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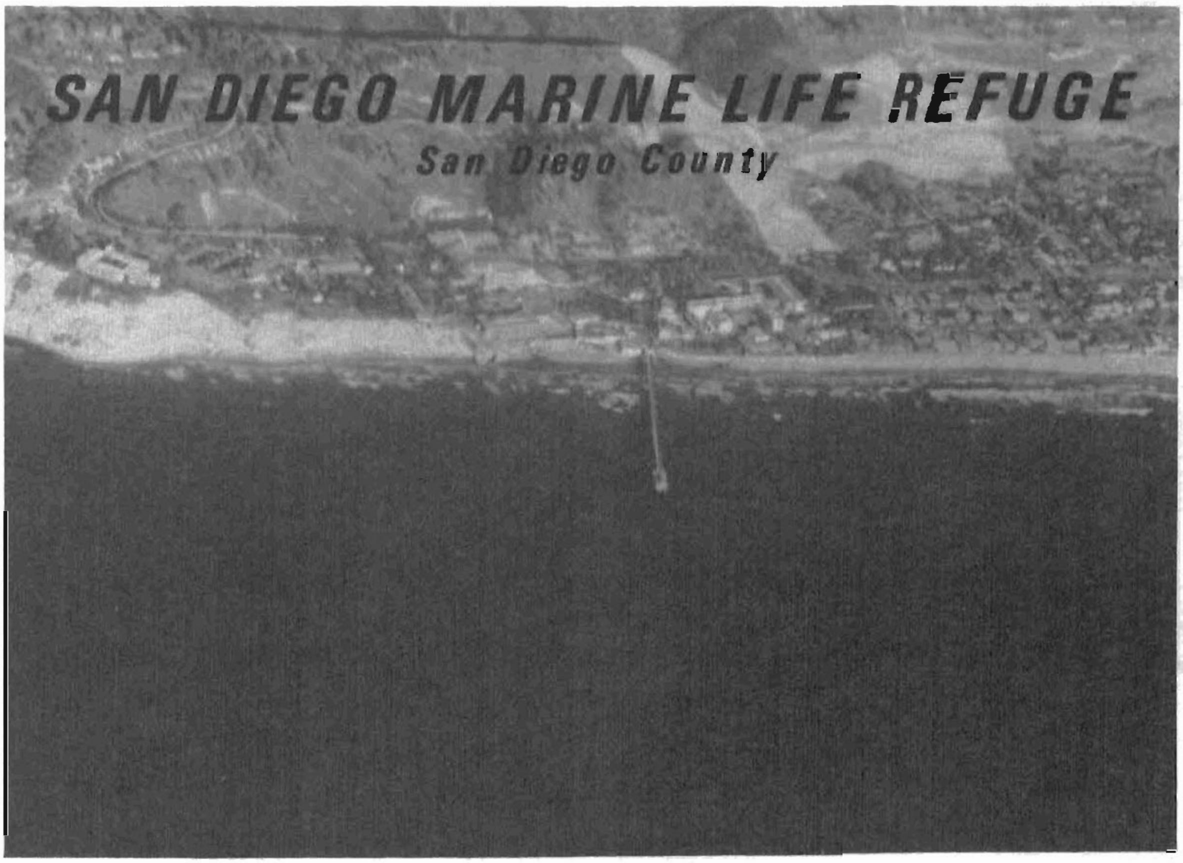
Areas of Special Biological Significance
Reconnaissance Survey Report



CALIFORNIA STATE WATER RESOURCES CONTROL BOARD

SURVEILLANCE AND MONITORING SECTION

September 1980

'ATER QUALITY MONITORING REPORT NO. 80–5

San Diego Marine Life Refuge Area of Special Biological Significance

Printed December 1980

CALIFORNIA MARINE WATERS
AREAS OF SPECIAL BIOLOGICAL SIGNIFICANCE

RECONNAISSANCE SURVEY REPORT

SAN DIEGO MARINE LIFE REFUGE
SAN DIEGO COUNTY

STATE WATER RESOURCES CONTROL BOARD

SURVEILLANCE AND MONITORING SECTION

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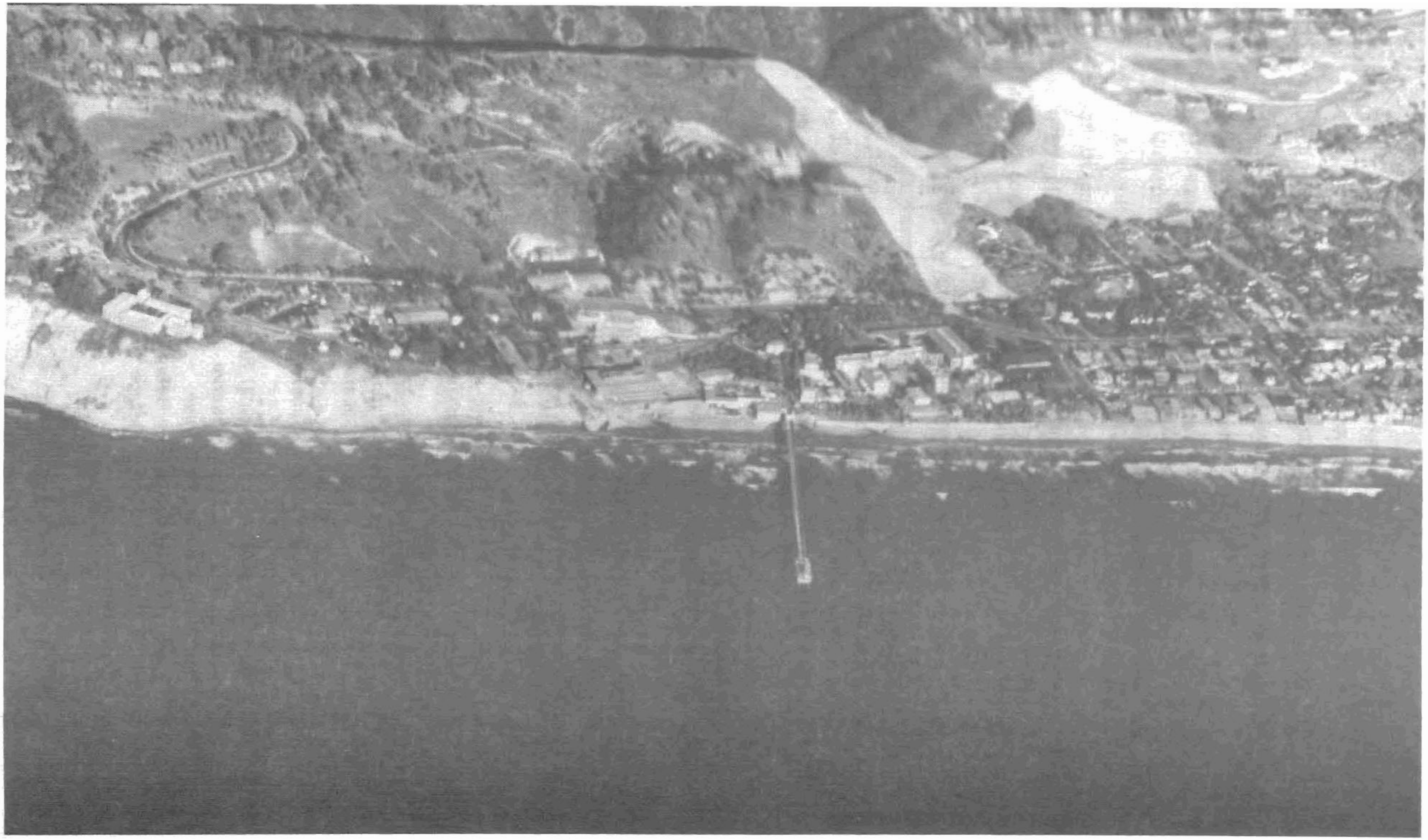
ACKNOWLEDGEMENT

This State Water Resources Control Board report is based entirely on a reconnaissance survey report submitted to the Board by Bert N. Kobayashi of the University of California, San Diego, in April, 1980. Mr. Kobayashi, in his report, also acknowledged the contributions of E. Fred Fischer and Joan-Marie Oltman.

Mr. Kobayashi's report was prepared in fulfillment of a contract with the California Department of Fish and Game, which has coordinated the preparation of a series of ASBS Survey Reports to the Board under Interagency Agreement.



SAN DIEGO MARINE LIFE REFUGE AREA OF SPECIAL BIOLOGICAL SIGNIFICANCE

STATE WATER RESOURCES CONTROL BOARD
AREAS OF SPECIAL BIOLOGICAL SIGNIFICANCE

Designated March 21, 1974, April 18, 1974, and June 19, 1975

1. Pygmy Forest Ecological Staircase
2. Del Mar Landing Ecological Reserve
3. Gerstle Cove
4. Bodega Marine Life Refuge
5. Kelp Beds at Saunders Reef
6. Kelp Beds at Trinidad Head
7. Kings Range National Conservation Area
8. Redwoods National Park
9. James V. Fitzgerald Marine Reserve
10. Farallon Island
11. Duxbury Reef Reserve and Extension
12. Point Reyes Headland Reserve and Extension
13. Double Point
14. Bird Rock
15. Ano Nuevo Point and Island
16. Point Lobos Ecological Reserve
17. San Miguel, Santa Rosa, and Santa Cruz Islands
18. Julia Pfeiffer Burns Underwater Park
19. Pacific Grove Marine Gardens Fish Refuge and Hopkins Marine Life Refuge
20. Ocean Area Surrounding the Mouth of Salmon Creek
21. San Nicolas Island and Begg Rock
22. Santa Barbara Island, Santa Barbara County and Anacapa Island
23. San Clemente Island
24. Mugu Lagoon to Latigo Point
25. Santa Catalina Island — Subarea One, Isthmus Cove to Catalina Head
26. Santa Catalina Island — Subarea Two, North End of Little Harbor to Ben Weston Point
27. Santa Catalina Island — Subarea Three, Farnsworth Bank Ecological Reserve
28. Santa Catalina Island — Subarea Four, Binnacle Rock to Jewfish Point
29. San Diego--La Jolla Ecological Reserve
30. Heisler Park Ecological Reserve
31. San Diego Marine Life Refuge
32. Newport Beach Marine Life Refuge
33. Irvine Coast Marine Life Refuge
34. Carmel Bay

ABSTRACT

The San Diego Marine Life Refuge Area of Special Biological Significance (ASBS) is located in La Jolla Bay, adjacent to Scripps Institute of Oceanography, La Jolla, San Diego County.

The San Diego Marine Life Refuge ASBS is part of the San Diego-La Jolla Underwater Park. The park has a total surface area of 5,977 acres while the surface area of the ASBS is approximately 92 acres.

The San Diego Marine Life Refuge ASBS includes three distinct habitats: a broad, sandy shelf; a concrete pier piling system; and an intertidal mudstone reef complex of dikes, boulders, and ledges. Therefore, the ASBS contains organisms representative of a sandy substrate and a rocky reef, while the pier exhibits a limited rocky biota.

This ASBS is immediately north of the San Diego-La Jolla Ecological Reserve ASBS, with which it shares many of the same species and organisms (Kobayashi, 1979).

Sailing, shore fishing, snorkeling, SCUBA diving, surfing, body surfing, and tide pooling are some of the water-use recreational activities that occur within the Refuge; sportfishing and commercial fishing, whale-watching, water-skiing, and jet-skiing occur in waters immediately adjacent to the ASBS.

There appear to be no actual point source pollution threats except that of sewage spills during periods of heavy rainfall. This threat appears minimal to the ASBS as the waters have not been found unsafe when tested.

Consideration should be given to the deliberate development of a program of periodic but regular monitoring of the San Diego Marine Life Refuge Area of Special Biological Significance. The status of protection afforded this designated area can only be accurately evaluated through such continuing surveys.

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The reconnaissance survey of the San Diego Marine Life Refuge Area of Special Biological Significance (ASBS) yielded the following findings and conclusions:

Findings

1. The intertidal and subtidal waters of the ASBS contain representatives of three distinct habitats:

   a. A broad sandy shelf ranging from the shoreline down to depths of 40 feet (12 m).

   b. A pier, with concrete pilings embedded in a sandy bottom to depths of 20 feet (7 m).

   c. An intertidal reef system of dikes, boulders, and ledges.

2. The flora and fauna of these areas reflect the substrate, with characteristic differences obvious between sand, pier pilings, and rocks.

3. There are two components of the biota which can be characterized as unique: the California halibut, *Paralichthys californicus*; and the grunion, *Leuresthes tenuis*. Each of these attracts an interest to the ASBS that is probably disproportionate to its role in the community dynamics of the habitat, but each is profound in its influence on humans.

4. The designation of this ASBS as a regulated marine life area offers protection to those species subject to human collection, such as many tidepool invertebrates and attached plants. The San Diego Marine Life Refuge ASBS includes the area around Scripps Pier and the small rocky reef adjacent to shore just north of the pier. It is an area that protects attached plants and invertebrates, but permits the taking of fish. It does not include the head of the Scripps branch of La Jolla Submarine Canyon.

Conclusions

1. The shoreline and waters of the ASBS, and the areas immediately adjacent, are heavily used for recreational and scientific activities. It appears from this survey that current levels of use are compatible with the biota as reflected by their health and vigor.

2. The observable impacts of disposal of industrial and other wastes are minimal, and the water quality of the area appears very conducive both to recreational use and to vigorous and healthy populations of marine organisms.

3. The designated status of "marine life refuge" for this ASBS should be perpetuated. Relaxation from protected status for any of the protected species would make it exceedingly difficult for enforcement and for evaluation of the full effect of the closure.

4. As the inclusion of three biotypes within this small ASBS is established and significant, efforts to eliminate any of these habitats from protected status must be thwarted.

5. The undertaking of monitoring studies and/or life-history investigations in this area under natural, in situ conditions should be encouraged. Natural fluctuations in biotic populations should be made a matter of scientific record.

6. Serious consideration should be given to extending the boundaries of the San Diego Marine Life Refuge to include the head of Scripps Canyon. The attached flora and invertebrate species would then be afforded the protection now available in the Marine Life Refuge.

INTRODUCTION

The California State Water Resources Control Board, under Resolution No. 74-28, designated certain Areas of Biological Significance (ASBS) in the adoption of water quality control plans for the control of wastes discharged to ocean waters. The ASBS are intended to afford special protection to marine life through prohibition of waste discharges within these areas. The concept of "special biological significance" recognizes that certain biological communities, because of their value or fragility, deserve very special protection that consists of preservation and maintenance of natural water quality conditions to practicable extents (from State Water Resources Control Board's and California Regional Water Quality Control Board's Administrative Procedures, September 14, 1970, Section XI. Miscellaneous--Revision 7, September 1, 1972).

Specifically, the following restrictions apply to ASBS in the implementation of this policy:

1. Discharge of elevated temperature wastes in a manner that would alter natural water quality conditions is prohibited.

2. Discharge of discrete point source sewage or industrial process wastes in a manner that would alter natural water quality conditions is prohibited.

3. Discharge of wastes from nonpoint sources, including but not limited to storm runoff, silt and urban runoff, will be controlled to the extent practicable. In control programs for wastes from nonpoint sources, Regional Boards will give high priority to areas tributary to ASBS.

4. The Ocean Plan, and hence the designation of areas of special biological significance, is not applicable to vessel wastes, the control of dredging, or the disposal of dredging spoil.

In order for the State Water Resources Control Board to evaluate the status of protection of the marine resources of this designated ASBS, a reconnaissance survey integrating all available hydrographic, geologic, and biological information was prepared under contract by Bert Kobayashi, University of California, San Diego. This report is one of a series being prepared by California Department of Fish and Game under an Interagency Agreement with the State Board.

The San Diego Marine Life Refuge ASBS is an area of keen scientific interest. Its close geographical proximity to Scripps Institution of Oceanography has undoubtedly contributed significantly to the large numbers of research projects conducted there. This area contains three (3) distinct biotic habitats: a gradual sloping sandy bottom; a pier complex with concrete pilings embedded in a sandy bottom; and a rocky intertidal reef.

Further, this area receives heavy recreational use--sunbathing, fishing, swimming, surfing, snorkeling, SCUBA diving, body-surfing, sailing, power boating, jet skiing, water skiing, picnicking, volleyball, frisbee throwing, and jogging are the most popular.

The head of the Scripps branch of the La Jolla Canyon approaches within 100 meters of the shoreline and is immediately adjacent to this ASBS. This steep-sided, mudstone canyon is the only local site of spectacular valleys and vertical walls for divers. As one of the few areas that abound with the purple-hinged rock scallop and the pink sea whip, there is a logic to future inclusion of this area as part of this ASBS.

The designation of this area as an ASBS is valid and should ensure its retention as a viable site for the multiple uses to which it is now subjected, without overtly changing the natural ecology of its biota.

ORGANIZATION OF SURVEY

This reconnaissance survey of the San Diego Marine Life Refuge Area of Special Biological Significance employed a number of differing means of investigation. These included a literature review, interviews, a search of records, map reconnaissance, shoreline observations, and underwater observations.

Background information on the area was gleaned from maps, city records, interviews with various persons, published literature, unpublished records, general shoreline and aerial observations, and impressions collected by the principal investigator from nearly 19 years of diving in the area.

Statistics on beach and water use were furnished by the San Diego City Lifeguard Service, various SCUBA diving organizations, and several local sportfishing companies. Estimates of some types of water use were extrapolated from gross counts made on several occasions by the investigation team.

Biological and corresponding environmental data were obtained primarily by point-counts in intertidal and supratidal areas, by estimating abundances along transects, and by listings of species in subtidal regions. The supratidal and intertidal observations were carried out while walking along the shoreline during low tides whereas the subtidal observations were made during a series of SCUBA dives.

In both intertidal and subtidal areas, the listing of species observed was compiled without much detailed quantitative data. The point counts in shoreline observations were carried out by taking actual counts in 10 x 10 centimeter squares.

In subtidal observations, one team of two persons was utilized. This team carried a 25-meter weighted transect line on a spool. Although the general location of the transect was initially selected to typify a given habitat, the actual placing of the transect line along the substrate was randomized within that habitat.

The composition of the plant cover of the subtidal substrate was noted at 1-meter intervals along the transect. The dominant or conspicuous plants were noted, and an estimate of abundance was made: R (rare) = $1-2/m^2$; F (few) = $3-5/m^2$; C (common) = $6-50/m^2$; A (abundant) = more than $50/m^2$.

The animal species in the subtidal environment at each meter-interval were listed, and abundance was estimated for the more conspicuous species at 5-meter intervals. The observations were limited to benthic epifauna and pelagic macro-animals.

Identifications of some organisms proved to be difficult with available keys; in all cases, identification was determined to the lowest unquestioned taxon, and different species within the same taxon were differentiated, even though unidentified.

PHYSICAL AND CHEMICAL DESCRIPTION

Location and Size

The San Diego Marine Life Refuge Area of Special Biological Significance is located at 32° 52' north latitude, 117° 15' 16" west longitude, in La Jolla, San Diego County. The seaward boundaries are formed by a line extending 1,000 feet westward from the mean high tide line along the north boundary of the San Diego-La Jolla Ecological Reserve Area of Special Biological Significance. The shoreward boundary line is the mean high tide line (Figure 1). This San Diego Marine Life Refuge Area of Special Biological Significance (ASBS) is part of the San Diego-La Jolla Underwater Park. The park extends from Point La Jolla westward, then northerly to the City of San Diego limits, a north-south distance of approximately seven (7) miles along a line about one (1) mile out from the shoreline for a total surface area of 5,977 acres. The surface area of the San Diego Marine Life Refuge ASBS is approximately 92 acres, or 37 hectares.

The legal description of the ASBS, given in Areas of Special Biological Significance, California State Water Resources Control Board, July 1976 (page 13), reads:

> "Ocean waters within that portion of Fish and Game District 19 consisting of that certain strip of land lying between the westerly edge of Pueblo Lot No. 1298 of the Pueblo Lands of the City of San Diego, according to the official map of said pueblo lands as made by James Pascoe, and filed in the office of the County Recorder of said County of San Diego, and the mean high tide line opposite to and west of said pueblo lot, which said strip of land is bounded on the north by the northerly boundary line of said pueblo lot extended westerly and on the south by the southerly boundary line of said pueblo lot extended westerly; together with the state waters of the State of California adjacent thereto, being those state waters which lie between said extended northerly and southerly boundaries of said pueblo lot and extend westerly from said mean high tide line for a distance of 1,000 feet."

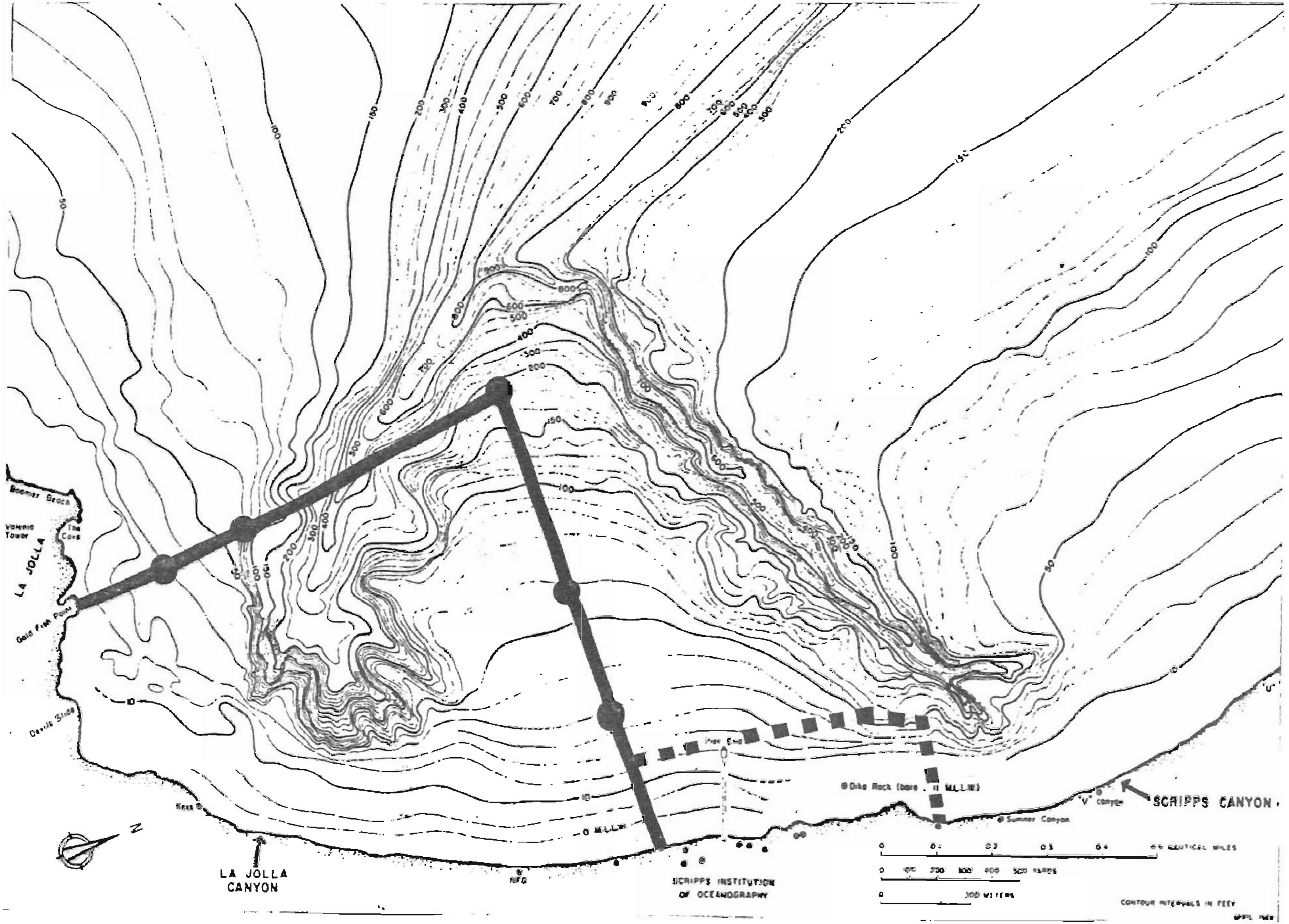

Figure 1. The San Diego Marine Life Refuge Area of Special Biological Significance (ASBS). The broken, dashed line represents the boundaries of this ASBS. The adjacent San Diego-La Jolla Ecological Reserve ASBS is circumscribed by the solid line connecting the solid circles which represent five orange-red buoys that mark

The shoreline boundary of the ASBS is 0.56 miles (0.9 km) in length. Along the shoreline, the southerly 0.4 miles (0.64 km) is composed of a wide sandy beach, whereas the northerly 0.16 miles (0.26 km) is variable, depending on seasonal changes as a narrow sandy beach or a boulder-strewn sandy beach. The extreme northern shoreline tip of the ASBS is composed of a rocky, mudstone dike running in a northeast-southwest direction. Ledges and boulders extend seaward of the 5 to 10 foot (1.5 to 3 m) wide dike for a distance of approximately 35 meters at its widest point. The dike rises 5 to 6 feet (1.5 to 2 m) above the surrounding basement and extends seaward in a southwesterly direction, and is visible as Dike Rock 100 meters south of the reef complex. The depth around the base of Dike Rock is about 10 feet (3 m) at high tide.

Nearshore Waters

The general submarine topography in the La Jolla Basin area can be described as a narrow continental shelf, traversed by a submarine canyon that approaches to within 328 to 984 ft. (100 to 300 m) of the shore. The canyon empties into the broad San Diego Trough, which is a part of the irregular submarine region of deep basins and intervening ridges termed the Southern California Continental Borderland.

Elements of the California Current and the Southern California Counter Current influence the ocean waters in the La Jolla area; additionally, late summer and winter Santa Ana winds from the northeast, or the prevailing north/northwest winds during the spring, promote periods of upwelling. The Oceanside Cell of sand transport flows southward and empties an estimated 260,000 cubic yards of sand annually into the Scripps branch of the submarine canyon. A small amount of sand bypasses this branch of the canyon and is deposited on La Jolla Shores Beach (Keen, 1976). Sand flowing further south is emptied into the La Jolla branch of the canyon complex (Shepard and Inman, 1951, and Inman, 1953).

Although this survey did not collect extensive physical chemical data, the oceanographic data taken daily at the end of the Scripps Institution of Oceanography pier were inspected (courtesy of Data Collection Processing Group, Marine Life Resources). Tables 1-4 summarize the temperature and salinity data, some of which have been gathered since 1916.

Over the more than 50 years of observations, surface water temperatures at this site have ranged annually between 46.4° and 58° F (8.3° and 14.5° C). The annual variation of surface and bottom water temperatures demonstrates the expected seasonal cycles (Tables 1-2).

The salinity of surface waters has a variate of 0.38 to 1.50 parts per thousand (o/oo) annually. Minimum salinity ranges between 32.34 o/oo and 33.47 o/oo; maximum salinity ranges between 33.68 and 34.65 o/oo. This variation in salinity (Tables 3-4) exhibits an annual cycle similar to that for temperatures, except that the peak occurs a month earlier in the summer.

The La Jolla Basin sandy areas are generally the clearest among San Diego nearshore waters, with vertical visibilities ranging from nearly zero to 50 feet (15 m) at the surface, although there is frequently greater visibility at deeper depths. Horizontal visibilities have a similar range. The rocky reef areas in the axis of Dike Rock and North Reef are generally clear, although the visibility may be deceptive due to the shallowness of these areas. At the outer edge of these reefs, at depths of 10 to 15 feet (3 to 5 m), the water is often clear enough to see the bottom, and visibilities of 20 to 30 feet (6 to 9 m) are not uncommon. Blooms of phytoplankton, commonly called Red Tides, affect both vertical and horizontal visibilities.

The immediate nearshore waters of the La Jolla Shores area, including the San Diego Marine Life Refuge ASBS, have had excellent water quality for recreational use. In recent years, the only known closures of this area to water use occurred during periods of heavy flooding coincident with sewage line breaks elsewhere along the San Diego coastline; the ASBS was among the first areas immediately (within two days) cleared for usage. These closures were in effect for up to two days per incident during 1978-1980.

TABLE 1. MEAN MONTHLY SURFACE WATER TEMPERATURES, IN °C, CALCULATED FROM TEMPERATURES TAKEN DAILY AT THE END OF THE PIER AT SCRIPPS INSTITUTION OF OCEANOGRAPHY

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
						Month						
1920	13.8	14.1	14.4	14.8	16.2	19.6	19.1	21.2	18.9	17.1	15.3	13.9
1925	13.3	13.6	14.6	15.1	17.0	19.0	21.1	21.1	18.7	17.7	16.5	16.4
1930	14.6	14.8	14.9	16.6	17.2	18.7	19.4	21.6	19.7	18.1	17.5	16.2
1935	14.4	14.1	13.3	15.0	17.6	18.9	20.0	20.7	19.4	17.2	15.3	14.8
1940	15.8	15.2	15.1	16.5	18.6	18.2	18.3	20.6	19.2	18.6	16.0	16.1
1945	14.2	14.0	13.1	13.8	15.9	18.6	20.0	21.4	20.3	18.5	15.2	14.3
1950	12.8	13.0	13.9	15.7	15.7	17.5	20.5	19.1	19.3	18.1	16.4	14.9
1955	13.4	13.0	14.4	14.1	16.4	18.1	19.6	21.5	20.6	17.3	15.7	13.8
1960	14.3	13.5	14.3	16.2	17.8	17.5	18.8	19.5	19.1	17.8	16.4	14.2
1965	13.1	13.4	14.5	15.8	17.5	16.9	17.2	20.7	18.9	18.1	16.9	15.4
1970	13.4	13.8	15.2	15.2	16.1	18.7	19.2	20.6	18.7	18.3	16.4	14.6
1975	13.1	13.2	13.3	13.8	14.9	16.7	20.0	18.1	18.3	16.9	14.5	13.6
1976	13.5	14.2	14.2	14.3	17.1	19.0	20.3	19.1	20.2	19.6	18.3	17.4
1977	16.2	15.7	13.8	15.6	16.6	17.7	19.4	20.4	19.8	18.0	17.4	16.3
1978	15.9	15.4	16.3									
$\bar{x}$	14.1	14.1	14.4	15.2	16.8	18.2	19.5	20.4	19.4	18.0	16.3	15.1

TABLE 2. MEAN MONTHLY BOTTOM (5 METERS) WATER TEMPERATURES, IN °C, CALCULATED FROM TEMPERATURES TAKEN DAILY AT THE END OF THE PIER AT SCRIPPS INSTITUTION OF OCEANOGRAPHY

Year	Month											
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1930	14.6	14.5	14.6	16.2	16.6	17.8	17.6	20.1	18.2	17.8	17.3	16.1
1935	14.4	13.9	12.9	14.2	16.6	18.0	17.4	17.8	16.8	16.1	15.0	14.7
1940	15.8	15.1	14.7	16.3	18.2	17.5	16.5	18.4	18.5	--	15.7	16.1
1945	14.2	14.1	13.1	13.2	14.6	18.1	18.7	20.2	19.0	18.0	14.9	14.3
1950	12.9	13.1	13.8	15.5	15.2	17.1	19.4	18.0	18.8	17.1	16.2	14.7
1955	13.7	--	--	--	17.1	17.5	18.2	19.3	19.0	17.0	15.6	13.7
1960	14.2	13.4	14.2	15.9	17.5	15.9	16.8	17.1	17.2	17.1	16.2	14.2
1965	13.1	13.4	14.4	15.5	17.4	16.3	15.7	19.6	18.1	17.6	16.8	15.5
1970	13.5	13.9	15.2	14.8	15.8	17.7	17.0	18.7	16.7	17.7	16.3	14.6
1975	13.0	13.2	13.2	13.9	14.8	16.3	19.5	16.6	17.7	16.3	14.2	13.5
1976	13.4	14.2	14.2	14.1	17.0	18.0	19.9	18.5	19.6	19.2	18.2	17.3
1977	16.2	15.8	13.7	15.6	16.5	17.3	18.5	19.6	19.0	17.5	17.3	16.2
1978	15.9	15.5	16.3									
$\bar{x}$	14.2	14.2	14.2	15.0	16.4	17.3	17.9	18.7	18.2	17.4	16.1	15.1

TABLE 3. MEAN MONTHLY SURFACE SALINITIES, IN ‰, CALCULATED FROM SALINITIES TAKEN DAILY AT THE END OF THE PIER AT SCRIPPS INSTITUTION OF OCEANOGRAPHY

Year	Month											
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1920	33.45	33.40	33.37	33.44	33.58	33.67	33.61	33.61	33.57	33.52	33.55	33.54
1925	33.66	33.62	33.57	33.62	33.69	33.70	33.65	33.58	33.48	33.25	33.44	33.45
1930	33.62	33.63	33.59	33.60	33.60	33.71	33.69	33.73	33.69	33.72	33.78	33.84
1935	33.40	33.28	33.42	33.51	33.60	33.65	33.62	33.59	33.51	33.50	33.49	33.54
1940	33.72	33.60	33.63	33.58	33.71	33.70	33.64	33.71	33.57	33.52	33.44	33.37
1945	33.59	33.53	33.50	33.64	33.71	33.69	33.71	33.71	33.71	33.65	33.60	33.53
1950	33.50	33.55	33.57	33.63	33.62	33.65	33.71	33.64	33.62	33.60	33.56	33.57
1955	33.49	33.56	33.57	33.57	33.62	33.65	33.65	33.75	33.71	33.66	33.60	33.60
1960	33.56	33.57	33.61	33.65	33.70	33.76	33.72	33.73	33.66	33.67	33.65	33.60
1965	33.59	33.57	33.58	33.48	33.64	33.72	33.71	33.72	33.66	33.64	33.44	33.32
1970	33.51	33.52	33.45	33.57	33.70	33.72	33.67	33.68	33.69	33.69	33.61	33.49
1974	33.56	33.64	33.57	33.66	33.87	33.83	33.75	33.67	33.70	33.63	33.63	33.59
1975	33.73	33.72	33.63	33.58	33.77	33.77	33.82	33.71	33.72	33.70	33.63	33.64
1976	33.67	33.55	33.61	33.70	33.79	33.81	33.86	33.73	33.61	33.73	33.72	33.90
$\bar{x}$	33.58	33.55	33.55	33.59	33.69	33.72	33.70	33.68	33.64	33.61	33.54	33.57

TABLE 4. MEAN MONTHLY BOTTOM (5 METERS) WATER SALINITIES, IN ‰, CALCULATED FROM SALINITIES TAKEN DAILY AT THE END OF THE PIER AT SCRIPPS INSTITUTION OF OCEANOGRAPHY

Year	Month: Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1930	33.66	33.63	33.58	33.60	33.61	33.73	33.68	33.68	33.68	33.72	33.80	33.84
1935	33.41	33.31	33.44	33.52	33.58	33.62	33.57	33.53	33.46	33.48	33.48	33.54
1940	33.72	33.60	33.63	33.59	33.70	33.70	33.62	33.65	33.55	--	33.42	33.38
1945	33.59	33.54	33.51	33.64	33.72	33.69	33.71	33.71	33.71	33.64	33.61	33.54
1950	33.50	33.55	33.57	33.61	33.59	33.62	33.69	33.62	33.61	33.58	33.56	33.56
1955	33.48	--	--	--	33.61	33.63	33.61	33.70	33.68	33.66	33.59	33.57
1960	33.57	33.57	33.61	33.65	33.71	33.74	33.71	33.71	33.64	33.67	33.64	33.60
1965	33.57	33.55	33.57	33.48	33.63	33.69	33.67	33.70	33.60	33.60	33.43	33.30
1970	33.55	33.57	33.49	33.65	33.77	33.76	33.70	33.72	33.72	33.73	33.68	33.56
1974	33.55	33.59	33.55	33.63	33.87	33.78	33.72	33.63	33.55	33.58	33.60	33.56
1975	33.69	33.67	33.60	33.54	33.71	33.75	33.76	33.65	33.69	33.64	33.58	33.61
1976	33.66	33.50	33.59	33.67	33.74	33.79	33.81	33.77	33.62	33.68	33.69	33.90
$\bar{\bar{x}}$	33.58	33.55	33.56	33.60	33.69	33.71	33.69	33.67	33.63	33.63	33.59	33.58

Vessel discharge and/or natural oil seepage have deposited oil globules on many San Diego beaches, including La Jolla Shores. These deposits appear to present more of a nuisance effect than a health hazard to humans. The impact of these pollutants on marine life, including birds, is not known.

Topography and Geomorphology

The La Jolla Shores area is a small alluvial basin bordered by a high ridge which forms the cliffs north of Scripps Institution of Oceanography. The alluvial fill of the basin rests on a seaward sloping basement of Eocene sandstone and shale with a thickness of 30 to 40 feet (10 to 12 m).

The substrate in the San Diego Marine Life Refuge ASBS is of three types: sand, pier pilings, and mudstone reef. The sand bottom is composed of fine sand mixed with varying amounts of silt and/or mud. During the surveys, the sand was found to be fine and white, interspersed with occasional patches of mud. Presumably, this mud is derived from shore water runoff during or after periods of storms. The mud is never so abundant that the sand appears anything other than clean and white at superficial glance. The sand is mainly quartz, although 5% is heavy minerals, 3% micaceous materials, and less than 3% silt (Fager, 1968). Fager's study areas were close to the seaward end of the Scripps pier. The silt/mud concentration or deposition is considerably greater as one moves southward, approaching the offshore area of the largest storm drain located at the foot of Avenida de la Playa.

The wide axis of the La Jolla branch of the La Jolla Submarine Canyon contains alluvial fill that characterizes the entire La Jolla Basin. This axis runs in a northwesterly direction away from La Jolla Shores and becomes confluent at depths of 800 to 900 feet (243 to 274 m) with the axis of the Scripps branch running southwest.

The axis of the La Jolla branch of the La Jolla Submarine Canyon lies along the Rose Canyon fault. Moore (1972) suggested that the Rose Canyon fault is part of a zone of faulting which includes the Newport-Inglewood fault and the Vallecito and San Miguel faults in Baja California.

The northern offshore extension of the Rose Canyon fault zone extends from La Jolla to within 28 miles (45 km) of the southern onshore termination of the Newport-Inglewood fault zone (Moore, 1972). According to Simons (1977), at least nine of the eleven earthquakes since 1963 in the San Diego area have occurred in a broad area in the vicinity of San Diego Bay, and the epicenter distribution suggests that the Rose Canyon fault zone is currently active. No epicenters were located in the immediate La Jolla area.

The intertidal substrate in the San Diego Marine Life Refuge ASBS consists of three different materials: a fairly wide, 98 ft. (30 m), sandy beach that constitutes the southern two-thirds of the shoreline; a series of concrete pier pilings extending out to the seaward limit of the ASBS, to depths of 20 feet (7 m); and a narrow, 33 ft. (10 m) system of rocky boulders, ledges, and a prominent dike.

The wide southern sand beach is composed of fine white sand that is partially or fully covered by high tides. The slope characteristics vary according to the surf regime, but this is usually an even and gently sloping beach. It is bordered throughout its entire length by a sea wall or tall cliffs.

As shown in Figure 1, the Scripps pier traverses the sand beach and extends out to the seaward limit of the ASBS (1,000 feet, or 300 meters) at a point about 300 yards (275 m) north of the southern boundary of the ASBS.

The northern end of the ASBS grades into an area that is composed of large boulders at the base of cliffs, before widening into a broad sandy beach north of the ASBS.

The geomorphology of the adjacent land mass is that of a small alluvial basin with surrounding ridges. The La Jolla Shores area is bordered on the south by the northwestern flanks of Soledad Mountain and to the east by a high ridge. The entire area is underlain with nearly flat-lying Eocene, Pliocene, and Pleistocene rocks and steeply-tilted Upper Cretaceous and Eocene rocks (Kennedy, 1975).

The La Jolla Shores area is a residential area, with a city-operated park, a hotel, a tennis club, and a number of private residences bordering the wide, sandy beach. There is a low sea wall that separates the beach from beachfront property throughout the major part of the La Jolla Shores beach. The high ridge to the east fronts the beach at the Scripps Institution of Oceanography campus and runs northward along the shoreline to Del Mar.

Although there are no significant natural watersheds within the San Diego Marine Life Refuge ASBS, a paved roadway leading down Black's Canyon approximately 500 yards (457 m) north of the ASBS concentrates storm runoff. Further, the sea wall that fronts the Scripps Institution of Oceanography campus is studded with nearly 20 runoff outlets; these are not all functional at the current time. The active drains discharge excess or used sea water from the various buildings and laboratories at Scripps; this discharge empties directly onto the sandy beach fronting the campus. The large, 50-foot (17 m) long concrete filtration system at the base of the Scripps pier has a continual overflow along the top half of the structure.

There are several other drainage pipes emptying into the ASBS area. A 12 in. outlet is situated along a dirt cliff that fronts the beach immediately south of the Scripps sea wall. This drains storm runoff from the surrounding area. Two large 36 in. pipes collect and drain the sea water systems from the Marine Biology building at Scripps (active virtually all the time) and from the buildings north of the Marine Biology building.

Climate

The warm, moderate weather of the San Diego region is due to the subtropical high pressure of the northeastern Pacific. In the fall and early winter, this high pressure is frequently centered over Nevada and produces dry winds known in southern California as Santa Anas. These winds are usually warm and produce La Jolla's high temperatures in late September and the early winter months.

The monthly median temperatures for the minimum daily temperatures range from 45° to 48° F (8° to 9° C) in the winter and to about 62° to 64° F (17° to 18° C) in the summer months; the maximum daily temperatures range from 57° to 59° F (14° to 15° C) in the winter and spring months to 68° to 72° F (20° to 22° C) in the late summer and early fall months (Appendix 1). Rainfall is largely concentrated in the winter months, although infrequent tropical squalls deposit significant rain during the summer.

The sea state of the La Jolla Basin waters is generally calm and smooth, with wind waves of less than two feet. Swells at the pier usually come from the west to west-northwest, although winter storm swells come from a more southerly direction. Waves have an average height of only 1 to 2 feet (although there are winter storms that produce waves of eight feet or greater in the vicinity of the Scripps pier).

BIOLOGICAL DESCRIPTION

Subtidal Biota

Although the number of plants and animals occurring in the subtidal environment of the San Diego Marine Life Refuge ASBS is limited, many uncommon or transient species move through the area. This is especially true for many fishes. Furthermore, none of the species of organisms occurring at the ASBS are endemic to this area only; all of them are widely distributed and occur in similar habitats throughout southern California. It was impossible to encounter all or even most of the species that could possibly occur during the interval of this survey; the listing of species reported for each habitat is thus incomplete. The seasonal changes that occur in any habitat or the subtle differences between similar habitats could not be adequately documented due to the limited scope of this survey and partly to unfavorable diving conditions from the beginning of January through March. Nevertheless, there is a sufficiency of data that includes a listing of species for each of the three distinct habitats. The pier and rocky reef systems were considered under the intertidal area, whereas the sandy substrate was effectively classed under both the subtidal and intertidal areas. Appendix II summarizes the data for the sandy subtidal areas.

No attached plants were found in any of the sandy areas observed. Whole plants, or parts of specimens in different stages of decomposition, were noted during dives into the area.

The number of animal species that are found in the sandy areas of the ASBS is nearly as restricted as observed for the plants, although many species of animals not normally living on or over sand are carried there by currents or employ this area as transportation corridors. The list given in Appendix II is not all-inclusive; rather, it lists those species which are common, abundant, or widely distributed. The shallow depths (less than 40 ft. or 14 m) of the sandy subtidal areas within the ASBS and the clay-banked walls of the La Jolla branch of the La Jolla Submarine Canyon, contained within the San Diego-La Jolla Ecological

Reserve ASBS, account for the major differences between the sandy substrate listings of the two areas.

The species, which by virtue of abundance or by frequency of occurrence, dominate this area include the burrowing anemone, Harenactis attenuata; sea pansy, Renilla kollikeri; sea pen, Stylatula elongata; Diopatra splendidissima; oppossum shrimp, Acanthomysis costata; Epitonium tinctum; olive snails, Olivella spp; sand star, Astropecten spp; brittle star, Amphiodia spp; sand dollar, Dendraster excentricus; speckled sanddab, Citharichthys stigmaeus; and California halibut, Paralichthys californicus. Additionally, the thornback Platyrhinoidis triseriata, shovelnose guitar fish, Rhinobatos productus, and the round sting ray, Urolophus halleri, were found.

During the series of dives made within the ASBS, both for the survey and on previous dives, many species of fish other than those included in Appendix II were observed. However, the listing is limited to those fish which were known to be sandy substrate-oriented.

Intertidal Biota

The intertidal areas of the San Diego Marine Life Refuge ASBS consist of three substrate types: a gently sloping sandy beach; a series of concrete pier pilings; and a rocky reef system made up of mudstone boulders, ledges, and a dike. The sandy intertidal and supratidal areas are restricted to a handful of species (Appendix III), whereas the rocky reef complex contains a large diversity of plants and animals. The concrete pier pilings exhibit a limited rocky flora and fauna--all species found on the pilings were found on the rocky reef systems but only a few of those found on the rocky reef were able to inhabit the pier pilings. Appendix IV contains a listing of those species found in the latter two habitats; observations were made chiefly in the intertidal zones.

The part of La Jolla Shores beach that is contained within the ASBS, known locally as Scripps beach, is entirely open to the sea, but the presence of the La Jolla Submarine Canyon produces a fauna that is typical for a protected outer coast. The canyon serves to break the full force of the waves over the long, gradually sloping sandy shelf offshore; wave heights average less than 1 to 2 feet (0.5 m) annually. The species listed in Appendix III are few in number, although some of these species are highly successful and abundant. The abundance levels vary considerably between sites and times of observation. For example, counts of 30,000 specimens per square meter have been reported for the bloodworm, Euzonus mucronata, (McConnaughey and Fox, 1949) whereas this survey noted densities no higher than 4,000 per square meter. The bean clam, Donax gouldi, was extremely rare during this survey (only three live individuals were observed); Coe (1955) noted fluctuations for this species of 1 to 20,000 specimens per square meter in a span of two months along the same stretch of beach.

The grunion, Leuresthes tenuis, and shore birds are not normally included in listings of intertidal species by most investigators. They are presented here as they constitute an integral part of the seashore life in the intertidal and supratidal areas of the ASBS. The grunion is a migrant, entering the intertidal zone only during its swim to the sandy beach for spawning.

The number of species found on this sand intertidal area is low. Any attempt to monitor or study biota of the area should include all elements present, although observations on the lower intertidal species (Pismo clam, Tivela stultorum, spiney sand crab, Blepharipoda occidentalis, and mole crab, Lepidopa myops, especially) may be somewhat difficult to obtain on a regular basis, due to surf/surge and limited visibility.

The shallow mudstone ledges, boulders, and a conspicuous dike make up the rocky intertidal substrate at the northern end of the ASBS. The area supports a flora and fauna that are indicative of a semi-protected outer coast zone. It is limited in size, with a narrow stretch of tidepools and ledges. Gross estimates of populations were applied to the higher intertidal zones, and the results given here should be interpreted relatively rather than absolutely. The lowermost zones were not intensively surveyed, but presence or absence was noted (Appendix IV). The estimates of abundance for these organisms listed for the lower zones are taken from the personal experiences and knowledge of the principal investigator.

The flora in the intertidal rocky substrate is dominated by red algae and surfgrass, Phyllospadix. These are virtually everywhere in the intertidal zone. Other attached plants are also abundant or common in the various tidal zones: yellow rock weed, Pelvetia fastigiata, is the most conspicuous form in the high intertidal zone, although another brown algae, probably Scytosiphon lomentaria, is more abundant in the upper margins of the Pelvetia-zone. The tops of many boulders and ledges in the tidepools contain a mat of coralline red algae, with many specimens of Enteromorpha and Sargassum interspersed throughout the area. Sea lettuce, Ulva, and Pachydictyon are also very common throughout the lower and middle zones, as is the very abundant surf grass. Sponge cushion, Codium, woody chain bladder, Cystoseira, Halidrys, Eisenia, and Gelidium were seen occasionally, but these were not common.

The species observed and listed for the rocky intertidal area are representative for those given for a semi-protected outer rocky coast. There are not any unexpected species, although the densities noted are not in perfect accord with published literature.

The species important to the community dynamics of the area include: Enteromorpha, Pelvetia, and crustose and coralline red algal cover; the incidence of soft red algae; Phyllospadix cover; Anthopleura spp. distributions; Phragmatopoma californica buildup; incidences of other polychaetous tube worms; notation of the various species of barnacles and limpets, littorine or periwinkle snails (Littorina spp.), and the black turban snail, Tegula funebralis; and numbers, sizes, and movements of the California spiny lobster, Panulirus interruptus. Fish that should be included are the wooly sculpin, Clinocottus analis, and the opaleye, Girella nigricans.

The plants and animals observed on the concrete pier pilings represent a greatly abbreviated listing of the species noted for the rocky reef. The primary species noted on the concrete pier piling were: bay mussel, Mytilus edulus and the California mussel, M. californianus; Chthamalus spp. and Balanus spp., two genera of barnacles; gooseneck barnacles, Mitella spp. and Pollicipes polymerus; Littorina planaxis and L. scutulina, two species of littorine or periwinkle snails; several species of anemones, including Anthopleura elegantissima and A. xanthogrammica; and sea lettuce and Eisenia, at the base of the pilings.

The intertidal species most likely to be influenced by human use in the San Diego Marine Life Refuge ASBS is the grunion, Leuresthes tenuis, and several of the shore birds; however, storm and spillage runoffs may adversely affect those elements that are sedentary or only slightly mobile.

Landside Vegetation

The land mass adjacent to the San Diego Marine Life Refuge ASBS is situated in the midst of developed residential and institutional areas so that the landside vegetation is primarily introduced and non-native or species that proliferate in disturbed-land sites. Steepness of the cliffs along the northern third of the ASBS limits the native plants to an occasional individual of the cliff spurge, Euphorbia misera, and Frankenia palmeri. The most conspicuous and abundant plant along the cliffs and above the sea walls is the ice plant, Mesembryanthemum spp.

Unique Components

Two species of fish are included as being unique in their influence on humans. These are the grunion, Leuresthes tenuis, and the California halibut, Paralichthys californicus.

The grunion is well known throughout southern California for its peculiar spawning behavior. It is included as a migrant component of the sandy intertidal zone as the female, usually accompanied by several males, swims completely out of the water to lay her eggs in the moist sand. She digs with a wriggling, tail-first motion into the sand with the males wrapped about her, deposits her eggs, and then wriggles back to the sea.

Walker (1952) gives an excellent review of the life history of the grunion. Although a great deal of information has been assessed on the aspects of spawning of the grunion, not much is yet known about the major part of its 2-3 year life span. Grunion apparently do not stray far from the beach areas on which they spawn.

Human use of the beaches and areas of the ASBS has appeared to influence the behavior of the grunion. The lighting of Kellogg Park in the southern end of the ASBS, coupled with the shoreline spotlights at the base of the Scripps pier, have served to concentrate much of the spawning runs of the grunion to that stretch of beach between these two lighted areas. But even there, the spawning runs are limited; the completely darkened beaches north of the ASBS, in that stretch appropriately called Black's, are now the best areas to observe a large run of spawning grunion.

The California halibut, Paralichthys californicus, is a favorite food fish of many anglers and spearfishermen. The San Diego Marine Life Refuge ASBS permits the taking of fish species, and the sandy areas beneath the Scripps pier and the sand/rock margins of the Dike Rock-North Reef complex are considered excellent for halibut. Halibut are generally found buried in sand or lying on top of the sand near rocks, seaweeds, and between rows of sand dollars, at varying depths from intertidal areas to deep waters. They have been reported to 72 pounds, although a 61.5 pound fish is the largest verified record (Feder, Turner, and Limbaugh, 1974). This fish is reported to have been about five feet long.

The halibut feeds on squid and small fishes, including other flatfishes. They are known to frequent shallower depths during periods of grunion runs.

LAND AND WATER USE DESCRIPTIONS

Marine Resource Harvesting

The San Diego Marine Life Refuge ASBS is designated as a reserve for invertebrates and plants. Consequently, no harvesting of these organisms is permitted within the ASBS. However, fish species can be taken. Most of the waters in the ASBS are shallow and lie over sandy bottom; subsequently, fishing is restricted chiefly to shore fishing, although an occasional boat is seen in the limits of the ASBS. The waters immediately adjacent to the ASBS are fished by sport-fishermen, especially in the area of Scripps branch of La Jolla Canyon.

Underwater photography, sight-seeing SCUBA and snorkel dives, tidepool observations and projects, shorebird watching, grunion hunting, and the enjoyment of intertidal and subtidal community dynamics have become a fascinating and integral part of the education of many San Diego citizens and visitors.

Municipal and Industrial Activities

The community of La Jolla, part of the City of San Diego, surrounds the entire shoreline of the San Diego Marine Life Refuge ASBS. La Jolla is primarily a residential and resort community, with a population of 30,000. Scripps Institution of Oceanography, a research and graduate training center for oceanographic studies, and the National Marine Fisheries Service, conducting research on tuna and related studies, are situated immediately shoreward in the northern half of the ASBS. There are no manufacturing or industrial concerns situated anywhere close to the ASBS.

Governmental Designated Open Space

The La Jolla Community Plan serves as the long-range policy guide for the future land use development of La Jolla. Its objectives and recommendations are in accord with the California Coastal Plan. One of the objectives calls for all types of open space to be preserved wherever possible. The plan points out La Jolla's reputation as an attractive seaside residential community and notes that its attraction to tourists is largely due to its fine beaches, parks, and topographical features. These assets should be emphasized for the benefit of community residents and visitors. Implementation of this objective is generally proposed through maintenance of La Jolla's relationship to the sea, through protection and improvement of existing physical and visual access to the shoreline and ocean. The plan calls for all forms of open space to be preserved--beaches, parks, cliffs, scenic vistas, tidepools, coastal waters, and canyons. Although the La Jolla Community Plan lists 27 specific recommendations for the Open Space and Recreation Element, only the following are specifically pertinent to this discussion of the ASBS (listed in same numerical designation as in La Jolla Community Plan):

"1. The City's beach and park land along the shoreline should be expanded wherever possible.

2. Construction, grading, or improvements of any sort, except those mentioned in this Plan, should be discouraged at beach areas. Public access to the shoreline should be increased (or improved) wherever possible...

3. No additional parking facilities should be provided adjacent to beach areas...If additional beach utilization is considered necessary, alternative means of transportation must be explored.

4. New developments should not prevent or unduly restrict access to beaches or other recreational areas.

5. A connected system of shoreline walkways should be developed to extend from La Jolla Shores Beach to Hermosa Terrace Park.

6. All beach lands in the public domain should be dedicated or otherwise legally reserved as park area to assure future public usage.

8. ...Concessions and other forms of commercial activity should not be permitted on any beaches or in any parks...

16. The ocean and submerged lands within the jurisdictional limits of San Diego should be preserved in their natural state. Plant and marine life in tidepools and offshore waters should be protected from environmental degradation.

23. Criteria for the selection of scenic vistas should be formulated and utilized. Outstanding scenic vistas should be preserved. These should include...c) Coast Walk..."

Although the La Jolla Community Plan lists 25 parks, only the La Jolla Underwater Park (of which the ASBS is a part), Ellen Scripps Cove Park, and Kellogg Park are adjacent to the ASBS. The La Jolla Underwater Park has been described above already. Both Ellen Scripps Cove and Kellogg Park are improved shoreline parks. Ellen Scripps Cove has a rocky shore, although the Cove itself is a pocket sand beach. Kellogg Park is adjacent to the sandy La Jolla Shores beach.

Recreational Uses

A variety of recreational activities occur within the San Diego Marine Life Refuge ASBS and its immediate vicinity. These include swimming, sunbathing, bodysurfing, surfboarding, snorkel and SCUBA diving, sport fishing (adjacent waters), yachting and boating, wildlife observation (already discussed under marine resource harvesting), picnicking, jogging, volleyball, softball, baseball, football, and frisbee throwing.

Swimming occurs primarily in the Ellen Scripps Cove area, where hardy swimmers swim long distances all year-round, as well as La Jolla Shores, and Scripps beaches.

Sunbathers flock to these beaches, especially during warm, sunny days. The beach attendance estimates, furnished by the San Diego City Lifeguard Service, are given in Table 5.

The commercial sportfishing fleet fishes the areas immediately adjacent to the San Diego Marine Life Refuge. Each boat makes two trips daily from Mission Bay, and the number of boats varies between 4 and 10 daily. This nearshore summer fishing is primarily for barracuda, Sphyraena

TABLE 5. ATTENDANCE ESTIMATES FOR LA JOLLA BEACHES FROM SAN DIEGO CITY LIFEGUARD SERVICE RECORDS.

Date	Beach	
	La Jolla Shores	Ellen Scripps Cove
1972	1,760,200	296,425
1973	1,320,943	207,617
1974	1,165,692	221,620
1975	1,482,262	320,659
1976	1,939,096	462,415
1977:	1,673,290 (10 months)	308,710 (10 months)
Jan	64,400	21,965
Feb	111,900	23,773
Mar	44,550	17,000
Apr	128,700	25,050
May	116,195	30,345
Jun	204,720	23,850
Jul	446,950	59,100
Aug	293,400	52,102
Sep	187,100	42,750
Oct	175,375	12,775

argentea, bonito, Sarda chiliensis, kelp or calico bass, Paralabrax clathratus, cabezon Scorpaenichthys marmoratus, sculpin, Scorpaena guttata, mackerel, Scomber japonicus, and yellowtail, Seriola dorsalis. The winter fishing is primarily for rockfish, Sebastes spp., and assorted bottom fishes. Interviews with the two leading sportfishing companies that regularly send their boats to La Jolla indicate that all skippers are aware of the protected status of the San Diego Marine Life Refuge for invertebrates and plants, but that taking of fish in these waters is permitted. However, they consider the waters of the ASBS to be too shallow and unproductive for their commercial operations. The proximity of fishing to the ASBS is dependent on the skipper, the weather, and the quality of fishing in Scripps Canyon.

The California gray whale, Eschrichtius gibbosus, travels fairly close to shore on its southward migration from the Bering Sea to the bays and lagoons of Baja California. This migration has become a great public attraction, coming within a few hundred meters of shore at certain spots. There are whale-watching boats, carrying more than 50 passengers, that daily ply the waters off La Jolla during January and February, as well as numerous small boats that intercept and follow the whales.

Scientific Study Uses

The ASBS has been, and continues to be, a study site for a wide variety of scientific investigations. The proximity of Scripps Institution of Oceanography, which celebrated the 75th anniversary of its founding in 1978, has greatly promoted the use of the surrounding waters, including the ASBS, for scientific studies. Many geological, chemical, physical oceanographic, and biological studies have been conducted either wholly or in part within the San Diego Marine Life Refuge or its immediate environs. The following list is representative of the recent studies completed to date; listing is chronological.

B.H. McConnaughey and D.L. Fox, 1949. Anatomy and ecological aspects of the bloodworm, Euzonus mucronata. Study site La Jolla Shores beach.

J.C. McGowan, 1954. Sexual behavior and spawning of the squid, Loligo opalescence. Observations at the head of La Jolla branch of the La Jolla Submarine Canyon.

W.R. Coe, 1955. Ecological studies of the bean clam, Donax gouldi. La Jolla Shores beach.

C. Limbaugh, 1964. T.A. Clarke, 1971. Life history aspects of the garibaldi, Hypsypops rubicunda.

R.W. Holmes, P.M. Williams, and R.W. Eppley, 1967. Study of red tides of 1964-66 in La Jolla Bay.

E.W. Fager, 1968. The composition and dynamics of a shallow subtidal sand bottom epifaunal community. Study sites in the vicinity of Scripps pier.

C.L. Hubbs, A.L. Kelly, and C. Limbaugh, 1970. Feeding preferences of the Brandt's coromorant, Phalacrocorax penicillatus. Nesting and roosting sites above La Jolla Caves.

A.C. Hartline, 1972. Investigations into the ecology of the subtidal acorn barnacle, Balanus pacificus, using the Zostera bed along La Jolla Canyon as one of the study sites.

T.J. Chow, H.G. Snyder, and C.B. Snyder, 1976. Mussels as an indicator of lead pollution. Specimens from Scripps pier.

M.S. Olsson, T.D. Finnigan, S.R. Glass, A. Milgrom, R. Kaufmann, R.A. Arkin, G. Rankin, and V. Paul, 1977-78. Studies on population dynamics and migration of the California spiny lobster Panulirus interruptus.

E.D. Goldberg, V.I. Bowen, J.W. Farrington, G. Harvey, J.H. Martin, P.L. Parker, R.W. Risebrough, W. Robertson, E. Schneider, and E. Gamble, 1978. Concentrations of Ag in the tissues of Mytilus.

M.S. Olsson and G. Newston, 1979. Population studies of the red urchin, Strongylocentrotus franciscanus.

The ASBS and the adjacent San Diego-La Jolla Ecological Reserve ASBS are the sites for considerable scientific projects of note. The character of the biological studies in this area has changed considerably with the establishment of the Ecological Reserve in 1972. In situ, natural population investigations have replaced the collection-oriented, laboratory-based studies of the past. SCUBA diving has provided the means of conducting these studies effectively in both ASBS.

Transportation Corridors

Shipping lanes are considerably removed offshore from the ASBS, and the primary surface water traffic is confined to sailboats and an occasional powerboat. Since the waters of the ASBS are shallow, the boating traffic rarely invades the actual ASBS.

ACTUAL OR POTENTIAL POLLUTION THREATS

Point Sources

There are no industrial or municipal wastes that are deposited in the ocean within a mile of the ASBS. The closest wastewater treatment plants are the Metro plant at Point Loma and the San Elijo Treatment Plant. These are located at straight-line distances of 12.7 and 9.2 miles, respectively, from the nearest border of the San Diego Marine Life Refuge ASBS. The nearest solid waste disposal site is located at Miramar, a distance of slightly more than 6.5 miles. There are no thermal effluent discharges anywhere near the ASBS.

Closure of the waters within the ASBS has paralleled heavy rainfall and associated flooding, which, when combined with sewage line breaks, have resulted in contamination of much of the local nearshore waters. Although the La Jolla Shores area has been subjected to closures within this period, each closure was for less than two full days; in each of the 3 to 5 cases, this beach was the first one given clearance in the San Diego area.

Nonpoint Sources

A report on the trace metal concentrations in the California mussel, *Mytilus californianus*, noted high concentrations of lead (Pb) and silver (Ag) in specimens collected in the ASBS or in adjacent waters. The report does not credit these elevated concentrations to any specific source; however, speculation that the Point Loma municipal discharge is the contaminating source is offered, although concession is yielded for other point or nonpoint source discharges contributing to these observed mussel tissue enhancements (Stephenson, Martin, Lange, Flegal, and Martin, 1979).

SPECIAL WATER QUALITY REQUIREMENTS

The present level of water quality within the San Diego Marine Life Refuge ASBS is of sufficient quality to enable the unique components to thrive as expected. Grunion, Leuresthes tenuis, and California halibut, Paralichthys californicus, occur in substantial numbers throughout the ASBS; hence, the quality of water is conducive, or at least non-inhibatory, for the growth and maintenance of these organisms.

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APPENDIX 1 WEATHER DATA COMPILED FROM DAILY OBSERVATIONS TAKEN AT THE END OF THE PIER AT SCRIPPS INSTITUTION OF OCEANOGRAPHY FROM 1974 THROUGH MARCH, 1978. THE FIGURES CITED ARE THE MONTHLY MEDIAN, WITH THE MONTHLY RANGE OF VALUES IN PARENTHESES, EXCEPT FOR RAINFALL (CUMULATIVE FOR EACH MONTH)

	Air Temp. in °C		Wind				Air	Swell			Cumulative
Date	Max	Min	Direction in °	Speed in Knots	Weather[a]	Sea State[b]	Visibility in Mi.	Direction in °	Period in Sec.	Height in Ft.	Rainfall in In.
1974											
Jan	13.9 (12.8-17.5)	10.1 (6.1-18.8)	280 (100-350)	0 (0-22)	00,01,02, 42,43,45, 49,80	1 (1-4)	7 (0-9)	290 (250-290)	9 (4-14)	2 (1-5)	3.13
Feb	14.7 (12.8)	9.2 (6.7-	158 (010-	0.1 (0-10)	00,01,02 10,41,43, 45	1 (0-2)	7 (5-8)	290 (265-295)	8 (4-12)	2 (0-5)	0.00
Mar	14.4 (12.8-17.3)	10.6 (6.7-12.8)	290 (160-360)	0 (0-20)	01,02,03, 21,43,45, 49,62,80	1 (1-4)	7 (0-8)	290 (270-305)	9 (5-13)	2 (1-8)	1.93
Apr	15.7 (14.2-19.2)	11.7 (9.0-14.4)	210 (090-290)	0 (0-12)	01,02,03 10,43,45, 47	1 (1-2)	7 (1-9)	290 (250-290)	8.5 (4-12)	2 (1-4)	0.01
May	16.7 (14.7-18.9)	13.9 (10.0-14.7)	220 (050-300)	0.1 (0-15)	01,02,03, 45,47,50	1 (1-2)	6 (1-8)	290 (270-290)	8 (5-13)	2 (0.5-4)	0.04
Jun	18.1 (16.7-21.8)	15.1 (13.9-16.7)	303 (210-320)	0 (0-6)	01,02,20 43,44,45, 47	1 (1-2)	6 (0-7)	290 (250-295)	8 (5-13)	2 (1-3)	0.01
Jul	20.1 (17.8-24.4)	18.4 (13.3-21.7)	260 (180-340)	0.5 (0-9)	00,01,02, 03,42,43, 45	1 (1-2)	7 (5-7)	290 (265-305)	8 (4-10)	1 (0.5-3)	0.02

APPENDIX 1 (cont.) WEATHER DATA COMPILED FROM DAILY OBSERVATIONS TAKEN AT THE END OF THE PIER AT SCRIPPS INSTITUTION OF OCEANOGRAPHY FROM 1974 THROUGH MARCH, 1978. THE FIGURES CITED ARE THE MONTHLY MEDIAN, WITH THE MONTHLY RANGE OF VALUES IN PARENTHESES, EXCEPT FOR RAINFALL (CUMULATIVE FOR EACH MONTH)

Date	Air Temp. in °C		Wind		Weather[a]	Sea State[b]	Air Visibility in Mi.	Swell			Cumulative Rainfall in In.
	Max	Min	Direction in °	Speed in Knots				Direction in °	Period in Sec.	Height in Ft.	
1974											
Aug	20.0 (19.4-28.6)	17.2 15.6-19.7)	295 (140-360)	2 (0-7)	00,01,02, 42,43,45, 47,49	1 (1-2)	6 (3-7)	290 (265-295)	7 (4-11)	1 (0.5-3)	0.00
Sep	20.4 (18.7-22.8)	17.2 (14.7-19.4)	285 (010-355)	0.8 (0-10)	00,02,41 42,44,45, 46	1 (1-2)	5 (2-7)	290 (255-310)	6 (4-10)	1 (0.3-2.5)	0.00
Oct	18.8 (16.9-25.6)	15.0 (9.4-17.6)	265 (160-360)	0.5 (0-12)	00,01,02, 03,42,43, 44,45	1 (0-3)	6 (2-8)	280 (260-310)	7 (2-10)	1 (0.5-6)	0.55
Nov	17.4 (15.0-25.3)	12.2 (8.4-17.8)	205 (100-290)	0 (0-5)	01,02,03, 40,42,43	1 (0-2)	6 (4-8)	280 (245-310	7 (4-10)	1.5 (0.5-5)	0.23
Dec	16.0 (15.3-20.0)	8.9 (2.8-12.8)	308 (020-360)	1 (0-13)	01,02,03, 21,40,43, 44,47,62	1 (0-3)	6 (1-9)	285 (265-315)	8 (5-10)	2 (1-4)	1.24
1975											
Jan	14.4 (12.2-21.1)	8.1 (6.1-13.1)	220 (100-360)	2 (0-15)	01,02,10, 42,45,49	1 (0-3)	7 (0-9)	280 (265-310)	8 (3-10)	1 (0.5-6)	0.05
Feb	--	--	--	--	--	--	--	--	--	--	--

APPENDIX 1 (cont.) WEATHER DATA COMPILED FROM DAILY OBSERVATIONS TAKEN AT THE END OF THE PIER AT SCRIPPS INSTITUTION OF OCEANOGRAPHY FROM 1974 THROUGH MARCH, 1978. THE FIGURES CITED ARE THE MONTHLY MEDIAN, WITH THE MONTHLY RANGE OF VALUES IN PARENTHESES, EXCEPT FOR RAINFALL (CUMULATIVE FOR EACH MONTH)

Date	Air Temp. in °C		Wind		Weather[a]	Sea State[b]	Air Visibility in Mi.	Swell			Cumulative Rainfall in In.
	Max	Min	Direction in °	Speed in Knots				Direction in °	Period in Sec.	Height in Ft.	
1975											
Mar	14.4 (11.3-20.6)	7.8 (6.1-13.6)	210 (010-350)	5 (0-25)	00,01,02,03,21,40,45,62,63	2 (1-3)	6 (1-8)	280 (260-310)	7 (3-15)	2 (1-6)	1.87
Apr	14.4 (11.9-16.7)	9.1 (6.6-13.1)	260 (100-360)	2.5 (0-15)	01,02,03,20,29,43,63	1 (1-3)	7 (4-9)	280 (245-295)	7 (4-15)	2 (0.5-6)	3.98
May	15.6 (13.3-17.2)	11.3 (9.2-13.3)	280 (130-360)	1 (0-18)	01,02,03,20,40,43,45,47	1 (0-3)	6 (0-7)	280 (250-295)	7 (5-12)	1.5 (0.5-4)	0.25
Jun	15.8 (15.4-19.4)	13.9 (12.8-14.7)	270 (105-340)	1 (0-11)	01,02,42,43,44,47	1 (1-2)	6 (4-8)	275 (250-290)	7.5 (4-10)	1 (0.5-4)	0.05
Jul	18.9 (16.1-22.2)	16.1 (11.1-18.3)	260 (010-340)	1 (0-7)	01,02,03 42,43,44,45,47	1 (1-3)	6 (3-8)	270 (255-300)	7 (5-10)	1.5 (0-4)	0.00
Aug	19.2 (17.2-21.1)	16.7 (12.2-17.8)	290 (005-355)	1 (0-5)	01,02,40,42,43,44,45	1 (1-2)	5 (1-8)	280 (250-290)	8 (6-12)	1 (0.5-3)	0.00
Sep	20.1 (18.3-30.6)	16.4 (12.2-20.6)	293 (200-320)	0.1 (0-3)	01,02,44,45,50,51	1 (1-2)	5.5 (1-8)	280 (250-300)	6 (5-12)	1 (0.5-3)	0.01

APPENDIX 1 (cont.) WEATHER DATA COMPILED FROM DAILY OBSERVATIONS TAKEN AT THE END OF THE PIER AT SCRIPPS INSTITUTION OF OCEANOGRAPHY FROM 1974 THROUGH MARCH, 1978. THE FIGURES CITED ARE THE MONTHLY MEDIAN, WITH THE MONTHLY RANGE OF VALUES IN PARENTHESES, EXCEPT FOR RAINFALL (CUMULATIVE FOR EACH MONTH)

Date	Air Temp. in °C Max	Air Temp. in °C Min	Wind Direction in °	Wind Speed in Knots	Weather[a]	Sea State[b]	Air Visibility in Mi.	Swell Direction in °	Swell Period in Sec.	Swell Height in Ft.	Cumulative Rainfall in In.
1975											
Oct	18.9 (17.2-22.2)	13.9 (11.7-16.7)	298 (030-350)	0.5 (0-11)	01,02,03, 42,44,45, 60	2 (0-3)	7 (0-9)	280 (260-310)	7 (4-10)	1.5 (1-4)	0.22
Nov	17.1 (12.2-25.6)	11.1 (6.7-15.0)	255 (040-350)	0.3 (0-17)	01,02,10, 42,45	2 (0-3)	7 (0-9)	280 (270-300)	7 (4-13)	2 (1-5)	0.91
Dec	14.4 (12.8-21.1)	8.9 (6.1-12.8)	255 (020-340)	0.1 (0-14)	01,02,03, 28,40,42, 44	1 (0-4)	6 (3-9)	290 (260-320)	8 (5-16)	1 (0.5-6)	0.56
1976											
Jan	16.1 (13.1-26.9)	8.9 (5.0-15.0)	205 (40-360)	0 (0-12)	01,02,03, 44	1 (1-2)	7 (4-9)	280 (270-300)	8 (6-15)	1.5 (1-3)	0.00
Feb	15.6 (13.9-23.3)	10.6 (8.2-13.6)	170 (60-330)	0.5 (0-25)	01,02,03, 21,25,28, 42,44,45, 52,63	1 (1-3)	7 (1-9)	270 (240-310)	7 (4-13)	1.5 (1-5)	3.80
Mar	15.8 (12.8-19.4)	10.0 (5.8-13.3)	265 (100-340)	0.5 (0-22)	01,02,03, 25,40,50, 62	2 (1-4)	7 (2-9)	280 (250-300)	7 (4-14)	2 (0.5-8)	0.65

APPENDIX 1 (cont.) WEATHER DATA COMPILED FROM DAILY OBSERVATIONS TAKEN AT THE END OF THE PIER AT SCRIPPS INSTITUTION OF OCEANOGRAPHY FROM 1974 THROUGH MARCH, 1978. THE FIGURES CITED ARE THE MONTHLY MEDIAN, WITH THE MONTHLY RANGE OF VALUES IN PARENTHESES, EXCEPT FOR RAINFALL (CUMULATIVE FOR EACH MONTH)

Date	Air Temp. in °C Max	Air Temp. in °C Min	Wind Direction in °	Wind Speed in Knots	Weather[a]	Sea State[b]	Air Visibility in Mi.	Swell Direction in °	Swell Period in Sec.	Swell Height in Ft.	Cumulative Rainfall in In.
1976											
Apr	15.6 (12.8-19.2)	10.9 (6.0-13.7)	270 (60-320)	1 (0-20)	01,02,03, 45,50,60	2 (1-4)	7 (5-9)	280 (260-310)	7 (3-11)	2 (0.5-7)	0.78
May	17.2 (15.6-18.6)	13.9 (11.7-15.6)	260 (150-330)	3 (0-12)	01,02,03, 42,43,45, 47	2 (1-4)	7 (2-8)	280 (240-300)	6 (3-10)	2 (1-7)	0.00
Jun	18.9 (16.9-26.4)	15.5 (13.3-19.7)	280 (120-330)	2.5 (0-10)	01,02,03, 20,40,42, 43,45,52	2 (1-3)	6.5 (0-8)	280 (240-300)	6 (3-9)	2 (0.5-5)	0.04
Jul	20.6 (19.4-22.2)	17.6 (16.4-19.4)	270 (110-360)	5 (0-12)	01,02,40, 43,44,45, 50,53,60	2 (1-4)	6 (1-8)	275 (260-300)	6 (3-10)	2 (1-5)	0.01
Aug	21.1 (20.0-23.9)	16.9 (15.0-19.2)	270 (020-330)	3 (0-10)	01,02,25, 40,42,44, 45	2 (1-3)	7 (1-8)	280 (260-300)	6 (3-10)	2 (1-5)	0.08
Sep	21.9 (21.1-26.1)	18.3 (15.4-20.6)	215 (020-330)	1 (0-10)	01,02,03, 40,42,45, 51,63	1 (1-2)	6 (1-9)	280 (260-330)	7.5 (3-10)	1 (0.5) 5)	2.24
Oct	21.7 (20.0-27.8)	16.8 (13.9-18.4)	230 (010-350)	1 (0-10)	01,02,03, 17,21,40, 42,45	2 (1-2)	7 (3-9)	280 (240-300)	8 (4-11)	1 (1-3)	0.29

APPENDIX 1 (cont.) WEATHER DATA COMPILED FROM DAILY OBSERVATIONS TAKEN AT THE END OF THE PIER AT SCRIPPS INSTITUTION OF OCEANOGRAPHY FROM 1974 THROUGH MARCH, 1978. THE FIGURES CITED ARE THE MONTHLY MEDIAN, WITH THE MONTHLY RANGE OF VALUES IN PARENTHESES, EXCEPT FOR RAINFALL (CUMULATIVE FOR EACH MONTH)

Date	Air Temp. in °C		Wind		Weather[a]	Sea State[b]	Air Visibility in Mi.	Swell			Cumulative Rainfall in In.
	Max	Min	Direction in °	Speed in Knots				Direction in °	Period in Sec.	Height in Ft.	
1976											
Nov	20.0 (17.2-28.9)	13.9 (6.1-17.8)	250 (015-350)	1 (0-15)	01,02,18, 20,25,28, 42,45	1 (0-3)	8 (4-9)	280 (270-310)	8.5 (5-13)	1 (0.5-4)	0.56
Dec	18.9 (15.8-25.7)	11.4 (8.3-13.9)	120 (030-340)	0.5 (0-12)	01,02,03, 25	1 (1-3)	8 (6-9)	280 (265-300)	8 (6-14)	1.5 (1-7)	0.00
1977											
Jan	17.2 (15.0-29.7)	10.6 (8.1-15.3)	155 (010-350)	2 (0-13)	01,02,03, 21	1 (1-3)	7 (6-9)	280 (260-300)	8 (5-15)	2 (1-5)	1.33
Feb	17.2 (14.4-22.8)	11.1 (7.6-14.4)	170 (020-310)	2 (0-6)	00,01,02, 03,40,42, 45,46,52	2 (1-3)	6 (0-9)	280 (270-310)	7.5 (5-12)	3 (1-6)	0.04
Mar	15.6 (12.8-19.4)	9.4 (6.5-12.8)	268 (020-320)	3 (0-30)	00,01,02, 03,47,50	2 (0-4)	7 (3-9)	285 (260-300)	7 (4-10)	2 (0-5)	0.33
Apr	15.6 (13.9-20.0)	12.2 (9.4-15.6)	285 (015-355)	3 (1-30)	01,02,03, 10,43,47	1 (0-2)	7 (1-8)	280 (265-300)	8 (5-10)	1.5 (0.5-8)	0.13
May	17.2 (15.6-18.9)	13.3 (10.0-15.0)	245 (140-350)	7.5 (0-30)	01,02,03, 44,50	2 (1-3)	7 (4-9)	280 (250-300)	7 (4-10)	2 (1-4)	1.02

APPENDIX 1 (cont.) WEATHER DATA COMPILED FROM DAILY OBSERVATIONS TAKEN AT THE END OF THE PIER AT SCRIPPS INSTITUTION OF OCEANOGRAPHY FROM 1974 THROUGH MARCH, 1978. THE FIGURES CITED ARE THE MONTHLY MEDIAN, WITH THE MONTHLY RANGE OF VALUES IN PARENTHESES, EXCEPT FOR RAINFALL (CUMULATIVE FOR EACH MONTH)

Date	Air Temp. in °C Max	Air Temp. in °C Min	Wind Direction in °	Wind Speed in Knots	Weather[a]	Sea State[b]	Air Visibility in Mi.	Swell Direction in °	Swell Period in Sec.	Swell Height in Ft.	Cumulative Rainfall in In.
1977											
Jun	18.3 (17.2-19.4)	15.6 (13.9-16.4)	280 (200-320)	6 (0-10)	00,01,02, 40,42,43, 44,45,91	2 (0-3)	6 (3-8)	280 (265-310)	8 (6-14)	2 (1-3)	0.03
Jul	19.4 (17.8-22.8)	16.7 (14.4-20.6)	275 (150-360)	5 (0-10)	00,01,02, 03,40,42, 44,45	2 (1-3)	6 (0-7)	275 (210-340)	6 (4-11)	1 (1-3)	0.00
Aug	21.1 (20.0-22.8)	18.3 (17.2-20.6)	280 (120-355)	4 (0-12)	01,02,20, 44,45,52	1 (0-3)	6 (2-8)	270 (200-300)	7 (3-30)	1 (0.5-3)	1.83
Sep	21.1 (20.0-23.9)	17.8 (15.0-19.4)	302 (010-355)	6 (0-12)	00,01,02, 43,44,45, 46	2 (0-3)	7 (1-9)	275 (210-315)	5.5 (3-9)	1.5 (0.5-10)	0.00
Oct	20.0 (18.9-23.3)	16.1 (14.4-17.8)	270 (080-357)	4 (0-8.5)	01,02,03, 21,42,43, 44,45,50	2 (1-4)	6 (2-8)	270 (225-315)	6 (2.5-13)	2 (1-7)	0.39
Nov	19.4 (16.1-25.6)	13.3 (9.4-16.7)	266 (20-357)	3 (0-13.5)	01,02,03, 42,43	1.2 (0-4)	8 (4-9)	270 (210-315)	7.5 (2.5-30)	2 (0.5-7)	0.08
Dec	17.8 (16.7-22.2)	13.9 (9.4-16.7)	240 (0-360)	3.5 (0-18)	01,02,03, 40,42,44, 45,61,81	2 (0-3)	6 (1-9)	270 (210-310)	7.5 (5-10)	2 (0-7)	2.73

APPENDIX 1 (cont.) WEATHER DATA COMPILED FROM DAILY OBSERVATIONS TAKEN AT THE END OF THE PIER AT SCRIPPS INSTITUTION OF OCEANOGRAPHY FROM 1974 THROUGH MARCH, 1978. THE FIGURES CITED ARE THE MONTHLY MEDIAN, WITH THE MONTHLY RANGE OF VALUES IN PARENTHESES, EXCEPT FOR RAINFALL (CUMULATIVE FOR EACH MONTH)

Date	Air Temp. in °C		Wind		Weather[a]	Sea State[b]	Air Visibility in Mi.	Swell			Cumulative Rainfall in In.
	Max	Min	Direction in °	Speed in Knots				Direction in °	Period in Sec.	Height in Ft.	
1978											
Jan	17.2 (15.6-18.9)	12.2 (7.2-14.4)	160 (045-330)	4 (0-15)	01,02,03, 20,21,45	2 (1-4)	7 (5-9)	270 (225-300)	8 (3.8-15)	3 (1-8)	7.29
Feb	16.9 (14.4-21.1)	11.1 (8.3-16.1)	270 (090-357)	2 (0-40)	01,02,03, 21,42,50, 81	2 (1-4)	7 (3-9)	270 (225-290)	8 (3-15)	2 (1-8)	2.20
Mar	17.8 (16.1)28.3)	13.6 (10.0-17.8)	200 (090-300)	4 (0-30)	00,01,02, 03,21,42, 50,53,58, 80	2 (1-4)	7 (1-9)	270 (200-300)	8 (4.3-15)	3 (1-6)	4.22

[a]Weather is listed in accord with the following descriptive code given by World Meteorological Organization Code 4677:

00 Cloud development not observed or not observable
01 Clouds generally dissolving or becoming less developed
02 State of sky on the whole unchanged
03 Clouds generally forming or developing
10 Mist
17 Thunderstorm, but no precipitation at the station
18 Squalls
20 Drizzle (not freezing), not falling as shower(s)
21 Rain (not freezing), not falling as shower(s)
25 Shower(s) of rain
28 Fog
29 Thunderstorm (with or without precipitation)

40 Fog at a distance but not at the station
41 Fog in patches
42 Fog, sky visible, thinning during preceding hour
43 Fog, sky invisible, thinning during preceding hour
44 Fog, sky visible, no change during preceding hour
45 Fog, sky invisible, no change during preceding hour
46 Fog, sky visible, thickening during preceding hour
47 Fog, sky invisible, thickening during preceding hour
49 Fog, depositing rime, sky invisible
50 Slight drizzle, not freezing, intermittent
51 Slight drizzle, not freezing, continuous
52 Moderate drizzle, not freezing, intermittent
53 Moderate drizzle, not freezing, continuous
58 Drizzle and rain, slight
60 Slight rain, not freezing, intermittent
61 Slight rain, not freezing, continuous
62 Moderate rain, not freezing, intermittent
63 Moderate rain, not freezing, continuous
80 Rain shower(s), slight
81 Rain shower(s), moderate or heavy
91 Slight rain at time of observation, thunderstorm during preceding hour but not at time of observation

[b]Sea state given in accord with code established by World Meteorological Organization Code 75:

0 Calm--glassy, height of wind waves 0 feet
1 Calm--rippled, height of wind waves 0-1/3 feet
2 Smooth--wavelets, height of wind waves 1/3 to 1-2/3 feet
3 Slight, height of wind waves 1-2/3 to 4 feet
4 Moderate, height of wind waves 4-8 feet

APPENDIX II. ORGANISMS OCCURRING ON SUBTIDAL SANDY SUBSTRATES WITHIN THE SAN DIEGO MARINE LIFE REFUGE ASBS. Numbers given are in individuals per square meter.

	This survey	Fager (1968)
ATTACHED PLANTS	None observed	None observed
ANIMALS		
PORIFERA (sponges)	None observed	None observed
COELENTERATA		
Harenactis attenuata, burrowing anemone	0-0.24	6.48
Renilla kollikeri, sea pansy	0-0.43	1.68
Stylatula elongata, sea pen	0.20-0.48	----
Zaolutus actius, anemone	None observed	1.76
Obelia dichotoma, hydroid	0-0.12	----
ANNELIDA/Polychaeta		
Diopatra splendidissima, parchment tube worm	0.24-1.00	----
Owenia fusiformis, tube worm	0-0.04	0.04
ARTHROPODA/Malacostraca		
Ancinus spp., isopod	None observed	Infrequent (less than 0.04)
Blepharipoda occidentalis, spiny sand crab	0-0.08	Infrequent
Cancer gracilis, cancer crab	0-0.04	Infrequent
Crangon nigromaculata, black spotted shrimp	None observed	Infrequent
Isocheles pilosus, moon snail hermit crab	None observed	0.26
Heterocrypta occidentalis, elbow crab	None observed	Infrequent
Lepidopa myops, mole crab	0-0.04	Infrequent
Acanthomysis costata, mysid shrimp	Dense hordes seen hovering 1-2 meters off the bottom	----
Portunus xantusii, swimming crab	0-0.12	Infrequent
Pugettia producta, northern kelp crab	One individual seen	----
Pyromaia tuberculata, spider crab	None observed	Infrequent
MOLLUSCA/Scaphopoda		
Dentalium spp., tooth shell	0.72	----

APPENDIX 11. (cont.) ORGANISMS OCCURRING ON SUBTIDAL SANDY SUBSTRATES WITHIN THE SAN DIEGO MARINE LIFE REFUGE ASBS. Numbers given are in individuals per square meter.

	This survey	Fager (1968)
MOLLUSCA/Pelecypoda		
Donax gouldi, bean clam	0-0.08	----
Leptopecten monotimeris, kelp scallop	0-0.08	----
MOLLUSCA/Cephalopoda		
Loligo opalescens, Pacific coast squid	None observed	None observed
Octopus bimaculoides, mudflat octopus	None observed	None observed
MOLLUSCA/Gastropoda		
Rictaxis punctocoelatus	None observed	Infrequent
Balcis spp, eulimid	0-0.08	Infrequent
Cerithidea spp, horn shell	0-0.84	----
Epitonium tinctum, tinted wentletrap	0-0.08	----
Hermissenda crassicornis, sea slug	0-0.04	----
Nassarius spp, basket shell	0-0.84	0.07-0.37
Olivella spp, olive shell	0-0.08	----
Armina californica, sea slug	None observed	Infrequent
Polinices recluzianus, Recluz' moonsnail	0-0.08	0.10
Turbonilla spp, pyramidellid	None observed	Infrequent
Unidentified dorid nudibranch	0-0.48	----
ECTOPROCTA (BRYOZOA)		
Diaperoecia californica, moss animal	0-0.08	----
Assorted encrusting species, probably Membranipora spp, Bugula spp, and Schizoporella unicornis	Encrusting on leaves and fronds of algae washed into area	
ECHINODERMATA/Asteroidea		
Astropecten armatus, southern sand star	0.04-0.52	0.04
Astropecten californicus, sand star	None observed	Infrequent
ECHINODERMATA/Ophiuroidea		
Amphiodia occidentalis, brittle star	0.04-0.16	----
Amphiodia urtica, brittle star	None observed	Infrequent

APPENDIX II. (cont.) ORGANISMS OCCURRING ON SUBTIDAL SANDY SUBSTRATES WITHIN THE SAN DIEGO MARINE LIFE REFUGE ASBS. Numbers given are in individuals per square meter.

	This survey	Fager (1968)
ECHINODERMATA/Echinoidea		
Dendraster excentricus, sand dollar	0-0.08	More than 10
Lytechinus anamesus, white sea urchin	0-0.20	----
ECHINODERMATA/Holothurioidea		
Molpadia arenicola, sweet potato	Two individuals seen	Infrequent
PISCES		
Citharichthys stigmaeus, speckled sanddab	0-0.20	----
Leuresthes tenuis, grunion	None observed	----
Paralichthys californicus, California halibut	Three individuals	----
Myliobatis californicus, bat ray	None observed	----
Platyrhinoidis triseriata, thornback	One individual	----
Rhinobatos productus, shovelnose guitar fish	Six individuals	Transient
Squatina californica, angel shark	One individual	----
Urolophus halleri, round sting ray	Ten individuals	----

APPENDIX III. ORGANISMS OCCURRING IN THE SANDY BEACH INTERTIDAL SUBSTRATE OF THE SAN DIEGO MARINE LIFE REFUGE ASBS. Numbers given are in individuals per square meter.

ATTACHED PLANTS	None observed, except for those washed ashore
ANIMALS	
COELENTERATA/Hydrozoa	
Clytia bakeri, clam hydroid	Variable, follows cycles of Donax and/or Tivela
ANNELIDA/Polychaeta	
Euzonus mucronata, bloodworm	Abundant, up to 30,000 reported by McConnaughey and Fox (1949)
Nephtys californiensis	0.08
ARTHROPODA/Crustacea	
Blepharipoda occidentalis, spiny sand crab	Rare
Emerita analoga, sand crab	Common in aggregations
Lepidopa myops, white sand crab	Rare
Orchestoidea spp.	Abundant, especially under piles of kelp on sand
MOLLUSCA/Pelecypoda	
Donax gouldi, bean clam	Variable, up to 20,000 reported by Coe (1955)
Tivela stultorum, Pismo clam	Rare
Unidentified cardiid, cockles	Four individuals observed
PISCES/Leuresthes tenuis, grunion	Migrant into zone for spawning
AVES/shore birds	
Calidris alba, sanderling	Common
Larus occidentalis, western gull	Common
Limosa fedoa, marbled godwit	Common
Pelecanus occidentalis, brown pelican	Rare on beach
Phalacrocorax penicillatus, Brandt's cormorant	Extremely rare on beach

APPENDIX IV. ORGANISMS OCCURRING ON THE MUDSTONE DIKE, BOULDERS, AND LEDGES, AND THE CONCRETE PIER PILINGS WITHIN THE SAN DIEGO MARINE LIFE REFUGE ASBS. These observations were made primarily in the intertidal zones. Numbers given are in individuals per square meter.

	Rocky Reef System	Pier Pilings
ATTACHED PLANTS		
CHLOROPHYTA/Green algae		
Chaetomorpha spp.	Common	None observed
Codium fragile, Dead man's fingers	Scattered few	None observed
Enteromorpha spp.	Abundant	Common
Ulva spp, sea lettuce	Common	Common
PHAEOPHYTA/Brown algae		
Colpomenia sinuosa	Common	None observed
Cystoseira spp and Halidrys spp	Scattered few	None observed
Eisenia arborea, southern palm kelp	Scattered few	Few at base of pilings
Pachydictyon coriaceum	Common	Rare
Pelvetia fastigiata	Abundant	Rare
Petrospongium rugosum, rock sponge	Rare	None observed
Sargassum agardhianum	Scattered few	None observed
Scytosiphon lomentaria	Abundant	None observed
RHODOPHYTA/Red algae		
Chondria californica	Common on other algae	None observed
Coralline reds (Corallina spp and Bossiella spp)	Abundant	None observed
Crustose reds	Abundant	Scattered few
Gelidium spp, agarweed	Rare	None observed
Gigartina spp	Common	None observed
Melobesia mediocris	Common on other algae	None observed
Plocamium coccineum	Common	None observed
ANGIOSPERMA		
Phyllospadix spp, surfgrass	Abundant	None observed
ANIMALS		
PORIFERA/Sponges	Not evaluated but definitely present	
COELENTERATA/Anthozoa		
Anthopleura elegantissima, aggregate sea anemone	Abundant	Common
Anthopleura xanthogrammica, green anemone	Common	Few

APPENDIX IV. (cont) ORGANISMS OCCURRING ON THE MUDSTONE DIKE, BOULDERS, AND LEDGES, AND THE CONCRETE PIER PILINGS WITHIN THE SAN DIEGO MARINE LIFE REFUGE ASBS. These observations were made primarily in the intertidal zones. Numbers given are in individuals per square meter.

	Rocky reef syster	Pier pilings
ANNELIDA/Polychaeta		
Eupomatus gracilis, calcareous tube worm	Common	Few
Phragmatopoma californica, colonial sandy-tubed worm	Abundant	None observed
Spirorbis spp	Common	Few
ARTHROPODA/Crustacea		
Balanus glandula, Pacific acorn barnacle	Common	Few
Balanus tintinnabulum, red and white barnacle	Few	Rare
Chthamalus fissus, buckshot barnacle	6,000-270,000	Abundant
Cirolana harfordi, dark-backed isopod	Few	None observed
Ligia occidentalis, rock louse	Common to few	None observed
Pachygrapsus crassipes, striped shore crab	Common	Few
Pagurus hirsutiusculus, hairy hermit crab	Few	None observed
Pagurus samuelis, blue-clawed hermit crab	Common	None observed
Panulirus interruptus, California spiny lobster	Few	None observed
Petrolisthes spp	Few	Rare
Pollicipes polymerus, gooseneck barnacle	Common	Common
Mitella spp., gooseneck barnacle	Few	Rare
Tetraclita squamosa, thatched barnacle	Few	None observed
MOLLUSCA/Polyplacophora		
Nuttalina fluxa and *Mopalia* spp, chitons	Few	Rare
MOLLUSCA/Gastropoda		
Acmaea spp and *Collisella* spp, limpets	700-1400	Scattered few
Aplysia californica, sea hare	Few	None observed
Crepidula onyx, onyx slipper shell	Few	None observed
Flabellina iodinea, violet sea slug	Rare	None observed
Littorina spp, periwindle or littorine snail	Abundant	Common
Lottia gigantea, owl limpet	400-800	Few
Navanax inermis, striped sea slug	Rare	None observed
Olivella biplicata, purple olive	Few	None observed
Tegula funebralis, black turban snail	Common	Few
Thais emarginata, dogwinkle	Few	Rare
MOLLUSCA/Pelecypoda		
Mytilus californianus, California mussel	Abundant	Abundant
Mytilus edulis, edible mussel	Common	Common
Diplodonta orbella, Pacific orb clam	Few	None observed
ECTOPROCTA/Bryozoa	Not evaluated but definitely present	

APPENDIX IV. (cont) ORGANISMS OCCURRING ON THE MUDSTONE DIKE, BOULDERS, AND LEDGES, AND THE CONCRETE PIER PILINGS WITHIN THE SAN DIEGO MARINE LIFE REFUGE ASBS. These observations were made primarily in the intertidal zones. Numbers given are in individuals per square meter.

	Rocky reef system	Pier pilings
ECHINODERMATA/Asteroidea		
Astrometis sertulifera, soft sea star	Rare	None observed
Patiria miniata, bat star	Few	Rare
Pisaster giganteus, knobby sea star	Rare	Rare
Pisaster ochraceus, ochre sea star	Few	Rare
ECHINODERMATA/Ophiuroidea	Not identified but common	Rare
ECHINODERMATA/Echinoidea, *Strongylocentrotus purpuratus*	Few	Rare
ECHINODERMATA/Holothurioidea, *Stichopus parvimensis*	Few	None observed
PISCES		
Clinocottus analis, wooly sculpin	Common	None observed
Girella nigricans, opaleye	Common	None observed
Heterostichus rostratus, kelpfish	Rare	None observed
Hypsypops rubicundus, garibaldi	Few	None observed

In addition to these fish, there were many others observed but these were transient to these areas.

STATE WATER RESOURCES CONTROL BOARD

P. O. Box 100, Sacramento, CA 95801

CALIFORNIA REGIONAL WATER QUALITY CONTROL BOARDS

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(707) 545-2620

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Fresno, California 93726
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Redding, California 96001
(916) 442-6376

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South Lake Tahoe, California 95702
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Victorville Branch Office
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Victorville, California 92392
(714) 245-6583

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Palm Desert, California 92260
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San Diego, California 92120
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