvenile rockfish) yielded the second highest annual counts and was found at more transects than any other species during routine subtidal surveys. In 1970, 82 were counted at 21 stations as compared to 146 at 27 stations in 1971. Found most frequently in protected habitats on cobble-boulder substrates, this species also occupied surging areas often hiding in the benthic flora. Their fear of divers appeared minimal as they would move only a few feet as we approached them, making counts easy.

Cottidae

The cottids were represented by more genera and species than any other family in the collections. Because of difficulty in sight identification, all cottids, with the exception of the cabezon, were recorded as "Cottidae - unidentified" during subtidal surveys. Because of this, we have limited the following discussion to data from the fish collections with the exception of the cabezon.

Artedius corallinus (Hubbs) - Coralline sculpin

The coralline sculpin ranges from San Martin Island, Baja California, to Orcas Islands, Washington. Recorded from the intertidal to 70 feet, this species attains a length of 5.5 inches (140 mm).

At Diablo Cove this sculpin was 7th numerically (183 collected) and was the most common species of this genus. Of the 183 taken, 112 were from the 20 foot station, 68 from the 70 foot station, and only three from the shore station. The North Cove summer collection yielded 143 specimens: 110 at the 25 foot station, 33 at the 60 foot station, and none from the shore.

Sizes ranged from 10-107 mm SL. Of 13 specimens aged (September collection) one 42 mm SL was 0; six averaging 83.5 mm SL were 1; five averaging 88.4 mm SL were 2; and one 95 mm SL was 3 years old.

Four females, (77, 77, 77, 95 mm TL) taken in May contained nearly ripe eggs, while in September one female 107 mm SL contained eggs which were free in the ovaries. Two other females in September, 97 and 86 mm SL, were spent, suggesting a late summer-fall spawning for this species.

Stomach analyses revealed that coralline sculpins ingested fishes up to half their own size. Stomach contents of four females (77, 77, 77, and 95 mm TL) taken in May included a juvenile cabezon 37 mm SL and 3 small juvenile rockfish (about 40 mm) (one fish per stomach). Additionally, two specimens, 104 and 97 mm SL from the fall collection had each ingested a small juvenile rockfish. Juvenile rockfishes were the most commonly encountered food item, but shrimps were also found.

Artedius creaseri (Hubbs) - Roughcheek sculpin

This sculpin ranges from Point San Pablo, Baja California, to Pescadero Point, Monterey County, and offshore as far as Guadalupe Island, intertidally into 90 feet of water.

In Diablo Cove, 14 roughcheek sculpins were taken: 10 in September, nine at the deep station and one at 20 feet. In May and January, one and three respectively were taken at the 20 foot station. In North Cove, only nine were taken, all at the 25 foot station.

These 23 fish ranged from 14 to 55 mm SL. Three inches (76 mm) is the maximum record length. Two specimens 51 and 47 mm SL were aged at 1 year, and one, 55 mm SL specimen was 2. Otoliths were difficult to read.

Artedius fenestralis Jordan and Gilbert - Padded sculpin

Only five padded sculpins were collected at Diablo Cove, all during January at the 20 foot station. These represent a southern range extension for the species. The northern range is Unalaska Island, Alaska. Depths from intertidal to 180 feet have been reported for this sculpin. None was taken in the North Cove collection.

Artedius harringtoni (Starks) - Scalyhead sculpin

The scalyhead sculpin ranges from San Miguel Island to Kodiak Island, Alaska. The largest reported is 4 inches (102 mm) in length.

Of the 77 specimens from the three collections at Diablo Cove, 65 were taken in September at 70 feet, a depth range extension for the species. The other 12 were taken at the 20 and 70 foot stations during May and January. In North Cove, all 16 were from the 20 foot station.

These 93 fish ranged from 20-69 mm SL. Four specimens, 45-53 mm SL, were aged at 1 year, and five from 58 to 67 mm SL were 2. Four specimens 47-58 mm SL taken in May had ingested crustaceans (unidentified parts). The largest of these, a female, contained nearly ripe eggs.

Artedius lateralis (Girard) - Smoothhead sculpin

The smoothhead sculpin ranges from Sulfur Point, San Quintin, Baja California, to Bering Island, Commander Islands, USSR.

Of 81 specimens taken in Diablo Cove, 50 were from the shore station (36 in September), and the rest from the 20 foot station (23 in September).

Individuals ranged from 26-91 mm SL. Three fish averaging 57.3 mm SL were aged at 1 year; two averaging 76.5 mm SL were 2; and two averaging 84.5 mm SL were 3.

In North Cove in July, 43 were taken: 23 at the shore station and 20 at 25 feet which equals the previously reported maximum depth. These specimens ranged from 32 to 129 mm TL. One smoothhead sculpin 86 mm SL contained a juvenile cottid about 25 mm TL, while several others had ingested pistol shrimp.

In the May collection, females contained nearly ripe eggs.

Artedius notospilotus Girard - Bonehead sculpin

This sculpin ranges from Point San Telmo, Baja California, to Puget Sound, Washington, occurring in the intertidal and to depths of 150 feet.

Ten bonehead sculpins were taken at Diablo Cove: three at 20 feet in September (30-39 mm SL), and seven at 70 feet in January. Two were collected in North Cove (99 and 104 mm SL), both at the 60 foot station. This fish attains a length to 10 inches (254 mm).

Clinocottus analis (Girard) - Wooly sculpin

The wooly sculpin ranges from Ascuncion Point, Baja California, to 2 miles south of Cape Mendocino, and is found offshore at Guadalupe Island. Lengths to 7 inches (178 mm) have been reported but 5 inch fish are rare.

This sculpin was found only at the shore stations. In Diablo Cove 16 of the 28 specimens were taken in September, seven in January, and five in May. In North Cove, the shore station yielded 16 in July. The wooly sculpin has been reported to depths to 60 feet.

These 44 fish ranged from 38-136.5 mm SL. Of five specimens aged, two averaging 91.5 mm SL were 2 years old, and three averaging 109.6 mm SL were 3. Stomachs of the five specimens from the Diablo Cove May collection contained crustaceans.

Only three of the 16 wooly sculpins from North Cove were females.

Clinocottus globiceps (Girard) - Mosshead sculpin

The mosshead sculpin occurs in the intertidal and shallow rocky areas ranging from Gaviota to Chagafka Cove, Kodiak Island, Alaska.

Mosshead sculpin were taken only at the shore stations. Three (49, 75 and 84 mm SL) were collected in September at Diablo Cove and two (106 and 131 mm SL) in July at North Cove. The record length is 7.5 inches (190 mm).

Clinocottus recalvus (Greeley) - Bald sculpin

This cottid ranges from Point Rompiente, Baja California, to Mill Beach near Brookings, Oregon. Found only in the intertidal zone, it attains a length to 5.12 inches (130 mm).

Bald sculpins were taken only at the shore stations. The 10 from Diablo Cove (47-94 mm SL) were all collected in September. Three of these averaging 65.8 mm SL were 1 year old, and 2 averaging 89.25 mm SL were 2. In North Cove, all nine specimens (23-81 mm SL) were taken in July.

Enophrys taurina (Gilbert) - Bull sculpin

An uncommon fish, this sculpin ranges from San Nicolas Island - Santa Catalina Island to off San Francisco. A length of 6.5 inches (165 mm) has been reported for the species and thus far it has been taken in depths from 36 to 840 feet.

The bull sculpin was found only at the 70 foot station in Diablo Cove during September. The four specimens ranged from 23-32 mm SL.

Hemilipidotus hemilipidotus (Tilesius) - Red Irish Lord

Two specimens (25 and 31 mm SL) were taken, both at Diablo Cove at the 70 foot station in May. These two juvenile red Irish lords represent a southern range extension for the species, previously reported at the south end of Monterey Bay. Its northern range is the Sea of Okhotsk. Lengths to 20 inches (508 mm) have been reported for this species but specimens over 12 inches (305 mm) are rare.

Hemilepidotus spinosus (Ayres) - Brown Irish lord

The brown Irish lord ranges from Santa Barbara Island and Ventura on the mainland, to Puffin Bay, Alaska.

Eight were taken in Diablo Cove during the three seasonal collections: two in September at 20 feet, and three each in September and January at 70 feet. In the North Cove July collection, 42 were taken at the 25 foot station and 19 at the 60 foot station. Fifty-one of these 61 were juveniles ranging from 32-53 mm SL. From both localities, sizes ranged between 35 and 209.5 mm SL. A 10 inch (254 mm) specimen is the record length. Ages ranged from 1 to 7 years (Table 44).

Jordania zonope (Starks) - Longfin sculpin

The longfin sculpin collected at Diablo Cove represent a southern range extension for this species. The northern range is Ucluelet, Barkley Sound, Vancouver Island, British Columbia. It has been recorded in depths from the intertidal to 126 feet attaining a maximum length of 5.12 inches (130 mm).

The longfin sculpin exhibited a preference for deeper water in Diablo Cove with 55 of the 60 specimens taken at 70 feet and the remainder at 20 feet. In North Cove, nine and eight individuals were taken at 25 and 60 feet respectively.

Sizes ranged from 30-117 mm SL representing ages from 0 to 5 (Table 45). Ages were determined for 19 of the 21 fish collected in Diablo Cove in January, and 12 of these ranging in length from 75 to 97 mm SL were 2 years old.

Nudibranchs were the only food items found in the 12 stomachs examined.

Nautichthys oculofasciatus (Girard) - Sailfin sculpin

The sailfin sculpin ranges from San Miguel Island to eastern Kamchatka, and attains a length of 6.8 inches (173 mm). It inhabits depths from the intertidal to 360 feet.

TABLE 44. Age-Length-Weight Data for a Select Sample of Brown Irish Lords, *Hemilepidotus spinosus*, Collected at Diablo and North Cove 1971.

Age Group	Number Sampled	Length Range (SL mm)	Length Mean (SL mm)	Weight Range (g)	Weight Mean (g)
1	4	115-129	122.0	35.0-53	44.6
2	1	145	145.0	84	84.0
4	5	164-179.5	167.5	89.5-153	133.9
5	2	153-184	168.5	101.0-180	140.5
6	1	163	163.0	154	154.0
7	2	197-209.5	203.3	237.0-256	246.5

TABLE 45. **Age-Length-Weight Data for 38 Longfin Sculpins, *Jordania zonope*, Collected at Diablo and North Cove 1970-71.**

Age Group	Number Sampled	Length Range (SL mm)	Length Mean (SL mm)	Number Weighed	Weight Range (g)	Weight Mean (g)
0	3	30-65	49.7	2	2.0-3	3.0
1	12	75-97	81.3	12	5.0-16	7.8
2	14	83-101	89.9	2	16.0-17	16.5
3	7	94-108	100.9	4	13.5-21	16.7
4	1	112	112.0	1	18.5	18.5
5	1	117	117.0	1	25.0	25.0

Nineteen were taken in Diablo Cove: 15 at 70 feet and four at 20 feet. In North Cove, nine were collected: five at 60 feet, and four at the 25 foot station.

These 25 fish ranged from 32 to 142 mm SL and were 0 to 2 years old (Table 46).

One female (138 mm SL) taken in September in Diablo Cove contained maturing eggs, and two females (119 and 142 mm SL) during the same period contained ripe eggs.

Stomach contents consisted of crab parts and small digested fishes; one juvenile rockfish was also noted.

One sailfin sculpin was removed from the stomach of a cabezon.

Oligocottus rimensis (Greeley) - Saddleback sculpin

The saddleback sculpin was found only in Diablo Cove. Two specimens (27 and 31 mm SL) were taken in September at the shore station. This species' range is from Dutch Harbor, San Nicolas Island, to British Columbia. A maximum length of 2.56 inches (65 mm) has been reported for this species.

Oligocottus rubellio (Greeley) - Rosy sculpin

This sculpin ranges from San Martin Island, Baja California, to Fort Bragg, and attains a length of 3.12 inches (79 mm).

Within Diablo Cove, 25 rosy sculpins were taken: 16 at the shore station, and nine at the 20 foot station. Fall and winter collections yielded approximately equal numbers, but none was taken in the summer.

These 25 fish ranged from 27 to 59 mm SL. It was very difficult to determine ages for rosy sculpins. One specimen (34 mm SL) weighing 1.4 g was aged as 0, three (55-59 mm SL) averaging 5.1 g were 1, and one (52 mm SL)

TABLE 46. Age-Length-Weight for 18 Sailfin Sculpins, *Nautichthys oculofasciatus*, collected at Diablo and North Cove 1970-71.

Age Group	Number Sampled	Length Range (SL mm)	Length Mean (SL mm)	Number Weighed	Weight Range (g)	Weight Mean (g)
0	3	32-55	40.2	3	1.6-4	2.5
1	12	81-129	108.7	8	30.5-53	38.9
2	3	126-142	135.3	3	55.0-72	65.7

weighing 4g was 2 years old.

In North Cove 10 (18.5-64 mm SL) were taken, all at the shore station. One at 18.5 mm SL weighed 0.25 g.

Oligocottus snyderi (Greeley) - Fluffy sculpin

The fluffy sculpin ranges from 2 miles south of Rio Socorro, Baja California, to Samsing Cove, Sitka, Alaska, and attains a length of 3.25 inches (83 mm).

Twenty-eight of the 32 collected in Diablo Cove were from the shore station. The other four were taken at 20 feet. None was collected in the summer, but 23 were taken in the winter, and the rest in the fall. These 32 fish ranged from 25-70 mm SL.

In North Cove eight were taken at the shore station and these ranged from 48.5 to 59 mm SL.

Orthonopias triacis Starks and Mann - Snubnose sculpin

The snubnose sculpin ranges from San Geronimo Island, Baja California to Monterey. Recorded from the intertidal to 100 feet, this species attains a length of 4 inches (102 mm).

This sculpin was the second most abundant sculpin and ranked 8th for all fishes collected at Diablo Cove and 9th in the North Cove collection.

Of the 132 individuals from Diablo Cove, 82 were taken at 70 feet, 38 at 20 feet, and 12 at the shore station. They were most common in the fall and winter at Diablo Cove, but in the North Cove July collection 141 specimens were taken: 100 at 25 feet, and 41 at 70 feet.

These 273 snubnose sculpins ranged from 23.5-76 mm SL. For those specimens aged, ages ranged from 0 to 2 years (Table 47).

Stomachs of the North Cove specimens yielded primarily polychaetes and a few crustaceans.

TABLE 47. Age-Length-Weight Data for a Selected Sample of Snubnose Sculpins, *Orthonopias triacis*, Collected at Diablo and North Cove 1970-71.

Age Group	Number Sampled	Length Range (SL mm)	Length Mean (SL mm)	Number Weighed	Weight Range (g)	Weight Mean (g)
0	1	45	45.9	1	2	2.0
1	24	35-72	52.8	12	3-9	5.9
2	11	61-76	69.9	8	5-10	8.1

Radulinus vinculus Bolin - Smoothgum sculpin

In earlier reports this fish was recorded as *Asemichthys vinculus.*

This sculpin was found only at Diablo Cove and only at the 70 foot station. One taken in May, a ripe female at 43.5 mm SL, was 2 years old. Two taken in September at 26.2 and 20 mm SL were hesitantly aged at 2 and 1 respectively. These specimens represent a new northern range for this species. The southern range is between Santa Cruz and Anacapa Islands. The depth range is 70-90 feet.

This species was not recorded from California until 1950 and is still quite rare in collections. Apparently it never exceeds 2 1/2 inches (64 mm).

Scorpaenichthys marmoratus (Ayres) - Cabezon

The cabezon ranges from Point Abreojos, Baja California to Sitka, Alaska. The largest recorded is 39 inches, while the heaviest authentic record, a 28 incher, is 15 pounds. Found in the intertidal (it is suspected they feed on mollusks and crustaceans with the tidal fluctuations) its maximum reported depth is 250 feet.

In Diablo Cove during three seasonal collections, 104 cabezon were taken. The May (summer) collection yielded 26 specimens including a large number of juveniles. At the 20 foot station in May, 14 of the 15 specimens were 37 to 42 mm SL. The two individuals from the 70 foot station also were juveniles, 41-43 mm SL. However, at the shore station (0-10 feet) eight of the nine specimens were 280-455 mm SL (average 349 mm) and all were females.

During September, juveniles were again found at the 20 foot station. The six cabezon collected ranged from 72-87 mm SL, indicating an approximate growth of 40 mm in 4 months. There were also a few juveniles in the shore and deep collections where the 26 and eight cabezon collected ranged from 73 to 410 and 61 to 335 mm SL, respectively.

In North Cove, 91 of the 106 specimens collected in July at the 20 foot station were juveniles (age 0) ranging from 43 to 92 mm SL. The other 15 fish were 134 to 380 mm SL.

At the North Cove shore station, the 19 specimens taken ranged from 50-402 mm SL. Three specimens examined averaging 397 mm SL were spent females.

The single cabezon taken at 60 feet in North Cove was a female 291 mm SL.

The 230 cabezon from the two localities ranged from 37-502 mm SL, and were 0 to 6 years old (Table 48).

The cabezon's food habits varied considerably (Table 49). Fish constituted 47% (numerically) of the stomach contents of the 29 examined, and 36% of these were juvenile rockfish. Crustaceans accounted for 38% while mollusks accounted for 14% (Table 48). *Octopus* spp. occurred in the most stomachs (11) but contributed only 10.3% of the total items (146) noted. All five cabezon from the deep stations at Diablo Cove and North Cove had eaten octopi. Of the two abalones eaten, one was a black and the other unidentifiable. The presence of a black abalone indicates very nearshore feeding.

In most instances stomachs were full. One cabezon (390 mm SL) had ingested a 350 mm TL *Xiphister mucosus*, a 100 mm TL striped perch and four kelp crabs. Another cabezon (427 mm SL) contained one crab (*Pugettia* sp.), one digested fish - 2 inches, and 26 juvenile rockfish. A third cabezon (270 mm SL) had swallowed a 110 mm SL kelp greenling along with three kelp crabs, and a 2 inch unidentified fish.

TABLE 48. Age-Length-Weight Data for a Selected Sample of Cabezon, *Scorpaenichthys marmoratus*, Collected at Diablo and North Cove 1970-71.

Age Group	Number Sampled	Length Range (SL mm)	Length Mean (SL mm)	Number Weighed	Weight Range (g)	Weight Mean (g)
0	5	45-116	79.2	5	5-45	19.2
1	7	122-162	143.7	7	[illegible]	[illegible]
2	5	225-346	295.4	5	321-990	659.4
3	7	282-335	300.4	7	790-1460	954.9
4	1	370	370.0	1	1605	1605.0
*5-6	3	363-410	387.7	3	2470.3	2470.3

TABLE 49. Stomach Contents of 29 Cabezon Collected at Diablo Cove and North Diablo Cove 1970-71.

Food Item	No. Stomachs Occurred In	No. Items Present	% of Total
Fish*			
Sebastes spp. juvenile	6	53	36.3
Fish (unidentified)	5	5	3.4
Oxyjulis californica	2	2	1.4
Oxylebius pictus	1	1	1.4
Hexagrammos decagrammus	2	2	1.4
Xiphister mucosus	1	1	0.6
Embiotoca lateralis	1	1	0.6
Xererpes sp.	1	1	0.6
Sebastes chrysomelas	1	1	0.6
Gibbonsia sp.	1	1	0.6
Otophidium taylori	1	1	0.6
Crustaceans			
Pugettia producta	6	22	15.1
Crabs (unidentified)	8	14	9.6
Pugettia sp.	4	7	4.3
Cancer productus	2	5	3.4
Cancer spp.	5	5	3.4
Crustacean parts	3	not counted	-
Pagurus sp.	1	1	0.6
Spirontocaris sp.	1	1	0.6

During subtidal surveys, cabezon were most abundant during the winter which correlates with the fish collections. In 1970, 17 were counted at 11 transects as compared to 21 counted at 15 stations in 1971. Most often the cabezon were found in shallow (less than 40 feet) protected areas associated with dense algal cover and deep rocky crevices. Stations 6 and 8 in North Cove accounted for 47% of those counted. Cabezon were also observed in exposed areas. South of Diablo Cove (Stations 13, 14 and 15) individuals were observed in surge on the reef crests. This fish's tolerance for turbulent water is further supported by the numbers of cabezon taken by shore fishermen in shallow water where the surf is heaviest.

Within Diablo Cove cabezon were commonly observed on reconnaissance dives. On two occasions in the summer of 1971, cabezon were observed tending eggs which had been laid on *Iridaea splendens*.

Synchirus gilli Bean - Manacled sculpin

This sculpin was found only at the 25 foot station in North Cove during the July collection. The five individuals ranged from 24 to 52.5 mm SL; the largest was a ripe female. These sculpins apparently live only on *Macrocystis* and probably in the canopy. During bull kelp studies in 1967-68 at Point Estero, this species was occasionally observed on the stipes and fronds (E. Ebert, CDF&G Pers. Commun.). The manacled sculpin was not reported from California until 1950 and was deemed rare until its habits and habitat were understood.

Cottids - Unidentified

During subtidal surveys, it was very difficult to identify by sight the small cottids scurrying across the bottom. These have been listed in

During subtidal surveys, cabezon were most abundant during the winter which correlates with the fish collections. In 1970, 17 were counted at 11 transects as compared to 21 counted at 15 stations in 1971. Most often the cabezon were found in shallow (less than 40 feet) protected areas associated with dense algal cover and deep rocky crevices. Stations 6 and 8 in North Cove accounted for 47% of those counted. Cabezon were also observed in exposed areas. South of Diablo Cove (Stations 13, 14 and 15) individuals were observed in surge on the reef crests. This fish's tolerance for turbulent water is further supported by the numbers of cabezon taken by shore fishermen in shallow water where the surf is heaviest.

Within Diablo Cove cabezon were commonly observed on reconnaissance dives. On two occasions in the summer of 1971, cabezon were observed tending eggs which had been laid on *Iridaea splendens*.

Synchirus gilli Bean - Manacled sculpin

This sculpin was found only at the 25 foot station in North Cove during the July collection. The five individuals ranged from 24 to 52.5 mm SL; the largest was a ripe female. These sculpins apparently live only on *Macrocystis* and probably in the canopy. During bull kelp studies in 1967-68 at Point Estero, this species was occasionally observed on the stipes and fronds (E. Ebert, CDF&G Pers. Commun.). The manacled sculpin was not reported from California until 1950 and was deemed rare until its habits and habitat were understood.

Cottids - Unidentified

During subtidal surveys, it was very difficult to identify by sight the small cottids scurrying across the bottom. These have been listed in

APPENDIX III - Contd.

SCIENTIFIC NAME	STATION TRANSECTS									
	1A	1B	2A	2B	3A	3B	4A	4B	4C	5A
RHODOPHYTA - Contd.										
Halosaccion glandiforme	S-2,S-3	S-2	S-1,S-2	S-1,S-2	C-1,S-2	S-1				
Iridaea flaccida	S-1,A-2, C-3	S-1,A-2	A-1,A-2	A-1,A-2, C-3	A-1,A-2	C-1,A-2, C-3	A-2	A-2	A-2,S-3	C-2,S-3
Iridaea heterocarpum	S-1,S-2	S-2	S-2	S-1,S-2	S-1,C-2	S-2	S-2			
Iridaea splendens	S-1,S-2	A-1	S-1,S-2	S-1,S-2	C-2	C-1,S-2	C-1,S-2	C-1,C-2	C-1,C-2	S-1,S-2
Laurencia spectabilis	S-1,S-2	S-1				S-1	P-2			
Microcladia borealis	S-2	S-1,S-2					C-1,C-2	S-1,S-2	C-1,S-2	C-1
Microcladia coulteri	S-1		C-1	C-1,S-2	P-1,C-2	C-1,C-2	S-1	S-2		S-1
Petrocelis franciscana	C-2,A-3	S-2	C-1,A-2, A-3	S-1,A-2, A-3	A-1,A-2, A-3	S-1,C-2, C-3	C-2	C-2	A-2,S-3	C-2,A-3
Plocamium coccineum	S-2		S-1	S-1		S-1,S-2	C-1,S-2			S-2
Polysiphonia spp.	S-1,S-2	S-2		S-1						S-2,S-3
Porphyra perforata	S-2,C-3	C-2	S-1,A-2, S-3	S-2,S-3	S-1,C-2, S-3	S-3	S-2	S-2	S-2,C-3	S-3
Prionitis spp.	S-1,S-2		S-1	C-1,S-2	P-1,S-2	C-1,C-2	S-1,S-2	S-1,C-2	S-1,S-2	C-1,S-2
Pterosiphonia baileyi	S-2									
Smithora naiadum						C-1				

Island, Alaska, commonly occurring on sand substrates. The largest recorded is 6.7 inches (170 mm) in length. This species' depth range is 10 to 1,200 feet.

Ninety-three speckled sanddabs were collected at Diablo Cove: one at the 20 foot station, and 92 at the deep station. None was collected in the winter. The 92 specimens from 70 feet (30-68 mm SL) were found on the sand that surrounded this pinnacled station. In North Cove, speckled sanddabs also were collected on sand but in much larger quantities. At the 25 and 60 foot stations, 548 and 406 specimens were taken respectively. These 954 sanddabs represent the largest number of any one species collected during the study. They ranged from 31-108 mm SL. Of the 406 taken at 60 feet, eight ranging from 84-102.5 mm SL (average 90.0 mm) and weighing 10.5-22 g (average 13.1 g) were age 1. The remaining 398 individuals were young of the year (age 0).

During routine subtidal surveys, nine speckled sanddabs were counted on one transect in the winter of 1971 (Table 20). This count was made at Station 7 where the 548 specimens were collected with the ichthyocide. The physiography of this station was such that only about 9 square feet of sand fell within the 30 x 2 m transect, and only once did the speckled sanddab occupy this area during a seasonal survey of that station. Speckled sanddabs often were observed off transects in protected sandy areas and were deemed common to abundant. They ranked 17th numerically out of 23 fishes observed.

Pleuronectidae

Pleuronichthys coenosus Girard - C-O Turbot

This turbot ranges from Cape Colnett, Baja California, to S.E. Alaska.

APPENDIX III - Contd.

SCIENTIFIC NAME	STATION TRANSECTS									
	1A	1B	2A	2B	3A	3B	4A	4B	4C	5A
PHAEOPHYTA - Contd.										
Fucus distichus				S-3	S-3	S-3				
Hesperophycus harveyanus				S-3		S-3				
Heterochordaria abietina	S-3	C-2							S-3	
Laminaria setchellii	S-2	S-1				S-1	S-1,S-2	A-1,C-2		C-1
Nereocystis luetkeana				(1)				S-1		(60)
Pelvetia fastigiata		S-2	S-3	S-2,A-3	S-2,S-3	C-3			S-2	
Pelvetiopsis limitata		S-2								
RHODOPHYTA										
Agardhiella tenera			C-1	C-1,S-2					S-2	
*Articulated corallines	C-1,C-2, S-3	C-1,C-2	A-1,A-2	A-1,C-2, C-3	P-1,S-2	C-1	A-1	A-1,C-2	C-1,S-2, S-3	A-1, A-2, C-3
Botryoglossum farlowianum			C-1			S-1	C-2	C-1,S-2	P-1	C-1
Callithamnion pikeanum	S-2	S-2	C-1,C-2	S-1,S-2, S-3	S-2		S-2	S-2	S-2	S-1,C-2, C-3

The station locations, time, and depths are reproduced in Table 50.

In all, 29 species of fish were taken. Their numbers by station including ranges in standard lengths are reproduced in Table 51. Of the 29 species taken by the R. V. Searcher, we collected seven with ichthyocides nearshore. Of special interest are the numbers of octopi taken with the trawl, as they were rarely observed during all diving surveys in the Diablo study area. However, octopus parts, primarily beaks, were commonly found in predatory fish stomachs (e.g. lingcod, cabezon and rockfishes). Due to the cryptic behavior of inshore octopi, we did not expect to observe this invertebrate in any great numbers. However, considerable numbers of octopi probably would be found in the Diablo area if proper collecting techniques were used.

These data are not intended to represent either the species composition or numbers found off the Diablo Canyon area; rather only to give some additional data on the fishes.

MARINE MAMMALS

Casual observations were made of pinnipeds during this investigation. An occasional curious California sea lion, *Zalophus californianus*, "visited" us during scuba surveys. Most sea lions, however, were seen on or about nearshore rocks and reefs.

California sea lions were continuously observed on Diablo Rock and Lion Rock. Approximately 15 animals were usually prominent on the south, leeward side of Diablo Rock. A few to several hundred were visible on Lion Rock depending on season, time of day, and tidal period.

Harbor seals, *Phoca vitulina*, were observed utilizing a large nearshore rocky shelf in South Cove as a haul out area. About 50 animals

APPENDIX II - Contd.

SCIENTIFIC NAME	STATION TRANSECTS									
	1A**	1B**	2A	2B	3A	3B	4A	4B	4C	5A
<u>SPERMATOPHYTA</u>										
**Phyllospadix scouleri*			A-1,S-2	C-1,C-2	C-1,S-2	C-1				
<u>COELENTERATA</u>										
Anthopleura elegantissima		C	S-3	C-2	C-2	C-3	S-2		S-2,A-3	
Anthopleura xanthogrammica	C		S-1,S-2	C-1		S-1	S-1,C-2		S-1,S-2	
<u>MOLLUSCA</u>										
Astraea gibberosa			S-1,S-2		S-1	S-1		Not Surveyed		Not Surveyed
Calliostoma ligatum							S-2		S-2	
Haliotis cracherodii	(223)	(292)	(274)	(95)	(25)	(40)	(56)		(40)	
Haliotis rufescens			(3)							
Octopus sp.							(1)			
Tegula brunnea		S		S-1	S-1	S-1	S-1,S-2		S-1,S-2	
Tegula funebralis	S	C	C-1,A-2, A-3	C-2,A-3	S-1,C-2, A-3	S-1,C-3				
<u>ECHINODERMATA</u>										
Pisaster ochraceous	S	S	(3)				(10)		(4)	
Strongylocentrotus Purpuratus		C							S-2	

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* See Appendix I

** Zones were not established for these two transects during this period.

TABLE 50 - Contd.

	No. of Specimens & Ranges in Standard Length by Station										
	1	2	3	4	5	6	8	11	12	13	14
Lycodopsis pacifica										14 (168-234)	3 (147-234)
Lyopsetta exilis			1 (108)					1 (162)		27 (108-165)	
Microstomus pacificus	3 (76-101)	16 (98-151)							1 (148)	10 (70-192)	3 (166-187)
Ophiodon elongatus		1 (213)						1 (229)		1 (202)	
Otophidium taylori		2 (79-99)				1 (nm)					
Parophrys vetulus		12 (127-178)									
Pleuronichthys decurrens	4 (102-116)	6 (42-186)									
Porichthys notatus	5 (54-191)	14 (94-198)		2 (nm)				18 (56-231)		15 (63-185)	2 (231-248)
Rhamphocottus richardsoni							1 (nm)				
Sebastes crameri											12 (75-95)

APPENDIX II - Contd.

SCIENTIFIC NAME	STATION TRANSECTS									
	1A**	1B**	2A	2B	3A	3B	4A	4B	4C	5A
<u>RHODOPHYTA</u>										
Agardhiella tenera			S-1	S-1,S-2		S-1				
*Articulated corallines	A	A	C-1,C-2, S-3	C-1,S-2	C-1,S-2	C-1	A-1,A-2		A-1,A-2, S-3	
Botryoglossum farlowianum			S-1	S-1			S-1			
Callithamnion pikeanum	S	S	S-1,S-2	P-1,C-2						
*Crustose corallines	C	C	A-1,A-2, S-3	C-1,C-2, S-3	C-1,S-2	A-1,C-3	A-1,A-2	Not Surveyed	A-1,A-2, A-3	Not Surveyed
**Cryptopleura* (group)	C	S	S-2	P-1,S-2			A-1,C-2		C-1,S-2	
Endocladia muricata	S	A	S-2,A-3	C-2,A-3	S-2,C-3	C-3	C-2		C-2,C-3	
Erythrophyllum delesserioides							P-1,P-2			
Gastroclonium coulteri	S		C-1,S-2	S-1,A-2	C-1	A-1	C-2		C-1,C-2	
Gelidium coulteri		P			P-2					
Gigartina canaliculata	S	C	S-1,S-2,	P-1,C-2, S-3	C-1	C-1	C-2		A-2	
**Gigartina corymbifera* (group)	S	S	C-1	C-1,S-2	S-1	S-1	C-1,S-2		C-1,S-2	
**Gigartina cristata* (group)	S	C	S-1,C-2, A-3	C-2,A-3	A-1,C-2 C-3	S-1	C-1,S-2		C-2	

TABLE 51. Station Information for 14 Trawls Conducted by the R. V. SEARCHER on January 18 and 19, 1970, off Diablo Canyon.

Station	Date (Jan.)	Fishing Time	Depth	
1	18	0730-0750	31-32	35° 12.2' N. 120° 53.2' W to 35° 12.7' N. 120° 54.3' W
2	18	0800-0830	30	35° 10.7' N. 120° 54.3' W
3	18	0845-0915	50	1 m. SW of Point Buchon buoy
4	18	0925-0955	50	2 mi. SW of Diablo Cove
5	18	1015-1045	70	35° 09.6" N 120° 54.2"W to
6	18	1110-1140	70	4 miles 020° T from Point Buchon
7	18	1150-1220	70	2 miles 310° T from Lion Rock
8	18	1245-1305	47	2 mi. 310°T from Lion Rock to 2.2 mi. 262° T from Lion Rock
9	18	1325-1345	32	1.3 mi. 051°T from Lion Rock
10	19	0830-0850	31-47	2 mi. 165°T from Diablo Creek
11	19	0900-0930	47	2.5 mi. 147°T from Diablo Creek
12	19			
13	19	1010-1040	60	35° 05.7'N 120° 50.6'W to
14	19	1150-1210	73	35° 03' N 120° 51.7' W to

APPENDIX I - Contd.

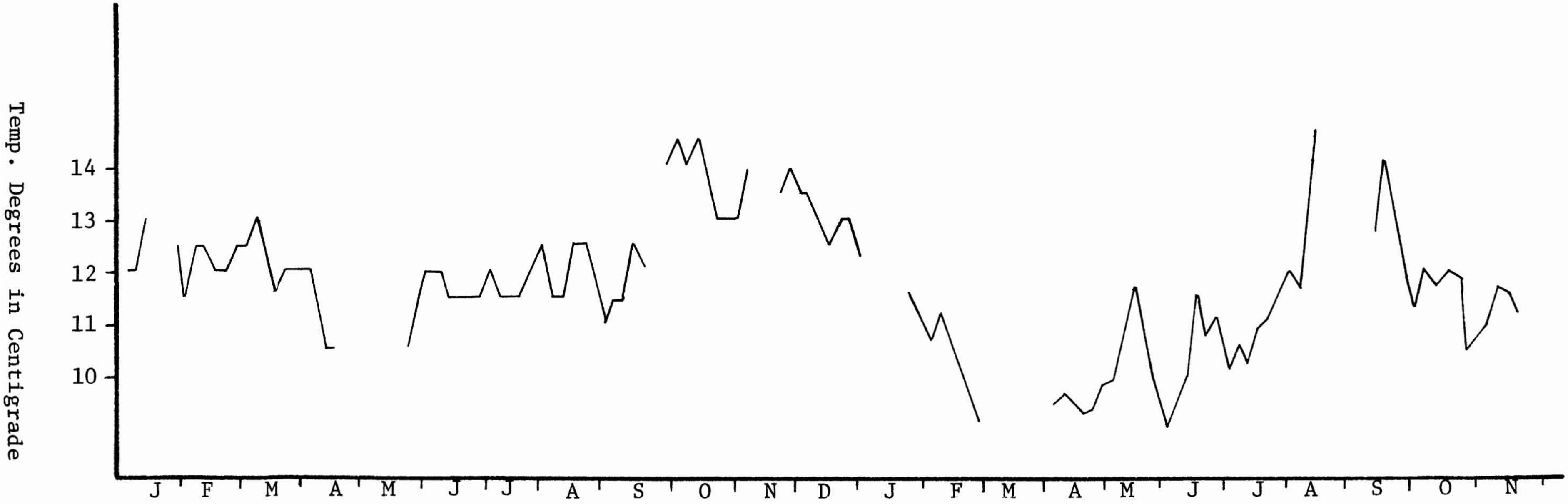
Gigartina cristata (group) - includes many of the smaller members of the genus Gigartina that could not easily be separately quantified in the field. *Gigartina cristata*, *G. papillata*, and *G. agardii* were included in this grouping.

Cryptopleura (group) - many members of the Ceramiales including *Botryoglossum*, *Hymenena*, and *Cryptopleura* were difficult or impossible to identify either in the field or the laboratory due to their small size and/or lack of reproductive structures. Those that could not be identified in the field or laboratory were included in this grouping.

Petrocelis franciscana - the non calcareous crustose algae were not separated in the field and all were recorded as *Petrocelis franciscana*. Although *Petrocelis* was the dominant form, *Ralfsia pacifica* appeared in the high zone and others may have been present.

Phyllospadix scouleri - both *P. scouleri* and *P. torreyi* occur at Diablo. *P. scouleri* appeared to be the dominant species inside Diablo Cove. Because the flower was rarely available to positively identify the plant, and nearly all blades that we examined were the wider form, we recorded all *Phyllospadix* plants encountered during seasonal surveys as *P. scouleri*.

Figure 18. Surface water temperatures recorded in Diablo Cove 1970-1971.



APPENDIX I

KEY TO SYMBOLS USED THROUGHOUT THE REPORT

ABUNDANCE SYMBOLS

A = Abundant - numerous and evenly distributed throughout the area.

C = Common - unevenly present throughout the area and only occasionally numerous.

S = Sparse - widely scattered throughout the area and nowhere numerous.

P = Present - present but not estimated or counted.

(N) = Number - actual count (in parenthesis in intertidal appendices to differentiate from zonation symbols.)

ZONATION SYMBOLS

Numbers (1, 2, or 3) following an abundance symbol for intertidal transects, indicate the relative tidal position that the plant or animal occupied in the intertidal:

*1 = low tide zone - from the mean lower low water (0.0) to the lowest of low tides of about -2.0.

2 - mid tide zone - from the mean lower low (0.0) to about +2.5 above.

3 - high tide zone - from the highest limit of the mid tide zone (+2.5) to standard mean high water, about +5.0.

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* The same vertical zonation as presented by Ricketts and Calvin (1962). The "uppermost beach" zone was not monitored during these surveys as neither abalones, their food items nor their associates are found here. Zones were renumbered to fit this study.

(1972) were located nearer the shoreline; one in Diablo Cove next to our Station 16 and the other just below South Cove.

EFFECTS OF CONSTRUCTION

Discharge Structure

The discharge structure, located just south of Diablo Creek in Diablo Cove, required a cofferdam to hold out ocean water during construction. Work began on the cofferdam in July, 1970. Occupying approximately 3 acres, the haul road and cofferdam were almost entirely within the intertidal (Figure 19). Prior to construction, 2,511 black abalones and 142 reds were removed from the immediate area.

The cofferdam was constructed of washed gravel and rock from the Santa Maria Kaiser Quarry. Silts and other fines did not appear to wash into Diablo Cove during construction. Water clarity inside the cove during construction did not appear appreciably different from that recorded outside the Cove. Silt deposits were never observed in the vicinity of the cofferdam after its completion.

Intake Structure

A cofferdam in South Cove was constructed from the intertidal to 30 foot depths. The structure included an EW leg built as a haul road and a series of circular cells forming the front of the dam and connected to land near the west breakwater. The structure encompassed approximately 4.5 acres. The intertidal here was often abrupt, and most construction was in the subtidal.

The access road and haul leg from shore to the cells utilized fill of nonwashed materials including waste rock from the Kaiser quarry, and

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sand and dirt from a borrow pit at the plant site. Cells were built circular with connecting sheet pilings that were driven vertically into the substrate. The cell bottoms were sealed with remmy concrete when necessary to prevent leakage. They were then filled with sand.

Leaks developed along the haul leg as pumping started and mud washed into the reservoir. Additional fill was dumped into these areas in an attempt to stop the leakage. This action added to the flow of mud into the reservoir. Sheet pilings were then driven along the haul leg to contain the flow.

The extent of benthic damage inside the cofferdam was realized after pumping operations lowered the reservoir level. When the drawdown reached approximately -15 feet mllw, many abalones were exposed and it was evident that mud covered a good portion of the bottom (later estimated at 1/3 - 1/2 the reservoir bottom). At this level an additional 324 black and 131 red abalones were removed from exposed rocky areas. Silt from the mud slide had clogged their gills and most were in poor condition. The abalones were transported to the CDF&G Morro Bay Laboratory where their mantle and gill cavities were washed with running salt water. Most of these survived; an estimated 20% died in the ensuing week. Leaks prevented further drawdown at this time.

Pumping later reduced the reservoir level to -27 feet mllw. At this point it appeared that an abalone and fin fish mortality had occurred. The site was thoroughly inspected by CDF&G personnel on December 19, 1971, in an attempt to assess the loss.

Two-hundred-eighty dead red abalones were counted, 47 about the mud slide and 233 in rocky areas. These counts included only those that were exposed: primarily abalones that were unavailable or missed during earlier

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As depth increased, the sedimentation increased and the biota diminished. On the bottom in 20 to 30 foot depths, a 1/2 to 2 inch layer of fine sediment covered most flat or sloping rock while a 3 to 4 inch or more layer was accumulated in crevices and depressions. In some areas, as immediately in front of the discharge, we measured sediment depths to 16 inches.

At these 20 to 30 foot depths, approximately 20 biotic constituents were recorded as follows:

Calliarthron cheilosporioides, sparse

Pterygophora californica, a few dense patches, all plants deteriorating

Balanophyllia elegans, a few on rocks not covered by silt

Tealia lofotensis, sparse

Tealia sp., sparse

Pateria miniata, an invertebrate that appears to have withstood siltation. Generally sparse but in places clumped and in fair numbers

Pycnopodia helianthoides, one observed

Strongylocentrotus franciscanus, dead urchin tests abundant everywhere - one live urchin found a few polychaetes, nemerteans, and nudibranchs

Acmaea mitra, two seen

Cryptochiton stelleri, four observed

Mitra idae, an occasional live miter

Cancer antennarius, several rock crabs burrowed into the mud, most numerous near the jetty entrance items were almost exclusively from the local fauna. Several fishes, including the monkeyface-eel, highcockscomb, black prickleback and the rock prickleback, had ingested red algae almost exclusively.

Age-length and weight are included in this report for most of the 90 collected species.

Offshore trawling by the R/V SEARCHER in depths of 31 to 70 fathoms with a 20 foot otter trawl produced 29 species of fishes which added to the knowledge of the fishes in the Diablo Cove area.

Approximately 50 harbor seals abandoned a reef in south cove during jetty construction. Only a few had returned as of January 1973.

Water temperatures were recorded during the study by a continuous recording thermograph located in the mouth of Diablo Cove. The seasonal pattern followed previous reports for central California: seasonal lows of 9 - 11° C were recorded during the spring and early summer during upwelling, annual highs of 14 - 16° C occurred during mid and late summer and early fall during the oceanic period, and the yearly decline began during mid-fall during the Davidson period.

To avoid or minimize adverse effects of construction activities, abalone transplants were conducted at several sites during 1969-1972. In all, 15,396 abalones were removed including 7,473 red abalones, 7,865 black abalones, 53 threaded abalones, and 5 flat abalones. All were replanted outside the Diablo Canyon area primarily at Montana De Oro State Park and Shell Beach.

Effects of construction activities were documented at Diablo. Major environmental degradation and biotic losses were sustained in South Cove following intake structure construction. Excessive silts and mud from fill the point that it would no longer support abalone production. PG&E agreed to restore the cove to its original clean condition following the cofferdam removal in 1973.

South Cove Breakwater

Two breakwaters were built to protect the South Cove intake structures (Figure 18). Core materials were excavated on site from Patton Peak. These materials were first crushed and then graded over 1 to 2 inch trash racks to separate usable rock from dirt and fines. The core was covered with large Kaiser Quarry rock which in turn was lined with concrete tri-bars weighing about 22 tons each. The finished breakwaters included a cap of concrete over their entire lengths.

During construction, sediments washed off the core rock, clouding the cove and adjacent waters. Turbidity from the construction area during spring and summer months may have limited kelp sporophyte development within the study area south of Diablo Cove. Substantial *Nereocystis* beds that existed in 1969 at Stations 13 and 14 and over a large reef area inside Station 15 failed to appear in 1970 and 1971. Currents displacing gametophytes, rough ocean conditions, or other factors may also have been responsible for the failure of these beds during the 2 year study.

SUMMARY

Diablo Cove is at about the midpoint of a 13 mile long rocky shoreside reef. The reef supports important communities of vertebrates and invertebrates each integrally dependent upon the other and upon dense stands of canopy forming kelps and lower growing algae. Damage to or

Adult rockfish (Family Scorpaenidae) accounted for 84.5% of the adult fishes counted in 1970 and 93.6% in 1971. Blue rockfish alone accounted for 74.1% of the total in 1970 and 91.4% in 1971.

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Of special interest were southern range extensions of the red Irish lord, longfin sculpin, graveldiver (rare in collections), and China rockfish (along the mainland). There also was a northern range extension of the smoothgum sculpin, which is extremely rare. Two blind gobies, collected intertidally in Diablo Cove, are rare north of Point Conception.

Counts of black abalones in 1971 ranged from $7.32/m^2$ at a wave exposed control station inside Lion Rock to $0.50/m^2$ at a wave protected station in the southern corner of Diablo Cove. The average density for all stations during 1971 was 2.69 black abalones/m^2. The average density for the three Diablo Cove stations during 1971 was 1.78 black abalones/m^2.

Juvenile black abalones, .25 to .5 inches in length, were often observed living with purple urchins in their eroded depressions.

Counts or relative abundance estimates of abalone associates were made during the seasonal surveys while other conspicuous invertebrates and marine algae were collected and identified. These collections documented the presence of at least 75 species of invertebrates and 113 species of marine plants in the intertidal. Those invertebrates considered to be major associates of abalones include predators as rock crabs and sunflower stars, and food and space competitors as purple urchins, aggregate anemones, solitary anemones, and black and brown turbans. A seasonal average of 6.4 rock crabs and 4.0 sunflower stars was observed at 11 transects during 1971.

The most abundant marine alga throughout the intertidal was the foliose red, *Iridaea flaccida,* which blanketed most rocky surfaces during summer months. Many differences were noted in the marine plants growing in the various sea exposures (e.g., rough, wave exposed areas compared to calm protected habitat).

In low zone protected cove areas the cover included *Phyllospadix, Gastroclonium, Gigartina, Iridaea, Microcladia, Smithora* and corallines. In exposed surging areas as along the cove's south point the cover included dense beds of *Laminaria, Dictyoneurum* in tidal pools, and restricted. Where urchin numbers were limited, surface beds of *Nereocystis* and shorter growing browns were common. The algal cover of the reefs in North Cove remained similar in composition to Diablo Cove but the density and depth distribution increased markedly. Dense beds of *Nereocystis* developed there annually. Benthic flora included *Pterygophora, Laminaria, Dictyoneurum, Desmarestia, Botryoglossum, Callophyllis, Hymenena,* and *Calliarthron.*

Important production of kelps and foliose red algae was usually limited to depths shallower than 50 feet throughout the Diablo system.

Life history, distribution, and abundance studies of *Nereocystis* were conducted at Diablo Cove during 1970 and 1971 and at Point Estero during earlier years (1967 and 1968). Sporophyte generation was normally observed in mid-spring each year, by late March or early April, and the first pneumatocysts usually reached the surface in May. The mortality rate is extremely high in the developing sporophyte generation as algivores graze heavily on the young plants and others are lost because attachment is common on small rock and other materials which is floated to shore by the forming pneumatocyst. Sporophytes grew at a rate of 13 to 16 cm a day until reaching the surface. After reaching the surface, growth slowed and eventually ceased. A host of bony fishes utilize the kelp bed canopy and stipe regions, both for protection and for the food items harbored therein. The kelp bed appears to be particularly important to adult and juvenile rockfishes. The first Pacific storms initiate the kelp bed decline. During late fall, winter, and early spring, the availability of *Nereocystis* to benthic algivores is maximal as the sea floor is littered with kelp stipes.

substantial numbers of red abalones. The substrate, often confluent with the shoreline, is composed of rocky ledges and large boulders which provide an abundance of protective niches for cryptic animals.

One station representing the shallow water zone was monitored inside Diablo Cove. The average of four seasonal counts at this station was 77.25 red abalones per 60 m^2 transect for a density of $1.29/m^2$. Similar beds of red abalones were observed throughout the shallow water zone of Diablo Cove as off Diablo Creek, off the cofferdam, and along the cove's northern edge.

As depth increases past 20 feet inside Diablo Cove, the habitat conducive to abalone production generally declines in quality. A few reefs and ledges provided protective crevices but much of the central cove bottom was composed of low relief bedrock, cobble and fines. Only an occasional red abalone was observed at permanent stations in 20 to 70 foot depths. However, several other localized beds of red abalones were observed during reconnaissance dives in other sections of the cove in 20 to 50 foot depths.

Flat abalones and pinto abalones were occasionally observed within the study area but were nowhere common.

Large extensive beds of red abalones exist in North Cove to depths of 40 feet. The massive and highly irregular rocky reef structures there provide excellent abalone habitat including hard surfaces for *Nereocystis* attachment.

Abalone predators documented during seasonal subtidal surveys included cabezon, sea stars, and rock crabs. Counts of sunflower stars averaged 1.02 per 60 m^2 in 1970 and 2.02 in 1971. Rock crabs numbered substantial numbers of red abalones. The substrate, often confluent with the shoreline, is composed of rocky ledges and large boulders which provide an abundance of protective niches for cryptic animals.

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the point that it would no longer support abalone production. PG&E agreed to restore the cove to its original clean condition following the cofferdam removal in 1973.

South Cove Breakwater

Two breakwaters were built to protect the South Cove intake structures (Figure 18). Core materials were excavated on site from Patton Peak. These materials were first crushed and then graded over 1 to 2 inch trash racks to separate usable rock from dirt and fines. The core was covered with large Kaiser Quarry rock which in turn was lined with concrete tri-bars weighing about 22 tons each. The finished breakwaters included a cap of concrete over their entire lengths.

During construction, sediments washed off the core rock, clouding the cove and adjacent waters. Turbidity from the construction area during spring and summer months may have limited kelp sporophyte development within the study area south of Diablo Cove. Substantial *Nereocystis* beds that existed in 1969 at Stations 13 and 14 and over a large reef area inside Station 15 failed to appear in 1970 and 1971. Currents displacing gametophytes, rough ocean conditions, or other factors may also have been responsible for the failure of these beds during the 2 year study.

SUMMARY

Diablo Cove is at about the midpoint of a 13 mile long rocky shoreside reef. The reef supports important communities of vertebrates and invertebrates each integrally dependent upon the other and upon dense stands of canopy forming kelps and lower growing algae. Damage to or items were almost exclusively from the local fauna. Several fishes, including the monkeyface-eel, highcockscomb, black prickleback and the rock prickleback, had ingested red algae almost exclusively.

Age-length and weight are included in this report for most of the 90 collected species.

Offshore trawling by the R/V SEARCHER in depths of 31 to 70 fathoms with a 20 foot otter trawl produced 29 species of fishes which added to the knowledge of the fishes in the Diablo Cove area.

Approximately 50 harbor seals abandoned a reef in south cove during jetty construction. Only a few had returned as of January 1973.

Water temperatures were recorded during the study by a continuous recording thermograph located in the mouth of Diablo Cove. The seasonal pattern followed previous reports for central California: seasonal lows of 9 - 11° C were recorded during the spring and early summer during upwelling, annual highs of 14 - 16° C occurred during mid and late summer and early fall during the oceanic period, and the yearly decline began during mid-fall during the Davidson period.

To avoid or minimize adverse effects of construction activities, abalone transplants were conducted at several sites during 1969-1972. In all, 15,396 abalones were removed including 7,473 red abalones, 7,865 black abalones, 53 threaded abalones, and 5 flat abalones. All were replanted outside the Diablo Canyon area primarily at Montana De Oro State Park and Shell Beach.

Effects of construction activities were documented at Diablo. Major environmental degradation and biotic losses were sustained in South Cove following intake structure construction. Excessive silts and mud from fill

As depth increased, the sedimentation increased and the biota diminished. On the bottom in 20 to 30 foot depths, a 1/2 to 2 inch layer of fine sediment covered most flat or sloping rock while a 3 to 4 inch or more layer was accumulated in crevices and depressions. In some areas, as immediately in front of the discharge, we measured sediment depths to 16 inches.

At these 20 to 30 foot depths, approximately 20 biotic constituents were recorded as follows:

Calliarthron cheilosporioides, sparse

Pterygophora californica, a few dense patches, all plants deteriorating

Balanophyllia elegans, a few on rocks not covered by silt

Tealia lofotensis, sparse

Tealia sp., sparse

Pateria miniata, an invertebrate that appears to have withstood siltation. Generally sparse but in places clumped and in fair numbers

Pycnopodia helianthoides, one observed

Strongylocentrotus franciscanus, dead urchin tests abundant everywhere - one live urchin found a few polychaetes, nemerteans, and nudibranchs

Acmaea mitra, two seen

Cryptochiton stelleri, four observed

Mitra idae, an occasional live miter

Cancer antennarius, several rock crabs burrowed into the mud, most numerous near the jetty entrance

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sand and dirt from a borrow pit at the plant site. Cells were built circular with connecting sheet pilings that were driven vertically into the substrate. The cell bottoms were sealed with remmy concrete when necessary to prevent leakage. They were then filled with sand.

Leaks developed along the haul leg as pumping started and mud washed into the reservoir. Additional fill was dumped into these areas in an attempt to stop the leakage. This action added to the flow of mud into the reservoir. Sheet pilings were then driven along the haul leg to contain the flow.

The extent of benthic damage inside the cofferdam was realized after pumping operations lowered the reservoir level. When the drawdown reached approximately -15 feet mllw, many abalones were exposed and it was evident that mud covered a good portion of the bottom (later estimated at 1/3 - 1/2 the reservoir bottom). At this level an additional 324 black and 131 red abalones were removed from exposed rocky areas. Silt from the mud slide had clogged their gills and most were in poor condition. The abalones were transported to the CDF&G Morro Bay Laboratory where their mantle and gill cavities were washed with running salt water. Most of these survived; an estimated 20% died in the ensuing week. Leaks prevented further drawdown at this time.

Pumping later reduced the reservoir level to -27 feet mllw. At this point it appeared that an abalone and fin fish mortality had occurred. The site was thoroughly inspected by CDF&G personnel on December 19, 1971, in an attempt to assess the loss.

Two-hundred-eighty dead red abalones were counted, 47 about the mud slide and 233 in rocky areas. These counts included only those that were exposed: primarily abalones that were unavailable or missed during earlier

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(1972) were located nearer the shoreline; one in Diablo Cove next to our Station 16 and the other just below South Cove.

EFFECTS OF CONSTRUCTION

Discharge Structure

The discharge structure, located just south of Diablo Creek in Diablo Cove, required a cofferdam to hold out ocean water during construction. Work began on the cofferdam in July, 1970. Occupying approximately 3 acres, the haul road and cofferdam were almost entirely within the intertidal (Figure 19). Prior to construction, 2,511 black abalones and 142 reds were removed from the immediate area.

The cofferdam was constructed of washed gravel and rock from the Santa Maria Kaiser Quarry. Silts and other fines did not appear to wash into Diablo Cove during construction. Water clarity inside the cove during construction did not appear appreciably different from that recorded outside the Cove. Silt deposits were never observed in the vicinity of the cofferdam after its completion.

Intake Structure

A cofferdam in South Cove was constructed from the intertidal to 30 foot depths. The structure included an EW leg built as a haul road and a series of circular cells forming the front of the dam and connected to land near the west breakwater. The structure encompassed approximately 4.5 acres. The intertidal here was often abrupt, and most construction was in the subtidal.

The access road and haul leg from shore to the cells utilized fill of nonwashed materials including waste rock from the Kaiser quarry, and

APPENDIX I

KEY TO SYMBOLS USED THROUGHOUT THE REPORT

ABUNDANCE SYMBOLS

A = Abundant - numerous and evenly distributed throughout the area.

C = Common - unevenly present throughout the area and only occasionally numerous.

S = Sparse - widely scattered throughout the area and nowhere numerous.

P = Present - present but not estimated or counted.

(N) = Number - actual count (in parenthesis in intertidal appendices to differentiate from zonation symbols.)

ZONATION SYMBOLS

Numbers (1, 2, or 3) following an abundance symbol for intertidal transects, indicate the relative tidal position that the plant or animal occupied in the intertidal:

*1 = low tide zone - from the mean lower low water (0.0) to the lowest of low tides of about -2.0.

2 - mid tide zone - from the mean lower low (0.0) to about +2.5 above.

3 - high tide zone - from the highest limit of the mid tide zone (+2.5) to standard mean high water, about +5.0.

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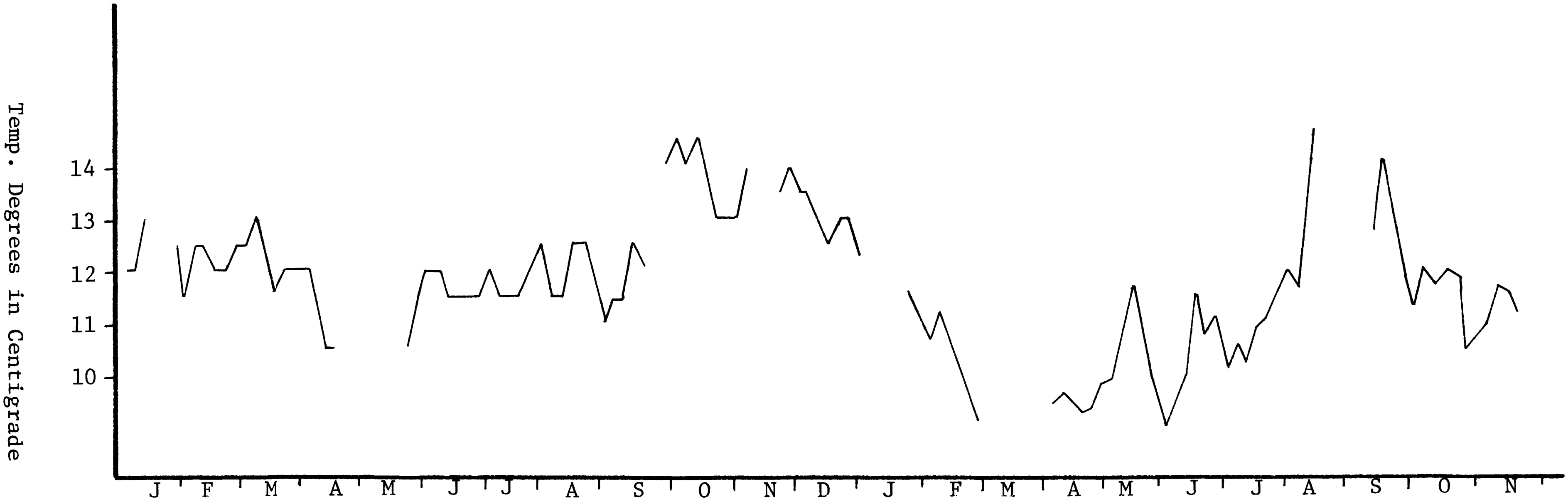
* The same vertical zonation as presented by Ricketts and Calvin (1962). The "uppermost beach" zone was not monitored during these surveys as neither abalones, their food items nor their associates are found here. Zones were renumbered to fit this study.

Figure 18. Surface water temperatures recorded in Diablo Cove 1970-1971.



APPENDIX I - Contd.

Gigartina cristata (group) - includes many of the smaller members of the genus Gigartina that could not easily be separately quantified in the field. *Gigartina cristata*, *G. papillata*, and *G. agardii* were included in this grouping.

Cryptopleura (group) - many members of the Ceramiales including *Botryoglossum*, *Hymenena*, and *Cryptopleura* were difficult or impossible to identify either in the field or the laboratory due to their small size and/or lack of reproductive structures. Those that could not be identified in the field or laboratory were included in this grouping.

Petrocelis franciscana - the non calcareous crustose algae were not separated in the field and all were recorded as *Petrocelis franciscana*. Although *Petrocelis* was the dominant form, *Ralfsia pacifica* appeared in the high zone and others may have been present.

Phyllospadix scouleri - both *P. scouleri* and *P. torreyi* occur at Diablo. *P. scouleri* appeared to be the dominant species inside Diablo Cove. Because the flower was rarely available to positively identify the plant, and nearly all blades that we examined were the wider form, we recorded all *Phyllospadix* plants encountered during seasonal surveys as *P. scouleri*.

TABLE 51. Station Information for 14 Trawls Conducted by the R. V. <u>SEARCHER</u> on January 18 and 19, 1970, off Diablo Canyon.

Station	Date (Jan.)	Fishing Time	Depth	
1	18	0730-0750	31-32	35° 12.2' N. 120° 53.2' W to 35° 12.7' N. 120° 54.3' W
2	18	0800-0830	30	35° 10.7' N. 120° 54.3' W
3	18	0845-0915	50	1 m. SW of Point Buchon buoy
4	18	0925-0955	50	2 mi. SW of Diablo Cove
5	18	1015-1045	70	35° 09.6" N 120° 54.2"W to
6	18	1110-1140	70	4 miles 020° T from Point Buchon
7	18	1150-1220	70	2 miles 310° T from Lion Rock
8	18	1245-1305	47	2 mi. 310°T from Lion Rock to 2.2 mi. 262° T from Lion Rock
9	18	1325-1345	32	1.3 mi. 051°T from Lion Rock
10	19	0830-0850	31-47	2 mi. 165°T from Diablo Creek
11	19	0900-0930	47	2.5 mi. 147°T from Diablo Creek
12	19			
13	19	1010-1040	60	35° 05.7'N 120° 50.6'W to
14	19	1150-1210	73	35° 03' N 120° 51.7' W to

APPENDIX II - Contd.

SCIENTIFIC NAME	STATION TRANSECTS									
	1A**	1B**	2A	2B	3A	3B	4A	4B	4C	5A
RHODOPHYTA										
Agardhiella tenera			S-1	S-1,S-2		S-1		Not Surveyed		Not Surveyed
*Articulated corallines	A	A	C-1,C-2, S-3	C-1,S-2	C-1,S-2	C-1	A-1,A-2		A-1,A-2, S-3	
Botryoglossum farlowianum			S-1	S-1			S-1			
Callithamnion pikeanum	S	S	S-1,S-2	P-1,C-2						
*Crustose corallines	C	C	A-1,A-2, S-3	C-1,C-2, S-3	C-1,S-2	A-1,C-3	A-1,A-2		A-1,A-2, A-3	
**Cryptopleura* (group)	C	S	S-2	P-1,S-2			A-1,C-2		C-1,S-2	
Endocladia muricata	S	A	S-2,A-3	C-2,A-3	S-2,C-3	C-3	C-2		C-2,C-3	
Erythrophyllum delesserioides							P-1,P-2			
Gastroclonium coulteri	S		C-1,S-2	S-1,A-2	C-1	A-1	C-2		C-1,C-2	
Gelidium coulteri		P			P-2					
Gigartina canaliculata	S	C	S-1,S-2,	P-1,C-2, S-3	C-1	C-1	C-2		A-2	
**Gigartina corymbifera* (group)	S	S	C-1	C-1,S-2	S-1	S-1	C-1,S-2		C-1,S-2	
**Gigartina cristata* (group)	S	C	S-1,C-2, A-3	C-2,A-3	A-1,C-2 C-3	S-1	C-1,S-2		C-2	

TABLE 50 - Contd.

	No. of Specimens & Ranges in Standard Length by Station										
	1	2	3	4	5	6	8	11	12	13	14
Lycodopsis pacifica										14 (168-234)	3 (147-234)
Lyopsetta exilis			1 (108)					1 (162)		27 (108-165)	
Microstomus pacificus	3 (76-101)	16 (98-151)							1 (148)	10 (70-192)	3 (166-187)
Ophiodon elongatus		1 (213)						1 (229)		1 (202)	
Otophidium taylori		2 (79-99)				1 (nm)					
Parophrys vetulus		12 (127-178)									
Pleuronichthys decurrens	4 (102-116)	6 (42-186)									
Porichthys notatus	5 (54-191)	14 (94-198)		2 (nm)				18 (56-231)		15 (63-185)	2 (231-248)
Rhamphocottus richardsoni							1 (nm)				
Sebastes crameri											12 (75-95)

APPENDIX II - Contd.

SCIENTIFIC NAME	STATION TRANSECTS									
	1A**	1B**	2A	2B	3A	3B	4A	4B	4C	5A
SPERMATOPHYTA										
Phyllospadix scouleri			A-1,S-2	C-1,C-2	C-1,S-2	C-1		Not Surveyed		Not Surveyed
COELENTERATA										
Anthopleura elegantissima		C	S-3	C-2	C-2	C-3	S-2		S-2,A-3	
Anthopleura xanthogrammica	C		S-1,S-2	C-1		S-1	S-1,C-2		S-1,S-2	
MOLLUSCA										
Astraea gibberosa			S-1,S-2		S-1	S-1				
Calliostoma ligatum							S-2		S-2	
Haliotis cracherodii	(223)	(292)	(274)	(95)	(25)	(40)	(56)		(40)	
Haliotis rufescens			(3)							
Octopus sp.							(1)			
Tegula brunnea		S		S-1	S-1	S-1	S-1,S-2		S-1,S-2	
Tegula funebralis	S	C	C-1,A-2, A-3	C-2,A-3	S-1,C-2, A-3	S-1,C-3				
ECHINODERMATA										
Pisaster ochraceous	S	S	(3)				(10)		(4)	
Strongylocentrotus Purpuratus		C							S-2	

* See Appendix I

** Zones were not established for these two transects during this period.

The station locations, time, and depths are reproduced in Table 50.

In all, 29 species of fish were taken. Their numbers by station including ranges in standard lengths are reproduced in Table 51. Of the 29 species taken by the R. V. Searcher, we collected seven with ichthyocides nearshore. Of special interest are the numbers of octopi taken with the trawl, as they were rarely observed during all diving surveys in the Diablo study area. However, octopus parts, primarily beaks, were commonly found in predatory fish stomachs (e.g. lingcod, cabezon and rockfishes). Due to the cryptic behavior of inshore octopi, we did not expect to observe this invertebrate in any great numbers. However, considerable numbers of octopi probably would be found in the Diablo area if proper collecting techniques were used.

These data are not intended to represent either the species composition or numbers found off the Diablo Canyon area; rather only to give some additional data on the fishes.

MARINE MAMMALS

Casual observations were made of pinnipeds during this investigation. An occasional curious California sea lion, *Zalophus californianus*, "visited" us during scuba surveys. Most sea lions, however, were seen on or about nearshore rocks and reefs.

California sea lions were continuously observed on Diablo Rock and Lion Rock. Approximately 15 animals were usually prominent on the south, leeward side of Diablo Rock. A few to several hundred were visible on Lion Rock depending on season, time of day, and tidal period.

Harbor seals, *Phoca vitulina*, were observed utilizing a large nearshore rocky shelf in South Cove as a haul out area. About 50 animals

APPENDIX III - Contd.

SCIENTIFIC NAME	STATION TRANSECTS									
	1A	1B	2A	2B	3A	3B	4A	4B	4C	5A
PHAEOPHYTA - Contd.										
Fucus distichus				S-3	S-3	S-3				
Hesperophycus harveyanus				S-3		S-3				
Heterochordaria abietina	S-3	C-2							S-3	
Laminaria setchellii	S-2	S-1				S-1	S-1,S-2	A-1,C-2		C-1
Nereocystis luetkeana				(1)				S-1		(60)
Pelvetia fastigiata		S-2	S-3	S-2,A-3	S-2,S-3	C-3			S-2	
Pelvetiopsis limitata		S-2								
RHODOPHYTA										
Agardhiella tenera			C-1	C-1,S-2					S-2	
*Articulated corallines	C-1,C-2, S-3	C-1,C-2	A-1,A-2	A-1,C-2, C-3	P-1,S-2	C-1	A-1	A-1,C-2	C-1,S-2, S-3	A-1, A-2, C-3
Botryoglossum farlowianum			C-1			S-1	C-2	C-1,S-2	P-1	C-1
Callithamnion pikeanum	S-2	S-2	C-1,C-2	S-1,S-2, S-3	S-2		S-2	S-2	S-2	S-1,C-2, C-3

Island, Alaska, commonly occurring on sand substrates. The largest recorded is 6.7 inches (170 mm) in length. This species' depth range is 10 to 1,200 feet.

Ninety-three speckled sanddabs were collected at Diablo Cove: one at the 20 foot station, and 92 at the deep station. None was collected in the winter. The 92 specimens from 70 feet (30-68 mm SL) were found on the sand that surrounded this pinnacled station. In North Cove, speckled sanddabs also were collected on sand but in much larger quantities. At the 25 and 60 foot stations, 548 and 406 specimens were taken respectively. These 954 sanddabs represent the largest number of any one species collected during the study. They ranged from 31-108 mm SL. Of the 406 taken at 60 feet, eight ranging from 84-102.5 mm SL (average 90.0 mm) and weighing 10.5-22 g (average 13.1 g) were age 1. The remaining 398 individuals were young of the year (age 0).

During routine subtidal surveys, nine speckled sanddabs were counted on one transect in the winter of 1971 (Table 20). This count was made at Station 7 where the 548 specimens were collected with the ichthyocide. The physiography of this station was such that only about 9 square feet of sand fell within the 30 x 2 m transect, and only once did the speckled sanddab occupy this area during a seasonal survey of that station. Speckled sanddabs often were observed off transects in protected sandy areas and were deemed common to abundant. They ranked 17th numerically out of 23 fishes observed.

Pleuronectidae

Pleuronichthys coenosus Girard - C-O Turbot

This turbot ranges from Cape Colnett, Baja California, to S.E. Alaska.

APPENDIX III - Contd.

SCIENTIFIC NAME	STATION TRANSECTS									
	1A	1B	2A	2B	3A	3B	4A	4B	4C	5A
RHODOPHYTA - Contd.										
Halosaccion glandiforme	S-2,S-3	S-2	S-1,S-2	S-1,S-2	C-1,S-2	S-1				
Iridaea flaccida	S-1,A-2, C-3	S-1,A-2	A-1,A-2	A-1,A-2, C-3	A-1,A-2	C-1,A-2, C-3	A-2	A-2	A-2,S-3	C-2,S-3
Iridaea heterocarpum	S-1,S-2	S-2	S-2	S-1,S-2	S-1,C-2	S-2	S-2			
Iridaea splendens	S-1,S-2	A-1	S-1,S-2	S-1,S-2	C-2	C-1,S-2	C-1,S-2	C-1,C-2	C-1,C-2	S-1,S-2
Laurencia spectabilis	S-1,S-2	S-1				S-1	P-2			
Microcladia borealis	S-2	S-1,S-2					C-1,C-2	S-1,S-2	C-1,S-2	C-1
Microcladia coulteri	S-1		C-1	C-1,S-2	P-1,C-2	C-1,C-2	S-1	S-2		S-1
Petrocelis franciscana	C-2,A-3	S-2	C-1,A-2, A-3	S-1,A-2, A-3	A-1,A-2, A-3	S-1,C-2, C-3	C-2	C-2	A-2,S-3	C-2,A-3
Plocamium coccineum	S-2		S-1	S-1		S-1,S-2	C-1,S-2			S-2
Polysiphonia spp.	S-1,S-2	S-2		S-1						S-2,S-3
Porphyra perforata	S-2,C-3	C-2	S-1,A-2, S-3	S-2,S-3	S-1,C-2, S-3	S-3	S-2	S-2	S-2,C-3	S-3
Prionitis spp.	S-1,S-2		S-1	C-1,S-2	P-1,S-2	C-1,C-2	S-1,S-2	S-1,C-2	S-1,S-2	C-1,S-2
Pterosiphonia baileyi	S-2									
Smithora naiadum						C-1				

APPENDIX III - Contd.

SCIENTIFIC NAME	STATION TRANSECTS									
	1A	1B	2A	2B	3A	3B	4A	4B	4C	5A
SPERMATOPHYTA										
**Phyllospadix scouleri*	S-1,S-2	S-2	A-1,S-2	A-1	S-1,C-2	A-1,S-2				
COELENTERATA										
Anthopleura elegantissima	S-2,S-3	S-2	S-3	S-2,C-3	S-1,S-2	S-2	C-2		A-3	
Anthopleura xanthogrammica	S-1,C-2	S-1,S-2	S-2,S-1	S-1,S-2			C-1,C-2			
ARTHROPODA										
Cancer antennarius					(1)					
MOLLUSCA										
Astraea gibberosa			S-1		S-2	(1)				
Calliostoma ligatum							S-2	S-2	S-2	
Haliotis cracherodii	(124)	(285)	(81)	(64)	(11)	(34)	(61)	(21)	(11)	(22)
Haliotis rufescens			(3)	(2)		(6)				
Tegula brunnea	S-1		S-2	S-2	S-1,S-2	S-1,S-2	S-2	S-2	S-2	S-1
Tegula funebralis		S-2	C-2,A-3	S-1,C-2, A-3	C-1,C-2, A-3	S-1,C-2, A-3				S-1

APPENDIX III - Contd.

SCIENTIFIC NAME	STATION TRANSECTS									
	1A	1B	2A	2B	3A	3B	4A	4B	4C	5A
ECHINODERMATA										
Pycnopodia helianthoides				(1)	(2)	(1)				(1)
Pisaster ochraceous	(2)	(18)	(5)	(4)		(2)	(1)		(1)	(23)
Strongylocentrotus purpuratus	C-2	S-1,S-2					S-2	S-2	S-2	

*See Appendix I

APPENDIX IV
PLANTS AND ANIMALS RECORDED IN THE DIABLO CANYON STUDY AREA AT PERMANENT INTERTIDAL STATION TRANSECTS OCCUPIED ON OCTOBER 12, 13, 14, 15 & 16, 1970 (Fall Survey)

SCIENTIFIC NAME	STATION TRANSECTS									
	1A	1B	2A	2B	3A	3B	4A	4B	4C	5A
CHLOROPHYTA										Not Surveyed
Cladophora trichotoma	S-3	C-2	S-3		S-2,S-3	P-3			S-3	
Codium fragile		S-2								
Codium setchellii	S-3	S-2		S-2		S-1				
Spongomorpha coalita					S-2					
Ulva lactuca	S-3	C-2	C-1,C-2	S-2	C-1,A-2	C-1,C-2, S-3				
Ulva sp.									S-3	
PHAEOPHYTA										
Alaria marginata							S-2	S-1,P-2		
Desmarestia herbacea	S-1									
Dictyoneurum californicum							A-1	A-1	A-1	
Egregia menziesii		S-2	S-1,S-2	S-1,S-2			S-1	S-1,S-2	C-2	
Fucus distichus				S-3	S-2	S-3				

APPENDIX IV - Contd.

SCIENTIFIC NAME	1A	1B	2A	2B	3A	3B	4A	4B	4C	5A
PHAEOPHYTA - Contd.										Not Surveyed
Hesperophycus harveyanus						S-3				
Heterochordaria abietina	S-2,S-3	C-2							S-3	
Laminaria setchellii	S-1	S-1					S-1	A-1		
Pelvetia fastigiata		S-2	S-3	A-3	S-2,S-3	S-2,C-3			S-2	
Pelvetiopsis limitata	S-3	S-2								
RHODOPHYTA										
Agardhiella tenera				S-1	S-1					
*Articulated Corallines	C-1,C-2	C-1,C-2	A-1,C-2	A-1	C-1,C-2	P-1,S-2	S-1,A-2	A-2	C-1,C-2, S-3	
Botryoglossum farlowianum	C-1		S-1	C-1			C-1	A-1	S-1	
Callithamnion pikeanum	S-2	S-1	S-2	S-1,P-2						
Callophyllis spp.		S-1	S-1	S-1			S-2	S-1	S-2	
Ceramium eatonianum			P-2	P-1						

APPENDIX IV - Contd.

SCIENTIFIC NAME	STATION TRANSECTS									
	1A	1B	2A	2B	3A	3B	4A	4B	4C	5A
RHODOPHYTA - Contd.										
*Crustose Corallines	A-1,A-2, S-3	A-1,C-2	A-1,C-2, S-3	A-1,C-2, S-3	C-1,S-2, S-3	C-1,S-2, S-3	C-1,A-2	A-2	A-1,A-2, A-3	Not Surveyed
Endocladia muricata	C-2,C-3	C-2	S-2,C-3	S-2,C-3	S-2	C-2,C-3	S-2	S-2	C-3	
Erythrophyllum delesserioides		S-1	S-1	S-1			C-1	S-1,P-2	C-1	
Gastroclonium coulteri	S-2	C-2	C-1,P-2	A-1,C-2	C-1,S-2	A-1	C-2	C-2	C-1,S-2	
Gelidium coulteri		C-2	S-2			S-2		S-1	S-2	
Gigartina canaliculata	S-2	S-2	S-1,S-2	S-1,S-2	C-1	A-1,C-2	C-2	C-2	S-1,C-2	
**Gigartina corymbifera* (group)	C-1	S-1	C-1	C-1,S-2	P-1	S-1	C-1,S-2	C-1	A-1,S-2	
**Gigartina cristata* (group)	S-2,S-3	S-2	S-1,C-2, A-3	A-2,A-3	A-1,A-2, A-3	S-1,A-2, A-3	C-1,S-2	C-2	S-2,S-3	
Halosaccion glandiforme	S-3	C-2	S-1,S-2	S-1	S-1,S-2	S-1				
**Cryptopleura* (group)	C-1,A-2	A-1,S-2	C-1,S-2	S-1,C-2	S-1	S-1	A-1,C-2	S-1,S-2	S-2	
Iridaea flaccida	S-1,A-2, C-3	S-1,A-2	C-1,A-2, C-3	C-1,A-2, C-3	A-1,C-2, S-3	A-1,A-2, S-3	C-1,A-2	A-2	C-2,S-3	
Iridaea heterocarpum			S-1,S-2	S-2,S-3		S-2,S-3		P-2		

APPENDIX IV - Contd.

SCIENTIFIC NAME	STATION TRANSECTS									
	1A	1B	2A	2B	3A	3B	4A	4B	4C	5A
<u>RHODOPHYTA - Contd.</u>										Not Surveyed
Iridaea splendens	S-1	C-1,S-2	S-1				C-1		C-1,S-2	
Laurencia blinksii							S-2			
Laurencia spectabilis	S-1,C-2	S-2	S-2	P-1	S-1,S-2	S-1,S-2	S-2		S-2	
Microcladia borealis	S-2	C-2				S-2	C-1,C-2	S-1		
Microcladia coulteri	S-1,S-2	S-1,S-2	C-1,C-2	C-1,C-2	A-1,S-2	A-1,C-2	A-1,S-2	C-1,S-2	A-1,S-2	
Petrocelis franciscana	C-2,S-3	S-1,S-2	C-2,A-3	A-2,A-3	C-1,C-2, A-3	S-1,A-2, A-3	S-2	S-2	C-2,C-3	
Plocamium coccineum		P-2					S-2		S-2	
Polysiphonia spp.	S-2,S-3	S-1,S-2			C-2	S-2				
Porphyra perforata	S-3	S-2	C-2,S-3	S-2,S-3	C-1,C-2	S-1,C-2, S-3			S-2,S-3	
Porphyrella gardneri								P-1		
Prionitis spp.	S-1		S-1	S-1	S-1	S-1,S-2	C-1,S-2	S-1,P-2	A-1,S-2	
Pterosiphonia baileyi	S-1						S-1			
Ptilota densa					S-2					
Smithora naiadum			A-1	S-1	P-1,C-2	S-1				

APPENDIX IV - Contd.

SCIENTIFIC NAME	STATION TRANSECTS									
	1A	1B	2A	2B	3A	3B	4A	4B	4C	5A
<u>SPERMATOPHYTA</u>										
**Phyllospadix scouleri*	S-1	S-2	A-1,S-2	C-1,S-3	S-1,C-2	S-1				Not Surveyed
<u>COELENTERATA</u>										
Anthopleura elegantissima	S-1,C-2	S-2	S-3	S-2,S-3	C-2	S-2,S-3			A-3	
Anthopleura xanthogrammica	S-1,C-2	S-1,S-2		S-1		S-1	C-2			
<u>ARTHROPODIA</u>										
Cancer antennarius							(1)			
<u>MOLLUSCA</u>										
Astraea gibberosa					S-1,S-2	S-2				
Calliostoma ligatum									S-1	
Haliotis cracherodii	(127)	(387)	(189)	(69)	(20)	(41)	(51)	(55)	(34)	
Haliotis rufescens			(1)	(5)	(2)					
Tegula brunnea	S-1,S-2		S-1,S-2	S-1,S-2	S-1,C-2	S-1	C-2	C-1,A-2	S-1,S-2	
Tegula funebralis			S-2,A-3	A-2,A-3	S-2,A-3	S-1,C-2, A-3				

APPENDIX IV - Contd.

SCIENTIFIC NAME	STATION TRANSECTS									
	1A	1B	2A	2B	3A	3B	4A	4B	4C	5A
<u>ECHINODERMATA</u>										
Pycnopodia helianthoides			(1)	(1)	(1)					
Pisaster ochraceous	(2)	(14)	(1)		(1)	(1)	(1)		(3)	
Strongylocentrotus purpuratus	A-2	S-1,C-2					S-2		S-2	

*See Appendix I

APPENDIX V
PLANTS AND ANIMALS RECORDED IN THE DIABLO CANYON STUDY AREA AT PERMANENT INTERTIDAL STATION 1/4m QUADRATS OCCUPIED ON MARCH 3, 5, 6 & 7, 1970 (1970 Winter Survey)

SCIENTIFIC NAME	QUADRATS																					
	1Aa	1Ab	1Ac	1Ba	2Aa	2Ab	2Ba	2Bb	2Bc	3Aa	3Ab	3Ac	3Ad	3Ba	3Bb	3Bc	4Aa	4Ba	4Ca	5Aa	5Ab	5Ac
PHAEOPHYTA																						
Hesperophycus harveyanus											3											
Heterochordaria abietina				S																		
Pelvetia fastigiata									5		4											
RHODOPHYTA																		Not Surveyed			Not Surveyed	
Agardhiella tenera														S								
*Articulated corallines	C	C		A	A		S			C				C			A					
Botryoglossum farlowianum						S																
Callithamnion pikeanum		S			S		S	S														
Callophyllis **spp.**	S	C																				
*Crustose Corallines	A	A		A	A	S	A			A	S		S	A	A	C	A		C			
Cryptopleura **(group)**					S		S										A					

APPENDIX V - Contd.

SCIENTIFIC NAME	QUADRATS																					
	1Aa	1Ab	1Ac	1Ba	2Aa	2Ab	2Ba	2Bb	2Bc	3Aa	3Ab	3Ac	3Ad	3Ba	3Bb	3Bc	4Aa	4Ba	4Ca	5Aa	5Ab	5Ac
RHODOPHYTA - Contd.																						
Endocladia muricata			C			C			S		A		S					Not Surveyed	S		Not Surveyed	
Erythrophyllum delesserioides																	C					
Gastroclonium coulteri					S		A			A				C	C							
Gelidium coulteri				C																		
Gigartina canaliculata					S		C								C							
Gigartina corymbifera* **(group)										S												
Gigartina cristata* **(group)					C	S		C	C		S	C	C		S	A						
Iridaea flaccida	S			C	C		S	C						S	A	S	S					
Iridaea heterocarpum					S										S							
Iridaea splendens							S										S					
Laurencia blinksii				S																		
Laurencia spectabilis	C			S			S										A					

APPENDIX V - Contd.

SCIENTIFIC NAME	QUADRATS																					
	1Aa	1Ab	1Ac	1Ba	2Aa	2Ab	2Ba	2Bb	2Bc	3Aa	3Ab	3Ac	3Ad	3Ba	3Bb	3Bc	4Aa	4Ba	4Ca	5Aa	5Ab	5Ac
RHODOPHYTA - Contd.																						
Microcladia borealis																	S					
Microcladia coulteri										C				C			S					
Petrocelis franciscana					A	S	S	A	A		C	C	A	C	C	A			S			
Prionitis spp.										C				C			S					
Pterosiphonia baileyi				C													P					
SPERMATOPHYTA																						
**Phyllospadix scouleri*										A				S				Not Surveyed				
COELENTERATA																						
Anthopleura elegantissima	4			4					7								3		C		Not Surveyed	
Anthopleura xanthogrammica		10																				
ARTHROPODA																						
Balanus spp.		S	A		S	C											S		A			
Pollicipes polymerus			C														1		A			
Pachgrapsus crassipes																3						

APPENDIX V - Contd.

SCIENTIFIC NAME	QUADRATS																					
	1Aa	1Ab	1Ac	1Ba	2Aa	2Ab	2Ba	2Bb	2Bc	3Aa	3Ab	3Ac	3Ad	3Ba	3Bb	3Bc	4Aa	4Ba	4Ca	5Aa	5Ab	5Ac
<u>ARTHROPODA - Contd.</u>																						
Pagurus **sp.**																S						
Tetraclida squamosa rubescens		S	S														1		15			
<u>MOLLUSCA</u>																						
Acanthina punctulata																	1		1			
Acmaea mitra															1		1	Not Surveyed				
Astraea gibberosa															1							
Collisella pelta					1					1											Not Surveyed	
Collisella scabra			5			C					3	9	5		4				32			
Cyanoplax **spp.**				2															1			
Fissurella volcano					1		2										1					
Haliotis cracherodii		13													1							
Littorina planaxis					S	S					A											
Littorina scutulata						S																
Lottia gigantea																			1			

APPENDIX V - Contd.

SCIENTIFIC NAME	QUADRATS																					
	1Aa	1Ab	1Ac	1Ba	2Aa	2Ab	2Ba	2Bb	2Bc	3Aa	3Ab	3Ac	3Ad	3Ba	3Bb	3Bc	4Aa	4Ba	4Ca	5Aa	5Ab	5Ac
MOLLUSCA - Contd.																		Not Surveyed			Not Surveyed	
Mytilus californianus	3																12		A			
Notoacmaea scutum						1					3	1										
Nuttallina californica			3																			
Ocenebra circumtexta											1		1									
Tegula brunnea		2													1							
Tegula funebralis					3	2			3		52	18	168		6	71						
Tegula montereyii														2								
Tonicella lineata	1																					
ECHINODERMATA																						
Leptasterias pusilla																	1					
Pisaster ochraceous		1																				
Strongylocentrotus purpuratus	46	28		33													21					

*See Appendix I

APPENDIX VI
PLANTS AND ANIMALS RECORDED IN THE DIABLO CANYON STUDY AREA AT PERMANENT INTERTIDAL STATION 1/4m QUADRATS OCCUPIED ON JUNE 23, JULY 3, 4, 5, & 6, 1970 (1970 Summer Survey)

SCIENTIFIC NAME	QUADRATS																					
	1Aa	1Ab	1Ac	1Ba	2Aa	2Ab	2Ba	2Bb	2Bc	3Aa	3Ab	3Ac	3Ad	3Ba	3Bb	3Bc	4Aa	4Ba	4Ca	5Aa	5Ab	5Ac
CHLOROPHYTA																						
Cladophora trichotoma													S									
Codium setchellii				S																		
Spongomorpha coalita					S																	
Ulva sp.					S							S										S
PHAEOPHYTA																						
Alaria marginata																	7	2		64	173	
Egregia menziesii																		3				
Heterochordaria abietina				S															S			
Laminaria setchellii																	2	3		6		
Pelvetia fastigiata									A		13					1						
RHODOPHYTA																						
***Articulated corallines**	C	C		A	A		C	S		C							A	S	S	A	C	

APPENDIX VI - Contd.

SCIENTIFIC NAME	QUADRATS																					
	1Aa	1Ab	1Ac	1Ba	2Aa	2Ab	2Ba	2Bb	2Bc	3Aa	3Ab	3Ac	3Ad	3Ba	3Bb	3Bc	4Aa	4Ba	4Ca	5Aa	5Ab	5Ac
RHODOPHYTA - Contd.																						
Callithamnion pikeanum		S			C		S										S	S			C	
Ceramium eatonianum	C																					
*Crustose corallines	A	A		A	C		A	S	S	C	C		S	C	A		A	A	C	A	A	
Cryptopleura **(group)**	C	C			S		C	S		S					S		A	S				
Endocladia muricata			C	C	S	C			S		A								S			
Erythrophyllum delesserioides																		S		A	S	
Gastroclonium coulteri							A			A					C							
Gigartina canaliculata				S	C		A							S	C							
Gigartina corymbifera* **(group)							C			S												
Gigartina cristata* **(group)			S			C		A	C		C	S	C		S	A						
Halosaccion glandiforme		S	S		S										S							
Iridaea flaccida	S		S	C	A		A	A		S				S	A	S	S	C				
Iridaea heterocarpum															S							

APPENDIX VI - Contd.

SCIENTIFIC NAME	QUADRATS																					
	1Aa	1Ab	1Ac	1Ba	2Aa	2Ab	2Ba	2Bb	2Bc	3Aa	3Ab	3Ac	3Ad	3Ba	3Bb	3Bc	4Aa	4Ba	4Ca	5Aa	5Ab	5Ac
RHODOPHYTA - Contd.																						
Iridaea splendens					S		S	S							S		S			S	S	
Laurencia spectabilis	C	S															C					
Microcladia borealis	S	S		C													A					
Microcladia coulteri										C				S	S					C		
Petrocelis franciscana		S		S	A	S		A	A		A	A		S	S	S			S		C	A
Plocamium coccineum		S															S					
Polysiphonia spp.	S	C		C																		
Porphyra perforata			S	S							S	C							C			
Prionitis spp.										C				C			S	S		C		
Smithora naiadum														A								
SPERMATOPHYTA																						
* *Phyllospadix scouleri*										A				A	S							
COELENTERATA																						
Anthopleura elegantissima	7		3						7								2	1	A			
Anthopleura Xanthogrammica		7																				

APPENDIX VI - Contd.

SCIENTIFIC NAME	QUADRATS																					
	1Aa	1Ab	1Ac	1Ba	2Aa	2Ab	2Ba	2Bb	2Bc	3Aa	3Ab	3Ac	3Ad	3Ba	3Bb	3Bc	4Aa	4Ba	4Ca	5Aa	5Ab	5Ac
ARTHROPODA																						
Balanus sp.	S		C			C																A
Hemigrapsus nudus						1																
Pollicipes polymerus			C																A			C
Pachygrapsus crassipes			1				2				1		1									1
Pagurus sp.					5					3				P								
Pachycheles rudis	2																					
Pugettia producta					3									1	2					1		
Tetraclita squamosa rubescens			9																9			6
MOLLUSCA																						
Acmaea mitra																	1					
Acmaea palaecea														S								
Acmaea sp.	4		3																			
Collisella pelta				2							1							1	1			4
Collisella scabra			16		7	14					7	8							C			A

APPENDIX VI - Contd.

SCIENTIFIC NAME	QUADRATS																					
	1Aa	1Ab	1Ac	1Ba	2Aa	2Ab	2Ba	2Bb	2Bc	3Aa	3Ab	3Ac	3Ad	3Ba	3Bb	3Bc	4Aa	4Ba	4Ca	5Aa	5Ab	5Ac
MOLLUSCA - Contd.																						
Cyanoplax **spp.**			1								1							1				
Fisurella volcano	1				2																	
Haliotis cracherodii	2	13				1											1	4				
Littorina planaxis			S			C																
Littorina scutulata			S								A											
Lottia gigantea																						1
Mopalia muscosa																1						
Mytilus californianus	1		C																A			A
Notoacmaea scutum					2						1	2					1			1	2	
Nuttallina californica			5	6	1						1	1							1	1	1	4
Tegula brunnea	1	2						4						1	1		1			1		
Tegula funebralis						41		26		1	42		49		7	15				1		
Thais emarginata																			1			5
Tonicella lineata	1	1																1				

APPENDIX VI - Contd.

SCIENTIFIC NAME	QUADRATS																					
	1Aa	1Ab	1Ac	1Ba	2Aa	2Ab	2Ba	2Bb	2Bc	3Aa	3Ab	3Ac	3Ad	3Ba	3Bb	3Bc	4Aa	4Ba	4Ca	5Aa	5Ab	5Ac
ECHINODERMATA																						
Leptasterias pusilla							3	1		2				1						2	2	
Leptasterias hexactis						1								4								
Strongylocentrotus purpuratus	39	15		47													15				2	

*See Appendix I

APPENDIX VII
PLANTS AND ANIMALS RECORDED IN THE DIABLO CANYON STUDY AREA AT PERMANENT INTERTIDAL STATION 1/4m QUADRATS OCCUPIED ON OCTOBER 12, 13, 14, 15 & 16, 1970 (1971 Fall Survey)

SCIENTIFIC NAME	QUADRATS																					
	1Aa	1Ab	1Ac	1Ba	2Aa	2Ab	2Ba	2Bb	2Bc	3Aa	3Ab	3Ac	3Ad	3Ba	3Bb	3Bc	4Aa	4Ba	4Ca	5Aa	5Ab	5Ac
<u>CHLOROPHYTA</u>																				Not Surveyed		
Cladophora trichotoma			S	S									S			S						
Codium setchellii			S																			
Ulva lactuca					5							C		S	S	S						
<u>PHAEOPHYTA</u>																						
Alaria marginata																	2	2				
Egregia menziesii																		15				
Heterochordaria abietina																			S			
Laminaria setchellii																		4				
Pelvetia fastigiata									6		11											
<u>RHODOPHYTA</u>																						
***Articulated corallines**	C	C		A	C		S							C			C	S	S			
Callithamnion pikeanum							S	S		S												

APPENDIX VII - Contd.

SCIENTIFIC NAME	QUADRATS																					
	1Aa	1Ab	1Ac	1Ba	2Aa	2Ab	2Ba	2Bb	2Bc	3Aa	3Ab	3Ac	3Ad	3Ba	3Bb	3Bc	4Aa	4Ba	4Ca	5Aa	5Ab	5Ac
RHODOPHYTA - Contd.																						
Callophyllis spp.																		S		Not Surveyed		
Ceramium eatonianum					S		S															
*Crustose corallines	A	A	S	A	A	S	C		S	C	C		S	C	C	S	A	A	C			
Cryptopleura (group)	C	C			S		S							S	S		A	S				
Endocladia muricata			C			C			S		S		S			S			S			
Erythrophyllum delesserioides																		S				
Gastroclonium coulteri					S		A							A	A							
Gelidium coulteri					S																	
Gigartina canaliculata					S									S	S							
**Gigartina corymbifera* (group)							C			S												
**Gigartina cristata* (group)			S		S	C		A	C		C	C	C		S	A	S					
Halosaccion glandiforme					S							S		S								
Iridaea flaccida	S		S	S	A		C	C	S						C	C	S	C				

APPENDIX VII - Contd.

SCIENTIFIC NAME	QUADRATS																					
	1Aa	1Ab	1Ac	1Ba	2Aa	2Ab	2Ba	2Bb	2Bc	3Aa	3Ab	3Ac	3Ad	3Ba	3Bb	3Bc	4Aa	4Ba	4Ca	5Aa	5Ab	5Ac
RHODOPHYTA - Contd.																						
Iridaea heterocarpum								S	S									S			Not Surveyed	
Laurencia blinksii																	S					
Laurencia spectablis	C	S					S								S		S					
Microcladia borealis		S		C													C					
Microcladia coulteri					S		S			S				S	S			S				
Petrocelis franciscana	S			S	C	S	S	A	A		C		A			A			S			
Plocamium coccineum		S		S																		
Polysiphonia spp.		S																				
Porphyra perforata			S									S							S			
Prionitis spp.										S				S			S	S				
Pterosiphonia baileyi	S																S					
Smithora naiadum										A												
SPERMATOPHYTA																						
**Phyllospadix scouleri*										A												
COELENTERATA																						
Anthopleura elegantissima	8								2								4		A			

APPENDIX VII - Contd.

SCIENTIFIC NAME	1Aa	1Ab	1Ac	1Ba	2Aa	2Ab	2Ba	2Bb	2Bc	3Aa	3Ab	3Ac	3Ad	3Ba	3Bb	3Bc	4Aa	4Ba	4Ca	5Aa	5Ab	5Ac
COELENTERATA - Contd.																						
Anthopleura xanthogrammica		5																	1			
ARTHROPODA																						
Balanus sp.		C	A			A													A			
Cancer antennarius	1	1																				
Cancer oregonesis										1												
Idothea sp.											1											
Pollicipes polymerus			A																A		Not Surveyed	
Pachygrapsus crassipes			1	6	1	1																
Pagurus sp.							P	P		P	S		C	S		S						
Pugettia producta				1	2									3				1				
Tetraclita squamosa rubescens			7																9			
MOLLUSCA																						
Acmaea mitra	3																					
Astraea gibberosa										1												

APPENDIX VII - Contd.

SCIENTIFIC NAME	QUADRATS																					
	1Aa	1Ab	1Ac	1Ba	2Aa	2Ab	2Ba	2Bb	2Bc	3Aa	3Ab	3Ac	3Ad	3Ba	3Bb	3Bc	4Aa	4Ba	4Ca	5Aa	5Ab	5Ac
MOLLUSCA - Contd.																						
Collisella pelta																			S		Not Surveyed	
Collisella scabra					11	25			1			17	6			8			C			
Crepidula adunca								1														
Cyanoplax spp.															2							
Fisurella volcano	2						2										2					
Haliotis cracherodii	15	16		6				1										1				
Littorina planaxis			C																			
Littorina scultulata						S					S											
Mytilus californianus			A																A			
Notoacmaea scutum					3	1			2		3	12	1			2						
Nuttallina californica	8		13	12																		
Ocenebra circumtexta					1						2											
Tegula brunnea		4						1							4			1				
Tegula funebralis					1			10	15		11	42	40			31						
Thais emarginata																	2		1			

APPENDIX VII - Contd.

SCIENTIFIC NAME	QUADRATS																					
	1Aa	1Ab	1Ac	1Ba	2Aa	2Ab	2Ba	2Bb	2Bc	3Aa	3Ab	3Ac	3Ad	3Ba	3Bb	3Bc	4Aa	4Ba	4Ca	5Aa	5Ab	5Ac
<u>MOLLUSCA - Contd.</u>																						
Tonicella lineata				3																	Not Surveyed	
<u>ECHINODERMATA</u>																						
Leptasterias pusilla				2	1		2							1			2	1				
Strongylocentrotus purpuratus	61	31		38													20					

*See Appendix I

APPENDIX VIII
PLANTS AND ANIMALS RECORDED AT SUBTIDAL STATIONS OCCUPIED ON FEBRUARY 3, 4, 6, 7, 24 (1970 Winter Survey)

SCIENTIFIC NAME	6	7	8	9	10	11	12	13	14	15	16
PHAEOPHYTA											
Cystoseira osmundacea	*S	C									
Desmarestia herbacea		S									
Desmarestia munda	S										
Dictyoneurum californicum	C	S	S	S						C	
Egregia menziesii	S										
Laminaria setchellii	S	S								C	
Macrocystis pyrifera		526						Not surveyed	Not surveyed		Not Surveyed
Nereocystis luetkeana				1							
Pterygophora californica	S	C									
RHODOPHYTA											
*Articulated corallines	A	C	A	C	S	S				A	
Botryoglossum farlowianum	C	C	A	S						C	

APPENDIX VIII - Cont'd.

SCIENTIFIC NAME	6	7	8	9	10	11	12	13	14	15	16
Callophyllis spp.	S	S	S					Not surveyed	Not surveyed	S	Not surveyed
*Crustose corallines	A	A	A	A	A	A	S			C	
Gelidium robustum										S	
**Gigartina californica* (group)	C		S							S	
Iridaea splendens										S	
Laurencia spectabilis		S				S					
Microcladia coulteri	S	S									
Opuntiella californica	S	C	S			S					
Polyneura latissima		S								S	
Prionitis spp.	S		S							C	
Ptilota densa			S							S	
Schizymenia epiphytica	S	S		S		S					
MOLLUSCA											
Astraea gibberosa	C	S	S	C	C	S					
Calliostoma annulatum	S	S	S	S	S	S	S				

APPENDIX VIII - Cont'd.

SCIENTIFIC NAME	6	7	8	9	10	11	12	13	14	15	16
Calliostoma canaliculatum		S	S		S	S	S	Not surveyed	Not surveyed	C	Not surveyed
Calliostoma ligatum	C		C								
Haliotis kamtschatkana		1				1					
Haliotis rufescens	2	5	4			1				11	
Tegula brunnea	S	A		S							
Tegula montereyi			S	C	S	S	S				
<u>ARTHROPODA</u>											
Cancer antennarius					1					6	
<u>ECHINODERMATA</u>											
Pycnopodia helianthoides	1	2			2		1				
Strongylocentrotus franciscanus	270	192	131	282	57	116	38			P	
Strongylocentrotus purpuratus	P										
<u>BONY FISH</u>											
Anarrhichthys ocellatus	1										

APPENDIX VIII - Cont'd.

SCIENTIFIC NAME	6	7	8	9	10	11	12	13	14	15	16
Coryphopterus nicholsi	4	2	2	1	3			Not surveyed	Not surveyed	1	Not surveyed
Cottidae		1									
Damalichthys vacca	1										
Embiotoca lateralis	1		2	1						1	
Hexagrammos decagrammus	1										
Ophiodon elongatus	1	1				3					
Oxylebius pictus	3		3	4	2		5			3	
Scorpaenichthys marmoratus	2	2	2							2	
Sebastes atrovirens	2										
Sebastes chrysomelas	1		1				1			1	
Sebastes mystinus	~ 150	2	~ 60			2				~ 75	
Sebastes serranoides-flavidus	3		1			1					
Sebastes spp. (Juveniles)	~ 200	8	~50	~200	2	5	9				

*See Appendix I

APPENDIX IX
PLANTS AND ANIMALS RECORDED AT SUBTIDAL STATIONS OCCUPIED ON JUNE 25, 26 & JULY 22, 1970 (1970 Summer Survey)

SCIENTIFIC NAME	6	7	8	9	10	11	12	13	14	15	16
CHLOROPHYTA											
Halicystis ovalis				*S		S					
PHAEOPHYTA											
Cystoseira osmundacea	S	C									A
Desmarestia herbacea	A	C		C	S	S					S
Desmarestia munda	S	S		S		S					C
Dictyota binghamiae	C	S	Not surveyed					Not surveyed	Not surveyed	Not surveyed	
Dictyoneurum californicum	C	C		C							P
Egregia menziesii	S										
Laminaria setchellii	S	S									S
Macrocystis pyrifera		467									
Nereocystis luetkeana	27	14		2		S (1-2")					10
Pterygophora californica	S	C				S					A
RHODOPHYTA											
*Articulated corallines	A	C		C	S	S	S				A

APPENDIX IX - Cont'd.

SCIENTIFIC NAME	6	7	8	9	10	11	12	13	14	15	16
RHODOPHYTA - Contd.											
Botryoglossum farlowianum	S	S	Not surveyed	C				Not surveyed	Not surveyed	Not surveyed	A
Callophyllis spp.	C	S		S	S	S					S
*Crustose corallines	C	A		A	A	A	A				C
**Gigartina californica* (group)	S										S
Hymenena flabelligera				S							
Laurencia spectabilis											S
Microcladia coulteri	S	S									S
Opuntiella californica	S	S		S	S	S					S
Plocamium coccineum	C	S									
Polyneura latissima	S	S		S		S	S				S
Polysiphonia paniculata	A	S		S							S
Ptilota densa		C									S
Rhodymenia pacifica						S					
Schizymenia epiphytica	C	C				S					
Smithora naiadum											S

APPENDIX IX - Contd.

SCIENTIFIC NAME	6	7	8	9	10	11	12	13	14	15	16
SPERMATOPHYTA											
**Phyllospadix scouleri*											C
MOLLUSCA											
Astraea gibberosa	C	C		S	S	C					S
Calliostoma annulatum	S	S			S	S	S				
Calliostoma canaliculatum	S			S	S	S					
Calliostoma ligatum	S		Not surveyed	C				Not surveyed	Not surveyed	Not surveyed	
Haliotis rufescens	1	5		2							73
Haliotis walallensis											1
Tegula brunnea		C		S		S					C
Tegula montereyi				S	S						
Tegula funebralis											S
Tegula pulligo				S		C					
ARTHROPODA											
Cancer antennarius	1										

APPENDIX IX - Contd.

SCIENTIFIC NAME	6	7	8	9	10	11	12	13	14	15	16
ECHINODERMATA											
Pycnopodia helianthoides	4	2			5	1					1
Strongylocentrotus franciscanus	340	125		333	87	80	36				97
Strongylocentrotus purpuratus	3										
BONY FISH											
Anarrhichthys ocellatus	1		Not surveyed					Not surveyed	Not surveyed	Not surveyed	
Aulorhunchus flavidus											P
Coryphopterus nicholsi	15	3		5	3	3	3				
Cottidae	1			2							
Damalichthys vacca	2	1			2						1
Embiotoca jacksoni							1				
Embiotoca lateralis	1	5		1			1				2
Hexagrammos decagrammus	1	1		2		1					
Ophiodon elongatus				2		1	2				1
Oxylebius pictus	10	5		8	1	4	4				3

APPENDIX IX - Contd.

SCIENTIFIC NAME	6	7	8	9	10	11	12	13	14	15	16
BONY FISH - Contd.											
Scorpaenichthys marmoratus	2	1	Not surveyed	1				Not surveyed	Not surveyed	Not surveyed	1
Sebastes atrovirens	2	7									1
Sebastes carnatus	2	2									
Sebastes chrysomelas	5			3		2	1				5
Sebastes melanops				23							
Sebastes mystinus	13	2				1	100				20
Sebastes serranoides-flavidus	5						3				
Sebastes spp. (Juveniles)	~400	~100		~200	~40	~300	~2,000				~40

*See Appendix I

APPENDIX X
PLANTS AND ANIMALS RECORDED AT SUBTIDAL STATIONS
OCCUPIED ON SEPT. 1, 4, 10, 11, 14, 28, 29, 1970 (1970 Fall Survey)

SCIENTIFIC NAME	6	7	8	9	10	11	12	13	14	15	16
<u>CHLOROPHYTA</u>											
Halicystis ovalis						*S					
<u>PHAEOPHYTA</u>											
Cystoseira osmundacea		S									A
Desmarestia herbacea	C	S	C	C		S		C		S	C
Desmarestia munda	S	S	S	S		S		S	S	S	S
Dictyoneurum californicum	S	S	S	C				S	S	C	C
Dictyota binghamiae		S				S					
Laminaria setchellii	S	S						S	S	C	S
Macrocystis pyrifera		847									
Nereocystis luetkeana			10					2	5	16	
Pterygophora californica	S	C				S		S	S		C
<u>RHODOPHYTA</u>											
*Articulated corallines	C	C	A	C	C	S	S	C	A	A	A
Botryoglossum farlowianum	C	C	A	S		S		A	A	S	A

APPENDIX X - Contd.

SCIENTIFIC NAME	6	7	8	9	10	11	12	13	14	15	16
RHODOPHYTA - Contd.											
Callophyllis sp.	S	S	S			S		A	C	S	S
*Crustose corallines	A	A	A	A	A	C	S	C	C	C	A
Fryeella gardneri		S					S				
Gelidium robustum									S	S	
**Gigartina californica* (group)	S	S	S	S				S	S	S	S
Hymenena flabelligera								S		C	
Iridaea splendens										S	
Laurencia spectabilis		S						S			S
Microcladia coulteri		S	C					C	S	S	C
Opuntiella californica	S	S	S	S		S		S	S	S	
Polyneura latissima		C				S	S	S	P		
Polysiphonia paniculata	C	P		C				S			
Prionitis spp.		S	C					S	S	S	S
Ptilota densa		S	C					S	S	S	
Pterochondria woodii											P

APPENDIX X - Contd.

SCIENTIFIC NAME	6	7	8	9	10	11	12	13	14	15	16
RHODOPHYTA - Contd.											
Rhodymenia californica							S				
Rhodymenia pacifica									S		
Schizymenia epiphytica	S	C	S	C	S	S	S	S		S	
Smithora naiadum											C
SPERMATOPHYTA											
**Phyllospadix scouleri*											C
MOLLUSCA											
Astraea gibberosa	S	S	S	C	C	S		S		S	S
Calliostoma annulatum		S	S			S					
Calliostoma canaliculatum		S	S			S					
Calliostoma ligatum	S	S	S	S	S	S	S	S	S	S	S
Haliotis kamtschatkana						1					
Haliotis rufescens	1	1	2						1	7	57
Tegula brunnea		S		C				S	S		C
Tegula montereyii					S						

APPENDIX X - Contd.

SCIENTIFIC NAME	6	7	8	9	10	11	12	13	14	15	16
MOLLUSCA - Contd.											
Tegula pulligo						S					
ARTHROPODA											
Cancer antennarius			4					2	1	1	2
ECHINODERMATA											
Pycnopodia helianthoides		2	2	3	1	1		2			
Strongylocentrotus franciscanus	243	247	167	274	91	79	50	152	53	206	61
BONY FISH											
Coryphopterus nicholsi	4	1		3	4	2	2			1	
Cottidae				1	2	1	1			1	
Damalichthys vacca			1								
Embiotocidae			1								
Embiotoca jacksoni	2		2					1		2	1
Embiotoca lateralis			1								
Hexagrammos decagrammus		1	1	2				1		1	

APPENDIX X - Contd.

SCIENTIFIC NAME	6	7	8	9	10	11	12	13	14	15	16
BONY FISH - Contd.											
Ophiodon elongatus				1				1		1	
Oxyjulis californica			~ 40								
Oxylebius pictus	1	5		6	3	3	4	3		2	
Pimelometopon pulchrum			1								
Scorpaenichthys marmoratus	1			1				2			
Sebastes atrovirens											1
Sebastes chrysomelas		1		3		1					1
Sebastes melanops			12								
Sebastes miniatus			1	1						2	
Sebastes mystinus	32	1	4	10	10	11	2	~500		~ 300	4
Sebastes serranoides-flavidus	1							~ 50		~35	2
Sebastes spp. (Juveniles)	~ 400	~100	~500	~300	~100	~120	13	~800	~300	~400	~100

*See Appendix I

APPENDIX XI
PLANTS AND ANIMALS RECORDED IN THE DIABLO CANYON STUDY AREA AT PERMANENT INTERTIDAL STATION TRANSECTS
OCCUPIED ON FEBRUARY 2, 9, 22, 23 and MARCH 7, 10, 1971 (1971 Winter Survey)

SCIENTIFIC NAME	STATION TRANSECTS									
	1A	1B	2A	2B	3A	3B	4A	4B	4C	5A
CHLOROPHYTA										Not surveyed
Cladophora trichotoma	*S-2,S-3	S-2			S-3					
Codium fragile		S-2								
Codium setchellii				S-2						
Ulva lactuca	S-2,S-3	S-2	S-1							
PHAEOPHYTA										
Cystoseira osmundacea						S-1				
Dictyoneurum californicum			S-1				S-1	A-1	C-1	
Egregia menziesii			S-1,S-2				S-1,S-2	S-1,S-2	S-2	
Fucus distichus				S-3		C-3				
Hesperophycus harveyanus					S-2	S-3				
Laminaria setchellii	S-1	S-1				S-1	S-1	A-1		
Pelvetia fastigiata		S-2	S-3	C-3	S-2,S-3	S-3				
Pelvetiopsis limitata	S-3	S-2								

APPENDIX XI - Contd.

SCIENTIFIC NAME	STATION TRANSECTS									
	1A	1B	2A	2B	3A	3B	4A	4B	4C	5A
<u>RHODOPHYTA</u>										
Agardhiella tenera			S-1,S-2	S-1	S-1	S-1				Not surveyed
*Articulated corallines	A-2	C-1,C-2	A-1,A-2	A-1,C-2	C-1,S-2	C-1	A-1,A-2	C-1,A-2	C-1,A-2	
Botryoglossum farlowianum	S-1		S-1	S-1		S-1	S-1			
Callithamnion pikeanum	C-2		S-1,S-2	S-1,S-2						
Callophyllis violacea			S-1				S-2			
Ceramium eatonianum			S-1							
*Crustose corallines	A-1,A-2, S-3	A-1,S-2	A-1,C-2, C-3	A-1,C-2	C-1,S-2, S-3	A-1,C-2, S-3	A-1,A-2	A-1,S-2	A-1,P-3	
Cryptopleura lobulifera	C-1,S-2									
Cryptopleura* **(group)		C-1					C-1			
Endocladia muricata	C-3	C-2	S-2,A-3	S-2,C-3	S-2	S-1,S-2, C-3			S-2,S-3	
Erythrophyllum delesserioides							C-1	S-2		

APPENDIX XI - Contd.

SCIENTIFIC NAME	STATION TRANSECTS									
	1A	1B	2A	2B	3A	3B	4A	4B	4C	5A
RHODAPHYTA - Contd.										
Gastroclonium coulteri	S-1		S-1	S-1,S-2	S-1,S-2	C-1,S-2	S-2		S-1,C-2	Not surveyed
Gelidium coulteri			S-2	S-2		S-1		S-2	S-2	
Gelidium robustum								S-1		
Gigartina canaliculata	C-2	S-2	C-1,S-2	S-2	C-1	C-1,A-2	C-2	C-2	C-2	
**Gigartina corymbifera* (group)	C-1	S-1	C-1,S-2	C-1	S-1	S-1,S-2	C-1,S-2	C-1,S-2	C-1	
**Gigartina cristata* (group)	S-2,S-3	S-2	C-2,A-3	A-2,C-3	C-1,A-2, A-3	C-2,A-3	C-2	S-2	S-1	
Halosaccion glandiforme		S-2	S-2							
Iridaea flaccida	C-2,S-3	C-2	C-1,A-2, S-3	S-1,A-2, S-3	A-1,C-2, S-3	C-1,A-2 S-3	C-2	C-2	S-1,C-2	
Iridaea heterocarpum		S-2	S-2		S-1	S-2	S-1	S-1,S-2	S-2	
Iridaea splendens	C-1,S-2	S-1	C-1	S-1	S-1	S-1	A-1			
Laurencia spectabilis			S-2	S-1	S-1				S-2	
Microcladia borealis		S-2					S-1,S-2	S-1		

APPENDIX XI - Contd.

SCIENTIFIC NAME	STATION TRANSECTS									
	1A	1B	2A	2B	3A	3B	4A	4B	4C	5A
RHODOPHYTA - Contd.										
Microcladia coulteri	S-1,S-2		S-1	C-1	S-1	C-1	S-1,S-2	S-1	S-1	Not surveyed
Petrocelis franciscana	C-2,S-3	S-2	A-2,A-3	A-2,A-3	C-1,A-2, C-3	S-2,C-3	C-2	S-2	S-2	
Pikea californica							S-1	S-1		
Polysiphonia sp.	S-1,C-2	S-1,S-2		S-1						
Porphyrella gardneri								S-1		
Prionitis australis							S-1	S-1		
Prionitis lanceolata	S-1,S-2		C-1	C-1	C-1,S-2	C-1,S-2	C-1,S-2	C-1,S-2	C-1,S-2	
Pterosiphonia baileyi	S-1									
Ptilota hypnoides							S-1			
Smithora naiadum			A-1							
SPERMATOPHYTA										
**Phyllospadix scouleri*	S-1,S-2		A-1,S-2	A-1,S-2	A-1,S-2	C-1				
COELENTERATA										
Anthopleura elegantissima	S-2,S-3	S-2	S-3	S-2,S-3	S-2	S-1,S-2, S-3	S-2	S-2	S-2,A-3	

APPENDIX XI - Contd.

SCIENTIFIC NAME	STATION TRANSECTS									
	1A	1B	2A	2B	3A	3B	4A	4B	4C	5A
COELENTERATA - Contd.										
Anthopleura xanthogrammica	S-1,C-2	S-1	S-1,S-2	S-1	S-1					
ARTHROPODA										
Cancer antennarius							(3 - juveniles)			
MOLLUSCA										Not surveyed
Astraea gibberosa					(1)	S-1				
Calliostoma ligatum							S-2		S-2	
Haliotis cracherodii	(186)	(419)	(247)	(118)	(22)	(45)	(69)	(85)	(47)	
Haliotis rufescens			(2)	(3)	(2)	(6)				
Hinnites multirugosus									(3 - juveniles)	
Lottia gigantea									S-2	
Tegula brunnea	S-1,S-2		S-1	S-1	S-1	S-1	S-1,S-2		S-1,S-2	
Tegula funebralis	S-2	C-2	S-1,C-2, A-3	A-2,A-3	C-1,A-2, C-3	A-2,C-3		S-1		
ECHINODERMATA										
Patiria miniata			(7)	(3)	(1)		(1)			

APPENDIX XI - Contd.

SCIENTIFIC NAME	STATION TRANSECTS									
	1A	1B	2A	2B	3A	3B	4A	4B	4C	5A
ECHINODERMATA - Contd.										
Pisaster ochraceous	(4)	(14)	(6)	(2)		(2)	(3)		(2)	Not surveyed
Pycnopodia helianthoides				(1)						
Strongylocentrotus purpuratus	C-2	C-1,C-2							S-2	

*See Appendix I

APPENDIX XII
PLANTS AND ANIMALS RECORDED IN THE DIABLO CANYON STUDY AREA AT PERMANENT INTERTIDAL STATION TRANSECTS OCCUPIED ON JUNE 10, 11, 12, 23, and 24, 1971. (1971 Summer Survey)

SCIENTIFIC NAME	STATION TRANSECTS									
	1A	1B	2A	2B	3A	3B	4A	4B	4C	5A
<u>CHLOROPHYTA</u>										
Bryopsis corticulans			S-2						S-2	
Cladophora trichotoma	*S-3	S-2		S-2					S-3	S-3
Codium fragile		S-2								
Codium setchellii	S-1	S-2		S-2		S-1				
Spongomorpha coalita	S-1,S-2	S-2			C-2					S-1,S-2, S-3
Ulva lactuca	S-1,S-2	C-2		S-1,S-2	S-2				S-2,S-3	S-1,S-2
<u>PHAEOPHYTA</u>										
Alaria marginata	S-1,S-2						S-1	S-1		A-1,A-2
Cystoseira osmundacea					S-1	C-1				
Desmarestia herbacea	S-1,S-2									
Dictyoneurum californicum			C-1				A-1	A-1	A-1	
Egregia menziesii	S-2			S-2		S-1	S-1,S-2	S-1,S-2	C-2	

APPENDIX XII - Contd.

SCIENTIFIC NAMES	STATION TRANSECTS									
	1A	1B	2A	2B	3A	3B	4A	4B	4C	5A
PHAEOPHYTA - Contd.										
Fucus distichus	~~S-2~~			S-3		S-3				
Haplogloia andersonii	S-1									
Hesperophycus harveyanus						S-3				
Heterochordaria abietina	S-2,S-3	C-2							C-3	S-3
Laminaria setchellii	S-1	S-1	S-2		S-1	S-1	S-1	A-1		A-1
Nereocystis luetkeana	(2)			(2)						(8)
Pelvetia fastigiata		S-2	S-3	A-3	S-2,S-3	C-2,C-3			S-2	
Pelvetiopsis limitata		S-2								
Scytosiphon lomentaria									S-3	
RHODOPHYTA										
Agardhiella tenera				C-1,S-3	S-1	S-1,S-2				
*Articulated corallines	C-1,C-2	C-1	S-1,S-2	S-1,S-2	C-1	C-1,S-2	C-1	A-1,A-2	S-1,C-2, C-3	A-1, A-2 S-3

APPENDIX XII - Contd.

SCIENTIFIC NAME	STATION TRANSECTS									
	1A	1B	2A	2B	3A	3B	4A	4B	4C	5A
RHODOPHYTA - Contd.										
Botryoglossum farlowianum	C-1		C-1	A-1	S-1		C-1	A-1		S-1,S-2
Callithamnion pikeanum	C-3	S-1,S-2	S-1,C-2	S-1,S-2	S-2	S-2	S-2	S-2	S-2,S-3	S-1,C-2 S-3
Callophyllis violacea			C-1	S-1			S-2	S-1	S-2	S-1
Ceramium eatonianum	S-1	S-2	S-1			S-1	S-2			
*Crustose corallines	A-1,A-2, S-3	A-1,S-2	A-1,C-2, C-3	A-1,S-2, S-3	A-1,S-2, S-3	A-1,S-2	C-1,S-2	P-1,A-2	P-1,A-2, P-3	A-1,A-2, S-3
Cryptopleura lobulifera	C-1,C-2	A-1	C-1	C-1,S-2	S-1,S-2	S-1	A-1,S-2	S-2	S-1,S-2	C-1
Endocladia muricata	S-2,C-3	C-1	S-2,A-3	C-3	S-2,S-3	C-3	S-2	S-2	S-2,S-3	S-3
Erythrophyllum delesserioides	S-1,S-2	C-1	S-1	S-1			A-1	A-1	S-1	A-1,A-2
Farlowia compressa							S-1			
Gastroclonium coulteri	S-1,S-2	S-2	C-1	C-1,C-2	C-1,C-2	C-1,S-2	S-2	S-1,C-2	C-1,C-2	
Gelidium coulteri	S-2	S-2	S-1	S-2	S-2	S-1		S-2		
Gelidium robustum							S-1			

APPENDIX XII - Contd.

SCIENTIFIC NAME	STATION TRANSECTS									
	1A	1B	2A	2B	3A	3B	4A	4B	4C	5A
RHODOPHYTA - Contd.										
Gigartina corymbifera* **(group)	C-1,S-2	S-1	C-1,S-2	C-1,S-2	S-1,S-2	S-1	C-1,S-2	C-1,C-2	A-1,S-2	
Gigartina cristata* **(group)	S-2,S-3	C-2	C-2,A-3	C-2,A-3	C-2,C-3	A-2,A-3	S-2	C-2	S-2	S-1
Halosaccion glandiforme	S-1,S-2, S-3		S-1,S-2	S-1,S-2	S-1,S-2	S-1,S-2				
Hymenena flabelligera								A-1	S-1,S-2	
Iridaea flaccida	A-2,C-3	C-1,A-2	A-1,A-2 S-3	S-1,A-2 C-3	S-1,A-2	A-1,A-2	A-2	A-2	A-2	S-2,S-3
Iridaea heterocarpum	S-2	S-2	S-2	S-2	S-2	S-2	S-2	S-2	S-2	S-2
Iridaea splendens	S-1,S-2	S-1	S-1,S-2	S-1	C-1,S-2	S-1	A-1	S-1,S-2	S-1,S-2	S-1
Laurencia blinksii				S-1,S-2						
Laurencia spectabilis	S-2						S-2			
Microcladia borealis	S-1,C-2	S-1	S-1		S-2	S-1	C-1,C-2	C-2	C-2,S-3	S-1,S-2
Microcladia coulteri	S-1,S-2		C-1,S-2	C-1,S-2	A-1,S-2	A-1,S-2	C-1	C-1,S-2	C-1	S-1,S-2
Petrocelis franciscana	S-2,S-3	S-2	A-2,A-3	S-1,A-2, A-3	S-1,A-2, C-3		S-2	S-2	S-2,C-3	C-2
Pikea californica			S-1							

APPENDIX XII - Contd.

SCIENTIFIC NAME	STATION TRANSECTS									
	1A	1B	2A	2B	3A	3B	4A	4B	4C	5A
RHODOPHYTA - Contd.										
Plocamium coccineum										S-1,S-2
Polyneura latissima										S-1
Polysiphonia hendryi										C-3
Polysiphonia paniculata	S-1,C-2	S-2		S-1			S-2		S-1,S-2	
Porphyra perforata	C-3	A-2	S-1,S-2, S-3	S-2,S-3	S-2	S-3	S-2	S-2	S-2,C-3	S-3
Prionitis andersonii				S-3						S-1
Prionitis lanceolata	S-1,S-2		S-1	C-1,S-2	S-1,S-2	C-1,S-2	C-1,S-2	C-1	C-1	S-1,S-2
Pterosiphonia baileyi	S-1,S-2						S-1			
Rhodymenia pacifica										S-1
Schizymenia pacifica			S-1							
Smithora naiadum			A-1	S-1						
SPERMATOPHYTA										
**Phyllospadix scouleri*	S-1		A-1,S-2	A-1,S-2	A-1,S-2	A-1				

APPENDIX XII - Contd.

SCIENTIFIC NAME	STATION TRANSECTS									
	1A	1B	2A	2B	3A	3B	4A	4B	4C	5A
COELENTERATA										
Anthopleura elegantissima	S-3	C-2	S-3	S-2,S-3	C-2	S-2,S-3	S-2		S-2,A-3	S-2,S-3
Anthopleura xanthogrammica	C-1		S-1,S-2	S-1,S-2						S-1
ARTHROPODA										
Cancer antennarius	(1)					(1)	(2)		(2)	
MOLLUSCA										
Calliostoma ligatum			(1)				S-2			
Haliotis cracherodii	(243)	(372)	(272)	(122)	(7)	(39)	(87)	(22)	(36)	(38)
Haliotis rufescens			(4)	(7)	(2)	(8)				
Hinnites multirugosus									(1)	
Lottia gigantea									S-2	
Tegula brunnea	S-1,S-2	S-1	S-1,S-2	S-1,S-2	C-1,S-2	S-1,S-2	S-1,S-2		S-1,S-2	S-1,S-2
Tegula funebralis			S-2,A-3	C-2,C-3	A-2,A-3	S-2,A-3				
ECHINODERMATA										
Patiria miniata			(19)		(4)		(1)			(3)

APPENDIX XII - Contd.

SCIENTIFIC NAME	STATION TRANSECTS									
	1A	1B	2A	2B	3A	3B	4A	4B	4C	5A
ECHINODERMATA - Contd.										
Pisaster ochraceous	(21)	(34)		(2)	(1)	(2)	(13)		(1)	(36)
Pycnopodia helianthoides				(1)		(1)				
Strongylocentrotus purpuratus	S-1,C-2	S-1,C-2					S-2			S-1,S-2

*See Appendix I

APPENDIX XIII
PLANTS AND ANIMALS RECORDED IN THE DIABLO CANYON STUDY AREA AT PERMANENT INTERTIDAL STATION TRANSECTS OCCUPIED ON OCTOBER 3,4,5,6 AND NOVEMBER 4, 1971 (1971 Fall Survey)

SCIENTIFIC NAME	STATION TRANSECTS									
	1A	1B	2A	2B	3A	3B	4A	4B	4C	5A
CHLOROPHYTA										
Bryopsis corticulans			S-1							
Cladophora trichotoma	S-3	S-2				S-3			S-3	S-3
Codium fragile		S-2								
Codium setchellii				S-2						
Spongomorpha coalita					S-1					
Ulva lactuca	S-1	C-2	S-1,S-2		S-1,C-2	S-1,S-2, S-3				
PHAEOPHYTA										
Alaria marginata							S-1,S-2	S-2		C-1,C-2
Cystoseira osmundacea						S-1				
Desmarestia herbacea	S-1				S-1					
Dictyoneurum californicum			S-1		S-1	S-1	A-1	A-1	C-1	
Egregia menziesii			S-1,S-2		S-1		S-1,S-2	C-2	C-2	

APPENDIX XIII - Contd.

SCIENTIFIC NAME	STATION TRANSECTS									
	1A	1B	2A	2B	3A	3B	4A	4B	4C	5A
PHAEOPHYTA - Contd.										
Fucus distichus				S-3	S-2	S-3				
Heterochordaria abietina	S-1,S-2, S-3	C-2							S-3	
Laminaria setchellii	S-1,S-2		S-1			S-1	S-1	A-1	S-1	C-1
Nereocystis luetkeana	(1)									(2)
Pelvetia fastigiata		S-2	S-3	C-3	S-2,S-3	C-3				
Pelvetiopsis limitata	S-3	S-2								
RHODOPHYTA										
*Articulated corallines	A-1,C-2	C-1,A-2	A-1,A-2	A-1,S-2, S-3	C-1,C-2	S-1	S-1,A-2	C-1,A-2	S-1,A-2	C-1,A-2, C-3
Agardhiella tenera				C-1	S-1,S-2	S-1,S-2				A-1,C-2
Botryoglossum farlowianum	C-1		C-1	C-1		S-1	S-1	C-1	C-1	
Callithamnion pikeanum	S-2		S-1,S-2							A-1
Callophyllis crenulata										A-1

APPENDIX XIII - Contd.

SCIENTIFIC NAME	STATION TRANSECTS									
	1A	1B	2A	2B	3A	3B	4A	4B	4C	5A
RHODOPHYTA - Contd.										
Callophyllis pinnata					S-1					
Callophyllis violacea	S-1		S-1	S-1	S-1		S-2			S-1
Ceramium eatonianum	S-2						S-2			
*Crustose corallines	A-2	A-1,S-2	C-1,C-2, C-3	A-1,C-2, S-3	A-1,C-2, C-3	C-1,C-2, S-3	C-1,C-2	A-1,A-2	C-1,A-2, C-3	A-1,C-2
Cryptopleura lobulifera	A-2	C-1,S-2	C-1,C-2	S-1,S-2			C-2	S-2	C-2	S-1
Endocladia muricata	S-2,C-3	C-2	C-2,C-3	S-2,A-3	S-2,S-3	S-2,C-3			S-2,S-3	S-2,C-3
Erythrophyllum delesserioides	S-1	S-1	S-1	S-1			C-1	S-1	S-1	C-1,S-2
Gastroclonium coulteri		C-2	C-1	C-1,S-2	C-1,S-2	C-1,C-2	S-2	S-1		
Gelidium coulteri		C-2	S-2		S-2	S-2		S-2		
Gelidium robustum	S-1									
Gigartina canaliculata	C-2	S-1,C-2	C-1,S-2	S-1,S-2	C-1,S-2	S-1,C-2	C-2	S-1,C-2	S-1,C-2	
**Gigartina corymbifera* (group)	C-1,S-2	S-1	C-1,S-2	C-1	C-1,S-2	C-1	S-2	A-1	A-1,S-2	
**Gigartina cristata* (group)		S-2	A-2,A-3	A-2,A-3	S-1,A-2, C-3	C-2,A-3		S-2	S-2,S-3	

APPENDIX XIII - Contd.

SCIENTIFIC NAMES	STATION TRANSECTS									
	1A	1B	2A	2B	3A	3B	4A	4B	4C	5A
RHODOPHYTA - Contd.										
Halosaccion glandiforme	S-1,S-2	C-2	S-1,S-2	S-1	S-1,S-2	S-2				
Hymenena flabelligera	S-1,S-2						A-1,S-2	S-1		
Iridaea flaccida	A-2,S-3	S-1,A-2	C-1,A-2, C-3	S-1,A-2, S-3	C-1,C-2, S-3	C-1,C-2, S-3	S-1,A-2	S-1,A-2	S-1,A-2	
Iridaea heterocarpum			S-1,S-2	S-1	S-1,S-2	S-2	S-2	S-2	S-2	
Iridaea splendens	C-1	C-1	C-1	S-1	S-1,S-2	S-1	S-1	C-1	C-1,S-2	S-1
Laurencia blinksii	S-2						S-2		S-2	
Laurencia spectabilis	S-2	S-2	S-1,S-2	S-1	S-1	S-1			S-1	
Microcladia borealis	C-2	S-1,S-2					C-1,S-2	S-2	S-2	
Microcladia coulteri	C-1,S-2	S-1,S-2	C-1,S-2	C-1,S-2	C-1,C-2	C-1,S-2	S-1	C-1	A-1,S-2	
Petrocelis franciscana	S-1,C-2	S-2	S-1,A-2, A-3	S-1,A-2, A-3	C-2,C-3	C-1,C-2, C-3		S-2	S-2,S-3	S-2, A-2
Plocamium coccineum		S-2								
Polysiphonia paniculata	S-1,C-2	S-2	S-1					S-2	S-2	
Porphyra perforata	S-3	C-2	S-2	S-3	C-2	S-2,S-3			S-3	
Porphyrella gardneri								C-1		
Prionitis lanceolata	S-1		C-1,S-2	C-1,S-2	C-1,S-2	C-1,S-2	S-1,S-2	C-1	C-1,S-2	S-1

APPENDIX XIII - Contd.

SCIENTIFIC NAME	STATION TRANSECTS									
	1A	1B	2A	2B	3A	3B	4A	4B	4C	5A
RHODOPHYTA - Contd.										
Pterosiphonia baileyi	S-2						S-1			
Rhodoglossum affine		S-2		S-2						
Rhodoglossum parvum			S-2							
Smithora naiadum			C-1	A-1,S-2	P-1,S-2	C-1				
SPERMATOPHYTA										
**Phyllospadix scouleri*	S-1,S-2	S-2	C-1,S-2	A-1,S-2	C-1,S-2	C-1,S-2				
COELENTERATA										
Anthopleura elegantissima	S-2,S-3	S-1,C-2	S-2,S-3	S-1,S-2, C-3	C-2	S-1,S-2, S-3			A-3	S-3
Anthopleura xanthogrammica	S-1,C-2	S-2	S-2	S-1,S-2	S-1,S-2	S-1	S-2		S-3	C-1,S-2, S-3
ARTHROPODA										
Cancer **sp.** (small)							(1)		(1)	
Cancer antennarius	(1)			(1)	(3)	(5)				
Cancer productus				(1)			(1 - juvenile)		(1 - juvenile)	

APPENDIX XIII - Contd.

SCIENTIFIC NAME	STATION TRANSECTS									
	1A	1B	2A	2B	3A	3B	4A	4B	4C	5A
MOLLUSCA										
Astraea gibberosa					(3)	(4)				
Calliostoma ligatum										S-1,S-2
Haliotis cracherodii	(214)	(343)	(281)	(100)	(37)	(54)	(65)	(59)	(48)	(30)
Haliotis rufescens			(2)	(1)	(3)	(8)				
Lottia gigantea	S-3		S-3						S-3	
Tegula brunnea	C-1,S-2	S-2	S-1,S-2	S-1,S-2, S-3	S-2	S-1,S-2	S-2	C-1,S-2	C-2	C-1
Tegula funebralis		S-2	A-2,A-3	S-1,A-2	A-2,A-3	A-2,A-3				
ECHINODERMATA										
Patiria miniata			(6)	(1)	(3)	(3)	(1)			P
Pisaster ochraceous	(13)	(35)	(2)		(1)	(3)	(4)		(1)	(28)
Pycnopodia helianthoides			(2)	(2)	(2)	(3)				
Strongylocentrotus franciscanus			(1)							
Strongylocentrotus purpuratus	A-2	C-1,C-2	S-2				C-2	S-2	C-2	C-1

*See Appendix I

APPENDIX XIV
PLANTS AND ANIMALS RECORDED IN THE DIABLO CANYON STUDY AREA AT PERMANENT INTERTIDAL STATION 1/4m QUADRATS
OCCUPIED ON FEBRUARY 7, 8, 9, 22, 23 and MARCH 10, 1971 (1971 Winter Survey)

SCIENTIFIC NAME	QUADRATS																					
	1Aa	1Ab	1Ac	1Ba	2Aa	2Ab	2Ba	2Bb	2Bc	3Aa	3Ab	3Ac	3Ad	3Ba	3Bb	3Bc	4Aa	4Ba	4Ca	5Aa	5Ab	5Ac
<u>CHLOROPHYTA</u>																						
Cladophora trichotoma			*S								S											
Ulva lactuca			S																			
Ulva sp.																	S					
<u>PHAEOPHYTA</u>																						
Alaria marginata																	S				Not Surveyed	
Egregia menziesii																		7				
Hesperophycus harveyanus											7											
Pelvetia fastigiata									5		5											
<u>RHODOPHYTA</u>																						
*Articulated corallines	S	C		A	C			S		S				C			C	S				
Callithamnion pikeanum		S			S																	
Ceramium eatonianum					P																	

APPENDIX XIV - Contd.

SCIENTIFIC NAME	QUADRATS																					
	1Aa	1Ab	1Ac	1Ba	2Aa	2Ab	2Ba	2Bb	2Bc	3Aa	3Ab	3Ac	3Ad	3Ba	3Bb	3Bc	4Aa	4Ba	4Ca	5Aa	5Ab	5Ac
RHODOPHYTA - Contd.																						
*Crustose corallines	A	A		A	C	S	C	S		A	S	S	S	C	C	S	A	A				
**Cryptopleura* (group)																	S					
Endocladia muricata			S			C			S		C					S						
Erythrophyllum delesserioides																		S				
Gastroclonium coulteri							C			C				C	S							
Gelidium coulteri					S										S							
Gigartina canaliculata					C			A						S	A							
**Gigartina corymbifera* (group)										S											Not Surveyed	
**Gigartina cristata* (group)						C		A	C		S		C		S	A						
Halosaccion glandiforme					S																	
Iridaea flaccida			S	S	A		C	S		C				S	C	S	S	S				
Iridaea heterocarpum					S																	
Iridaea splendens	S																					

APPENDIX XIV - Contd.

SCIENTIFIC NAME	QUADRATS																					
	1Aa	1Ab	1Ac	1Ba	2Aa	2Ab	2Ba	2Bb	2Bc	3Aa	3Ab	3Ac	3Ad	3Ba	3Bb	3Bc	4Aa	4Ba	4Ca	5Aa	5Ab	5Ac
<u>RHODOPHYTA - Contd.</u>																						
Laurencia spectabilis	S						S										S					
Microcladia borealis				S													C					
Microcladia coulteri										S				S			S					
Petrocelis franciscana				S	C	S	C	A	A	S	C	S	C		S	A						
Polysiphonia paniculata		S		S			S															
Prionitis lanceolata										C							S					
<u>SPERMATOPHYTA</u>																						
* *Phyllospadix scouleri*										C				S								
<u>COELENTERATA</u>																						
Anthopleura elegantissima	7		1						1								2		C		Not Surveyed	
Anthopleura xanthogrammica		6																				
<u>ARTHROPODA</u>																						
Balanus **spp.**		C	A	4		A											S					
Cancer antennarius																	1					
Pachygrapsus crassipes				1									2									

APPENDIX XIV - Contd.

SCIENTIFIC NAME	QUADRATS																					
	1Aa	1Ab	1Ac	1Ba	2Aa	2Ab	2Ba	2Bb	2Bc	3Aa	3Ab	3Ac	3Ad	3Ba	3Bb	3Bc	4Aa	4Ba	4Ca	5Aa	5Ab	5Ac
ARTHROPODA - Contd.																						
Pagurus sp.							P			P	P	P	P	P	P	P						
Pollicipes polymerus			C	1															A			
Pugettia producta					1																	
Tetraclita squamosa rubescens			16																7			
MOLLUSCA																						
Acmaea mitra	4	3																				
Astraea gibberosa										3												
Collisella digitalis											1				1			1				
Collissella pelta																			2			
Collissella scabra					7	A					3	20				11			11			Not Surveyed
Crepidula adunca						1																
Cyanoplax sp.						1					1											
Fissurella volcano	2				2		3	1							2		1					
Haliotis cracherodii	1	13		1													1					

APPENDIX XIV - Contd.

SCIENTIFIC NAME	1Aa	1Ab	1Ac	1Ba	2Aa	2Ab	2Ba	2Bb	2Bc	3Aa	3Ab	3Ac	3Ad	3Ba	3Bb	3Bc	4Aa	4Ba	4Ca	5Aa	5Ab	5Ac
MOLLUSCA - Contd.																						
Littorina planaxis			C			10																
Littorina scutulata											A											
Mopalia muscosa					1																	
Mytilus californianus		S	C	2													2		A			
Notoacmea scutum			A	1							3	9	1			1						
Nuttallina californica	2		13	66																		
Ocenebra circumtexta												3							1			
Tegula brunnea		2												1								
Tegula funebralis					8				6	4	17	6	23		8	31					Not Surveyed	
Thais emarginata			1																			
Tonicella lineata	4	1		1														1				
ECHINODERMATA																						
Leptasterias pusilla	1	1		1			1										1					
Patiria miniata															1							

APPENDIX XIV - Contd.

SCIENTIFIC NAME	QUADRATS																					
	1Aa	1Ab	1Ac	1Ba	2Aa	2Ab	2Ba	2Bb	2Bc	3Aa	3Ab	3Ac	3Ad	3Ba	3Bb	3Bc	4Aa	4Ba	4Ca	5Aa	5Ab	5Ac
<u>ECHINODERMATA - Contd.</u>																						Not Surveyed
Pisaster ochraceous		1	2	1				2														
Strongylocentrotus purpuratus	59	33		33													25		1			

* See Appendix I

APPENDIX XV
PLANTS AND ANIMALS RECORDED IN THE DIABLO CANYON STUDY AREA AT PERMANENT INTERTIDAL STATION 1/4m QUADRATS OCCUPIED ON JUNE 10, 11, 12, 23 and 24, 1971(1971 Summer Survey)

SCIENTIFIC NAME	QUADRATS																					
	1Aa	1Ab	1Ac	1Ba	2Aa	2Ab	2Ba	2Bb	2Bc	3Aa	3Ab	3Ac	3Ad	3Ba	3Bb	3Bc	4Aa	4Ba	4Ca	5Aa	5Ab	5Ac
<u>CHLOROPHYTA</u>																						
Cladophora trichotoma			S																			
Codium setchellii	S			S																		
Spongomorpha coalita		S			S																	
Ulva lactuca	S		S	S	S														S			
<u>PHAEOPHYTA</u>																						
Alaria marginata	1																31	5		147	92	
Desmarestia herbacea		S																				
Egregia menziesii																		6				
Fucus distichus											1											
Haplogloia andersonii	S																					
Hesperophycus harveyanus											4											
Heterochordaria abietina			S	S															S			
Laminaria setchellii																		5		9		

APPENDIX XV - Contd.

SCIENTIFIC NAME	QUADRATS																					
	1Aa	1Ab	1Ac	1Ba	2Aa	2Ab	2Ba	2Bb	2Bc	3Aa	3Ab	3Ac	3Ad	3Ba	3Bb	3Bc	4Aa	4Ba	4Ca	5Aa	5Ab	5Ac
<u>PHAEOPHYTA - Contd.</u>																						
Nereocystis luetkeana																					1	
Pelvetia fastigiata									5		11					C						
<u>RHODOPHYTA</u>																						
Agardhiella tenera										S												
*Articulated corallines	C	C		C	C					S				C			C	S	S	A	A	
Callithamnion pikeanum		S			S		S										S			S	A	
Ceramium eatonianum		S			S		S															
*Crustose corallines	A	A		A	C	S	S	S		C	S		S	S	S	S	A	A	C	A	A	
Cryptopleura lobulifera	C	C								S					S		A	S				
Endocladia muricata			C	S		C			S		C	S							S			S
Erythrophyllum delesserioides																		S		A	S	
Gastroclonium coulteri							A			A					S							
Gelidium coulteri		S			S																	

APPENDIX XV - Contd.

SCIENTIFIC NAME	QUADRATS																					
	1Aa	1Ab	1Ac	1Ba	2Aa	2Ab	2Ba	2Bb	2Bc	3Aa	3Ab	3Ac	3Ad	3Ba	3Bb	3Bc	4Aa	4Ba	4Ca	5Aa	5Ab	5Ac
RHODOPHYTA - Contd.																						
Gigartina canaliculata					S		C							S	C							
**Gigartina corymbifera* (group)										S												
**Gigartina cristata* (group)	S				S	C		A	S		C	C	C		A	A						S
Halosaccion glandiforme	S	S			C									S								
Iridaea flaccida			S	S	A		C	C						C	A	S	S	S			S	
Iridaea heterocarpum					S										S			S				
Iridaea splendens	S									S				S				C				
Laurencia spectabilis	C																C					
Microcladia borealis	S	S		S	S												A				S	
Microcladia coulteri		S								C				A	S			S		S		
Petrocelis franciscana	S	S		S	C	S	S	A	A		C	C	A					S	C	S	S	
Plocamium coccineum																					S	
Polysiphonia paniculata	C	C		C			S															
Porphyra perforata			C		S													S	C			

APPENDIX XV - Contd.

SCIENTIFIC NAME	QUADRATS																					
	1Aa	1Ab	1Ac	1Ba	2Aa	2Ab	2Ba	2Bb	2Bc	3Aa	3Ab	3Ac	3Ad	3Ba	3Bb	3Bc	4Aa	4Ba	4Ca	5Aa	5Ab	5Ac
RHODOPHYTA - Contd.																						
Prionitis lanceolata										S				C			S	S		C		
Pterosiphonia baileyi	S																					
SPERMATOPHYTA																						
* *Phyllospadix scouleri*										C				A								
COELENTERATA																						
Anthopleura elegantissima	11			1					2								3	1	C			
Anthopleura xanthogrammica		6																				
Epiactus prolifera																		1				
ARTHROPODA																						
Balanus sp.			A			A						18	P						A			A
Cancer antennarius	1									1												
Hemigrapsus nudus											1				1							
Pachgrapsus crassipes			1	3																		
Pagurus sp.					P		P			P	P		P			P						

NOTE: The remaining pages of this report should be Page 323 to Page 423.

APPENDIX XV - Contd.

SCIENTIFIC NAME	QUADRATS																					
	1Aa	1Ab	1Ac	1Ba	2Aa	2Ab	2Ba	2Bb	2Bc	3Aa	3Ab	3Ac	3Ad	3Ba	3Bb	3Bc	4Aa	4Ba	4Ca	5Aa	5Ab	5Ac
ARTHROPODA - Contd.																						
Pollicipes polymerus	1		A																19			C
Pugettia producta							1			1											1	
Pugettia richii										2				1								
Tetraclita squamosa rubescens			18		3														10			3
MOLLUSCA																						
Acmaea mitra		1															1					
Amphineura													1									
Astraea gibberosa														1								
Collisella asmi																			P		1	
Collisella digitalis			A														1					A
Collisella limatula												3										
Collisella pelta	9	2	4	2	1				1		6							2				
Collisella scabra				18	3	c					11	22				3			A			A

APPENDIX XV - Contd.

SCIENTIFIC NAME	QUADRATS																					
	1Aa	1Ab	1Ac	1Ba	2Aa	2Ab	2Ba	2Bb	2Bc	3Aa	3Ab	3Ac	3Ad	3Ba	3Bb	3Bc	4Aa	4Ba	4Ca	5Aa	5Ab	5Ac
MOLLUSCA - Contd.																						
Cyanoplax **spp.**					1								2									1
Diodora aspera																						1
Fissurella volcano																	2					
Haliotis cracherodii	1	9																				
Littorina planaxis			C								24								P			
Lottia gigantea																			1			2
Mytilus californianus	2		A																A			A
Notoacmea scutum				2		2		1					1									
Nuttallina californica	4		5	92															1			2
Stenoplax conspicua																						2
Tegula brunnea	1	2					4							1				2		1		
Tegula funebralis						5		19	10		107	4	7			10						
Tonicella lineata	1			2													2	2				1

APPENDIX XV - Contd.

SCIENTIFIC NAME	QUADRATS																					
	1Aa	1Ab	1Ac	1Ba	2Aa	2Ab	2Ba	2Bb	2Bc	3Aa	3Ab	3Ac	3Ad	3Ba	3Bb	3Bc	4Aa	4Ba	4Ca	5Aa	5Ab	5Ac
<u>ECHINODERMATA</u>																						
Leptasterias hexactis								1												2		
Leptasterias pusilla	2			8			3			5		1					2			1	1	
Pisaster ochraceus																1		1				
Strongylocentrotus purpuratus	48	17		36													14					
<u>CHORDATA</u>																						
Styela montereyensis														P								

* See Appendix I

APPENDIX XVI
PLANTS AND ANIMALS RECORDED IN THE DIABLO CANYON STUDY AREA AT PERMANENT INTERTIDAL STATION 1/4m QUADRATS OCCUPIED ON OCTOBER 3,4,5,6 and NOVEMBER 4,1971 (1971 Fall Survey)

SCIENTIFIC NAME	QUADRATS																					
	1Aa	1Ab	1Ac	1Ba	2Aa	2Ab	2Ba	2Bb	2Bc	3Aa	3Ab	3Ac	3Ad	3Ba	3Bb	3Bc	4Aa	4Ba	4Ca	5Aa	5Ab	5Ac
CHLOROPHYTA																						
Cladophora trichotoma			S																S			
Ulva lactuca				S								C										
PHAEOPHYTA																						
Alaria marginata																	27	3		59	9	
Egregia menziesii																		7				
Fucus distichus											1											
Heterochordaria abietina			S	S															S			
Laminaria setchellii																		5				
Pelvetia fastigiata									6		7											
RHODOPHYTA																						
Agardhiella tenera										S												
*Articulated corallines	S	C	A	A	S									C			S	C	S	C	A	

APPENDIX XVI - Contd.

SCIENTIFIC NAME	QUADRATS																					
	1Aa	1Ab	1Ac	1Ba	2Aa	2Ab	2Ba	2Bb	2Bc	3Aa	3Ab	3Ac	3Ad	3Ba	3Bb	3Bc	4Aa	4Ba	4Ca	5Aa	5Ab	5Ac
RHODOPHYTA - Contd.																						
Callithammnion pikeanum							S															
Ceramium eatonianum							S															
*Crustose corallines		A	A	A	A	S	C	S		S	S	S		S	C	S	A	A	S	A	A	
Cryptopleura lobulifera	C	C		S			S										C	S				
Endocladia muricata			C			C		S	S		C					S						
Erythrophyllum delesserioides																		S		S		
Gastroclonium coulteri							S			A				S	S							
Gelidium coulteri				C	S																	
Gelidium pusillum													S									
Gigartina canaliculata		S			S		S							S	S							
**Gigartina corymbifera* (group)										S												
**Gigartina cristata* (group)					C	C		A	C		C	C	C		S	A						

APPENDIX XVI -Contd.

SCIENTIFIC NAME	QUADRATS																					
	1Aa	1Ab	1Ac	1Ba	2Aa	2Ab	2Ba	2Bb	2Bc	3Aa	3Ab	3Ac	3Ad	3Ba	3Bb	3Bc	4Aa	4Ba	4Ca	5Aa	5Ab	5Ac
RHODOPHYTA - Contd.																						
Halosaccion glandiforme					S																	
Hymenena flabelligera																		S				
Iridaea flaccida	S	S	S	S	A		S	S						S	C	S		C				
Iridaea splendens										S							S	S				S
Laurencia blinksii	S																S					
Laurencia spectabilis	S	S								S												
Microcladia borealis	S	S		S													S					
Microcladia coulteri							S			S				S								
Petrocelis franciscana				C	C	S	C	A	A	S	C	C	A	S	C	C		S	S		S	
Polysiphonia paniculata		S		C	S		S															
Porphyra perforata			S									S	S						S			
Prionitis lanceolata										S			C				9	S		S		
Pterosiphonia baileyi	S																					
Rhodoglossum affine								S														
Smithora naiadum										P				C								

APPENDIX XVI - Contd.

SCIENTIFIC NAME	QUADRATS																				
	1Aa	1Ab	1Ac	1Ba	2Aa	2Ab	2Ba	2Bb	2Bc	3Aa	3Ab	3Ac	3Ad	3Ba	3Bb	3Bc	4Aa	4Ba	4Ca	5Aa	5Ab	5Ac
SPERMATOPHYTA																						
**Phyllospadix scouleri*										C				A								
COELENTERATA																						
Anthopleura elegantissima	6								3										A			
Anthopleura xanthogrammica		6																	1			
Corynactis californica		P																				
ARTHROPODA																						
Balanus sp.	S	S	A		S	C					S	S	S					S	A	S	S	A
Cancer sp.							1															
Cancer antennarius		1												2								
Idothea sp.										2												
Pachygrapsus crassipes												1	1									
Pagurus sp.										P												
Petrolisthes manimaculis		1																				

APPENDIX XVI - Contd.

SCIENTIFIC NAME	QUADRATS																					
	1Aa	1Ab	1Ac	1Ba	2Aa	2Ab	2Ba	2Bb	2Bc	3Aa	3Ab	3Ac	3Ad	3Ba	3Bb	3Bc	4Aa	4Ba	4Ca	5Aa	5Ab	5Ac
ARTHROPODA - Contd.																						
Pollicipes polymerus			C																A			C
Pugettia producta							2	1						3				1				
Tetraclita squamosa rubescens			12																8			5
MOLLUSCA																						
Acanthina punctulata										1			1									
Acmaea mitra			1																			
Amphineura			2																			
Astraea gibberosa										1												
Collisella asmi			1													4						C
Collisella digitalis			A								C	C	C						C			C
Collisella pelta			4								2	2										
Collisella scabra					S	A					P	P	P						A			A
Crepidula adunca														1								

APPENDIX XVI - Contd.

SCIENTIFIC NAME	QUADRATS																					
	1Aa	1Ab	1Ac	1Ba	2Aa	2Ab	2Ba	2Bb	2Bc	3Aa	3Ab	3Ac	3Ad	3Ba	3Bb	3Bc	4Aa	4Ba	4Ca	5Aa	5Ab	5Ac
MOLLUSCA - Contd.																						
Cyanoplax spp.					1																	1
Fissurella volcano					1												3	3				
Haliotis cracherodii		13						2									2	2				
Haliotis rufescens																		1				
Littorina planaxis			P																			
Littorina scutulata						2					C		3			3			1			
Mopalia muscosa																				1		
Mytilus californianus	2		C		1														A			A
Nuttallina californica	2		6	62	1														P			
Ocenebra circumtexta					1						1					1						
Tegula brunnea							1							3	1			2		3		
Tegula funebralis					1	2		16	3		42	4	27		1	26						
Thais emarginata																						12
Tonicella lineata	5	1		1													4			4	1	

APPENDIX XVI - Contd.

SCIENTIFIC NAME	QUADRATS																					
	1Aa	1Ab	1Ac	1Ba	2Aa	2Ab	2Ba	2Bb	2Bc	3Aa	3Ab	3Ac	3Ad	3Ba	3Bb	3Bc	4Aa	4Ba	4Ca	5Aa	5Ab	5Ac
<u>ECHINODERMATA</u>																						
Leptasterias pusilla	1	1		1			7	1		6				3						5		
Strongylocentrotus purpuratus	54	31		37	2		6										24			7		

* See Appendix I

APPENDIX XVII
PLANTS AND ANIMALS RECORDED AT SUBTIDAL STATIONS
OCCUPIED ON FEBRUARY 1 & 4, MARCH 19 and APRIL 5, 1971 (1971 Winter Survey)

SCIENTIFIC NAME	6	7	8	9	10	11	12	13	14	15	16
CHLOROPHYTA											
Ulva sp.	*S										
PHAEOPHYTA											
Alaria marginata	S										
Cystoseira osmundacea	S	S									
Desmarestia herbacea	**S		**C	**S				Not surveyed	Not surveyed		Not surveyed
Desmarestia munda	S	S									
Dictyoneurum californicum	S	S	S	S						C	
Dictyota binghamiae		S									
Laminaria setchellii	S	S								C	
Macrocystis pyrifera		378									
Nereocystis luetkeana			2								
Pterygophora californica	S	S									
RHODOPHYTA											
*Articulated corallines	C	S	C	C	S	S				C	

APPENDIX XVII - Contd.

SCIENTIFIC NAME	6	7	8	9	10	11	12	13	14	15	16
RHODOPHYTA - Contd.											
Botryoglossum farlowianum	C	S	A	S				Not surveyed	Not surveyed	C	Not surveyed
Callophyllis flabellulata	S					S					
Callophyllis obtusifolia			S								
Callophyllis pinnata	S	S	S	S						C	
*Crustose corallines	C	A	S	A	A	A	A			C	
Gelidium robustum										S	
**Gigartina californica* (group)	S	S	C							S	
Gymnogongrus platyphyllus	S										
Hymenena flabelligera			S							C	
Iridaea splendens	S	S								S	
Laurencia spectabilis		S									
Microcladia coulteri		S	C	S						S	
Opuntiella californica	S	C	S	S		S					
Pikea californica			S								
Polyneura latissima	S	S	S			S					

APPENDIX XVII - Contd.

SCIENTIFIC NAME	6	7	8	9	10	11	12	13	14	15	16
RHODOPHYTA - Contd.											
Polysiphonia paniculata	S	S		S							
Prionitis australis			S	S							
Prionitis lanceolata	S		C	S						S	
Ptilota densa	S	S	C	S						S	
Rhodoptilum densum	S										
Rhodymenia pacifica			A			S					
Schizymenia epiphytica	S	C	S	S	S	S	S	Not surveyed	Not surveyed		Not surveyed
ARTHROPODA											
Cancer antennarius	1	3		1						2	
MOLLUSCA											
Astraea gibberosa	S	S	S	C	S	C				S	
Calliostoma annulatum	S	S	S	S		S				S	
Calliostoma canaliculatum		S				S				S	
Calliostoma ligatum	S	S	C	C	S	S	S			C	
Haliotis kamtschatkana	1	1									

APPENDIX XVII - Contd.

SCIENTIFIC NAME	6	7	8	9	10	11	12	13	14	15	16
MOLLUSCA - Contd.											
Haliotis rufescens		5									
Tegula brunnea		C	S								
Tegula montereyi	S	S		S	S						
Tegula pulligo				S	S	S					
ECHINODERMATA											
Pycnopodia helianthoides	2	1	1	6	4	1	1	Not surveyed	Not surveyed	1	Not surveyed
Strongylocentrotus franciscanus	203	293	187	359	116	107	35			317	
Strongylocentrotus purpuratus	8										
BONY FISH											
Aulorhynchus flavidus		2	4								
Citharichthys stigmaeus		9									
Coryphopterus nicholsi	11	5		9	8	1	2			3	
Cottidae	7	4	3	1	3		3			1	
Damalichthys vacca	5		1							4	

APPENDIX XVII - Contd.

SCIENTIFIC NAME	6	7	8	9	10	11	12	13	14	15	16
BONY FISH - Contd.											
Embiotoca jacksoni	2		2	2				Not surveyed	Not surveyed	2	Not surveyed
Embiotoca lateralis	1	2	1	2						4	
Hexagrammos decagrammus	2	2	1	1	2	2					
Ophiodon elongatus	1	1				1	1			1	
Oxylebius pictus	8	5	5	8	4	2	3			6	
Scorpaenichthys marmoratus	3		2			1	1			2	
Sebastes atrovirens	1	1		2							
Sebastes carnatus	1	2			1		1				
Sebastes caurinus	1										
Sebastes chrysomelas	4	7	2	1	1					3	
Sebastes miniatus		1									
Sebastes mystinus	~500	1	1	12		7				~ 2,000	
Sebastes serranoides	7	1		2		3				4	
Sebastes spp. (Juveniles)	~ 500	~600	~200	~600	14	~200	~ 50			~ 400	

*See Appendix I

**Small plants 1 - 2" in height

APPENDIX XVIII
PLANTS AND ANIMALS RECORDED AT SUBTIDAL STATIONS OCCUPIED ON JUNE 3 & 4 and JULY 16 & 17, 1971 (1971 Summer Survey)

SCIENTIFIC NAME	6	7	8	9	10	11	12	13	**14	15	16
<u>CHLOROPHYTA</u>											
Halicystis ovalis		S		S		S					
Spongomorpha coalita				S							
Ulva sp.	S			S	S				S	S	S
<u>CHRYSOPHYTA</u>											
Biddulphia sp.	*C			A					S	S	
<u>PHAEOPHYTA</u>								Not surveyed			
Alaria marginata									S		
Coilodesme californica											S
Cystoseira osmundacea	S	S									C
Desmarestia herbacea	C	S	C	C	S				S	S	S
Desmarestia munda	S	C	S	S		S			C	S	S
Dictyoneurum californicum	S	S	S	S					C	C	C
Dictyota binghamiae	S	S									
Egregia menziesii											S

APPENDIX XVIII - Contd.

SCIENTIFIC NAME	6	7	8	9	10	11	12	13	**14	15	16
PHAEOPHYTA - Contd.								Not surveyed			
Laminaria setchellii	S	S							S	C	S
Macrocystis pyrifera		200									
Nereocystis luetkeana	17	58	19	11			3		1	6	6
Pterygophora californica	S	S					****S		S		A
RHODOPHYTA											
*Articulated corallines	C	S	C	C	S	S	S		A	A	A
Botryoglossum farlowianum	S	S	A	S					A	A	A
Callophyllis flabellulata		S	S	S	S	S	S			S	
Callophyllis obtusifolia	S	S	S						S	S	S
Callophyllis pinnata	S	S	C	S					A	C	S
Callophyllis violacea		S	S	S					S		
*Crustose corallines	A	A	A	A	A	A	A		C	A	A
Cryptopleura lobulifera									S		
Erythrophyllum delesserioides	S		S	S					S	S	

APPENDIX XVIII - Contd.

SCIENTIFIC NAME	6	7	8	9	10	11	12	13	**14	15	16
RHODOPHYTA - Contd.											
Farlowia mollis									S		
Fryeella gardneri		S									
Gelidium purpurascens											S
Gelidium robustum									S	S	S
**Gigartina californica* (group)	S		S	S					S	S	S
Halymenia sp.							S	Not surveyed			
Hymenena flabelligera									S	S	
Iridaea splendens	S		S	S					S	S	S
Laurencia spectabilis			S								S
Microcladia borealis										S	S
Microcladia coulteri	S	S	S	S					C	S	S
Opuntiella californica	S	S	S	S		S	S			S	
Petrocelis franciscana											S
Pikea californica		S								S	S
Platythamnion villosum			S								

APPENDIX XVIII - Contd.

SCIENTIFIC NAME	6	7	8	9	10	11	12	13	**14	15	16
RHODOPHYTA - Contd.											
Polyneura latissima	S	C	S	S	S	S	S	Not surveyed	S	S	S
Polysiphonia pacifica			S								
Polysiphonia paniculata	S	C	S	C	S					S	S
Prionitis australis			S								
Prionitis lanceolata	S	S	S	S					S	S	S
Pseudogloiophloea confusa	S				S		S			S	S
Pterosiphonia baileyi											S
Ptilota densa	S	S	S	S					S	S	S
Ptilota hypnoides									S		
Rhodoglossum roseum				S							
Rhodymenia **spp.**		C	S	S		S	S		C	S	
Schizymenia epiphytica	S	S	S	S	S	S	S				
Smithora naiadum											S
SPERMATOPHYTA											
**Phyllospadix scouleri*											S

APPENDIX XVIII - Contd.

SCIENTIFIC NAME	6	7	8	9	10	11	12	13	**14	15	16
ARTHROPODA											
Cancer antennarius		1	1						1	1	1
Pugettia producta				1							
MOLLUSCA											
Astraea gibberosa	S	S	S	S	C	S			S	S	S
Calliostoma annulatum	S	S	S				S				
Calliostoma canaliculatum			S			S					
Calliostoma ligatum	S	S	S	S	S	S	S	Not surveyed	S	S	S
Haliotis rufescens		7								12	89
Haliotis walallensis											1
Tegula brunnea	S	S		C	S						C
Tegula montereyi	S	S			S						
Tegula pulligo				S	S	S					S
ECHINODERMATA											
Pycnopodia helianthoides	1	4		3	1				1		5

APPENDIX XVIII - Contd.

SCIENTIFIC NAME	6	7	8	9	10	11	12	13	**14	15	16
ECHINODERMATA - Contd.											
Strongylocentrotus franciscanus	346	***342	265	345	107	99	20		17	227	78
Strongylocentrotus purpuratus	27			5							
BONY FISH											
Cebidichthys violaceus											1
Coryphopterus nicholsi	11	2		2	6		3		1	3	1
Cottidae	1		2	2	8	1	3	Not surveyed		1	
Damalichthys vacca	1			3	1		1			2	2
Embiotoca jacksoni		1	3	2					2	6	6
Embiotoca lateralis		1	1							2	2
Hexagrammos decagrammus	1	1	3	1	1					2	3
Ophiodon elongatus	2		4		1		1		1	3	
Oxyjulis californica											
Oxylebius pictus	4	5	5	6	3	5	8		2	5	3
Scorpaenichthys marmoratus	1		1						1		1

APPENDIX XVIII - Contd.

SCIENTIFIC NAME	6	7	8	9	10	11	12	13	**14	15	16
<u>BONY FISH - Contd.</u>											
Sebastes atrovirens	1									3	5
Sebastes carnatus							1				
Sebastes caurinus	1	3						Not surveyed			
Sebastes chrysomelas	1	2	1	5	3				1	1	3
Sebastes melanops	1			3	2				1	12	4
Sebastes mystinus	~ 1,000	~200	21	31	35	~75			~ 60	~2,000	8
Sebastes serranoides		1		2		3			2	33	
Sebastes spp. (Juveniles)	~ 500	~1,000	~2,000	~200	~100	~750	~3,000		~ 500	~3,000	~ 500

* See Appendix I
** Survey near but not on permanent station
*** 25% were juveniles in *Macrocystis* holdfast
**** Small plants, 12 inches in height

APPENDIX XIX
PLANTS AND ANIMALS RECORDED AT SUBTIDAL STATIONS
OCCUPIED ON SEPTEMBER 21, 22, 23, 24 and OCTOBER 14, 1971 (1971 Fall Survey)

SCIENTIFIC NAME	6	7	8	9	10	11	12	13	14	15	16
CHLOROPHYTA											
Halicystis ovalis	S	S									S
Ulva sp.	S										
PHAEOPHYTA											
Cystoseira osmundacea	S	S		S							C
Desmarestia herbacea	C	S	S	S				S	S	S	S
Desmarestia munda	S	S	S	S				S	S	S	S
Dictyoneurum californicum	S	S	S	C					S	C	C
Dictyota binghamiae		S									
Laminaria setchellii	S	S						A	S	C	S
Macrocystis pyrifera		118									
Nereocystis luetkeana	7	20	20							2	1
Pterygophora californica	S										C
RHODOPHYTA											
*Articulated corallines	C	C	A	C	S			A	A	C	A

APPENDIX XIX - Contd.

SCIENTIFIC NAME	6	7	8	9	10	11	12	13	14	15	16
RHODOPHYTA - Contd.											
Botryoglossum farlowianum	C	S	A	S				C	A	C	A
Callophyllis firma	S	S	S								
Callophyllis flabellulata	S	S	S	S		S				S	
Callophyllis obtusifolia			C	S				S	S	S	
Callophyllis pinnata	S	S	C	S				S	S	S	S
Callophyllis violacea			S					S		S	S
*Crustose corallines	C	A	A	A	A	C	A	A	A	A	A
Erythrophyllum delesserioides			S					S	S	S	
Gelidium robustum									S	S	S
**Gigartina californica* (group)		S	C					S	S	S	S
Hymenena flabelligera		S	S	S				C	A	C	
Iridaea splendens	S		S					S	S	S	
Laurencia spectabilis		S	S						S		
Microcladia borealis											S
Microcladia coulteri	S	S	S					S	S	S	S

APPENDIX XIX - Contd.

SCIENTIFIC NAME	6	7	8	9	10	11	12	13	14	15	16
RHODOPHYTA - Contd.											
Opuntiella californica	S	S	S			S		S		S	
Pikea californica			S						S		
Pikea pinnata										S	
Polyneura latissima	S	C	S			S	S	S	S	S	
Polysiphonia paniculata	S	S		S							
Prionitis lanceolata			S					S	S	S	
Pseudogloiophloea confusa	S	S		S						S	
Pterochondria woodii											P
Pterosiphonia baileyi	S										
Ptilota densa	S		S	S				C	C	S	S
Rhodoptilum densum	S	S									
Rhodymenia spp.	S	S	S			S		S	S	S	
Schizymenia epiphytica	S	C	S	S	S	S	S				
Smithora naiadum											S

APPENDIX XIX - Contd.

SCIENTIFIC NAME	6	7	8	9	10	11	12	13	14	15	16
SPERMATOPHYTA											
**Phyllospadix scouleri*											C
ARTHROPODA											
Cancer antennarius			1	1				1	3	4	4
MOLLUSCA											
Astraea gibberosa	S	S	S	C	C	C	S				C
Calliostoma annulatum	S	S	S				S				
Calliostoma canaliculatum	S	S			S			S			
Calliostoma ligatum	S	S	S	S	S			S	S	S	S
Haliotis kamtschatkana						1					
Haliotis rufescens		3	5	1				1		6	90
Tegula brunnea	S	S		S						S	C
Tegula gloriosum			S								
Tegula montereyi		S		S							
Tegula pulligo		S		S							

APPENDIX XIX - Contd.

SCIENTIFIC NAME	6	7	8	9	10	11	12	13	14	15	16
ECHINODERMATA											
Pycnopodia helianthoides	1	4	3	4	5	2		1	2	3	2
Strongylocentrotus franciscanus	232	191	321	361	104	47	37	82	99	212	157
Strongylocentrotus purpuratus	20							3			
BONY FISH											
Coryphopterus nicholsi	13		1	5	6		3		1		
Cottidae	8	11	3	6	4	1	5	3		1	3
Damalichthys vacca			1	6		2					22
Embiotoca jacksoni	3	3	3			2			2	4	3
Embiotoca lateralis	3	2		4							
Hexagrammos decagrammus	3	3		2	2			1	3	3	3
Ophiodon elongatus	6	1	2					1	1		
Oxyjulis californica			4					2		2	
Oxylebius pictus		8	7	11	10	8	2	2	3	8	
Pholidae							10				

APPENDIX XIX - Contd.

SCIENTIFIC NAME	6	7	8	9	10	11	12	13	14	15	16
BONY FISH - Contd.											
Scorpaenichthys marmoratus	2	1	2	1				1	1		
Sebastes atrovirens	2	1									3
Sebastes carnatus	1				1	1	2				
Sebastes chrysomelas	1		3	4	1	3			1	1	2
Sebastes melanops	3			10		1					
Sebastes miniatus		1									
Sebastes mystinus	~500		~1,000	~500		30	4	40	20	27	25
Sebastes serranoides		3	3	3		1	2			2	
Sebastes spp. (Juveniles)	~1,500	~500	~3,000	~1,000	27	~150	~400	~2,000	~300	~500	~150
Stichidae					3						

* See Appendix I

APPENDIX XX

PLANTS, INVERTEBRATES AND VERTEBRATES OBSERVED IN THE DIABLO CANYON STUDY AREA DURING 1970 AND 1971

Scientific Name	Common Name	Occurrence Intertidal	 Subtidal
Chlorophyta			
Bryopsis corticulans Setchell	green alga	X	
Cladophora trichotoma (C.A. Agardh) Kützing	green alga	X	
Codium fragile (Suringar) Hariot	green alga	X	
Codium setchellii Gardner	green alga	X	
Halicystis ovalis (Lyngbe) Areschoug	green alga		X
Rhizoclonium sp.	green alga	X	
Spongomorpha coalita (Ruprecht) Collins	green alga	X	X
Ulva lactuca Linnaeus	sea lettuce	X	X
Ulva lobata (Kutzing) Setchell and Gardner	sea lettuce	X	
Ulva rigida C.A. Agardh	sea lettuce	X	
Chrysophyta			
Biddulphia sp.	diatom		X
Phaeophyta			
Alaria marginata Postels & Ruprecht	brown alga	X	X
Coilodesme californica (Ruprecht) Kjellman	brown alga	X	X

Scientific Name	Common Name	Occurrence Intertidal	 Subtidal
Cystoseira osmundacea (Menzies) C.A. Agardh	brown alga	X	X
Desmarestia herbacea (Turner) Lamouroux	brown alga	X	X
Desmarestia latifrons (Ruprecht) Kützing	brown alga		X
Desmarestia munda Setchell & Gardner	brown alga	X	
Dictyoneurum californicum Ruprecht	brown alga	X	X
Dictyota binghamiae J.G. Agardh	brown alga		X
Egregia menziesii (Turner) Areschoug	feather boa kelp	X	X
Fucus distichus Linnaeus subsp. *edentatus* (De la Pylaine) Powell	brown alga	X	
Haplogloia andersonii (Farlow) Levring	brown alga	X	
Hesperophycus harveyanus (Decaisne) Setchell & Gardner	brown alga	X	
Heterochordaria abietina (Ruprecht) Setchell & Gardner	brown alga	X	
Laminaria setchellii Silva	palm kelp	X	X
Leathesia difformis (Linnaeus) Areschoung	sea potato	X	
Leathesia nana Setchell and Gardner	brown alga	X	
Macrocystis pyrifera (Linnaeus) C.A. Agardh	pea kelp		X
Nereocystis luetkeana (Mertens) Postels & Ruprecht	bull kelp	X	X

Scientific Name	Common Name	Occurrence Intertidal	 Subtidal
Pelvetia fastigiata (J.G. Agardh) DeToni	brown alga	X	
Pelvetiopsis limitata (Setchell) Gardner	brown alga	X	
Phaeostrophion irregulare (Setchell & Gardner)	brown alga	X	
Pterygophora californica Ruprecht	tree kelp		X
Ralfsia pacifica Hollenberg	brown alga	X	
Scytosiphon lomentaria (Lyngbye) J.G. Agardh	brown alga	X	
Soranthera ulvoidea Postels & Ruprecht	brown alga	X	
Rhodophyta			
Agardhiella tenera (J.G. Agardh) Schmitz	red alga	X	
Antithamnion sp.	red alga	X	X
Bossiella sp.	coralline alga	X	X
Botryocladia pseudodichotoma (Farlow) Kylin	red alga		X
Botryoglossum farlowianum (J.G. Agardh) DeToni	red alga	X	X
Calliarthron cheilosporioides Manza	coralline alga	X	X
Calliarthron tuberculosum (Postels & Ruprecht) Dawson	coralline alga	X	X
Callithamnion pikeanum Harvey	red alga	X	
Callithamnion rupicolum Anderson	red alga	X	
Callophyllis crenulata Setchell	red alga	X	X
Callophyllis firma (Kylin) Norris	red alga		X
Callophyllis flabellulata Harvey	red alga		X

Scientific Name	Common Name	Occurrence Intertidal	 Subtidal
Callophyllis obtusifolia J.G. Agardh	red alga		X
Callophyllis pinnata Setchell & Swezy	red alga	X	X
Callophyllis violacea Setchell & Swezy	red alga	X	X
Ceramium eatonianum (Farlow) DeToni	red alga	X	
Corallina officinalis var. *chilensis* (Harvey) Kützing	coralline alga	X	
Corallina vancouveriensis Yendo	coralline alga	X	
Cryptopleura lobulifera (J.G. Agardh) Kylin	red alga	X	X
Crytosiphonia woodii J.G. Agardh	red alga	X	X
Delesseria decipiens J.G. Agardh	red alga	X	
Endocladia muricata (Postels & Ruprecht) J.G. Agardh	red alga	X	
Erythrophyllum delesserioides J.G. Agardh	red alga	X	X
Farlowia compressa J.G. Agardh	red alga	X	
Farlowia mollis (Harvey & Bailey) Farlow & Setchell	red alga	X	X
Fauchea sp.	red alga		X
Fryeella gardneri (Setchell) Kylin	red alga		X
Gastroclonium coulteri (Harvey) Kylin	red alga	X	
Gelidium coulteri Harvey	red alga	X	
Gelidium purpurascens Gardner	red alga		X

Scientific Name	Common Name	Occurrence Intertidal	Occurrence Subtidal
Gelidium pusillum (Stackhouse) Le Jolis	red alga	X	
Gelidium robustum (Gardner) Hollenberg & Abbott	red alga	X	X
Gigartina agardhii Setchell & Gardner	red alga	X	
Gigartina californica J.G. Agardh	red alga	X	X
Gigartina canaliculata Harvey	red alga	X	
Gigartina corymbifera (Kutzing) J.G. Agardh	red alga	X	X
Gigartina cristata (Setchell) Setchell & Gardner	red alga	X	
Gigartina harveyana (Kutzing) Setchell & Gardner	red alga	X	
Gigartina leptorhynchos J.G. Agardh	red alga	X	
Gigartina papillata (C.A. Agardh) J.G. Agardh	red alga	X	
Gigartina volans (C.A. Agardh) J.G. Agardh	red alga	X	
Grateloupia doryphora (Montagne) Howe	red alga	X	
Grateloupia setchellii Kylin	red alga	X	
Gymnogongrus linearis (Turner) J.G. Agardh	red alga	X	
Gymnogongrus platyphyllus Gardner	red alga		X
Halosaccion glandiforme (Gmelin) Ruprecht	red alga	X	
Halymenia coccinea Harvey (Abbott)	red alga		X
Herposiphonia verticillata (Harvey) Kylin	red alga	X	
Heterosiphonia densiuscula Kylin	red alga		X

Scientific Name	Common Name	Occurrence Intertidal	 Subtidal
Hymenena flabelligera (J.G. Agardh) Kylin	red alga	X	X
Hymenena multiloba (J.G. Agardh) Kylin	red alga	X	
Iridaea flaccida (Setchell & Gardner) Hollenberg & Abbott	red alga	X	
Iridaea heterocarpum Postels & Ruprecht	red alga	X	
Iridaea lineare (Setchell & Gardner) Kylin	red alga	X	
Iridaea splendens (Setchell & Gardner) Papenfuss	red alga	X	X
Laurencia blinksii Hollenberg & Abbott	red alga	X	
Laurencia spectabilis Postels & Ruprecht	red alga	X	X
Lithophyllum sp.	coralline alga	X	
Lithothamnion aculeiferum Mason	coralline alga	X	X
Lithothamnion californicum Foslie	coralline alga	X	X
Melobesia mediocris (Foslie) Setchell & Mason	coralline alga	X	X
Microcladia borealis Ruprecht	red alga	X	X
Microcladia coulteri Harvey	red alga	X	X
Nienburgia andersoniana (J.G. Agardh) Kylin	red alga	X	
Opuntiella californica (Farlow) Kylin	red alga		X
Petrocelis franciscana Setchell & Gardner	red alga	X	X
Pikea californica Harvey	red alga	X	X

Scientific Name	Common Name	Occurrence Intertidal	Occurrence Subtidal
Pikea pinnata Setchell	red alga		X
Platythamnion villosum Kylin	red alga		X
Plocamium coccineum var. *pacificum* (Kylin) Dawson	red alga	X	X
Plocamium violaceum Farlow	red alga	X	
Polyneura latissima (Harvey) Kylin	red alga	X	X
Polyporolithon conchatum (Setchell & Foslie) Mason	coralline alga	X	X
Polyporolithon parcum (Setchell & Foslie) Mason	coralline alga	X	X
Polysiphonia hendryi var. *gardneri* (Kylin) Hollenberg	red alga	X	
Polysiphonia pacifica Hollenberg	red alga	X	X
Polysiphonia paniculata Montagne	red alga	X	X
Porphyra nereocystis Anderson	red alga		X
Porphyra perforata J.G. Agardh	red alga	X	
Porphyrella gardneri Smith & Hollenberg	red alga	X	X
Prionitis andersonii Eaton	red alga	X	
Prionitis australis J.G. Agardh	red alga	X	X
Prionitis filiformis Kylin	red alga	X	
Prionitis lanceolata Harvey	red alga	X	X

Scientific Name	Common Name	Occurrence Intertidal	 Subtidal
Prionitis lyallii Harvey	red alga	X	
Pseudogloiophloea confusa (Setchell) Levring in Svedelius	red alga		X
Pterochondria woodii (Harvey) Hollenberg	red alga		X
Pterosiphonia baileyi (Harvey) Falkenberg	red alga	X	X
Ptilota densa C.A. Agardh	red alga	X	X
Ptilota hypnoides Harvey	red alga	X	X
Rhodoglossum affine (Harvey) Kylin	red alga	X	
Rhodoglossum parvum G.M. Smith & Hollenberg	red alga	X	
Rhodoglossum roseum (Kylin) G.M. Smith	red alga	X	X
Rhodomela larix (Turner) C.A. Agardh	red alga	X	
Rhodoptilum densum (Smith) Dawson	red alga		X
Rhodymenia californica Kylin var. *attenuata* (Dawson) Dawson	red alga		X
Rhodymenia pacifica Kylin	red alga	X	X
Schizymenia epiphytica (Setchell & Lawson) Smith & Hollenberg	red alga		X
Schizymenia pacifica Kylin	red alga	X	X
Smithora naiadum (Anderson) Hollenberg	red alga	X	X

		Occurrence	
Scientific Name	Common Name	Intertidal	Subtidal
Stenogramme interrupta (C.A. Agardh) Montagne	red alga	X	X
Weeksia reticulata Setchell	red alga		X
Spermatophyta			
Phyllospadix scouleri Hooker	surf grass	X	X
Phyllospadix torreyi S. Watson	surf grass	X	X
Coelenterata			
Allopora porphyra (Fisher)	staghorn coral		X
Anthopleura elegantissima (Brandt)	aggregate anemone	X	
Anthopleura xanthogrammica (Brandt)	solitary anemone	X	X
Balanophyllia elegans Verrill	solitary coral	X	X
Corynactis californica Carlgren	aggregate anemone	X	X
Epiactus prolifera Verrill	anemone	X	
Metridium senile (Linnaeus)	white anemone		X
Tealia lofotensis (Danielssen)	anemone		X
Tealia sp.	anemone		X
Arthropoda			
Balanus sp.	barnacle	X	X
Callianassa affinis Holmes	ghost shrimp	X	
Cancer antennarius Stimpson	rock crab	X	X
Cancer oregonensis (Dana)	Oregon cancer crab	X	
Cancer productus Randall	rock crab	X	

Scientific Name	Common Name	Occurrence Intertidal	 Subtidal
Cryptolithodes sitchensis Brandt	umbrella-backed crab		X
Hapalogaster cavicauda Stimpson	crab		X
Hemigrapsus nudus (Dana)	purple shore crab	X	
Idothea sp.	isopod	X	
Lophopanopeus sp.	crab	X	
Loxorhynchus crispatus Stimpson	masking crab	X	X
Pachycheles rudis Stimpson	crab	X	
Pachygrapsus crassipes Randall	striped shore crab	X	
Pagurus samuelis (Stimpson)	hermit crab	X	X
Petrolisthes cinctipes (Randall)	porcelain crab	X	
Petrolisthes manimaculis Glassell	crab	X	
Pollicipes polymerus Sowerby	goose barnacle	X	
Pugettia gracilis Dana	crab	X	
Pugettia producta (Randall)	kelp crab	X	X
Pugettia richii Dana	crab	X	
Tetraclita squamosa rubescens Darwin	barnacle	X	
Mollusca			
Acanthina punctulata (Sowerby)	spotted unicorn	X	
Acmaea mitra Rathke	white cap limpet	X	X
Acmaea paleacea Gould	chaffy limpet	X	

Scientific Name	Common Name	Occurrence Intertidal	Occurrence Subtidal
Astraea gibberosa (Dillwyn)	red turban	X	X
Calliostoma annulatum (Lightfoot)	purple ring top shell		X
Calliostoma canaliculatum (Lightfoot)	channeled top shell		X
Calliostoma gloriosum Dall	glorious top shell		X
Calliostoma ligatum (Gould)	top shell	X	X
Collisella asmi (Middendorff)	limpet	X	
Collisella digitalis (Rathke)	fingered limpet	X	
Collisella limatula (Carpenter)	file limpet	X	
Collisella pelta (Rathke)	shield limpet	X	
Collisella scabra (Gould)	rough limpet	X	
Conus californicus Hinds	California cone	X	X
Crepidula adunca Sowerby	hooked slipper shell	X	X
Crepidula perforans (Valenciennes)	white slipper shell	X	
Cryptochiton stelleri Middendorff	gumboot chiton		X
Cyanoplax dentiens (Gould)	chiton	X	
Cyanoplax hartwegii (Carpenter)	Hartweg's chiton	X	
Diodora aspera (Rathke)	rough keyhole limpet	X	X
Epilucina californica (Conrad)	California lucine	X	

Scientific Name	Common Name	Occurrence Intertidal	 Subtidal
Fissurella volcano Reeve	volcano limpet	X	
Fusinus luteopictus (Dall)	painted spindle	X	
Haliotis cracherodii Leach	black abalone	X	X
Haliotis kamtschatkana assimilis Jonas	pinto abalone		X
Haliotis rufescens Swainson	red abalone	X	X
Haliotis walallensis Stearns	flat abalone		X
Hinnites multirugosus (Gale)	rock scallop	X	X
Hipponix antiquatus (Linnaeus)	hoof shell	X	
Homalopoma luridum (Dall)	turban shell		X
Katherina tunicata (Wood)	black chiton	X	
Lithophaga plumula (Hanley)	date mussel		X
Littorina planaxis Philippi	eroded periwinkle	X	
Littorina scutulata Gould	checkered periwinkle	X	
Lottia gigantea Sowerby	owl limpet	X	
Mitra idae Melvill	Ida's miter		X
Mitrella sp.	dove shell-snail	X	
Mopalia lignosa (Gould)	chiton	X	
Mopalia muscosa (Gould)	chiton	X	

		Occurrence	
Scientific Name	Common Name	Intertidal	Subtidal
Mytilus californianus Conrad	California mussel	X	
Notoacmea fenestrata (Reeve)	limpet	X	
Notoacmea persona (Rathke)	limpet	X	
Notoacmea scutum (Rathke)	limpet	X	
Nuttallina californica (Reeve)	chiton	X	
Ocenebra circumtexta Stearns	circled rockshell	X	
Octopus sp.	octopus	X	
Olivella biplicata (Sowerby)	purple olive snail		X
Penitella penita (Conrad)	flat-tipped piddock		X
Pododesmus cepio (Gray)	abalone jingle	X	X
Pteropurpura trialata (Sowerby)	three-winged murex		X
Stenoplax conspicua (Pilsbry)	conspicuous chiton	X	
Tegula brunnea (Philippi)	brown turban	X	X
Tegula funebralis (A. Adams)	black turban	X	X
Tegula montereyi (Kiener)	turban snail		X
Tegula pulligo (Martyn)	turban snail		X
Thais emarginata (Deshayes)	emarginate dogwinkle	X	
Tonicella lineata (Wood)	lined chiton	X	

Scientific Name	Common Name	Occurrence Intertidal	 Subtidal
Trivia californiana (Gray)	California trivia		X
Echinodermata			
Dendraster excentricus (Escholtz)	sand dollar		X
Henricia leviuscula (Stimpson)	sea star		X
Leptasterias hexactis (Stimpson)	sea star	X	
Leptasterias pusilla (Fisher)	sea star	X	
Orthasterias koekleri (De Loriol)	sea star		X
Patiria miniata (Brandt)	bat star	X	X
Pisaster brevispinus (Stimpson)	sea star		X
Pisaster giganteus (Stimpson)	sea star		X
Pisaster ochraceus (Brandt)	ocher seastar	X	X
Pycnopodia helianthoides (Brandt)	sunflower star	X	X
Stichopus californicus (Stimpson)	sea cucumber		X
Strongylocentrotus franciscanus (Agassiz)	red urchin	X	X
Strongylocentrotus purpuratus (Stimpson)	purple urchin	X	X
Urochordata			
Styela montereyensis (Dall)	tunicate	X	X

Scientific Name	Common Name	Depth Range (ft.) Documented in the Diablo Canyon Area
Pisces		
Ammodytes hexapterus Pallas	Pacific sand lance	60
Anarrhichthys ocellatus Ayres	wolf-eel	15
Anoplarchus purpurescens Gill	high cockscomb	shore - 20
Apodichthys flavidus Girard	penpoint gunnel	shore - 25
Artedius corallinus (Hubbs)	coralline sculpin	shore - 70
Artedius creaseri (Hubbs)	roughcheek sculpin	20 - 70
Artedius fenestralis Jordan	padded sculpin	20
Artedius harringtoni (Starks)	scalyhead sculpin	20 - 70
Artedius lateralis (Girard)	smoothhead sculpin	shore - 25
Artedius notospilotus Girard	bonehead sculpin	20 - 70
Atherinops affinis (Ayres)	topsmelt	shore
Aulorhynchus flavidus Gill	tubesnout	shore - 60
Bothragonus swani (Steindachner)	rockhead	25 - 60
Brosmophycis marginata (Ayres)	red brotula	20 - 70
Cebidichthys violaceus (Girard)	monkeyface-eel	shore - 10
Cephaloscyllium ventriosum (Garman)	swell shark	15 - 25
Chirolophis nugator (Jordan & Williams)	mosshead warbonnet	20 - 70

Scientific Name	Common Name	Depth Range (ft.) Documented in the Diablo Canyon Area
Citharichthys stigmaeus Jordan & Gilbert	speckled sanddab	20 - 70
Clinocottus analis (Girard)	wooly sculpin	shore
Clinocottus globiceps (Girard)	mosshead sculpin	shore
Clinocottus recalvus (Greeley)	bald sculpin	shore
Coryphopterus nicholsi (Bean)	blackeye goby	shore - 70
Cymatogaster aggregata Gibbons	shiner surfperch	shore
Damalichthys vacca (Girard)	pile surfperch	shore - 70
Embiotoca jacksoni Agassiz	black surfperch	shore - 70
Embiotoca lateralis Agassiz	striped surfperch	shore - 70
Engraulis mordax Girard	northern anchovy	shore
Enophrys taurina Gilbert	bull sculpin	70
Gibbonsia elegans (Cooper)	spotted kelpfish	shore - 20
Gibbonsia metzi Hubbs	striped kelpfish	shore - 20
Gibbonsia montereyensis Hubbs	crevice kelpfish	shore - 70
Girella nigricans (Ayres)	opaleye	shore
Gobiesox maeandricus (Girard)	northern clingfish	shore - 25
Hemilepidotus hemilepidotus (Tilesius)	red Irish lord	20 - 70
Hemilepidotus spinosus (Ayres)	brown Irish lord	20 - 70

Scientific Name	Common Name	Depth Range (ft.) Documented in the Diablo Canyon Area
Hexagrammos decagrammus (Pallas)	kelp greenling	shore - 70
Hyperprosopon argenteum Gibbons	walleye surfperch	shore
Hypsurus caryi (Agassiz)	rainbow surfperch	shore - 25
Jordania zonope Starks	longfin sculpin	20 - 70
Kasatkia-(Askoldia?) sp. nov.	stichaeid	20
Lethops connectens Hubbs	kelp goby	20 - 60
Liparis florae (Jordan & Starks)	tidepool snailfish	shore - 20
Liparis mucosus Ayres	slimy snailfish	shore - 20
Liparis sp. nov.	snailfish	20
Liparis sp. (unid.)	snailfish	shore - 70
Lythrypnus dalli (Gilbert)	bluebanded goby	25
Lythrypnus zebra (Gilbert)	zebra goby	25
Micrometrus aurora (Jordan & Gilbert)	reef surfperch	shore
Micrometrus minimus (Gibbons	dwarf surfperch	shore
Nautichthys oculofasciatus (Girard)	sailfin sculpin	20 - 70
Oligocottus rimensis (Greeley)	saddleback sculpin	shore
Oligocottus rubellio (Greeley)	rosy sculpin	shore - 20
Oligocottus snyderi Greeley	fluffy sculpin	shore - 20

Scientific Name	Common Name	Depth Range (ft.) Documented in the Diablo Canyon Area
Ophiodon elongatus Girard	lingcod	shore - 70
Orthonopias triacis Starks and Mann	snubnose sculpin	shore - 70
Chilara taylori (Girard)	spotted cusk-eel	25 - 70
Oxyjulis californica (Günther)	senorita	shore - 70
Oxylebius pictus Gill	painted greenling	shore - 70
Pholis schultzi Hubbs	red gunnel	25 - 60
Pimelometopon pulchrum (Ayres)	California sheephead	30
Plagiogrammus hopkinsi Bean	crisscross prickleback	shore - 70
Platyrhinoidis triseriata (Jordan and Gilbert)	thornback	shore
Pleuronichthys coenosus Girard	C-O Turbot	20 - 70
Pleuronichthys decurrens Jordan and Gilbert	curlfin Turbot	25 - 60
Psettichthys melanostictus Girard	sand sole	25
Radulinus vinculus (Bolin)	smoothgum sculpin	70
Rathbunella hypoplecta (Gilbert)	smooth ronquil	20 - 70
Rhacochilus toxotes Agassiz	rubberlip surfperch	25
Rimicola muscarum (Meek & Pierson)	kelp clingfish	25
Scorpaenichthys marmoratus (Ayres)	cabezon	shore - 70
Scytalina cerdale Jordan & Gilbert	graveldiver	shore - 25
Sebastes atrovirens Jordan & Gilbert	kelp rockfish	20 - 60

Scientific Name	Common Name	Depth Range (ft.) Documented in the Diablo Canyon Area
Sebastes aurora (Gilbert)	aurora rockfish	70
Sebastes carnatus (Jordan and Gilbert)	gopher rockfish	25 - 70
Sebastes (caurinus-vexillaris)	copper-whitebelly rockfish	20 - 70
Sebastes chrysomelas (Jordan & Gilbert)	black-and-yellow rockfish	shore - 70
Sebastes entomelas (Jordan & Gilbert)	widow rockfish	shore
Sebastes flavidus (Ayres)	yellowtail rockfish	shore - 70
Sebastes goodei (Eigenmann & Eigenmann)	chilipepper	25 - 70
Sebastes melanops Girard	black rockfish	shore - 70
Sebastes miniatus (Jordan & Gilbert)	vermilion rockfish	20 - 60
Sebastes mystinus (Jordan & Gilbert)	blue rockfish	shore - 70
Sebastes nebulosus Ayres	china rockfish	70
Sebastes paucispinis Ayres	bocaccio	shore - 60
Sebastes pinniger (Gill)	canary rockfish	20 - 70
Sebastes rastrelliger (Jordan & Gilbert)	grass rockfish	shore
Sebastes serranoides (Eigenmann and Eigenmann)	olive rockfish	shore - 70
Stellerina xyosterna (Jordan & Gilbert)	picklebreast poacher	25
Stichaeopsis?sp. nov.	masked prickleback	shore - 70
Sygnathus sp.	pipefish	shore
Synchirus gilli Bean	manacled sculpin	25

Scientific Name	Common Name	Depth Range (ft.) Documented in the Diablo Canyon Area
Typhlogobius californiensis Steindachner	blind goby	Intertidal (mid-tide zone)
Xererpes fucorum (Jordan & Gilbert)	rockweed gunnel	shore - 25
Xiphister atropurpureus (Kittlitz)	black prickleback	shore - 25
Xiphister mucosus (Girard)	rock prickleback	shore
Mammalia		
Phoca vitulina	harbor seal	
Zalophus californianus	California sea lion	

APPENDIX XXI

PHYSICAL DATA FOR 5 INTERTIDAL STATIONS INCLUDING 10 TRANSECTS SURVEYED IN THE DIABLO CANYON AREA DURING 1970

Station	Transects	Dates Surveyed	Tide Level	Ocean Conditions	Station Description	Transect Length	Exposure to Sea
1	A	March 5	-1.4	Rough swell	Bedrock with deep crevices of 3-6' relief including a tide pool.	10 m	Moderately protected by offshore rocks and reefs.
		July 3	-0.9	Light swell			
		October 16	-0.7	Light swell			
	B	March 5	-1.4	Rough swell	Flat bedrock with 1-2' relief terminating on a rocky ridge about 6' in height.	28 m	
		July 3	-0.9	Light swell			
		October 16	-0.7	Light swell			
2	A	March 7	-1.0	Moderate swell	Boulders of 1-4' relief with one rocky ridge 5' high.	30 m	Generally well protected in the northwest corner of Diablo Cove.
		July 6	-0.4	Light swell			
		October 14	-0.6	Calm			
	B	March 7	-1.0	Moderate swell	Strewn boulders of 1-4' relief interspersed with sand and cobble.	33 m	
		July 6	-0.4	Light swell			
		October 14	-0.6	Calm			

APPENDIX XXI - Contd.

Station	Transects	Dates Surveyed	Tide Level	Ocean Conditions	Station Description	Transect Length	Exposure to Sea
3	A	March 3	-0.9	Rough swell	Strewn boulders interspersed with sand and cobble with 1-3' relief and one verticalrocky outcrop 5' high.	30 m	Generally well protected in the southern corner of Diablo Cove.
		July 5	-0.6	Moderate swell			
		October 13	-0.1	Calm			
	B	March 3	-0.9	Rough swell	Strewn boulders with 1-5' relief interspersed with sand and cobble.	38 m	
		July 21	-1.0	Calm			
		October 13	-0.1	Calm			
4	A	March 6	-1.3	Moderate swell	Generally flat bedrock with several 1-2' crevices, one large, deep tide pool and a rocky projection 5' high.	13 m	Unprotected jutting point of land.
		June 23	-0.9	Light swell			
		October 10	+0.7	Rough swell			
	B	June 23	-0.9	Light swell	Bedrock with 5' relief including a large tide pool.	11 m	
		October 15	-0.8				
	C	March 6	-1.3	Moderate swell	Flat bedrock with 5' relief including a large deep tide pool.	19 m	
		June 23	-0.9	Light swell			
		October 10	+0.7	Rough swell			
5	A	July 4	-1.1	Calm	Irregular bedrock and boulder with 2-10' relief.	20 m	Partially protected by offshore reefs.

APPENDIX XXII

PHYSICAL DATA FOR 5 INTERTIDAL STATIONS, INCLUDING 10 TRANSECTS IN THE DIABLO CANYON AREA DURING 1971

Station	Transects	Dates Surveyed	Tide Level	Ocean Conditions	Station Description	Transect Length	Exposure to Sea
1	A	March 10	-0.3	Heavy swell-chop	Bedrock with deep crevices of 3-6' relief including a tide pool.	10 m	Moderately protected by offshore rocks and reefs.
		June 23	-1.3	Calm			
		October 6	-0.7	Moderate swell			
	B	February 23	-1.3	Heavy swell	Flat bedrock with 1-2' relief terminating on a rocky ridge about 6' in height.	28 m	
		June 23	-1.3	Calm			
		October 6	-0.7	Moderate swell			
2	A	February 8	-0.9	Heavy swell	Boulders of 1-4' relief with one rocky ridge 5' high.	30 m	Generally well protected, in the northwest corner of Diablo Cove.
		June 11	-1.0	Moderate swell			
		October 4	-0.5	Light swell-chop			
	B	February 8	-0.9	Heavy swell	Strewn boulders of 1-4' relief interspersed with sand and cobble.	33 m	
		June 11	-1.0	Moderate swell			
		October 4	-0.5	Light swell-chop			

APPENDIX XXII - Contd.

Station	Transects	Dates Surveyed	Tide Level	Ocean Conditions	Station Description	Transect Length	Exposure to Sea
3	A	February 9	-0.8	Moderate swell	Strewn boulders interspersed with sand & cobble with 1-3' relief and one **vertical rocky outcrop** 5' high.	30 m	Generally well protected, in the southern corner of Diablo Cove.
		June 10	-1.0	Calm			
		October 5	-0.7	Calm-light chop			
	B	February 9	-0.8	Moderate swell	Strewn boulders with 1-5' relief interspersed with sand and cobble.	38 m	
		June 10	-1.0	Calm			
		October 5	-0.7	Calm-light chop			
4	A	March 17	-0.6	Moderate swell-chop	Generally flat bedrock with several 1-2' crevices, one large, deep tidepool & a rocky projection 5' high.	13 m	Unprotected jutting point of land.
		June 12	-0.8	Heavy swell			
		October 3	-0.0	Light swell			
	B	March 7	-0.6	Moderate swell-chop	Bedrock with 5' relief including a large tide pool.	11 m	
		June 12	-0.8	Heavy swell			
		October 3	-0.0	Light swell			
	C	March 7	-0.6	Moderate swell-chop	Flat bedrock with 5' relief including a large deep tide pool.	19 m	
		June 12	-0.8	Heavy swell			
		October 3	-0.0	Light swell			

APPENDIX XXII - Contd.

Station	Transects	Dates Surveyed	Tide Level	Ocean Conditions	Station Description	Transect Length	Exposure to Sea
5	A	Not surveyed	-	-	Irregular bedrock and boulder with 2-10' relief.	20 m	Partially protected by offshore reefs.
		June 24	-1.2	Moderate swell			
		November 4	-1.2	Moderate swell			

APPENDIX XXIII

PHYSICAL DATA FOR 11 SUBTIDAL DIVING STATIONS SURVEYED IN THE DIABLO CANYON AREA DURING 1970

STATION NO.	DATES SURVEYED	OCEAN CONDITIONS	VISIBILITY ON SURVEY (ft.)	C. WATER TEMP.		BOTTOM DESCRIPTION
				TOP	BOTTOM	
6	February 7	Light swell	10	12.0		Two pinnacle shaped outcrops approx. 25' in height reaching to within 3-5' of the surface - fine sand between,depth 5 - 30 feet.
	July 22	Light swell	8	10.5	10.0	
	September 4	Calm	20	11.0	10.5	
7	February 3	Light swell	4-8	12.0	12.0	A rocky ridge running perpendicular to shore with 5-10' relief laterally bordered by sand, depth 25-35 feet.
	July 22	Light swell	8	10.5	10.0	
	September 11		10	11.5	11.0	
8	February 6	Moderate swell	30	12.5		Irregular rocky outcropping, high relief of 5-20' reaching to within 15' of the surface with several deep fissures, depth 15-35 feet.
	September 14	Calm	20	11.0	10.5	
9	February 6	Moderate swell	6	12.0		Bedrock with boulders interspersed with some mixed sand and gravel and transversed by rocky reefs of 5-10' relief, depth 10-20 feet.
	June 26	Light chop	30	10.5	10.0	
	September 1	Moderate swell	15	11.0	10.0	
10	February 6	Moderate swell	10	12.0		Flats and ledge outcroppings of 1-5' relief with small patches of sand and cobble throughout, depth 30-35 feet.
	June 25	Calm	20	11.0	10.5	
	September 1	Moderate swell	20	11.0	10.0	

APPENDIX XXIII - Contd.

STATION NO.	DATES SURVEYED	OCEAN CONDITIONS	VISIBILITY ON SURVEY (ft.)	C. WATER TEMP.		BOTTOM DESCRIPTION
				TOP	BOTTOM	
11	February 4	Moderate swell	3-5	12.0	11.0	Boulders and rocky outcrop of 2-10' relief interspersed with some sand, gravel and cobble, depth 40-50 feet.
	June 25	Calm	20	11.0	10.5	
	September 14		8	12.0	11.0	
12	February 24		2-8	12.5	11.5	Boulders and rocky outcrop of 3-5' relief interspersed with sand and cobble, with 1/3 of transect sand, depth 70-75 feet.
	June 25	Calm	20	11.0	10.5	
	September 11		6	11.5	11.0	
13	September 29	Calm	10-12	16.0	12.0	Large reef with 2-10' relief, depth 10-20 feet.
14	September 10		5	11.5	11.5	Irregular reef continuous with the shore with 2-10' relief, depth 15-25 feet.
15	February 4	Moderate swell	15	12.0	11.5	Irregular reef running parallel to shore with 5-20' relief reaching within 5' of the surface, depth 5-45 feet.
	September 10		5	11.5	11.5	
16	June 26	Light swell	20	10.5	10.5	Boulders and rocky outcrop of 2-5' relief with numerous crevices, depth 5-10 feet.
	September 28	Calm	15			

APPENDIX XXIV

PHYSICAL DATA FOR 11 SUBTIDAL STATIONS SURVEYED IN THE DIABLO CANYON AREA 1971

STATION NO.	DATES SURVEYED	OCEAN CONDITIONS	BOTTOM WATER VISABILITY (ft.)	C WATER TEMP. TOP	BOTTOM
6	February 4	Moderate swell	40	11.5	10.5
	June 3	Moderate swell	20	10.0	9.5
	September 23	Calm	25	13.0	12.5
7	February 4	Moderate swell	40	11.5	10.5
	June 3	Moderate swell	30	10.0	9.5
	September 23	Calm	25	13.0	12.5
8	February 1	Moderate swell	50	12.0	11.5
	June 3	Moderate swell	30	10.0	9.5
	September 21	Calm	12	14.0	12.0
9	February 4	Moderate swell	40	11.5	10.5
	June 4	Moderate swell	25	10.5	9.5
	September 24	Light swell-chop	20	14.5	14.0
10	February 1	Moderate swell	50	12.0	11.5
	June 4	Moderate swell	30	10.5	9.5
	October 14	Moderate swell	8	12.0	12.0

APPENDIX XXIV - Contd.

STATION NO.	DATES SURVEYED	OCEAN CONDITIONS	BOTTOM WATER VISABILITY (ft.)	C WATER TEMP. TOP	BOTTOM
11	April 5	Moderate swell-chop	15	10.5	9.5
	June 4	Moderate swell	30	10.5	9.0
	October 14	Heavy swell	8	12.0	12.0
12	March 19	Heavy swell	5	10.5	9.0
	July 16	Light swell	30	-	9.5
	September 21	Calm	6	14.0	12.0
13	Not Surveyed	-	-	-	-
	Not Surveyed	-	-	-	-
	September 22	Flat	10	14.5	14.0
14	Not Surveyed	-	-	-	-
	July 17	Light swell	30	11.0	9.5
	September 22	Flat	20	14.0	12.0
15	February 1	Moderate swell	50	12.0	11.5
	July 16	Light swell	20	11.0	9.5
	September 21	Flat	5-6	14.0	12.0
16	Not Surveyed	-	-	-	-
	July 16	Light swell	20	11.5	-
	September 24	Flat	15	14.5	14.0

APPENDIX XXV

LENGTH (IN 10 mm SIZE CLASSES) - WIDTH MEASUREMENTS FOR 438 BLACK ABALONES, *Haliotis cracherodii*, REMOVED FROM DIABLO COVE DISCHARGE SITE

Size Class mm	21-30	31-40	41-50	51-60	61-70	71-80	81-90
Width mm	19	28	-	39	46	53	64
		25		39	44	53	61
		29			49	40	62
					45	52	62
					47	60	64
					48	55	62
					47	55	63
					51	50	67
					53	57	69
					50	52	62
						62	69
						45	61
						61	75
						61	63
						58	57
							65
							65
							66
							60
							60
							70
							62
							62

APPENDIX XXV - Contd.

Size Class mm	81-90	91-100	101-110	111-120		121-130	
Width mm	67	81	88	91	92	99	100
	69	68	79	95	87	100	101
	62	75	83	79	95	88	105
	63	76	80	91	85	107	101
	65	76	80	105	90	111	93
		86	78	88		102	96
		73	81	85		110	92
		73	78	92		103	93
		74	83	86		96	100
		77	87	100		95	98
		74	83	93		93	98
		69	79	85		93	95
		73	86	87		96	95
		72	75	89		109	104
			78	89		102	102
			85	93		98	101
			84	95		96	
			82	93		91	
			85	86		105	
			85	90		100	
			80	97		96	
			81	93		98	
			76	95		102	
			88	93		98	
				91		101	
				93		104	

APPENDIX XXV - Contd.

Size Class mm	131-140			141-150			
Width mm	110	103	101	119	120	115	121
	100	118	108	121	115	112	114
	111	112	103	121	123	125	117
	106	103	109	127	120	124	107
	106	106	102	120	120	112	110
	111	104	96	115	123	115	110
	119	113	120	134	117	105	106
	116	106	104	124	138	113	117
	108	109	108	119	127	120	115
	111	110	106	120	125	112	121
	100	101	108	116	118	117	105
	109	109	105	123	124	122	
	100	110		132	113	118	
	117	114		119	120	132	
	105	98		120	120	124	
	106	109		115	119	117	
	100	105		117	115	112	
	116	104		112	113	112	
	104	107		123	127	113	
	119	113		112	112	115	
	111	106		119	118	119	
	123	105		120	134	125	
	119	122		113	133	124	
	100	128		111	130	112	
	112	112		122	116	113	

APPENDIX XXV - Contd.

Size Class mm	151-160			161-170		171-180	181-190
Width mm	125	134	126	132	152	145	143
	134	123	128	137	129	144	150
	124	129	129	135	135	146	148
	127	137	115	140	125	148	
	132	128	124	139	133	147	
	121	124	140	133	139	135	
	135	125	120	135	142	140	
	138	121	136	139	145	147	
	130	123	126	122	142	144	
	118	128		150	132	151	
	132	135		144	131	148	
	123	127		131	135	144	
	140	125		130	129	136	
	123	120		132	134		
	122	118		130	131		
	124	130		128	132		
	132	129		141	135		
	129	134		128	126		
	133	125		143			
	130	132		136			
	120	120		142			
	136	121		137			
	125	131		121			
	138	134		142			
	129	117		125			

APPENDIX XXV - Contd.

Size Class mm	191-200
Width mm	149
	159

APPENDIX XXVI

LENGTH (10 mm SIZE CLASSES) - WIDTH MEASUREMENTS OF 199 BLACK ABALONES, *Haliotis cracherodii*, REMOVED FROM SOUTH COVE INTAKE SITE IN SEPTEMBER, 1969

Size Class mm	21-30	31-40	41-50	51-60	61-70			71-80
Width mm	21	-	30	41	37	45	47	61
			33	45	45	55	54	62
			34	43	43	50	47	59
			30	37	37	48	50	59
			33	42		46	50	56
			35	45		48	48	57
			31	42		50	45	55
			37	40		51	52	54
			33	43		52	43	60
			30	43		51		52
			32	38		46		54
			32	41		45		60
				35		47		55
				42		50		56
				43		52		58
				42		46		63
				43		48		55
				41		46		55
				44		48		61
				37		50		54
				38		48		59
				45		48		54
				42		58		54

APPENDIX XXVI - Contd.

Size Class mm	71-80	81-90		91-100		101-110	111-120
Width mm	61	71	71	75	79	83	84
	52	66	59	76	70	82	88
	60	63	69	74	82	81	99
	59	62	61	69	77	88	89
	53	75	65	71	70	83	96
	60	68	72	71	76	81	88
	60	62	62	79	69	80	93
	51	64	67	70	72	79	
	52	61	62	72		80	
		70	68	68		84	
		70	61	73		81	
		64	71	79		75	
		64	65	75		88	
		66	68	76		90	
		69		76		82	
		61		75		79	
		67		78			
		67		74			
		64		77			
		65		75			
		58		69			
		61		70			
		67		81			
		65		73			
		60		76			

APPENDIX XXVII

WIDTH AND WEIGHT MEASUREMENTS FOR 721 RED ABALONES, *Haliotis rufescens*, BY 20 mm LENGTH SIZE CLASSES, REMOVED FROM INSIDE THE EAST BREAKWATER, SOUTH COVE DURING MARCH - MAY, 1972

Size Class mm	61 - 80		81 - 100		101 - 120		121 - 140	
	Width	Weight	Width	Weight	Width	Weight	Width	Weight
	51	50	67	100	89	220	107	420
	57	70	71	105	85	170	102	310
	51.5	30	61.5	65	86.5	200	104	420
	58	60	58.5	55	80	-	106.5	400
	45	35			76.5	200	90	210
	59	75			85	-	92	300
					76.5	100	88.5	210
					75	-	96.5	270
					85	-	95	-
					94	275	104	400
					79.5	180	104	-
					87	205	98	300
					75	120	92	210
					85	-	93	240
					87	150	109	380
					79	140	95	260
					84	220	94	-
					79.5	150	95	180
					83.5	180	108.5	330
					80.5	185	107.5	350
					82	165	103	-
					86.5	225	111	-

APPENDIX XXVII - Contd.

Size Class	121 - 140		141 - 160					
mm	Width	Weight	Width	Weight	Width	Weight	Width	Weight
	97	-	119	540	118	-	112	-
	91.5	250	115	680	116	480	119	-
	95.5	260	132	590	114	-	123	600
	97.5	260	115	500	115	-	130	730
	92.5	230	127	600	122	-	106	390
	107	355	114	500	116	-	123.5	625
	94	255	125	850	118	-	115.5	425
	106	365	119.5	550	122.5	570	116	460
	104	410	130	700	116	-	107.5	375
	98	290	116.5	550	120	-	113.5	475
	105	350	119	610	115	-	104.5	400
	105	290	114	-	125.5	520	111.5	440
	106	350	112	490	121	-	109	370
	95.5	285	115	500	117	-	116	550
	117	410	116	500	115	-	111	560
			117	500	109	-	110	400
			108	450	108	-	111	455
			104	-	107	-	126	680
			112	400	124	-	116	420
			119.5	700	118	-	110.5	480
			110	-	122	-	124	570
			111	480	114	450	110.5	400
			119	680	110	-	120	600
			119	-	111.5	340	128	750
			121	530	114	-	112	520

APPENDIX XXVII - Contd.

Size Class	141 - 160		161 - 180					
mm	Width	Weight	Width	Weight	Width	Weight	Width	Weight
	119	475	132	980	128	670	140	680
	120	550	140.5	870	123	-	146.5	750
	109	355	133	900	127.5	900	124.5	500
	122	569	138	1260	146	-	145	920
	118	530	137	750	136	-	114	500
	113.5	510	151	1300	122	750	138	-
	122	680	132	750	141	-	132	-
	118	515	142	1000	120.5	650	125	-
	120	760	139	880	134	760	139	-
	111.5	530	141	880	141.5	810	135	900
	124.5	540	146.5	1250	129.5	710	136	860
	127	690	145	1050	135	745	127	850
	121	670	132	820	128.5	735	132	-
	120	580	121	690	140	780	132	-
	120	580	140	1090	141.5	990	136.5	850
	121	460	126.5	900	147.5	970	130	-
	115.5	530	140	890	129	765	131	910
	113	500	133	900	138	1050	129	-
	116	510	133	860	133.5	950	134	-
	113	390	134.5	950	124	670	129	650
	113.5	480	143	1050	137	820	135	-
	112	420	128	750	130.5	640	135	-
	116	530	139	-	140	770	130	900
			139	950	140	870	142	-
			138	870	129.5	920	140.5	-

APPENDIX XXVII - Contd.

Size Class mm	161 - 180							
	Width	Weight	Width	Weight	Width	Weight	Width	Weight
	126.5	750	138	1075	129	650	135	-
	140	-	130	870	118.5	550	129.5	670
	134	920	130	910	126	550	125	-
	136	-	132	810	127	800	138.5	890
	135	760	134	800	139.5	-	139	840
	128.5	640	126	700	119.5	800	129	-
	136	890	132.5	890	134	850	135	-
	137	985	144	1090	125	-	133	-
	136	895	136	970	117.5	800	131	-
	134	825	135	770	126	-	126	-
	134	800	137	910	137	1130	133	-
	128	695	131	-	125	-	137	-
	129	1005	131.5	800	139.5	875	190	-
	135	630	134	-	136	1000	132	-
	133	1030	129	-	120	-	132.5	630
	132	995	132	-	124	700	139.5	850
	146.5	895	137	950	125.5	620	137	-
	128	700	133.5	800	127	-	128	720
	132	860	136	620	124	-	127	670
	128	670	134.5	750	137	-	134	-
	130.5	840	143	870	130	-	146	960
	140.5	1030	117	-	131.5	1050	140.5	800
	135	955	1395	1200	143.5	870	130	-
	131	720	126	750	137	-	119.5	610
	137	910	132.5	870	132	650	144	1050

APPENDIX XXVII - Contd.

Size Class	161 - 180				181 - 200			
mm	Width	Weight	Width	Weight	Width	Weight	Width	Weight
	135	830	125.5	825	149	1380	140	960
	134	-	140	875	144	1310	150.5	1250
	123	-	136.5	990	149	1330	147	1250
	140	-	133.5	890	160	1460	143	930
	131	-	146.5	865	141	1270	154.5	1300
	135	820	135	1030	147	1200	150	-
	139.5	1060	128	765	150	970	157.5	1500
	138	-	136	855	157	1150	146	-
	125.5	800			151	1320	142	-
	131.5	-			132	920	147	1410
	132	590			147.5	1130	151	1300
	141	984			141	1220	144	-
	127	-			151.5	1400	144	1200
	132.5	970			154	1170	137.5	1000
	128	860			142	1500	148.5	1000
	136	800			147	1300	147	940
	138	1015			154	1310	149	1150
	132.5	830			143	1200	144.5	-
	127	730			148	1050	139.5	1100
	120.5	780			149	1300	135.5	1150
	132.5	760			148	1100	145	1300
	142	895			150.5	1100	137.5	950
	139	700			149	1300	161.5	1920
	145	745			140	1030	141	1100
	122	490			153	1220	159.5	1250

APPENDIX XXVII - Contd.

Size Class	181 - 200							
mm	Width	Weight	Width	Weight	Width	Weight	Width	Weight
	151.5	1450	157	-	143	998	152	1050
	145	1200	157	-	154.5	1080	134.5	1150
	148.5	1150	150	1140	146	1010	154	1150
	159	1400	148	1020	146	945	156	1180
	145	-	137	800	148	1240	154	1350
	133	930	152	1250	150.5	1270	168	1490
	145.5	1550	148	1130	153	1080	152	1200
	134.5	1000	153	-	146.5	1490	147	1000
	152	-	154	-	141	980	146	1190
	136	-	136	950	156	1210	138	900
	141	1010	156	1250	156.5	1260	149.5	1230
	147.5	-	149.5	1460	157	1270	154	1230
	142	1220	143	-	157	1120	139.5	700
	153	1400	149	-	159.5	1630	150	1120
	140.5	1050	142	-	151	1230	152	1170
	142.5	1120	155.5	1420	158	1030	156.5	1210
	146.5	1170	142	1070	143	1030	172	1790
	153	1330	152	-	140.5	1000	149.5	1395
	136	-	149.5	1235	146	1305	139.5	1000
	143	-	158	1090	149	1150	157	1220
	142	-	152	1580	146	1210	145	970
	151	-	156	1420	147	1000	160	1180
	150	-	136	930	150.5	1120	151.5	1245
	150	1050	152	1090	150	1130	144	1630
	151	-	158.5	1495	142	880	149	2075

APPENDIX XXVII - Contd.

Size Class	181 - 200							
mm	Width	Weight	Width	Weight	Width	Weight	Width	Weight
	152	1200	144	1130	147	-	147	1360
	157	-	142	900	146	1000	142.5	1260
	145	960	153	-	158.5	1370	140	750
	145	1310	142	-	155	1370	151.5	1100
	157	-	158.2	-	137	-	147	-
	146	-	154	-	151.5	1250	157	-
	140	-	155	1240	154	-	144	-
	145.5	1200	151	1370	146	-	157.5	1520
	145	1459	150	-	147	-	152	1100
	153.5	1620	149	-	146	-	137	880
	144	-	159	-	155.5	1250	141.5	-
	146	-	149	-	140	-	144.5	1150
	148	-	158.5	1410	150	-	143.5	1000
	153	1050	152	1350	142	1100	152.5	1270
	154	-	147	-	152	1350	150	1030
	143.5	1200	135	-	139	-	149	1250
	147.5	1300	145	-	143	1050	144	-
	146	1050	146.5	1250	143	-	149	-
	148.5	1430	145	-	157	-	140	805
	150	-	152	-	147	-	145	953
	140	1100	152	1180	142	-	140.5	985
	147	1100	163	-	139.5	1040	146	1100
	140	1050	147	-	146.5	1300	154.5	1195
	138.5	950	156	1050	150.5	1200	149	1050
	155	-	140.5	850	150	-	153.5	1385

APPENDIX XXVII - Contd.

Size Class	181 - 200				201 - 220			
mm	Width	Weight	Width	Weight	Width	Weight	Width	Weight
	147.5	1105	138.5	955	166	1360	168.5	-
	161.5	1325	143.5	915	165	1600	162	-
	155.5	1145	147	1000	165	1570	167	-
	157.5	1480	153.5	1145	156	1400	168	1500
	148.5	1180	147	1115	164	1470	161	-
	140.5	1115	147	1120	158	1920	153	-
	150.5	1365			163	1910	163	-
	152	1280			160	1460	160	1370
	156	960			169	1700	161	-
	143.5	1040			160	1350	164	-
	147	1060			160	1240	173	1870
	152	1385			170	-	147	-
	154	865			156	1600	163	-
	146	1020			173	2100	168	-
	147	1065			160.5	1950	161.5	1630
	156	1325			161	1450	157.5	1310
	149.5	1020			159	1570	168	1630
	149.5	1145			165.5	1350	165.5	1600
	142.5	1125			158	1750	155	1570
	161.5	1060			165.5	1920	153	-
	163.5	1370			158	1600	170	1650
	142	1180			152.5	1650	160	1160
	162	1470			158.5	1520	155	-
	143	1060			156	1650	163.5	1455

APPENDIX XXVII - Contd.

Size Class	201 - 220		221 - 240	
mm	Width	Weight	Width	Weight
	163	1680	179	1800
	163.5	1370	165	1750
	155.5	1445	169	-
	156	1470	150.5	1985
	165	1650		
	168	1710		
	154	1640		
	164	1540		
	166.5	1700		
	159.5	1850		
	158	1600		
	160.5	1530		
	159.5	1870		
	167.5	1695		

APPENDIX XXVIII

SURFACE WATER TEMPERATURES IN C RECORDED AT THE MOUTH OF DIABLO COVE DURING 1970

Date	High	Mean	Low
January			
1	12.0	12.0	12.0
2	12.0	12.0	12.0
3	12.0	12.0	12.0
4	12.0	12.0	12.0
5	12.0	12.0	12.0
6	12.0	12.0	12.0
7	12.0	12.0	12.0
8	12.0	12.0	12.0
9	12.0	12.0	12.0
10	12.0	12.0	12.0
11	13.0	12.5	12.0
12	13.0	13.0	13.0
13	13.0	13.0	13.0
14	13.0	13.0	13.0
15	13.0	13.0	13.0
16	13.0	13.0	13.0
Thermograph jammed - no recordings from 17th - 29th			
30	13.0	12.5	12.5
31	12.5	12.0	12.0
February			
1	12.0	11.5	11.5
2	11.5	11.5	11.5
3	11.5	11.5	11.5
4	12.0	11.5	11.5
5	12.0	11.5	11.5
6	12.5	12.0	12.0
7	13.0	12.5	12.5
8	13.0	12.5	12.5
9	12.5	12.5	12.5
10	13.0	12.5	12.5
11	12.5	12.5	12.5
12	12.5	12.5	12.5
13	12.5	12.5	12.5
14	12.5	12.5	12.5
15	12.5	12.5	12.5
16	12.5	12.5	12.5
17	12.5	12.5	12.5
18	12.5	12.0	12.0
19	12.0	12.0	11.5
20	12.0	12.0	12.0
21	12.0	12.0	12.0
22	12.0	12.0	12.0
23	12.0	12.0	12.0
24	12.5	12.0	12.0

APPENDIX XXVIII--Contd.

Date	High	Mean	Low	Date	High	Mean	Low
February - Contd.				21	12.0	12.0	12.0
25	12.5	12.5	12.5	22	12.0	12.0	12.0
26	12.5	12.5	12.5	23	12.0	12.0	12.0
27	12.5	12.5	12.5	24	12.5	12.0	12.0
28	12.5	12.5	12.5	25	12.5	12.0	12.0
March				26	12.0	12.0	12.0
1	13.0	12.5	12.5	27	12.0	12.0	12.0
2	12.5	12.5	12.5	28	12.5	12.0	12.0
3	13.0	12.5	12.5	29	12.0	12.0	12.0
4	13.0	12.5	12.5	30	12.0	12.0	11.5
5	13.0	12.5	12.5	31	11.5	11.5	11.0
6	13.0	13.0	12.5	April			
7	13.0	13.0	12.5	1	12.0	11.5	11.5
8	13.5	13.0	13.0	2	12.0	12.0	12.0
9	13.5	13.0	13.0	3	12.0	12.0	12.0
10	12.5	12.5	12.5	4	12.0	12.0	12.0
No recordings for 11th and 12th				5	12.0	12.0	12.0
13	12.5	12.0	12.0	6	12.0	12.0	12.0
14	12.0	12.0	12.0	7	12.0	12.0	12.0
15	12.0	11.5	11.5	8	12.0	11.5	11.5
16	11.5	11.5	11.5	9	11.5	11.0	11.0
17	11.5	11.5	11.5	10	11.0	11.0	11.0
18	11.5	11.5	11.0	11	11.0	11.0	11.0
19	12.0	11.5	11.0	12	11.0	10.5	10.5
20	12.0	12.0	12.0	13	10.5	10.5	10.5

APPENDIX XXVIII--Contd.

Date	High	Mean	Low	Date	High	Mean	Low
April - Contd.				4	12.0	11.5	11.5
14	10.5	10.5	10.5	5	11.5	11.5	11.5
15	10.5	10.5	10.5	6	11.5	11.5	11.5
16	10.5	10.5	10.5	7	12.0	12.0	11.5
17	10.5	10.5	10.5	8	12.0	12.0	12.0
No recordings from April 18th				9	12.0	12.0	12.0
to May 18th				10	12.5	12.5	12.0
May				11	12.0	12.0	11.5
19	11.5	11.0	11.0	12	11.5	11.5	11.0
20	11.0	10.5	10.5	13	11.0	11.0	10.5
21	10.5	10.5	10.5	14	11.5	11.5	11.0
22	10.5	10.5	10.0	15	12.0	12.0	11.5
23	11.0	10.5	10.5	16	12.0	12.0	11.5
24	11.5	11.5	11.0	17	12.0	11.5	11.5
25	11.5	11.5	11.5	18	11.5	11.0	11.0
26	12.0	11.5	11.5	19	11.5	11.0	11.0
27	12.0	11.5	11.5	20	11.5	11.5	11.0
28	11.5	11.5	11.5	21	11.5	11.5	11.0
29	11.5	11.5	11.5	22	11.0	11.0	11.0
30	11.5	11.5	11.5	23	11.0	11.0	11.0
31	12.0	11.5	11.5	24	11.5	11.5	11.0
June				25	11.5	11.5	11.5
1	12.0	12.0	11.5	26	12.0	12.0	11.5
2	12.0	12.0	12.0	27	12.0	11.5	11.5
3	12.0	12.0	12.0	28	11.5	11.5	11.5

APPENDIX XXVIII—Contd.

Date	High	Mean	Low	Date	High	Mean	Low
June - Contd.				23	12.0	12.0	12.0
29	11.5	11.5	11.5	24	12.0	12.0	12.0
No recordings for 30th and 31st				25	12.0	12.0	12.0
July				26	12.0	12.0	12.0
No recordings for 1st and 2nd				27	12.0	12.0	12.0
3	13.0	12.5	12.0	28	12.5	12.0	12.0
4	12.0	12.0	11.5	29	13.0	12.5	12.5
5	11.5	11.0	11.0	30	13.0	13.0	13.0
6	11.0	11.0	11.0	31	13.0	12.5	12.0
7	11.0	11.0	11.0	August			
8	11.0	11.0	11.0	1	12.0	11.5	11.5
9	12.0	11.5	11.0	2	11.5	11.5	11.0
10	12.0	12.0	12.0	3	11.5	11.5	11.5
11	12.0	12.0	11.5	4	11.5	11.5	11.5
12	11.5	11.5	11.5	5	12.0	12.0	11.5
13	11.5	11.5	11.5	6	12.0	12.0	12.0
14	11.5	11.5	11.5	7	12.0	12.0	11.5
15	11.5	11.5	11.5	8	11.5	11.5	11.0
16	11.5	11.5	11.5	9	11.5	11.0	11.0
17	11.5	11.5	11.0	10	12.5	11.0	11.5
18	12.0	11.5	11.0	11	13.5	13.0	12.5
19	12.0	12.0	12.0	12	13.0	12.5	12.5
20	12.0	12.0	12.0	13	12.5	12.5	12.5
21	12.0	12.0	12.0	14	12.5	12.5	12.5
22	12.0	12.0	12.0	15	12.5	12.5	12.5

APPENDIX XXVIII—Contd.

Date	High	Mean	Low	Date	High	Mean	Low
August - Contd.				18	12.5	12.0	12.0
16	12.5	12.5	12.5	No recordings from 19th to 28th			
17	13.0	12.5	12.5	29	14.5	14.0	14.0
18	13.0	12.5	12.5	30	14.0	14.0	14.0
No recordings from 19th to 28th				October			
29	14.5	14.0	14.0	1	14.0	14.0	14.0
30	14.0	14.0	14.0	2	14.5	14.5	14.0
September				3	14.5	14.5	14.5
1	11.5	11.5	11.0	4	14.5	14.5	14.0
2	11.5	11.5	11.0	5	14.0	14.0	14.0
3	11.5	11.0	11.0	6	14.0	14.0	13.5
4	11.5	11.5	11.5	7	14.0	13.5	13.5
5	11.5	11.5	11.5	8	14.5	14.0	13.5
6	11.5	11.0	11.0	9	15.0	14.5	14.0
7	11.0	11.0	11.0	10	15.0	14.5	14.0
8	12.0	11.5	11.0	11	15.0	14.5	14.0
9	12.0	12.0	12.0	12	15.0	14.5	14.0
10	12.0	12.0	12.0	13	15.0	14.5	14.5
11	12.5	12.0	12.0	14	14.5	14.0	14.0
12	12.0	12.0	12.0	15	14.0	14.0	14.0
13	12.5	12.5	12.0	16	14.0	13.5	13.5
14	13.0	13.0	12.5	17	13.5	13.5	13.5
15	13.0	12.5	12.5	18	13.5	13.5	13.5
16	12.5	12.5	12.0	19	13.5	13.5	13.5
17	12.0	12.0	12.0	20	13.5	13.5	13.5

APPENDIX XXVIII—Contd.

Date	High	Mean	Low	Date	High	Mean	Low
October - Contd.				25	13.5	13.5	13.0
21	14.0	13.5	13.5	26	14.0	14.0	14.0
22	14.0	13.5	13.5	27	14.0	14.0	14.0
23	14.0	13.5	13.5	28	14.0	14.0	14.0
24	13.5	13.0	13.0	29	14.0	13.5	13.5
25	13.0	12.5	12.5	30	13.5	13.5	13.5
26	12.5	12.5	12.5	December			
27	13.0	12.5	12.5	1	14.0	13.5	13.5
28	13.0	13.0	13.0	2	14.0	14.0	14.0
29	13.0	13.0	13.0	3	14.0	14.0	13.5
30	13.0	13.0	13.0	4	13.5	13.5	13.5
31	13.0	13.0	13.0	5	13.5	13.5	13.5
November				6	14.0	13.5	13.5
1	13.0	13.0	13.0	7	14.0	13.5	13.5
2	13.0	13.0	13.0	8	14.0	13.5	13.5
3	13.0	13.0	12.5	9	14.0	14.0	13.5
4	13.0	13.0	13.0	10	13.5	13.5	13.0
5	13.0	13.0	13.0	11	13.0	13.0	13.0
6	13.0	13.0	13.0	12	13.0	13.0	13.0
7	14.0	13.5	13.5	13	13.0	13.0	13.0
8	14.0	14.0	14.0	14	13.0	13.0	13.0
9	14.0	14.0	14.0	15	13.0	13.0	13.0
10	14.0	14.0	14.0	16	13.0	13.0	13.0
No recordings from 11th to 23rd				17	13.0	13.0	12.5
24	13.0	13.0	13.0	18	12.5	12.5	12.5

APPENDIX XXVIII—Contd.

Date	High	Mean	Low	Date	High	Mean	Low
December - Contd.							
19	12.5	12.5	12.5				
20	12.5	12.5	12.5				
21	12.5	12.5	12.5				
22	13.0	12.5	12.5				
23	13.0	13.0	12.5				
24	13.0	13.0	13.0				
25	13.0	13.0	13.0				
26	13.0	13.0	13.0				
27	13.0	13.0	13.0				
28	13.0	13.0	13.0				
29	13.0	13.0	13.0				
30	13.0	13.0	13.0				
31	13.0	13.0	13.0				

APPENDIX XXIX

SURFACE WATER TEMPERATURES IN C RECORDED AT THE MOUTH OF DIABLO COVE DURING 1971

Date	High	Mean	Low
January			
1	13.0	13.0	13.0
2	13.0	13.0	12.5
3	12.5	12.0	12.0
4	12.0	11.5	11.0
No recordings from 4th - 29th			
29	12.0	12.0	12.0
30	12.0	11.5	11.5
31	11.5	11.5	11.5
February			
1	11.5	11.5	11.5
2	11.5	11.5	11.5
3	11.5	11.0	11.0
4	11.0	11.0	11.0
5	11.0	11.0	11.0
6	11.0	10.5	10.5
7	10.5	10.5	10.5
8	11.0	10.5	10.5
9	11.0	11.0	11.0
10	11.0	11.0	11.0
11	11.0	11.0	11.0
12	11.5	11.0	11.0
13	11.5	11.5	11.5
14	11.5	11.5	11.5
15	11.5	11.5	11.0
16	11.0	11.0	11.0
17	11.0	11.0	11.0
18	11.0	11.0	11.0
19	11.0	10.5	10.5
20	10.5	10.5	10.0
21	10.0	10.0	10.0
22	10.5	10.5	10.0
23	10.5	10.5	10.0
24	10.0	10.0	10.0
25	10.0	10.0	10.0
26	10.0	10.0	10.0
27	10.0	9.5	9.5
28	9.5	9.5	9.5
March			
1	9.5	9.5	9.5
2	9.5	9.0	9.0
3	9.0	9.0	9.0
4	9.0	9.0	9.0

Thermograph was removed to replace the zincs on the case. No recordings from March 4 - April 5.

APPENDIX XXIX - Contd.

Date	High	Mean	Low	Date	High	Mean	Low
April				30	10.0	9.5	9.5
6	10.0	9.5	9.5	May			
7	10.0	9.5	9.5	1	10.0	9.5	9.5
8	9.5	9.5	9.5	2	10.0	10.0	10.0
9	9.5	9.5	9.5	3	10.0	10.0	10.0
10	9.5	9.5	9.5	4	10.0	10.0	10.0
11	9.5	9.5	9.5	5	10.5	10.0	10.0
12	9.5	9.5	9.5	6	10.0	10.0	10.0
13	10.0	9.5	9.5	7	10.0	10.0	10.0
14	10.0	10.0	10.0	8	10.0	10.0	10.0
15	10.0	10.0	10.0	9	10.0	10.0	10.0
16	10.0	10.0	10.0	10	10.5	10.0	10.0
17	10.0	9.5	9.5	11	10.5	10.5	10.5
18	9.0	9.5	9.0	12	11.0	10.5	10.5
19	9.5	9.0	9.0	13	11.0	11.0	11.0
20	9.5	9.5	9.0	14	11.0	11.0	11.0
21	9.5	9.0	9.0	15	11.5	11.5	11.0
22	9.5	9.5	9.0	16	11.5	11.5	11.5
23	9.5	9.5	9.0	17	12.0	11.5	11.5
24	9.5	9.5	9.0	18	12.0	12.0	11.5
25	9.0	9.0	9.0	24	No reading		
26	9.0	9.0	9.0	25	9.5	9.5	9.5
27	9.5	9.5	9.5	26	9.5	9.5	9.5
28	10.0	9.5	9.0	27	10.0	9.5	9.5
29	9.5	9.5	9.5	28	10.0	10.0	10.0

APPENDIX XXIX - Contd.

Date	High	Mean	Low	Date	High	Mean	Low
May - Contd.				21	11.0	11.0	10.5
29	10.0	10.0	10.0	22	11.0	11.0	11.0
30	10.0	9.5	9.5	23	11.0	11.0	10.5
31	9.5	9.5	9.5	24	10.5	10.5	10.0
June				25	10.5	10.0	10.0
1	9.5	9.0	9.0	26	11.5	11.0	10.5
2	9.5	9.0	9.0	27	12.0	11.5	11.0
3	9.0	9.0	9.0	28	11.0	11.0	10.5
4	9.5	9.0	9.0	29	11.0	11.0	11.0
5	9.5	9.0	9.0	30	11.0	11.0	11.0
6	9.5	9.5	9.0	July			
7	9.5	9.5	9.5	1	11.0	10.5	10.0
8	9.5	9.5	9.5	2	10.5	10.0	10.0
9	9.5	9.5	9.5	3	10.5	10.0	10.0
10	10.0	9.5	9.5	4	10.0	10.0	10.0
11	10.0	10.0	10.0	5	10.5	10.0	10.0
12	10.0	10.0	10.0	6	11.0	10.5	10.5
13	10.0	10.0	10.0	7	11.0	11.0	10.5
14	10.0	10.0	10.0	8	11.0	11.0	11.0
15	10.0	10.0	10.0	9	11.0	10.5	10.5
16	11.0	10.5	10.0	10	10.5	10.0	10.0
17	12.0	11.5	11.0	11	10.0	10.0	10.0
18	13.0	12.0	12.0	12	10.0	9.5	9.5
19	13.0	12.5	12.0	13	11.0	10.0	9.5
20	12.0	11.5	11.0	14	11.0	11.0	10.5

APPENDIX XXIX - Contd.

Date	High	Mean	Low	Date	High	Mean	Low
July - Contd.				6	12.0	11.5	11.5
15	11.0	10.5	10.5	7	11.5	11.5	11.5
16	11.0	10.5	10.5	8	12.0	11.5	11.5
17	11.0	10.5	10.5	9	12.0	12.0	11.5
18	11.5	11.0	11.0	10	12.0	11.5	11.0
19	11.5	11.0	11.0	11	12.5	12.0	11.0
20	11.5	11.5	11.5	12	12.5	12.5	12.5
21	11.5	11.5	11.5	13	13.0	13.0	12.5
22	11.5	11.0	11.0	14	13.5	13.5	13.0
23	11.0	11.0	11.0	15	15.0	15.0	13.5
24	11.0	11.0	11.0	16	15.5	15.0	14.5
25	11.5	11.0	11.0	17	15.0	14.5	13.0
26	11.5	11.5	11.0	No reading August 18 through			
27	11.5	11.5	11.5	September 9			
28	11.5	11.0	11.0	September			
29	11.5	11.0	11.0	10	13.0	13.0	12.5
30	12.0	12.0	11.5	11	12.5	12.0	12.0
31	12.5	12.0	12.0	12	12.0	12.0	11.5
August				13	13.0	12.5	12.0
1	12.5	12.0	12.0	14	13.5	13.5	13.0
2	12.0	12.0	12.0	15	14.0	13.5	13.5
3	12.0	12.0	11.5	16	14.5	14.0	14.0
4	12.0	12.0	11.5	17	14.5	14.0	14.0
5	12.0	12.0	12.0	18	14.5	14.0	13.5

APPENDIX XXIX - Contd.

Date	High	Mean	Low	Date	High	Mean	Low
September - Contd.				12	11.5	11.5	11.0
19	14.5	14.0	14.0	13	12.0	11.5	11.0
20	14.0	14.0	13.5	14	12.0	12.0	12.0
21	14.0	13.5	13.5	15	12.0	12.0	11.5
22	14.0	14.0	13.5	16	12.0	11.5	11.5
23	13.5	13.0	13.0	17	12.0	11.5	11.5
24	13.0	13.0	13.0	18	12.0	12.0	12.0
25	13.0	13.0	13.0	19	12.0	12.5	12.5
26	12.5	12.0	12.0	20	12.5	12.5	12.5
27	12.0	12.0	12.0	21	12.5	12.0	12.0
28	12.0	11.5	11.5	22	12.5	12.5	12.5
29	11.5	11.5	11.0	23	12.5	12.0	12.0
30	11.0	11.0	11.0	24	12.0	11.5	11.0
October				25	11.0	11.0	10.5
1	11.0	11.0	11.0	26	11.0	11.0	11.0
2	11.0	11.0	11.0	27	11.0	11.0	11.0
3	11.0	11.0	11.0	28	11.0	10.5	10.0
4	11.5	11.5	11.5	29	10.0	10.0	10.0
5	12.0	12.0	11.5	30	10.0	10.0	10.0
6	12.0	12.0	12.0	31	10.0	10.0	10.0
7	12.0	12.0	12.0	November			
8	12.0	12.0	12.0	1	10.0	10.0	10.0
9	12.0	12.0	12.0	2	10.5	10.5	10.5
10	12.0	12.0	12.0	3	11.0	10.5	10.5
11	11.5	11.5	11.0	4	11.0	11.0	11.0

APPENDIX XXIX - Contd.

Date	High	Mean	Low	Date	High	Mean	Low
November - Contd.							
5	11.0	11.0	11.0				
6	11.0	11.0	11.0				
7	11.0	11.0	11.0				
8	11.0	11.0	11.0				
9	11.0	11.0	11.0				
10	11.0	11.0	11.0				
11	11.5	11.5	11.5				
12	12.0	11.5	11.5				
13	12.0	12.0	12.0				
14	12.0	12.0	12.0				
15	12.0	11.5	11.5				
16	11.5	11.5	11.5				
17	11.5	11.5	11.5				
18	11.5	11.5	11.5				
19	11.5	11.5	11.5				
20	11.5	11.5	11.5				
21	11.5	11.0	11.0				
22	11.0	11.0	11.0				
23	11.0	11.0	11.0				
24	11.0	11.0	11.0				

APPENDIX XXX

GROWTH MEASUREMENTS OF *NEREOCYSTIS* AT POINT ESTERO DURING 1967

	Tag #	4/27	5/26	6/25	7/26 7/27 7/28	8/16 8/18	9/20
Length cm	N-1	20	414	1010	1285	1318	
	N-2	8	152				
	N-2R			43			
	N-3	8	76	287			
	N-3R				15	117	
	N-4	11	356	897	1323	*1392	
	N-5	8	264	879	*1387	*1450	*1440
	N-6	8					
	N-6R			84			
	N-7	8					
	N-8	6	114				
	N-9	9	356	1019			
	N-10	9					
	N-10R			30			
	N-11			36	109		
	N-12			18	144	452	1072
	N-13			80	683	1176	*1367
	N-15			25			
	N-16			114	688	1054	
	N-17			64	363		
	N-18			48	462	876	1203

APPENDIX XXX - Contd.

					7/26		
					7/27	8/16	
	Tag #	4/27	5/26	6/25	7/28	8/18	9/20
Length cm	N-19			43			
	N-20			89	370	683	1107

* Reached surface on this date.

APPENDIX XXXI

GROWTH MEASUREMENTS OF *NEREOCYSTIS* AT POINT ESTERO DURING 1968

Length cm

	5/7	6/12	6/25				
Tag #	5/8	6/13	6/26	7/11	7/24	8/22	9/11
**N-101			71	114	124		
N-102	182	1052	1237				
N-103	56						
N-105	48	851	1110	1377	*1450	1509	1501
N-107	63	958	Lost				
N-107R		89	201	404	655		
***N-108-NB	15	30					
***N-108R-NB		25	34	53	58		
N-110	170	1214					
N-111	39	980	1227	*1412	1467		
**N-112			91				
N-113		64			191		
N-114	27	650	922	1176	1293	*1394	1393
****N-114-BR		66	71		71		
N-115	62	973	1123	1257	1311	1318	1358
N-116	108						
N-117	239	1267	*1382	1463	1524	1588	1598
N-118		13					
N-121	84		1163				
**N-125			71	89	135		

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* Reached surface on this date.

** Shaded plants.

*** No blades on sporophyte.

**** Blades experimentally removed.

APPENDIX XXXII

AVERAGE MONTHLY SURFACE AND BOTTOM (50 feet) TEMPERATURE AND WATER CLARITY DATA AT PT. ESTERO DURING 1967

	# of Observations		Temp. °C		Water Clarity	
Month	Surface	Bottom	Surface	Bottom	Surface	Bottom
January	3	3	12.2	12.1	23	16
February	3	3	11.6	11.6	17	13
March	2	2	12.5	11.7	27	27
April	2	2	11.0	10.0	30	25
May	1	1	10.5	10.0	15	12
June	1	1	11.0	10.0	25	15
July	2	3	13.7	11.8	32	22
August	1	2	14.5	13.2	27	19
September	2	2	15.1	14.1	28	14
October	1	1	14.5	13.5	30	25
November	2	2	15.9	14.9	35	15
December	1	1	14.3	13.5	15	10

APPENDIX XXXIII

AVERAGE MONTHLY SURFACE AND BOTTOM (50 feet) TEMPERATURE AND WATER CLARITY DATA AT PT. ESTERO DURING 1968

	# of Observations		Temp. °C		Water Clarity	
Month	Surface	Bottom	Surface	Bottom	Surface	Bottom
January	2	2	13.0	12.9	30	18
February						
March	2	2	12.1	11.2	28	16
April						
May	4	3	11.1	10.4	16	16
June	3	3	11.2	10.1	18	17
July	3	3	12.8	10.9	14	28
August	1	1	14.0	12.1	12	8
September	2	2	13.1	11.0	26	22
October	1	1	13.6	12.2	25	20
November	Thermograph average		-	12.5	-	-
December	Thermograph average		-	12.2	23	14

APPENDIX XXXIV

FISHES COLLECTED AT DIABLO COVE

MAY 20, 1970, SEPTEMBER 23-24, JANUARY 25-26, 1971

	Shore Stat.			20 ft. Stat.			70 ft. Stat.			Total		
	May	Sept.	Jan.	May	Sept.	Jan.	May	Sept.	Jan.	May	Sept.	Jan.
Anoplarchus purpurescens	1	51	1		1	1				1	52	2
Apodichthys flavidus	1	39	13		1					1	40	13
Artedius corallinus		1	2	36	45	31	14	26	28	50	72	61
Artedius creaseri				1	1	3		9		1	10	3
Artedius fenestralis						5						5
Artedius harringtoni				3		5	2	65	2	5	65	7
Artedius lateralis	4	10	36	3	23	5				7	33	41
Artedius notospilotis					3				7		3	7
Atherinops affinis			6									6
Aulorhynchus flavidus	1		2							1		2
Brosmophycis marginata				2	3		19	16	15	21	19	15
Cebidichthys violaceus	1	12	10							1	12	10
Chirolophus nugator				1	15	11	7	15	8	8	30	19
Citharichthys stigmaeus				1			29	63		30	63	

APPENDIX XXXIV--Contd.

	Shore Stat.			20 ft. Stat.			70 ft. Stat.			Total		
	May	Sept.	Jan.	May	Sept.	Jan.	May	Sept.	Jan.	May	Sept.	Jan.
Clinocottus analis	5	16	7							5	16	7
Clinocottus globiceps		3									3	
Clinocottus recalvus		9									9	
Coryphopterus nicholsi	1			11	5	12	10	23	56	22	28	68
Damalichthys vacca	6	17					1	2		7	19	
Embiotoca jacksoni	2	6			1				2	2	7	2
Embiotoca lateralis	5	3	1		2	1		1	1	5	6	3
Engraulis mordax			115									115
Enophrys taurinas								4			4	
Gibbonsia elegans		20	4		1						21	4
Gibbonsia metzi		12	18		1	1					13	19
Gibbonsia montereyensis	16	104	42	5	23	25		1		21	128	67
Girella nigricans	1									1		
Gobiesox maeandricus		66	1		7	4					73	5
Hemilepidotus hemilepidotus							1			1		
Hemilepidotus spinosus					2			3	3		5	3
Hexagrammos decagrammus	7	3	7	1	4	3		1	4	8	8	14

APPENDIX XXXIV-Contd.

	Shore Stat.			20 ft. Stat.			70 ft. Stat.			Total		
	May	Sept.	Jan.	May	Sept.	Jan.	May	Sept.	Jan.	May	Sept.	Jan.
Hypsurus caryi	1									1		
Hyperprosopon argenteum		1									1	
Jordania zonope				2	1	2	17	17	21	19	18	23
Kasatkia - (*Askoldia*?) - new species					6	1					6	1
Lethops connectens						1						1
Liparis florae		6			9	2					15	2
Liparis mucosus		2			4	4					6	4
Liparis new species				1	1					1	1	
Liparis species		1			3	1		2	5		6	6
Micrometrus aurora	2	17	3							2	17	3
Micrometrus minimus		1									1	
Nautichthys oculofasciatus				2		2	2	6	7	4	6	9
Oligocottus rimensis		2									2	
Oligocottus rubellio		2	14		9						11	14
Oligocottus snyderi		9	19			4					9	23
Ophiodon elongatus		2		1		1		1	6	1	3	7

APPENDIX XXXIV - Contd.

	Shore Stat.			20 ft. Stat.			70 ft. Stat.			Total		
	May	Sept.	Jan.	May	Sept.	Jan.	May	Sept.	Jan.	May	Sept.	Jan.
Orthonopias triacis			12	15	13	10	13	40	29	28	53	51
Chilara taylori							8	19	3	8	19	3
Oxyjulis californica	11	3	17	12			6			29	3	17
Oxylebius pictus	3	2	20	21	31	37	48	95	73	72	128	130
Plagiogrammus hopkinsi		1	1	4	8	13	1	3	3	5	12	17
Platyrhinoidis triseriata	1									1		
Pleuronichthys coenosus					2		1			1	2	
Radulinus vinculus							1	2		1	2	
Rathbunella hypoplecta						2	27	53	48	27	53	50
Scorpaenichthys marmoratus	9	15	38	15	6	9	2	8	2	26	29	49
Scytalina cerdale		17									17	
Sebastes atrovirens					1	6					1	6
Sebastes aurora							6			6		
Sebastes carnatus							14	23	12	14	23	12
Sebastes caurinus-vexillaris					1	1	58			58	1	1
Sebastes chrysomelas	36	14	8	17	20	22		1		53	35	30
Sebastes entomelas								28			28	
Sebastes flavidus		1		3	1		7	1		10	3	

APPENDIX XXXIV-Contd.

	Shore Stat.			20 ft. Stat.			70 ft. Stat.			Total		
	May	Sept.	Jan.	May	Sept.	Jan.	May	Sept.	Jan.	May	Sept.	Jan.
Sebastes goodei							1			1		
Sebastes melanops	3	2			13	4		124		3	139	4
Sebastes miniatus					1						1	
Sebastes mystinus	9	32	24	13	41	32	61	308	22	83	381	78
Sebastes nebulosus							1	2	1	1	2	1
Sebastes pinniger						1	3	8	5	3	8	6
Sebastes rastrelliger	4	1	4							4	1	4
Sebastes serranoides		2	3		10			1	9		13	12
Sebastes spp.					1		3			3	1	
Stichaeopsis? **sp. nov.**					1			1			2	
Syngnathus sp.	2									2		
Xererpes fucorum	28	485	91	1	4	5				29	489	96
Xiphister atropurpureus	30	248	113			1				30	248	114
Xiphister mucosus		361	11								361	11

APPENDIX XXXIV-Contd.

	Shore Station		20 ft. Station		70 ft. Station		Total	
TOTALS --	May	189	May	171	May	363	May	723
	Sept.	1,599	Sept.	325	Sept.	972	Sept.	2,896
	Jan.	643	Jan.	268	Jan.	372	Jan.	1,283
		2,431		764		1,707		4,902

APPENDIX XXXV

FISHES COLLECTED ON NORTH DIABLO COVE ON JULY 6, 1971-60 FOOT STATION JULY 7, 1971-SHORE STATION AND JULY 15, 1971-25 FOOT STATION

Species	Shore Station	25 Foot Station	60 Foot Station	Total Number
Ammodytes hexapterus			1	1
Anoplarchus purpurescens	16			16
Apodichthys flavidus		2		2
Artedius corallinus		110	33	143
Artedius creaseri		9		9
Artedius harringtoni		16		16
Artedius lateralis	23	20		43
Artedius notospilotus			2	2
Aulorhynchus flavidus		724	1	725
Bothragonus swanii		4	1	5
Brosmophycis marginata		40	42	82
Cebidichthys violaceus	2			2
Chirolophis nugator		72	6	78
Citharichthys stigmaeus		548	406	954
Clinocottus analis	16			16
Clinocottus globiceps	2			2
Clinocottus recalvus	10			10
Coryphopterus nicholsi		26	57	83
Cymatogaster aggregata	18			18
Damalichthys vacca	1	4	1	6
Embiotoca jacksoni	1	6	1	8

APPENDIX XXXV - Contd.

Species	Shore Station	25 Foot Station	60 Foot Station	Total Number
Embiotoca lateralis	11	14		25
Gibbonsia elegans	5			5
Gibbonsia metzi	20	2		22
Gibbonsia montereyensis	26	30		56
Gobiesox maeandricus	9	1		10
Hemilepidotus spinosus		42	19	61
Hexagrammos decagrammus		23	2	25
Hyperprosopon argenteum	1			1
Hypsurus caryi		2		2
Jordania zonope		9	8	17
Lethops connectens			1	1
Liparis mucosus	3			3
Liparis sp.		31	1	32
Lythrypnus zebra		1		1
Micrometrus aurora	4			4
Nautichthys oculofasciatus		4	5	9
Oligocottus rubellio	10			10
Oligocottus snyderi	8			8
Ophiodon elongatus		4	1	5
Orthonopias triacis		100	41	141
Chilara taylori		46	109	155
Oxyjulis californica		2		2
Oxylebius pictus	1	106	87	194

APPENDIX XXXV - Contd.

Species	Shore Station	25 Foot Station	60 Foot Station	Total Number
Pholis schultzi		12	1	13
Plagiogrammus hopkinsii		5	1	6
Pleuronichthys coenosus			1	1
Pleuronichthys decurrens		6	23	29
Psettichthys melanostictus		4		4
Rathbunella hypoplecta			29	29
Rhacochilus toxotes		2		2
Rimicola muscarum		2		2
Scorpaenichthys marmoratus	19	106	1	126
Scytalina cerdale		6		6
Sebastes atrovirens		11	1	12
Sebastes carnatus		59	25	84
Sebastes chrysomelas	12	11		23
Sebastes flavidus		1	3	4
Sebastes goodei		11	4	15
Sebastes melanops		3	1	4
Sebastes miniatus		2	1	3
Sebastes mystinus	2	833	44	879
Sebastes nebulosus			1	1
Sebastes paucispinis	5	103	29	137
Sebastes pinniger		198	178	376
Sebastes rastrelliger	5			5
Sebastes serranoides	15	69	39	123
Sebastes sp.		1		1

APPENDIX XXXV - Contd.

Species	Shore Station	25 Foot Station	60 Foot Station	Total Number
Stellerina xyosterna		8		8
*Stichaeopsis?*sp. nov.	1	1	3	5
Synchirus gilli		6		6
Xererpes fucorum	319	1		320
Xiphister atropurpureus	163	3		166
Xiphister mucosus	169			169
TOTAL	897	3,462	1,210	5,569