California Marine Waters
Areas of Special Biological Significance
Reconnaissance Survey Report

CALIFORNIA STATE WATER RESOURCES CONTROL BOARD

SURVEILLANCE AND MONITORING SECTION

June 1982

WATER QUALITY MONITORING REPORT NO. 81-6

CALIFORNIA MARINE WATERS
AREAS OF SPECIAL BIOLOGICAL SIGNIFICANCE

RECONNAISSANCE SURVEY REPORT

SANTA ROSA ISLAND
SANTA BARBARA COUNTY

STATE WATER RESOURCES CONTROL BOARD

DIVISION OF TECHNICAL SERVICES

SURVEILLANCE AND MONITORING SECTION

June 1982

WATER QUALITY MONITORING REPORT NO. 81-6TS

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*

ACKNOWLEDGEMENTS

The survey results reported herein are those of the contractor and do not necessarily reflect the opinion or the policies of the State Water Resources Control Board or the California Department of Fish and Game.

This State Water Resources Control Board Report is based on a reconnaissance survey report by Drs. Bruce H. Robison and James L. Cox of the University of California, Santa Barbara, Marine Science Institute. The authors, and the Board, acknowledge with thanks the efforts of the field team, composed of T. Bailey, K. Johnson, K. Reisenbichler and S. Willason, and the expert assistance of H. Ehrenspeck and R. Williamson.

The reconnaissance survey 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 Area of Special Biological Significance Survey Reports for the State Water Resources Control Board under an interagency agreement.

ABSTRACT

The objective of this study was to survey the nearshore and coastal shoreline regions of the Santa Rosa Island Area of Special Biological Significance. This preliminary survey is intended to provide the necessary background for preparing and conducting future baseline surveys and monitoring programs. The survey included subtidal diving operations, intertidal transects, beach and coastline surveys, and aerial photographic surveys. This report provides a description of the Santa Rosa ASBS in terms of its biological, geological, and hydrographic characteristics.

Santa Rosa Island has a rugged coastal perimeter, 50.3 miles in length, with steep rocky cliffs punctuated by sand and cobble beaches. Its intertidal and subtidal zones contain rich and diverse biotic communities, particularly the series of kelp forests which ring the island. Santa Rosa is a breeding and pupping area for the harbor seal and California sea lion. It is also an important rookery area for three marine bird species. The principal pollution threats to the ASBS come from the exploitation of petroleum resources in the Santa Barbara Channel and shipping traffic in the Channel. The ASBS has been divided into four subregional areas, based on watershed configuration, which can form the basis for baseline and monitoring surveys.

TABLE OF CONTENTS

TABLE OF CONTENTS (cont.)

LIST OF FIGURES

LIST OF TABLES

FINDINGS AND CONCLUSIONS

Santa Rosa Island is a fine example of southern California's natural coastal environment. The degree of protection which it now receives from water quality degradation is adequate because of the enlightened attitude of its private owners and its relative isolation from mainland influences. If the Channel Islands National Park is developed as planned, then the degree of protection afforded should be adequate, except as noted below. The Channel Islands Marine Sanctuary also offers protection, although the sanctuary itself is threatened by the development of petroleum resources. Baseline and monitoring programs should be conducted, whatever the outcome of the Park's progress, in order to fully categorize and characterize the island's marine habitats and communities so that they may be sustained. The greatest present destructive threat is oil pollution from offshore drilling platforms and increasing tanker and commercial vessel traffic in the Channel. There is little predictive capability to estimate the effects of such pollution because of the paucity of information on the area's current patterns, particularly along the southern coastlines of the northern Channel Islands, where the next stages of petroleum resource development will take place.

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 Board's 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 the Santa Rosa Island ASBS, a reconnaissance survey integrating existing information and additional field study was performed by Drs. Bruce H. Robison and James L. Cox of the University of California, Santa Barbara. 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.

This reconnaissance survey was conducted as a necessary prelude to future baseline and monitoring surveys of this Area of Special Biological Significance. Its purpose was to explore the area and provide a descriptive characterization and categorization for use in planning future surveys. The reader is advised that the photographic record of the survey is archived at the State Water Resources Control Board, Division of Technical Services.

Santa Rosa Island is an area of particular biotic significance because of the rich kelp forests which surround it and because of the nesting areas for sea birds which occur along the northern shoreline. Santa Rosa is habitat for endemic plants, the Channel Islands fox, rare and endangered plant species, the endangered California brown pelican, 35 resident bird species and 100 seasonal migrants, and 6 marine mammal species. It is also an area with Chumash archaeological sites.

Its isolation from the mainland plus the character and extent of its subtidal and intertidal substrates make the island's nearshore waters an outstanding marine habitat. The nearshore area contains many plant and animal species which have suffered greatly from anthropogenic perturbation and which occur nowhere else in comparably "natural" habitats.

ORGANIZATION OF SURVEY

Santa Rosa Island is the second largest of southern California's eight Channel Islands. Santa Rosa is 15 miles long and 9 miles wide at its widest point; it has a coastal perimeter of 50.3 miles and an area of 84 mi^2. Because of the large area covered in this survey, the island has been divided into subregional watershed areas. Figure 2 depicts the division of Santa Rosa Island into subregions. Using detailed USGS topographic maps, major watershed areas were identified and outlined. The criteria for determining subregions and their associated watershed areas were:

1. subregions of roughly equal size;

2. shore areas representative of different combinations of microclimate, oceanic influences, terrestrial influences, and geomorphology;

3. convenience of access to each area for shoreline surveys and subtidal transects; and

4. suitability as sites for future baseline surveys and monitoring programs.

Tables 1 and 2 summarize the areal coverage and other salient features of each subregion. The nearshore components are circumscribed by boundaries drawn one mile out from major promontories, normal to the general coastline, and connected by lines parallel to the general coastline (see Figures 3 through 6).

The severity of the local weather and sea state, and the inaccessibility of representative study sites, were major factors in the present survey and must be basic considerations in any future studies. Access to the island itself is limited because of its distance offshore. It is accessible by boat but landing permits must be obtained in advance, [from the Vail and Vickers Co., 123 West Padre Street, Suite D, Santa Barbara, CA 93105.] The island's terrain and rugged coastline make much of it inaccessible. Small boats are necessary for access to those areas which cannot be reached by land.

In the present study, the four subregional areas were investigated by: beachwalks for adjacent land area, beach, and intertidal zone surveys; SCUBA and free-diving surveys of the subtidal zone; and aerial surveys. Not all procedures were conducted in each area due to legal restrictions and because of obvious factors such as the lack of a beach or because of weather and sea state conditions. In addition to the field work, much information was obtained from discussions with researchers who are currently conducting programs at Santa Rosa.

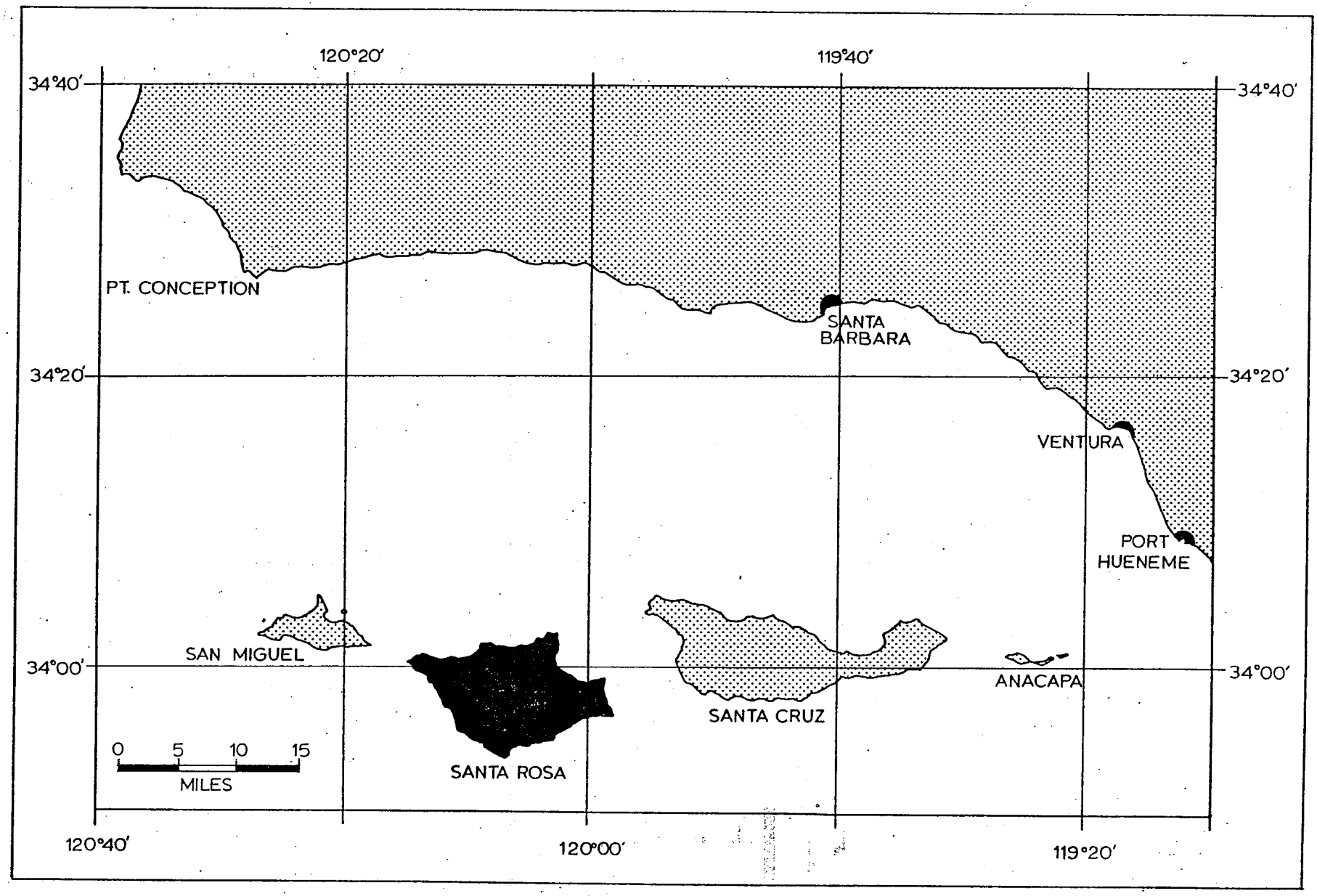


Figure 1. Location map of Santa Rosa Island.

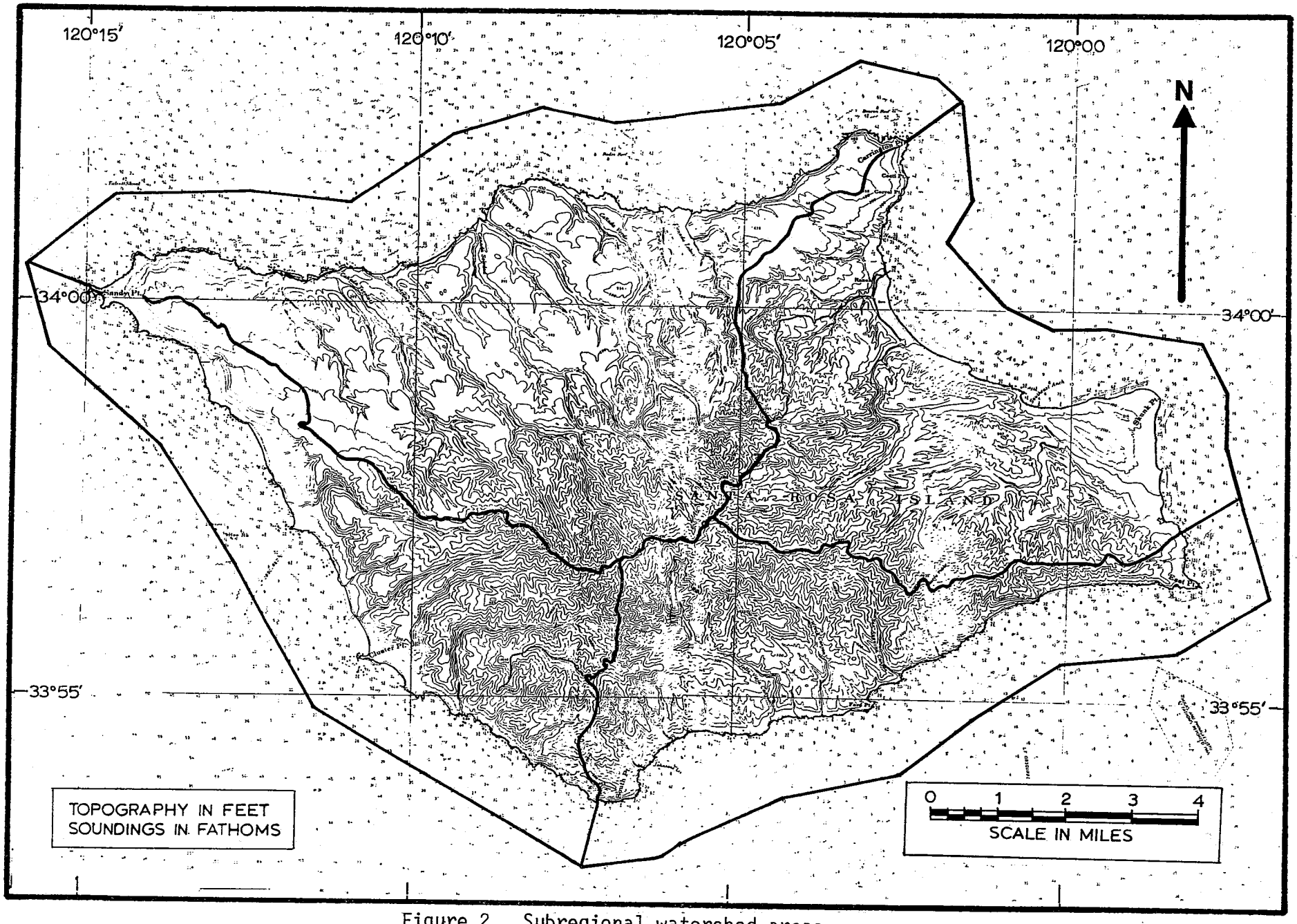


Figure 2. Subregional watershed areas.

PHYSICAL AND CHEMICAL DESCRIPTION

Location and Size

Santa Rosa Island is bounded on the west, at Sandy Point, by longitude 120° 14' 48" W; to the east, at East Point, by 119° 57' 54" W; on the north, at Carrington Point, by latitude 34° 02' 12" N; and to the south, at South Point, by 33° 53' 42" N. Its area is 84 mi^2.

The island is part of Santa Barbara County and lies offshore: Skunk Point, the pier at Bechers Bay, and Carrington Point are 33.8, 34.5, and 32.9 statute miles respectively, from the City of Santa Barbara's breakwater. The nearest mainland point is Coal Oil Point, 44.8 miles from Carrington Point on Santa Rosa. The greatest elevation is 1560 ft. (475m).

The surface extent of (fresh) water area is so small and transitory that it is negligible.

The coastal perimeter (shoreline) of Santa Rosa Island comprises 50.3 statute miles (80.5 km) excluding any islets. The shoreline lengths of subregional areas A through D are: 9.8 mi, 15.7 mi, 13.4 mi and 11.4 mi, respectively. Regional watershed and nearshore areal data are presented in Table 1.

Table 1. Proportions of watershed and nearshore areas (flat projection) of Santa Rosa Island.

Region	Regional Area(mi^2)	Watershed Area				Nearshore Area				Ratio N/W
		Km^2	acres	Hectares	%	Km^2	acres	Hectares	%	
A	33.9	60.3	14900	6019	71	24.8	6128	2475	29	0.41
B	50.2	88.3	21819	8815	68	41.6	10279	4152	32	0.47
C	27.6	38.6	9538	3853	54	32.9	8129	3284	46	0.85
D	29.3	41.2	10180	4112	46	34.7	8574	3463	54	0.84
TOTAL	140	228.4	56437	22799	60	134	33110	13374	40	$\bar{x}$= 0.64

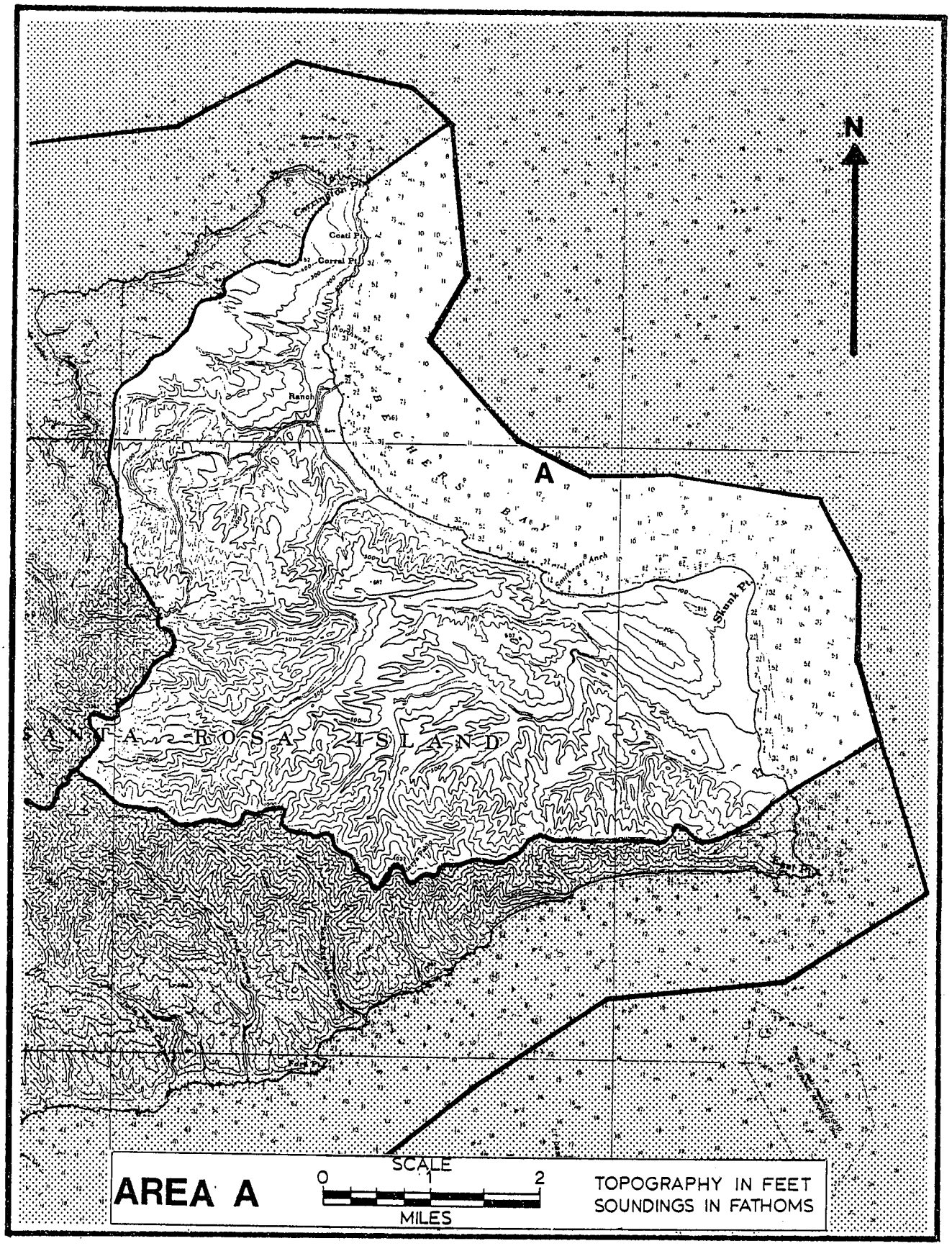


Figure 3. Subregional area A.

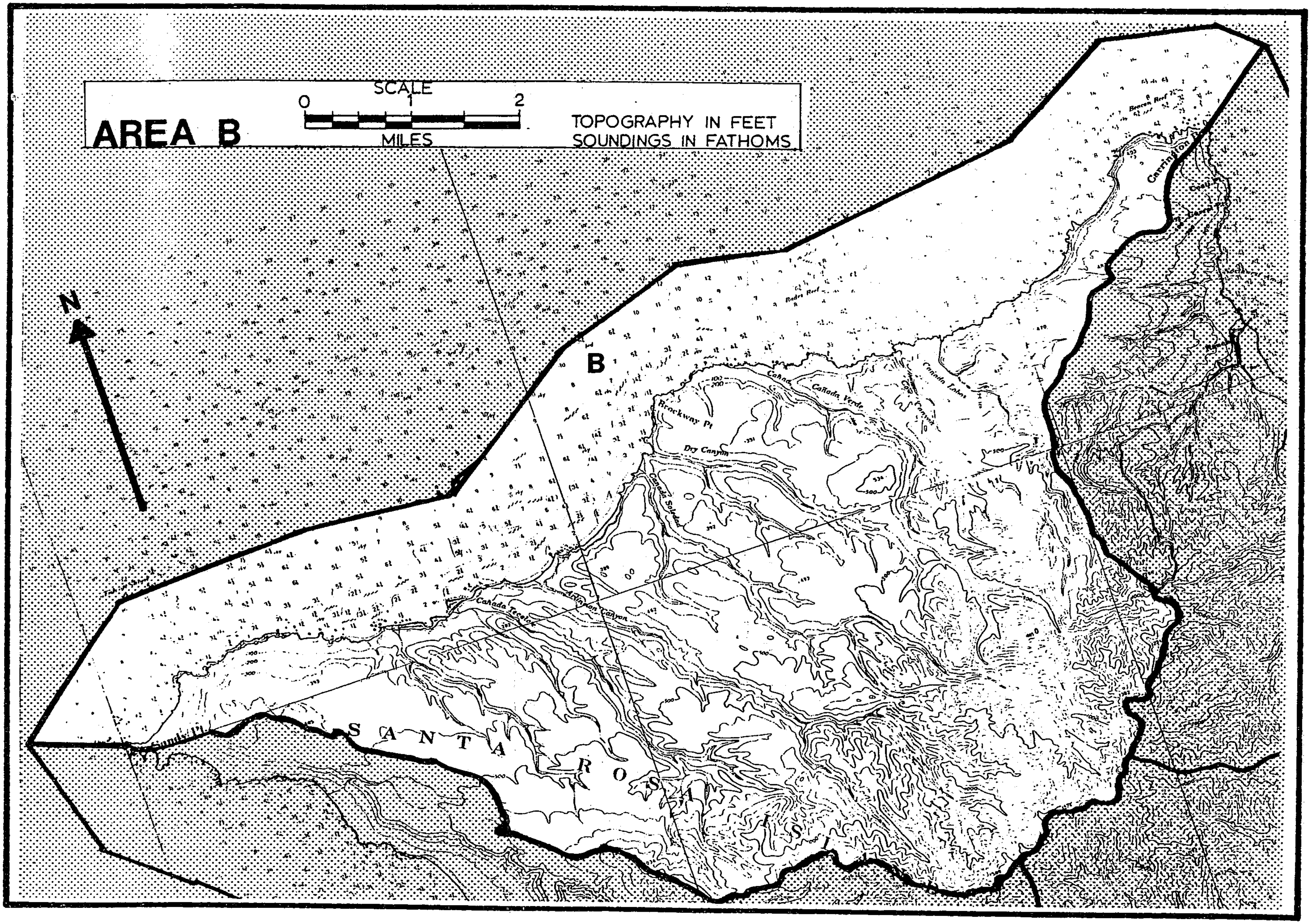


Figure 4. Subregional area B.

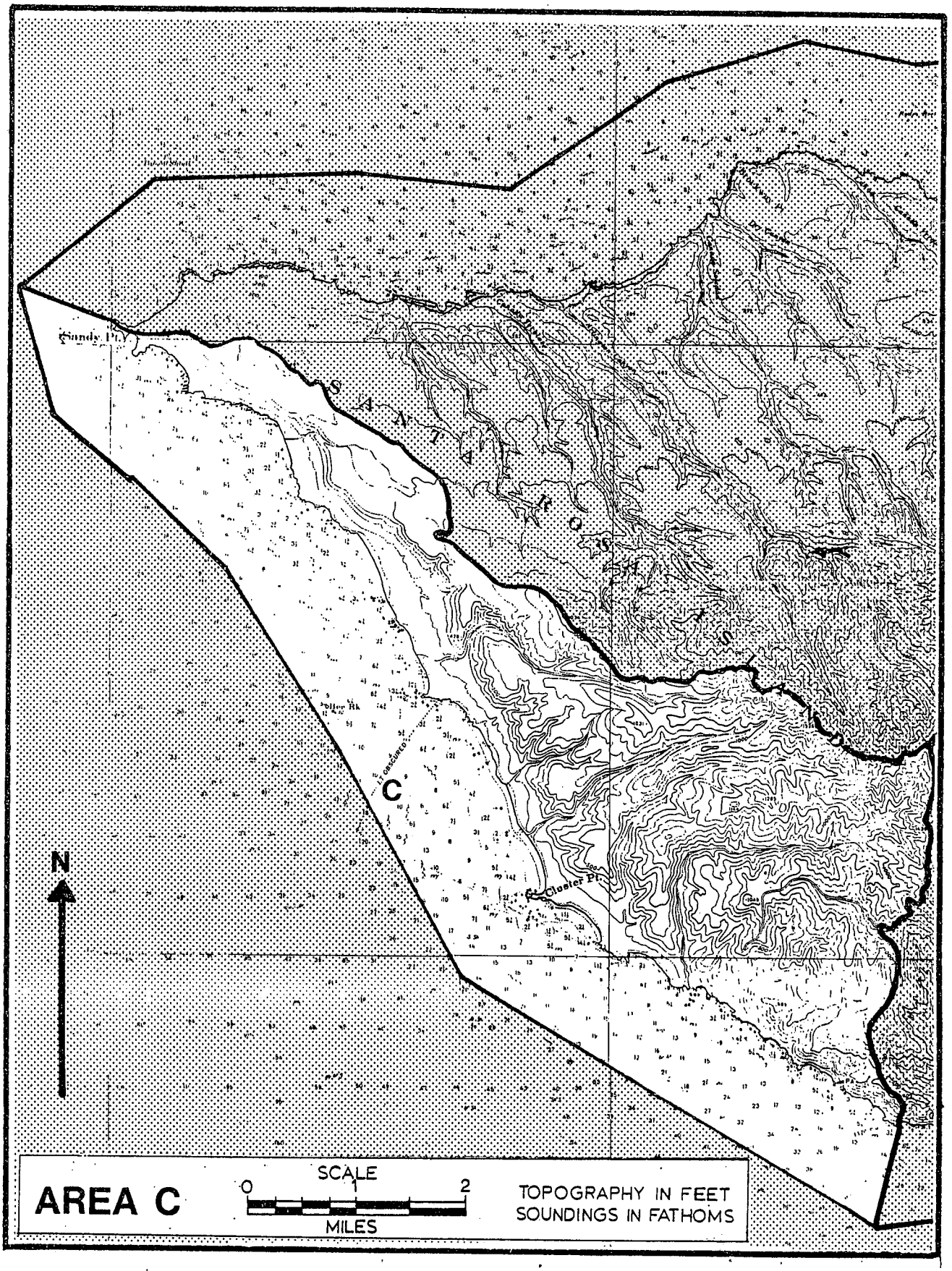


Figure 5. Subregional area C.

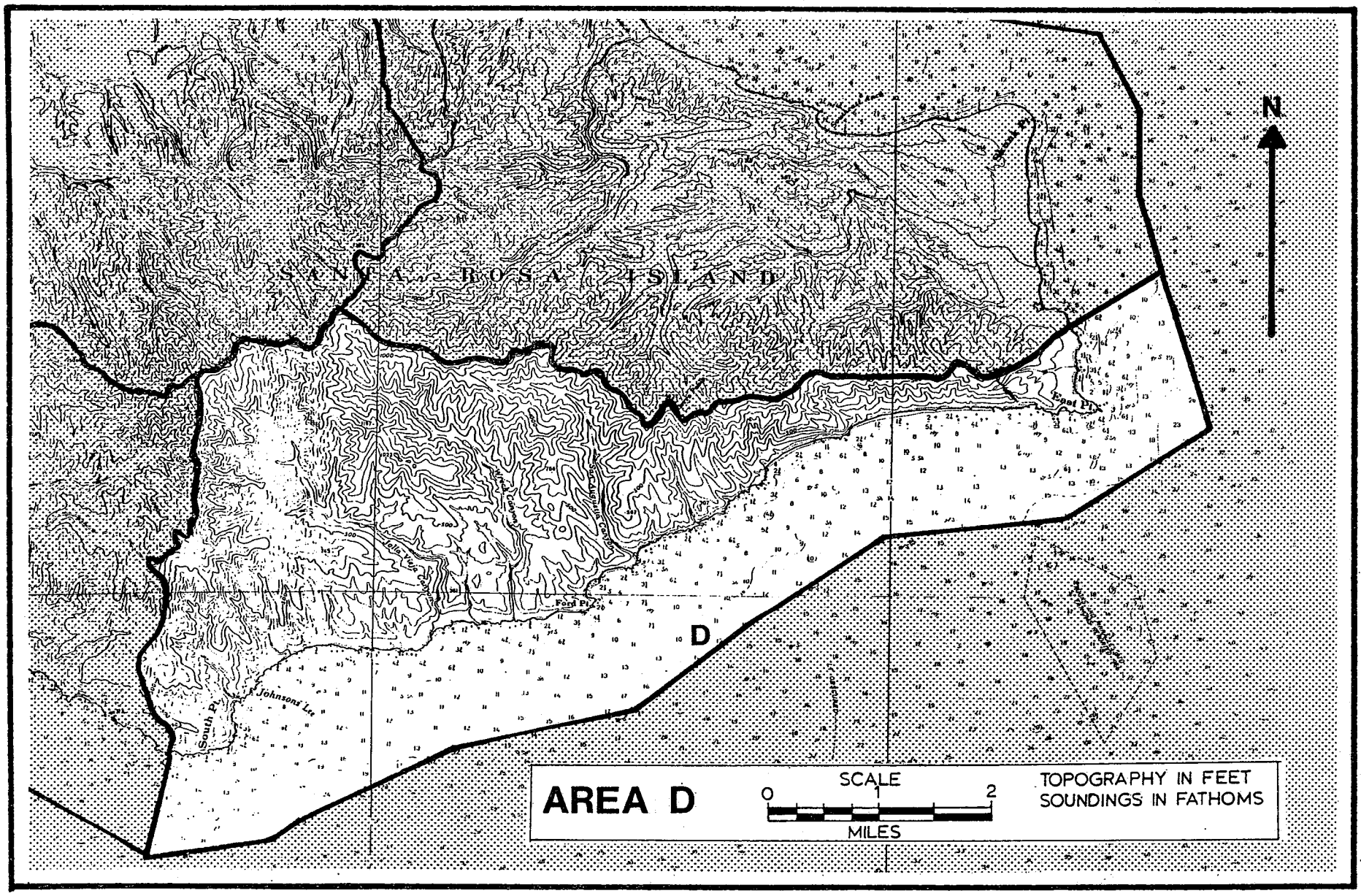


Figure 6. Subregional area D.

Submarine Topography

The northern tier of southern California's Channel Islands - San Miguel, Santa Rosa, Santa Cruz, and Anacapa - comprise a subsection of the mainland shelf that is surrounded by seafloor depths of at least 700 ft (200 m). West of the islands' shelf, off San Miguel and Santa Rosa, is the outer slope of the southern California bight, which grades into deep water offshore. The northern edge of the island platform drops rather steeply into the Santa Barbara Basin (maximum depth about 2000 ft or 600 m), an elongate depression running north and west off the mainland coast between Ventura and Point Conception. The south-eastern margin is bounded by the Santa Rosa-Cortez Ridge and the upper Tanner Basin. Northeast of Anacapa, the sill ridge between the inshore basins is cut by the Hueneme Canyon, which provides a connecting deep water link.

The shelf along the northern coast of Santa Rosa Island is relatively broad and the greatest depth within one nautical mile of shore is only 130 ft (40 m); within three miles of the northern shore the greatest depth is 262 ft (80 m). This gradual descent begins to break sharply downward about 4.5 mi (7.25 km) from Carrington Point at a depth of 330 ft (100 m). It drops another 1640 ft (500 m) to the basin floor within 10 mi (16 km) of the northern peninsula. The shelf on the south side of the island is narrower and extends deeper because of the slope of the upper Tanner Basin. The greatest depth within the southern one-nautical-mile ASBS boundary is 278 ft (85 m); within three miles of the southern coast the greatest depth is 820 ft (250 m). The southern shelf is narrowest along the coast between Cluster Point and South Point and broadens to the northwest and southeast. The 330 ft (100 m) isobath is 1.66 mi (2.65 km) off South Point above a steep drop to 1150 ft (350 m) within 4.2 mi (6.7 km) from shore. At a distance of 16 mi (25.6 km) from the southern tip of the island the depth is about 3280 ft (1000 m) and this grade continues downward irregularly to the edge of the Patton escarpment.

The interisland shelf areas between San Miguel on the west and Santa Cruz on the east is broad and continuous at depths less than 165 ft (50 m). Cardwell Point on San Miguel is 4.4 mi (7 km) from Sandy Point on Santa Rosa; Kinton Point on Santa Cruz is 5.25 mi (8.7 km) from Skunk Point on Santa Rosa. Southeast of Santa Rosa is a deep water intrusion of the shelf by the Santa Cruz Canyon. The Canyon is at the head of the Santa Cruz Basin but while relatively deep water occurs off South Point and East Point, the interisland shelf is not breached.

Benthic substrates in the nearshore area are mostly a mixture of relatively coarse sediments with substantial outcroppings of hard rock bottom. An exception is the silt and mud bottom off the coast between Cluster Point and South Point. Nearly all of the exposed hard bottom areas shallower than about 60 ft (18 m) support kelp forests, and reef locations can be determined by kelp bed surveys (see Figures 9 through 12).

Currents

The California Current is the eastern boundary current of the North Pacific Gyre; it bears cold subarctic water and flows south-easterly along the California coast, departing seaward at Point Conception because of the indentation of the southern California coastline. Circulation in the southern California borderland and continental shelf region below Point Conception is dominated by a large, anticyclonic coastal eddy. The effect of this large eddy is to recycle water originally derived from the California Current. This recirculated water is subject to coastal warming during its circuit encompassing the area off lower California. The eddy is driven by the entrainment of surface waters by the California Current as it deflects offshore. Northward flow within the southern California bight is seasonally enhanced by the Davidson Current in winter. At depths below about 630 ft (200 m) equatorial water is carried north by the California undercurrent or countercurrent.

No comprehensive survey of the oceanographic climate of the nearshore waters of Santa Rosa Island is available, but a general picture can be gained from a synthesis of information from a variety of sources (Figure 7). Within the Santa Barbara Channel, there are consistent indications of an anticyclonic circulation, although the general pattern of surface circulation is variable, depending on wind direction and velocity. A weak, non-tidal flow sets east in the spring and summer, and west in autumn and winter. California Current water enters from the west and flows easterly along the northern edge of Santa Rosa Island. Circulation is somewhat more complex in the Santa Rosa Passage, which is under the influence of California Current water carried in from the west as well as waters derived from coastal gyres to the south. Water passes though the gap between Santa Rosa and Santa Cruz in either direction, and this circulation is apparently strongly influenced by the set of tidal currents, which average about one knot.

Little information is available on circulation of the nearshore water of the southern fringe of Santa Rosa although there is direct influence of California Current water in the southwest region. Northerly flow is indicated through the passage between Santa Rosa and Santa Cruz, although tidal influences are likely to predominate, causing periodic current reversals, despite the net flow patterns.

An interesting and significant feature of the oceanographic climate in the vicinity of Santa Rosa Island is related to the wind patterns. Prevailing northwest winds dominate the southern California region. The east-west orientation of the shore and the mountainous eastern Channel Islands create a corridor which channels the wind patterns into a more easterly direction, resulting in a divergence over the center of the channel. This creates a wind drift of warmer surface waters towards the mainland

coast and also towards the northerly edge of the Channel Islands, especially Santa Cruz. The divergence under these circumstances may oppositely affect temperature distributions on the southern (lee) side of Santa Rosa.

Nearshore upwelling is a consistent feature along the south-facing mainland coast between Ventura and Point Conception. This upwelling is caused by the strong northwesterly winds which drive surface water offshore and bring cooler subsurface waters to the surface. Upwelling due to the same wind patterns is likely to occur along the southern coast of Santa Rosa Island where the extent of the shelf and water column temperature are similar to that of the mainland coast. The occurrence of upwelling is supported by qualitative observations of lesser water clarity and sporadic cooler water conditions on the island's southern fringe.

Unfortunately, no systematic quantitative observations of sufficient frequency are available to document upwelling events there.

Oceanographic observations within the Santa Barbara Channel (Cox, unpublished data) indicated that during the productive months of March through June, primary productivity can be as high as that at the major upwelling which occurs to the east off Point Purisma and Point Conception. Satellite imagery shows that ramifications of upwelling structures extend into the Channel and, given conditions of wind, high concentrations of chlorophyll produced within the upwelling structures can impinge on the nearshore waters of the northern coast. This is likely to be a sporadic event owing to variations in wind patterns and its effects on surface water movement.

Upwelling off the southern lee shore is likely to be displaced further offshore than in the case of San Miguel, although localized upwelling nearshore is likely to occur. Again, ramifications from upwelling centers off Point Purisma and Point Conception appear to

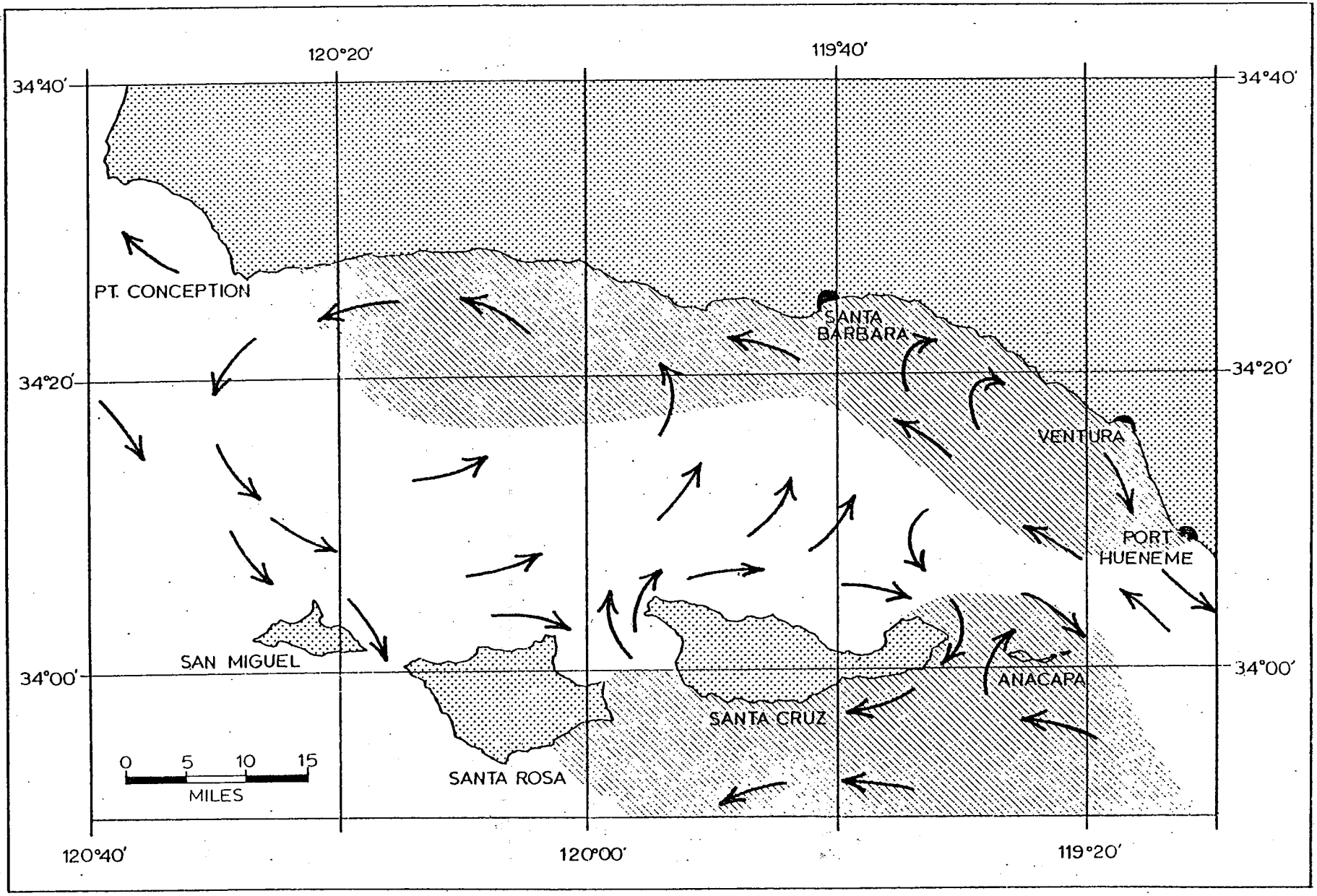


Figure 7. Surface currents and thermal fronts around Santa Rosa Island.

proceed in a southwesterly direction. These main bands of upwelling may be influenced by currents in the region and, in one instance, the upwelling frontal zone was observed as close as 2 km from the southwest lee shore of Santa Rosa. Prevailing southerly winds tend to create conditions of extreme water clarity in the southern fringe of all of the Channel Islands, and this is associated with a cessation of upwelling conditions.

There are three apparent hydrographic seasons. January through April brings a wind-generated period of surface mixing; May through July is the cooler, upwelling period; and August through December is a period of vertical stratification.

Water Column

The most extensive series of oceanographic observations which are relevant to interpretation of nearshore conditions in the ASBS study sites were made between 1956 and 1960 by scientists at the University of Southern California's Allan Hancock Foundation, under sponsorship of the California State Water Resources Control Board. These observations, published in 1965, extended from the mainland coast out to the 300 ft depth contour. While this zone does not encompass the nearshore waters of Santa Rosa Island, the information can be extrapolated in general terms to create an overall picture of oceanographic conditions in those waters, especially when they are considered in the context of the broader data base of the CalCOFI studies which extend considerably beyond the islands into the California Current.

The areas covered by the Southern California Mainland Shelf survey of the California State Water Resources Control Board which have particular relevance to nearshore waters of the ASBS study sites are:

Area I. The Point Conception Shelf, Point Conception to Santa Barbara Point

Area IIa. Las Pitas Point to Santa Barbara Point

Area IIb. Las Pitas Point to Hueneme Submarine Canyon.

The major axes of hydrographic variability are the windward/leeward break along the main island ridges and the east/west gradient of exposure to offshore conditions. Surface seawater temperatures around the islands generally range from 55^{o} F (13^{o} C) in winter to 65^{o} F (18^{o} C) in summer. Warmer temperatures occur on the southern, leeward coasts and toward the mainland eastward. In waters over the Santa Barbara Basin, surface warming and thermal stratification within the upper 250 ft (75 m) occur between June and November; mixing removes the thermocline and reduces the temperature of the water in this upper layer between January and March. South of the islands over the Santa Cruz Basin, the thermocline persists longer and the mixing period is restricted to February-March.

Salinity variations follow a similar pattern. Surface layers south of the islands have a generally higher salinity range (34 to 37‰) than is found on the windward side (34 to 36‰). Dissolved oxygen concentration is a function of mixing in the surface layers; in the Santa Cruz Basin, 60% saturation is the lowest level usually found within the upper 250 ft (75 m); in the Santa Barbara Basin this layer may contain levels as low as 50%, and in 2000 ft (600 m) deep water near the bottom, anoxic conditions occur. Turbidity is a wind and current related factor and is generally higher on the north or windward side of the islands and higher downcurrent to the east. Localized turbidity is determined by wind, rain, waves, and shore type and thus is greatest off areas like Bechers Bay, the coast between Brockway Point and Sandy Point, and between Sandy Point and Cluster Point, where the substrate and dynamic factors are most suited for particle suspensions. Interisland regions of the shelf are also areas of high turbidity. Larger scale turbidity patterns form downstream and

thus are generally more common along the northern coast of Santa Rosa. Turbidity along the southern coast may flow westward when south winds or west gyral currents prevail.

Water quality around the island is generally good because of its isolated location. However, oil and tar pollution from natural seeps and ship traffic is chronic, particularly along the north coast and along the eastern shores adjacent to interisland passages. Primary productivity in the Santa Barbara Channel shows a peak bloom in the spring and a minor bloom in the summer. Overall, primary productivity is highest in the northeastern portion of the Channel. Upwelling along islands may lead to periods of locally high productivity. Assuming an analogy with periodic inshore upwelling events documented in some detail at Ellwood Pier, just east of Santa Barbara (R. Holmes, unpublished data), this periodic upwelling may produce sporadic blooms from late December through early April, and occasionally through July and August.

Geophysical Characteristics

The four northern Channel Islands appear to be the tops of submerged mountains and most likely are an extension of the coastal Santa Monica Range. The geomorphology of the region shows that it has had a history of volcanism, uplift, and subsidence. It is near the leading edge of the continental plate, and the area around Santa Rosa Island has a low to moderate average level of seismic activity. The major fault in the area of Santa Rosa Island runs along the central axis of the island, above Skunk Point at the east end and below Sandy Point at the west. North and south of the fault are primarily Cenozoic marine sedimentary rocks. Lesser faults occur both south and north of the major one; the southern ones in a maze pattern and the northern ones generally running east and west. Fault locations and seismic activity patterns are shown in Figure 8.

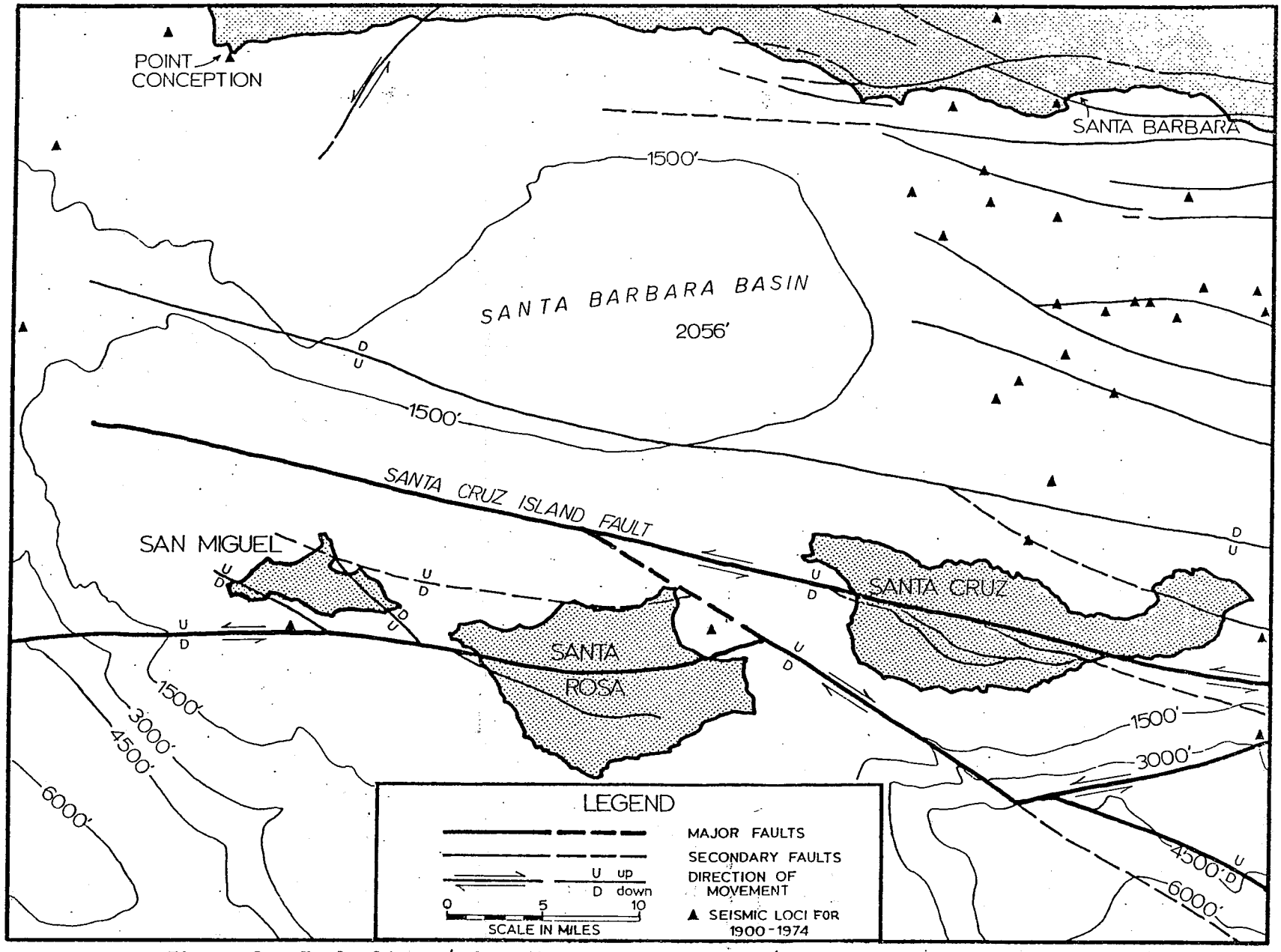


Figure 8. Fault lines (after Weaver, et al., 1969) and seismic loci (Calif. Dept. Mines & Geol., 1978).

Santa Rosa Island has a coastline that consists largely of bluffs, rocky cliffs, and sandy beaches. Wave action has formed the cliffs and has created a multitude of caves and clefts in them. Subtidal terraces have been formed in places by uplift. Sedimentation is generally most extensive on the northern and southern reaches of the shelf and is thickest to the north. Tidal flow and reversing currents flush the shallow inter-island shelf areas, and their sediments are generally sparser with larger particle sizes.

Santa Rosa is a large, generally four-sided island; it is flat and lowest along the northwest coast with tall, gently rounded hills toward the southeast. Long broad canyons run from the hills down the northwest plain to the shore. Along the south and southeast the canyons drop steeply. At the west end and along the southwest shore are broad sandy beaches. Skunk Point and Becher's Bay along the northeast coast also have long stretches of sand.

Subtidal Substrate

Major reef locations and their extent are indicated in Figures 9 through 12 by the dark areas representing kelp beds. Stands of Macrocystis and other brown algae occupy nearly all of the island's subtidal rocks. The aerial survey photographs show these features in greater detail. About 85% of the sediments in the Santa Barbara Basin, and thus the deep northern margin of Santa Rosa, originate as runoff from the Santa Clara River south of Point Conception. To the south, the deep sediments are mostly a mixture of materials of varied southern origin. Shallow shelf sediments are more directly influenced by the islands themselves.

The western periphery of the ASBS subtidal substrate is mud, replaced on the east by sandy bottom with an area of shelly

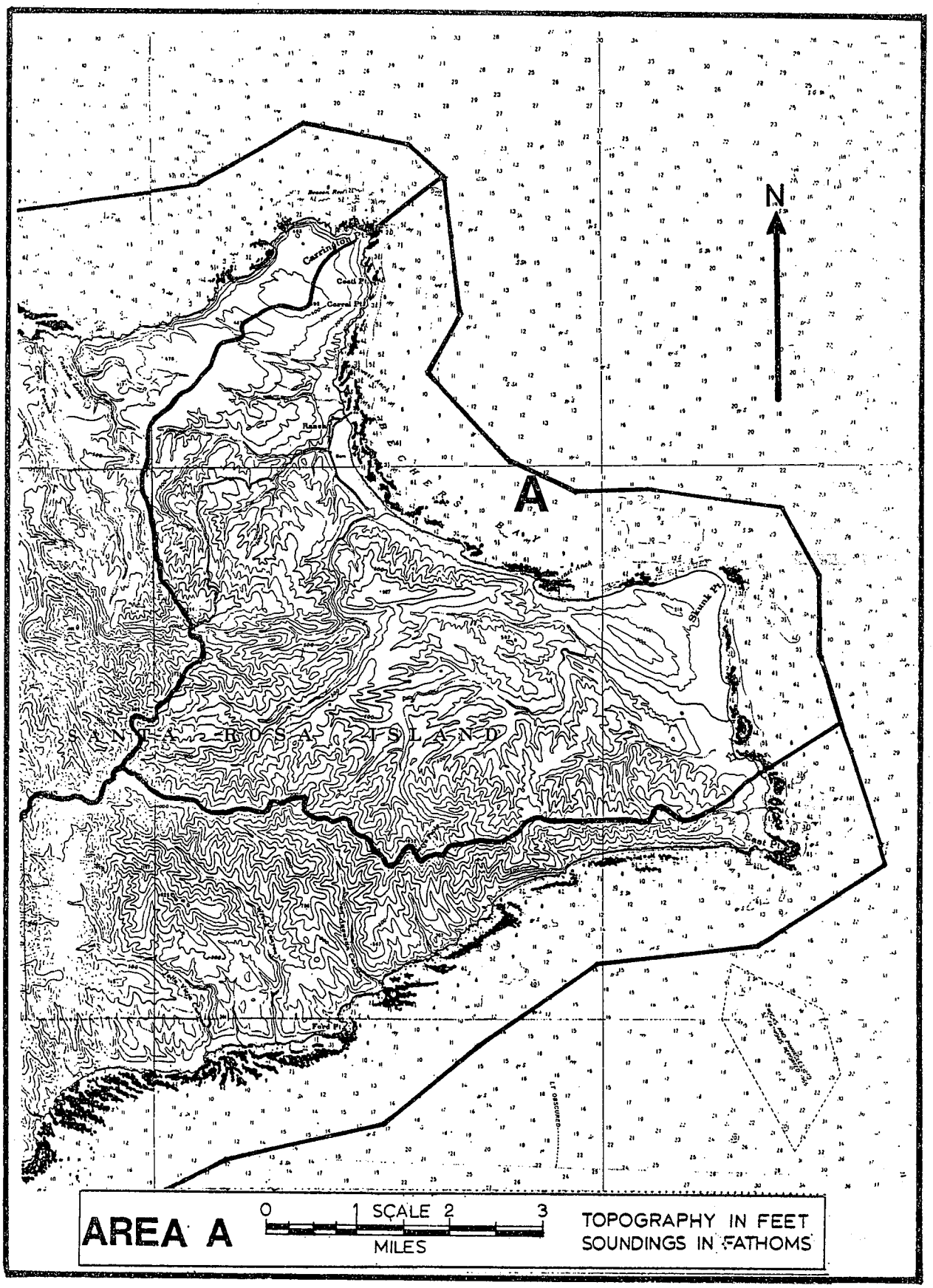


Figure 9. Kelp beds (rocky subtidal substrate) in area A.

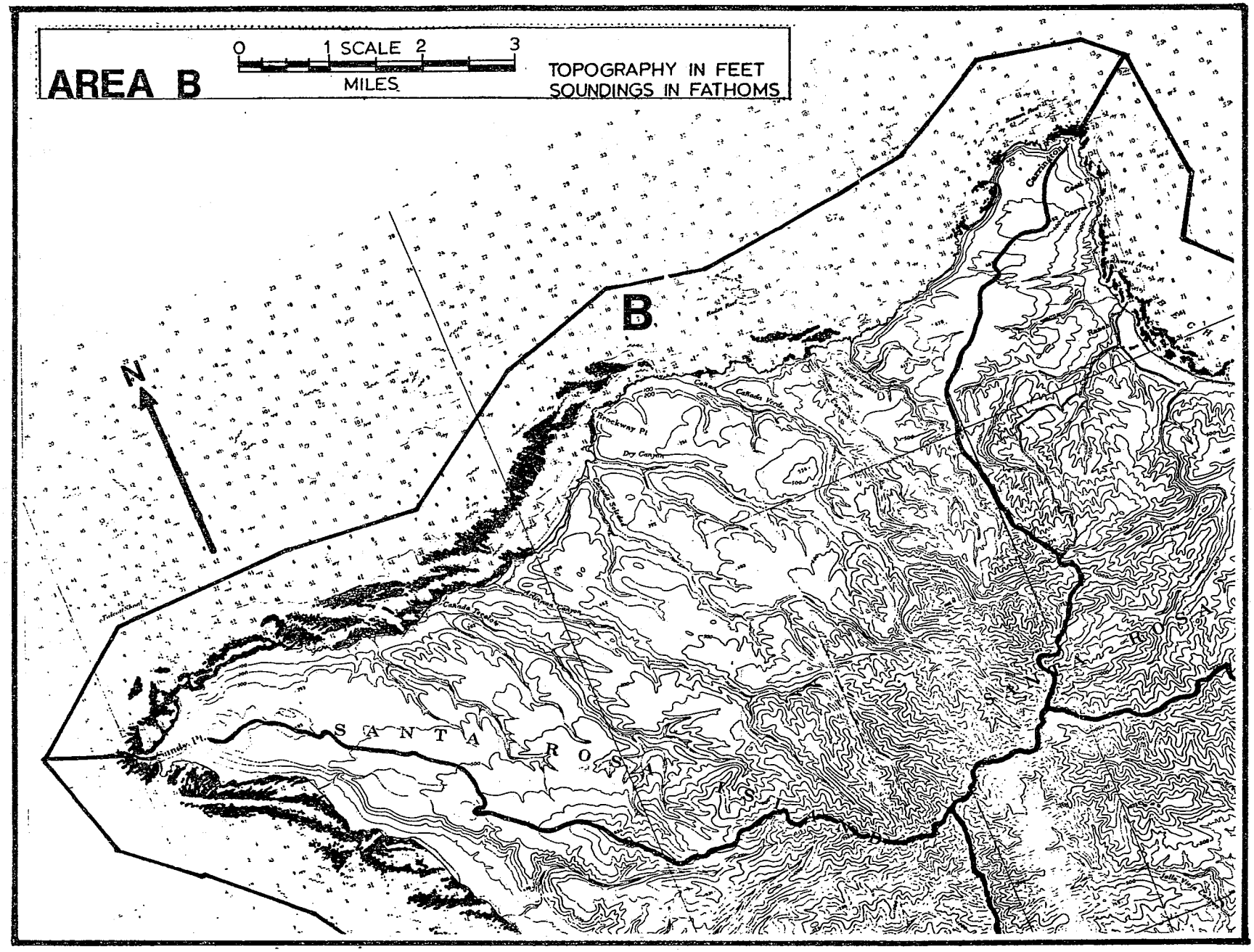


Figure 10. Kelp beds (rocky subtidal substrate) in area B.

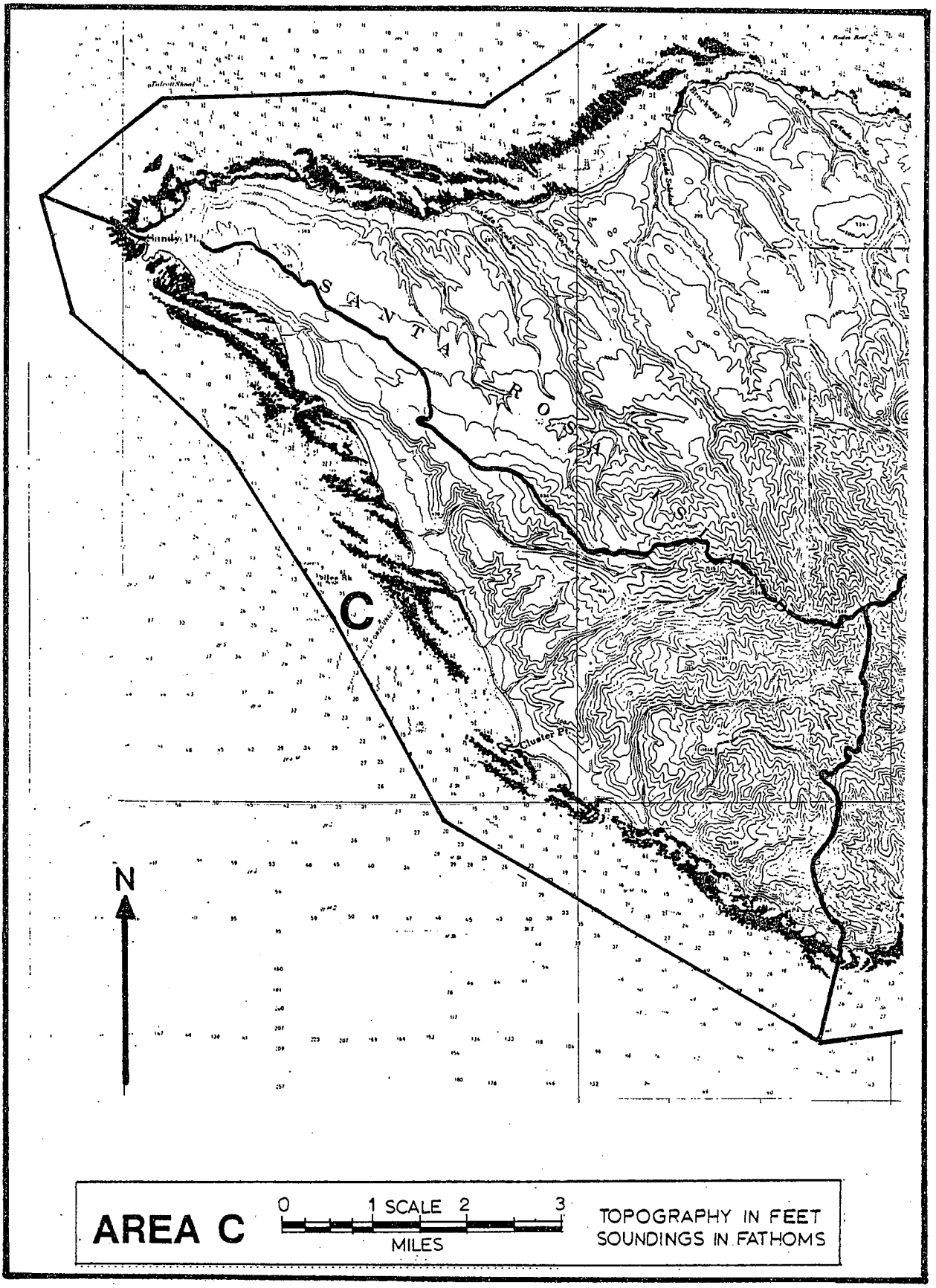


Figure 11. Kelp beds (rocky subtidal substrate) in area C.

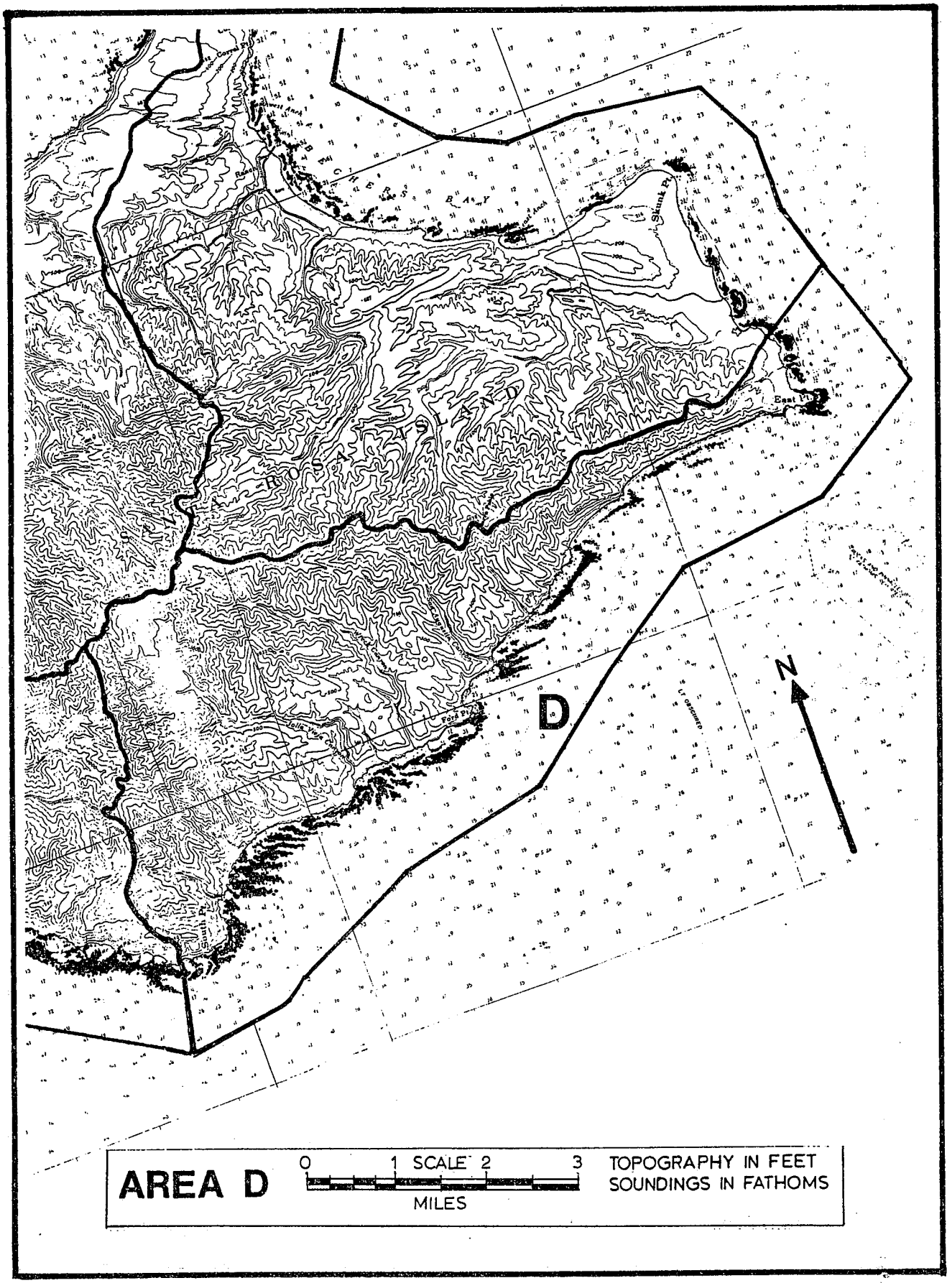


Figure 12. Kelp beds (rocky subtidal substrate) in area D.

substrate to the southeast. The immediate subtidal substrate is almost entirely sedimentary rock. Sandy areas occur off the southeast coast and Skunk Point. A small area of shelly substrate occurs east of Johnson's Lee.

Intertidal Substrate

See Table 2 and surface and aerial photographs.

Area A - East Point to Carrington Point. Most of the intertidal zone in this area is sandy beach with occasional rocky outcrops. Toward the southeast the beaches are broad with a low bluff at the high tide level. Toward the northwest the sandy beaches are narrower and the high tide level is at the foot of low rocky bluffs. At the extreme northwest the intertidal zone is mostly rocky bluff face and rock outcrops with a lower sandy margin.

At Skunk Point, the beach intertidal zone is relatively fine, white sand. At the northern and southern bases of the point are low rocky outcrops, scoured by sand and with resultant low levels of intertidal life.

At Southeast Anchorage, the intertidal zone is primarily sandy substrate, although low rocky projections mark the western margin of the cove. At the upper high tide level of this beach are low rocky bluff faces.

Becher's Bay, to the southeast above Anchorage, has an intertidal zone of principally rocky cliff face with a sandy subtidal zone, but no beach except for a few sandy pockets. Much of the cliff-base intertidal zone is undercut, but sand scouring prevents a diverse biota.

From Becher's Bay to Carrington Point, just north of the ranch pier, the sandy beach is terminated by a rock bluff face;

from here to Carrington Point the intertidal zone narrows except for a few sandy stretches. Notches, caves, small rocky points and sand pockets mark the intertidal zone around Corral, Coati and Carrington Points. The number of boulders in the intertidal area increases northward.

Area B - Carrington Point to Sandy Point. This part of the coast has a generally rocky intertidal zone; often it is narrow because of the near vertical cliff or bluff faces, but there are also low rocky projections, occasional boulders and sandy stretches. The width of the intertidal zone generally increases from east to west as the steepness of the shore declines. This part of the island shoreline is swept by strong prevailing winds and currents which, east of Brockway Point, contribute to suspension of the sandy subtidal substrate nearshore, and leads to considerable scouring of the intertidal zone. In some rocky areas, wave action has eaten the slope to form an intertidal rocky shelf with an overhanging ledge.

Carrington Point has steep rocky slopes and bluffs cut by conical clefts and notches. There is a considerable rocky shelf intertidal zone below the bluffs and a few intertidal rocks and boulders separated from shore.

From Carrington Point to Cow Canyon, sandy pocket beaches below steep cliffs become vertically narrow but horizontally variable as the foot of the bluff proliferates into many low, rocky projections. Many of the intertidal invaginations of sand are associated with erosion ravines and canyon mouths.

The mouth of Cow Canyon is marked on the east by shelf-like projections of flat rock into the intertidal zone. On the west is a concave, sheer bluff with a small sandy beach below the cliff's undercut notch and extending around large intertidal rocks to the

flare of the canyon mouth. The intertidal zone is a mix of small, sandy beaches, vertical rock faces, crumbled rock and boulder at cliff bases, and flat rock sheets.

The intertidal zone from Cow Canyon to Brockway Point is primarily low and rocky with a few small sandy areas. In many places the rock has crumbled providing a relatively high intertidal surface area.

Brockway Point to Sandy Point is generally a low rocky intertidal reach with sand substrate in the low tide range. Sandy beaches occur beneath steep cliffs and rounded bluffs, and at canyon mouths. The influence of the prevailing northwesterly winds is apparent in both the substrate shape and the biota.

Area C - Sandy Point to South Point. The intertidal zone of this southwest facing shore is largely one of sandy beaches. Rocky outcrops occur periodically and steeper rocky slopes increase toward South Point. The broad sandy beaches and the flattened low rocks at the northwest margin are primary rookery and haul-out areas for several pinniped species. The width of the intertidal zone decreases from northwest to southeast as the vertical relief increases.

At Sandy Point, numerous flat, rocky projections flank both long and pocket sandy beaches. There is considerable beach wrack on the northern side, and numerous intertidal rocks offshore. The substrate is sandy at the lowest intertidal levels, even in most areas with rocky outcrops. Caves and clefts have been eroded into the low bluff faces at the highest intertidal levels.

Sandy Point to Cluster Point is a region of alternating rocky and sandy intertidal substrates. The sandy beaches are relatively wide and show far less tar than those on the northern coast. Small boulders surround most of the rocky points and a cobbled intertidal area occurs below low bluffs over the point opposite

Bee Rock. Nearly all of the intertidal zone south of this point is sandy beach.

Cluster Point has a low rocky intertidal zone with sandy beaches behind and on either side. The rock is striated with numerous crevices, but is also sand-scoured.

From Cluster Point to South Point, the intertidal zone begins as a pair of wide sandy arcs bordered by low rocky headlands. The sand is fine and white, the stone mainly uplifted sedimentary rock. There are intertidal boulders and flat rocky sheets with tide pools but these are usually filled with sand. Caves and clefts in the low bluffs at the headlands usually contain pocket sandy beaches. The uppermost high tide level probably does not reach the bluff base over the sandy beaches except where they narrow by the headlands. South of these two sandy beaches, the intertidal zone becomes increasingly rocky, with low shelf rocks and fallen boulders at the bases of crumbling bluffs. Just west of South Point, the wreck of the S. S. Chickasaw occupies the intertidal zone at the sand-filled mouth of a canyon.

South Point is a rounded headland with a rocky intertidal margin and a sandy subtidal substrate. The intertidal margin is relatively narrow because of the vertical rock faces and the occurrence of a low flat terrace.

Johnson's Lee has alternating sandy beaches, small to the west, larger to the east, and rocky points. A large pier extends from the abandoned military base.

From Johnson's Lee to Ford Point, the intertidal zone is chiefly small rocky shelves at the foot of low, steep bluffs and cliffs, with occasional sandy stretches below vertical rock faces. Evidence of wind influence is far less than on the northwest coast. Ford Point is a low rocky plateau with a relatively wide intertidal zone.

Ford Point to East Point is primarily a region of long, narrow sandy beaches, punctuated by rocky areas below projecting headlands. In several places the headlands have been eroded and undercut so that there is either an overhang or small flat shelf in the intertidal. The accumulation of driftwood and other flotsam is least on these beaches. Just east of Ford Point is an area where the uplifted sedimentary rock has split to form a small outer breakwater and the intertidal area between the bar and the shore is somewhat protected but has a sandy bottom from canyon runoff.

East Point is a low rocky peninsula with a wave-swept, flat rocky intertidal margin. At the base of the point on both sides are sandy beaches. The intertidal surf is more turbulent here and the rocky substrate shows clear signs of sand scouring.

Adjacent Land Mass

Area A - Behind the shoreline between East Point and Skunk Point are low, gently rounded hills. Drainage from numerous ravines accumulates in a wide, flat canyon that reaches to beach level. Skunk Point is a low, flat sandy area, usually covered with wind-driven sand. Streaks of windswept sand at the base of the Point give it its skunk-like stripes. Southeast Anchorage is bordered by a flat shelf backed by gradually rising hills. At the northern margin is a rocky ridge with several erosion gulleys along its north face. Along Becher's Bay is a low, flat shelf through which two major canyons cut. Just above the beach are short, steep cliffs where the shelf has broken off. Behind the shelf are a series of low rising hills.

Carrington Point is at the tip of a broad, rounded peninsula, about 400 ft high, with its slopes cut by steep erosion ravines. Above the rocky shore are steep cliffs and bluffs, topped by a gentler slope and a relatively flat upper surface. Wind scars at

the base of the point run parallel to erosion gulleys and it is apparent that wind-transported sand flows over the island here and into Becher's Bay.

Area B - The entire northwest coast of Santa Rosa is a low, relatively flat area draining from the hilly central region. Eight major canyons span the coastal plateau and numerous erosion gulleys and ravines cut the low relief. The shoreline, except at most canyon mouths, is backed by short but steep cliffs and bluffs. Runoff is widespread because of the regular spacing of the canyons. Wind scarification and sand transport are low in the eastern and central portions of this coast, and much greater toward the west. Just behind Sandy Point the wind scars are quite pronounced. At the western end of area B the landscape continues to be low, with even less vertical relief and few drainage channels. The cliffs along the beach are backed by a gently sloping ridge at about 300 ft.

Area C - Sandy Point is the terminus of a low, flat projection, and is obviously the leading edge of the island into the prevailing wind. Only minor erosion gulleys mark the face of the higher ground and the relief is very low. Toward the south is a long, low ridge well back from the beach. Opposite Bee Rock the landscape changes and becomes more convoluted with rounded hills and some canyons. The hills behind Cluster Point are the westward extent of the island's central high ground, although here too the slopes begin well back from the beach. Immediately behind the intertidal zone are low, flat shelves and terraces. Between Cluster Point and South Point, the elevation of the adjacent land mass rises sharply and the tallest hills are above 900 ft. Just above beach level there is often a flattened plain, but near South Point this feature disappears and there is no break in the slope of the hills. South Point and the area to its west are high rounded hills with their slopes cut by canyons and ravines that fall steeply to the rocky shore. The tops of the hills are generally smooth and broad.

Table 2. Proportions of sandy beach, cliff shore, and sloping rocky shore, along the coastline of Santa Rosa Island.

Region	Sandy Beach		Cliff Shore		Rocky Slope		Total Shoreline	
	km	mi	km	mi	km	mi	km	mi
A	13.0	8.0	1.9	1.2	0.9	0.6	15.8	9.8
%	82		12		6			
B	9.9	6.1	10.9	6.8	4.5	2.8	25.3	15.7
%	39		43		18			
C	12.3	7.6	5.2	3.2	4.1	2.6	21.6	13.4
%	57		24		19			
D	5.9	3.6	7.5	4.7	4.9	3.1	18.3	11.4
%	32		41		27			
Totals	41.1	25.3	25.5	15.9	14.4	9.1	81.0	50.3
%	51		32		17			

Area D - Johnson's Lee is a protected area just inside South Point and is flanked by high hills on both sides. Between Johnson's Lee and Ford Point the coastal landscape flattens and bears two major canyons. Above the beach-level bluffs the land rises gently to the first ridge line at about 200 ft. From Ford Point to East Point the height of the coastal hills declines, but the slope up from the beach remains relatively steep until the eastern end of the island begins to flatten out about midway. Erosion ravines and small canyons are common. Towards East Point there is clear evidence of wind scarification and sand transport. East Point is a low sandy hummock with a rocky coastal margin.

Climate

The overall climate of the region surrounding Santa Rosa Island is maritime-mediterranean with cool, wet winters and warm, dry summers. Because of its location, Santa Rosa is strongly influenced by winds and fog derived from oceanic conditions offshore. The characteristic weather pattern of Santa Rosa Island is dominated by the East Pacific High Pressure Area, as is the general weather pattern of southern California. The high pressure area blocks the southerly flow of cold, wet air masses into southern California and deflects them to the east. In summer, the pressure maximizes, yielding a seasonal climate that is relatively dry and warm. During winter, the pressure in the high is decreased and it is located further to the south. This allows cold fronts to penetrate further south, bringing rain and cooler temperatures in a southeasterly direction. The effects of these factors are modified by dynamic balancing of the land and sea temperature regimes.

In summer, cool marine air flows toward a warm, low pressure area that develops inland. A marine layer is established over the coast, which shifts onshore at night and offshore during the day

due to diel thermal balancing between land and sea. A sea breeze blows during the day and flows in a general southeasterly direction. Clouds and fog associated with the marine layer increase the humidity and lower the temperature. Because of its location offshore, Santa Rosa Island has somewhat lower temperatures generally than the mainland and is more often enveloped by fog. Hot, dry Santa Ana winds occur during winter months when a high pressure area develops inland and blows warm air seaward but their effect is diluted seaward over the islands.

The prevailing regional wind flow pattern is from the northwest, but in the Santa Barbara Channel the islands and coastal mountain range act to funnel a major divergence eastward. In the lee of the northwest winds, the mainland coast of the Channel and the southern coast of Santa Rosa Island receive occasional winds from the west and southwest (Figure 13). In the Channel, west winds blow nearly every afternoon, then slacken at sundown although at the western end of the Channel beyond Santa Rosa the winds may continue through the night then diminish at dawn. In the winter, southeast Santa Rosa is also subject to occasional northeasters. In strong northwest weather outside the Channel, the northern shores of the islands experience a buildup of wind, waves, and swell. This belt of rough seas is known as Windy lane and occupies a six-mile-wide belt along the islands.

Rainfall on Santa Rosa is sparse, usually occurring in the winter along with dense fog that is more persistent than on the mainland coast. Santa Rosa is within the semi-humid maritime zone which receives more than 13 inches of rain a year. The driest time of year is in the spring although the least rainfall occurs during summer; frequent summer fogs account for the difference. Average annual rainfall, measured over 27 years, is about 14 in (36 cm) with yearly totals ranging from 6 in (15 cm) to 28 in (66 cm).

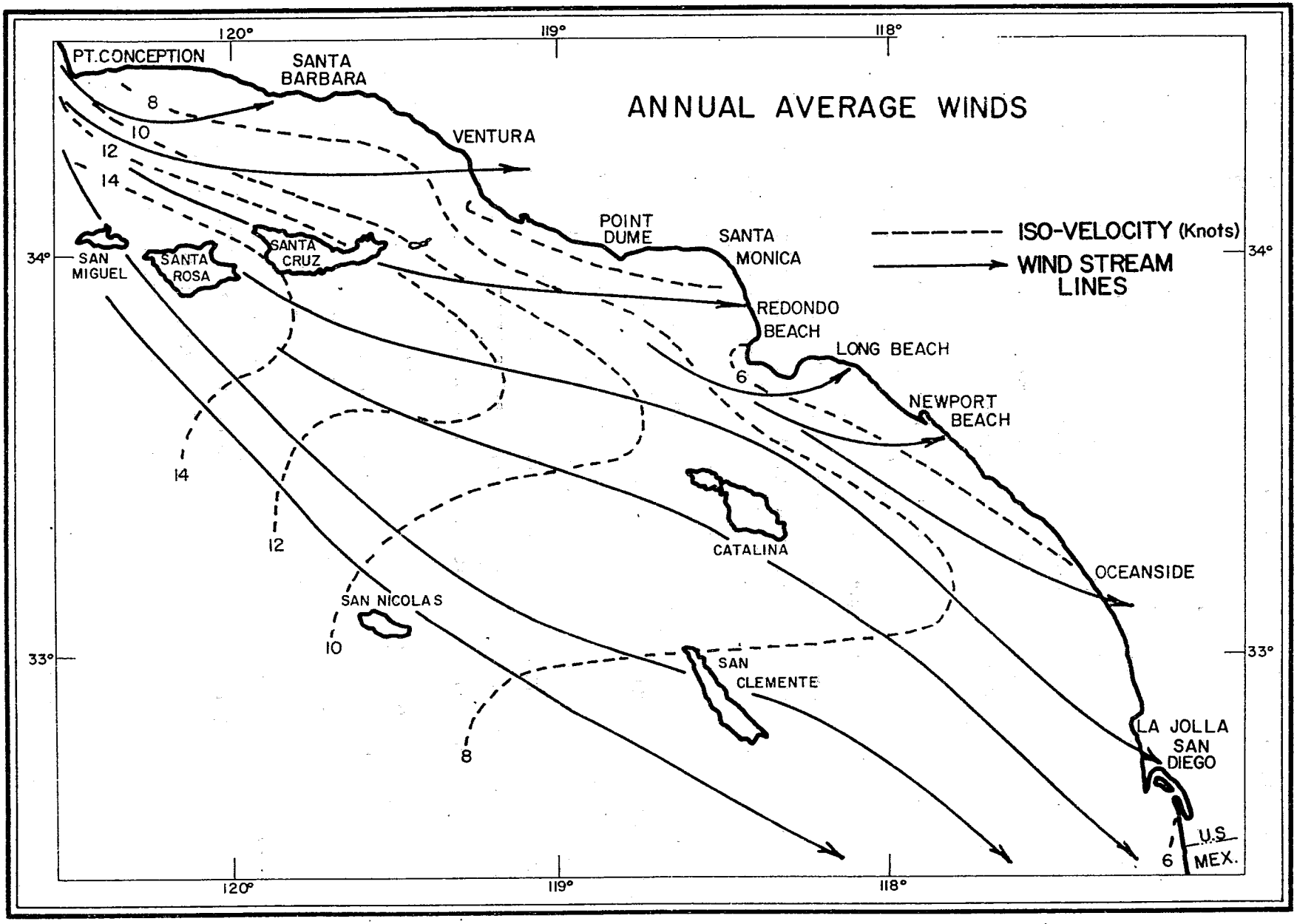


Figure 13. Wind patterns of the Channel Islands (after Hancock Foundation, 1969).

Air temperature at the islands is closely related to the range of the surrounding sea temperatures. Coastal temperatures on Santa Rosa are strongly influenced by fog and wind. Coastal temperatures usually range between a low of 35^{o} F (2^{o} C) and an average high of 85^{o} F (30^{o} C).

The prevailing wind pattern is from the northwest or west as described above (see Figure 13). Santa Rosa is strongly influenced by the cool, powerful, northwest winds which blow off the open Pacific past Point Conception.

BIOLOGICAL DESCRIPTION

Subtidal biota.

The subtidal biota of Santa Rosa Island are not well known. From only occasional dives for research purposes, and the surveys conducted in the present studies, we can conclude that the biota and community interrelationships are characteristic of more fully described subtidal habitats of neighboring Anacapa and Santa Cruz Islands. Of significance in the surveys was the extremely abundant sea urchin population encountered at the Cluster Point dive site (Figues 14 & 15), an atypical condition for more easterly Channel Island subtidal environments, but also characteristic of the Cuyler Harbor dive site off San Miguel Island.

Two dive sites were employed by Nicholsen and Cimberg (1971) in a subtidal algal survey in 1969 (see positions indicated on Figure 14). At the Corral point site, algal diversity was greater, with a higher species diversity (31 species) than that at the leeward station between East Point and Ford Point (24 species). The latter had a higher proportion of warm water species. Both stations were notable for a relative lack of species of brown algae (Phylum Phaeophyta), relative to the adjacent eastern island (Santa Cruz Island) and mainland control stations. Otherwise, species list diversity was comparable to other locations within the Southern California islands region.

Diving conditions are almost always different between the north and south coasts of Santa Rosa. Warm, clear conditions can prevail on the south side while north side conditions are turbid and cool. Northwestern subtidal habitats are continuously bathed by cool upwelling plumes, creating conditions which favor species of cool water affinities (see Figure 7). The resultant differences suggest that community structure and interactions (discussed in detail by Ebeling, el al., 1980) may be different on the south and north shores of Santa Rosa, and especially on the northwest section of the island, where cool, turbid waters are a consistent environmental feature.

At dive site 1, Cow Canyon, the dominant subtidal algal species, in order of abundance, were: Macrocystis pyrifera, Eisenia arborea, and encrusting corallines. The most common invertebrates were Styela, Strongylocentrotus purpuratus and franciscanus, Pisaster brevispinus. Spirorbis was occasionally dominant.

At shallow locations, eelgrass (Zostera marina) and Bosiella sp. were the dominant algal species, while lower, gelatinous red algae were numerous. Turf community macroinvertebrates were diverse and locally abundant throughout the transect.

Fish populations were overwhelmingly dominated by black surfperch (Embiotoca jacksoni) and striped surfperch (Embiotoca lateralis). Kelp-bass (Paralabrax clathratus) and blacksmith (Chromis punctipinnis) were common. This pattern is typical of northside channel island fish communities, and suggests that community structure at this transect is similar to the "island pattern" discussed in detail by Ebeling, et al., 1980).

Dominant and Common Subtidal Biotic Components - Transect 1 Santa Rosa (*dominant)

Macroinvertebrates

- *Anthopleura elegantissima*
- *Hymenamphiastra*
- *Leucilla*
- **Spirorbis*
- *Cancer*
- **Styela*
- *Olwilla*
- *Dermasterias*
- **Patiria*
- **Pisaster brevispinus*
- **Strongylocentrotus purpuratus*
- **Strongylocentrotus franciscanus*

Fish

- *Sebastes serranoides*
- **black surfperch*
- **striped surfperch*
- *kelpbass*
- *blacksmith*

Algae

- **Macrocystis pyrifera*
- *Eisenia arborea*
- *corallines*
- *Zostera marina*
- *Bosiella*

Although the southside transect at Cluster Point (see Figure 14) had many species in common with the transect at Cow Canyon, macroinvertebrates were overwhelmingly dominated by sea urchins of the genus Strongylocentrotus. Molluscs of various species were also much more abundant.

Fish populations were sparse, though opaleye (Girella nigricans) and convictfish (Oxylebuis pictus) were present.

Although there were many locations optimal for Macrocystis attachment on the region surveyed, only a few were found where attachment was evident. This may be a region where grazing on kelp is enhanced due to an imbalance between grazers and predators. Visual observations in the region suggest that this condition was widespread in the southwestern sector.

Eisenia arborea was absent from this site, as it was in the two diving surveys of Nicholsen and Cimberg (1971), on the extreme east end of Santa Rosa.

Dominant and Common Subtidal Biotic Components - Transect 2 Santa Rosa (* dominant; ** very dominant)

Macroinvertebrates

*Anthopleura elegantissima
Tealis
Anthopleura xanthogrammica
*Balanophyllia
Corynactis
Acarnus
Tethya
Spirorbis
Pugettia

Macroinvertebrates, continued

- †Panulirus
- †Cancer
- †Haliotis cracherodii
- †Haliotis rufescens
- †**Astraea*
- †*Olivella*
- †*Conus*
- †Dermasterias
- †*Patiria*
- †Pisaster brevispinus
- †Ophioplocus
- †Ophiothrix
- †Ophioderma
- †Cucumaria
- †Centrostephanus
- †**Strongylocentrotus purpuratus*
- † Strongylocentrotus franciscanus

Fish

- †*convict fish
- †black surfperch
- †*opaleye

Aglae

- †Macrocystis pyrifera
- †corallines

Santa Rosa is no exception to the general case of the northern Channel Islands region in its higher diversity of kelp bed fishes and turf communities than of mainland analogues. Clearer water, more high-relief rocky bottom, and exposure to warmer oceanic water cited as the reason for this "island effect" (Ebeling, et al., 1980) are much more obvious in southeastern (Area D) nearshore waters than in northern and western nearshore waters (Areas B and C).

According to Fish and Game records, certain species of fish are more commonly taken at Santa Rosa than at neighboring San Miguel. These may be summarized as follows:

Commercially Important Species Not in Common

at

Santa Rosa	San Miguel
China rockfish	vermilion rockfish
California sheephead	kelp greenling
	barred surfperch
	grass rockfish

It is notable that the china rockfish (Sebastoides nebulosus), which occurs at San Miguel and Santa Rosa at the extreme southern end of its range, is present in much higher abundances at Santa Rosa (and also at neighboring Santa Cruz). This finding suggests a higher affinity to the Santa Cruz "island type" fish fauna (Ebeling, et al., 1980) than to that of San Miguel. In fact, all commercially important species at Santa Rosa are in common with those of Santa Cruz. This is interpreted as an indication that Santa Rosa (at least the easternmost section) is situated at the end of a faunal gradient which breaks sharply between the west end of Santa Rosa and neighboring San Miguel Island to the west. This interpretation is also borne out by comparative analyses of intertidal data (reported elsewhere).

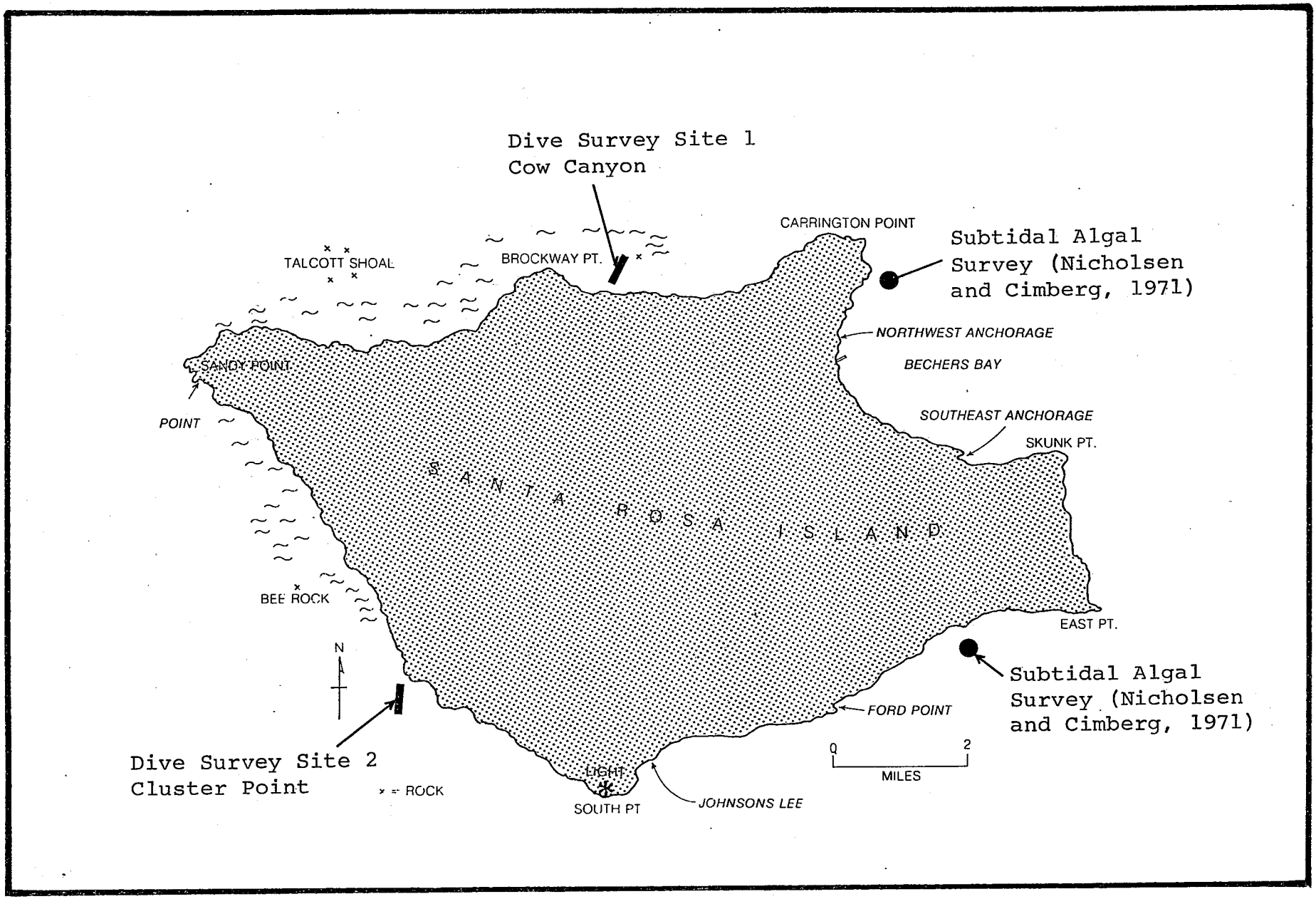
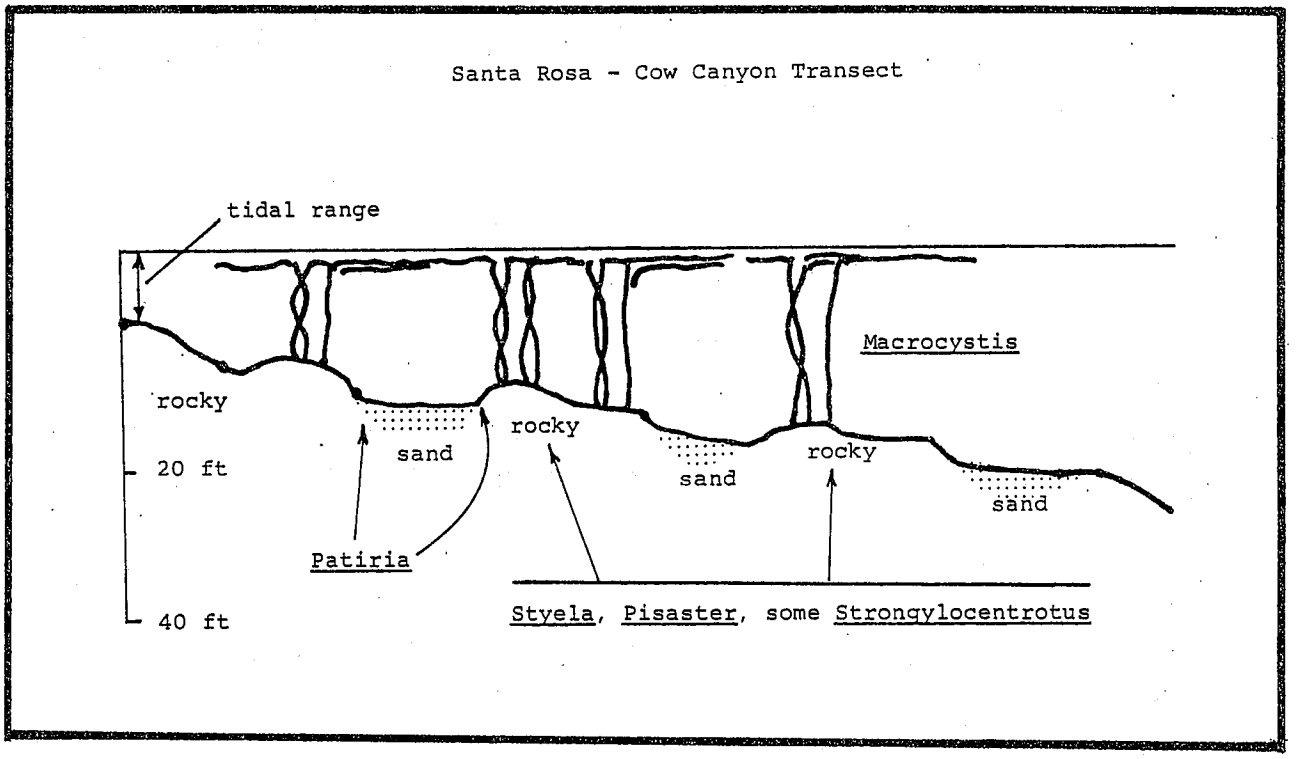


Figure 14. Subtidal survey sites.



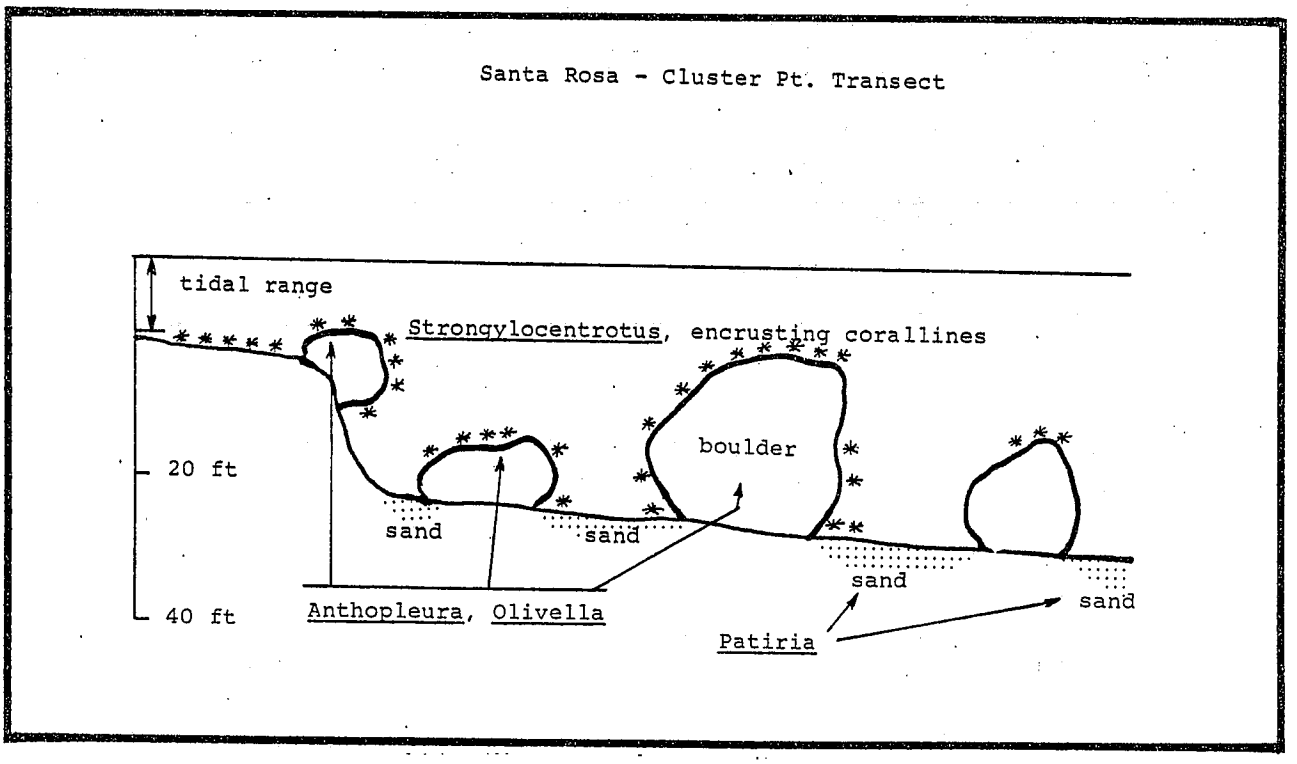


Figure 15. Subtidal profiles.

Intertidal biota.

Santa Rosa intertidal biota are known from very few systematic faunal and floral surveys. Much of the rocky shore is inaccessible, and sandy beaches are the predominant shore type. The rocky habitats of the north shore are fully exposed to prevailing northeasterly swells and seasonal storms, so they can be characterized as exposed outer rocky coasts. Beaches on the north side are steeper and composed of coarser sediment than at southside locations.

Rocky intertidal algae have been systematically collected and analyzed for species composition (Murray, et al., 1980) at a location on the southside in Area D (see Figure 16). Comparing algal species patterns, it has been concluded that the Santa Rosa intertidal flora are most closely associated with those of San Miguel and San Nicolas Islands, indicative of an "island type". Nonetheless, 94.5% of all species enumerated at the Santa Rosa site were in common with mainland species assemblages. Relative abundance patterns, however, indicate that it is transitional between a clearly Santa Cruz Island type (characteristic of both Santa Barbara Island and Santa Cruz Island) and a clearly San Miguel type (characteristic of San Miguel and San Nicolas Islands). As noted by many studies, Santa Rosa is a biological transition region between cool water habitats characteristic of San Miguel, and warm water habitats characteristic of Santa Cruz and other southern islands (Murray, et al., 1980).

A major difference in the intertidal algal communities of Santa Rosa, as well as all of the island intertidal floras, is the relative presence of intertidal coralline algae, and, lower in the intertidal zone, the relative presence of various species of brown algae (Littler, 1980). Greater abundance of corallines is associated with the more consistent surge and wave stress, and greater cover in the lower intertidal by browns may be related to a more oceanic water quality, and especially to a greater nutrient supply in the cooler waters bathing the northside habitat.

An analysis similar to that performed on collections of rocky intertidal algal species (described above) at Santa Rosa (see Figure 16) indicates essentially the same features prevail with regard to rocky intertidal macroinvertebrates (Seapy and Littler, 1980). Santa Rosa is transitional between the cool, oceanic community type observed at San Miguel, and a more "island-type" fauna of the rest of the northern Channel Islands, Santa Barbara Island, and Catalina Island (Seapy and Littler, 1980). In fact, according to their figure, Santa Rosa Island has highest affinity with the rocky intertidal communities of San Diego. As both are on the fringes of the cool water core of the California current, they are likely to reflect this similarity in macroinvertebrate communities.

For gastropoda and species not common to all survey sites (Seapey and Littler, 1980), affinities of the Santa Rosa fauna with those of San Miguel and Santa Barbara Islands remain, and the Santa Rosa fauna appears to be more closely associated with those habitats than with the rest of the island group. This further underscores the transitional nature of the Santa Rosa macroinvertebrate fauna. It is clear from satellite imagery in the Santa Barbara Channel Region that pronounced thermal fronts may bisect the island in a fashion which places the front further to the east on the northern shore, and further to the west on the southern shore, although the pattern may be quite variable.

Other observations have confirmed the general pattern of intertidal zonation characteristic of both Santa Cruz Island and San Miguel Island (Littler, 1980), with regard to intertidal, rocky shore macroinvertebrates.

Zone	Dominant Types
upper intertidal	blue green algae, *Littorina*
mid upper	*Cthamalus*, blue green algae
mid intertidal	*Pelvetia* community
mid lower	*Mytilus* community
lower intertidal	*Gigartina* community
	Phragmatopoma
	Phyllospadix community, *Dodecaceria*

In more exposed areas, such as at Cow Canyon on the northern shore, the picture was substantially altered, with encrusting coralline algae, urchins, and coelenterate species relatively more abundant. This pattern was also seen at Cluster Point, except that *Anthopleura* seemed to be more prevalent intertidally. These more exposed locations were notable for an abundance of tar deposits which were relatively sparse at southeast and northeast (Becher Bay) locales.

It is felt that the presence of an abundance of tar at northwest and southwest intertidal locations (Areas B and C) may represent an important environmental feature in the intertidal zone in those subregions. This was especially true in the upper intertidal zone, where the impression is that blue-green algae were much less abundant in the mid upper zone. Much of this oil must have originated from nearshore seeps which are known to occur in the region. Unfortunately, no detailed seasonal data are available from any intertidal region, except for samples from Area D in the vicinity of Johnson's Lee (see Figure 16) (Seapy and Littler, 1980) which is outside the area of interest.

Detailed analysis of mussel bed communities (Kanter, 1980) has been made at two intertidal sites on Santa Rosa, at Carrington Point and Johnson's Lee (see Figure 16). Cluster analysis of

species composition shows that Santa Rosa mussel communities were most closely allied with patterns seen at San Miguel and San Nicolas Islands, although Santa Rosa had a higher affinity with other island groups than with either of those islands, since it is within a faunal transition zone.

Differences in mussel community composition varied between the Carrington Point site (Area A) and the Johnson's Lee site (Area D). Carrington Point mussel communities had higher numbers (120) compared to Johnson's Lee (109). Diversity was about average for a large number of mainland and island sites, and significantly higher than those at San Miguel, presumably due to a mix of species with warmer and colder water affinities (Kanter, 1980). Cluster analysis showed that the Johnson's Lee site was most closely allied with other sites on the north and south sides of Santa Cruz and Santa Rosa, and on the south side of San Miguel. Similar analysis of the Carrington Point data showed closest affinities with Anacapa, San Nicolas Island, and the mainland at Pt. Conception, indicative of different oceanic conditions.

Analysis of bird populations at Becher's Bay, Santa Rosa Island revealed the following species present:

- falcon ?
- black oystercatcher
- surf scoter
- arctic loon
- sooty shearwater
- brown pelican
- double crested cormorant
- black legged kittiwake ?
- heerman's gull
- western gull
- herring gull
- white winged scoter ?
- Canada goose
- Western goose ?

Observations during a circumnavigation of the island confirmed the occurrence of all these species at various Santa Rosa Island locations.

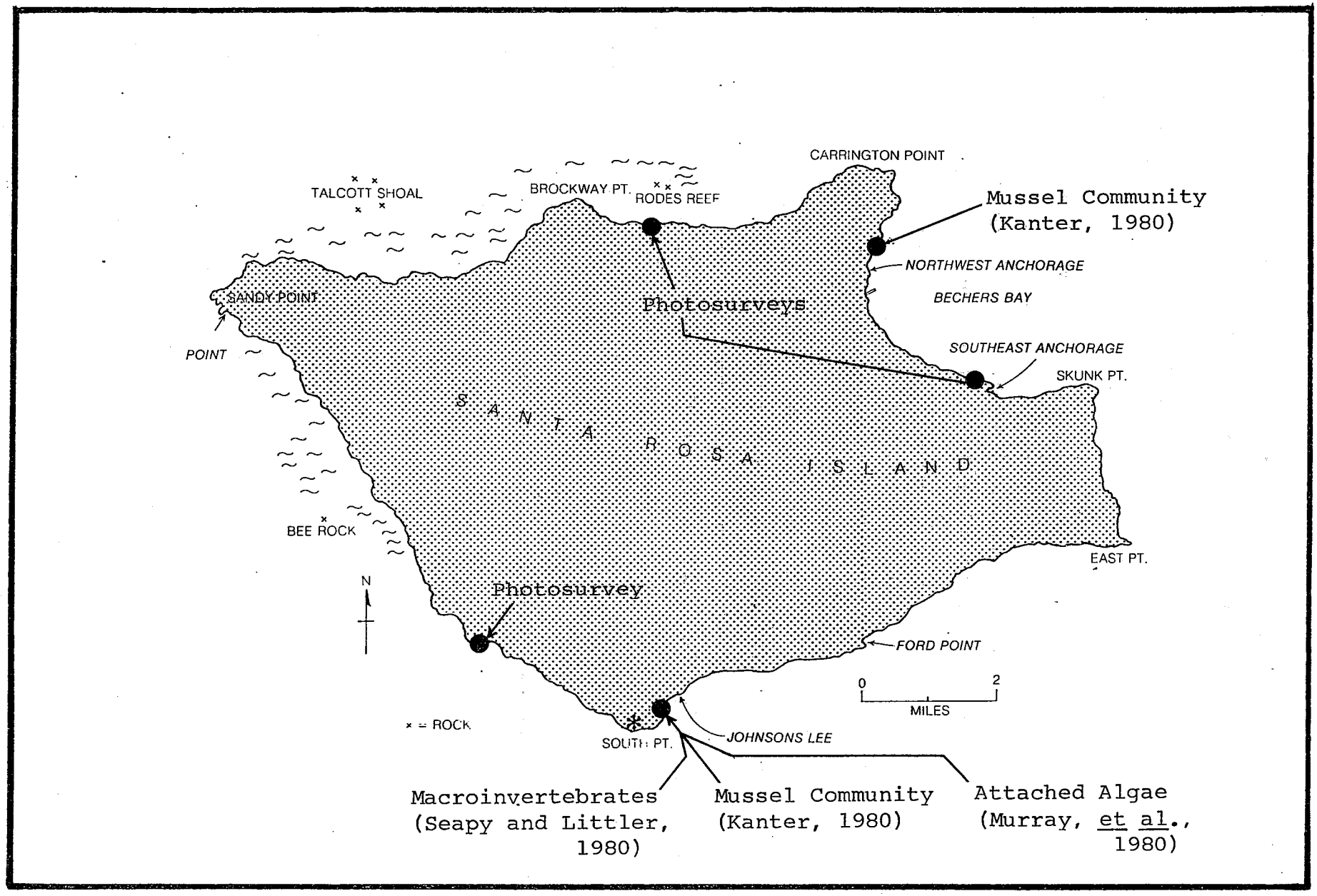


Figure 16. Intertidal survey sites.

Landside Vegetation.

The dry and rocky character of the coastal zone on Santa Rosa Island has restricted the adjacent land vegetation to coastal strand, coastal sage scrub, and mixed grassland types (Munz, 1968). Topographically, Santa Rosa is less diverse and defined compared to the other California islands. Canyons emptying into the coastal zone dominate the topography. Some canyons have perennial water flow, but only three permanent springs are known. Average annual rainfall of 14" is typical of the above-mentioned vegetational regimes. Sand dunes comprise much of the land area on the eastern and western extremities of the island.

Inland, annual grasses are the dominant floral constituent. Salt bush (Atriplex californica) dominates. In the southern subregions (Areas C and D) coastal sage scrub communities (Munz, 1968) predominate. Coastal strand communities are common in Area A and the western extremities of Areas B and C. The woodland-chaparral type habitat (Munz, 1968) which can be observed in the inland portions of coastal canyons and mid-island ridges on the southeastern portion of the island (Area D) does not extend into the coastal zone.

Unusual and endemic species occur as part of the community-types cited above, and define a level of uniqueness for the Santa Rosa Island coastal zone flora.

Davis (1980) reported the presence of Malacothrix coulteri, var. cogmata, M. implicata, and incana. According to Hochberg (1980), the chaparral is comprised of Prunus ilicifolia, Dendromecon rigida, and Ceanothus arboreus, the island mallow Lavatera assurgentiflora, island ironwood Lyonothamnus floribundus asplenifolius, Astragalus miguelensis and mevinii, Dudleya candelabrum and greenei, buckwheat Eriogonum arborescens and grande grande, Haplopappus detonsus, the shrubby paintbrush Castilleya hololeuca,

yarrow, *Achillea borealis*, *Jepsonia* spp., island morning glory, *Calyptegia macrostegia macrostigia*, and island poppy, *Eschsholzia ravosa*. All of these are (by their relative abundance or co-occurrence with other species) unique components of Santa Rosa landside vegetation.

Unique Components.

Populations of the pelagic shrimp *Sergestes similis* occur in great abundance in the waters of the Santa Barbara Channel, over the Santa Barbara Basin. This species has potential commercial significance and may be harvested in the near future. Inshore swarms of this species may occur periodically along the northern coast of Santa Rosa Island.

Santa Rosa Island is the site of breeding and pupping (rookery) grounds for two species of pinnipeds (Le Boeuf and Bonnell, 1980). The harbor seal, *Phoca vitulina*, uses Sandy Point on the west end of the island as a rookery; while the California sea lion, *Zalophus californianus*, uses Becher's Bay at the east end. In addition, four other pinniped species use Santa Rosa rocks and beaches for haul-out areas. These species are:

Eumetopias jubatus - Stellar sea lion
Callorhinus ursinus - Northern fur seal
Mirounga angustirostris - Northern elephant seal
Arctocephalus townsendi - Guadalupe fur seal

None of the pinniped species are considered to be endangered or threatened under the Endangered Species Act; however, *A. townsendi* has been nominated for endangered species status and *M. angustirostris* is regarded as threatened by some authorities.

Eight other species of marine mammals have been reported in the nearshore waters of the Santa Rosa Island ASBS:

- Esochrichtius robustus - Gray whale
- Balenoptera physalus - Fin whale
- Orcinus orca - killer whale
- Globicephala macrorhyncus - Pilot whale
- Lagenorhyncus obliquidens - Pacific white-sided dolphin
- Phocoenoides dalli - Dall's porpoise
- Delphinus delphis - Common dolphin
- Lissodelphis borealis - Northern right whale

Four marine bird species (about 900 pairs) have nesting colonies within the Santa Rosa Island ASBS (Hunt et al., 1980) see Figure 17:

- Larus occidentalis - Western gull
- Cepphus columba - Pigeon guillemot
- Phalacrocorax pelagicus - pelagic cormorant
- Phalacrocorax penicillatus - Brandt's cormorant

The nesting colonies are located along the northern coast of Santa Rosa, in subregional areas A and B, more or less continuously distributed between the southern end of Becher's Bay and the western margin of Brockway Point. In 1975 the estimated population of all nesting marine birds on Santa Rosa Island was 600. Another 25-35 species of marine birds have been sighted on or over Santa Rosa Island. The relative isolation of Santa Rosa Island from the mainland and from other islands has led to the differentiation of some land plants such that distinct varieties of some forms are restricted to Santa Rosa or to Santa Rosa and only one or two other islands. Thus endemism is a factor in characterizing the landside vegetation of Santa Rosa, but the case for endemic plants restricted solely to Santa Rosa is not clear. Among the endemic or near-endemic forms are:

- Ceanothus arboreus - Lilac
- Lavatera assurgentiflora - Island mallow

†Lyonothamnus floribundus - Island ironwood
†Astralagus miguelensis - Island locoweed
†Dudleya candelabrum - Live-forever
†Dudleya greenei - Live-forever
†Eriogonum arborescens - Buckwheat
†Eriogonum grande grande - Buckwheat
†Haplopappus detonsus - no common name
†Calystegia microstegia microstegia - Morning glory
†Castilleja hololenca - Paintbrush

While not all of these forms are typical nearshore plants, they are actual or potential residents of the shoreside ASBS region. Because of their quasiendemic status they should be regarded as unique components of this ASBS.

An endemic subspecies of the Channel Island Fox† Urocyon littoralis santarosae is widespread and relatively abundant on Santa Rosa Island. This diminutive, omnivorous form of the mainland gray fox may be an occasional visitor to the intertidal zone; however, this aspect of its behavior has not been well-documented. During the course of the present survey, a fox den was located in a large cave in the bluff base at upper-beach level at the second (unnamed) sandy beach southeast of Cluster Point. A seep from the ceiling collected in a pool on the cave floor and in the surrounding wet earth were dozens of fox tracks. This is the first record of a fox den so close to the intertidal margin. In 1971, the island fox was classified as a rare species under the California Endangered Species Act of 1970.

The dense and abundant kelp beds (primarily†Macrocystis pyrifera) off Santa Rosa Island represent a significant portion of one of the most important marine habitat types in southern California. Kelp plants are the foundation species of a unique natural assemblage of marine organisms. More than 800 plant and animal species are known to be associated with kelp plants in these marine forest

communities; this figure includes at least 125 fish species (Ebeling, pers. comm.). The kelp provide food, oxygen, protection, habitat, and substrate for these organisms. The largest beds near Santa Rosa occur along the southern coast and around Sandy Point, but the island is nearly surrounded by a series of thick beds.

Around Santa Rosa the kelp beds occur on and over rocky substrates at depths chiefly between about 20 to 80 ft. Because of the relative isolation of Santa Rosa, its kelp beds generally support higher densities and diversities of associated organisms. Commercial harvesting of kelp occurs around all of the northern Channel Islands including Santa Rosa.

The hydrocoral *Allopora california*, one of the rarest species identified by the recent BLM southern California bight surveys, has been reported from Santa Rosa.

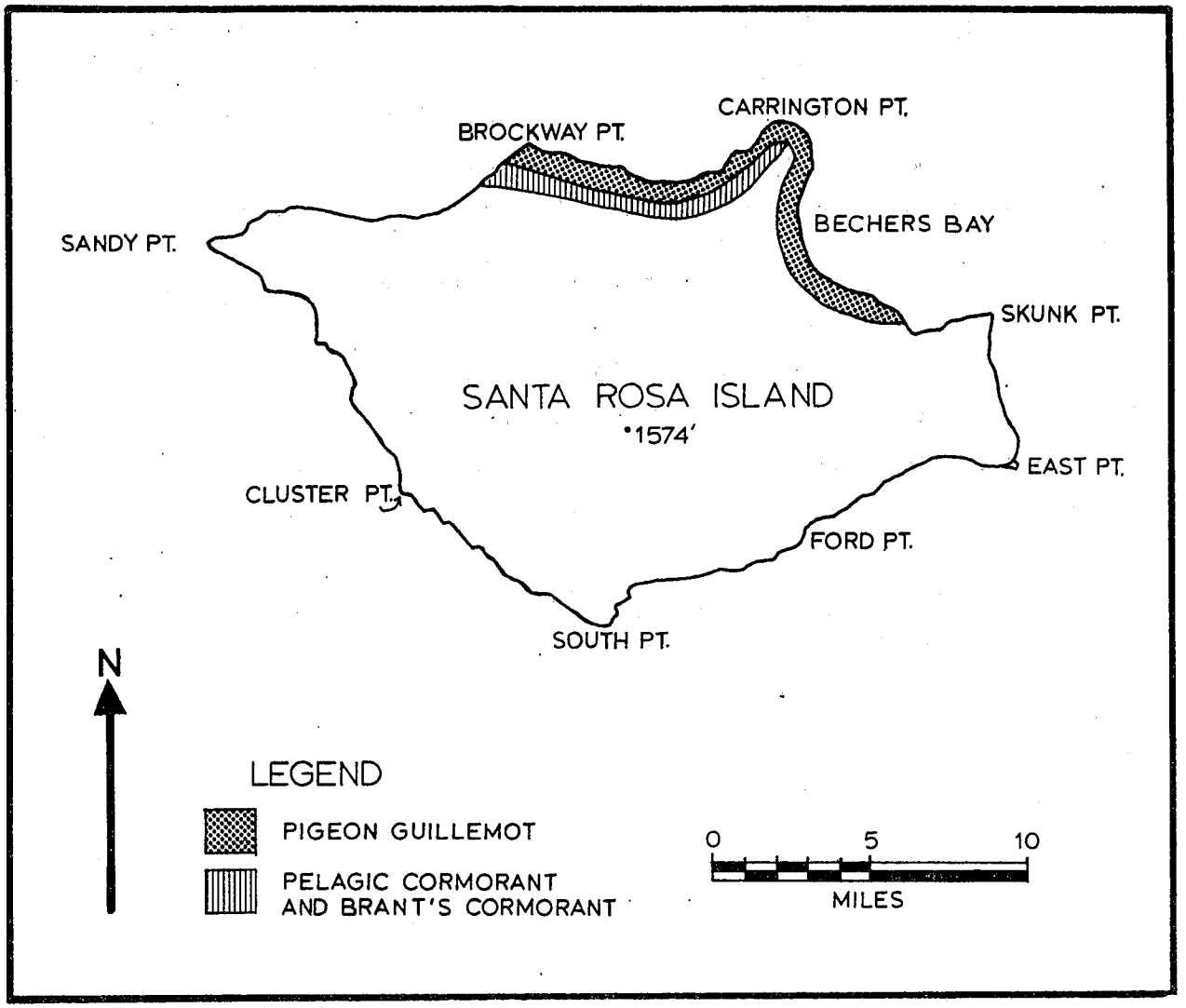


Figure 17. Bird rookery areas (after NOAA, 1979).

LAND/WATER USE DESCRIPTION

Marine Resource Harvesting.

The primary commercial fishing activities within the Santa Rosa Island ASBS area are the collection of abalone, sea urchins, and lobsters. Four species comprise the bulk of the abalone catch: *Haliotus cracherodii*, *H. rufescens*, *H. corrugata*, and *H. fulgens*. The commercial catch is harvested by divers working in the middle and deep subtidal zone. Intertidal and shallow subtidal collection are prohibited, but this rule is often violated. With the decline of abalone stocks north of Point Conception, pressure on the Channel Island populations has increased and these stocks appear also to be in decline.

Sea urchin fisheries, conducted out of Santa Barbara, Ventura, and Port Hueneme, are locally important within the ASBS areas. *Strongylocentrotus purpuratus* and *S. franciscanus* are harvested subtidally off Santa Rosa for export. This is a small export fishery and to date there have been no apparent detrimental effects within the island's ASBS boundaries.

The lobster fishery for *Panularis interruptus* places a heavy pressure on the ASBS population and, like the abalone, this resource is in a steady decline. Regulation by licensing, season, and size limits has slowed the drop in population size, and the recent development of aquaculture techniques for the eastern lobster *Homarus americanus* offers some promise for relief.

Other species harvested commercially include pelagic forms - anchovy, squid and tuna; and benthic or nearshore forms - spot prawn and rockfish. Recent yearly averages of total commercial catch from the Santa Rosa area have ranged from 500 to 1000 tons. The most productive and heavily fished area is that off the northwest quadrant of Santa Rosa.

No oil exploration or production takes place within the ASBS boundaries; however, nearby oil platforms do influence the area, and proposed development of petroleum resources within the marine sanctuary borders would significantly impact the Santa Rosa ASBS. The effects of this activity are discussed below.

Commercial kelp harvesting by the Kelco and Stauffer Companies takes place in leased beds around all of the northern Channel Islands, and within the Santa Rosa ASBS boundaries. Beds #113 and #114 lie off the southwest and southeast shores of Santa Rosa, bed #115 is off the northwest and #116 is off the northeast coast. The northern Channel Island beds provide the richest source of kelp for harvest in all of southern California.

Kelp harvesting has continued for nearly 30 years. Low-flying aircraft are used to scout the beds so that cutting can focus on the densest areas. The kelp is harvested by special ships which comb, cut and scoop the upper 4 ft of the plant's near-surface canopy. Harvesting usually takes place several times during the year, depending on regrowth.

Harvesting significantly reduces the kelp canopy, which provides substrate, protection and a food source for the myriad of species which occur in kelp forest communities. Kelp is the foundation (or keystone) species of these communities which are among the richest, most diverse and productive of the southern California nearshore and subtidal waters. Harvesting causes a temporary but significant reduction of the quality and character

of the kelp forest communities by removing the canopy and thus reducing the shelter and crowding many of the inhabitants into the remaining undamaged habitat. This leads to increased predation and a reduction of the overall community far beyond the direct removal of the kelp canopy itself.

Natural disruption of the kelp habitat also takes place due to the action of wind, waves, and natural grazers. Often these effects are more damaging than commercial harvesting because natural removal can dislodge the entire plant instead of just its upper canopy. Representatives of the kelp harvesting industry have challenged a statement in previous surveys of Santa Cruz and Anacapa Islands (Water Quality Monitoring Reports 79-8 and 79-7) which maintained that the character and quality of the kelp forest habitat is substantially reduced by harvesting; the authors of this report still stand by that statement.

Sport fishing and SCUBA diving activities are extensive within the Santa Rosa ASBS. The majority of the sport fishing pressure is due to partyboats which come from Santa Barbara, Oxnard, Ventura and Port Hueneme. Their catch levels vary from year to year but range from about 50 to 150 tons annually. The most heavily exploited species are: rockfish (chiefly Sebastes serranoids), halfmoon (Medialuna californiensis), sheephead (Pimelometopon pulchrum), kelp bass (Paralabrax clathratus), sand bass (chiefly P. maculato-fasciatus), lingcod (Ophiodon elongatus), and ocean whitefish (Caulolatilus princeps). The eastern and northeastern coastal regions generally yield the best catch levels for party boats although the entire nearshore periphery of Santa Rosa is visited by recreational fishermen.

SCUBA divers utilize both party boats and commercially chartered boats to dive the nearshore waters of Santa Rosa. The most popular locations are Talcott Shoals, Carrington Point, East Point, South Point, and Sandy Point. Most dives take place within

the ASBS boundaries and are usually conducted in kelp beds. The harvest of marine resources by divers is generally small although specific localities can be heavily exploited during a long period of good weather. The most commonly collected animals are abalone, lobster and a variety of finfish species. These activities appear to pose no substantial threat to the ASBS biota.

Municipal and Industrial Activities.

There are no municipalities within one mile of the Santa Rosa Island ASBS. The nearest municipality is Santa Barbara, 33 statute miles from Carrington Point.

There are no industrial activities within one mile of the Santa Rosa Island ASBS. The nearest industrial activities are the offshore oil drilling platforms in the Santa Barbara Channel. The ranch at Becher's Bay and the abandoned military base at Johnson's Lee represent the only developments on the island.

Agribusiness and Silviculture.

There are no forestry, logging or dairying operations within or immediately adjacent to the Santa Rosa Island ASBS. The island is used for cattle grazing but their present overall impact on the ASBS is minimal. Overgrazing by sheep in decades past has significantly altered the island's vegetation and led to considerable erosion. The sheep have since been completely eradicated.

Governmental designated open space.

On March 5, 1980, Channel Islands National Park was established. The park includes San Miguel, Santa Rosa, Santa Cruz, Anacapa, and Santa Barbara Islands, with an administrative boundary one nautical mile around each island. The park is administered by the National Park Service (NPS), Department of the Interior. The NPS is in the

process of preparing resource management recommendations; the first such report is due by October 1, 1982. Updates will be provided every two years until 1990. The development of management plans for the park will consider a variety of public access alternatives, from primitive to highly structured. Obviously, the evolution of the park is of crucial significance to the future of the ASBS. (Appended to the present report is a NPS environmental assessment for San Miguel, Anacapa and Santa Barbara Islands, prepared before the five-island park was established (Appendix III, archived at the SWRCB).

On September 21, 1980, the six miles surrounding each of the five Santa Barbara Channel Islands were designated a marine sanctuary. The sanctuary is administered by the National Oceanic and Atmospheric Administration (NOAA), Office of Coastal Zone Management, Sanctuary Programs Office, of the Department of Commerce. The sanctuary was established by executive order, under the Ocean Dumping Act of 1972. New oil production and exploration within the sanctuary are prohibited but existing oil leases can be worked until the leases expire. Existing leases must conform to sanctuary regulations, and oil spill containment equipment must be present during operations. Solid waste discharges from tankers and vessels larger than 150 gross tons are prohibited within the sanctuary. Benthic drilling, dredging, construction and seabed alteration are prohibited within two nautical miles of the island. Ship traffic is prohibited within one nautical mile of the islands. Aircraft overflights are restricted to altitudes above 100 feet within one horizontal mile. The disturbance of submerged archaeological resources is also prohibited. Commercial and sport fishing, oil production, kelp harvesting and all other resource extraction from the sanctuary are still implemented and enforced by the appropriate federal or state agency, under a cooperative interagency agreement.

On May 7, 1981, the Secretary of the Interior announced a moratorium on land acquisition by the NPS, a move which may

seriously threaten the ASBS. A further threat exists from Department of the Interior plans to allow petroleum exploration and drilling within the newly-created Santa Barbara Channel Islands Sanctuary. The State of California has filed suit against the Department of the Interior over this and related issues. If successful, the sanctuary would be protected.

Recreational Uses

Santa Rosa Island has become increasingly popular as a boating, fishing, diving and nature study area for day-trippers in private boats from Santa Barbara, Ventura, and Port Hueneme. Visits by private boats from the population centers further south have also increased in recent years. Chartered boats with groups of fishermen, divers, and those interested in nature study visit the nearshore waters during good weather, but the distance from the mainland and the frequency of bad weather and seas tend to isolate Santa Rosa ASBS, and it is visited with far less regularity than Anacapa or Santa Cruz Islands. The nearshore region visited most frequently by divers and fishermen is Talcott Shoals but the entire nearshore region is popular.

The mere existence of the Channel Islands National Park will undoubtedly increase the degree to which the Santa Rosa Island ASBS is visited in the future. However, the stewardship of the park by NPS should ensure an adequate level of protection from recreational over-use.

Scientific Study Uses

Numerous scientific studies are conducted on or around Santa Rosa Island; all are now coordinated by the National Park Service and Vail and Vickers, except for offshore sampling by the Southern

California Coastal Water Research Project (SCCWRP), the California Cooperative Oceanic Fisheries Investigations (CalCOFI), and the Bureau of Land Management (BLM).

Five general categories of scientific study are conducted in northern Channel Islands, some but not all of which may concern Santa Rosa Island directly. The categories and their supporting agencies or groups are:

1) marine mammal and seabird studies - U. S. Fish and Wildlife Service (USFWS), National Park Service (NPS), National Marine Fisheries Service (NMFS), California Department of Fish and Game (CFG), Marine Mammal Commission (MMC), Department of Energy (DOE), BLM, and Department of Defense (DOD).

2) fishery resource studies - NMFS, CFG, CalCOFI, NPS.

3) environmental baseline and monitoring studies - NPS, BLM, SCCWRP, Office of Coastal Zone Management (OCZM), EPA, DOE, CFG.

4) hydrocarbon pollution monitoring - BLM, OCZM, EPA, DOE.

5) university research - this category includes both applied research, supported by many of the above-listed agencies as well as by the Office of Sea Grant, and basic research sponsored chiefly by the National Science Foundation. University research tends generally to include a wider range of research subjects and goals than the other categories.

Transportation Corridors

Figure 18 shows the Santa Barbara Channel shipping lane, which approaches Santa Rosa Island at the west end of the Channel by about 10 nautical miles. The Channel is a major shipping route

and traffic has increased substantially in recent years. Many commercial vessels use the Channel enroute between southern California ports and ports around the entire North Pacific. Approximately 15 large vessels (greater than 300 ft in length) pass through the Channel daily at the present time. About the same number of smaller vessels also use the Channel shipping lanes daily. In addition, cross-Channel traffic is also fairly heavy; it is estimated that 30-40 commercial vessels cross the shipping lanes each day.

The bulk of the cargo carried by all these vessels is petroleum products. A large percentage of the vessels carrying the petroleum are of foreign registry. Much of the cross-Channel traffic is also petroleum related, in that service and supply functions for the offshore oil rigs are carried out by these smaller vessels. Furthermore, since few onshore pipelines exist for transporting petroleum produced in the Channel, most of it is carried to the refineries further south by ship.

Projected increases in ship traffic through the channel are highly significant and could account for a quadrupling of the current traffic levels within a few years.

Military Activities

The U. S. Navy maintains a practice aerial mine range in Becher's Bay and in the Santa Cruz Channel between Santa Rosa and Santa Cruz Islands. The dummy mines are laid by low-flying aircraft and are recovered by divers from a surface vessel. The southern two-thirds of the Santa Rosa ASBS is within the U. S. Navy's Pacific Missile Test Range, and the entire ASBS is within overflight range of missiles from Vandenberg Air Force Base. Future impact on the ASBS can be expected from the Space Shuttle Program.

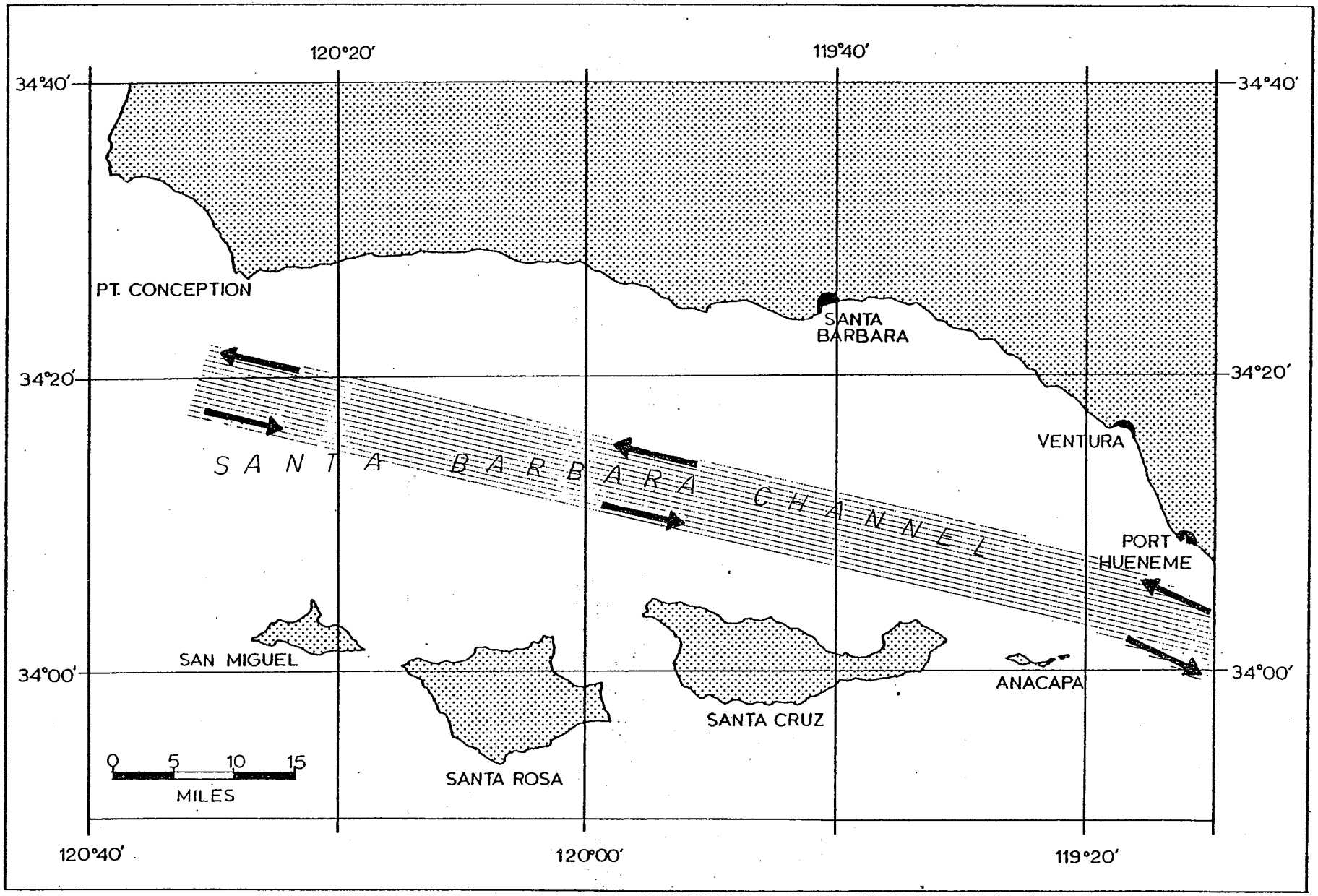


Figure 18. Santa Barbara Channel shipping lane.

ACTUAL OR POTENTIAL POLLUTION THREATS

Point Sources

There are no radioactive wastes within the Santa Rosa Island ASBS. However, about 45 miles to the south (at 33° 35' N, 119° 30' W in the Santa Cruz Basin) there is a radioactive waste dumpsite that was used by the Atomic Energy Commision in the early 1950's. Approximately 3,300 55-gallon drums containing uranium and thorium wastes were dumped. This is mostly low-level material (about 60 curies of activity) but the existence of this dumpsite has not been widely known and the pernicious nature of radionuclide pollution makes it a potential threat. The same general area of the Santa Cruz Basin has also been used as a chemical and munitions dumpsite.

No oil development takes place within the Santa Rosa Island ASBS boundaries. However, nearby operations in the Santa Barbara Channel and off the mainland coast undoubtedly lead to chronic oil and tar pollution on the island's coast. Oil slicks extending downstream from the drilling platforms are common (or regular) occurrences and the prevailing weather and current patterns dictate that a portion of this petroleum discharge will impact the island's northern coastline. Many of the nearby offshore site leases were granted before the institution of strong environmental considerations and thus are not constrained by the more recently adopted controls. The proposed sale of future lease sites (Bureau

of Land Mangement sale no. 68, see Figure 19) includes areas close to the northern Channel Islands. Furthermore, the Secretary of the Interior has announced plans to open previously excluded tracts adjacent to Santa Rosa Island. Development of these areas will greatly increase the level of oil pollution on the islands. The effects of this increase cannot be predicted because as yet there has been little data available concerning the effects of even the current level. It should be noted, however, that observations showed a striking difference between the intertidal biota at oil impacted areas and non-impacted areas on Santa Rosa.

In addition to chronic low-level oil pollution, the threat of a catastrophic oil spill also exists for the Santa Rosa ASBS. The threat arises from four types of events: blowouts at platforms, pipeline ruptures, tanker discharges or accidents, and discharges during operation.

Shipping traffic through the Santa Barbara Channel, and also south of the islands, undoubtedly leads to some pollution of their shorelines. It is common practice for large vessels to flush their bilges, sewage tanks, and oil storage tanks prior to and/or after leaving port. The Coast Guard polices this problem, but they can be effective only during the day, and vessels have adopted the practice of flushing at night to avoid detection. Expanding vessel traffic due to the increasing transportation of Alaskan oil and liquified natural gas will add to this pollution problem. Recent increases in tanker traffic and future expansion of cross- and through-Channel traffic due to increasing oil exploration and production will also add to the threats.

Non-point Sources

Agricultural wastes, while present, represent an insignificant pollution threat.

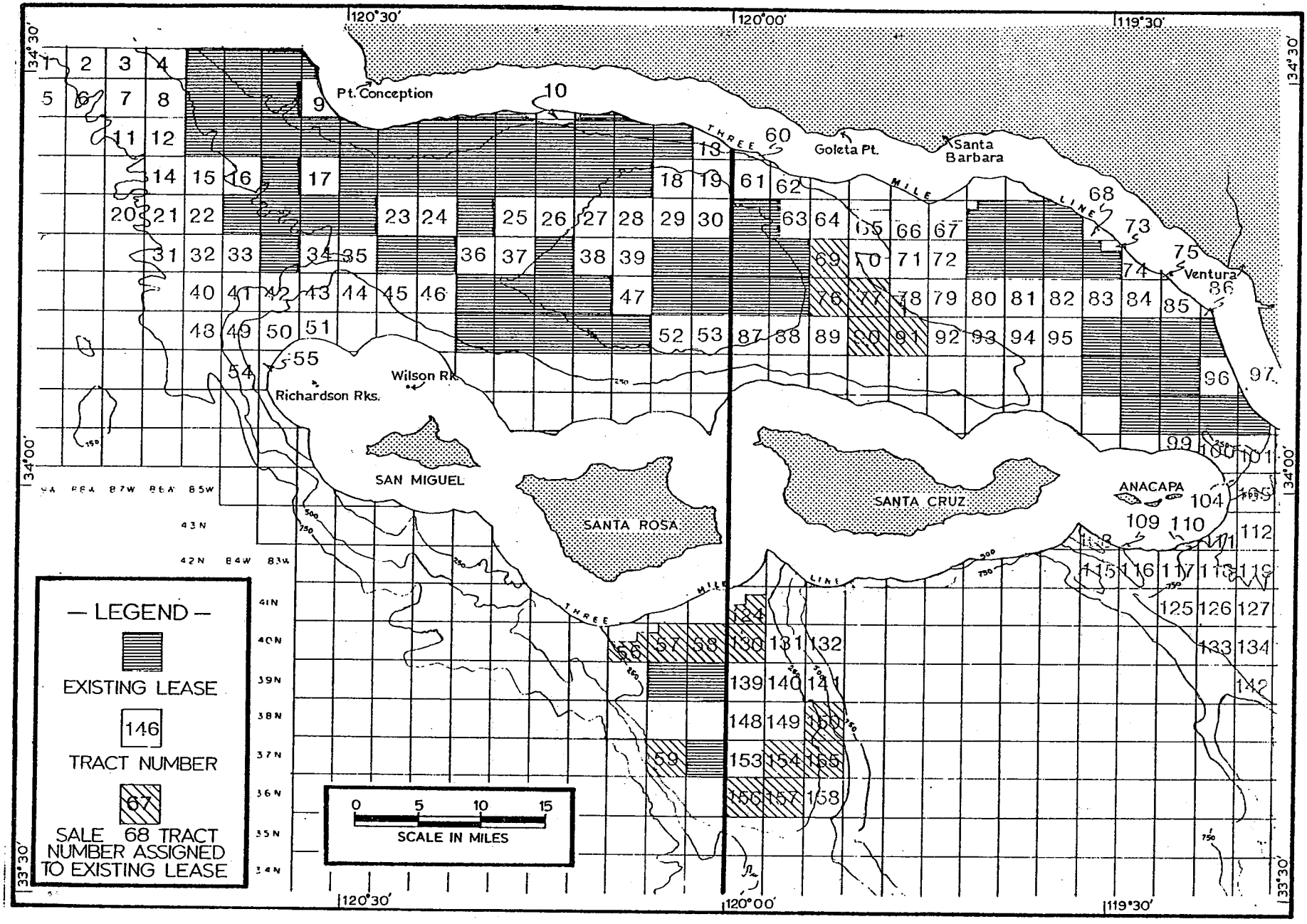


Figure 19. Oil development lease tract localities.

The Santa Barbara Channel is a preferred route for north and southbound vessel traffic in periods of bad weather. Traffic is increasing and thus the possibility of oil spills from shipping accidents is also increasing. Oil spills from the offshore drilling rigs also pose a very real threat. Natural oil seeps are common features in the marine environment around the northern channel islands. There has been no systematic survey of these seeps but several are known to directly affect the islands. Clusters of seeps are sources of oil and gas which escape into the overlying water and which may spread as a tar-like crust on the seafloor adjacent to the seep (Kolpack, 1979; Stuermer, 1979). The clusters, known as "seep trends", have been extensively mapped in certain regions of the Channel, and, from existing information, certain generalizations about them can be made:

1) Seeps are most common along basin margins in areas of present day tectonic activity where there is little or no overburden of unconsolidated sediments (Fisher, 1979; Fisher and Stevenson, 1973a, b; Link, 1952).

2) Seeps generally occur along geologic structure trends in recently uplifted young sediments (Fisher, 1979).

3) Natural seeps have been active in the Santa Barbara Channel region for at least the last 10,000 years, and probably for much longer (Fisher, 1979).

4) Oil production may be responsible for recent declines in seep activity (Fisher, 1979; Fisher and Stevenson, 1973a, b; Fisher and Berry, 1973).

All of the seeps in the Santa Barbara region which have been studied to date are essentially shallow water features (<100 meters depth), and, judging from the presence of tar deposits on Santa Rosa's eastern and northern shores and the shallow water geological features of those crusts, seeps are undoubtedly a common feature

there. It is reasonable to assume that petroleum fractions are present at high concentrations in nearshore waters along those coasts, and that they are a significant aspect of regional water quality. A known major seep exists off Skunk Point on Santa Rosa.

Measurements by the Southern California Coastal Water Research Project (SCCWRP) have shown higher Channel-side fluxes of airborne DDT and PCB than on the southern side of the northern Channel Islands. There is a gradient of flux which decreases toward the western end of the Channel.

Beginning in 1983 the Air Force and NASA will begin launches of the Space Shuttle from Vandenberg Air Force Base. About 20 launches are anticipated, some 8 of which will pass over the northern Channel Islands at from 160,000 to 180,000 feet. Over-pressures or sonic booms will impact the islands on both launches and return flights. The return flights will pass over the islands at between 80,000 to 100,000 feet. In addition, spent booster rockets will be dropped into the sea offshore and will eventually be towed by barge from Port Hueneme to Vandenberg, past the northern Channel Islands. Expendable fuel tanks will also be transported in this manner prior to launch, thus increasing vessel traffic around the islands.

The threat of the launch and return activities can be regarded as occasional, extreme noise pollution. Sonic booms create the risk of startling pinniped and/or seabird populations which could have disastrous results such as death of young and abandonment of rookery areas. Other potential effects include damage to and collapse of geological features and disruption of subtidal communities. The Air Force has begun to investigate this problem and results of their preliminary studies may be found in Appendix II, archived at the State Water Resources Control Board, Division of Technical Services.

SPECIAL WATER QUALITY REQUIREMENTS

A special consideration with regard to the biota of the northern Channel Islands concerns its tolerance to oil pollution. The Santa Barbara Channel has been an area of natural oil seepage through a relatively long period of geological time. The resident biota of this region have evolved under these conditions and thus can be considered to be adapted to them. If this is so, then two possibilities exist concerning the potential effects of increased levels of petroleum in the environment due to spills or seepage from offshore drilling and oil production operations. 1) The present biota may be preadapted to cope with catastrophic or gradually increasing oil levels because it evolved with this factor as an essential feature of the habitat. 2) The present biota may already be near the limit of its tolerance to oil and could not cope with substantial increases. Natural systems seldom adhere to strict classifications, and a third possibility, that the actual situation is somewhere between, seems most likely.

BIBLIOGRAPHY

Below are listed the references used in the preparation of this survey report. Appendix V, a comprehensive bibliography recently compiled by the Santa Barbara Museum of Natural History, is archived at the SWRCB.

California Division of Mines and Geology. 1978. Map sheet series of California. Sheet #39. Epicenter map of California, 1900-1974.

Coast Pilot-7, Pacific Coast; thirteenth edition - June, 1977. Dept. of Commerce, Nat. Oceanic and Atmos. Admin., 384 pp. Comments: A good specific reference for navigational parameters, weather, and currents.

Davis, W. S. 1980. Distribution of Malacothrix (Asteraceae) on the California Islands and the origin of endemic insular species. In: The California Islands: Proceedings of a Multidisciplinary Symposium (D. M. Power, ed.). Santa Barbara Museum of Natural History.

Dunkle, M. B. 1950. Plant ecology of the Channel Islands of California. Allan Hancock Pacific Expeditions 13:247-386. Comments: Contains a nearly complete vegetation list and climate data.

Ebeling, A. W., R. J. Larson, and W. S. Alevison. 1980. Habitat groups and island-mainland distribution of kelp-bed fishes off Santa Barbara, California. In: The California Islands: Proceedings of a Multidisciplinary Symposium (D. M. Power, ed.). Santa Barbara Museum of Natural History.

Emory, K. O. 1960. The Sea off Southern California. Wiley & Sons, New York, 366 pp. Comments: An excellent background reference with a few specifics to the ASBS.

Fisher, P. J. 1979. Natural gas and oil seeps, Santa Barbara Basin. In: California Offshore Gas, Oil, and Tar Seeps, State Lands Commission Publication pp. 1-62.

Fisher, P. J. and R. Berry. 1973. Environmental hazards of the Santa Barbara Channel: Oil and gas seeps and Holocene faulting. In: (Moran, D. E., ed.), Geology, Seismicity and Environmental Impact. Assn. Eng. Geologists, Spec. Pub. pp. 417-431.

Fisher, P.J. and A. J. Stevenson. 1973. Natural hydrocarbon seeps, Santa Barbara Basin, California. Am. Assn. Petroleum Geologists, Soc. Econ. Paleontologists and Mineralogists, Soc. Eng. Geologists, Pacific Secs. Guidebook, Joint Ann. Mtg. Fifth Annual Offshore Tech. Conf., Houston, Texas, Paper No. OTC-1738, pp. 1728.

Hancock Foundation. 1965. An oceanographic and biological survey of the Southern California mainland shelf. Calif. State Water Quality Control Bd.; Calif. State Resources Agency, Pub. 27, 232 pp. Comments: Discussed in text.

Hochberg, M. C. 1980. Factors affecting leaf size of chaparral shrubs on the California Islands. In: The California Islands: Proceedings of a Multidisciplinary Symposium (D. M. Power, ed.). Santa Barbara Museum of Natural History.

Hunt, G. L., Jr., R. L. Pitman, and H. L. Jones. 1980. Distribution and abundance of seabirds breeding on the California Channel Islands. In: The California Islands: Proceedings of a Multidisciplinary Symposium (D. M. Power, ed.). Santa Barbara Museum of Natural History. Johnson, D. L. 1980. Episodic vegetation stripping, soil erosion, and landscape modification in prehistoric and recent historic time, San Miguel Island, California. In: The California Islands: Proceedings of a Multidisciplinary Symposium (D. M. Power, ed.). Santa Barbara Museum of Natural History.

Kanter, R. G. 1979. Mussel community study. Southern California Baseline Study, Final Report. Vol. II, Rept. 7; Vol. III, Rept. 2.0; Vol. IV, Rept. 2.0. Bureau of Land Management, U. S. Dept. Interior, Wash., D.C.

Kanter, R. G. 1980. Biogeographic patterns in mussel community distribution from the Southern California bight. In: The California Islands: Proceedings of a Multidisciplinary Symposium (D. M. Power, ed.). Santa Barbara Museum of Natural History.

Kolpack, R. L. 1979. Relationship of migration of natural seep material to oceanography of Santa Barbara Channel. In: California Offshore Gas, Oil and Tar Seeps, State Lands Commission Publication, pp. 226-255.

Laughrin, L. 1980. Populations and status of the Island Fox. Pp. 745-749 In: The California Islands: Proceedings of a Multidisciplinary Symposium (D. M. Power, ed.). Santa Barbara Museum of Natural History.

Le Boeuf, B. J. and M. L. Bonnell. 1980. Pinnipeds of the California Islands: abundance and distribution. In: The California Islands: Proceedings of a Multidisciplinary Symposium (D. M. Power, ed.). Santa Barbara Museum of Natural History.

Link, W. A. 1952. Significance of oil and gas seeps in world oil exploration. Am. Assn. Petroleum Geologists Bull. 36:1505-1540.

Littler, M. M. 1980. Overview of rocky intertidal systems of Southern California. In: The California Islands: Proceedings of a Multidisciplinary Symposium (D. M. Power, ed.). Santa Barbara Museum of Natural History.

Munz, P. A. 1968. A California flora. 1681 p. Univ. of Calif. Press, Berkeley.

Murray, S. N., M. M. Littler, and I. A. Abbott. 1980. Biogeography of California marine algae with emphasis on the Southern California Islands. In: The California Islands: Proceedings of a Multidisciplinary Symposium (D. M. Power, ed.). Santa Barbara Museum of Natural History.

NOOAA, 1979. Draft environmental impact statement for proposed Channel Islands Marine Sanctuary. U. S. Dept. Commerce, Nat'l. Oceanic & Atmos. Agency, Office of Coastal Zone Management.

National Park Service. 1979. Environmental assessment report. Alternatives for visitor use, interpretation and general development. U. S. Dept. of the Interior, NPS. 82 pp.

National Park Service, Channel Islands National Monument, W. H. Ehorn, Superintendent. March 1977. Statement for management for San Miguel and Prince Islands (Recommendations). Comments: Discussion of Natural resources and their management, including park policies, park visitation and research.

Nicholsen, N. L. and R. L. Cimberg. 1971. The Santa Barbara Oil Spills of 1969: a post-spill survey of the rocky intertidal. Ch. 17, pp. 325-355. In: Biology and Oceanographic Survey of the Santa Barbara Oil Spill, 1969-1970. Vol. I. Biological Studies. (R. L. Kolpack, ed.). Allan Hancock Foundation, Sea Grant Pub. No. 2.

Owen, R. W. 1980. Eddies of the California Current system: physical and ecological characteristics. In: The California Islands: Proceedings of a Multidisciplinary Symposium (D. M. Power, ed.). Santa Barbara Museum of Natural History.

Philbrick, R. N., ed. 1967. Proceedings of the symposium on the biology of the California Islands. Santa Barbara Botanic Garden. Comments: Articles on geology, archaeology, terrestrial and marine flora and fauna. (Includes Bartholomew, 1967. Seal and Sea Lion populations of the Calif. Islands.)

Philbrick, R. 1980. Distribution and evolution of endemic plants of the California islands. In: The California Islands: Proceedings of a Multidisciplinary Symposium (D. M. Power, ed.). Santa Barbara Museum of Natural History.

Seapy, R. R. and M. M. Littler. 1980. Biogeography of rocky intertidal macroinvertebrates of the Southern California Islands. In: The California Islands: Proceedings of a Multidisciplinary Symposium (D. M. Power, ed.). Santa Barbara Museum of Natural History.

Southern California Coastal Water Research Project. Annual Reports, 1969-1980. Comments: Useful for information from ongoing studies of the Southern California bight; but these programs seldom include Santa Rosa or San Miguel Islands.

Stuermer, D. 1979. Seminar on gas and oil seep research, presented at UCSB, February, 1979.

Weaver, D. W., et al. 1969. Geology of the northern Channel Islands, Southern California borderland. Am. Assoc. of Petroleum Geologists and the Soc. of Econ. Paleontologists and Mineralogists (Pacific Sections) Misc. Pub., 200 p., 34 plates, 16 Figs. Comments: A classification and characterization of island geography with fault maps.

Weissman, D. B. and D. C. Rentz. 1977. Rainfall data for the California Channel Islands and adjacent mainland. Calif. Acad. Sci. offprint.

APPENDICES

APPENDICES I THROUGH V
Are Archived At The State Water
Resources Control Board
Division of Technical Services
Sacramento, California

STATE WATER RESOURCES CONTROL BOARD

P. O. Box 100, Sacramento, CA 95801

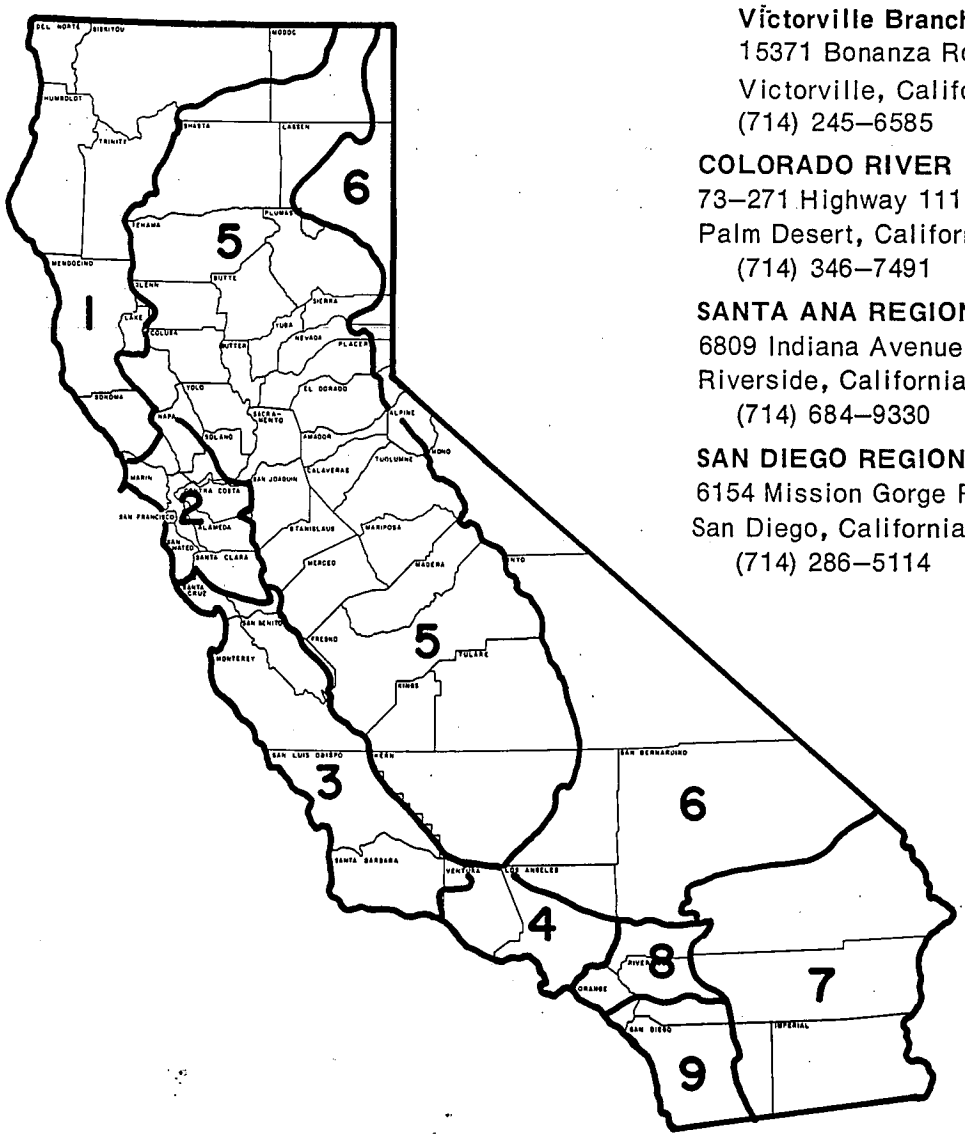
CALIFORNIA REGIONAL WATER QUALITY CONTROL BOARDS

NORTH COAST REGION (1)
1000 Coddingtown Center
Santa Rosa, California 95401
(707) 545–2620

SAN FRANCISCO BAY REGION (2)
1111 Jackson Street, Room 6040
Oakland, California 94607
(415) 464–1255

CENTRAL COAST REGION (3)
1122–A Laurel Lane
San Luis Obispo, California 93401
(805) 549–3147

LOS ANGELES REGION (4)
107 South Broadway, Room 4027
Los Angeles, California 90012
(213) 620–4460



CENTRAL VALLEY REGION (5)
3201 S Street
Sacramento, California 95816
(916) 445–0270

Fresno Branch Office
3374 East Shields Avenue
Fresno, California 93726
(209) 488–5116

Redding Branch Office
1815 Sacramento Street
Redding, California 96001
(916) 442–6376

LAHONTAN REGION (6)
2092 Lake Tahoe Boulevard
P. O. Box 14367
South Lake Tahoe, California 95702
(916) 544–3481

Victorville Branch Office
15371 Bonanza Road
Victorville, California 92392
(714) 245–6585

COLORADO RIVER BASIN REGION (7)
73–271 Highway 111, Suite 21
Palm Desert, California 92260
(714) 346–7491

SANTA ANA REGION (8)
6809 Indiana Avenue
Riverside, California 92506
(714) 684–9330

SAN DIEGO REGION (9)
6154 Mission Gorge Road, Suite 205
San Diego, California 92120
(714) 286–5114