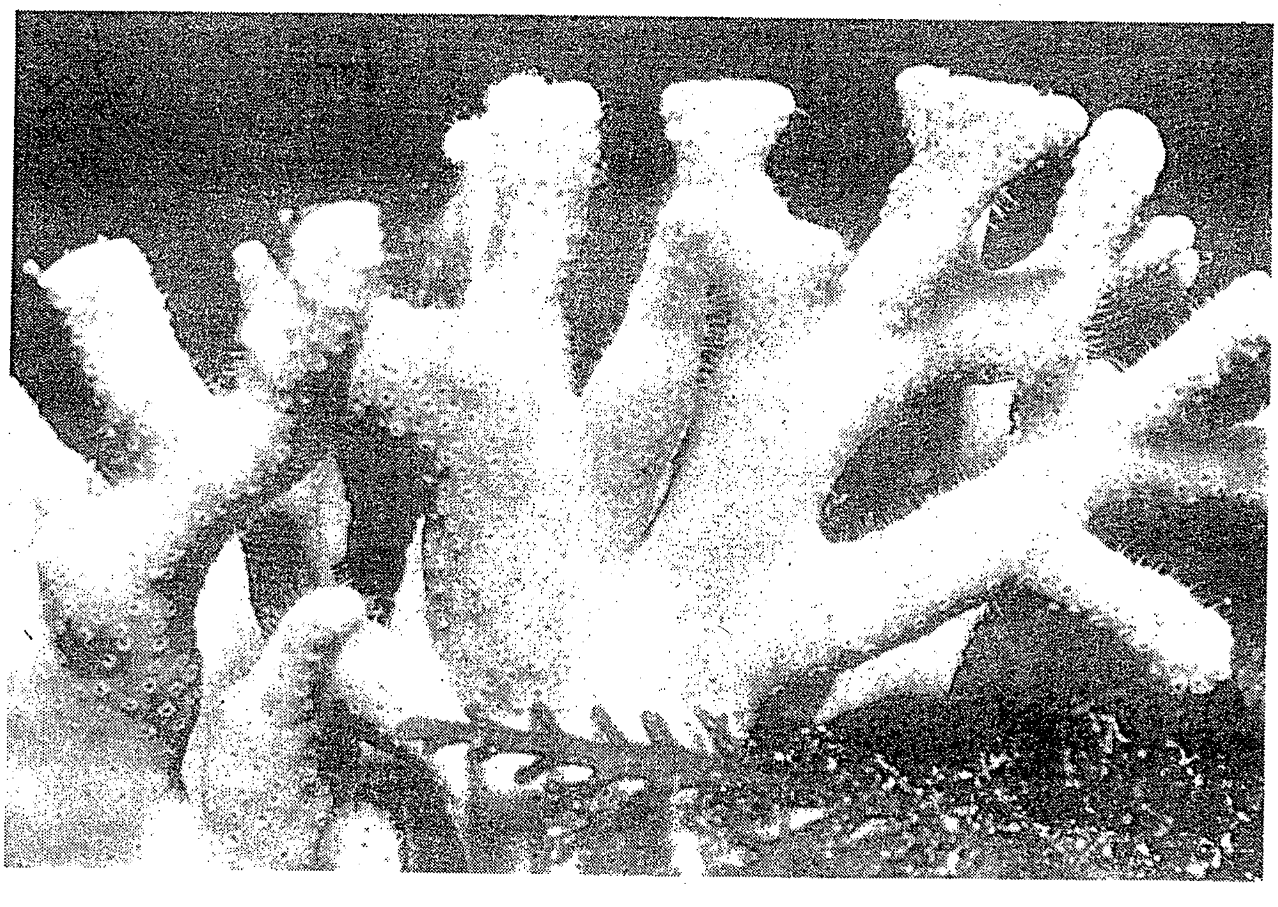
California Marine Waters
Areas of Special Biological Significance
Reconnaissance Survey Report

SANTA CATALINA ISLAND-
SUBAREA THREE FARNSWORTH BANK ECOLOGICAL RESERVE
Los Angeles County



CALIFORNIA STATE WATER RESOURCES CONTROL BOARD

SURVEILLANCE AND MONITORING SECTION

September 1981

WATER QUALITY MONITORING REPORT NO. 81-4

Cover Photograph:

Purple Hydrocoral, Allopora californica

found on

Santa Catalina Island-Subarea III

Farnsworth Bank Ecological Reserve

Printed October 1981

CALIFORNIA MARINE WATERS

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RECONNAISSANCE SURVEY REPORT

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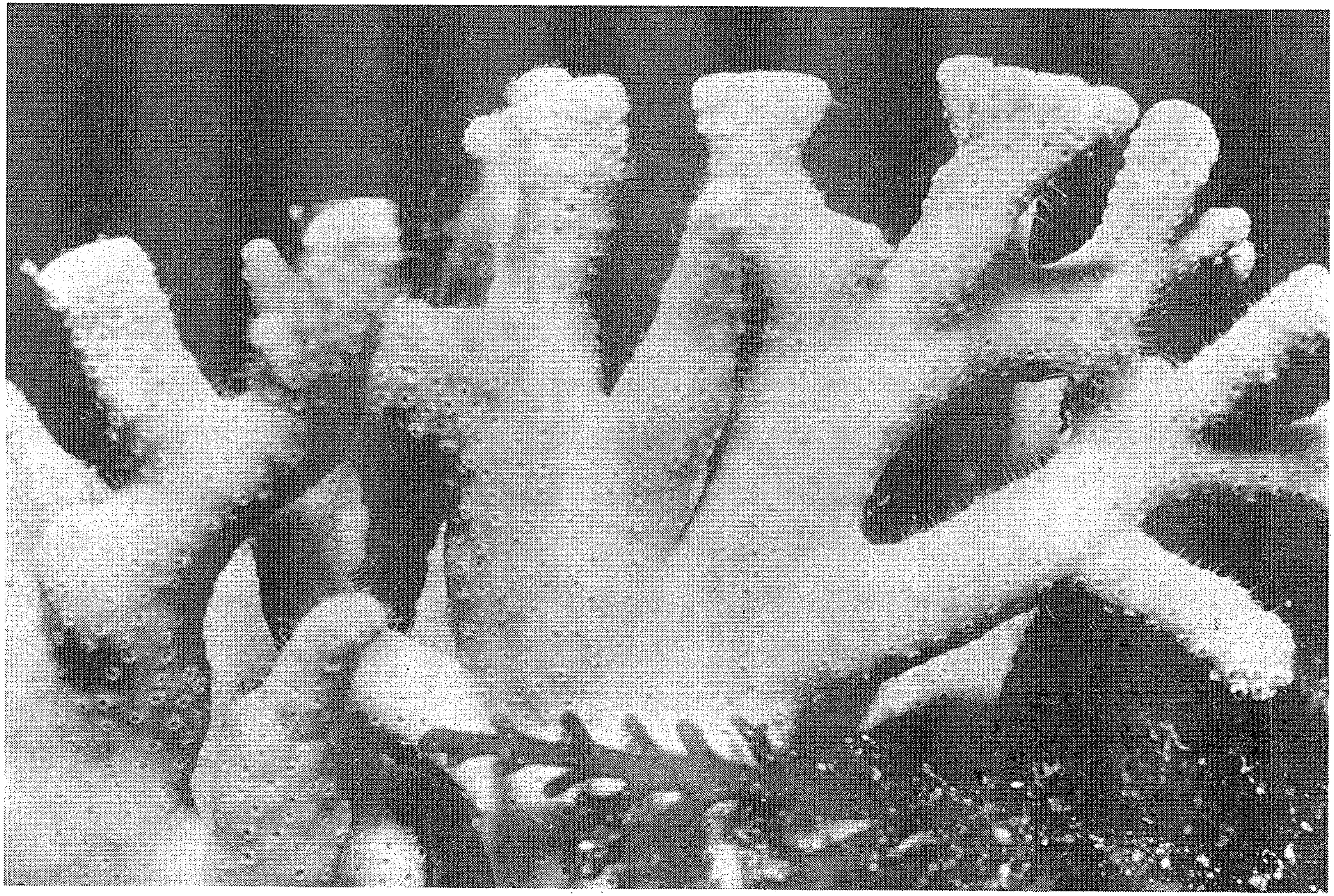

Purple Hydrocoral, *Allopora californica* Found on Santa Catalina Island-Subarea III
Farnsworth Bank Ecological Reserve Area of Special Biological Significance

STATE WATER RESOURCES CONTROL BOARD

AREAS OF SPECIAL BIOLOGICAL SIGNIFICANCE

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

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

ACKNOWLEDGMENT

This State Water Resources Control Board Report is based on a reconnaissance survey report submitted by Drs. John M. Engle and James A. Coyer of the Los Angeles County Museum of Natural History. The latter report was prepared in fulfillment of an agreement with the California Department of Fish and Game, which has coordinated the preparation of a series of Areas of Special Biological Significance Survey Reports for the Board under an Interagency Agreement.

ABSTRACT

Santa Catalina Island ASBS Subarea III, the Farnsworth Bank Ecological Reserve, is composed of an underwater group of rocky pinnacles, 1.5 mi southwest of Ben Weston Point on the southwestern side of Catalina (33°21'N, 118°31'W). It is the only ASBS that is completely submerged, rising from a sandy substrate in approximately 250 ft of water to within 50 ft of the surface. Farnsworth Bank occupies an area approximately 1725 x 600 ft totaling nearly 14 acres. Only the Bank and the overlying waters are included in the ASBS.

The high diversity of algal, invertebrate, and fish communities on Farnsworth can be attributed largely to the physical conditions characteristic of an offshore bank habitat: vigorous water motion, clean water free of coastal sediments, and localized upwelling. Several species found at the Bank are rare or absent around nearby Catalina Island; some of these occurrences represent range extensions of distributions centered further north or south.

The purple hydrocoral, *Allopora californica*, is very abundant on Farnsworth Bank, and its protection is the sole reason for designating the Bank as an Ecological Reserve. The Farnsworth population is unique among the seven known locations for *Allopora* in southern California because of the high densities and the large sizes of colonies.

Commercial fishing generally does not occur within the ASBS but does occur in adjacent areas. Net fishing is the most popular activity, and a few nets have been accidentally snagged and abandoned on the Bank. Moderate amounts of sportfishing occur, primarily from small private vessels. Sportdiving is popular on Farnsworth during summer months, and most dives originate from commercial passenger sportdiving vessels.

No threats to water quality are evident, as point and non-point sources

of pollution are not present within or adjacent to the ASBS. However, threats to the health and survival of the purple hydrocoral population include damage caused by boat anchors and chains, breakage or illegal collecting by scuba divers, and destruction or smothering by abandoned commercial fishing nets.

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Findings

1. Santa Catalina Island ASBS Subarea III (Farnsworth Bank) is composed of an underwater group of sheer rocky pinnacles, located 1.5 mi (2.4 km) southwest of Ben Weston Point. It is the only ASBS not bound by shoreline.

2. The diversity of algal, fish, and especially invertebrate communities on Farnsworth Bank is high. A number of species, including purple hydrocoral (*Allopora californica*) and its obligate commensals, have not been found elsewhere around Catalina Island. Occurrences of some species on Farnsworth represent unusual range extensions of distributions normally centered further north or south. The assemblage of marine organisms at Farnsworth collectively is quite different from Catalina's nearshore kelp/rock habitats and is unique to the few exposed, offshore bank habitats in southern California.

3. Farnsworth Bank was declared an Ecological Reserve in 1973 by the California Fish and Game Commission, solely to provide special protection for the dense population of purple hydrocoral. This protection is justified, as Farnsworth Bank is one of only a few areas in southern California where *Allopora* is found, and because it apparently grows at a very slow rate (0.3 in/yr).

4. Subtidal sediments adjacent to Subarea III have trace metal concentrations almost as high as for Los Angeles/Long Beach Harbor, but very low amounts of petroleum hydrocarbons and pesticides. The major sources of these contaminants presumably are the sewer outfalls on the mainland and airborne particles

from the Los Angeles Basin. Other sources of pollution in or near Subarea III are negligible.

5. Several threats to the purple hydrocoral population are evident. The most serious is damage caused by boat anchors and chains. Farnsworth is visited by a number of boats during the summer months, and all anchor on the shallow portion of the Bank. The setting of an anchor cause a great deal of initial damage to the fragile hydrocoral. Even more damage is caused by swing of the chain during anchorage. Patterns of broken coral observed during the present survey are mute evidence of this type of destruction. Fishermen on private boats are less of a threat, as most simply drift over or through the area. Another source of destruction is scuba divers. The brittle branches are easily broken by divers' knees and fins, and although it is illegal to collect Allopora, divers often pick up pieces of broken coral, and a few remove large, living colonies. Commercial fishing nets that are snagged and abandoned on the Bank present a third source of destruction. Large numbers of coral heads can be broken and destroyed as a net is dragged over the Bank. Furthermore, unbroken coral covered by an abandoned net is likely to die, as the coral requires direct exposure to clean and vigorously moving water.

Conclusions

1. The findings of this survey suggest that water-quality protection in the ASBS appears adequate; however, the purple hydrocoral is threatened by recreational diving and commercial fishing activities on Farnsworth Bank, and these impacts should be monitored. It is recommended strongly that alternatives to anchoring directly on the Bank be developed. A permanent mooring

established on the Bank would reduce destruction caused by anchoring but would require periodic maintenance and may increase diving activity by private vessels. Another solution may be to select an "Anchor Drop Zone" and require all vessels to anchor only within this zone.

2. The growth rate of <u>Allopora</u> is extremely slow; thus increased destruction of adults on Farnsworth Bank will have a devastating effect on the population. The impact of current destructive activities should be monitored, and this program should include a detailed investigation of the distribution, life history, and population dynamics of purple hydrocoral. The Farnsworth population has never been examined with this level of detail.

3. Considering the small area of Farnsworth Bank, its unique species assemblage, and its popularity for recreational diving, the findings of the survey suggest that regulations relating to the Farnsworth Bank Ecological Reserve should be expanded to provide protection for all algae, invertebrates, and fishes within the immediate area of the Bank. With this level of protection, Farnsworth Bank can be preserved in a natural state for scientific study and recreational diving now and in the future.

INTRODUCTION

The California State Water Resources Control Board, under its Resolution No. 74-28, designated certain Areas of Special Biological Significance (ASBS) in the adoption of water quality control plans for the control of wastes discharged to ocean waters. To date, thirty-four coastal and offshore island sites have been designated ASBS. The ASBS are intended to afford special protection to marine life through prohibition of waste discharges within these areas. The concept of "special biological significance" recognizes that certain biological communities, because of their value or fragility, deserve very special protection that consists of preservation and maintenance of natural water quality conditions to practicable extents (from State Water Resources Control Board's and California Regional Water Quality Control Boards' Administrative Procedures, September 24, 1970, Section XI. Miscellaneous--Revision 7, September 1, 1972).

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

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

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

3. Discharge of wastes from nonpoint sources, including but not limited to storm water runoff, silt and urban runoff, will be controlled to the extent

practicable. In control programs for wastes from nonpoint sources, Regional Boards will give high priority to areas tributary to ASBS.

4. The Ocean Plan, and hence the designation of Areas of Special Biological Significance, is not applicable to vessel wastes, the control of dredging, or the disposal of dredging spoil.

In order for the State Water Resources Control Board to evaluate the status of protection of Santa Catalina Island ASBS Subarea III, a reconnaissance survey integrating existing information and additional field study was performed by Drs. John M. Engle and James A. Coyer, Los Angeles County Museum of Natural History. The survey report was one of a series prepared for the State Board under the direction of the California Department of Fish and Game and provided the information compiled in this document.

Reasons for Designating the Area of Special Biological Significance

The recommendations of the Ocean Advisory Committee to the California Regional Water Quality Control Board, Los Angeles Region, state the rationale for designation of the Farnsworth Bank Ecological Reserve as Santa Catalina Island Subarea III ASBS:

> "Has been recently declared an Ecological Reserve by the California Department of Fish and Game for the protection of purple coral (Allopora californica). This is an outstanding example of an offshore bank, rising abruptly from depths of 40 fathoms to 8 fathoms. The bank is best known for the extensive growths of purple coral and for the unique biological communities associated with banks."

ORGANIZATION OF THE SURVEY

This project summarized existing data to describe the physical, chemical, and biological aspects of Santa Catalina Island ASBS Subarea III, the Farnsworth Bank Ecological Reserve. Current patterns of water use, actual or potential pollution threats, and special water quality requirements also were addressed. As this ASBS is not bound by shoreline, no intertidal aspects exist.

The biological and geological descriptions of Farnsworth were based primarily on the results of an extensive diving survey conducted from 28 November through 4 December 1979 by Drs. John M. Engle and James A. Coyer. These investigators have resided at the Catalina Marine Science Center on Catalina Island since 1972 and are thoroughly familiar with the marine communities of Catalina. This background has enabled them to compare the species assemblages of Farnsworth to those found in other areas surrounding Catalina.

Assisting the investigators on this survey were Lisbeth Hart (algae), Drs. David Hadley and Robert Hart (geology), and several USC and UCLA graduate students from the Catalina Marine Science Center. Divers and diving activities were based from the R/V Cormorant.

Reconnaissance dives covered a large area of Farnsworth Bank, but were restricted to a maximum depth of 100 ft (30 m). From 0800-1000 on each morning of the survey, each dive team made a single dive on the Bank. A total of 38 person-dives were logged during the seven-day survey. From late morning to early evening, reconnaissance dives were conducted in Subareas II or IV;

results from these surveys are discussed in another report.

Before each dive, the following were recorded from the *Cormorant*: 1) tidal height and direction, 2) sea state, 3) weather, 4) current strength and direction, 5) surface water temperature, and 6) water visibility (Appendix 1). Underwater, the habitats were described (some were photographed), bottom temperatures were recorded, and depth of the thermocline was noted. Algae, macroinvertebrates, and fishes were identified (some were photographed), and abundances were estimated on a relative scale from 1 (rare) to 4 (abundant). Unknown organisms were collected and preserved for later identification and eventual storage at USC's Allan Hancock Foundation (algae) or the Catalina Marine Science Center (invertebrates).

Each evening, all divers were debriefed on the day's activities by the investigators. Information recorded during the day was discussed and transferred to permanent data books. Overall impressions were recorded by each investigator.

Photographs and field notes are archived at the State Water Resources Control Board.

PHYSICAL AND CHEMICAL DESCRIPTION

General Description

Santa Catalina Island, the easternmost of the eight Channel Islands, lies about 21 miles southwest of Los Angeles Harbor, but is within the continental borderland (Fig. 1). It is bounded on the east by the San Pedro Basin and on the west by the Santa Catalina Basin. The island is irregularly shaped, 22 mi (35 km) long, 8 mi (13 km) at its greatest width, 0.5 mi (0.8 km) at the narrowest point (Isthmus), and 76 mi^2 (48,438 acres) in area.

Santa Catalina ASBS Subarea III, the Farnsworth Bank Ecological Reserve, is composed of an underwater group of sheer rocky pinnacles located 1.5 mi (2.4 km) southwest of Ben Weston Point (Fig. 2). It is the only ASBS not bound by shoreline and is called a bank because it is a rock outcropping of intermediate depth, neither deeper than 600 ft (180 m) nor shallow enough to pose a threat to passing ships. It was named in honor of George Farnsworth, a fisherman from nearby Avalon, who guided fishing parties to the Bank in the early 1900s. Farnsworth Bank was declared an Ecological Reserve on 2 March 1973 by the California Department of Fish and Game.

Catalina and its offshore banks and islets were formed by the emergent portion of an elevated northwest-trending fault block, rising a mile above the ocean floor. Consequently, they are oriented in a northwest/southeast direction, and the island is traversed from end to end by a single main ridge which is unbroken except at the Isthmus. This ridge ranges from 1500-2100 ft (457-640 m) and effectively divides the island into a windward (southwest)

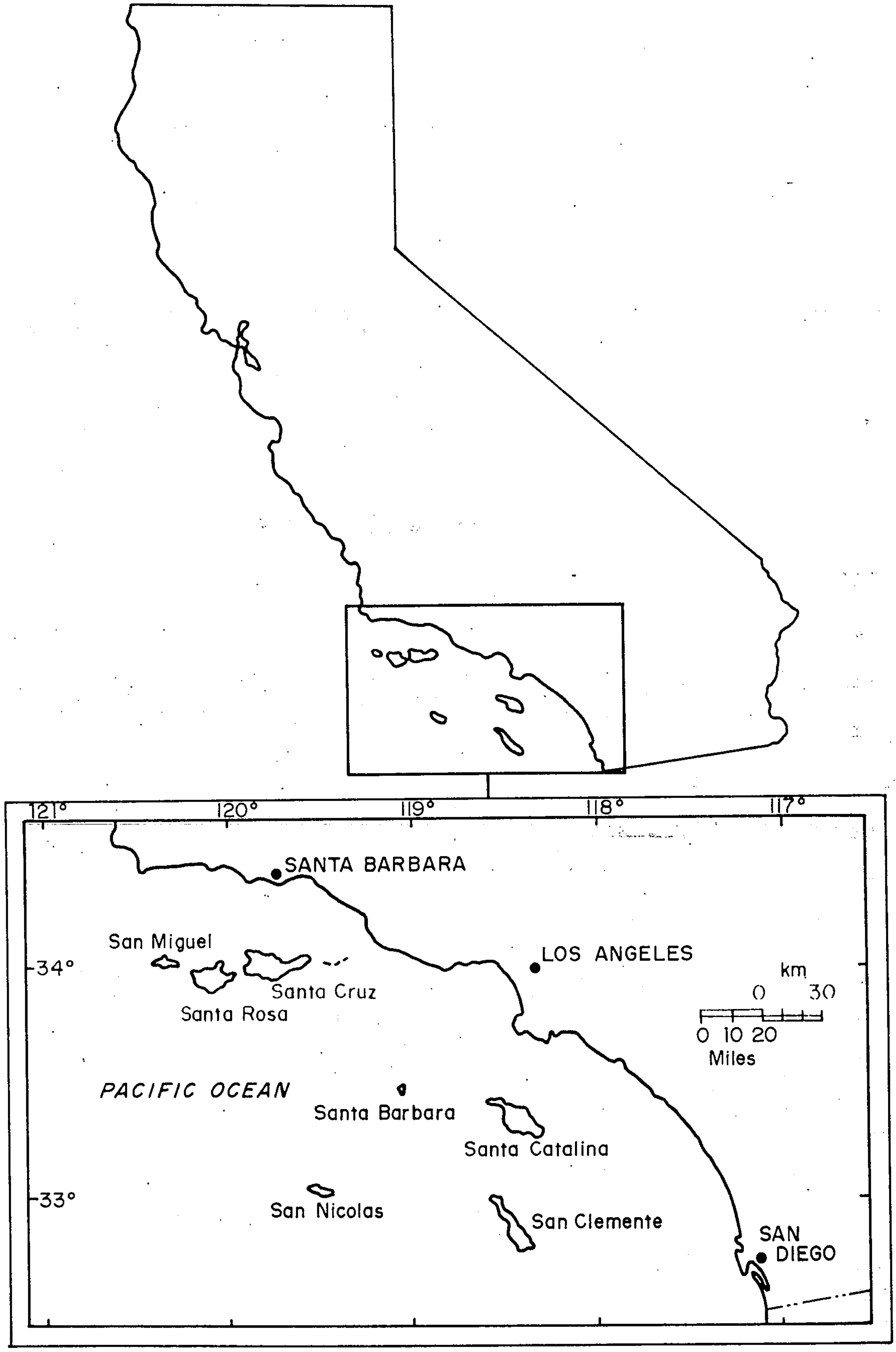

Figure 1: General Location of Santa Catalina Island.

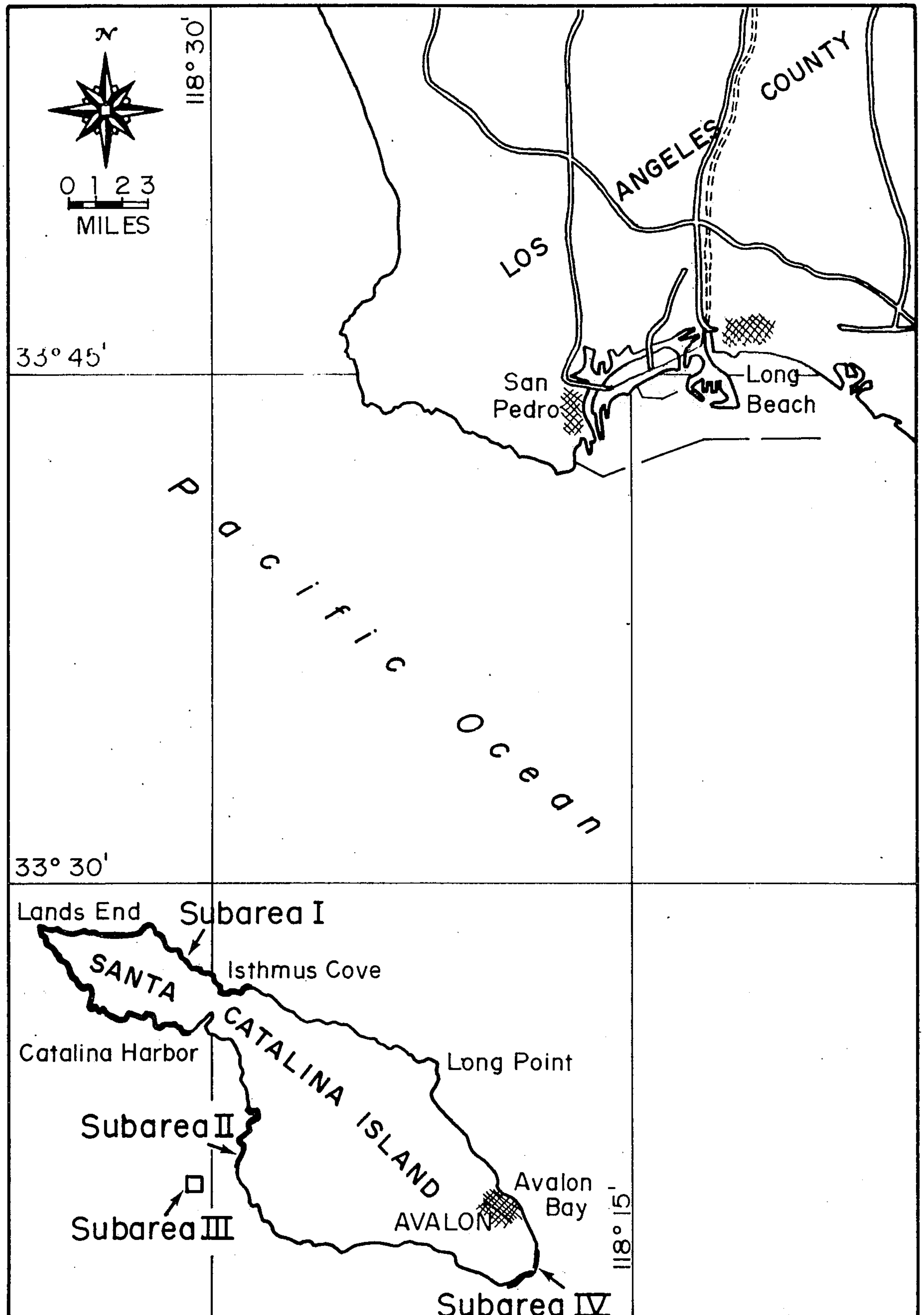

Figure 2: Locations of Santa Catalina Island Subareas I, II, III, and IV.

aspect directly affected by the open Pacific and a leeward side (northeast) which is relatively protected. The leeward side has far more sheltered coves and sandy beaches than the windward side.

The island is rugged and mountainous throughout, intersected by numerous steep-sided canyons and ravines. The shoreline consists largely of precipitous seacliffs 200-1400 ft (61-427 m) in height, which are somewhat reduced and less extensive on the leeward side. Underwater, Catalina is surrounded by a narrow shelf extending offshore. Farnsworth Bank lies on the windward shelf, which has an average width of 1.2 mi (2 km).

The island and offshore banks and islets are part of Los Angeles County. Avalon is the only city on the island and is supported primarily by tourism. The population is approximately 1800 during the winter, but can approach 10,000 on major summer weekends. A small community is located at the Isthmus, where approximately 200 permanent residents maintain recreational facilities for a summertime population of 3500.

Location and Size

Santa Catalina Island ASBS Subarea III, the Farnsworth Bank Ecological Reserve (33°20'40"N, 118°31'00"W) is located 1.5 mi (2.4 km) southwest (240° True) of Ben Weston Point, Catalina Island or 5.7 mi (9.1 km) south (174° True) of Catalina Harbor (Fig. 3). The Bank rises from the sandy ocean bottom in approximately 250 ft (75 m) of water to within 50 ft (15 m) of the surface. It occupies an area approximately 1725 x 600 ft (525 x 180 m), totaling approximately 14 acres (5.7 ha). Only the overlying waters within the boundary of the Reserve are included in the ASBS.

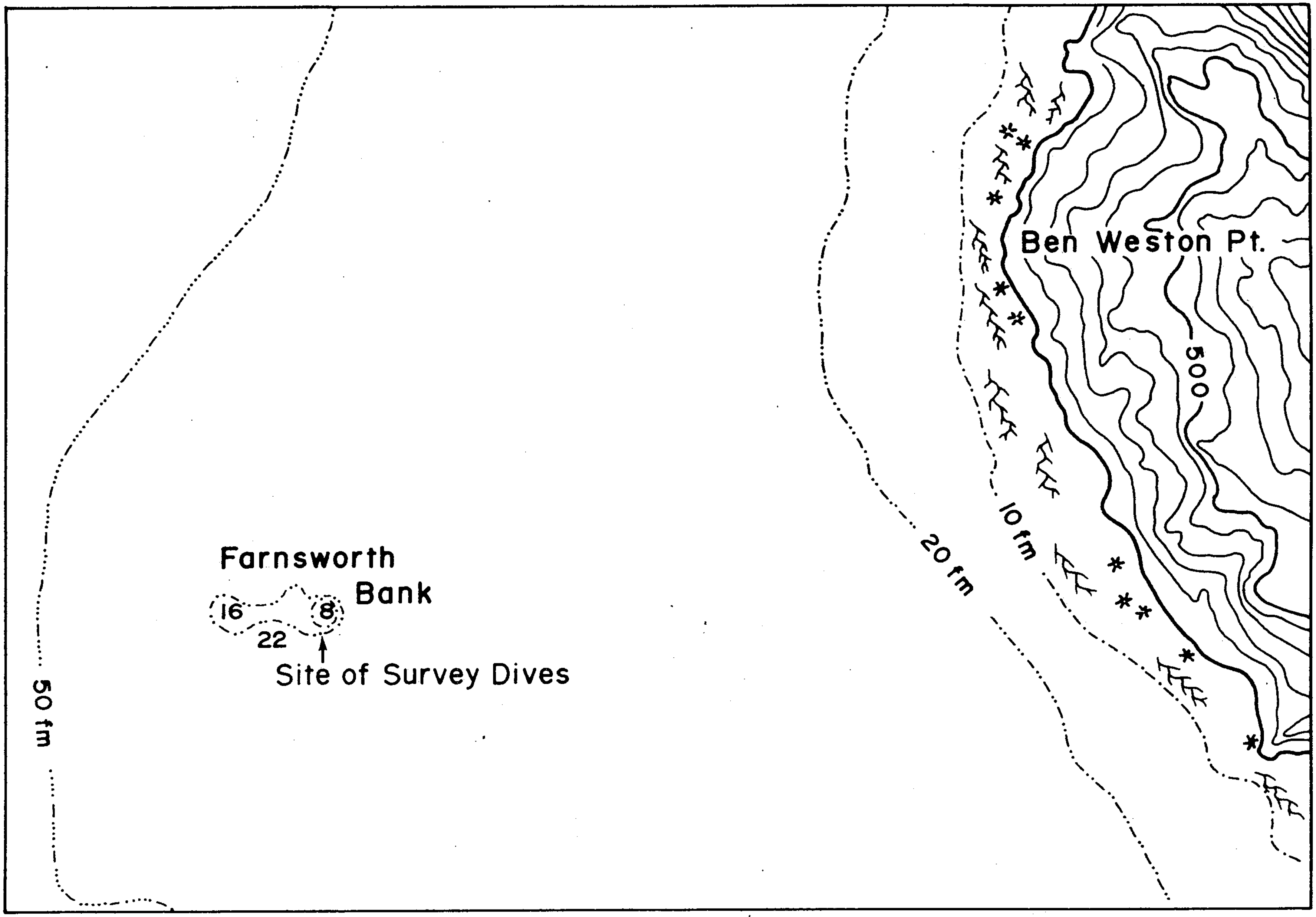

Figure 3: Position of Subarea III (Farnsworth Bank) relative to Ben Weston Point.

Nearshore Waters

Currents

General. Surface water circulation within the nearshore waters of Catalina Island is complex. It is influenced by interactions between major oceanic or geostrophic currents within the Southern California Bight and by local phenomena such as winds, swells, and tides.

The major geostrophic current influencing surface water flow along the California coast is the California Current. This cold-water current originates near the Canadian border and slowly flows in a southeasterly direction along the western coast of North America (Fig. 4). At Pt. Conception, California, the coastline assumes an east/west configuration, while the edge of the outer continental slope continues in a generally south-southeasterly direction. When the California Current reaches Pt. Conception, it divides into two general flows. A nearshore flow extends eastward at San Miguel Island and part of this water mass continues southeast along the coastline.

The major flow, however, continues south, well off the coast of southern California and beyond the outer Channel Islands. A portion of this flow is deflected eastward, then northward through the southern Channel Islands. This return flow is the Southern California Countercurrent, and it creates a large eddy or counterclockwise gyre within the Bight.

As the northerly flowing Countercurrent approaches the northern Channel Islands, a portion moves east and joins the nearshore flow of the California Current. This combined water mass moves southeastward along the coast beyond the Mexican border where it eventually rejoins the main portion of the California Current.

When the Countercurrent is well established in summer and fall, surface

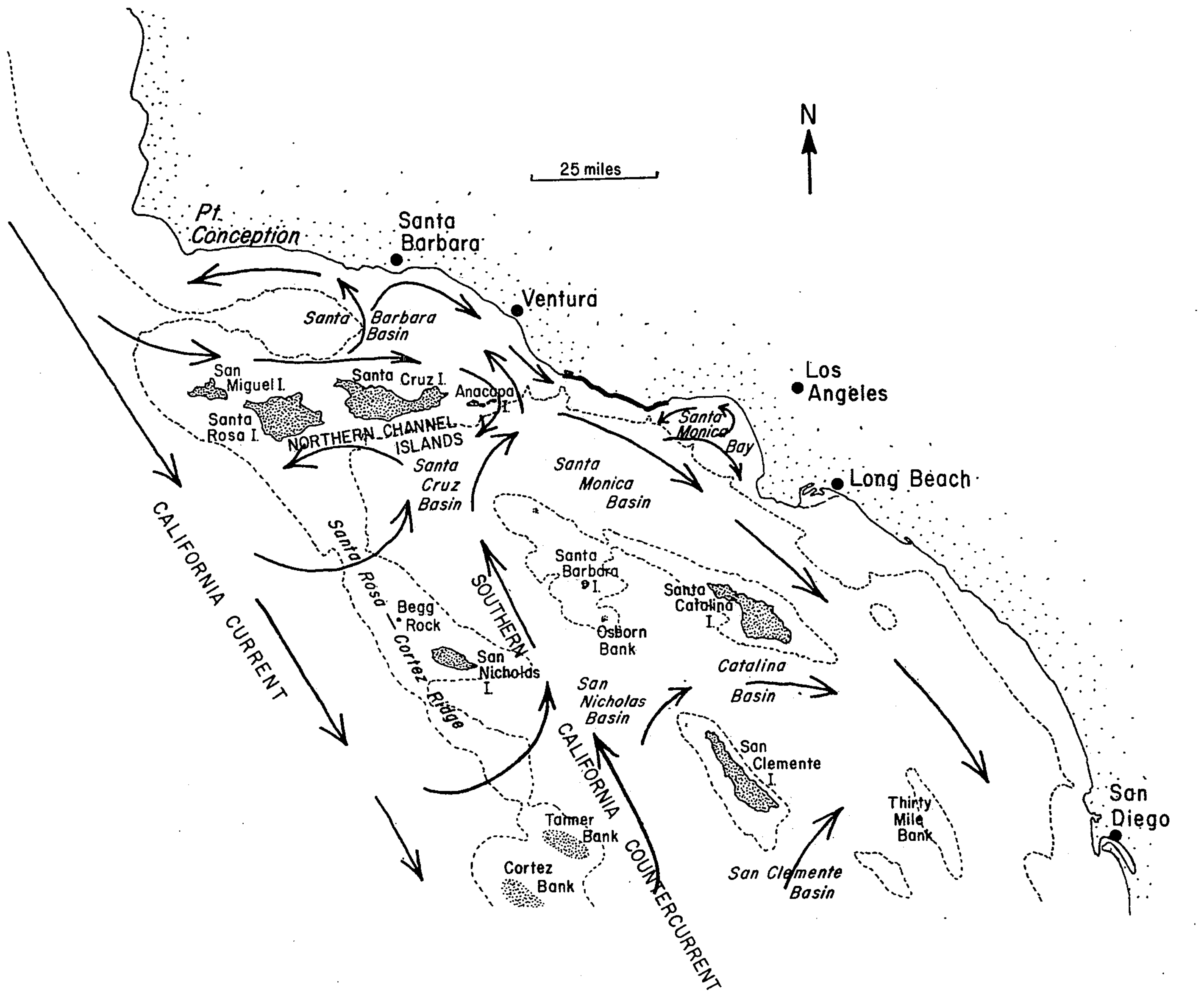

Figure 4: Major oceanic surface current patterns within the Southern California Bight (from Morin and Harrington 1979).

flow is primarily northwesterly along the windward coast of Catalina, including the Subarea III. Superimposed on this general flow, however, are surface currents induced by the prevailing westerly winds and swells (Figs. 5, 6). During summer and fall, the gentle morning westerlies increase in intensity by early afternoon, augmented by the normal onshore sea breezes. This generates short-period wave chop in a southeasterly direction over Subarea III, but the waves rarely are large. The winds and waves are reduced in the evening, and the whole cycle is repeated the next day.

Additionally, tropical storms or "Chubascos" regularly occur during summer and fall off Mexico and Central America, with 1-2 each year generating significant swells in the Bight. These southerly swells pass over Subarea III, conflict with local wind- and swell-induced currents, and create an unpredictable sea. On rare occasions, the storms have appeared as far north as southern California, subjecting south-facing coastlines and other areas to high winds and waves.

Violent north and northeast winds called Santa Anas occasionally blow across the southern California landmass and out to sea from late fall to spring. These hot and dry winds are very strong, sometimes exceeding 100 mph in the canyons on the mainland and persist for 1-12 days. On Catalina, gusts up to 50 mph and the steady north-northeast winds strongly influence surface circulation all along the northeastern coastline. Santa Anas do not affect Subarea III as the winds are shallow or low-lying and are blocked by the Catalina landmass.

The Countercurrent is reduced in winter and spring, and during these periods surface flow is determined largely by prevailing winds. In the spring, "Pacific" storms with violent northwest winds from 25-50 mph commonly last for days.

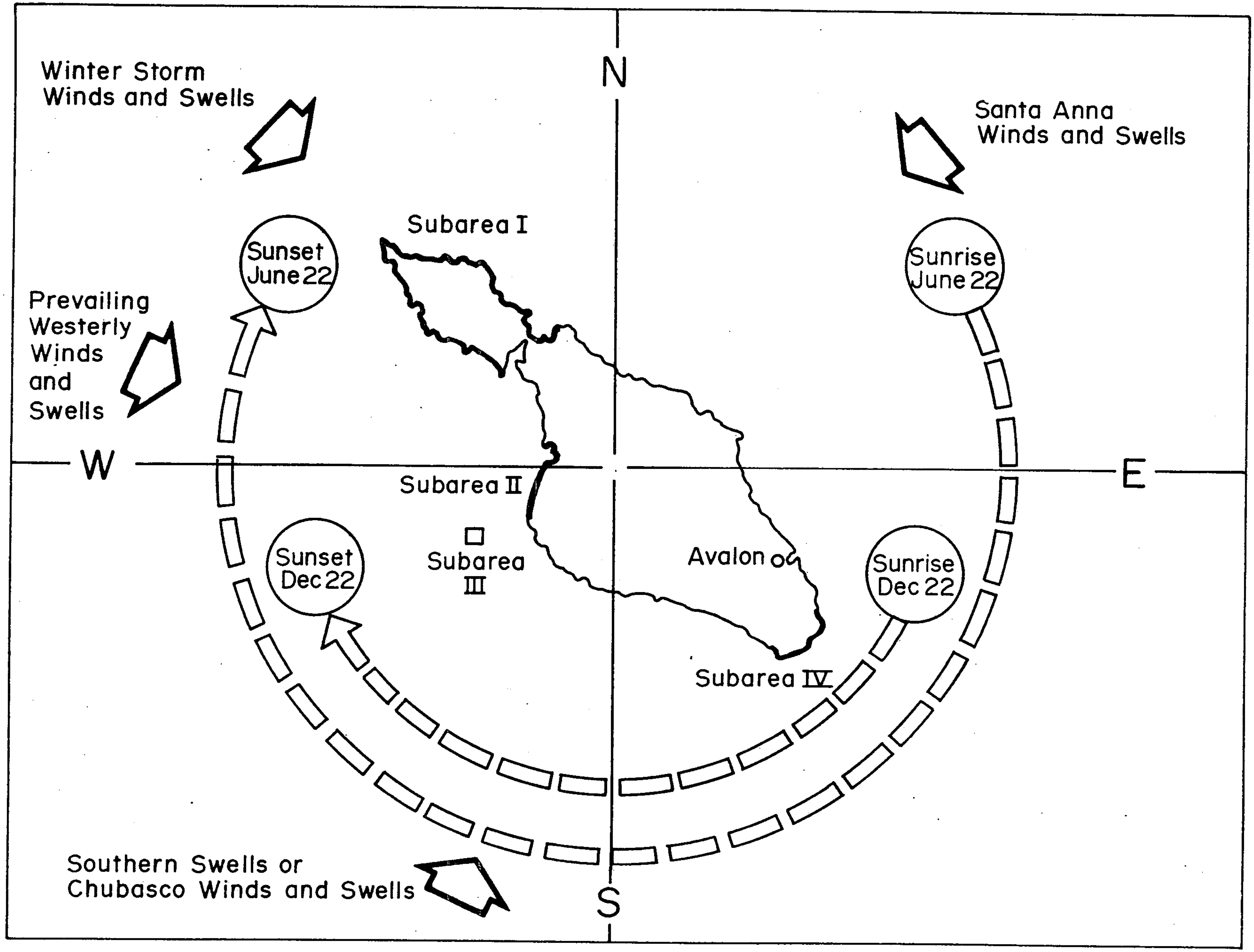

Figure 5: Position of Santa Catalina Island and Farnsworth Bank relative to seasonal winds, swells, and sun positions (from Center for Nat. Areas 1976).

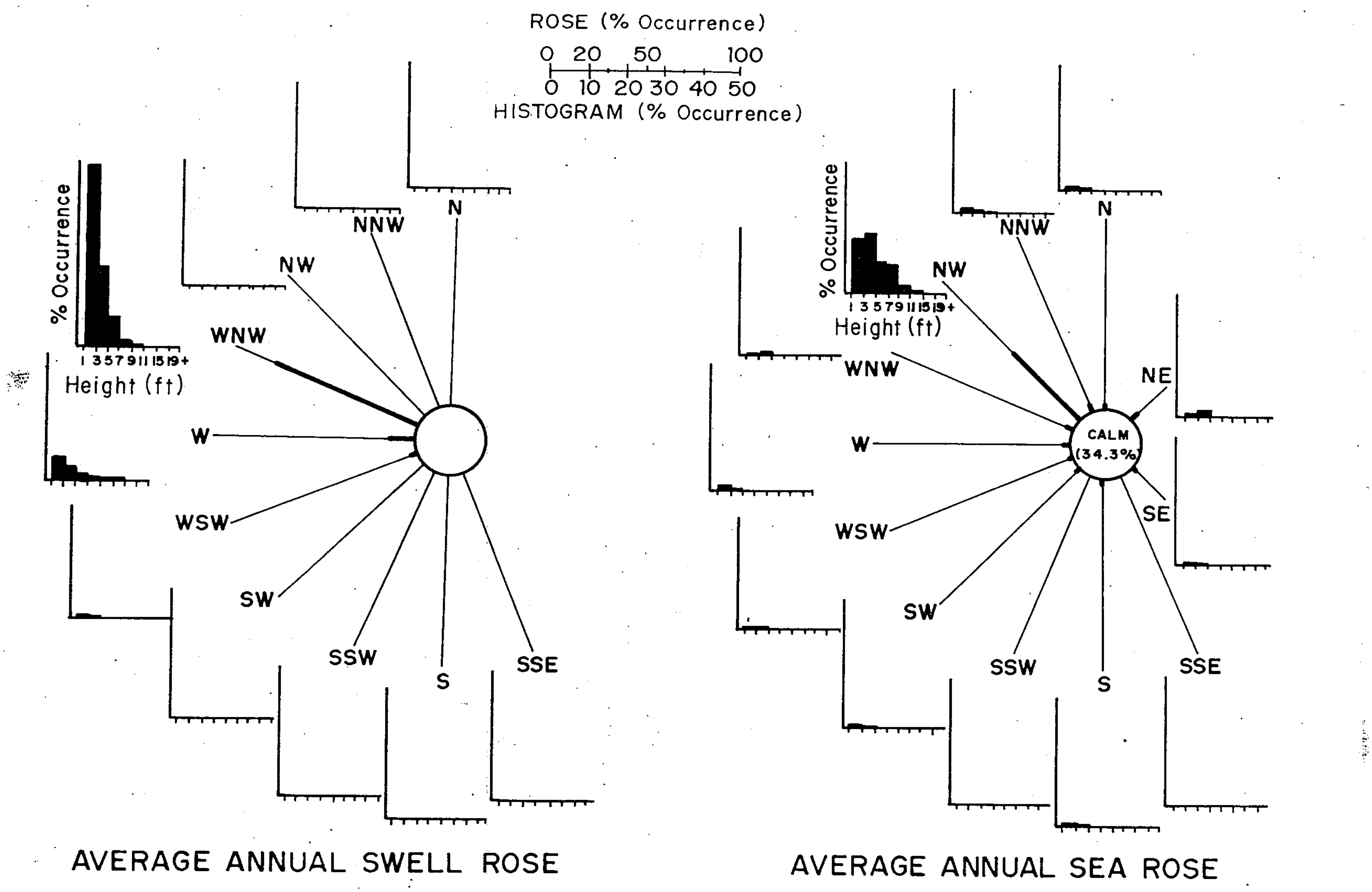

Figure 6: Average annual swell and wind roses for an area 14 nmi west of Santa Catalina Island and Farnsworth Bank. Data are from Nat. Mar. Cons. Station 7 (33.5°N, 119.5°W).

The entire southwestern coast of Catalina is affected, including Subarea III.

The general description of surface flow was synthesized from Emery (1960), Jones (1971), Fay (1972), Water Quality Control Plan Report (1975), and Hendricks (1977).

Tides can have a major effect on surface currents. The most obvious influence is movement of water on- and offshore as the tide rises and falls. Maximum movement occurs during spring tides; minimum during neaps. Emery (1960) documented northwest/southeast tidal currents within the Southern California Bight. On ebb tides, water movement is to the southeast and generally stronger than the northwest flow induced by flood tides.

Upwelling

Upwelling activity along the ASBS can be expected throughout most of the year. Anytime surface water is moved from a boundary and a source of deeper water for replacement exists, upwelling will occur. Farnsworth Bank forms an effective boundary and is surrounded by deep water.

Water Column

Because of its offshore location, water clarity within Subarea III is clearer than within the nearshore areas of Catalina Island. Nevertheless, clarity can be influenced by many factors, such as water motion and plankton productivity. Maximum turbidity can be expected throughout the ASBS in winter and spring because of storms and surface runoff from Catalina, and from April to July when plankton blooms occur. Clarity is usually greatest during fall, often exceeding 100 ft (30 m). Changing tidal currents often modify water clarity within a very short period of time; the water column during rising tides is slightly clearer than during falling tides. Within the ASBS, visibility generally ranges from 50-70 ft (15-21 m) throughout the year; during the diving survey, it ranged from 50-100 ft (15-30 m) (Appendix 1).

Water Temperatures

Water temperatures have not been collected on a regular basis within Subarea III. Satellite imagery studies, however, suggest that the surface temperatures are 2.5-5°F (1.4-2.8°C) cooler than surface temperatures near the Catalina Marine Science Center (CMSC) on the leeward side of Catalina (Hendricks 1977, p. 76). Using CMSC data collected from the past 10 years as a guide, the following estimates of water temperature dynamics within the ASBS are proposed: 1) surface temperatures normally range between 52-68°F (11-20°C), with minimum values from December to February and maximum values between July and September, and 2) a thermocline of 2-5°F (1-3°C) is present above 66 ft (20 m) from March to October.

During the diving survey of the ASBS from 28 November through 4 December 1979, temperatures were 61°F (16°C) at the surface and 55-59°F (13-15°C) at 60 ft (29 m) (Appendix 1).

Water Chemistry

An approximation of water chemistry levels and variability within the ASBS can be obtained by examining data collected at a California Cooperative Oceanic Fisheries Investigation (CalCOFI) station (90.37) off Catalina's East End (Fig. 7). Salinity within the ASBS probably remains relatively constant throughout most of the year. Average monthly salinities at the CalCOFI station ranged between 33.4-33.8 o/oo within the upper 100 m for the period 1950-66. These values were highest in summer and lowest in winter.

Dissolved oxygen levels within the ASBS are adequate to support marine life.

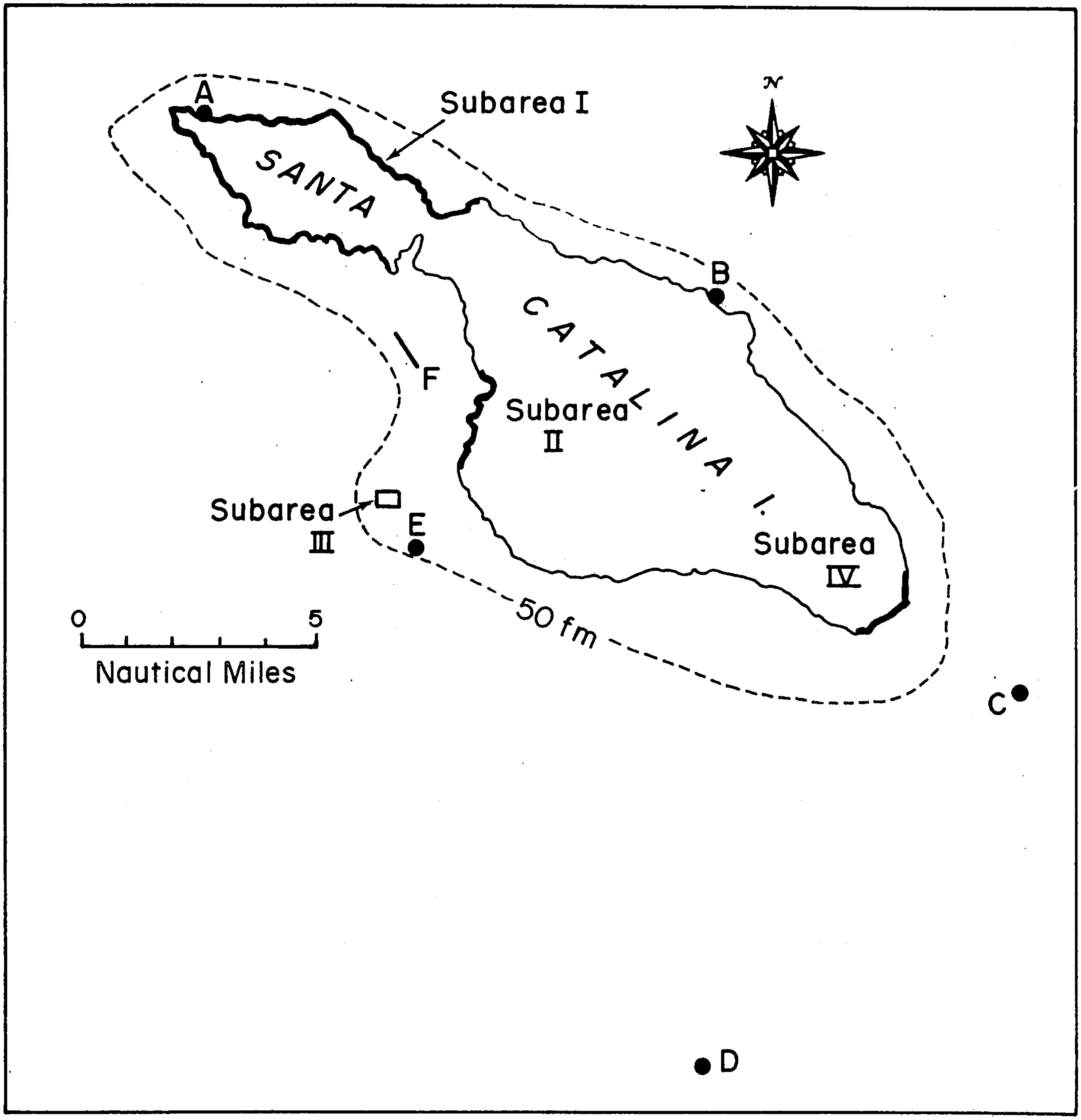

Figure 7: Locations of previous marine studies near Subarea III (Farnsworth Bank). Studies include: State Mussel Watch Program Stations, Catalina West (A) and Catalina East (B); Chen and Lu (1974) sediment quality stations (C, E); California Cooperative Oceanic Fisheries Investigation Station #90.37 (D); and Southern California Coastal Water Research Program, otter trawl station (F).

Average monthly values from the CalCOFI station ranged from 5.5 mg O_2/l at the surface to 3.0 mg O_2/l at 100 m. Surface values are usually higher because of aeration by swells and wind chop.

At the CalCOFI station, phosphate and nitrate-nitrogen values in October and December ranged from 0.34-2.12 and 0.1-23.2 g at/l, respectively, with lowest values at the surface and highest values at 100 m. No nitrite-nitrogen was present except for 9.28 g at/l at 50 m.

During the rainy season, water chemistry within Subarea III undoubtedly is modified by surface runoff from nearby Catalina Island. The amount and duration of these changes, however, are not known.

The State Water Quality Control Board has maintained a State Mussel Watch Program in California since 1977, with two stations on the leeward (northeast) side of Catalina (Fig. 7). In this program, samples of mussel tissue are analyzed for trace elements, synthetic organics, and petroleum derivatives. Data from these stations can be used to estimate water quality within ASBS III. Levels of cadmium, lead, and zinc from samples collected at Catalina West were higher than mainly other coastal stations on the mainland; levels from Catalina East appeared to be slightly elevated as well (Table 1). Levels of DDE, PCB, and hydrocarbons were 1-2 orders of magnitude below levels on the mainland (Table 2).

Geophysical Characteristics

General

Geologic formations on Santa Catalina Island consist of metamorphic rocks of Jurassic-Cretaceous age capped by Tertiary volcanics. The metamorphic rocks or Catalina Schist are the oldest assemblage of basement rocks found

Table 1. Levels of trace metals (μg/g dry wt) in tissue of mussels (*Mytilus* spp) from Catalina West (West End) and Catalina East (Long Point). Data were taken from the California Mussel Watch Program (Stephenson et al. 1979).

	Aluminum	Cadmium	Chromium	Copper	Iron	Mercury	Manganese	Nickel	Lead	Silver	Zinc
Catalina West											
1977	46.7	8.4	2.4	5.3	181.7	0.1	3.2	1.6	25.3	1.7	195.7
1978	195.0	11.0	3.3	5.5	--	0.3	9.8	--	26.5	1.9	216.7
Catalina East											
1978	272.3	5.6	2.6	4.9	--	0.3	11.5	--	4.2	1.5	150.0

Table 2. Levels of organic pollutants (ng/g dry wt) in tissue of California mussels (*Mytilus californianus*) from Catalina West (West End) and Catalina East (Long Point). Data were taken from the California Mussel Watch Program (Risebrough et al. 1980).

	PCB		DDE		Total Unresolved Hydrocarbons		Total Resolved Hydrocarbons	
	Winter	Summer	Winter	Summer	Winter	Summer	Winter	Summer
Catalina West								
1978	41	19	23	9	--	--	--	--
Catalina East								
1977	56	57	49	12	0.004	0.001	0.002	0.001
1978	35	17	9	9	--	--	--	--

offshore of the Southern California Borderland. This assemblage is the equivalent of the Franciscan complex in the borderland and consists of three tectonic units. The Blueschist Unit is overlain by the Greenschist Unit, and both are in turn overlain by the Amphibolite Unit (including Serpentinite). These units were formed about 110 million years ago, when various proportions of sediments and volcanic rocks were deposited on the ocean bottom in a region of active vulcanism. This material subsequently was thrust into the upper mantle via a subduction zone. Metamorphosis of the schists occurred as a result of the high pressures and geothermal gradients associated with the zone of subduction, and a period of gradual uplift began.

The schists were exposed and covered during Miocene time (13-25 million yrs ago), although the timing and mechanisms are poorly understood. At some point in the Miocene, Catalina was submerged to account for the presence of marine sediments (diatomaceous shale and limestone) overlying the metamorphic rocks (schists).

Mid-Miocene was a period of extensive volcanic and tectonic activity. Consequently, the schists were folded and faulted with numerous igneous intrusions and extrusions.

The gradual uplift of metamorphic rock which began in Jurassic-Cretaceous time was completed by the late Miocene. Cessation of the uplift and the absence of sediments younger than Miocene age, suggest that the physiography of Catalina at the end of the Miocene was similar to that of today. Block faulting and regional warping continued into the Pleistocene, and local tectonic movements are still common within the Southern California Borderland. These movements cause the active seismicity of the area, of which Catalina and the offshore banks and islets are a part.

Pleistocene events on Catalina within the last 1-2 million years have consisted of considerable submergence and emergence in response to changing sea levels associated with glaciation and tectonic activity. During maximum submergence about 500,000 years ago, the island was submerged to the 1500 ft (457 m) level. Subsequent emergence reached maximum levels about 17,000-18,000 years ago, exposing most of the Catalina shelf, including Farnsworth Bank. Since this time, the sea level gradually has risen to present levels, submerging the shelf and Farnsworth Bank (Vedder and Howell 1980).

Seismic Activity

Potentially active faults traverse the Catalina Shelf and Basin off the southwest side of the island and many are near the ASBS (Fig. 8). The maximum probable and maximum credible earthquakes along any of the major offshore faults are Richter magnitude 6+ and 7+, respectively. No earthquakes greater than magnitude 5 have been located instrumentally within 25 mi (40 km) of Catalina, but small earthquakes commonly occur within this area. Several have been located offshore of the ASBS. In October 1973, the epicenter of a 4.5 magnitude earthquake was located 15 mi (24 km) east of the ASBS, off the southeastern tip of Catalina Island. Seismic activity is to be expected along the local or distant faults, and this activity may produce variable degrees of seismic shaking on Farnsworth Bank.

Land and Intertidal

No exposed land mass or intertidal zone exists at Farnsworth Bank as the Bank is completely submerged.

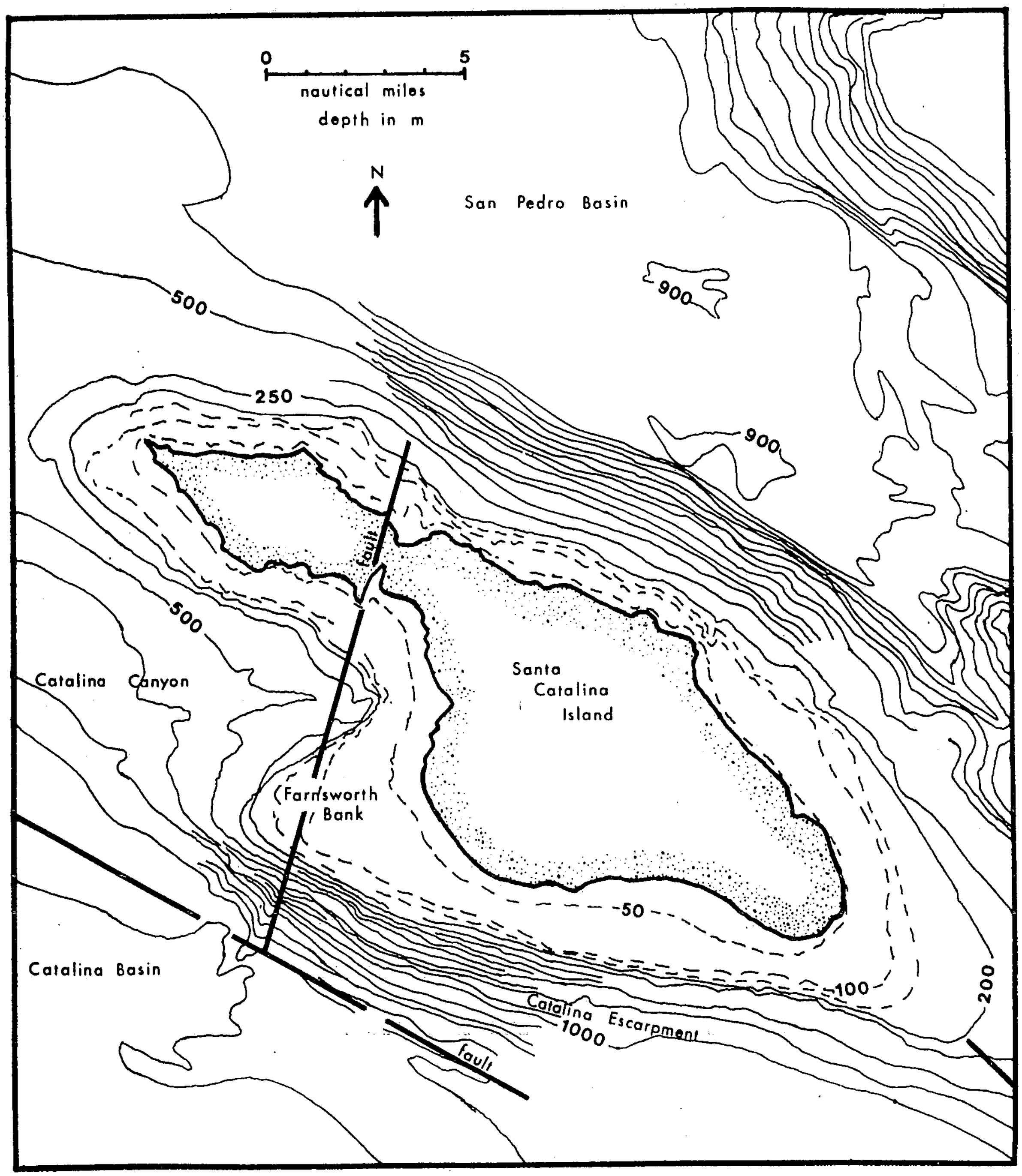

Figure 8: Submarine topography surrounding Santa Catalina Island (from Assoc. Eng. Geologist 1967). Dark lines indicate the positions of potentially active earthquake faults.

Subtidal

Topography and Geomorphology

Farnsworth Bank is a rocky outcropping on the gently sloping (1:350), southwesterly facing shelf of Catalina, which extends for an average distance of 1.4 mi (2 km) from the windward coast. The shallowest pinnacle is located near the center of the Bank, rising to within 50 ft (15 m) of the surface (Fig. 9). Several other pinnacles rise to a depth of 70 ft (21 m). A ridge, 80 ft (24 m) long and 60-80 ft (18-24 m) deep, extends from the shallowest pinnacle to the southwestern edge of the Bank. The depth of the Bank proper ranges from 80-100 ft (24-30 m) before dropping precipitously to over 130 ft (40 m) along the north and northeastern edge and to 110 ft (33 m) on the other sides. At these depths, the bottom continues to slope down to depths of 200-250 ft (61-76 m).

Sheer vertical walls are a common feature of Farnsworth Bank. The more horizontal aspects of the Bank are characterized by deep crevices and numerous pinnacles. A few small pockets of sediment are interspersed around the Bank. This coarse sediment is composed of biogenic fragments such as shells, sea urchin tests and spines, and the calcareous pieces of coralline algae.

The Bank is an outcropping of hard bedrock which is difficult to sample; no movable rocks or large boulders are present. Dredge samples collected from the Catalina Escarpment directly southwest of the Bank consisted of basaltic andesite, foraminifera-bearing dolostone, well-indurated dark olive-gray siltstone, and basalt, all of Miocene age (G. W. Moore, pers. comm.). Farnsworth Bank probably consists of Miocene volcanics and/or metamorphic Catalina Schists.

Approximately 3 mi (5 km) north of Farnsworth lies the head of the Santa

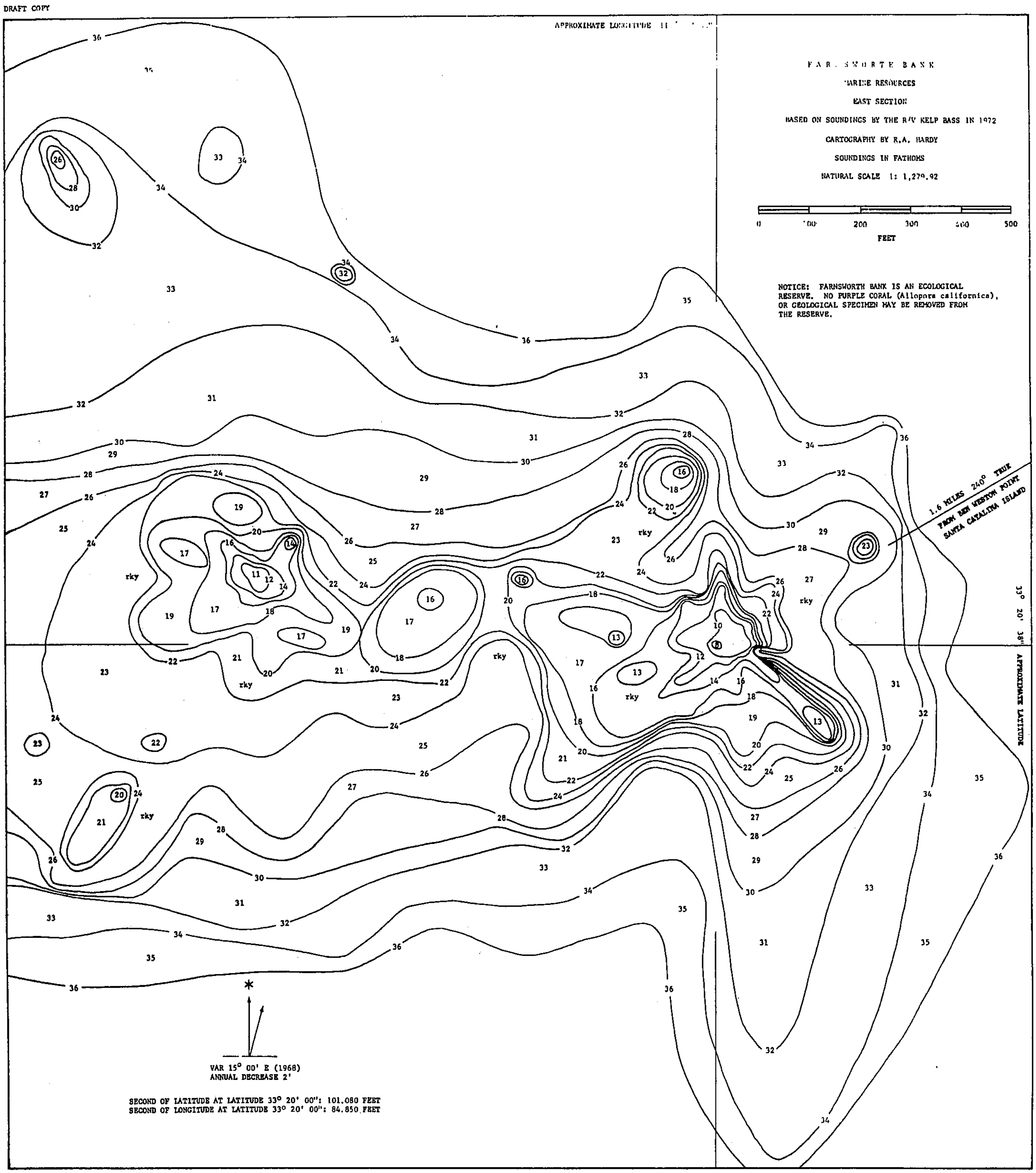

Figure 9: Topographic maps of Farnsworth Bank (from Calif. Dept. Fish and Game). (A), eastern portion of Bank; (B), western portion of Bank.

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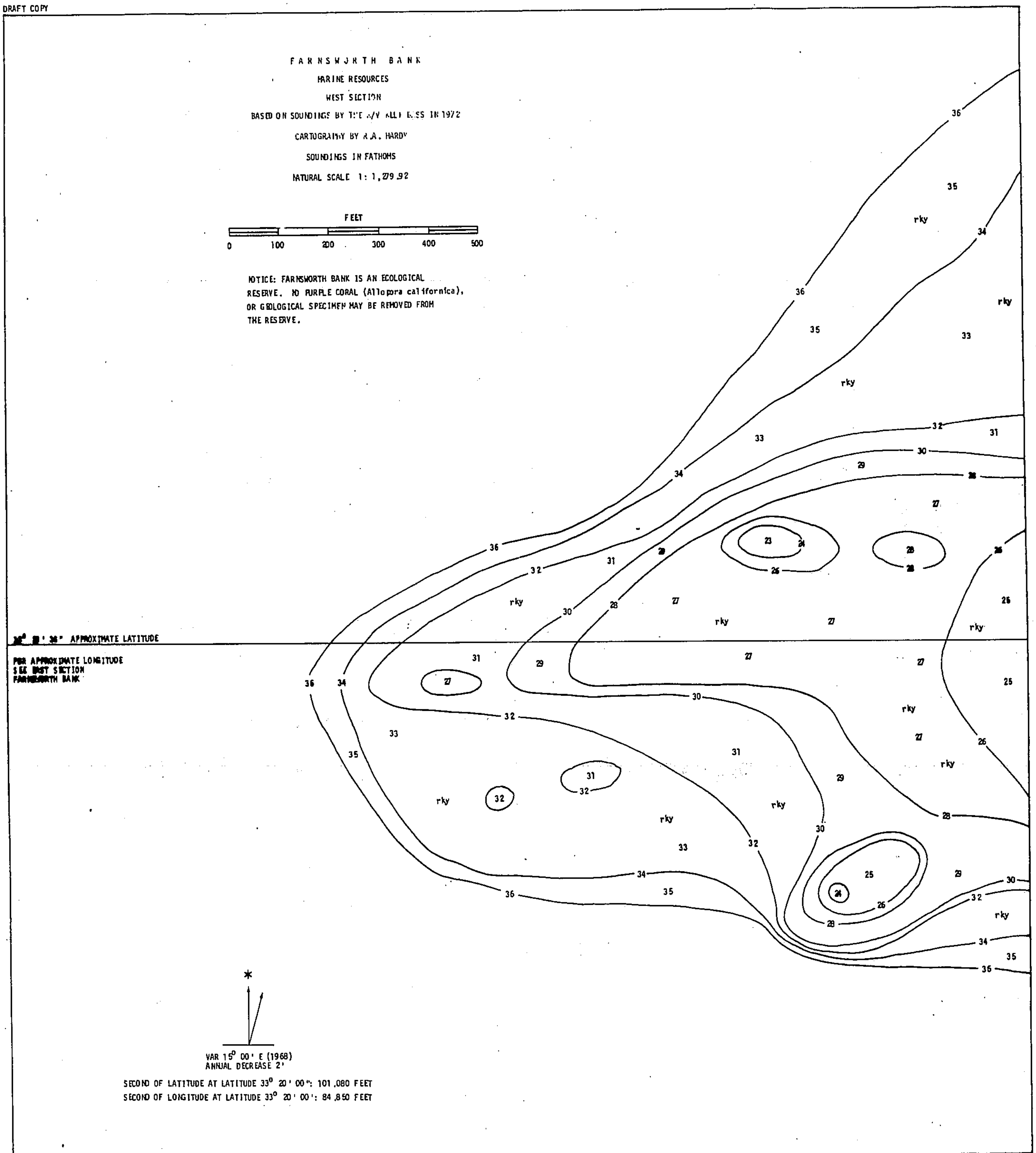


R.R. BELL, CALIFORNIA DEPARTMENT OF FISH AND GAME NOTICE: THIS CHART IS NOT INTENDED FOR USE IN NAVIGATION SEPTEMBER 8, 1975

Figure 9: (continued) western portion of Bank

Catalina Canyon, one of the 13 major submarine canyons within the Southern California Bight (Fig. 8). This canyon extends into the Santa Catalina Basin and receives a high proportion of all surface drainage on Catalina Island.

The above descriptions of geophysical characteristics were synthesized from Bailey (1940), Platt (1976), and Assoc. of Engineering Geologists (1977).

Sediment Chemistry

According to Chen and Lu (1974), sediments surrounding Catalina Island have trace metal concentrations almost as high as those of the Los Angeles/ Long Beach Harbor complex. One of the many Catalina areas investigated in Chen and Lu's study was slightly south of Subarea III at a depth of 50 m (Fig. 7). At this station, levels of chromium, copper, and nickel were much higher than background levels for the entire San Pedro Channel (Table 3). The high chromium and nickel levels, however, may be due to rock and soil compositions in the drainage areas producing the surface runoff to this area (Chen and Lu 1974).

Concentrations of chlorinated pesticides (DDT) and polychlorinated biphenyls (PCB) are much lower in all Catalina sediments than within sediments off the mainland coast (Table 4). Levels of other organic compounds, however, are similar.

A study by the Los Angeles County Sanitation District in 1971-1972 for the Southern California Coast Water Research Project (SCCWRP) examined the levels of DDT and PCB in the muscle tissue of Dover sole, a flatfish that lives on the substrate. The fish were trawled from a depth of 100 m, near Subarea III (Fig. 7). Levels of DDT and PCB were 0.05 and 0.03 mg/kg (wet wt.) respectively, much lower than mainland levels which ranged up to 9.3 for DDT

Table 3. Levels of trace metals (mg/kg) in sediments near Santa Catalina Island ASBS Subarea III (after Chen and Lu 1974). Data are reported for three levels of sediment depth (in).

	Arsenic	Cadmium	Chromium	Copper	Iron	Lead	Mercury	Nickel	Zinc
Subarea II									
0-2"	2.29	1.67	107.0	23.0	25,690	37.7	0.029	142.7	39.1
2-6"	2.11	1.30	86.9	21.7	27,950	39.1	0.025	133.2	34.8
6-12"	2.03	1.51	117.6	22.5	24,680	33.8	0.031	91.4	27.9
Subarea IV									
0-2"	2.82	2.79	54.0	12.6	16,470	57.3	0.034	46.5	42.9
2-6"	2.40	2.46	40.6	12.7	14,100	55.9	0.028	39.1	37.8
Natural Background	1-1.5	1-1.5	20-30	5-10	12,000-15,000	20-25	0.025-0.050	15-20	30-35

Table 4. Levels of organic pollutants in sediments near Santa Catalina Island ASBS Subarea III (after Chen and Lu 1974). Data are reported for three levels of sediment depth (in).

	Chemical Oxygen Demand ($x10^4$ppm)	Organic Nitrogen (ppm)	Oil and Grease (ppm)	Total Phosphorus (ppm)	Total Organic Carbon (%)	Total Volatile Substances (%)	DDD (ppm)	p,p'DDE (ppm)	Total DDT (ppm)
Subarea II									
0-2"	1.35	103.0	2,350	507	0.549	3.08	0.001	0.004	0.005
2-6"	1.41	87.0	1,630	493	0.354	2.69	--	0.002	0.002
6-12"	1.33	60.4	1,250	418	0.134	2.43	--	--	--
Subarea IV									
0-2"	1.40	180.0	2,110	1,215	0.365	1.81	0.034	0.006	0.007
2-6"	1.53	229.0	2,130	1,153	0.327	2.57	--	0.002	--
Mainland Ranges									
0-2"	1.1-7.4	81-1,406	1,060-4,630	750-1,575	0.205-2.309	1.15-15.70	0.002-0.296	0.031-0.864	0.016-1.332
2-6"	0.6-6.7	36-1,330	1,140-2,920	438-1,568	0.110-1.824	1.26-7.50	0.002-0.228	0.003-1.430	0.003-2.112
6-12"	2.5-4.4	91-1,512	1,150-5,560	1,155-1,645	0.212-1.502	2.69-4.50	0.018-0.150	0.063-0.776	0.101-1.112

and 4.1 mg/kg (wet wt.) for PCB. This study also examined Dover sole liver tissue and found copper levels of 1.7 mg/kg (dry wt.), slightly lower than the highest mainland value (6.8). There was a normal incidence of tumors and fin erosion disease in flatfishes caught off Catalina (SCCWRP 1972).

Another study examined DDT levels in liver tissue from numerous fish species and found Catalina levels to be 1-2 orders of magnitude below mainland levels (Los Angeles Co. Sanit. Dist. 1973).

In summary, studies of sediment and organism tissue from Catalina have revealed high concentrations of trace metals, but relatively low amounts of petroleum hydrocarbons. The major sources of these contaminants are the sewer outfalls and the Los Angeles/Long Beach Harbor complex on the mainland, but airborne contaminants from the mainland also may be important (Chen and Lu 1974; Stephenson et al. 1979). Although none of these samples have been collected within Subarea III, the islandwide patterns for these contaminants strongly suggest similar values for the ASBS.

Climate

The climate of Catalina Island is classified as semi-arid Mediterranean, characterized by mild, wet winters and a warm, dry period from late spring to late autumn. Temperatures in the high 30s and upper 40s (1-4°C) are recorded a few times each winter, but freezing temperatures have never been recorded at sea level. This pattern is controlled by a high-pressure cell, the Eastern Pacific High, which is located off the coast of northern California. During spring and summer, this high-pressure cell prevents storm-producing, low-pressure systems from reaching the southern California area. Consequently, the summers are warm, dry, and moderated by prevailing westerlies. The westerlies increase in intensity during the afternoon, die-off in the evening, and repeat the cycle the next day.

Skies are mostly clear from late spring through autumn, and each year an average of 267 days are sunny or partly sunny. Heavy cloudiness occurs primarily in the early spring months when stratus clouds drifting in from the sea may cause low ceilings or fog. The clouds are usually 300-400 ft (90-122 m) thick, with bases near 1500 ft (457 m). The relative humidity averages 60-70%, largely influenced by the surrounding Pacific Ocean.

The Eastern Pacific High weakens and moves south in the fall, allowing storm systems to move down the coast. Stormy southeast winds and clearing westerlies are typical of winter, whereas violent storms with strong westerly winds (25-50 mph) lasting for days are common in spring. Fogs develop in late spring and persist into late summer or until the afternoon westerlies develop.

The winter and spring patterns are broken at irregular intervals by the occurrence of Santa Ana winds. A high-pressure system is established over the Great Basin, creating a strong northeast-southwest pressure gradient over southern California. This can last for 1-12 days. The resulting Santa Ana winds blow from the northeast and are typically strong, gusty, hot and very dry. They frequently attain speeds of 100 mph on the mainland, but rarely exceed 50 mph at Catalina. Usual Santa Ana conditions on the island consist of high temperatures, very low humidities, gentle warm breezes, and smog from the Los Angeles Basin.

The average yearly rainfall at Catalina is approximately 12 in (30 cm), falling mainly from November through April, with 62% occurring in December, January, and February (Fig. 10). Precipitation is usually in the form of

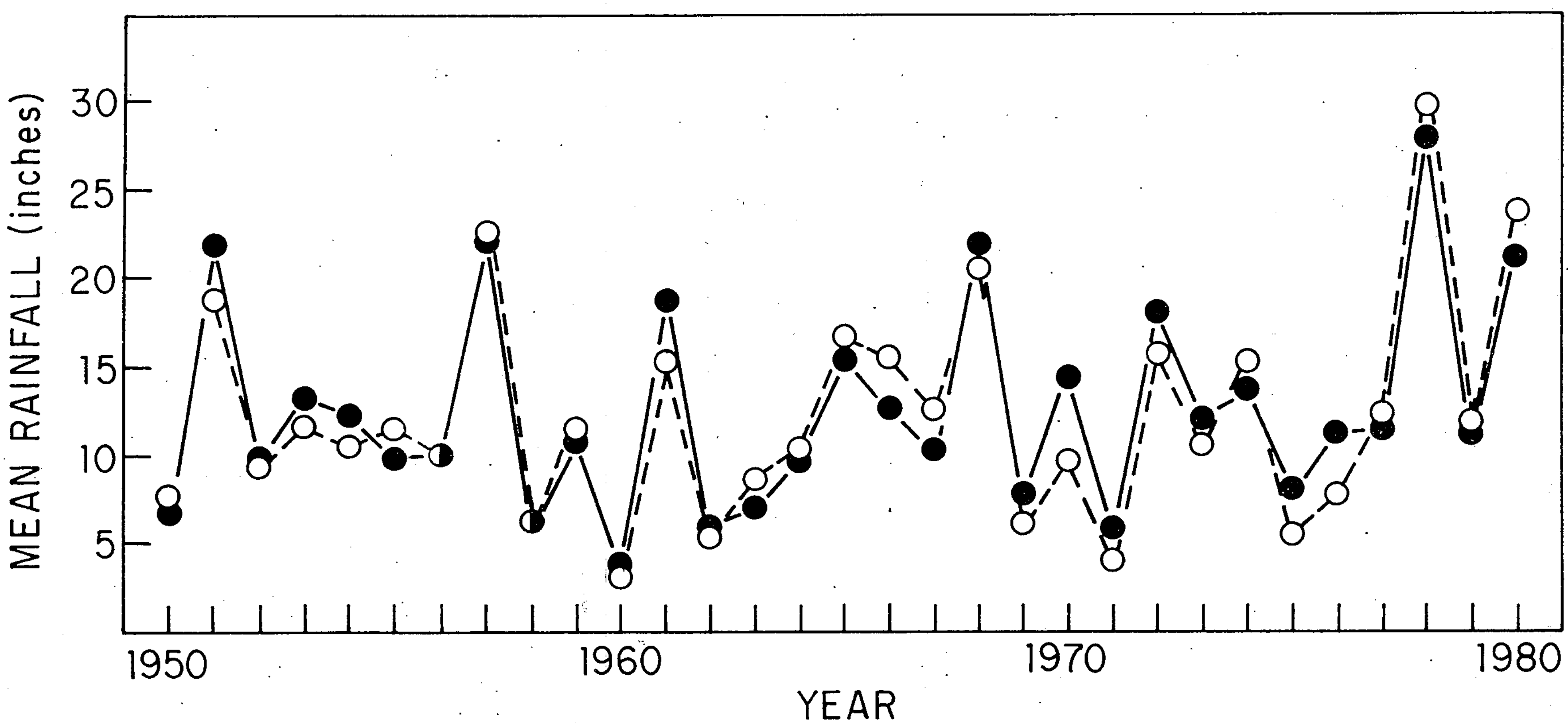


Figure 10: Annual rainfall at Airport-in-the-Sky and Avalon on nearby Catalina Island, from 1950-1980. Solid lines depict Airport levels; dashed lines are for Avalon.

a steady, gentle rain. Squalls and thundershowers are rare, usually associated with the rare "Chubascos" from the south, or unusually strong Pacific storms from the west. Catalina experienced severe drought conditions in 1975-78, averaging less than 10 in/yr (25 cm/yr). Abnormally high amounts of rain fell during the winters of 1978 and 1980, with annual totals of 29 and 22 in (74, 57 cm), respectively. Snowfall, with slight accumulations of 1-2 in (2.5-5 cm) occurs about once every 20 years and is restricted to altitudes above 1500 ft.

BIOLOGICAL DESCRIPTION

Subtidal Biota

Algae. Three major algal assemblages are present at Farnsworth Bank: 1) lush foliose and bushy algae dominating the ridge tops at depths between 55 and 80 ft (17-24 m), 2) small foliose or filamentous red algae interspersed with sessile invertebrates along the vertical rock walls, and 3) long-bladed kelps in deeper areas with less physical relief (especially in the rock/sand ecotone along pinnacle bases). Forests of giant kelp (Macrocystis pyrifera) are characteristic of most rocky subtidal areas in southern California, but Macrocystis is not present at Farnsworth Bank. The absence of giant kelp may be related to low light levels reaching the relatively deep pinnacles, few horizontal rock surfaces suitable for attachment, adverse current and surge conditions, and/or isolation from sources of gametes for recruitment (i.e., other Macrocystis plants).

Ridge tops at depths from 55-80 ft are dominated by southern sea palms (Eisenia arborea), bladder kelp (Cystoseira osmundacea), bushy reds (Gelidium robustum, G. purpurascens, G. nudifrons, Plocamium cartilagineum, Pterocladia capillacea), and erect corallines (Calliarthron cheilosporioides/Bossiella orbigniana, Corallina sp). Most of the bushy reds are covered with numerous epiphytic invertebrates and algae. One common epiphyte is the small red alga, Acrosorium uncinatum. Other conspicuous algae on pinnacle tops include Codium cuneatum, C. hubbsii/C. setchellii, Dictyopteris sp, Dictyota/Pachydictyon, Botryocladia pseudodichotoma, Nienburgia andersoniana, Polysiphona spp, Prionitis sp, Ceramiaceae, Delesseriaceae, and encrusting corallines (Lithothamnion/Lithophyllum). Bushy reds become sparse on pinnacle tops below 80 ft. Deeper pinnacles are dominated by purple hydrocoral (Allopora californica) and other invertebrates. Low reds, encrusting corallines, and occasional southern sea palms are present.

Contrasting with the rich plant cover on ridge tops is the sparse algal assemblage on vertical rock walls. Typical of this invertebrate-dominated, low-turf community are small foliose or filamentous species of red algae such as Binghamia forkii, Callophyllis firma, Carpopeltis bushiae, Ceramiaceae, Delesseriaceae, Rhodymenia californica, R. pacifica, and Sciadophycus stellatus. These species become less common with increasing depth. Small reds and encrusting corallines also are present on snagged commercial fishing nets draping over some of the many pinnacles.

Long-bladed kelps (Laminaria farlowii, Agarum fimbriatum) are present in low to moderate numbers on reef ledges, depressions, and other horizontal rock surfaces below 80 ft. These breaks in the otherwise high relief often are partially covered by coarse shelly debris. Laminarian kelps also are present on low- and medium-relief rocks at the bases of pinnacles near the deep-sand bottom. In some areas, these low-lying kelps may be found as deep as 180 ft (55 m; Dr. R. Given, CMSC, pers. comm.).

Invertebrates. The offshore rocky ridges and pinnacles forming Farnsworth Bank provide a unique environment for a spectacular array of marine invertebrates. The benthic reef fauna is dominated by solitary or colonial invertebrates adapted to filtering food particles from the surrounding water, while remaining firmly attached despite vigorous currents and surge. Typical organisms at Farnsworth Bank include sponges, hydroids, anemones, corals, worms, clams, bryozoans, and tunicates. Three major assemblages are present, though there is considerable overlap between one assemblage and another. These invertebrate assemblages are associated with ridge/pinnacle tops, vertical walls, and the bases of rock ledges/ridges.

Most invertebrates on ridge tops at depths from 55-80 ft (17-24 m) are associated with the predominant foliose or bushy algae. Epiphytes are abundant. Southern sea palms often are encrusted with frost bryozoans (Membranipora sp), calcareous tube worms (Spirorbidae), and other unidentified organisms. Proliferating anemones (Epiactis prolifera) are clustered at the junction of stipe and blades, and herbivorous kelp turbans (Norrisia norrisi) graze all over the plant surfaces. Bladder kelp also is a substrate for frost bryozoans, calcareous tube worms, and proliferating anemones, as well as various hydroids and other bryozoans (e.g., Cellaria mandibulata, Celleporaria brunnea, Hippothoa distans, Fenestrulina malusi). Ostrich-plume hydroids (Aglaophenia sp) and frost bryozoans cover the bushy red alga, Gelidium robustum. Less conspicuous are smaller hydroids (e.g., Eucopella sp, Sertularella sp) and the bryozoan, Thalamoporella californica.

Around and under the algal cover on ridge tops are mobile snails such as herbivorous wavy-top turbans (Astraea undosa), red turbans (A. gibberosa), and queen turbans (Tegula regina), as well as carnivorous cones (Conus californicus), whelks (Kelletia kelletii), and giant keyhole limpets (Megathura crenulata). Snail shells harbor hermit crabs (e.g., Paguristes spp, Pagurus sp, Pylopagurus sp). Often covering these shells is the lumpy brown bryozoan, Antropora tincta. Small masking crabs (e.g., Pugettia dalli, Scyra acutifrons) are hidden amidst low algae. Also present or common on rock tops are several echinoderms, particularly southern sea cucumbers (Parastichopus parvimensis), bat stars (Patiria miniata), and soft spiny stars (Astrometis sertulifera).

Narrow horizontal and vertical crevices on ridge tops provide shelter for larger mobile invertebrates, especially crustaceans, mollusks, and echinoderms. Spiny lobsters (Panulirus interruptus), red rock shrimp (Lysmata californica), and various crabs (e.g., Cancer antennarius, Lophopanopeus sp, Paraxanthias taylori) are present, as well as chestnut cowries (Cypraea spadicea), two-spot octopus (Octopus bimaculatus), red urchins (Strongylocentrotus franciscanus), and purple urchins (S. purpuratus). Pink (Haliotis corrugata) and white abalone (H. sorenseni) are uncommon. Small yellow anemones (Metridium exilis) and strawberry anemones are abundant around crevice edges and irregular rock formations where bushy algae is sparse. Metridium exilis appears to be an opportunistic species which can settle and quickly spread over newly exposed rock surfaces created by storm swells or other disturbances (i.e., boat anchors).

The spectacular vertical walls at Farnsworth Bank are dominated by a rich assemblage of sessile, suspension-feeding invertebrates. All available space is occupied, and many organisms can be found growing on other organisms. Strawberry anemones (Corynactis californica), rock oysters (Chama arcana), head-forming bryozoans (Diaporoecia californica, Hippodiplosia insculpta, Phidolopora labiata), calcareous tube worms (Spirobranchus spinosus), red-and-white barnacles (Megabalanus californicus), and small white tunicates (Trididemnum opacum) are the most abundant invertebrates on vertical surfaces at depths from 55-80 ft (17-24 m). Strawberry anemones are able to reproduce asexually by budding, therefore whole areas of walls and pinnacles may become carpeted with hundreds of anemones derived from a few initial individuals. Colonial staghorn bryozoans (D. californica) produce erect coral-like branches which form large heads (up to 2 ft or more in diameter). These heads project from the rock walls, especially near the apexes of pinnacles. Interstices within staghorn bryozoan heads provide a microhabitat for other invertebrates, such as the brittlestar, Ophiothrix spiculata. Colonies of fluted bryozoans (H. insculpta) and lacy bryozoans (P. labiata) form fragile, foliaceous heads smaller in size than the staghorn heads. In many areas anemones, bryozoans, and other invertebrates are not attached directly to the rock surface, but adhere to the outer shells of rock oysters (Chama arcana). The highly rugose oyster shells apparently promote settlement of some invertebrates, which in turn camouflage the oysters from predators, such as the blue sea star, Pisaster giganteus (Vance 1978). The inner valves of Chama shells are cemented firmly to the rock wall.

Other sessile invertebrates present or common on vertical walls include solitary and colonial sponges (e.g., Tethya aurantia, Verongia aurea, Acarnus erithacus, Axinella mexicana, Penares cortius, Spheciospongia confoederata), hydroids (e.g., Sertularella spp, Sertularia sp), purple hydrocoral (Allopora californica), cup corals (Astrangia lajollensis, Coenocyathus bowersi, Paracyathus stearnsi), gorgonians (Lophogorgia chilensis, Muricea californica, M. fruticosa), soft octocorals (Clavularia sp), tube-building polychaetes (Dodecaceria sp, Salmacina tribranchiata), tube snails (Serpulorbis squamigerus), rock scallops (Hinnites giganteus), numerous encrusting and erect bryozoans (e.g., Rhynchozoon rostratum, Lichenopora novae-zelandiae, Bugula sp, Scrupocellaria sp, Celleporaria sp, Crisia spp), salmon sea cucumbers (Cucumaria salma), and tunicates (e.g., Clavelina huntsmani, Euherdmania claviformis, Aplidium sp, Metandrocarpa taylori, Pyura haustor). Commercial fishing nets snagged on the pinnacles provide additional substrates for many of the smaller invertebrates. Recently lost nets are relatively clean, but older nets are heavily fouled. Bryozoans are conspicuous on these nets, especially Diaporoecia californica, Hippodiplosia insculpta, Phidolopora labitata, and Lichenopora novae-zelandiae. During the survey, bat stars (Patiria miniata) were observed foraging on the encrusted nets.

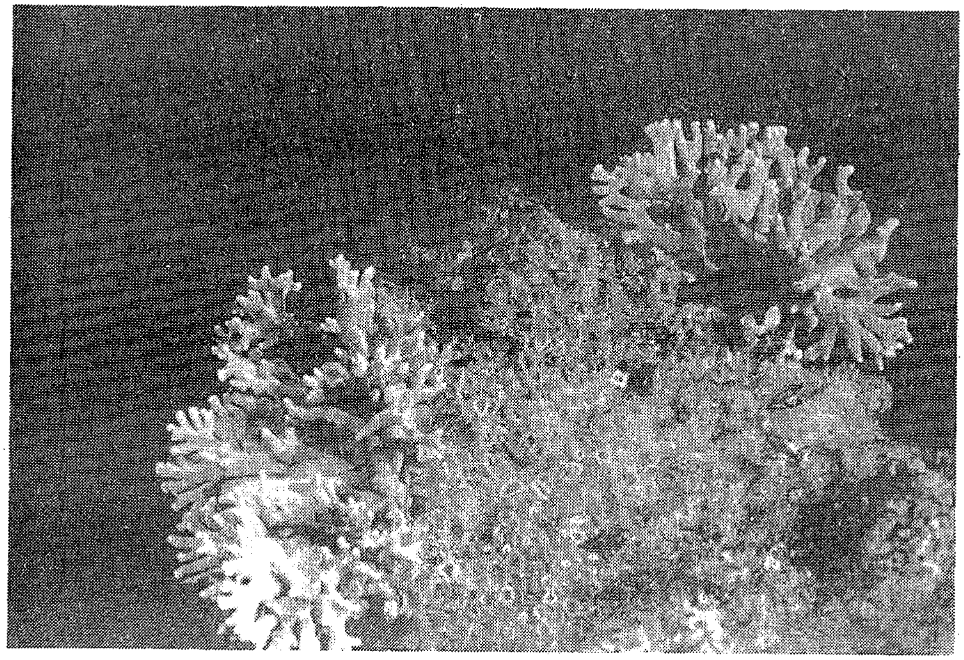
Mobile carnivorous or omnivorous invertebrates are relatively sparse on the vertical rock walls. Bat stars, blood stars (Henricia leviuscula), and giant keyhole limpets (Megathura crenulata) are conspicuous. Also present are large blue stars (Pisaster giganteus), comet stars (Linckia columbiae), gem murex (Maxwellia gemma), coffee bean snails (Trivia sp), and various nudibranchs (e.g., Flagellinopsis iodinea, Anisodoris nobilis, Cadlina luteomarginta, Doriopsilla albopunctata, Hermissenda crassicornis). Black urchins (Centrostephanus coronatus) occasionally are present in depressions or narrow crevices, which provide shelter from surge and protection from predatory fish such as the sheephead, Semicossyphus pulcher.

Two unusual sea stars were encountered on the vertical rock wall during the survey. One specimen of the rainbow sea star, Orthasterias koehleri, was found at a depth of 90 ft (27 m). Orthasterias is usually found in colder water north of Point Conception. Several individuals of another unusual sea star, tentatively identified as Pharia pyrimidata, were encountered at depths between 80 and 90 ft. One specimen was collected. If the species identification proves correct, this record represents a new northern range extension for this tropical eastern Pacific species. Specimens from Farnsworth Bank represent a new color variant as well.

Deeper rock walls are dominated by many of the organisms discussed above, but especially conspicuous are dense populations of the beautiful purple hydrocoral, Allopora californica. Colonies of this unique hydrozoan are restricted to a few offshore reefs, pinnacles, and rocks along the Pacific Coast where strong currents provide relatively clean water and abundant planktonic food. Though superficially resembling staghorn anthozoan corals (of tropical waters) because of its branching calcareous skeleton, A. californica is more closely related to hydroids (Fig. 11a). At Farnsworth Bank, purple hydrocoral is rare on the shallowest ridge tops (55-80 ft). Ostarello (1973) found that competition for space with faster-growing organisms and an inability to withstand sedimentation were the main sources of mortality to newly settled Allopora off Carmel, California. On the ridge tops at Farnsworth Bank, Allopora may be outcompeted by bushy algae, smothered by siltation, or broken by storm-related water motion. The ideal habitat for purple hydrocoral appears to be vertical surfaces, devoid of algae, and exposed to currents and surge which keep the surface free of sediment.

Small colonies of Allopora (2-4 in high, 6-8 in dia) are present on the walls of tall vertical crevices at depths between 60 and 80 ft. These crevices are partially protected from vigorous surge and current conditions characteristic of the ridge-top environment. With greater depths, the size and density of Allopora colonies gradually increase to the point where they dominate most rock walls and pinnacles. At 90 ft, the density of colonies is approximately $9/m^2$, and average colonies are 6 in high and 9-12 in diameter. Within its optimum depth range of 100-180 ft, purple hydrocoral colonies may cover 50-90% of the available rock surface. Colonies appear to be more abundant on pinnacle surfaces oriented perpendicular to the prevailing currents and receiving the greatest amount of water motion. Individual heads may grow up to 8-15 in high and 15-30 in diameter. Since growth rates are estimated to be approximately 0.3 in/yr, these colonies are very old. Ostarello (1973)

A



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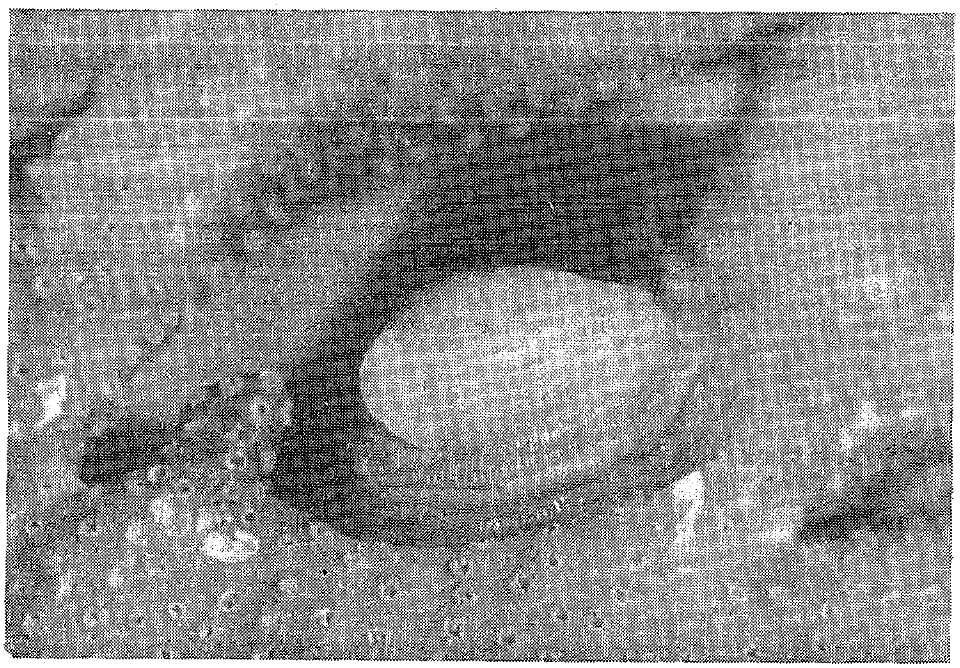

Figure 11: Photographs of purple hydrocoral (Allopoa californica) and its obligated commensal snail, Pedicularia californica, at Farnsworth Bank. (A), Allopora colonies and strawberry anemones (Corynactis californica) a top bedrock pinnacles; (B), enlarged view of Pedicularia on Allopora branch. Photographs were taken by Lewis Trusty (A) and Dr. Robert Given (B).

found no evidence of predation on large colonies and concluded that adult mortality appeared to be limited to mechanical abrasion and breakage. At Farnsworth, broken outer branches can be observed on numerous Allopora heads. This damage may have been caused by boat anchors, scuba divers, fishing nets, or storms. Evidence of regeneration of broken branches also can be seen. Purple hydrocoral off Carmel resumes upward growth 4-5 months after a branch has been cut (Ostarello 1973).

Allopora colonies provide a microhabitat for smaller invertebrates, such as the brittlestars, Ophiothrix spiculata. In addition, four obligate commensals are intimately associated with Allopora colonies: a snail, a barnacle, and two species of polychaete worms. The limpet-like ovulid snail, Pedicularia californica, lives in a slight depression on the surface of a hydrocoral branch, usually near a branch junction (Fig. 11b). The depression matches the size and shape of the snail's purplish-pink shell, thus individuals are well camouflaged. Pedicularia are common on Allopora at Farnsworth Bank, and often several snails can be observed on a single colony. Of 30 Allopora heads surveyed at 80-90 ft by the investigators, 14 contained one or more snails.

A second commensal on Allopora is the barnacle Armatobalanus nefrens. Barnacle larvae settle on the surface of purple hydrocoral branches. The hydrocoral slowly grows over the barnacle, eventually covering all but a small opening at the top. Numerous barnacles may be found on a single colony, forming pyramid-shaped growths along the branches. Armatobalanus is common on Allopora heads at Farnsworth Bank.

A third obligate commensal, the spionid worm, Polydora alloporis, burrows longitudinally through the central core of Allopora branches and secretes a calcareous tube (Light 1970). Paired openings to the worm tubes are found scattered over the surface of the hydrocoral colony. In Carmel, almost every colony was infested; sometimes so many worms were present that the hydrocoral skeleton was weakened. These polychaete worms also are common on Allopora at Farnsworth Bank.

Another polychaete worm, Autolytus penetrans, lives on the surface of Allopora within minute (3 mm) blisters formed by the hydrocoral. This small worm was not observed by the investigators during the survey, but specimens have been collected at Farnsworth Bank (Wright and Woodwick 1977).

Besides the ridge-top and rock-wall habitats at Farnsworth Bank, a lesser-known invertebrate assemblage is associated with low- to medium-relief rock ledges or ridge bases. These areas become catch basins for calcareous and other debris that fall from the cliffs above. Rubble from purple hydrocoral, bryozoan skeletons, and mollusk shells accumulate, and ledges may be covered with coarse sand and shelly debris. Present on these ledges at depths from 60-90 ft are several sea anemones (Anthopleura sp, Tealia coriacea, T. lofotensis), bivalves (Saxidomus nuttalli, Ventricolaria fordii), and large pink gorgonians (Lophogorgia chilensis). Some of the gorgonians have been overgrown and killed by colonies of the yellow zoanthid anemone, Parazoanthus lucificum. Under small rocks are brittlestars (e.g., Ophiothrix spiculata/Ophiopteris papillosa), and orange file shells (Lima hemphilli).

Mixed rock and coarse sand habitats along ridge bases at depths greater than 100 ft have been poorly studied. Red sea stars (Mediaster aequalis), bat stars (Patiria miniata), and white sea urchins (Lytechninus anemesus) are common (Dr. R. Given, CMSC, pers. comm.). Numerous species of polychaete worms and bryozoans have been recorded from dredge samples (Hartman 1966).

Pelagic macroinvertebrates occasionally can be observed in the water column above Farnsworth Bank. These include transparent, gelatinous zooplankton: chains of floating tunicates (salps), solitary comb jellyfish (ctenophores), purple-striped jellyfish (Pelagia colorata), and various stinging siphonophores. The presence of numerous pelagic invertebrates sometimes indicates the presence of localized upwelling.

Fishes. Farnsworth Bank is an area of high physical relief with numerous pinnacles, deep crevices, ledges, and sheer drop-offs. Many species of fish are present on Farnsworth, but few occur in large numbers. Blacksmith (Chromis punctipinnis) are an exception, as giant schools composed of thousands of individuals swim slowly across the Bank, always facing into the current. They range throughout the water column when the water is very clear, but crowd around the Bank when water clarity is poor. Small aggregations of halfmoon (Medialuna californiensis) often mix with the blacksmith schools but are much less abundant.

Benthic species that are moderately abundant include large and mobile sheephead (Semicossyphus pulcher), opaleye (Girella nigricans), kelp bass (Paralabrax clathratus), and garibaldi (Hypsypops rubicundus), as well as small and cryptic convict fish (Oxylebius pictus), island kelpfish (Alloclinus holderi), bluebanded gobies (Lythrypnus dalli), and blackeye gobies (Coryphopterus nicholsii). Convict fish are more abundant on the many banks and islets offshore of Catalina than on Catalina proper; the population at Farnsworth always has been one of the largest. Blackeye gobies typically are associated with the small pockets of sand interspersed throughout the Bank. Somewhat less abundant are señoritas (Oxyjulis californica) and black perch (Embiotoca jacksoni).

Most of the fish species reported from Farnsworth are present in very low numbers, and some observations consist of only one individual. Several of these species, however, may be more abundant in the deeper areas not investigated by the divers. Giant kelpfish (Heterostichus rostratus) and kelp perch (Brachyistius frenatus) rarely are observed, but this is not surprising as both species are closely associated with giant kelp, and giant kelp is not found at Farnsworth. Moray eels (Gymnothorax mordax) are uncommon, but those that are present are very large.

Other uncommon species include swell sharks (Cephaloscyllium ventriosum), C-O turbot (Pleuronichthys coenosus), and pile perch (Damalichthys vacca). A few cottids (Artedius creaseri, A. corallinus) are present, but these species are never abundant at Catalina. Nine species of rockfish were observed during the survey, all in very low numbers: kelp (Sebastes atrovirens), gopher (S. carnatus), copper (S. caurinus), black-and-yellow (S. chrysomelas), starry (S. constellatus), blue (S. mystinus), rosy (S. rosaceus), treefish (S. serriceps), and the sculpin, Scorpaena guttata. Most of the rockfish are more abundant in deeper water. A single Pacific electric ray (Torpedo californica) slowly swam over the Bank on each day of the diving survey, often stopping and hovering for several minutes.

At night, the distribution of fishes changes dramatically. Sheephead, garibaldi, blacksmith, opaleye, and a few kelp bass seek shelter within the rocky crevices. Señoritas bury in the small pockets of sand and shelly debris scattered on the Bank. Other diurnally active fishes remain in essentially the same areas at night but are inactive. Commercial fishing nets snagged on the pinnacles provide shelter for some fishes but entrap others. Several dead sheephead were found entangled in these nets during the survey.

Electric rays, swell sharks, horn sharks, and moray eels are relatively quiescent during the day but are more active at night. Other fishes such as the queenfish, Seriphus politus, and various species of rockfish may move from deeper areas during the day into the shallower portions of Farnsworth at night.

Past ichthyological investigations of Farnsworth Bank have reported the presence of 17 species not observed during the current ASBS survey (Appendix 2). However, most of these species were uncommon, and the small, cryptic species were observed only after the application of poison into the deep crevices. Four of these fishes, striped surfperch (Embiotoca lateralis), red brotula (Brosmophycis marginata), smooth ronquils (Rathbunella hypoplecta), and an undescribed prickleback (Stichaeidae), have not been found elsewhere on Catalina Island.

Intertidal Biota

No intertidal region exists in ASBS Subarea III, as Farnsworth Bank is completely submerged.

Marine Birds and Mammals

Western gulls (Larus occidentalis) are the most common sea birds present within ASBS Subarea III, and flocks of brown pelicans (Pelecanus occidentalis) and double-crested cormorants (Phalacrocorax auritus) regularly fly through the area. Solitary sea lions (Zalophus californianus) occasionally swim through and usually make a series of dives to the shallow part of the Bank before swimming away. Pilot whales (Globicephala macrorhyncus) and porpoise can be expected to swim through the ASBS, as can gray whales (Eschrichtius robustus) during their annual migration through the southern California Borderland from December to March.

Land Vegetation

No land vegetation can exist at Farnsworth Bank, as the area is completely submerged.

Unique Components

The assemblage of marine organisms in ASBS Subarea III is characteristic of the few offshore bank habitats in southern California. Several physical factors combine to account for the assemblage found at Farnsworth Bank: 1) isolation from Catalina Island proper, 2) presence of deep-water ridges and pinnacles rising sharply from the sea floor, 3) exposure to a high degree of water motion caused by open ocean swells and currents, 4) availability of relatively clean water, free of suspended sediments, and 5) upwelling of cold, nutrient-rich water stimulating high biological productivity. The benthic fauna at Farnsworth is dominated by solitary and colonial species of suspension-feeding invertebrates, which remain firmly attached to the steeply sloping pinnacles despite the vigorous currents and surge. These include a wide variety of sessile sponges, hydroids, sea anemones, corals, worms, barnacles, bivalves, bryozoans, and tunicates. Especially abundant are strawberry anemones (*Corynactis californica*), erect bryozoans (e.g., *Diaporoecia californica*, *Hippodiplosia insculpta*, *Phidolopora labiata*), and purple hydrocoral (*Allopora californica*).

ASBS Subarea III also contains individual species unique to this area of Santa Catalina Island. The following species from Farnsworth Bank have not been found (or are very rare) elsewhere around Catalina: the red algae, *Halymenia californica* and *Platysiphonia parva*; the small anemone, *Metridium exilis*; purple hydrocoral (*A. californica*), and its obligate commensal worms

(Autolytus penetrans, Polydora alloporis), barnacle (Armatobalanus nefrens), and snail (Pedicularia californica); top snails (Calliostoma spp); several sea stars (Dermasterias imbricata, Orthasterias koehleri, Pharia pyrimidata); and fishes (Brosmophycis marginata, Rathbunella hypoplecta, Embiotoca lateralis, Sebastes carnatus, S. caurinus, S. chrysomelas, and S. mystinus). Convict fish (Oxylebius pictus) are common at Farnsworth Bank but uncommon elsewhere around Catalina.

Several undescribed species have been collected at Farnsworth Bank. These include a small red alga epiphytic on Carpopeltis bushiae, a hydroid (Podocoryne n sp) epiphytic on Codium cuneatum, two hermit crabs (Pagurus n sp, Pylopagurus n sp), and a prickleback fish (Stichaeidae). Specimens of several of these undescribed species occasionally have been collected in other California locations.

Three specimens of an unusual sea star, tentatively identified by Dr. F. Ziesenhenne (USC) as Pharia pyrimidata, were found during the survey at depths between 80 and 90 ft. The sea star is a colorful tropical species which normally ranges from Peru and the Galapagos Islands north to the Gulf of California. If the species identification proves correct, the Catalina Island records represent an unusual northern range extension for this warm-water species. Other specimens of this sea star have been observed sporadically by divers at Farnsworth Bank since 1959. Three specimens are archived at the Allan Hancock Foundation of USC: two from Farnsworth Bank (1959, 1960) and one from 80 ft at Blue Cavern Point on the lee side of Catalina Island (1967). The P. pyrimidata collected from Catalina and Farnsworth have a lighter color pattern (tan with longitudinal bands of reddish-brown spots) and narrower ray tips than the tropical specimens.

A large population of densely spaced colonies of purple hydrocoral (A. californica), together with their obligate commensal worms, barnacles, and snails, represent the most striking biological component at Farnsworth Bank. Within its entire range (Farallon Islands, San Francisco to Johnston's Rock, Mexico), A. californica is known only from twelve separate locations (Dr. N. Davis, SIO, pers. comm.). In southern California, purple hydrocoral has been found in specific areas at Santa Cruz, Santa Barbara, San Nicolas, and San Clemente Islands, as well as Tanner, Cortes, and Farnsworth Banks. None of the other areas have the concentration of large heads (2 ft or more in diameter) found at Farnsworth.

The biology of A. californica is still not well known. Besides the large, purple "staghorn" variety at Farnsworth, pink and red varieties and other growth forms have been observed elsewhere, especially at Tanner and Cortes Banks. The taxonomic status of these color and structural morphs has not been resolved. Ostarello (1973) studied the reproduction, recruitment, and mortality of colonies off Carmel, California. She found that natural mortality was highest in young colonies and appeared to result primarily from competition for space with other faster-growing organisms or from sedimentation. She also discovered that Allopora was relatively slow growing; one year after settling, colonies averaged 5 mm in diameter. It is not known whether this information is applicable to Allopora at Farnsworth Bank, since the marine environment in central California is different from conditions at Farnsworth. It would be valuable to have similar information, particularly growth rates, at Farnsworth Bank, where the colonies grow to such large sizes.

General information on the distribution and abundance of Allopora and its obligate commensals at Farnsworth Bank is discussed above (see Biological

Description). Specific, quantitative information is not readily obtainable because of the depths involved (100-180 ft) and the difficult and often unsafe diving conditions. Information on the distribution and abundance of Allopora at Tanner and Cortes Banks has been obtained from a recent series of submersible surveys (U.S. Dept. of Interior, Bureau of Land Management 1979). Further information on the commensal syllid and spionid worms (Autolytus penetrans, Polydora alloporis), archaeobalanid barnacle (Armatobalanus nefrens), and ovulid snail (Pedicularia californica) can be found in Zullo (1963), Light (1970), Ostarello (1973), and Wright and Woodwick (1977).

The protection afforded Allopora at Farnsworth Bank by the Ecological Reserve (see Government Designated Open Space, below) is justified considering the rarity and slow growth of this organism, the popularity of Farnsworth with recreational divers, and the desirability of the branching purple colonies as curios for collectors and tourists.

LAND AND WATER USE DESCRIPTIONS

Marine Resource Harvesting

Commercial fishing. The California State Department of Fish and Game has divided oceanic waters along the California coast into a series of units called "Catch Blocks." These units enable the Department to organize, record, and monitor all commercial and sportfishing activities along the coast. ASBS Subarea III lies within Catch Block 762, an area that also includes all of Subarea I, which consists of the entire western portion of Catalina Island (Fig. 12). Catch Block 762 is an important commercial area. Catch statistics for Block 762 are summarized in Dykzeul and Given (1979) and Table 5; however, fishing efforts in the Catch Block do not reflect efforts within Subarea III. Very little commercial fishing occurs within Subarea III as the area is small and few fishermen will risk snagging and losing their fishing gear on the many rocky pinnacles of Farnsworth Bank. Nevertheless, some fishermen set nets in the waters immediately surrounding the Bank, because they believe that fish congregate around the pinnacles. Occasionally fishermen have been unlucky, as evidenced by old and heavily overgrown nets wrapped around several of the pinnacles and newer, less fouled nets over others.

Net and hook-and-line fishing are the only commercial fishing activities near the ASBS. The area does not attract spawning aggregations of market squid, few lobster are present, and abalone are rare within diving depths.

Sportfishing. In general, sportfishing from Commercial Passenger Sportfishing Vessels in Catch Block 762 has declined steadily since 1970. Few

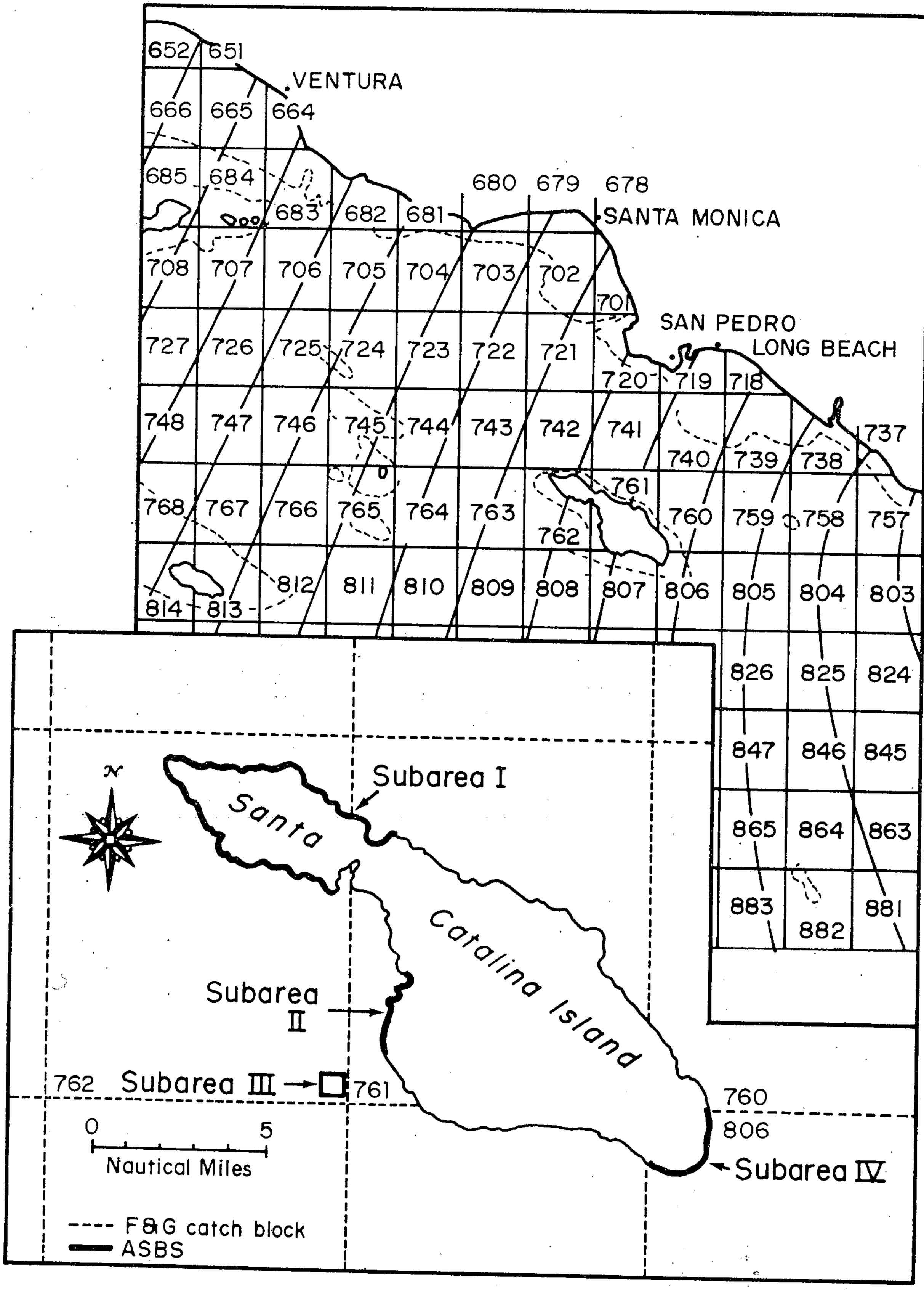

Figure 12: Location of Santa Catalina ASBS Subarea I, II, III, and IV in relation to California Department of Fish and Game Catch Blocks.

Table 5. Commercial fisheries activity from Catch Block 762 during 1975.

Fish	Total Pounds	% Landed in Los Angeles Area	% Landed in California
Jack mackerel (*Trachurus symmetricus*)	3,421,545	9.3	9.3
Northern anchovy (*Engraulis mordax*)	100,620	<0.1	<0.1
Swordfish (*Xiphias gladius*)	72,067	13.6	8.3
Pacific mackerel (*Scomber japonicus*)	11,235	4.0	3.9
Rockfish (*Sebastes* spp.)	7,087	0.9	<0.1
Shark	5,398	4.7	1.2
Bocaccio (*Sebastes paucispinis*)	2,937	--	--
Albacore (*Thunnus alalunga*)	2,446	0.2	<0.1
Vermilion rockfish (*Sebastes miniatus*)	1,227	--	--
White sea bass (*Cynoscion nobilis*)	990	1.8	0.5
Soupfin shark (*Galeorhinus zyopterus*)	855	--	--
Chilipepper (*Sebastes goodei*)	690	--	--
Sculpin (*Scorpaena guttata*)	640	17.8	0.6
Giant sea bass (*Stereolepis gigas*)	195	12.9	3.1
Halfmoon (*Medialuna californiensis*)	195	2.6	1.9
Yellowtail (*Seriola dorsalis*)	127	1.2	0.4
Pacific bonito (*Sarda chiliensis*)	116	<0.1	<0.1
California halibut (*Paralichthys californicus*)	107	<0.1	<0.1
Sheephead (*Semicossyphus pulcher*)	21	0.7	0.3

Table 5 (continued)

Fish	Total Pounds	% Landed in Los Angeles Area	% Landed in California
Perch (embiotocids)	17	0.1	<0.1
Eel	7	100.0	0.9
Invertebrates			
Market squid (*Loligo opalescens*)	1,539,625	11.4	6.5
Lobster (*Panulirus interruptus*)	10,618	13.3	5.3
Abalone	4,781	0.9	0.2
Green (*Haliotis fulgens*)	2,592	1.8	1.5
Pink (*H. corrugata*)	1,067	0.5	0.2
Black (*H. cracherodii*)	562	0.6	0.1
Red (*H. rufescens*)	495	5.5	<0.1
White (*H. sorenseni*)	65	0.1	<0.1
Rock crab (*Cancer* spp.)	310	<0.1	<0.1

of these vessels fish within Subarea III, as it is very small, and other areas closer to the island are more popular. Sportfishing from small private vessels occurs primarily during calm-water conditions, when up to five boats may be present, each with 1-3 fishermen. Most of these boats originate from Catalina Harbor, and several of the fishermen are island residents. Judging from the kinds of sportfish landed in Catch Block 762 during 1978, rockfish and kelp bass are probably the major species caught at Farnsworth, followed by halfmoon, Pacific mackerel, and Pacific bonito (Table 6).

Sportdiving. Farnsworth Bank is one of the most exotic and exciting dive areas in southern California, as it is the nearest to the mainland of the four banks shallow enough for diving off the southern California coast. However, the strong currents and extreme depths require all divers to possess a considerable amount of diving skill and experience. On 8 November 1980, four divers from one boat died while diving on Farnsworth, in what has become the worst single diving accident in California's history.

Commercial Passenger Sportdiving Vessels regularly schedule trips to Farnsworth, but permit diving only when conditions are calm. A survey of five dive-boat skippers conducted in 1980 by the investigators indicated that most vessels make 1-5 trips/mo from May through December and no trips during the remaining months. The skippers considered Farnsworth excellent for photography and average to excellent for sportfish, but poor for abalone, lobsters, and scallops. Not surprisingly, the area was considered a poor place to conduct check-out dives for newly trained divers. Rockfish, sheephead, halfmoon, and kelp bass are the most popular sportfish species, based on the diving survey and sportdiver catches recorded for Catch Block 762 (Table 7).

A limited amount of sportdiving occurs from small private vessels.

Table 6. Catch from commercial passenger sportfishing vessels in Catch Block 762 during 1978. Skin and scuba-diving catches are not included. The southern California area includes all ports between Huntington Beach-Balboa and Santa Barbara-Port Hueneme.

Fish	Number	% Landed in Southern California	% Landed in California
Rockfish (*Sebastes* spp.)	20,824	3.4	0.7
Kelp bass (*Paralabrax clathratus*)	17,790	15.4	4.9
Halfmoon (*Medialuna californiensis*)	9,509	44.3	21.1
Pacific mackerel (*Scomber japonicus*)	7,599	2.7	0.8
Pacific bonito (*Sarda chiliensis*)	6,456	8.4	2.0
Sheephead (*Semicossyphus pulcher*)	2,843	22.3	8.3
Ocean whitefish (*Caulolatilus princeps*)	1,869	13.4	4.9
Lingcod (*Ophiodon elongatus*)	394	18.3	0.6
Rock bass (*Paralabrax* spp.)	339	7.0	5.3
Opaleye (*Girella nigricans*)	222	--	34.4
Cowcod (*Sebastes levis*)	139	12.4	2.3
California halibut (*Paralichthys californicus*)	118	4.8	2.2
Jack mackerel (*Trachurus symmetricus*)	114	25.4	2.2
Yellowfin croaker (*Umbrina roncador*)	111	--	38.9
Sanddab (*Citharichthys* spp.)	106	--	20.2
Blue shark (*Prionace glauca*)	89	--	22.9
Jacksmelt (*Atherinopsis californiensis*)	69	--	30.5

Table 6 (continued)

Fish	Number	% Landed in Southern California	% Landed in California
California barracuda (*Sphyraena argentea*)	55	0.3	<0.1
Yellowtail (*Seriola dorsalis*)	43	2.9	0.1
Sand bass (*Paralabrax nebulifer*)	21	0.1	<0.1
Perch (embiotocids)	12	--	4.5
Sargo (*Anisotremus davidsonii*)	9	--	3.5
White sea bass (*Cynoscion nobilis*)	3	2.8	0.7
Giant sea bass (*Stereolepis gigas*)	1	0	0.7
Silver salmon (*Oncorhynchus kisutch*)	1	0	1.7
Cabezon (*Scorpaenichthys marmoratus*)	1	0.1	<0.1
Kelpfish (*Heterostichus rostratus*)	1	--	--

Table 7. Catch from commercial passenger diving vessels in Catch Block 762 during 1977.

Fish		Number
Sheephead (Semicossyphus pulcher)		699
Kelp bass (Paralabrax clathratus)		322
Sculpin (Scorpaena guttata)		56
Halfmoon (Medialuna californiensis)		32
California halibut (Paralichthys californicus)		23
Rockfish (Sebastes spp.)		22
Sand bass (Paralabrax nebulifer)		11
White seabass (Cynoscion nobilis)		1
Opaleye (Girella nigricans)		1
Yellowtail (Seriola dorsalis)		1
Invertebrates		
Abalone		4,454
Green (Haliotis fulgens)	2,331	
Pink (H. corrugata)	1,576	
Black (H. cracherodii)	349	
Unidentified	102	
White (H. sorenseni)	96	
Rock scallop (Hinnites giganteus)		447
Lobster (Panulirus interruptus)		172

Farnsworth is not marked with surface buoys, and unless line-ups and a fathometer are available, finding the Bank can require a prohibitive amount of time.

Kelp harvesting. Adult specimens of giant kelp have never been found on Farnsworth Bank. Consequently, kelp harvesting does not occur within ASBS Subarea III.

Governmental Designated Open Space

The State of California has designated Farnsworth Bank as an Ecological Reserve. The definition and authority for designation of an "ecological reserve" are included in the following sections of the California Fish and Game Code (Division 2, Chapter 5, Article 4):

> Section 1580. For the purpose of protecting rare or endhangered wildlife or aquatic organisms or specialized habitat types both terrestrial and aquatic, the Department of [Fish and Game], with the approval of the [Fish and Game] Commission, may obtain by purchase, lease, gift, or otherwise, land and water for the purpose of establishing ecological reserves. Such ecological reserves shall not be classed as wildlife management areas pursuant to Section 1504 and shall be exempt from the provisions of Section 1504.
>
> Section 1584. As used in this article "ecological reserve" refers to land or land and water areas preserved in a natural condition for the benefit of the general public to observe native flora and fauna and for scientific study.

The establishment of the Farnsworth Bank Ecological Reserve was first recommended in June 1972 by the Los Angeles County Museum of Natural History. Subsequently, the California Department of Fish and Game received a ten-year lease agreement from the State Lands Commission to manage the area's natural resources. Official designation of the Ecological Reserve at Farnsworth Bank was made by the California Fish and Game Commission on March 3, 1973. The purpose of this action was "to provide protection for the most accessible population of purple coral, Allopora californica, a rare species of coral found in only seven known localities in southern California." Regulations specifically prohibit the collection of purple coral and geological specimens. The Los Angeles County Museum of Natural History also recommended that the taking of any attached plant or animal at Farnsworth Bank be prohibited; however, this recommendation was not accepted by the Fish and Game Commission. Commercial and sportfishing are permitted within the ecological reserve, and all invertebrates may be harvested except purple coral.

In order to prevent damage to the coral heads by anchors, the Natural History Museum further recommended that the state establish a permanent mooring buoy on Farnsworth Bank and prohibit anchoring. The Museum believed that the buoy would facilitate locating the bank and mark the area so that commercial fishermen would not lose their nets on the pinnacles. The Fish and Game Commission ruled that no development of the Ecological Reserve was necessary or anticipated.

Recreational Uses

Party boats and private pleasure boats frequently venture to Catalina Island and its environs for fishing, diving or sightseeing. Sportfishing and scuba diving activities within ASBS Subarea III are discussed above (see Marine Resource Harvesting). Most recreational boating around Catalina Island is pursued with light sailboats and small power boats, during daylight hours, and almost exclusively on the leeward side of the island. The seaward side, including Farnsworth Bank, is several miles more distant and is subject to dangerous waves and swells. Some recreational boats may pass over Farnsworth Bank; however, most skippers are unaware of its presence since the Bank is not marked with surface buoys.

Scientific Study Uses

As Farnsworth Bank is the only ASBS that is completely submerged, all scientific studies must be marine and subtidal. The first scientific studies of Farnsworth occurred in 1955 when USC scientists on board the R/V Velero IV sampled the biota using an orange-peel grab. Two samples were collected from a depth of 96 ft (29 m) and consisted mainly of bryozoans and polychaetes (Hartman 1966). Another sample was collected in 1965. Drs. R. Given and D. Lees of the Catalina Marine Science Center conducted the first biological survey of Farnsworth using scuba when they made a single dive in September 1966.

The Los Angeles County Museum of Natural History conducted a major diving expedition to Farnsworth Bank in December 1970. During this period, biologists made at least 12 person-dives from the R/V Searcher to survey the Bank and to collect representative species. As a result of this study, the Museum supported another series of dives by Bergen and Goenthe from 1971-1973. Information from all surveys led the Museum to recommend the establishment of Farnsworth Bank as an Ecological Reserve in 1972. The photographs and collections from these surveys also were used to construct a diorama of Farnsworth Bank for the Museum's Hall of Marine Biology.

Species lists generated by all of the above surveys are presented in Appendix 2.

Transportation Corridors

No shipping lanes for ocean vessels are located near Subarea III. The nearest shipping lane is the Coast Guard-established Gulf of Catalina shipping lane into Los Angeles-Long Beach Harbors, located 11 mi (18 km) east of Subarea III.

ACTUAL OR POTENTIAL POLLUTION THREATS

Point Sources of Pollution

No municipal or industrial wastes are discharged into ocean waters in or within one mile of Santa Catalina Island ASBS Subarea III. No cooling water effluents, dredge spoils, radioactive wastes, or other materials are known to be dumped in or near Farnsworth Bank. There is no offshore mining or oil development near the ASBS Subarea. Coast Guard regulations prohibit the discharge of untreated sewage from vessels within three miles of shore; however, some vessels ignore these regulations. Minor discharges of sewage from vessels anchored on Farnsworth Bank or passing through the Subarea may occur. The probable impact of any such discharges on the marine environment would be negligible.

Non-Point Sources of Pollution

There are no oil or tar seeps within or near Subarea III. The closest known seeps are near the west end of Catalina (Emery 1960), 12 mi (19 km) from Farnsworth. However, these seeps actually may emanate from shipwrecks (Straughan, cited in Dykzeul and Given 1979).

No major oil spills have been reported within Subarea III. Studies by the Bureau of Land Management (BLM) have calculated the probability of Catalina Island being contacted by one or more 1000-barrel oil spills from tankers or pipes between the years 1979 and 2000 (Table 8). These figures may be applied to Subarea III because of its close proximity to the island. Although there are no beaches within Subarea III to become fouled by oil spills, the water-soluble fractions of a spill may adversely affect the biota on Farnsworth.

The oil spill sources most likely to affect Farnsworth are the existing leases along the Santa Rosa-Cortes Ridge and near Santa Barbara Island. To date, however, there are no production platforms within these areas. Sites yet to be proposed within OCS Lease Call #68 also may be important sources.

Table 8. Probability of Catalina Island being contacted by one or more 1000-barrel oil spills between the years 1979 and 2000 (source: U.S. Dept. Interior, BLM, 1979).

	Days from Spill			
Source	3	10	30	60
Proposed leases	0.02	0.13	0.20	0.22
Existing leases	0.03	0.21	0.32	0.33
Both	0.06	0.32	0.45	0.48

SPECIAL WATER QUALTIY REQUIREMENTS

Observations and preliminary research on the biology of _Allopora californica_ indicate that populations of purple coral are extremely susceptible to sedimentation. Inputs of suspended sediment to an area like Farnsworth Bank would probably kill most coral colonies outright, as well as preventing any new recruitment. Even if water quality were to improve following an episode of destructive sedimentation, _Allopora_ recolonization might not occur or would require a very long period of time. Mortality rates of newly settled individuals are high, and the growth rates of successful recruits are extremely slow. Consequently, any human activities which would increase the sediment load to Farnsworth Bank should not be allowed. No sedimentation problem currently exists, but examples of future activities which could increase offshore sedimentation include the discharge of sewage from upcurrent locations on Catalina Island, or the dumping of dredged material from the Bank.

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Bergen, M. 1973. Farnsworth Bank background and dive survey information (unpublished materials). Los Angeles Co. Mus. Nat. Hist.

Unpublished collection of information gathered from 1971-1973 as background for recommending the establishment of Farnsworth Bank as an Ecological Reserve. Includes a general description of the Bank, a species list, and some (poor quality) movie footage.

California State Department of Fish and Game. Catch Block records for Block 762 for commercial fishing, commercial passenger sportfishing vessels, and commercial passenger diving vessels (unpublished records).

These are computer printouts, with catch items organized by numbers in Catch Blocks.

California State Department of Fish and Game. Fish Bulletin series.

Contains yearly bulletins detailing California marine fish landings. Commercial landings are listed by species, month, and region.

Chen, K. Y and J. C. S. Lu. 1974. Sediment compositions in Los Angeles-Long Beach Harbors and San Pedro Basin. Pages 1-177 in: D. F. Soule and M. Oguri (eds). Marine studies of San Pedro Bay, Calif. Part VII. Sediment investigations.

An extensive analysis of sediment compositions near the mainland, in San Pedro Basin, and around Catalina Island. Three sediment depths were examined for amounts of trace metals, petroleum hydrocarbons, and chlorinated hydrocarbons.

Dykzeul, J. E. and R. R. Given. 1979. California marine waters areas of special biological significance. Reconnaissance survey report. Santa Catalina Island subareas I-IV. Calif. State Water Res. Control Bd. Water Qual. Mon. Rep. 79-6. 192 pp.

A discussion of all ASBS criteria for the west end of Catalina Island (Subarea I). Subareas II-IV are briefly mentioned.

Emery, K. O. 1960. The sea off southern California. Wiley, New York. 366 pp.

The author is a recognized expert and has synthesized oceanographic, geological, and biological information for the Southern California Bight. The recovery of offshore petroleum also is discussed. Some examples are from Catalina Island. An important reference book with an extensive bibliography.

Fay, R. M. 1972. An evaluation of the health of the benthic marine biota of Ventura, Los Angeles, and Orange counties. So. Calif. Assoc. Gov. 117 pp.

This book emphasizes the marine environment within the southern California area and thoroughly discusses the physical, economic, biological, and ecological aspects. An important reference even though Catalina is not discussed in detail.

Gaal, R. A. P. 1966. Marine geology of the Santa Catalina Basin area, California. Ph.D. dissertation, Univ. So. Calif. 275 pp.

Presents a discussion of the submarine geology near Catalina Island, including Santa Catalina Canyon.

Given, R. R. and D. Lees. 1967. Santa Catalina Island biological survey report no. 1, August through December 1965. Univ. So. Calif. Allan Hancock Foundation. 126 pp. (unpublished report).

A mimeographed report detailing biological surveys of various subtidal and intertidal areas off Catalina, including several dives on Farnsworth. Field notes and species lists are presented.

Hartman, O. 1966. Quantitative survey of the benthos of San Pedro Basin, southern California. Part II. Final results and conclusions. Allan Hancock Pac. Exped. 19:1-456.

Three stations were established on Farnsworth Bank and are briefly discussed in this report. Species of bryozoans and polychaetes are listed.

Hendricks, T. J. 1977. Satellite imagery studies. Pages 75-78 in: So. Calif. Coastal Water Res. Project Ann. Rept.

A discussion of surface currents and water temperatures in the Southern California Bight as determined by satellite imagery. An excellent computerized color image is presented.

Jones, J. H. 1971. General circulation and water characteristics in the Southern California Bight. So. Calif. Coastal Water Res. Project. 37 pp.

A detailed discussion of currents and circulation patterns in the Southern California Bight.

Light, W. J. 1970. Polydora alloporis, new species, a commensal spionid (Annelida, Polychaeta) from a hydrocoral off central California. Proc. Calif. Acad. Sci. 37:459-472.

Describes the morphology and general biology of Polydora alloporis. Though material from Farnsworth Bank was not examined, the information should be applicable.

Morin, J. G. and A. Harrington. 1979. California marine waters of special biological significance. Reconnaissance survey report. Mugu Lagoon to Latigo Point. Calif. State Water Res. Control Bd. Water Qual. Mon. Rep. 79-5. 224 pp.

An excellent discussion of all ASBS criteria for the Mugu Lagoon to Latigo Point ASBS on the mainland. Some information on currents is applicable to Catalina.

Ostarello, G. L. 1973. Natural history of the hydrocoral Allopora californica Verrill (1866). Biol. Bull. 145:548-564.

Describes the life history, settlement, mortality, and regeneration of subtidal Allopora colonies at Carmel, California. Much of this information should be applicable to Allopora colonies at Farnsworth.

Platt, J. P. 1976. The petrology, structure, and geologic history of the Catalina Schist terrane, southern California. Cal. Univ. Pubs. Geol. Sci. Vol. 112.

Provides a detailed description and maps of the three main tectonic units exposed on Santa Catalina Island (Blueschist Unit, Greenschist Unit, and Amphibolite Unit).

Risebrough, R. W., B. W. de Lappe, E. F. Letterman, J. L. Lane, M. Firestone-Gillis, A. M. Springer, and W. Walker III. 1980. California mussel watch 1977-1978. Vol. III. Organic pollutants in mussels Mytilus californianus and M. edulis, along the California coast. Water Qual. Mon. Rep. No. 79-22. 278 pp.

A detailed analysis and discussion of organic pollutants found in mussel tissue collected all along the California coast. Two stations are located on Catalina Island.

Southern California Coastal Water Research Project (SCCWRP). 1972. Annual report for the year ended 30 June 1972. W. Bascom, Project Director.

Contains a series of reports documenting the sources and distribution of pollutants in the marine environment off southern California and assesses the impact of these pollutants on the biota.

Stephenson, M. D., M. Martin, S. E. Lange, A. R. Flegal, and J. H. Martin. 1979. California mussel watch 1977-1978. Vol. II. Trace metal concentrations in the California mussel Mytilus californianus. Water Qual. Mon. Rep. No. 79-22. 110 pp.

A detailed analysis and discussion of trace metals found in tissues of the California mussel collected all along the California coast. Two stations are located on Catalina Island.

U.S. Department of the Interior. Bureau of Land Management. 1979. Biological and geological reconnaissance and characterization survey of the Tanner and Cortes Banks. Los Angeles, Calif.

Includes results of a submersible survey conducted to evaluate the distribution and abundance of purple hydrocoral (Allopora californica) relative to proposed commercial harvesting.

U.S. Department of the Interior. Bureau of Land Management. 1979. Final environmental statement for proposed outer continental shelf oil and gas lease sale of southern California. OCS Sale No. 48. Los Angeles, CA.

A series of four volumes describing in great detail the physical, geological, meterological, and biological characteristics of the Southern California Bight. These volumes form the environmental impact report for proposed oil and gas exploration and production within the Bight. Much information is applicable to Catalina in general.

Vance, R. R. 1978. A mutualistic interaction between a sessile marine clam and its epibionts. Ecology 59:679-685.

This study demonstrates that the high rugosity of the Chama shell tends to encourage other suspension-feeding organisms to settle on them. Anemones are one example of these organisms and apparently deter predatory sea stars from preying on the Chama.

Vedder, J. G. and D. G. Howell. 1980. Topographic evolution of the southern California borderland during late Cenozoic time. Pages 7-34 in: D. M. Power (ed). The California Islands: proceedings of a multidisciplinary symposium. Santa Barbara Mus. Nat. Hist. 787 pp.

An excellent summarization of geological and paleontological information for the period beginning in late Miocene (5-6 million years ago) to the Recent. The authors describe in general terms the key events that created the present seafloor topography of the Southern California Borderland.

Water Quality Control Plan Report. 1975. Los Angeles River Basin (4B). Vol. I, Part II. Calif. State Water Res. Control Bd., March 1975.

Wright, J. D. and K. H. Woodwick. 1977. A new species of Autolytus (Polychaeta: Syllidae) commensal on a California hydrocoral. So. Cal. Acad. Sci. Bull. 76:42-48.

Describes the polychaete worm, Autolytus penetrans, an obligate commensal on Allopora californica.

Zullo, V. A. 1963. A review of the subgenus Armatobalanus Hoek (Cirripedia: Thoracica), with the description of a new species from the California coast. Ann. Mag. Natur. Hist., Series 13, 6:587-594.

Contains the original description of the barnacle, Armatobalanus nefrens, an obligate commensal on purple hydrocoral colonies.

Appendix 1. Subtidal Survey Station Data for Santa Catalina Island ASBS Subarea III (Farnsworth Bank).

LOCATION KEY

Dive Site A = The main pinnacle area, marked by a buoy during the diving surveys.

Dive Site B = A secondary pinnacle approximately 350 yds (320 m) west of the main pinnacle.

SEA STATE KEY

Calm = 0-2 ft swells

Slight = 2-4 ft swells

Mod = 4-8 ft swells

CURRENT KEY

None = 0-0.25 knots

Low = 0.25-0.75 knots

Med = 0.75-1.5 knots

High = 1.5-3.0 knots

Survey Station	Date	Dive Site	Sea State	Current	Water Temp (°C) Surface	Water Temp (°C) Bottom	Depth (ft)	Visibility (ft)
III-0	11-28-79	A	Calm	Med	16.0	14.0	80	50
III-1	11-29-79	A	Calm	Low	16.0	14.5	80	60
III-6	11-30-79	A	Mod	None	16.0	13.0	100	100
III-10	12-1-79	A	Mod	Med	16.0	15.0	70	60
III-15	12-2-79	B	Slight	None	16.0	13.5	100	50
III-21	12-3-79	A	Slight	Med	16.0	13.5	90	50
III-27	12-4-79	A	Calm	Low	16.0	14.0	100	70

APPENDIX 2. Organisms Found at FarnsworthBank during the ASBS Survey and by Previous Investigators.

SURVEYS

1) **ASBS SITE A:** Scuba surveys conducted in the area of the main pinnacle by the investigators during the period November 28 to December 4, 1979. Data from ASBS Stations 0, 1, 6, 10, 21, and 27 are combined.

2) **ASBS SITE B:** Scuba surveys conducted in the area of a secondary pinnacle by the investigators on December 2, 1979 (ASBS Station 15).

3) **BERGEN (1973):** Scuba surveys conducted by the Los Angeles County Museum of Natural History during December 1970, and by museum divers M. Bergen and H. Goenthe from 1971 to 1973.

4) **GIVEN (1967):** Scuba survey dive conducted by R. Given and D. Lees on September 30, 1966, for the Catalina Marine Science Center (SCIBS 58:66).

5) **HARTMAN (1966):** Orange-peel grab samples taken by USC scientists from the R/V *Velero IV* on October 29, 1955 (Stations 3594 and 3596) and February 14, 1965 (Station 10334).

KEY

1=Rare
2=Present
3=Common
4=Abundant
X=Abundance not determined
*=Laboratory identification (voucher specimens preserved)

	ASBS Site A	ASBS Site B	Bergen (1973)	Given (1967)	Hartman (1966)
PHYLUM CHLOROPHYTA (green algae)					
Codium cuneatum	2*	2	X*	X	
Codium fragile		1			
Codium hubbsii			X*		
Codium hubbsii/setchellii	3	3			
Codium setchellii	3*			X	
Derbesia marina ("*Halocystis*" stage)	2			X	
PHYLUM PHAEOPHYTA (brown algae, kelp)					
Agarum fimbriatum			X*		
Colpomenia sinuosa/Hydroclathrus clathratus		1			
Cystoseira osmundacea (bladder kelp)	3*	3	X*	X*	
Cystoseira setchellii	2*				
Dictyopteris undulata		2			
Dictyota binghamiae	2*				
Dictyota flabellata	2*				
Eisenia arborea (southern sea palm)	3*	3	X*	4	
Laminaria farlowii	3	2	X*	X	
Pachydictyon coriaceum	1				
PHYLUM RHODOPHYTA (red algae)					
Acrosorium uncinatum	1	3	X*		
Antithamnion defectum	2*				
Antithamnion hubbsii	2*				
Antihamnion sp.			X*		
Binghamia forkii			X*		
Bossiella sp.			X*	X	
Botryocladia pseudodichotoma		1	X*		
Calliarthron cheilosporioides			X*	X*	
Calliarthron/Bossiella (erect corallines)	3	2			
Callophyllis firma			X*		
Callophyllis sp.			X*		
Carpopeltis bushiae	2	2			
Ceramiales	3	3			
Ceramium sp.			X*		
Corallina officinalis chilensis				X	
Corallina vancouveriensis	3	3			
Corallines-encrusting	3	3			
Corallines-erect	3	3			
Cryptopleura corallinara			X*		
Delesseriaceae	3	3			
Gelidium nudifrons	2	1		X*	
Gelidium purpurascens	3	3	X*		
Gelidum robustum	3	3	X*	X*	
Gigartina corambifera	1		X*		
Gigartina spinosa	1				
Griffithsia pacifica	1				
Halymenia californica			X*		
Herposiphonia plumula	2*		X*		
Heterosiphonia erecta	2*		X*		
Laurencia spectabilis	2*				

	ASBS Site A	ASBS Site B	Bergen (1973)	Given (1967)	Hartman (1966)
PHYLUM RHODOPHYTA (continued)					
Lithothamnion giganteum				X	
Lithothamnion lamellatum				X	
Melobesia sp.				X*	
Membranoptera weeksiae	2*				
Murrayellopsis dawsonii	2*				
Myriogramme repens	2*				
Nienburgia andersoniana			X*		
Platysiphonia parva	2*				
Pleonosporium vancouverianum	3*		X*		
Plocamium cartilagineum	3*	2	X*		
Polysiphonia sp.	3	3			
Prionitis australis			X*		
Prionitis cornea			X*		
Prionitis sp.	2*	2			
Pterocladia capillacea	2	2		X*	
Pterosphonia dendroidea	2*				
Ptilothamnion lejolisea	2*				
Pugetia fragilissima	2*				
Rhodymenia californica	3	3	X*	X	
Rhodymenia pacifica	2	2	X*	X	
Sciadophycus stellatus	2*	2			
Sorella delicatula	2*				
PHYLUM PORIFERA (sponges)					
CLASS DEMOSPONGIAE (common sponges)					
Acarnus erithacus	2				
Axinella mexicana	2		X*	X*	
Cliona celata				X*	
Haliclona permollis			X*		
Lissodendoryx firma				X*	
Lissodendoryx topsenti			X*		
Mycale psila				X*	
Penares cortius	1	1	X*		
Spheciospongia confoederata (gray moon sponge)	1	1		X	
Stelleta sp.				X*	
Tethya aurantia (orange puffball sponge)	3	2		X	
Verongia aurea (sulphur sponge)	2				
CLASS CALCAREA (calcareous sponges)					
Leucandra heathi				X*	
Sycon sp.				X*	
PHYLUM CNIDARIA					
CLASS ANTHOZOA (anemones, corals, etc.)					
ORDER ZOANTHINIARIA (zoanthid anemones)					
Parazoanthus lucificum	2				
ORDER CORALLIMORPHARIA					
Corynactis californica (strawberry anemone)	4	4	4	X	
ORDER ACTINIARIA (anemones)					
Anthopleura elegantissima (green anemone)	1		X		
Epiactis prolifera (proliferating anemone)	3	2	3	4*	
Metridium exilis	3	3	X*	X	
Sagartia catalinensis				X	
Tealia coriacea	1		X*		
Tealia lofotensis	1			X	
ORDER SCLERACTINIA (corals)					
Astrangia lajollensis (aggregate coral)	2				
Coenocyathus bowersi (colonial coral)	2	1	X	X	
Paracyathus stearnsi (goblet coral)	3	2	4	X	
ORDER STOLONIFERA (octocorals)					
Clavularia sp.	2				
ORDER GORGONACEA (gorgonians)					
Lophogorgia chilensis (pink gorgonian)	3	2	3	X	
Muricea californica (golden gorgonian)	3	1	X	X	
Muricea fruticosa (brown gorgonian)	2	1		X	
CLASS HYDROZOA (hydroids)					
Abietinaria expansa				X*	
Aglaophenia octocarpa				X*	
Aglaophenia struthionides (ostrich-plume hydroid)				X*	
Aglaophenia sp.	3	3		X	
Allopora californica (purple hydrocoral)	4*	3*	4*	4*	X*
Antenella avalonia			X*	X*	
Calycella syringa				X*	
Campanularia urceolata				X*	
Clitia attenuata				X*	
Eucopella everta				X*	
Filellum serpens				X*	
Garvia annulata				X*	
Halecium pygmaeum				X*	
Hydractinia sp.	1				
Plumularia insolens				X*	
Sertularella sinuosa				X*	
Sertularella turgida				X*	
Sertularia sp.	3				
Synthecium cylindricum				X*	

	ASBS Site A	ASBS Site B	Bergen (1973)	Given (1967)	Hartman (1966)
PHYLUM ANNELIDA (segmented worms)					
CLASS POLYCHAETA (polychaete worms)					
Allia monicae					X*
Anaitides madeirensis					X*
Aricidia neosuecica					X*
Autolytus penetrans (purple hydrocoral syllid)			3		
Capitella capitata					X*
Caulleriella alata					X*
Chloeia pinnata					X*
Chone gracilis					X*
Circeis americana				X*	
Dodecaceria sp.					X*
Eurythoe complanata					X*
Haploscoloplos elongatus					X*
Harmothoe extenuata					X*
Harmothoe hirsuta					X*
Hesionura difficilis					X*
Laonice cirrata					X*
Lumbrineris acutiformis					X*
Lumbrineris japonica					X*
Lumbrineris latreilli					X*
Lysidice ninetta					X*
Minuspio cirrifera					X*
Myriochele gracilis					X*
Notomastus latericeus					X*
Odontosyllis phosphorea					X*
Ophiodromis pugettensis					X*
Owenia collaris					X*
Pareurythoe californica					X*
Pherusa capulata					X*
Pherusa papillata					X*
Pholoe glabra					X*
Pholoides aspera					X*
Pisione remota					X*
Pista cristata					X*
Placostegus californicus				X*	
Plakosyllis americana					X*
Platynereis bicanaliculata					X*
Polydora alloporis (purple hydrocoral spionid)	3	3	X*		X*
Prionospio malmgreni					X*
Protodorvillea gracilis					X*
Protolaeospira eximius			X*		
Psammolyce spinosa					X*
Questa caudicirra					X*
Salmacina tribranchiata					X*
Scoloplos acmeceps					X*
Spiochaetopterus costarum	1				X*
Spiophanes bombyx					X*
Spirobranchus spinosus (calcareous tube worm)	3	2		X	
Spirorbidae	3				X*
Tauberia gracilis					X*
Tharyx monilaris					X*
Vermiliopsis biformis					X*
PHYLUM ARTHROPODA					
CLASS CRUSTACEA					
SUBCLASS CIRRIPEDIA (barnacles)					
Armatobalanus nefrens (purple hydrocoral barnacle)	3	3			
Balanus nubilus/aquila			X*		
Balanus trigonus			X*		
Conopea galeatus			X*		
Megabalanus californicus (red and white barnacle)	3	3	3*	X*	
SUBCLASS MALACOSTRACA					
ORDER DECAPODA (shrimp, lobster, crabs, etc.)					
Alpheus clamator (snapping shrimp)				X*	
Cancer antennarius (rock crab)			X*		
Erileptus spinosus (crab)			X*		
Lophopanopeus bellus (crab)			X*		
Lophopanopeus sp. (crab)			X*	X*	
Lysmata californica (red rock shrimp)	1			X*	
Paguristes parvus (hairy hermit crab)			X*	X*	
Paguristes ulreyi (hairy hermit crab)			X*		
Pagurus n. sp. (hermit crab)			X*		
Panulirus interruptus (California spiny lobster)	2		X		
Paraxanthias taylori (bumpy crab)			X*	3*	
Petrolisthes sp. (porcelain crab)				X*	
Podochelia hemphilli (crab)			X*		
Pugettia dalli (masking crab)			X*	X*	
Pugettia venetiae (crab)			X*	X*	
Pylopagurus californiensis (hermit crab)			X*		
Pylopagurus diegensis (hermit crab)			X*		
Pylopagurus guatemoci (hermit crab)			X*		
Pylopagurus n. sp. (hermit crab)				X*	

	ASBS Site A	ASBS Site B	Bergen (1973)	Given (1967)	Hartman (1966)
ORDER DECAPODA (continued)					
Scyra acutifrons (masking crab)			X*	X*	
Synalpheus lockingtoni (shrimp)				X*	
Taliepus nuttalli (crab)				X*	
PHYLUM MOLLUSKA					
CLASS GASTROPODA					
SUBCLASS PROSOBRANCHIA (snails)					
Acanthina spirata			X*		
Acmaea funiculata (limpet)			X*		
Amphissa versicolor			X*		
Astraea gibberosa (red turban)	1	1	X*		
Astraea undosa (wavy top turban)	2		X	X	
Calliostoma annulatum		1	X*		
Calliostoma supragranosum			X*	3*	
Calliostoma sp.	1			X*	X*
Conus californicus (California cone)	2		X*	X*	X*
Crepidula dorsata (half slipper)			X*		
Cypraea spadicea (chestnut cowrie)	3	2	X	X	
Dendropoma sp.			X*	X*	
Diodora arnoldi (keyhole limpet)			X*		
Engina strongi			X*		
Fusinus luteopictus			X*		
Haliotis corrugata (pink abalone)	1		X		
Haliotis sorensoni (white abalone)	1		X	X	
Hipponix cranioides			X*		
Hipponix tumens			X*		
Homalopoma luridum			X*		
Homalopoma paucicostatum			X*		
Kelletia kelletii (Kellet's whelk)	2	2	3	X	
Latiaxis oldroydi	1		X*		
Macrarene cookeana			X*		
Maxwellia gemma (gem murex)	2	1	X*		
Maxwellia santarosana	1		X*		
Megathura crenulata (giant keyhole limpet)	3	1	3	X	
Nassarina penicillata			X*		
Nassarius sp.			X*		
Norrisia norrisi (kelp turban)	1				
Ocenebra minor			X*		
Pedicularia californica (purple hydrocoral snail)	3	3	X*		X*
Seila montereyensis			X*	X*	
Serpulorbis squamigerus (tube snail)	2		X		
Tegula regina (queen turban)	1		X*		
Trivia californiana (coffee bean snail)			X*		
Trivia solandri (coffee bean snail)	1				
Vermicularia fewkesi			X*		
Volvarina sp.					X*
SUBCLASS OPISTHOBRANCHIA (sea slugs)					
Aeolidia papillosa			X*		
Anisodoris nobilis	1		X*		
Armina californica			X*		
Cadlina limbaughi			X*		
Cadlina luteomarginata	1	1	X*		
Cadlina modesta			X*		
Chromodoris macfarlandi			X*		
Diaulula sandiegensis			X*		
Doriopsilla albopunctata			X*	X*	
Doto amyra			X*		
Flabellinopsis iodinea (iodine sea slug)	2	2	X*	X	
Hermissenda crassicornis	2		X*		
Hypselodoris californiensis			X*		
Jorunna n. sp.	1				
Mexichromis porterae	1		X*		
Navanax inermis	1				
Phidiana pugnax			X*		
Pleurobranchus strongi			X*		
Tritonia exsulans			X*		
Tritonia festiva			X*		
CLASS PELECYPODA (clams and mussels)					
Chama arcana (rock oyster)	3	2			
Chlamys hastata (spear scallop)			X*		
Epilucina californica (clam)	1				
Hiatella artica (clam)			X*	X*	X*
Hinnites giganteus (rock scallop)	2	2	3	X	X*
Kellia laperousii (clam)			X*		X*
Leptopecten latiauratus (scallop)				X*	
Lima hemphilli (file shell)			X*		X*
Lithophaga plumula (date mussel)			X*		
Lucina californica (clam)			X*		
Modiolus capax (horse mussel)			X*		
Pecten diegensis (scallop)			1*	1*	
Saxidomus nuttalli (clam)			X*		
Ventricolaria fordii (clam)			X*		

	ASBS Site A	ASBS Site B	Bergen (1973)	Given (1967)	Hartman (1966)
CLASS CEPHALOPODA (octopus and squid)					
Octopus bimaculatus (two-spot octopus)	2			X	
PHYLUM ECTOPROCTA (bryozoans)					
Alderina smitti					2*
Amastigia rudis					2*
Antropora tincta	1		X*	X*	2*
Arthropoma cecili			X*		
Arthropoma circinata			X*		
Bugula neritina	2		X*		
Caberia boryi					2*
Callopora circumclathrata			X*		2*
Callopora corniculifera			X*		2*
Callopora horrida			X*		
Callopora inconspicua			X*		2*
Caulibugula ciliata				X*	
Cauloramphus brunnea					2*
Cauloramphus spiniferum			X*		2*
Cellaria mandibulata			X*		2*
Celleporaria brunnea			X*		3*
Celleporella sp.				X*	
Celleporina procumbens					2*
Celleporina robertsoniae			X*	X*	3*
Chaperiella californica			X*		2*
Chaperiella patula					2*
Cleidochasma porcellana					2*
Coleopora gigantea			X*		
Colletosia radiata			X*		2*
Copidozoum tenuirostre					2*
Crepidacantha poissoni			X*		2*
Crisia maxima				X*	
Crisia occidentalis					2*
Crisia serrulata			X*		
Crisidia corunata					2*
Dendrobeania longispinosa					2*
Diaperoecia californica (staghorn bryozoan)	3	3	X*	X*	3*
Disporella californica				X*	
Disporella fimbriata			X*		
Ellisina levata			X*		
Emballotheca obscura					2*
Escharella major			X*		2*
Fenestrulina malusi			X*		2*
Figularia hilli			X*		2*
Filicrisia sp.				X*	
Hincksina velata			X*		
Hippodiplosia insculpta (fluted bryozoan)	3	2	X*	X*	2*
Hippomenella flava			X*		
Hippomonavella longirostrata			X*		2*
Hippoporella gorgonensis					2*
Hippothoa distans			X*		2*
Hippothoa hyalina			X*	X*	2*
Lagenipora hippocrepis			X*		
Lagenipora mexicana			X*		
Lagenipora punctulata			X*		2*
Lagenipora socialis					2*
Lagenipora spinulosa					2*
Lichenopora novae-zelandiae	2	2	X*	X*	
Lyrula hippocrepis			X*	X*	2*
Membranipora tuberculata (frost bryozoan)	3	2		X*	
Micropora coriacea			X*		3*
Microporella californica				X*	2*
Microporella ciliata			X*		2*
Microporella cribrosa			X*		2*
Microporella gibbosula			X*		
Microporella vibraculifera			X*		2*
Mollia patellaria					2*
Oncousoecia ovoidea			X*		
Pachyegis brunnea			X*		
Phidolopora labiata (lacy bryozoan)	3	2	4*	X*	4*
Porella patens					2*
Porella porifera			X*		3*
Proboscina sp.			X*	X*	2*
Reginella mucronata			X*		2*
Rhamphostomella curvirostrata					2*
Rhynchozoon grandicella			X*		2*
Rhynchozoon rostratum (pink encrusting bryozoan)	3	2	X*	X*	2*
Rhynchozoon tumulosum			X*		
Schizomavella auriculata					2*
Scrupocellaria varians					2*
Smittina altriostris			X*		
Smittina landsborovi					2*
Smittina maccullochae			X*		
Smittoidea prolifica			X*		
Stephansula vitrea					2*

	ASBS Site A	ASBS Site B	Bergen (1973)	Given (1967)	Hartman (1966)
PHYLUM ECTOPROCTA (continued)					
Stomachetosella sp.				X*	
Stomatopora granulata			X*		
Thalamoporella californica				X*	
Trypostega claviculata			X*		2*
Tubulipora flabellaris			X*	X*	
Tubulipora pacifica					2*
PHYLUM ECHINODERMATA					
CLASS ASTEROIDEA (sea stars)					
Astrometis sertulifera (soft spiny star)	1		3*	X	
Dermasterias imbricata (leather star)			2		
Henricia leviuscula (blood star)	3	3	3	X	X*
Linckia colombiae (comet star)	1		X		
Mediaster aequalis (red star)			X		
Orthasterias koehleri (rainbow star)	1				
Patiria miniata (bat star)	3	3	2		X*
Pharia pyrimidata	1*		X*		
Pisaster giganteus (blue star)	2	2	3	X	
Pisaster ochraceus (ochre star)			X		
Sclerasterias heteropaes			X		
CLASS ECHINOIDEA (sea urchins)					
Centrostephanus coronatus (black urchin)	2	2	X	1	
Lytechinus anamesus (white urchin)			3		X*
Strongylocentrotus franciscanus (red urchin)	2	1	X	3	
Strongylocentrotus purpuratus (purple urchin)	2	1			
CLASS OPHIUROIDEA (brittle stars)					
Amphoiodia urtica					X*
Amphipholis squamata			X*		X*
Amphipholis pugetana					X*
Ophioncus granulosus			X*		
Ophiopsila californica					X*
Ophiopteris papillosa			X*	X*	X*
Ophiothrix spiculata			X*	X*	X*
CLASS HOLOTHUROIDEA (sea cucumbers)					
Cucumaria salma (salmon cucumber)	1		X*		
Parastichopus parvimensis (southern cucumber)	3	1	3	X	
PHYLUM CHORDATA					
CLASS ASCIDIACEA (tunicates)					
Aplidium californicum			X*		
Aplidium solidum				X*	
Clavelina huntsmani (light bulb tunicate)	2		X		
Euherdmania claviformis (sand tunicate)	2				
Metandrocarpa taylori (orange tunicate)	1				
Pyura haustor	1			X	
Trididemnum opacum (white tunicate)	3	3		X*	
CLASS CHONDRICHTHYS (sharks and rays)					
Cephaloscyllium ventriosum (swell shark)	1		X		
Prionace glauca (blue shark)	1		3		
Squatina californica (angel shark)			2		
Torpedo californica (Pacific electric ray)	1				
CLASS OSTEICHTHYES (bony fishes)					
ORDER ANGUILLIFORMES (eels)					
Gymnothorax mordax (moray eel)	1		2	X	
ORDER GADIFORMES					
Brosmophycis marginata (red brotula)			X*		
Chilara taylori (spotted cusk-eel)			X*		
ORDER GASTEROSTEIFORMES					
Syngnathus sp. (pipefish)			X*		
ORDER PERCIFORMES					
FAMILY BATHYMASTERIDAE (ronquils)					
Rathbunella hypoplecta (smooth ronquil)			2*		
FAMILY BRANCHIOSTEGIDAE					
Caulolatilus princeps (ocean whitefish)			2*		
FAMILY CARANGIDAE (jacks)					
Seriola dorsalis (yellowtail)				X	
Trachurus symmetricus (jack mackerel)			X		
FAMILY CLINIDAE (clinids)					
Alloclinus holderi (island kelpfish)	3	3	X*		
Cryptotrema corallinum (deepwater blenny)			X*		
Gibbonsia erythra (scarlet kelpfish)			X*		
Gibbonsia sp. (kelpfish)	1				
Heterostichus rostratus (giant kelpfish)			X*		
FAMILY COTTIDAE (sculpins)					
Artedius corallinus (coralline sculpin)	1		X*		
Artedius creaseri (roughcheek sculpin)	1		X*		
Scorpaenichthys marmoratus (cabezon)			X*		
FAMILY EMBIOTOCIDAE (surf perches)					
Brachystius frenatus (kelp perch)	1				
Damalichthys vacca (pile perch)	1		X*		
Embiotoca jacksoni (black perch)	1		X*	X	
Embiotoca lateralis (striped perch)			2		
Phanerodon atripes (sharpnose perch)	1		X*		
Rhacochilus toxotes (rubberlip perch)			X*		

	ASBS Site A	ASBS Site B	Bergen (1973)	Given (1967)	Hartman (1966)
FAMILY GOBIIDAE (gobies)					
Coryphopterus nicholsii (blackeye goby)	2	3	3*	X	
Lythrypnus dalli (bluebanded boby)	2	3	3*	X	
Lythrypnus zebra (zebra goby)	1		X*		
FAMILY HEXAGRAMMIDAE (greenlings)					
Oxylebius pictus (convict fish)	2	2	3*	X	
FAMILY KYPHOSIDAE (sea chubs)					
Girella nigricans (opaleye)	2	2	3	X	
Medialuna californiensis (half moon)	3	2	3	X	
FAMILY LABRIDAE (wrasses)					
Oxyjulis californica (senorita)	2	1	4*	X	
Semicossyphus pulcher (sheephead)	2	1	4*	X	
FAMILY POMACENTRIDAE (damselfishes)					
Chromis punctipinis (blacksmith)	3	4	X*	X	
Hypsypops rubicunda (garibaldi)	2	2	X		
FAMILY SCOMBRIDAE (mackerels)					
Sarda chiliensis (Pacific bonito)			X		
FAMILY SCORPAENIDAE (rockfishes)					
Scorpaena guttata (sculpin)	1	2	3*		
Sebastes atrovirens (kelp rockfish)	1		2*		
Sebastes carnatus (gopher rockfish)		1	X*		
Sebastes caurinus (copper rockfish)	1				
Sebastes chrysomelas (black-and-yellow rockfish)		1			
Sebastes constellatus (starry rockfish)	1		3*		
Sebastes hopkinsi (squarespot rockfish)			X*		
Sebastes miniatus (vermillion rockfish)			2		
Sebastes mystinus (blue rockfish)	1	1	4*		
Sebastes rosaceus (rosy rockfish)	1		X*		
Sebastes serranoides (olive rockfish)			2		
Sebastes serriceps (tree fish)	1	2	3*	X	
FAMILY SERRANIDAE (sea basses)					
Paralabrax clathratus (kelp bass)	2	2	2	2	
FAMILY STICHAEIDAE (pricklebacks)					
Stichaeid-unid.			X*		
ORDER PLEURONECTIFORMES (flatfishes)					
FAMILY PLEURONECTIDAE					
Pleuronichthys coenosus (c-o turbot)	1		X*		
ORDER TETRAODONTIFORMES					
FAMILY MOLIDAE					
Mola mola (common mola)				X	
CLASS MAMMALIA					
ORDER CARNIVORA					
Globicephala macrorhyncus (pilot whale)			X		
Zalophus californianus (California sea lion)	1	1	X		

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