California Marine Waters
Areas of Special Biological Significance
Reconnaissance Survey Report

CALIFORNIA MARINE WATERS
AREAS OF SPECIAL BIOLOGICAL SIGNIFICANCE

RECONNAISSANCE SURVEY REPORT

SAN DIEGO - LA JOLLA ECOLOGICAL RESERVE
SAN DIEGO COUNTY

STATE WATER RESOURCES CONTROL BOARD

DIVISION OF PLANNING AND RESEARCH

SURVEILLANCE AND MONITORING SECTION

February, 1979

WATER QUALITY MONITORING REPORT NO. 79-1

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 May, 1978. Mr. Kobayashi in his report also acknowledged the contributions of:

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

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 objective of this reconnaissance survey was to assess the physical, biological and water quality characteristics of the San Diego-La Jolla Ecological Reserve Area of Special Biological Significance (ASBS) in order to evaluate the status of protection of its marine resources. The assessment included the following character descriptions: location and size; nearshore waters and submarine topography; geophysical characteristics; climate; biota of both subtidal and intertidal habitats; landside flora; and unique biotic components.

The San Diego-La Jolla Ecological Reserve ASBS is unique in its inclusion of a variety of habitats: a broad, sandy shelf; a submarine canyon; a small kelp bed; a small submerged cobble patch; reefs composed of flat sandstone/shale ledges interspersed with patches of sand; and a boulder-strewn mudstone reef complex. It thus includes organisms of a sandy substrate, clay-bank canyon inhabitants, many of the rich biota surrounding a kelp bed, and various other rocky-reef fauna and flora.

Further, the submerged cobble patch is a proven archaeological site from which more than 2000 artifacts believed to have belonged to the La Jollan culture, ca. 5000-7000 years before the present, have been recovered.

Sailing, water-skiing on glassy calm days, snorkeling, SCUBA diving, surfing, body surfing, and jet-skiing are some of the water-use recreational activities that occur within the Reserve; sportfishing and commercial fishing, as well as whale-watching, occur in waters immediately adjacent to the Ecological Reserve.

There appear to be no actual pollution threats other than storm water runoff with its heavy silt concentration. The biotic effects of the periodic infrequent influx of fresh-water and silt along an open-water coastline are not adequately known and could be the subject of

intense interest. The major impact from runoff should be expected in the vicinity of the head of La Jolla branch of the submarine canyon inasmuch as a large storm drain empties out just adjacent to the boat launch.

A conclusion of the survey is that consideration should be given to development of a program of periodic but regular monitoring of the San Diego-La Jolla Ecological Reserve Area of Special Biological Significance. The status of protection of this designated area can be determined only through such continuing surveys.

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FINDINGS AND CONCLUSIONS

The reconnaissance survey of the San Diego-La Jolla Ecological Reserve Area of Special Biological Significance (ASBS) yielded the following findings and conclusions:

FINDINGS

1. The intertidal and subtidal waters of this ASBS contain representatives of several different biotic habitats, composed of:

a. A broad sandy shelf in the northern part ranging from the shoreline down to depths of 100 feet (30 meters).

b. The relatively wide, peaty-clay banked head of the southern branch of the La Jolla Submarine Canyon.

c. Relatively flat ledges of sandstone/shale constitute the southern third of the ASBS and are indented by numerous sand channels.

d. A complex reef system of mudstone boulders that occupies the seaward margin of the rocky subtidal areas off the La Jolla Caves area.

2. The flora and fauna of these areas reflect the substrate, with characteristic differences obvious between the sandy and rocky substrates. The differences between rocky habitats are not as conspicuous, although the absence of large attached plants makes the boulder reef complex distinct from the others.

3. There are some components of the biota which can be characterized as unique--*Macrocystis pyrifera*, giant bladder kelp; *Loligo opalescens*, Pacific Coast squid; *Leuresthes tenuis*, grunion; and garibaldi, *Hypsypops rubicundus*. Each of these attracts an interest to the ASBS that is probably disproportionate to its role (except for *Macrocystis*) in the community dynamics of the habitat, but each is profound in its influence on humans. All of the animal species appear vigorous, whereas the kelp bed here undergoes cycles of waxing and waning but is persistent in its occurrence.

4. The designation of this ASBS as an ecological reserve offers protection to those species subject to human use, such as the California spiny lobster, abalone, grunion, California halibut, kelp or calico bass, assorted other species of fish, and many tidepool invertebrates. Observations of dense subpopulations of abalones and lobsters were encouraging and may signal the beneficial growth in number for these species within the overall protection of the ASBS. The "tame" behavior of fishes also indicates the results of the protective status.

5. The research into various aspects of this reconnaissance survey led to some inescapable study of adjacent areas. The San Diego Marine Life Refuge ASBS is north of this ASBS. It 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. Many dives into this part of the canyon have highlighted the unique character of this rocky and steep-sided canyon environment. It is much more spectacular in its steepness and narrowness than the southerly La Jolla branch, and the biota reflects this difference. There is a greater abundance of species such as rock scallop, pink sea whip, and bluebanded goby.

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 health and vigor of the biota.

2. The observable impacts of industrial and other waste disposal 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 as an ecological reserve for this ASBS should be perpetuated. The relaxation from protective status for any of the contained species would make it exceedingly difficult for enforcement and for evaluation of the full effect of the closure and therefore should not be granted.

4. Since the inclusion of varied biotypes within this small ASBS is established and significant efforts to eliminate any of these habitats

INTRODUCTION

The California State Water Resources Control Board, under Resolution No. 74-28, designated certain Areas of Special Biological Significance (ASBS) in the adoption of water quality control plans for the [illegible]

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-La Jolla Ecological Reserve ASBS is an area of keen scientific interest. Its geographical proximity to the Scripps Institution of Oceanography undoubtedly contributes significantly to its desirability as a scientific study locale, along with its easy accessibility and usually pacific waters. The area contains a variety of biotic habitats, including rocky bottoms, sandy substrates, and the broad head of a submarine canyon.

Further, this area receives heavy recreational use--sunbathing, swimming, surfing, snorkeling, SCUBA diving, body-surfing, sailing, power boating, jet skiing, water skiing, picnicking, volleyball, frisbee throwing, and jogging are the most popular. Prior to its designation as an Ecological Reserve, this area was fished in several ways--shore fishing, spear-fishing, and boat fishing.

Commercial bait boats formerly caught squid and anchovy within this area. SCUBA certification organizations from the entire San Diego area utilize the generally calm and gentle waters in this area for ocean certification check-out dives and for instructor training classes.

The submerged cobble patch directly offshore from the La Jolla Beach and Tennis Club is a proven underwater archaeological site--one of very few such sites in Southern California. The inclusion of this site within the Ecological Reserve will preserve the artifacts for proper scientific study.

The head of the La Jolla Canyon approaches within 300 meters of the shoreline. This sandy and peaty-clay banked canyon is the only site of spawning for the squid that is easily accessible to sight-seeing divers.

Thus, 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.

METHODS AND MATERIALS

The reconnaissance survey of the San Diego-La Jolla Ecological Reserve 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 of 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 over nearly 18 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, two teams of three persons each were utilized. Each 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 haphazard within that habitat. The following nonbiological data were gathered for each transect: actual depth at the line at 5-meter intervals; water temperature at the line at 5-meter intervals; surface water temperature at the start and end points of the transect; vertical water visibility at the start and end points of the transect; horizontal visibility along the line at 5-meter intervals; surge (zero, light, moderate, heavy) at 5-meter intervals along the line; the percentage of rock cover at 1-meter intervals along the line; and substrate composition notes at 5-meter intervals.

The composition of the plant cover of the subtidal substrate was noted at 1-meter intervals along the transect. The dominant or prominent 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 prominent 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 unquestionable taxon, and different species within the same taxon were differentiated even though unidentified.

PHYSICAL AND CHEMICAL DESCRIPTION

Location and Size

The San Diego-La Jolla Ecological Reserve Area of Special Biological Significance is located at 32°51'-52" N Lat, 117°15'15"-16'15" W long, in La Jolla Bay, adjacent to the town of La Jolla, in San Diego county. The seaward boundary is formed by a line extending from Goldfish Point northward one mile and intersecting with a line drawn one mile westward from the south end of Scripps Institution of Oceanography. The shoreward boundary line is the mean high tide line from the south end of Scripps Institution of Oceanography back to Goldfish Point. It is the southern one-sixth of the San Diego-La Jolla Underwater Park, which was created by City Ordinance 10363 on August 13, 1970. The Park itself extends from Point La Jolla westward, then northerly to the San Diego City limits, a north-south distance of approximately seven (7) miles along a line about one mile out from the shoreline for a total surface area of 5977 acres.

The Ecological Reserve area was set aside by the San Diego City Council in the late spring of 1971, and a proposal to set it up as an ecological reserve was adopted by the California Department of Fish and Game on June 25, 1971. Dedication ceremonies were held, and the Ecological Reserve was formally established on August 30, 1971.

The surface area of the San Diego-La Jolla ASBS is approximately 518 acres, or 210 hectares (0.8 sq. mi.). The seaward boundaries are designated by a series of five orange-red marker buoys which are clearly identified, and the on-land accesses at Goldfish Point, the south end of the La Jolla Beach and Tennis Club, and the south end of Kellogg Park are visibly marked as entrances to the Ecological Reserve.

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

> "Ocean waters within the boundaries of the City of San Diego, County of San Diego, State of California, as follows: beginning at the most northerly point of Goldfish Point as shown on La Jolla Park Map No. 352 filed in the office of the County Recorder of said county, thence in a northerly direction to a point being the intersection of longitude 117°16'15" west with the easterly prolongation of the southerly line of Pueblo Lot 1298 as shown on the map of Pueblo Lands of San Diego made by James Pascoe known as miscellaneous Map No. 36 filed in the office of the County Recorder of said county, thence easterly along said prolongation of the southerly line of Pueblo Lot 1298 to the intersection with the mean high tide line, thence in a generally southerly direction along said mean high tide line to the point of beginning."

Figure 29 (page 50) in Areas of Special Biological Significance and Figure 1 present aerial projection maps of the San Diego-La Jolla Ecological Reserve. The area marked as La Jolla Caves on Figure 29 in the reference noted above (taken from Reference Map: USGS La Jolla, CA) is more commonly called Devil's Slide by local scientists and divers, with the La Jolla Caves designation strictly applied to the area just east of Goldfish Point, which is characterized by large waterlevel caves. Use of these names in this report will therefore be in accord with this latter more specific Devil's Slide/La Jolla Caves terminology instead of that given in Figure 29.

The shoreline, from Goldfish Point to the northern boundary of the Ecological Reserve, is 1.65 miles (2.65 kilometers) in length.

The northern 0.96 miles (1.55 kilometers) is a fine sandy beach, whereas the southern 0.63 miles (1.10 kilometers) is composed of rocky boulders or ledges at the base of cliffs with one pebble beach in the Devil's Slide area. The northern three-fourths of the shoreline faces westward while the southernmost one-fourth faces northward.

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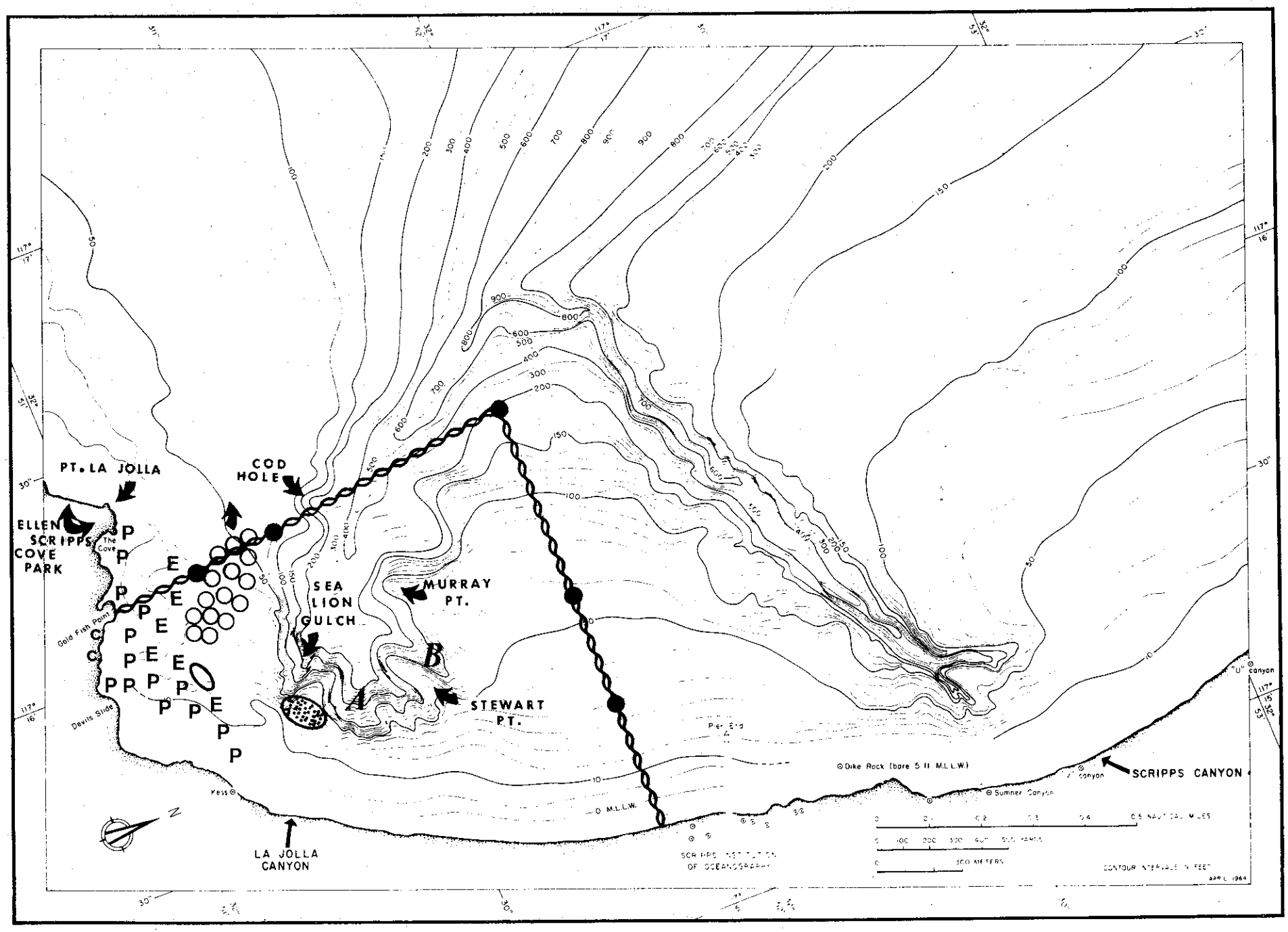

PT. LA JOLLA
ELLEN SCRIPPS COVE PARK
The Cove
Gold Fish Point
Devils Slide
COD HOLE
SEA LION GULCH
MURRAY PT.
STEWART PT.
A
B
Dike Rock (bare 5 ft M.L.L.W.)
Sumner Canyon
SCRIPPS CANYON
LA JOLLA CANYON
0 M.L.L.W.
SCRIPPS INSTITUTION OF OCEANOGRAPHY
CONTOUR INTERVALS IN FEET
APRIL 1964

Nearshore Waters

In designating this area as an ecological reserve, due consideration was given to the varying types of submarine topography extant within it. Figure 1 depicts the areas of sand, mud/clay, shale and sandstone/mudstone that characterize the subtidal substrates of this area. There is a small patch of cobbles offshore from the La Jolla Beach and Tennis Club that becomes exposed periodically.

The general submarine topography in the La Jolla Basin area can be described as a narrow (about 2 miles) continental shelf, traversed by a submarine canyon that approaches to within about 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 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 or the prevailing north/northwest winds during the spring promote varying periods of upwelling. The Oceanside Cell of sand transport movement flows southward and empties an estimated 260,000 cu. yds of sand annually into the Scripps branch of the La Jolla 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 virtually all emptied into the La Jolla branch of the canyon (Shepard and Inman, 1951, and Inman, 1953).

Although this survey did not itself collect extensive physical-chemical data, the oceanographic data taken daily at the end of the Scripps Institution of Oceanography pier were inspected (courtesy Data Collection Processing Group, Marine Life Resources). This locale, although technically outside the boundaries of the Ecological Reserve, is no more than 400-500 meters north of the Reserve, and the data are expected to be representative of it. 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 have exhibited annual ranges (between maximum and minimum) of 8.3-14.5°C, with minimum temperatures varying between 10.1° and 14.5°C and maxima between 21.1° and 24.6°C. Surface water temperatures taken from various sites within the Ecological Reserve compared with those taken at the Scripps Institution of Oceanography pier indicate that the surface waters are consistently warmer than the surface waters at the end of the pier (Table 5). Of the 85 days in 1976-1978 for which comparative data are available, the temperatures at the Scripps pier were warmer only 17 days (mean +0.62 ± 0.46°C, range 0.1 to 1.5°C); the pier temperatures were colder 66 days (mean -0.91 ± 0.75°C, range -0.1 to -4.1°C); and the temperatures were the same on only two days. It thus appears that the waters in the Reserve area, at least in the southern half, are about 0.5°C warmer at the surface than the water at the end of the Scripps pier. However, this relationship may not be consistent for all areas of the Reserve; the majority of temperature observations in the Reserve were made over the boulder reef complex area (∾30-35 ft., or 10 m.). The two sets of temperature data are otherwise more or less correlated positively; the water warms or cools at both areas in synchrony (43 out of 58 instances). The annual variation of surface and bottom water temperatures demonstrates the expected seasonal cycles (Tables 1-2).

The salinity of surface waters has annual ranges (between maxima and minima) of 0.38-1.50°/₀₀ (there is actually a range of 4.52°/₀₀ in 1967, but this is due to a suspiciously low reading of 29.64°/₀₀ on September 27), with minimum salinities varying between 32.34°/₀₀ and 33.47°/₀₀ (except for the anomalous 29.64°/₀₀ just mentioned) and maxima between 33.68°/₀₀ and 34.65°/₀₀. The variation in salinities (Tables 3-4) exhibits an annual cycle similar to that for temperatures except that the peak occurs a month earlier in the summer.

No turbidity measurements were available although visual estimates of horizontal and vertical water visibilities were taken on the observation dives and by a group observing lobsters in the boulder reef complex area. The La Jolla Shores sandy areas are generally the clearest among San Diego nearshore waters, and interviews with veteran divers

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	Month											
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
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									
Total	**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

	Month											
Year	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									
Total	**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

	Month											
Year	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
Total	**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	33.65	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
Total	**33.58**	**33.55**	**33.56**	**33.60**	**33.69**	**33.71**	**33.69**	**33.67**	**33.63**	**33.63**	**33.59**	**33.58**

TABLE 5. COMPARISON OF SURFACE WATER TEMPERATURES TAKEN AT SITES WITHIN THE SAN DIEGO-LA JOLLA ECOLOGICAL RESERVE ASBS AND AT THE END OF THE PIER AT SCRIPPS INSTITUTION OF OCEANOGRAPHY

Date	Surface Water Temperature in °C: SIO Pier	Ecological Reserve	Δ (Pier-Ecol Res)	Horizontal Distance between Observation Sites
1976:				
8/28	18.4	17.5	0.9	1800 m
8/29	19.5	18.0	1.5	↓
8/30	14.9	18.0	-3.1	
8/31	18.2	19.0	-0.8	
9/6	19.5	21.0	-1.5	
9/11	20.3	20.5	-0.2	
9/12	20.3	21.0	-0.7	
9/23	20.7	20.5	0.2	
9/24	20.0	20.5	-0.5	
9/25	20.2	20.5	-0.3	
10/1	20.5	21.0	-0.5	
10/4	20.3	21.5	-1.2	
10/10	20.8	21.5	-0.7	
10/13	20.8	21.0	-0.2	
10/20	19.3	20.0	-0.7	
10/29	17.6	17.5	0.1	
10/30	18.0	19.0	-1.0	
11/6	19.0	21.5	-1.5	
11/17	18.1	18.5, 19.0	-0.4, -0.9	
11/24	18.1	19.0	-0.9	
11/25	18.4	18.5	-0.1	
12/15	17.1	18.0	-0.9	
12/17	17.2	18.0	-0.8	
1977:				
1/12	16.1	16.0	0.1	
1/14	16.1	17.0	-0.9	
1/21	16.1	16.5	-0.4	
1/25	16.1	16.5	-0.4	
1/27	16.2	17.0	-0.8	
1/28	16.6	16.5	0.1	
2/4	16.0	16.5	-0.5	
2/11	15.6	15.8, 16.0	-0.2, -0.4	
2/14	15.9	17.5	-1.6	
2/15	16.1	17.5	-1.4	
2/18	16.1	16.5	-0.4	1800 m

TABLE 5. (cont.) COMPARISON OF SURFACE WATER TEMPERATURES TAKEN AT SITES WITHIN THE SAN DIEGO-LA JOLLA ECOLOGICAL RESERVE ASBS AND AT THE END OF THE PIER AT SCRIPPS INSTITUTION OF OCEANOGRAPHY

Date	Surface Water Temperature in °C: SIO Pier	Ecological Reserve	Δ (Pier-Ecol Res)	Horizontal Distance between Observation Sites
1977 (cont.):				
2/19	15.9	16.0	-0.1	1800 m
2/25	15.5	16.0	-0.5	↓
3/4	13.9	14.0	-0.1	↓
3/11	12.5	14.5	-2.0	↓
3/18	12.7	13.5	-0.8	↓
4/7	14.8	16.0	-1.2	↓
4/16	15.6	16.5	-0.9	↓
4/17	15.9	16.5	-0.6	↓
4/18	15.6	16.5	-0.9	↓
4/19	16.1	17.0	-0.9	↓
4/22	16.5	17.0	-0.5	↓
4/23	16.9	17.0	-0.1	↓
4/24	16.8	18.0	-1.2	↓
4/25	17.1	18.0	-0.9	↓
5/12	16.4	17.0	-0.6	↓
5/20	17.0	17.0	0	↓
5/21	17.9	17.0	0.9	↓
5/27	17.9	22.0	-4.1	↓
6/3	16.9	19.0	-2.1	↓
6/6	18.8	19.0	-0.2	↓
6/25	17.8	18.0	-0.2	↓
6/26	16.7	17.0	-0.3	↓
7/2	18.9	19.2, 19.1	-0.3, -0.2	↓
7/9	18.5	20.2	-1.7	↓
8/7	22.2	23.0	-0.8	↓
8/9	20.5	23.0	-2.5	↓
8/11	19.6	18.5	1.1	↓
8/14	19.4	20.5	-1.1	1800 m
8/24	20.8	24.0	-3.2	1300 m
8/25	21.1	21.0	0.1	1850 m
8/26	20.8	22.0, 21.8	-1.2, -1.0	1950 m
8/27	21.0	21.0	0	1800 m
8/28	21.2	21.5	-0.3	1300 m
8/31	21.8	21.0, 21.2	0.8, 0.6	1300 m
9/1	21.3	22.0, 23.0/21.7	-0.7, -1.7/-0.4	550 m/1800 m
9/4	21.3	20.1	1.2	1800 m
9/5	20.1	19.8	0.3	1800 m

TABLE 5. (cont.) COMPARISON OF SURFACE WATER TEMPERATURES TAKEN AT SITES WITHIN THE SAN DIEGO-LA JOLLA ECOLOGICAL RESERVE ASBS AND AT THE END OF THE PIER AT SCRIPPS INSTITUTION OF OCEANOGRAPHY

	Surface Water Temperature in °C			Horizontal Distance between Observation Sites
Date	SIO Pier	Ecological Reserve	Δ (Pier-Ecol Res)	
1977 (cont.):				
9/6	20.0	21.0	-1.0	2100 m
9/7	20.3	21.0	-0.7	2075 m
9/27	20.0	20.6	-0.6	1800 m
9/29	18.5	19.1	-0.6	↓
10/4	17.4	18.7	-1.3	↓
10/6	17.3	17.8	-0.5	↓
10/11	18.3	19.1	-0.8	↓
10/13	17.6	18.3	-0.7	↓
10/18	16.6	17.4	-0.8	↓
11/10	17.9	17.8	0.1	↓
12/11	16.9	17.0, 16.0	-0.1, 0.9	↓
1978:				
1/22	16.0	15.0	1.0	↓
2/23	15.6	15.0	0.6	↓
3/9	15.8	15.0	0.8	1800 m

indicate vertical visibilities ranging from nearly zero to 50 feet (15 meters) at the surface, although there is frequently greater visibility at depths. Horizontal visibilities have a similar range, but those estimates reported by untrained divers are subjective and may be inaccurate due to the lack of a reference distance (such as is available when one snorkels at the surface and sees the bottom). The rocky reef areas in the axis of the Devil's Slide corner are generally dirty, although the visibility noticeably improves with depth. At the outer edge of these reefs, at depths of 30-40 ft. (9-12 meters), the water is often clear enough to see the bottom, and visibilities of 20-30 ft. (6-9 meters) are not uncommon. Blooms of phytoplankton, commonly called Red Tides, affect both vertical and horizontal visibilities. Concentrations of dinoflagellates have been reported by Holmes, Williams, and Eppley (1967) of up to 20 X 10^6 cells per liter. These blooms consist of unicellular microscopic dinoflagellates, such as Gonyaulax polyedra, Gymnodinium sp., Cochlodinium sp., and Prorocentrum micans.

The immediate nearshore waters of the La Jolla Shores area, including the Ecological Reserve, have had excellent water quality for recreational use. The only known closure in recent years of the La Jolla Shores area to swimming occurred in February, 1978, due to possible effects from raw sewage that poured out of the nearest beach-area pumping station at Casa de Manana beach about 650 meters south of Point La Jolla/Alligator Head. The pump station was one of several that stopped pumping during a massive San Diego power failure; this necessitated the discharge of raw sewage collected at the pump stations into adjacent ocean waters. This closure was in effect for two days, although the actual bacteriological contamination at La Jolla Shores may not have been significantly dangerous.

Vessel discharge and/or natural oil seepage have deposited oil globules on many San Diego beaches, including La Jolla Shores, from time to time in the past. These present more of a nuisance effect than a health hazard.

Geophysical Characteristics

The La Jolla Shores area is a small alluvial basin bounded on the south by the westward-trending sides of Soledad Mountain, which reach the sea at Devil's Slide to Point La Jolla (commonly called Alligator Head). To the east and north the basin is bordered by a high ridge which forms the cliffs north of Scripps Institution of Oceanography. The alluvial fill of this basin rests on a seaward sloping basement of Eocene sandstone and shale with a thickness of 30-40 ft. (10-12 m.).

Figure 1 depicts the extent of the sand and rocky reefs that characterize the subtidal substrate within the San Diego-La Jolla Ecological Reserve Area of Special Biological Significance.

The substrate in the northern half of the Reserve is fine sand mixed with varying amounts of silt and/or mud. Surveys on sandy substrates, both on the northern sand shelf and inshore of the head of La Jolla Canyon, describe this sand as fine and white, interspersed with occasional patches of mud. Presumably, this mud is derived from storm water runoff. The mud is never so abundant that the sand appears anything other than clean, white sand on superficial glance. The fine sand is well sorted, with median grain diameters of: 0.20 mm in samples from the beach; 0.12 mm in samples from 5-10 meters depth; and 0.09 mm in samples from 30 meters depth. The sand grains are fairly uniform in size, with 90% of the 5-10 meter samples in the 0.08-0.19 mm size range. The sand is mainly quartz, although 5% is heavy minerals, 3% micaceous materials, and less than 3% silt (Fager, 1968). According to Fager, this silt/mud content from storm runoff is insignificant, but his study area was close to the end of Scripps Institution of Oceanography pier. The silt/mud concentration or deposition is probably 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 sandy bottom in the northern third of the Reserve slopes evenly and gently seaward down to depths of 100 ft. (30 m.) at a distance of 1200-1300 ft. (365-396 m.) from shore. The slope steepens somewhat so

that depths of 400-500 ft. (122-152 m.) are reached in the next 500 meters. This broad sandy shelf is bordered on the north and south by the two branches of the La Jolla Submarine Canyon (Scripps branch to the north and La Jolla branch to the south).

The middle third of the Ecological Reserve is dominated by the broad head of the La Jolla branch of the La Jolla Submarine Canyon. The shoremost 300 meters consist of a fine, white sandy substrate that is similar to the sandy shelf immediately north. At a depth of ca. 30 ft. (9 m.), however, the slope steepens noticeably and there is a 4-5 ft. (1-2 m.) clay bank that distinguishes the canyon at a depth of 50 ft. (15 m.). The canyon head itself is characterized as a wide bowl-like structure, rimmed by a basement of Eocene sandstone/shale. The sides are extremely steep (nearly vertical) in some areas, whereas other areas have a gradual sloping side. There are occasional small rock outcroppings, but these are rare and this branch of the canyon is much less spectacular in its steepness and undercut ledges than the head of the more northern Scripps branch. The biota reflects the difference between the physical structure of these two heads. There is an overload of detached and decomposing marine plants, usually Phyllospadix (surf grass, eel grass) and various attached macroalgae (kelp, palm kelp, coralline reds, other reds, and ribbon kelp are the more prominent) that rest on the sand in Sea Lion Gulch and the two valleys north of it (A, B in Figure 1). This organic concentration is periodically flushed so that the exact location and density of plant material shifts from time to time. Artifacts of recent vintage (various snorkeling equipment, clothing, beach chairs, cans and bottles, etc.) are often encountered in this area by SCUBA divers.

The wide axis of the La Jolla branch of the La Jolla Submarine Canyon contains the alluvial fill that characterizes the entire La Jolla Basin, as well as the marine organic deposits (chiefly vegetation). This axis runs along a general northwesterly direction away from La Jolla Shores and becomes confluent at depths of 800-900 ft. (243-274 m.) with the axis of the Scripps branch running southwest.

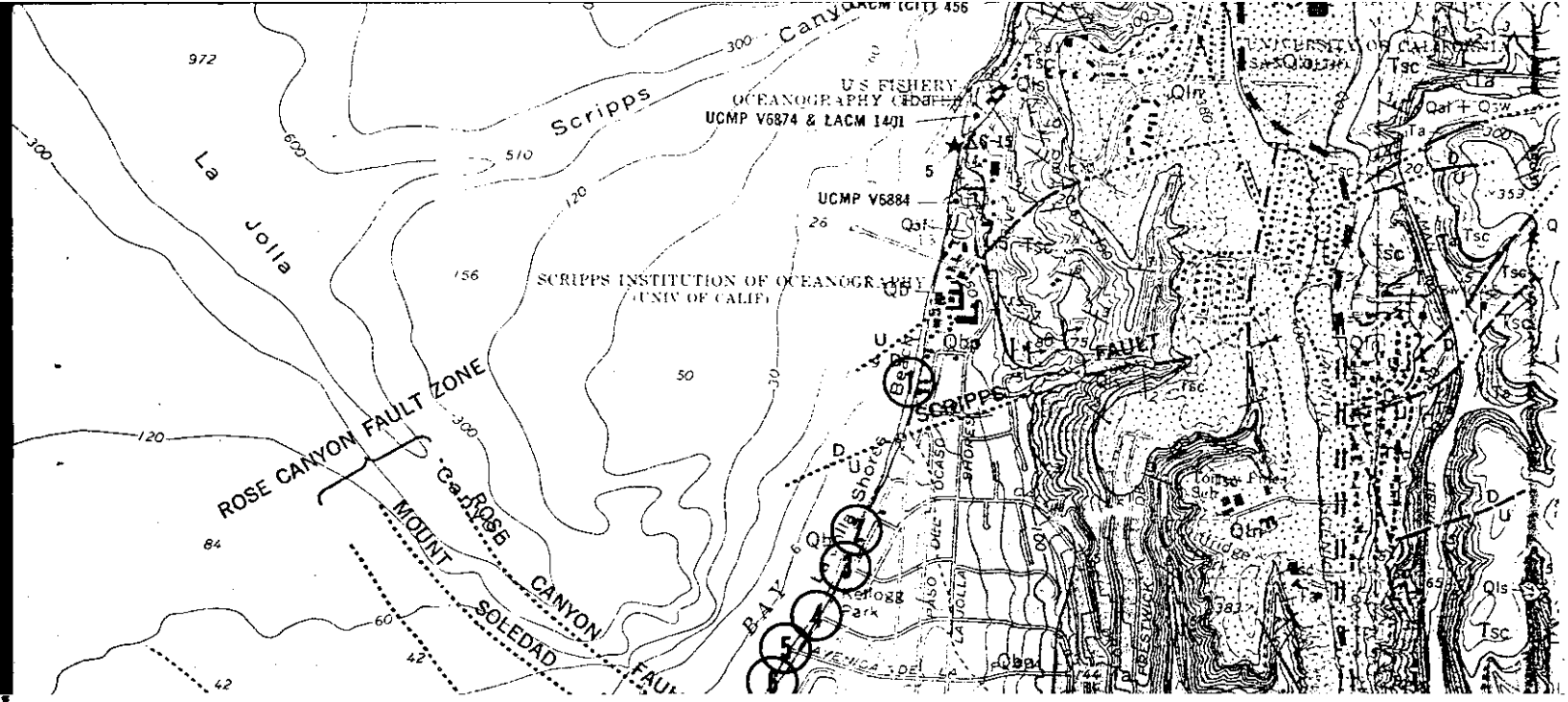
The southern third of the Ecological Reserve is much more diverse in substrate than the others. The area immediately inshore of the southern wall of the canyon is sandy, at least to depths of 35 ft. (10 m). Flat sandstone ledges are exposed in much of the Devil's Slide corner of the Ecological Reserve, extending as far northward as the southern end of the La Jolla Beach and Tennis Club. These ledges are found from shore to depths of at least 25-30 ft. (7.5-9 m.). In the subtidal areas offshore from the westward-facing section of shoreline (between "KESS" and "DEVIL'S SLIDE" in Figure 1), these flat ledges are a reflection of the intertidal and cliff strata, being tipped up some 20-30° northward. This allows for undercutting along the northern edge of these reefs, and it is along these northern, undercut ledges of the larger reef formations that many of the marine animals concentrate. Offshore from the northward-facing shoreline, this pronounced tipping becomes less and less distinguishable, especially with the shallow substrate along this section of the shoreline. At depths between 20-35 ft., there is a series of more or less parallel ridges made up of mudstone boulders. These ridges point shoreward toward the corner between Devil's Slide and La Jolla Caves and trend seaward on a northwesterly direction where they cross the Ecological Reserve boundary at depths of 35-50 ft. (10-15 m.).

There is a small deposit of cobbles offshore from the La Jolla Beach and Tennis Club that becomes exposed during the winter months in some years after a period of heavy surf; this patch extends for about 100 meters along a front parallel to the shoreline and at depths of 10-40 ft. (3-12 m.). It is denoted in Figure 1 by a stippled area offshore from the arrow noting La Jolla Canyon. This is the site from which more than 2000 artifacts were removed over the years prior to the establishment of the Ecological Reserve. Mortars, weight stones, bifaced manos, metates, scrapers, and projectile points have all been recovered from this site, and dates ranging between 5000-7000 years before the present have been estimated for these evidences of early San Diego humans (Marshall and Moriarity, 1964).

Figure 2 is a partial reproduction of an appended map in Kennedy (1975) and clearly identifies the faults and fault zone that lie within this area. The axis of the La Jolla branch of the La Jolla Submarine Canyon lies along the Rose Canyon fault (Photograph F). Moore (1972) has 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. Simons (1977) reports that the Newport-Inglewood fault was the source of the 1933 Long Beach earthquake (magnitude 6.3), and the San Miguel fault was the site of two earthquakes of magnitude greater than 6.0 in 1956 and one greater than 5.7 in 1949 within 40 miles of San Diego. He also notes that the epicenters of earthquakes in the intensity range of V-VI have been located near the Rose Canyon fault system, including a series in 1964 in or near San Diego Bay. The Rose Canyon fault has a surface trace of at least 15 miles (24 km) in length and could support earthquakes of up to magnitude 6.8 (McEuen and Pinckney, 1972). The mapped northern offshore extension of the Rose Canyon fault zone extends from La Jolla to within 45 km of the southern onshore termination of the Newport-Inglewood fault zone (Moore, 1972). According to Simons (1977), at least 9 of the 11 earthquakes since 1963 in the San Diego area have occurred in a broad area around San Diego Bay, and the epicenter distribution suggests that the Rose Canyon fault zone is currently active (although none of the epicenters are located in the La Jolla area).

The intertidal substrate in the Ecological Reserve is of four distinct types: a fairly wide (50 meters) sandy beach that constitutes the northern three-fifths (3/5) of the shoreline; a fairly wide system of rocky ledges and boulders; a short (200 meters) and narrow (10 meters) pebble/cobble strip that lies at the base of shale/sandstone cliffs; and the sheer base of cliffs that go right to the water's edge in the southernmost 300-400 meters.

The wide northern sandy 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 virtually throughout its entire



Scripps
Canyon
La Jolla
U S FISHERY
OCEANOGRAPHY
UCMP V6874 & LACM 1401
UCMP V6884
SCRIPPS INSTITUTION OF OCEANOGRAPHY
(UNIV OF CALIF)
ROSE CANYON FAULT ZONE
ROSE CANYON FAULT
MOUNT SOLEDAD
SCRIPPS FAULT
BAY
Kellogg Park

length by a low sea wall, the top usually lying no more than 3-4 ft. (1 m.) above the sand at the base; this sea wall ends at the north side of Avenida de la Playa, which is the street access to the boat launch area. The La Jolla Beach and Tennis Club fronts the remaining 100 meters of the sandy beach south of the boat launch site.

The rocky intertidal zone immediately south of the sandy beach contains flat sandstone/shale ledges, mudstone boulders, and dikes (probably due to wave erosion) that run seaward, as well as the pebble/cobble beach mentioned above and two very small sandy pocket beaches. These lie at the base of sandstone/shale cliffs that are as high as 50 ft. (15 m.). At low tides, as much as 100 meters of this area is uncovered although the extent of intertidal substrate is quite variable within this stretch. There are several areas along the base of the cliffs which have been eroded sufficiently to have developed undercut caves, with the largest extending 15 ft. (5 m.) back and 10 ft. (3 m.) high. The flat ledges are of either sandstone or shale and underlie the entire area. Mudstone boulders are scattered throughout the area.

The pebble/cobble beach is composed of various sized rocks. This beach appears to be covered only by the highest tides and fronts a shale-layered cliff (with the layers tipped up northward some 30°). The pebble beach itself is shoreward of an extensive bay-like area of shale and/or sandstone flat ledges that make up the widest part of the entire rocky intertidal substrate (130 meter-wide band of exposed rocks at a -1.0 ft. tide level). This complex of flat ledges appears to be substantially lower than the system of ledges to the north and/or south and are tipped up northward at an angle of 45°; the most widespread tidepools are in this location.

The south end of the pebble beach grades into an area that is composed of large boulders at the base of the cliffs. The intertidal zone is the southern part of the system of flat ledges, although boulders are scattered throughout. The entire intertidal area fronting this Devil's Slide corner is composed of ledges and boulders and is only

partially uncovered at low tide. The beach is consequently narrow, varying from 5-10 meters. The intertidal zone in the southernmost portion of the Ecological Reserve is restricted to the base of the cliffs, with very little shelf or boulders exposed.

The geomorphology of the adjacent land mass to this Area of Special Biological Significance is generally that of a small alluvial basin. 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. These two high areas are severed by a stream-controlled canyon (currently the vicinity of Ardath Road), the source of water that supported the lagoon that once existed in the La Jolla Shores area (the last remnants of this lagoon is being maintained as a duck pond at the La Jolla Beach and Tennis Club). 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 low-lying residential area, with the city-operated Kellogg Park, Sea Lodge Hotel, La Jolla Beach and Tennis Club, and a few houses bordering the wide sandy beach. As previously stated, there is a low seawall that separates beach from beachfront property throughout the major portion of this area. The high ridge to the east approaches the shoreline closer to the north. The ridge eventually fronts the shoreline just north of Scripps Institution of Oceanography, then continues northward 5 miles (8 km) to Torrey Pines Beach to form the stretch of sandy beach known as Black's Beach.

At the south end of the pebble beach there is a small [illegible]

another seaward-jutting area; the elevation at the seaward tip is ca. 20-30 ft. (6.1-9.1 m.). The cliffs then gradually dip down toward La Jolla Cove and Alligator Head (Point La Jolla) so that the extreme tip is at water level. Residences line this entire ridgeline from the La Jolla Beach and Tennis Club to the La Jolla Caves.

There are no significant natural watersheds that are situated near to or within the Ecological Reserve, although there are at least ten storm drains that empty into the Ecological Reserve waters. These are listed in Table 6.

Climate

The warm, moderate weather of the San Diego region (in fact, all of southern California) is largely due to the subtropical high pressure of the northeastern Pacific. Dry air, moving down from high altitudes, spreads out at the earth's surface. In the fall and early winter, this high pressure is centered inland over Nevada and produces dry winds from the northeast known locally as Santa Anas. These usually warm winds produce La Jolla's high temperatures in late September and early winter months.

Appendix 1 gives verification to the claim for the excellent weather for the La Jolla environs. The monthly median temperatures for the minimum daily temperatures range from 8-9°C (46-48°F) in the winter months to ca. 17-18°C (62-64°F) in the summer months and those for the maximum daily temperatures range from 14-15°C (57-59°F) in the winter and/or spring months to 20-22°C (68-72°F) in the late summer and/or early fall months. The rainfall is largely concentrated in the winter months, although infrequent tropical squalls deposit significant rain during the summer months.

The sea state of the La Jolla Basin waters is generally calm, and it is rare that the ocean waters of the Ecological Reserve approach sea state 4 (moderate, with wind waves of 4-8 feet). The monthly medians are 1-2 (calm or smooth, with wind waves of less than 2 feet). The

TABLE 6. LOCATION OF STORM DRAINS IN THE IMMEDIATE VICINITY OF THE SAN DIEGO-LA JOLLA ECOLOGICAL RESERVE ASBS; CIRCLED NUMBERS CORRESPOND TO THOSE IN FIGURE 2

Type/Size of Drain	Location	Approximate of Areas Drainage
48" reinforced concrete pipe (RCP) (1)	Midblock between eastward extension of El Paseo Grande and Camino del Collado, crossing El Paseo Grande to shoreline	Areas north and east of intersection of Camino del Collado and El Paseo Grande
(2) 42" X 6" concrete box (2) (3)	On seaward side of Kellogg Park; northern one between Camino del Oro and Calle Frescota and southern one directly off Calle Frescota	Areas north and east of Calle Frescota and Camino del Oro
48" X 24" concrete box (4)	At foot of Vallecitos Street	Areas north of Vallecitos St.
72" RCP, surrounded by a large (9'-14' X 20' X 10'-15') wooden box lined with concrete. Although city records show one pipe outlet, there are actually two such outlets here, and the large unsightly box covers both (5)	At foot of Avenida de la Playa	Areas north, east, and south, 72" RCP runs along Avenida de la Playa, La Jolla Shores Dr., and receives drainage from 24" RCP along Torrey Pines Road and 36" RCP along Ardath Road. This is the largest drainage area; heavy rains produce a massive brown, silty runoff out from this drain

TABLE 6. (cont.) LOCATION OF STORM DRAINS IN THE IMMEDIATE VICINITY OF THE SAN DIEGO-LA JOLLA ECOLOGICAL RESERVE ASBS

Type/Size of Drain	Location	Approximate of Areas Drainage
36" X 8" X 5" concrete box (6)	Just south of the north wall of the La Jolla Beach and Tennis Club	Duck pond and surrounding areas of the La Jolla Beach and Tennis Club
18" RCP (7)	Intersection of Roseland St. and Spindrift Dr. and seaward between the two houses just south of the La Jolla Beach and Tennis Club	South and east of Roseland St. and Spindrift Dr.
18" RCP (8)	Foot of Princess St. and seaward	South and east of location
18" RCP (9)	Seaward end of Park Row (seaward of intersection of Park Row and Prospect St.)	South and east of intersection of Prospect St. and Park Row; receives drainage from Prospect St. and Park Row
18 RCP (10)	At Coast Boulevard where a small parking lot fronts the La Jolla Caves Curio Shop	South, east, and southwest of its exit; runs up Coast Boulevard and connects with drainage from Prospect, Cave, and Silverado streets.

direction of swells at the pier, as one might expect, usually come from a magnetic bearing of 270-290° (W to WNW), although the winter storm swells swing in from a slightly more southerly direction. The waves have an average height of only 1-2 feet (although there are winter storms that produce waves of 8 feet or so in the vicinity of the Scripps Institution of Oceanography pier), with an average period of 7-8 seconds, ranging from extremely short period waves of 2 seconds to long period waves of 15 seconds.

BIOLOGICAL DESCRIPTION

Subtidal Biota

Although the number of plants and animals occurring in the subtidal environment of the San Diego-La Jolla Ecological Reserve ASBS is large, many species are uncommon or transient through the area. This is especially true for many of the fishes. Furthermore, none of the species of organisms occurring in the Reserve are endemic to that area only; all of them are widely distributed and occur in similar habitats throughout southern California. However, because of the inclusion of several distinct biotic habitats within the relatively close confines of this ASBS, the scope and composition of the list of included species are more extensive and varied than one would expect from a similar area of this size. It was impossible to encounter all or even most of the species that possibly occur here 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-appearing habitats could not be adequately documented due to the limited nature of this survey and to unfavorable diving conditions from the middle of December through the middle of March. Quarterly observation dives were not carried out according to plan. Nevertheless, there is a sufficiency of data that includes a listing of species for each of the distinct habitats in the Ecological Reserve--broad, gently sloping sandy shelf; peaty-clay and sandy head of a submarine canyon; *Phyllospadix*-lined shallow sandstone ledges; a small *Macrocystis* bed; *Egregia* and smaller phaeophytes overlying sandstone reefs; and a mudstone boulder reef complex. There was another habitat that could not be effectively sampled--the extremely shallow mudstone boulders covered with *Phyllospadix* in the Devil's Slide area. This area is so shallow that limited visibility and/or heavy surge made observation dives virtually untenable. Appendices 2 and 3 summarize the data for the sandy substrate and rocky reefs, respectively.

Although the head of La Jolla Canyon within the ASBS is not strictly a "sandy" substrate, its lack of a considerable rocky bottom flora and fauna justifies inclusion in Appendix 2.

No attached plants were found in any of these sandy substrates. Whole plants, or parts of specimens in different stages of decomposition, were observed on many dives in these areas. The slump areas (Figure 1--Sea Lion Gulch, A. B) at the head of the canyon, at depths of 45-120 feet (14-37 meters), always contain some deposited plant material, although the density varies considerable over time and area. When dense, the entire sand substrate is overlain with plant matter. The most common plants carried to these areas are: Phyllospadix sp. (surf grass, mistakenly but almost universally called eel grass); Egregia laevigata (feather-boa or ribbon kelp); Macrocystis pyrifera (kelp or giant bladder kelp); and assorted rhodophytes (both coralline and noncoralline red algae). Occasional specimens of Eisenia arborea (southern palm kelp) and other phaeophytes (brown algae), as well as an infrequent specimen of Codium fragile (dead man's fingers) and other chlorophytes (green algae) are seen.

Although not observed during the survey, Hartline (1972) reported the occurrence of a bed of Zostera marina (true eel grass) at a depth of 45 feet (14 meters) along the southern rim of Sea Lion Gulch. This bed is small, 90 meters long and 5 meters wide, and grows in the sandy edge just shoreward of the clay-bank break in the canyon. This bed was observed in 1970 and 1971 as having a low density of plants, with many of the plants dead and decomposing, although still rooted.

The southernmost of the two small points south of Stewart Point in La Jolla Canyon usually contains a very sparse population of rhodophytes (probably Gigartina sp.), attached to the exposed clay ledges at a depth of 50 feet (15 meters). These noncoralline red algae are found on the horizontal ledges that extend 5-10 feet (2-3 meters) immediately shoreward of the 5-7 foot (2 meter) vertical clay bank. These ledges appear to be fairly unchanged over time although the overlying sand does shift and cause minor alterations of the geography.

There may be an occasional attachment of a few Macrocystis pyrifera juveniles along the upper margin of the clay-banks at 50 feet (15 meters). However, these are "transient", and no adult or half-grown kelp has ever been found here. The number of animal species that occur in the sandy areas of the Ecological Reserve is as restricted as for plants, although many species of animals not normally living on or over sand use these areas as transportation corridors or are carried there by currents. The list given in Appendix 2 does not attempt to include all the animals that may occur here; rather, it focuses on animals which are common or abundant. Analysis of the distributional pattern derived from Appendix 2 demonstrates the difference between the sandy shelf and the actual clay-banked head of the canyon. For example, Stylatula elongata, the sea pen, is quite common and abundant in sandy substrates, whereas the abundance drops off sharply in the clay-bank area. Depth also appears to be a factor, inasmuch as the number of sea pens dropped off sharply at depths greater than 15 meters, even though the bottom was sandy. Lophogorgia chilensis, the pink sea whip, is another example of this effect of substrate and depth (probably controlled by temperature more than depth).

The species (either by abundance or by extent of occurrence) on which future surveys in these areas should focus include: Harenactis attenuata; Renilla köllikeri, Stylatula elongata; Diopatra splendidissima; mysid (probably Acanthomysis costata); Epitonium tinctum; Olivella sp.; Diaperoecia californica (in the clay-bank areas of the canyon); Astropecten sp.; Amphiodia sp.; Dendraster excentricus; Citharichthys stigmaeus; and Coryphopterus nicholsi.

There are many species of fish other than those included in Appendix 2 that were observed during the survey dives or on previous dives. The listing of species of these fishes was limited to those which were definitely "sandy" substrate-oriented, even though some of the others were seen in fair numbers (such as a school of ca. 25 white seaperch, Phanerodon furcatus, passing through one of our transect areas). Included in the species list are the grunion, Leuresthes tenuis, and Otophidium sp., the cusk eel, inasmuch as they are attractions of this area. The grunion inhabits the nearshore waters off a sandy beach at the time of

spawning (and may be thus considered as seasonal). Both species of cusk eels, Otophidium scrippsi and Chilara taylori, may be observed at night along the margin of La Jolla Canyon (as shallow as 20-25 ft./6-7 m.), and it is presumed that they are much deeper than 100 ft. (30 m.) during the day. The cusk eels exhibit the unique behavior of digging tail first into the sand when disturbed and 6- to 12-in. (15-30 cm.) fish will disappear completely in a matter of a few seconds.

The sun star (Pycnopodia helianthoides) the Pacific Coast squid (Loligo opalescens), the angel shark (Squatina californica), and the electric ray (Torpedo californica) have all been incorporated as part of the species list for this area because of their presence noted on dives other than the survey and of their novelty appeal to divers. All of these animals frequent the margin of the canyon head and may be observed from time to time. Like the grunion, the squid is only found concentrated during periods of spawning and thus must be considered seasonal. Further descriptions of these species are included in the section on unique components of the biota.

Appendix 3 cumulates the survey data gathered for the rocky substrates in the ASBS. The areas in which transects were taken are designated by the dominant attached plant: shallow Phyllospadix-lined sandstone ledges; Egregia canopy over flat, sandstone/mudstone ledges; a small Macrocystis bed; and an area where there are no large attached plants, but many small ones, especially red algae, called the boulder reef complex. The abundance data collected for this survey are included in the appendices as indications of relative abundance, rather than as statistically reliable bases from which variances may be measured. The data reveal some differences among these four subtidal rocky habitats, but these differences are subtle and difficult to quantify.

The lack of large attached plants makes the boulder reef complex quite a bit distinct from the other three rocky areas. The rhodophytes are the abundant and dominant flora in this area, and there is much of the surface area encrusted with sponges and crustose red algae. The large gray-green Pacific loggerhead sponge, Spheciospongia confoederata, is restricted to this area of the Ecological Reserve. Muricea californica, the orangish California gorgonian, is a sea fan that is either restricted here, or relatively rare in some of the other rocky substrates. The

stony coral (Astrangia lajollaensis), striped cleaner shrimp (Lysmata californica), orange lacy bryozoan (Diaperoecia californica), sun star (Pycnopodia helianthoides), sea cucumber (Stichopus parvimensis), and many of the species of fish are most abundant in this boulder area. The red sea urchin (Strongylocentrotus franciscanus) is common in this area. The California spiny lobster (Panulirus interruptus) is fairly common in this area, although our survey results do not indicate this. Abalone, on the other hand, are not as plentiful here as in the shallow waters (compare the numbers for Haliotis corrugata). A recent shallow snorkel dive to the shallow Phyllospadix-lined boulder area inshore of the Phyllospadix-lined ledges revealed dense concentrations of Haliotis fulgens, the green abalone, in 5-10 ft. (2-3 m.) of water. These abalone were concentrated in caves (up to as many as 17 in one cave), with estimated shell diameters of 7-9 inches (178-229 mm). A census of 12 small caves netted a count of 67 abalones, all H. fulgens. About 15 lobsters were encountered in the same caves. It thus appears that this nearshore, very shallow bouldery area in the Devil's Slide corner is a haven for Haliotis and Panulirus.

The differences between the Macrocystis-, Phyllospadix-, and Egregia-dominated areas are not as easily discernible as those of the boulder reef complex. Aside from the conspicuous change in the dominant vegetation, the animal species vary slightly in their preferences for a particular substrate. Tegula funebralis, the black turban, for example, was quite common in the shallow environs of the Phyllospadix reefs whereas it was not observed at all in the other two areas. Both species of abalones (Haliotis fulgens and H. corrugata) occurred everywhere except in the Egregia beds. The purple-hinged rock scallop, Hinnites multirugosus, was absent from the Macrocystis and Egregia beds, whereas Kellet's whelk (Kelletia kelleti) was as abundant in the Macrocystis bed as in the boulder reef complex and rare in the Egregia bed and absent from the Phyllospadix reefs.

large, and colorful may have omitted some species that are probably significant in the dynamics of rocky reef ecosystems. However, even this abbreviated list makes it apparent that the rocky substrate promotes a more diverse fauna than that of a sandy substrate. The dominant plant species and corresponding animals (dominant and/or abundant plus "edible" species) should be observed in future surveys, and these include:

Phyllospadix reefs--Phyllospadix, Eisenia arborea, various rhodophytes, several sponges, serpulid tube worms, Panulirus interruptus, Tegula funebralis, Haliotis spp., piddock clams, and ophiuroids (brittle stars).

Egregia beds--Egregia, Cystoseira/Halidrys, Eisenia arborea, Laminaria sp., assorted rhodophytes (especially the coralline forms), a few sponges, tube worms, Panulirus interruptus, and Haliotis spp.

Macrocystis bed--Macrocystis, Cystoseira/Halidrys, Egregia laevigata, Eisenia arborea, Pachydictyon coriaceum, a few reds, tube worms, Panulirus interruptus, Kelletia kelleti, Haliotis spp., ophiuroids, and Strongylocentrotus franciscanus.

Boulder reef complex--various rhodophytes, several sponges, Muricea californica, Astrangia lajollaensis, Aglaophenia struthionides, Obelia and other hydroids, tube worms, Panulirus interruptus, Astraea undosa, Haliotis spp., Kelletia kelleti, piddock clams, Pisaster giganteus, ophiuroids, Strongylocentrotus franciscanus, and Stichopus parvimensis.

The fishes to be investigated for each area should at least include the garibaldi (Hypsypops rubicundus), senorita (Oxyjulis californica), kelp bass (Paralabrax clathratus), blacksmith (Chromis punctipinnis), blackcrested goby (Coryphopterus nicholsii), and sheephead (Pimelometopon pulchrum).

As this entire area is designated as an ecological reserve, it is unlikely that current frequencies of human use will substantially affect the biota of this ASBS. The restrictions against the taking of edible and/or aquarium species should protect these species from human predation, although "poaching" must be thwarted. In the sandy areas, including the canyon head, halibut (Paralichthys californicus), various species of

turbots and flounders, bluebanded goby (Lythrypnus dalli), grunion (Leuresthes tenuis), blackcrested goby (Coryphopterus nicholsii), rockfish species (Sebastes sp., Scorpaena guttata), octopus (Octopus bimaculoides), squid (Loligo opalescens), clam species, and rock scallop (Hinnites multirugosus) are being protected from human consumption. It is difficult to assess how the presence of nonpredatory humans within these subtidal areas affects the population dynamics of the biotic elements. There does not appear to be any indication that the behavior of spawning squid has altered, but it does appear that the lighting of the beach along Kellogg Park has dampened the probability of a massive spawn of grunion at La Jolla Shores beach. The grunion prefer the darkened areas of the beach.

In the rocky areas, protection against the taking of species should result in the maintenance and/or increase of populations of spiny lobsters (Panulirus interruptus), abalones (Haliotis fulgens and H. corrugata), sea urchins (Strongylocentrotus franciscanus), various nudibranchs, rock scallops (Hinnites multirugosus), octopi (Octopus bimaculatus), and many species of fishes (especially Paralabrax spp., Pimelometopon pulchrum, Scorpaena guttata, and the larger surf perches). Frequent dives made in the same rocky area (boulder reef complex) since 1974 indicate that the animals, especially the fishes, in the areas are not as "gun-shy" and tend to become conditioned to the presence of divers, and sheepheads and other fish frequently stalk or follow the observer-diver.

Intertidal Biota

The intertidal areas of the San Diego-La Jolla Ecological Reserve ASBS are of two general types: gently sloping sandy beach and a sandstone/shale reef complex with mudstone boulders. Although the sandy intertidal and supratidal areas are restricted to only a handful of species, the rocky areas contain a large diversity of plants and animals.

The La Jolla Shores sandy beach, even though it is entirely open to the sea, constitutes a protected outer coast habitat for its fauna. The long, gradually sloping sandy shelf offshore and the presence of the La Jolla Submarine Canyon serve to break the full force of the waves, so

that wave heights average less than 2-2.5 ft. (~0.7 m.) annually. The species listed in Table 7 are characteristic of a protected outer coast fauna. There are no attached macro-plants, even though there are considerable drifts of subtidal and rocky intertidal attached plants that are washed ashore.

The animal species found on the La Jolla sandy beach are limited to a few more or less abundant forms. The numbers of the abundant forms vary considerably between sites and times of observation. For example, McConnaughey and Fox (1949) observed densities of 2,500-3,000 per square foot (27,778-33,333 per m^2) for the bloodworm, Euzonus mucronata, whereas the survey probes along this same beach noted densities no higher than 500 per square foot (5556 per m^2). The variance for Donax gouldi, the bean clam, is even more spectacular. Coe (1955) noted fluctuations from one specimen per m^2 to 20,000 per m^2 in a period of two months on La Jolla Shores beach. Within three years, this abundant clam had decreased to the point that only a dozen individuals were found along the beach. Our survey probes failed to locate a single live individual, although several shells were uncovered.

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

The number of species found on this sandy intertidal area is so limited that it is recommended that observations include all elements present, although observations on the lower intertidal species (Tivela, Blepharipoda, and Lepidopa, especially) may be somewhat difficult to obtain on a consistent basis, due to surf and limited visibility.

The sandstone/shale ledges and dikes, with scattered mudstone boulders, make up the rocky intertidal substrate between the south end of the La Jolla Shores beach and the beginning of the La Jolla Caves cliffs. This area supports a flora and fauna that are indicative of a semi-protected outer coast zone. It is an extensive area, with a wide stretch of tidepools, especially in the small, bay-like area off the

TABLE 7. ORGANISMS OCCURRING IN THE SANDY BEACH INTERTIDAL SUBSTRATE OF THE SAN DIEGO-LA JOLLA ECOLOGICAL RESERVE ASBS. NUMBERS GIVEN ARE INDIVIDUALS PER m^2

Species	Abundance
ATTACHED PLANTS	
None, except for those carried ashore by waves and/or currents	0
ANIMALS	
Coelenterata	
Clytia bakeri, clam hydroid	Variable, follows cycles of *Donax* and/or *Tivela*
Annelida/Polychaeta	
Euzonus mucronata, bloodworm	Abundant, up to 30,000[a]
Nephtys californiensis	0.08
Arthropoda/Crustacea	
Blepharipoda occidentalis, spiny sand crab	Rare
Emerita analoga, sand crab	Common
Lepidopa myops, white sand crab	Rare
Orchestoidea sp.	Abundant, especially under piles of kelp on shore
Mollusca/Pelecypoda	
Donax gouldi, bean clam	Variable, up to 20,000[b]
Tivela stultorum, Pismo clam	Rare
Unidentified cardiid (cockles)	Rare
Pisces	
Leuresthes tenuis, grunion	Seasonal
Aves/water birds	
Calidris alba, sanderling	Common
Larus occidentalis, western gull (Photograph N)	
Limosa fedoa, marbled godwit (Photograph O)	Common
Pelecanus occidentalis, brown pelican (Photograph P)	Rare on beach
Phalacrocorax penicillatus, Brandt's cormorant (Photograph Q)	Extremely rare on beach

[a]From McConnaughey and Fox, 1949

[b]From Coe, 1955

pebble beach at Devil's Slide. Because of the large number of potential and actual species occurring here, the plants and animals observed were limited to those which are large, obvious, readily identifiable, common, or edible, or otherwise useful for human consumption. Gross estimates of populations by zone were applied to the higher intertidal zones, and the results reported here should be interpreted relatively rather than absolutely. The lower intertidal zones were not intensively surveyed, with observations limited to presence or absence. The estimates of abundance for these organisms are derived from the personal experience and knowledge of the principal investigator. Those organisms that inhabit the undersurfaces of rocks, or use the cobbles or boulders as protective cover, were insufficiently sampled in this survey as rocks were left undisturbed. Therefore, this listing of species (Appendix 4) is strongly biased toward the easily observed ones.

The flora in the intertidal rocky substrate is dominated by the rhodophytes, or red algae. These are virtially everywhere in the intertidal zone, from the highest to the lowermost levels. Other attached plants are also abundant or common in various tidal zones--Pelvetia fastigiata is the most conspicuous in the high intertidal zone, although another phaeophyte, a stringy brownish species (probably Scytosiphon lomentaria), is most abundant in the upper margins of the Pelvetia zone. A thick mat of Enteromorpha sp. abounds below the Pelvetia zone, along with Gigartina and Plocamium. Colpomenia sinuosa and Petrospongium rugosum occur in this lower zone. The tops of many boulders in the tidepools contain a mat of Enteromorpha, with numerous coralline red algae and Sargassum occurring at the bases of these boulders. The commonness of Sargassum differs from the observation of only one plant by Kanykowski and Yoshioka (1972) in this same general area. Ulva and Pachydictyon are also common plants throughout the lower and middle zones. Codium, Cystoseira and/or Halidrys, Eisenia, and Gelidium were plants that were few in number. Phyllospadix was abundant in the lowermost zone. These observations are in general agreement with those reported by Kamykowski and Yoshioka (1972).

The animal species of this rocky intertidal region are representative of species expected for a semi-protected outer rocky coast. There are no unexpected species, although the densities may not be in perfect accord with published literature. Temporal and spatial variances in the distribution and abundance of animal species make it virtually impossible to construct a model that fits exactly to a given area; however, the observations almost always provide reasonable agreement. This is true for the intertidal zones surveyed here.

In order to evaluate more accurately the population or community dynamics of this area, a monitoring study should be conducted taking at least the following species into account: Enteromorpha, Pelvetia, and crustose and coralline red algae cover; incidence of soft red algae; Phyllospadix cover; Anthopleura elegantissima cover; as well as that of Phragmatopoma californica; incidences of other polychaetous tube worms, the various species of barnacles and limpets, littorine or periwinkle snails (Littorina spp.), and the black turban snail (Tegula funebralis); identification of numbers, sizes, and movements of the spiny lobster (Panulirus interruptus) and the abalones (Haliotis cracherodii and H. fulgens). The susceptibility to tidepool "poachers" of the various starfishes may require their inclusion in the study. The only fish that should be included is the wooly sculpin, Clinocottus analis.

The shore birds are included in this list as in that for the sandy beach due to their regular occurrence in the intertidal areas. A count of them probably will enhance the monitoring study.

The intertidal species most likely to be influenced by human use in this ecological reserve are:

Sandy beach--none known, although the storm runoffs may adversely affect those elements that are sedentary or only slightly mobile.

Rocky reefs--none known, although those organisms inhabiting boulders or parts of reefs at the base of cliffs may be buried under mud by the infrequent cave-ins. However, a goodly portion of the highermost intertidal areas is at least 20-30 ft. (6-9 m.) from

the base of cliffs. The many visitors to these tidepools should not upset the equilibrium of the ecosystem by turning over rocks, or, if necessary to inspect the organisms under rocks, by not replacing the rocks back in their original position.

This enumeration of the effect of human use of the intertidal areas does not account for the improbability of the ecological reserve restrictions being terminated. In that event, and in the event of poaching, the usual edible species (abalones, octopi, lobsters, mussels) and "attractive" species (starfish, sea urchins, some plants, crabs, fish, snails) are apt to undergo population changes.

Landside Vegetation

The land mass adjacent to the San Diego-La Jolla Ecological Reserve ASBS is situated in the midst of residential and commercial areas so that the landside vegetation is primarily introduced and non-native or favors those species that proliferate in disturbed-land sites. The blue grass fields in Kellogg Park, lined with tall, stately palm trees, constitute the entire northern landside flora. The cliffs along the southern half do not support very much vegetation, as they are nearly vertical and subjected to constant erosive forces. Residents along the northern half of these cliffs have planted *Mesembryanthemum* spp. (ice plant, sea fig) in order to aid in the control of erosion; these plants are visible along the ridgeline and down in the areas where slides have occurred. The upper margin of the cliffs and the gulleys or slides in the southern half of the cliff area (Devil's Slide to Goldfish Point) contain a mixture of grasses and other introduced species like *Nasturtium* and *Pelargonium*. Human habitation along the ridgeline and the steepness of the cliffs restrict the zone of native plants to a very narrow area along the ridgeline and in gulleys, ledges, and slides on the face of the bluffs. There are scattered specimens of various grasses and low shrubs such as *Haplopappus*. A small stand of a gramineae, probably *Arundo* sp., a giant reed, occurs at the Devil's Slide point. An occasional individual of *Euphorvia misera*, the cliff spurge, occurs on the

face of the cliffs, along with Frankenia palmeri. On the ridgeline are clumps of Encelia californica, the bush sunflower. Most of these plants are characteristic of the coastal sage scrub community, which would be the flora expected in this region if it were undeveloped and not influenced by human use. Clumps of Rhus integrifolia, lemonade berry, line the coast walk from the point of Devil's Slide to the southern corner of Devil's Slide. Rhus laurina, laurel sumac, Atriplex semibaccata, Australian saltbush, and Agave shawii, a century plant, all occur along the northern half of the Devil's Slide point.

Unique Components

The only plant species that is considered as a unique component of the San Diego-La Jolla Ecological Reserve ASBS is the giant bladder kelp, Macrocystis pyrifera. Since its diminishment in conspicuous areas in the 1950's, there has been considerable study undertaken on the life history and ecology of this important resource of California. The results of all this effort make possible the description that follows.

Macrocystis is extensively utilized in Southern California. The harvest of the uppermost 3-4 ft. (1 m.) of fronds and stipes is processed to varying degrees, yielding several products. These include fertilizer, food additives, alginic acid (or its derivative, algin, which is used as a stabilizer and emulsifier in jellies, plastics, cosmetics, medicine, etc.) and fuel to provide energy. This is a multimillion dollar industry, with the major part located in California. Further, the kelp beds

bed in the San Diego-La Jolla Ecological Reserve is tiny, measuring no more than 75-100 m. long and 25-30 m. wide. It is in very shallow water (15-25 ft./4.5-7.5 m.) over flat, sandstone ledges, and its extent and density vary considerably from season to season and from year to year. There are Macrocystis plants throughout the area where Egregia dominates, but these are widely scattered.

The large kelp plant represents only one stage of a complicated life cycle. This tall, spore-producing phase alternates with an inconspicuous, microscopic stage, and the minimum time necessary for the cycle to be completed is 12-14 months.

Three species of animals are included here as unique components of the ASBS, the Pacific Coast squid, Loligo opalescens, the grunion, Leuresthes tenuis, and the garibaldi, Hypsypops rubicunda (Figure 3). Both the squid and grunion and conspicuous during their spawning periods, and thus are considered seasonal even though they may be present in the waters all year long. The large spawning aggregation of squids is a prime attraction to assorted marine animals (due to the death of the spawners providing a ready source of food) and to SCUBA divers who denote the onset of a spawning mass of squid by the activity and concentration of gulls on the surface of the water over the head of La Jolla Canyon.

Although this spawning behavior in inshore areas has been known for some time, it was not until 1953 that this congregation and spawning behavior was observed in nature (McGowan, 1954). Since that time, countless SCUBA scientists and interested divers have observed this. The prime area of spawning is the head of the La Jolla branch of the La Jolla Submarine Canyon (between Sea Lion Gulch and Stewart Point), although other areas are known to be spawning sites. Spawns have been observed at similar depths of 40-70 ft. (12-21 m.) in the Scripps branch of this canyon. The squid normally inhabit offshore waters and only move into the waters of the Ecological Reserve as spawning approaches. The squid tend to be aggregated over the sandy areas but in depths deeper than 40-50 ft. (12-15 m.). The males clasp the females and deposit sperm in the mantle cavity of the females; the females then lay

Figure 3

Shown here among recently spawned egg capsules, adult Pacific Coast squid (Loligo opalescens) are special biological components of this ASBS.

their egg capsules and attach them to the sandy bottom or to the base of previously lain egg capsules. Thus, large masses of egg capsules cumulate. Both males and females die after the spawning, and the eggs hatch in 30-35 days. As mentioned above, the large die-off of squid results in a concentration of many other animals to this area, including halibut, Angel shark, bat rays, white sea bass, and an occasional blue shark. Fields (1950) gives an excellent account of the fishery and biology of this species.

Concentrations and length of spawning in the area vary at different times. Although no squid were noted during the survey, one previous dive encountered egg masses over an area more than 50 m. wide and ranging from 35 ft. (10 m.) to deeper than 120 ft. (36.5 m.). The dive was terminated at this depth and the egg mass showed no signs of diminishing in size or density. There were dead or dying squid all over the bottom, and schools of live squid swimming near the bottom at depths of 60-80 ft. (18-24 m.).

The grunion, Leuresthes tenuis, is equally well known for its spawning behavior. It is included as a seasonal component of the sandy intertidal zone as the female, usually accompanied by several males, comes completely out of the water to lay her eggs into 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 known about the major part of its 2-3 year life span. The grunion apparently do not stray far from the beach areas on which they spawn.

The only other species of animal that will be treated here as a unique component is the garibaldi, Hypsypops rubicundus. It is such a strikingly red-orange fish that Goldfish Point was named from the abundance of garibaldi in the waters surrounding it. One of only two pomacentrids (damsel fishes) in Southern California waters (the other is the blacksmith, Chromis punctipinnis), the garibaldi inhabits rocky subtidal

areas, although juveniles can occasionally be seen in deep tide pools. Adult fish are observed as deep as 25 m. The garibaldi feeds almost exclusively on benthic organisms and is a protected fish (no taking or possession) throughout California waters. Adults defend a territory which includes a shelter hole, grazing area, and (for some males) a nest site. Limbaugh (1964) and Clarke (1971) give good descriptions of the life history of this pugnacious fish.

Human use of the beaches has appeared to affect the behavior of at least one of these unique components. The lighting of Kellogg Park has reduced the number of grunion which use this wide stretch of beach as a spawning site. Most of the spawners are observed in the northern edge of the Ecological Reserve, along the beach fronting Scripps Institution of Oceanography but not in the immediate vicinity of the pier (where there is a bright spotlight that shines south). However, the stretch of beach from the north end of Kellogg Park toward the pier is darkened and many spawning runs have been observed here.

Otherwise, these unique components appear to be flourishing as well as expected in this ASBS. There has been no noticeable decrease in squid spawns and garibaldi are common in rocky areas. The Macrocystis bed struggles along, but this is not a typical habitat for Macrocystis, although it persists from year to year.

Although not technically a part of the usual list of marine animals, attention should be directed to two shorebirds that roost in the cliffs over the La Jolla Caves area. The brown pelican, Pelecanus occidentalis, and Brandt's cormorant, Phalacrocorax penicillatus are presently common

LAND AND WATER USE DESCRIPTIONS

Marine Resource Harvesting

The San Diego-La Jolla ASBS is designated as an ecological reserve, and consequently no harvesting is done within its boundaries. The waters immediately adjacent to it are heavily fished, especially by lobster fishermen, and care must be exercised in ensuring that encroachment into the Ecological Reserve by overzealous fishermen is not allowed to go unchecked.

Wildlife observation by the public is one marine resource that is "harvested" within the Ecological Reserve in increasing numbers. Underwater photography, observation dives, tidepool observations, shorebird watching, grunion hunting (without taking), and enjoyment of intertidal and subtidal dynamics have become a part of the education of many San Diegans and visitors.

Municipal and Industrial Activities

The community of La Jolla, part of the City of San Diego, surrounds the entire shore margin of the San Diego-La Jolla ASBS. It is primarily a residential and resort community, with a population of 28,000. Scripps Institution of Oceanography, a research and graduate training center for oceanographic studies, is situated immediately north of the ASBS. There are no manufacturing or heavy construction industries situated here.

Agribusiness and Silviculture

Agricultural, dairying, grazing, or logging operations do not occur in La Jolla, and there are no plans calling for such industries.

Governmental Designated Open Space

The La Jolla Community Plan, presented in April, 1975, to the City

of San Diego, 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, presented in December, 1975, by the California Coastal Zone Conservation Commission. 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 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

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 this 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-La Jolla Ecological Reserve and its immediate vicinity. These include swimming, sunbathing, bodysurfing and 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, in startling contrast with the overwhelming majority of "swimmers" who enter the water at the Cove, La Jolla Shores, and Scripps beaches and swim or wade out to the surf zone or just beyond and return to shore.

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 8.

TABLE 8. ATTENDANCE ESTIMATES GLEANED FROM SAN DIEGO CITY LIFEGUARD SERVICE RECORDS FOR LA JOLLA BEACHES

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

There are no separate records kept for the other activities that occur within these areas, but the totals cited for the beaches include those persons participating in most of these activities.

Interviews with representatives from the two leading SCUBA diver-certification organizations in San Diego produced the following minimal estimate of instructional SCUBA dives in this area: 2000 divers certified in 1977, each diver entering the water at least four times. The preponderance of these dives toward certification use the water directly off Vallecitos Street (one block north of the boat launching site), as do most other dives into this La Jolla Canyon area.

The commercial sportfishing fleet fishes the areas immediately adjacent to the Ecological Reserve. Each boat makes two trips daily from Mission Bay, and the number of boats varies between 4-10 boats daily. This nearshore (within one mile of shore) summer fishing is primarily for barracuda, Sphyraena argentea, bonito, Sarda chiliensis, kelp or calico bass, Paralabrax clathratus, 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 companies that regularly send their boats to La Jolla indicate that all skippers are aware of the Ecological Reserve and its boundaries. The proximity of fishing to the Ecological Reserve is dependent on the skipper and/or the quality of the fishing.

One particular wildlife observation is particularly popular to boaters during the winter months. 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 now 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

This ASBS has been, and continues to be, the study site or one of the study sites for a wide variety of scientific investigations. The proximity of Scripps Instituions of Oceanography, which is celebrating 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 Ecological Reserve or its immediate environs. To make a listing of each study that has been based here would be tedious and difficult. The following list is representative of the recent studies completed to date:

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

2. F. P. Shepard and D. L. Inman, 1951. D. L. Inman, 1953. D. L. Inman and G. A. Rusnak, 1956. Dynamics of sand transport along the coast, especially the influence of Scripps and La Jolla heads of the La Jolla Submarine Canyon.

3. B. W. Walker, 1952. Life history of the grunion, Leuresthes tenuis. Part of study area La Jolla Shores beach.

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

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

6. R. J. Ghelardi and W. J. North, 1958. Effects of upwelling on

8. C. Limbaugh, 1964. T. A. Clarke, 1971. Life history aspects of the garibaldi, Hypsypops rubicunda. Some of study areas in the Ecological Reserve.

9. N. F. Marshall and J. R. Moriarity, 1964. Review of local underwater archaeology, with special discussion on the cobble patch off the La Jolla Beach and Tennis Club.

10. R. F. Ford, 1965. Life history study of the speckled sanddab, Citharichthys stigmaeus. Sandy subtidal areas of the Ecological Reserve.

11. F. P. Shepard and R. Dill, 1966. Description of La Jolla Submarine Canyon.

12. R. W. Holmes, P. M. Williams, and R. W. Eppley, 1967. Study of red tides of 1964-1966 in La Jolla Bay.

13. E. W. Fager, 1968. The composition and dynamics of a shallow subtidal sand bottom epifaunal community. Study sites in the vicinity of the Scripps Pier, near to the northern boundary of the Ecological Reserve.

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

15. 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.

16. D. L. Kamykowski, 1972. Physical and chemical aspects of phytoplankton ecology of La Jolla Bay.

17. J. N. Suhayda, 1972. Model prescribed for the transformation of waves on a sloping bottom; applied to the subtidal areas in the northern boundary area of this ASBS.

18. A. J. Bowen and D. L. Inman, 1974. Nearshore mixing effects of waves and currents. Scripps beach, among others.

19. L. Cheng and R. A. Lewin, 1976. Goose barnacles washed ashore on flotsam at La Jolla Shores beach.

20. M. S. Olsson, T. D. Finnigan, S. R. Glass, A. Milgrom, R. Kaufmann, R. A. Arkin, 1977. R. Arkin, R. Kaufmann, A. Milgrom, V. Paul, G. Rankin, 1978. Continuing studies on population dynamics and migration of the spiny lobster, Panulirus interruptus. Boulder reef complex area of Ecological Reserve.

21. M. S. Olsson and G. Newton, 1977. Population studies of the red urchin, Strongylocentrotus franciscanus. Boulder reef complex area

ACTUAL OR POTENTIAL POLLUTION THREATS

Point Sources

There are no industrial or municipal wastes that are deposited in the ocean within a mile of this ASBS. The closest wastewater treatment plants are the Metro plant at the tip of Point Loma and the San Elijo Treatment Plant. These are located at straight-line distances of 11.5 and 10 miles, respectively, from the Ecological Reserve. The nearest solid waste disposal site is the Miramar one, at a distance of slightly more than 6.5 miles. There are no thermal effluent discharges anywhere near this ASBS.

There was raw sewage discharge from the auxiliary pump stations along the coast during the massive power failure that struck San Diego in February, 1978, and the resultant bacterial contamination led to the closure of virtually all area beaches, including La Jolla Shores. This closure lasted for two days. This is the only known closure of the La Jolla Shores beach in recent years. The nearest pumping stations are located at Casa de Manana beach, about 650 meters south of Point La Jolla.

Nonpoint Sources

The only major problem with point source pollution is the storm water runoff drains that empty into the ocean along the shoreline of the ASBS. Table 6 details the type and sizes of the drains, their locations, and an approximation of the areas of drainage. The ocean receives not only all the sand washed out to sea, but it also receives the fresh water and the silt as well. The result of this one large drainage is conspicuous initially as a large head of brown water spreading outward from the drain. The other drainages are not as spectacular, and their effects must be considerably less.

SPECIAL WATER QUALITY REQUIREMENTS OF ASBS BASED ON UNIQUE COMPONENTS

The present level of water quality within the San Diego-La Jolla Ecological Reserve ASBS is of sufficient quality to enable the unique components described above to thrive as expected. Of those described, the effects of pollutants on one, the giant bladder kelp (*Macrocystis pyrifera*), have been reported by Grigg and Kiwala (1970) and North (1963). Although the direct ecological effects of pollutants have not been substantiated, suggestions are that effluents such as sewage probably lead to deterioration of a healthy *Macrocystis* bed. However, other ecological considerations, such as the influence of grazing by urchins (*Strongylocentrotus* spp., especially *S. franciscanus*) and "warm" water, also lead to declining beds. Further, the effects of storms and wave action also materially affect individual plants. The struggling persistence of the tiny kelp bed of *Macrocystis* in the ASBS and its limitations to the present location and size suggest that this is not a prime site for the development of a lush, extensive bed. The degree of sand movement between the patchy rocky reefs in the southern subtidal area limits the growth of *Macrocystis* to those areas where the reefs are substantial. Wave action and surge probably operate to keep the kelp bed from extending into shallower waters; it already is in extremely shallow water for a *Macrocystis* bed in the San Diego area; temperature fluctuations and/or cycles promote and inhibit the growth of the bed at different seasons. The quality of water otherwise does not affect this bed.

Squid (*Loligo opalescens*) and grunion (*Leuresthes tenuis*) occur in substantial numbers periodically in the Ecological Reserve; hence the water quality is conducive, or at lease does not inhibit, to the maintenance of these organisms. The garibaldi, *Hypsypops rubicundus*, is common in the rocky subtidal areas of this ASBS and does not appear to be inhibited by the current level of water quality.

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APPENDICES

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)

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											
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 (5-10)	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	0 (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	--	--	--	--	--	--	--	--	--	--	--

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)

Temp. °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.
[illegible]	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
[illegible]	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
[illegible]	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
[illegible]	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
[illegible]	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
[illegible]	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
[illegible]	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		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											
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		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											
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, 48,42,44, 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 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											
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 (15.8-25.6)	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)

PILED FROM DAILY OBSERVATIONS TAKEN AT THE END OF THE PIER AT
ION OF OCEANOGRAPHY FROM 1974 THROUGH MARCH, 1978. THE FIGURES
NTHLY MEDIAN, WITH THE MONTHLY RANGE OF VALUES IN PARENTHESES,
ALL (CUMULATIVE FOR EACH MONTH)

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but not at the station

thinning during preceding hour
, thinning during preceding hour
no change during preceding hour
, no change during preceding hour
thickening during preceding hour
, thickening during preceding hour
lme, sky invisible
ot freezing, intermittent
ot freezing, continuous
not freezing, intermittent
not freezing, continuous
slight
reezing, intermittent
reezing, continuous
freezing, intermittent
freezing, continuous
ight
derate or heavy
e of observation, thunderstorm during preceding hour but not at
ation

cord with code established by World Meteorological Organization

ht of wind waves 0 feet
ght of wind waves 0-1/3 feet
height of wind waves 1/3 to 1-2/3 feet
wind waves 1-2/3 to 4 feet
f wind waves 4-8 feet

APPENDIX 2 ORGANISMS OCCURRING ON SUBTIDAL SANDY SUBSTRATES WITHIN THE SAN DIEGO-LA JOLLA ECOLOGICAL RESERVE ASBS. NUMBERS GIVEN ARE INDIVIDUALS PER m^2

Species	Sandy Shelf in Northern Part--Shallower Than 15 m	La Jolla Canyon Head: Shallower Than 15 m	La Jolla Canyon Head: 15 m and Deeper
ATTACHED PLANTS			
Phaeophyta (brown algae)			
Macrocystis pyrifera, giant bladder kelp	0	0	Rare
Rhodophyta (red algae)			
Assorted rhodophytes, red algae	0	0	Few
Flowering plants			
Zostera marina, eel grass	0	1-3	0
ANIMALS			
Porifera (sponges)--orange encrusting (Plocamia sp.?) and Verongia thiona, sulfur sponge	0	0	Few
Coelenterata			
Harenactis attenuata--borrowing anemone	6.48[a]	0-0.04	0
Lophogorgia chilensis, pink sea whip	0	0	0-0.24
Obelia dichotoma (hydroid)	0	0-0.12	0-0.04
Renilla köllikeri, sea pansy	1.68[a]/0-0.24	0-0.20	0-0.76
Stylatula elongata, sea pen	0.20-0.48	0-1.48	0-0.04
Zaolutus actius (anemone)	1.76[a]	Unobserved	Unobserved
Annelida/Polychaeta			
Diopatra splendidissima, parchment tube worm	0.60-0.76	0.24-1.00	0.04-2.04
Owenia fusiformis (tube worm)	Infrequent[a] (less than 0.04/m^2)	Unobserved	Unobserved
Arthropoda/Malacostraca			
Ancinus sp. (isopod)	Infrequent[a]	Unobserved	Unobserved
Blepheripoda occidentalis, spiny sand crab	Infrequent[a]	0-0.08	0
Cancer gracilis (cancer crab)	Infrequent[a]	0-0.04	0-0.04
Crangon nigromaculata, black spotted shrimp	Infrequent[a]	Unobserved	Unobserved
Isocheles pilosus, moon snail hermit crab	0.26[a]	Unobserved	Unobserved
Heterocrypta occidentalis, elbow crab	Infrequent[a]	Unobserved	Unobserved

APPENDIX 2 (cont.) ORGANISMS OCCURRING ON SUBTIDAL SANDY SUBSTRATES WITHIN THE SAN DIEGO-LA JOLLA ECOLOGICAL RESERVE ASBS. NUMBERS GIVEN ARE INDIVIDUALS PER m^2

Species	Sandy Shelf in Northern Part--Shallower Than 15 m	La Jolla Canyon Head: Shallower Than 15 m	La Jolla Canyon Head: 15 m and Deeper
Arthropoda/Malacostraca (cont.)			
Lepidopa myops, mole crab	Infrequent[a]	Unobserved	Unobserved
Mysid (probably Acanthomysis costata)	0	Dense hordes seen hovering 1-5 ft (1-2 m) off the bottom	0
Portunus xantusii (swimming crab)	Infrequent[a]	0-0.12	0
Pugettia producta, northern kelp crab	0	0-0.04	0
Pyromaia tuberculata (spider crab)	Infrequent[a]	Absent	0-0.04
Mollusca			
Gastropoda			
Rictaxis punctocoelatus	Infrequent[a]	Unobserved	Unobserved
Aplysia californica, California sea hare	0	0	0-0.04
Balcis sp. (eulimid)	Infrequent[a]	0-0.08	0
Cerithidea sp. (horn shell)	0-0.84	0	0
Epitonium tinctum, tinted wentletrap	0-0.08	0-0.08	0-0.04
Hermissenda crassicornis, sea slug	0-0.04	0	0
Nassarius sp. (basket shell)	0.07-0.37[a]/ 0-0.84	0-0.08	0
Chelidonura inermis, striped sea slug	0	0	0-0.08
Olivella sp. (olive shell)	0-0.08	0-0.08	0-0.04
Armina californica (sea slug)	Infrequent[a]	Unobserved	Unobserved
Polinices reclluzianus, Recluz's moonsnail	0.10[a]	0-0.08	0
Triopha sp. (dorid nudibranch)	0	0	0-0.04
Turbonilla sp. (pyramidellid)	Infrequent	Unobserved	Unobserved
Unidentified dorid nudibranch	0-0.08	0-0.48	0-0.04
Vermetid, probably Serpulorbis squamigerus, scaled worm shell	0	0	0-0.20

IDAL SANDY SUBSTRATES WITHIN THE SAN DIEGO-LA JOLLA
UMBERS GIVEN ARE INDIVIDUALS PER m^2

	Sandy Shelf in Northern Part-- Shallower Than 15 m	La Jolla Canyon Head Shallower Than 15 m	La Jolla Canyon Head 15 m and Deeper
	0-0.72	0	0
	0	0-0.08	0
scallop	0	0	0-0.04
p scallop	0	0-0.08	0-0.20
ly *Parapholas* piddock	0	0	0-10.00
past squid	Unobserved	Unobserved	Unobserved
t octopus	0	0	0-0.04
s animal)	0	0-0.08	0-0.20
probably sp., and	Encrusting on leaves and fronds of algae washed into area		
n sand star	0.04[a]/0.04-0.52	0-0.04	0-0.04
nd star)	Infrequent[a]	Unobserved	Unobserved
a star	0	0	0-0.04
n star	Unobserved	Unobserved	Unobserved
tle star)	0.04-0.16	0-0.04	0
ar)	Infrequent[a]	Unobserved	Unobserved
dollar	More than 10[a]/ 0-0.08	0-0.32	0-0.08
sea urchin	0	0	0-0.20
tato	Infrequent[a]	0	0

APPENDIX 2 (cont.) ORGANISMS OCCURRING ON SUBTIDAL SANDY SUBSTRATES WITHIN THE SAN DIEGO-LA JOLLA ECOLOGICAL RESERVE ASBS. NUMBERS GIVEN ARE INDIVIDUALS PER m^2

Species	Sandy Shelf in Northern Part--Shallower Than 15 m	La Jolla Canyon Head: Shallower Than 15 m	La Jolla Canyon Head: 15 m and Deeper
Urochordata			
Styela sp. (tan stalked tunicate)	0	0-0.08	0-0.84
Styela sp. (brown stalked tunicate)	0	0	0-0.04
Pisces			
Citharichthys stigmaeus, speckled sanddab	0-0.20	0-1.36	0-2.72
Coryphopterus nicholsii, blackcrested goby	0	0-0.16	0.04-3.00
Leuresthes tenuis, grunion	Unobserved	Unobserved	Unobserved
Lythrypnus dalli, bluebanded goby	0	0	0-0.04
Otophidium sp. (cusk-eel)	Unobserved	Unobserved	Unobserved
Paralichthys californicus, California halibut	0	0-0.04	0-0.04
Sebastes spp (rockfish)	0	0	0-1.12
Myliobatis californicus, bat ray	Unobserved	0-0.08	0-0.16
Platyrhinoidis triseriata, thornback	Unobserved	0-0.08	Unobserved
Rhinobatos productus, shovelnose guitar fish	Transient[a]	Unobserved	Unobserved
Squatina californica, angel shark	Unobserved	Unobserved	0-0.04
Torpedo californica, electric ray	Unobserved	Unobserved	Unobserved
Urolophus halleri, round sting ray	Unobserved	0-0.04	0-0.04

[a]From Fager (1968), on a sandy site just north of the Reserve in 5-10 meters of depth

APPENDIX 3 ORGANISMS OCCURRING ON SUBTIDAL ROCKY SUBSTRATES WITHIN THE SAN DIEGO-LA JOLLA ECOLOGICAL RESERVE ASBS. NUMBERS CITED ARE INDIVIDUALS PER m^2

Species	*Phyllospadix* Bed 7-15 ft/ 2-5 m	*Macrocystis* Bed 18-21 ft/ ~6 m	*Egregia* Bed 20-26 ft/ 6-8 m	Boulder Reef Complex 26-34 ft/ 8-10 m
ATTACHED PLANTS				
Chlorophyta (green algae)				
Chaetomorpha sp.	0	0.08	0	0
Codium fragile, Dead man's fingers	0.12	0	0	0.04
Enteromorpha sp.	0.04	0.04	0	0
Ulva sp. (sea lettuce)	0.08	0.08	0.08	0.04
Phaeophyta (brown algae)				
Colpomenia sinuosa	0	0.04	0	0.04
Cystoseira/Halidrys dioica	0.12	Abundant	0.56	0.04-0.72
Dictyopteris zonarioides	0.08	0.04	Unobserved	0.08-0.16
Egregia laevigata, feather-boa kelp	0	0.56-1.00	0.84	0
Eisenia arborea, southern palm kelp	Common	0.48	0.52	0
Laminaria sp.	0	0.04	0.40	0
Macrocystis pyrifera, giant bladder kelp	0	0.16-0.40	0.04	0
Pachydictyon coriaceum	0.24	Common	Unobserved	0.04
Petrospongium rugosum, rock sponge	0	0	0	0.04
Pterygophora californica	0	0	0.16	0
Sargassum agardhianum	0.08	0	0	0
Rhodophyta (red algae)				
Callophyllis sp.	Common	Unobserved	Unobserved	Unobserved
Chondria californica (epiphyte)	Abundant	Abundant	Unobserved	Unobserved
Coralline reds (*Corallina* spp. and *Bossiella* spp., especially)	Abundant	Abundant	Abundant	Abundant
Gelidium purpurascens, agarweed	Common	0.12	0.16	0.10
Gigartina sp.	Few	0.12	0.12	Abundant
Lithothamnium giganteum	0	0.04	0.16	0.08
Melobesia mediocris (epiphyte)	Abundant	Abundant	Unobserved	Unobserved

APPENDIX 3 (cont.) ORGANISMS OCCURRING ON SUBTIDAL ROCKY SUBSTRATES WITHIN THE SAN DIEGO-LA JOLLA ECOLOGICAL RESERVE ASBS. NUMBERS CITED ARE INDIVIDUALS PER m^2

Species	*Phyllospadix* Bed 7-15 ft/ 2-5 m	*Macrocystis* Bed 18-21 ft/ ~6 m	*Egregia* Bed 20-26 ft/ 6-8 m	Boulder Reef Complex 26-34 ft/ 8-10 m
Rhodophyta (red algae)(cont.)				
Plocamium coccineum	Common	0.12	0	0
Porphyra perforata, nori	0	0.04	0	0
Rhodoglossum affine	Common	Unobserved	Unobserved	Unobserved
Flowering plant				
Phyllospadix sp., surf grass	Abundant	Abundant	Rare	0
ANIMALS				
Porifera				
Cliona celata, boring sponge	Common	Common	Common	Common
Haliclona permollis, purple sponge	0.96	0.04	0	Common
Orange, encrusting	0-0.64	0.12-0.32	0.52	Common
Plocamia karykina, red sponge	0	0.04	Few	Few
Spheciospongia confoederata, Pacific loggerhead sponge	0	0	0	Few
Tethya aurantia, orange ball sponge	0	0.04	0	0
White, prob. *Leucosolenia nautilia*	0.48	0.08	0.64	Common
White, prob. *Rhabdodermella nuttingi*	0	0.08	0	0.36
Xestospongia vanilla, vanilla sponge	0.68	0	0.24	0.08
Yellow, prob. *Verongia thiona*, sulfur sponge	0.20-0.36	0	0.04	0
Coelenterata				
Aglaophenia struthionides, ostrich plume	0	Unobserved	Unobserved	Common
Anthopleura xanthogrammica, green anemone	0.08	0.08	0.12	0.04
Astrangia lajollaensis, stony coral	0	0	0	Common
Epiactis prolifera	0.24	0	0	0
Muricea californica, California gorgonian	0	0	0	0.64

APPENDIX 3 (cont.) ORGANISMS OCCURRING ON SUBTIDAL ROCKY SUBSTRATES WITHIN THE SAN DIEGO-LA JOLLA ECOLOGICAL RESERVE ASBS. NUMBERS CITED ARE INDIVIDUALS PER m^2

Species	Phyllospadix Bed 7-15 ft/ 2-5 m	Macrocystis Bed 18-21 ft/ ~6 m	Egregia Bed 20-26 ft/ 6-8 m	Boulder Reef Complex 26-34 ft/ 8-10 m
Mollusca (cont.)				
Pelecypoda				
Hinnites multirugosus, rock scallop	0.08	0	0	Few
Unidentified piddock, prob. Parapholas californica, scale-sided piddock	0.50	0.20	0	Common
Cephalopoda				
Octopus bimaculatus, two-spotted octopus	0	0.04	0	0.08
Ectoprocta (Bryozoa)				
Assorted encrusting species, (prob. Membranipora sp., Bugula sp., Schizoporella unicornis, and Eurystomella bilabiata)	Common	Abundant	Common	Abundant
Diaperoecia californica (moss animal)	0	0	0	0.04
Echinodermata				
Asteroidea				
Astrometis sertulifera, soft sea star	0	0	0	0.04
Pisaster giganteus, knobby sea star	0.30	0	0.08	0.68
Pisaster ochraceus, ochre sea star	0	0.04	0	0.08
Pycnopodia helianthoides, sun star	0	0	0	0.04
Ophiuroidea				
Unidentified brittle stars under rocks	Few	Common	Rare	Common
Echinoidea				
Strongylocentrotus franciscanus, red urchin	0	0.12	0	Common
Strongylocentrotus purpuratus, purple urchin	0	0	0	0.04

APPENDIX 3 (cont.) ORGANISMS OCCURRING ON SUBTIDAL ROCKY SUBSTRATES WITHIN THE SAN DIEGO-LA JOLLA ECOLOGICAL RESERVE ASBS. NUMBERS CITED ARE INDIVIDUALS PER m^2

Species	*Phyllospadix* Bed 7-15 ft/ 2-5 m	*Macrocystis* Bed 18-21 ft/ ~6 m	*Egregia* Bed 20-26 ft/ 6-8 m	Boulder Reef Complex 26-34 ft/ 8-10 m
Echinodermata (cont.)				
Holothurioidea				
Stichopus parvimensis, southern California cucumber	0	0	0	0.48
Urochordata				
Styela clava, brown stalked tunicate	0	0.08	0.04	0.16
Unidentified white colonial tunicate	0	0	0	0.30
Pisces				
Anisotremus davidsonii, sargo	0	0	0	0.04
Atherinops affinis, topsmelt	0	0	0	2.00
Brachyistius frenatus, kelp surf perch	0	0.08	0	0
Cheilotrema saturnum, black croaker	0	0	0	0.04
Chromis punctipinnis, blacksmith	0	0	5.00	1.16
Coryphopterus nicholsii, black crested goby	0	0	0	0.52
Cymatogaster aggregata, shiner surf perch	0	0.08	0	0
Embiotoca jacksoni, blackperch	0.08	0.12	0	0.04
Gibbonsia sp. (kelpfish)	0.04	0	0	0.04
Girella nigricans, opaleye	0	0	0	0.32
Gymnothorax mordax, moray	0	0	0	0.08
Halichoeres semicinctus, rock wrasse	0.04	0.24	0	0.32
Hermosilla azurea, zebraperch	0	0.60	0	0.04
Heterodontus francisci, horn shark	0.04	0	0	0
Heterostichus rostratus, kelpfish	0.04	0.08	0.16	0
Hyperprosopon argenteum, walleye surf perch	0	0	0	0.24
Hypsypops rubicundus, garibaldi	0.24	1.00	0.08	0.80
Medialuna californiensis, halfmoon	0	0	0	0.16

S OCCURRING ON SUBTIDAL ROCKY SUBSTRATES WITHIN THE SAN DIEGO-LA JOLLA
L RESERVE ASBS. NUMBERS CITED ARE INDIVIDUALS PER m^2

ecies	Phyllospadix Bed 7-15 ft/ 2-5 m	Macrocystis Bed 18-21 ft/ ~6 m	Egregia Bed 20-26 ft/ 6-8 m	Boulder Reef Complex 26-34 ft/ 8-10 m
lifornica, senorita	0.04	1.00	2.16	1.52
clathratus, kelp bass	0.12	0.20	0.44	0.60
maculatofasciatus, bass	0	0	0	0.04
nebulifer, sand bass	0	0	0	0.24
furcatus, white surfperch	0	0	1.00	0
on pulchrum, sheepherd	0	0	0	0.36
uttata, sculpin	0	0	0.04	0.12
rovirens, kelp rockfish	0	0	0	0.08
rriceps, treefish	0	0	0	0.08
aliforniensis, salema	0	0.08	0	0

APPENDIX 4 ORGANISMS OCCURRING IN THE ROCKY INTERTIDAL SUBSTRATE OF THE SAN DIEGO-LA JOLLA ECOLOGICAL RESERVE ASBS. NUMBERS GIVEN ARE INDIVIDUALS PER m^2

Species	Abundance
ATTACHED PLANTS	
Chlorophyta (green algae)	
Chaetomorpha, sp.	Common
Codium fragile, dead man's fingers	Few
Enteromorpha sp.	Abundant
Ulva sp. (sea lettuce)	Common
Phaeophyta (brown algae)	
Colpomenia sinuosa	Common
Cystoseira/Halidrys	Rare
Eisenia arborea, southern plam kelp	Rare
Pachydictyon coriaceum or Dictyota flabellata	Common
Pelvetia fastigiata	Abundant
Petrospongium rugosum, rock sponge	Few
Sargassum agardhianum	Common
Scytosiphon lomentaria (?)	Abundant
Rhodophyta (red algae)	
Chondria californica (epiphyte)	Common
Coralline reds (Corallina spp. and Bossiella spp., especially)	Abundant
Crustose reds	Abundant
Gelidium sp. (agarweed)	Few
Gigartina sp.	Common
Melobesia mediocris (epiphyte)	Common
Plocamium coccineum	Common
Flowering plants	
Phyllospadix spp., surfgrass	Abundant
ANIMALS	
Porifera (sponges)--not evaluated but present	
Coelenterata/Anthozoa	
Anthopleura elegantissima, aggregate sea anemone	Abundant
Anthopleura xanthogrammica, green anemone	Common

APPENDIX 4 (cont.) ORGANISMS OCCURRING IN THE ROCKY INTERTIDAL SUBSTRATE OF THE SAN DIEGO-LA JOLLA ECOLOGICAL RESERVE ASBS. NUMBERS GIVEN ARE INDIVIDUALS PER m^2

Species	Abundance
Annelida/Polychaeta	
Eupomatus gracilis, calcareous tube worm	Common
Phragmatopoma californica, colonial sandy-tubed worm	Abundant
Spirorbis spp.	Common
Unidentified serpulid tube worm	Common
Arthropoda/Crustacea	
Balanus glandula, Pacific acorn barnacle	Common
Balanus tintinnabulum, red and white barnacle	Few
Chthamalus fissus, buckshot barnacle	6,000-270,000
Cirolana harfordi, dark-backed isopod	Few
Ligia occidentalis, rock louse	Few
Pachygrapsus crassipes, striped shore crab	Common
Pagurus hirsutiusculus, hairy hermit crab	Few
Pagurus samuelis, blue-clawed hermit crab	Common
Panulirus interruptus, California spiny lobser	Rare
Petrolisthes sp.	Few
Pollicipes polymerus, gooseneck barnacle	Common
Tetraclita squamosa, thatched barnacle	Few
Mollusca	
Polyplacophora	
Unidentified chitons (*Nuttalina fluxa* and *Mopalia* spp.)	Few
Gastropoda	
Acmaea spp. and *Collisella* spp. (limpets)	700-1400
Aplysia californica, sea hare	Few
Crepidula onyx, onyx slipper shell	Few
Flabellina iodinea, violet sea slug	Rare
Haliotis cracherodii, black abalone	Rare
Haliotis fulgens, green abalone	Very rare
Littorina spp. (periwinkle)	Abundant
Lottia gigantea, owl limpet	400-800
Navanax inermis, striped sea slug	Rare
Olivella biplicata, purple olive	Few
Tegula funebralis, black turban	Common
Thais emarginata, dogwinkle	Few

APPENDIX 4 (cont.) ORGANISMS OCCURRING IN THE ROCKY INTERTIDAL SUBSTRATE OF THE SAN DIEGO-LA JOLLA ECOLOGICAL RESERVE ASBS. NUMBERS GIVEN ARE INDIVIDUALS PER m^2

Species	Abundance
Mollusca (cont.)	
Pelecypoda	
Mytilus californianus, California mussel	Abundant
Unidentified clam, prob. *Diplodonta orbella*, Pacific orb	Few
Ectoprocta (Bryozoa)--not evaluated, but present	
Echinodermata	
Asteroidea	
Astrometis sertulifera, soft sea star	Rare
Patiria miniata, bat star	Rare
Pisaster giganteus, knobby sea star	Rare
Pisaster ochraceus, ochre sea star	Rare
Ophiuroidea	
Unidentified brittle stars	Common
Echinoidea	
Strongylocentrotus purpuratus, purple urchin	Few
Holothurioidea	
Stichopus parvimensis, sea cucumber	Few
Pisces	
Clinocottus analis, wooly sculpin	Common
Girella nigricans, opaleye	Few
Heterostichus rostratus, kelpfish	Rare
Hypsypops rubicundus, garibaldi	Very rare
Aves	
Calidris alba, Sanderling	Few
Larus occidentalis, western gull	Common
Limosa fedoa, marbled godwit	Few
Melanitta perspicillata, surf scoter	Rare
Pelecanus occidentalis, Brown pelican	Few
Phalacrocorax penicillatus, Brandt's cormorant	Rare