California Marine Waters
Areas of Special Biological Significance
Reconnaissance Survey Report

CALIFORNIA MARINE WATERS
AREAS OF SPECIAL BIOLOGICAL SIGNIFICANCE
RECONNAISSANCE SURVEY REPORT

San Miguel Island
Santa Barbara County

STATE WATER RESOURCES CONTROL BOARD
Division of Technical Services
Surveillance and Monitoring Section

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WATER QUALITY MONITORING REPORT NO. 81-7TS

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. *Duxbury Marine Life Refuge*

ACKNOWLEDGEMENT

This Water Resources Control Board Report is based on a reconnaissance survey report submitted by Drs. B. H. Robison and J. L. Cox of the University of California at Santa Barbara, Marine Science Institute. The latter report was prepared in fulfillment of an agreement with the California Department of Fish and Game, which has coordinated the preparation of a series of Areas of Special Biological Significance Survey Reports for the Board under an Interagency Agreement.

The University's effort involved a field team composed of T. Bailey, K. Johnson, K. Reisenbichler, and S. Willason, with assistance by H. Ehrenspeck and R. Williamson. Their work is acknowledged with thanks.

ABSTRACT

The objective of this study was to survey the nearshore and coastal shoreline regions of the San Miguel 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 overall survey included subtidal diving operations, intertidal transects, beach and coastline surveys, and aerial photographic surveys. This report provides a description of the San Miguel ASBS in terms of its biological, geological, and hydrographic characteristics.

San Miguel Island has a rugged coastal perimeter, 25.9 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 dense kelp beds at the western and southern promontories. San Miguel Island is the only place in the United States and one of the few places in the world where breeding populations of five pinniped species occur together. As such, it is a critically important marine locality. Similarly, San Miguel is a very important rookery area for eight species of marine birds. The principal pollution threats to the ASBS can come from the development of petroleum resources and shipping traffic in the Santa Barbara Channel. The ASBS has been divided into four subregional areas, based on watershed configuration, which can form the basis for baseline and monitoring surveys.

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FINDINGS AND CONCLUSIONS

San Miguel Island is a unique 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 protection provided by Navy ownership, National Park Service management, and its 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 may be threatened by the development of petroleum resources. Baseline and periodic monitoring programs are needed. The greatest present destructive threats are 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. The landside substrate and vegetation are extremely fragile and must be protected from heavy usage by visitors if it is to survive. The pinniped rookeries at the west end are irreplaceable resources and must be protected from harm. Whatever the outcome of the National Park's progress, baseline and periodic monitoring programs are needed to fully categorize and characterize the island's marine habitats and communities so that they may be sustained.

INTRODUCTION

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

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

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

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

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

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

In order for the State Water Resources Control Board to evaluate the status of protection of the San Miguel 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.

San Miguel Island is an area of particular biotic significance because of the rich kelp forests which surround it, because of the sea bird nesting areas around Prince Island, and in particular because of the rookery areas for five pinniped species, which has no other U.S. counterpart. Except for the effects of grazing, the topsoil and the terrestrial biota have remained essentially unchanged for 200 years. San Miguel is habitat for endemic plants, the channel islands fox, rare and endangered plant species, the endangered California brown pelican, several resident bird species and many seasonal migrants, and marine mammal species. It is also an area possessing Chumash archaeological sites.

Isolation from the mainland plus the character and extent of its subtidal and intertidal substrates make the islands' 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

San Miguel Island is the sixth largest of southern California's eight Channel Islands. San Miguel is 7.6 miles long and 4 miles wide at its widest point; it has a coastal perimeter of 25.9 miles and an area of 14 mi^2. Figure 2 depicts the division of San Miguel Island into subregional watershed areas. Using detailed USGS topographical 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 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 baseline and monitoring 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 National Park Service. The island's rugged coastline makes much of it unapproachable by sea, yet 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

PHYSICAL AND CHEMICAL DESCRIPTION

Location and Size

San Miguel Island is bounded on the west, at Point Bennett, by longitude 120° 26' 54" W; to the east, at Cardwell Point, by 120° 18' 6" W; on the north, at Harris Point, by latitude 34° 04' 36" N; and to the south, at Crook Point, by 34° 00' 54" N. Its area is 14 mi^2.

The island is part of Santa Barbara County and lies offshore; Cardwell Point, Cuyler Harbor,and Harris Point are 43.6, 45.3 and 45.1 statute miles, respectively, from the City of Santa Barbara's breakwater. The nearest mainland point is Government Point below Point Conception, 42.0 miles from Harris Point on San Miguel. The nearest municipality is the City of Santa Barbara. The greatest elevation is 830 ft (253 m).

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

The coastal perimeter (shoreline) of San Miguel Island comprises 25.9 statute miles (41.4 km) excluding any islets. The coastline of Prince Island in Cuyler Harbor is 1.0 mi (1.6 km), and the coastline of Castle Rock is 0.5 mi (0.8 km). The shoreline lengths of subregional areas A through D are: 4.6 mi, 6.9 mi. 11.4 mi and 3.0 mi, respectively. Regional watershed and nearshore areal data are presented in Table 1.

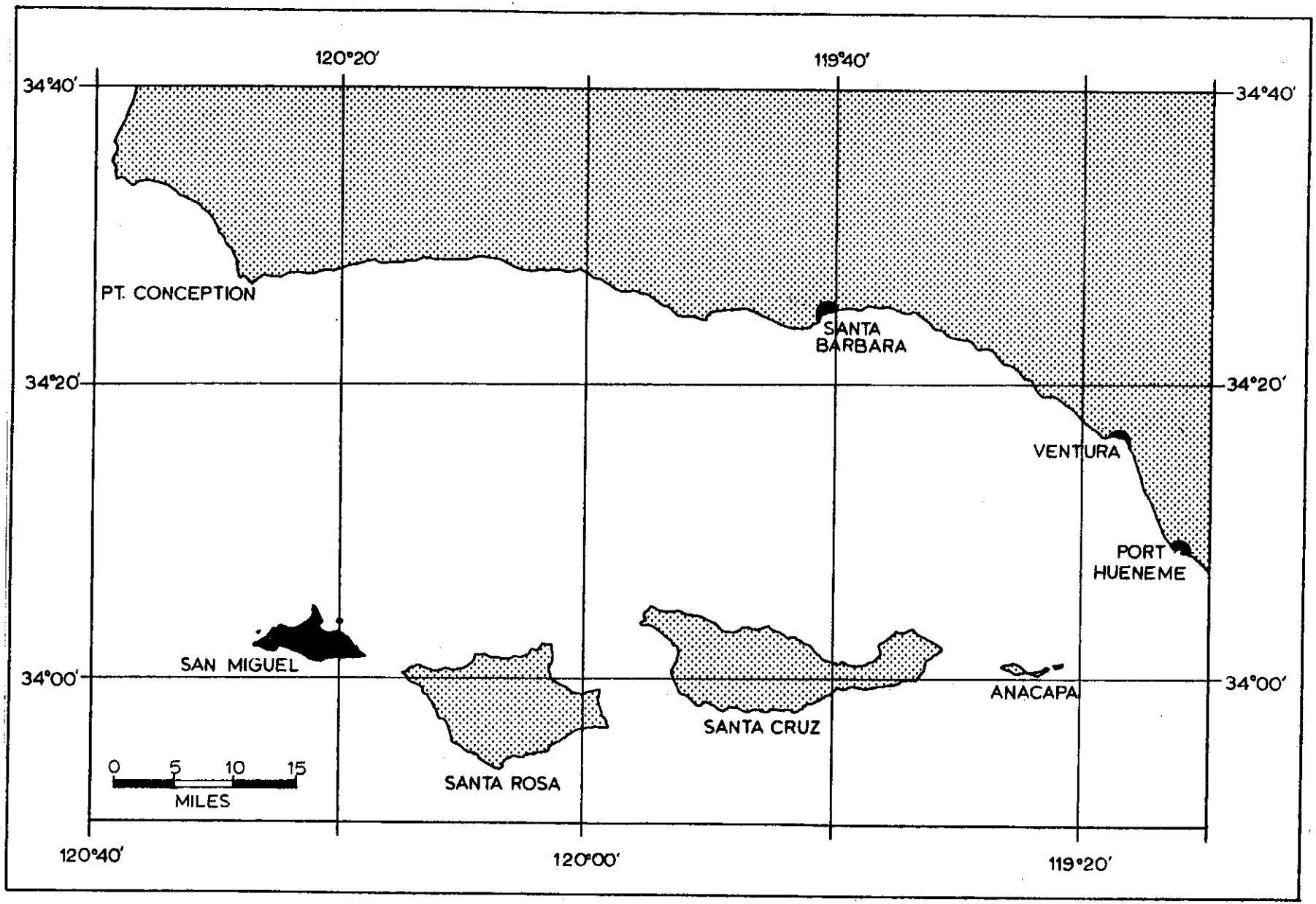
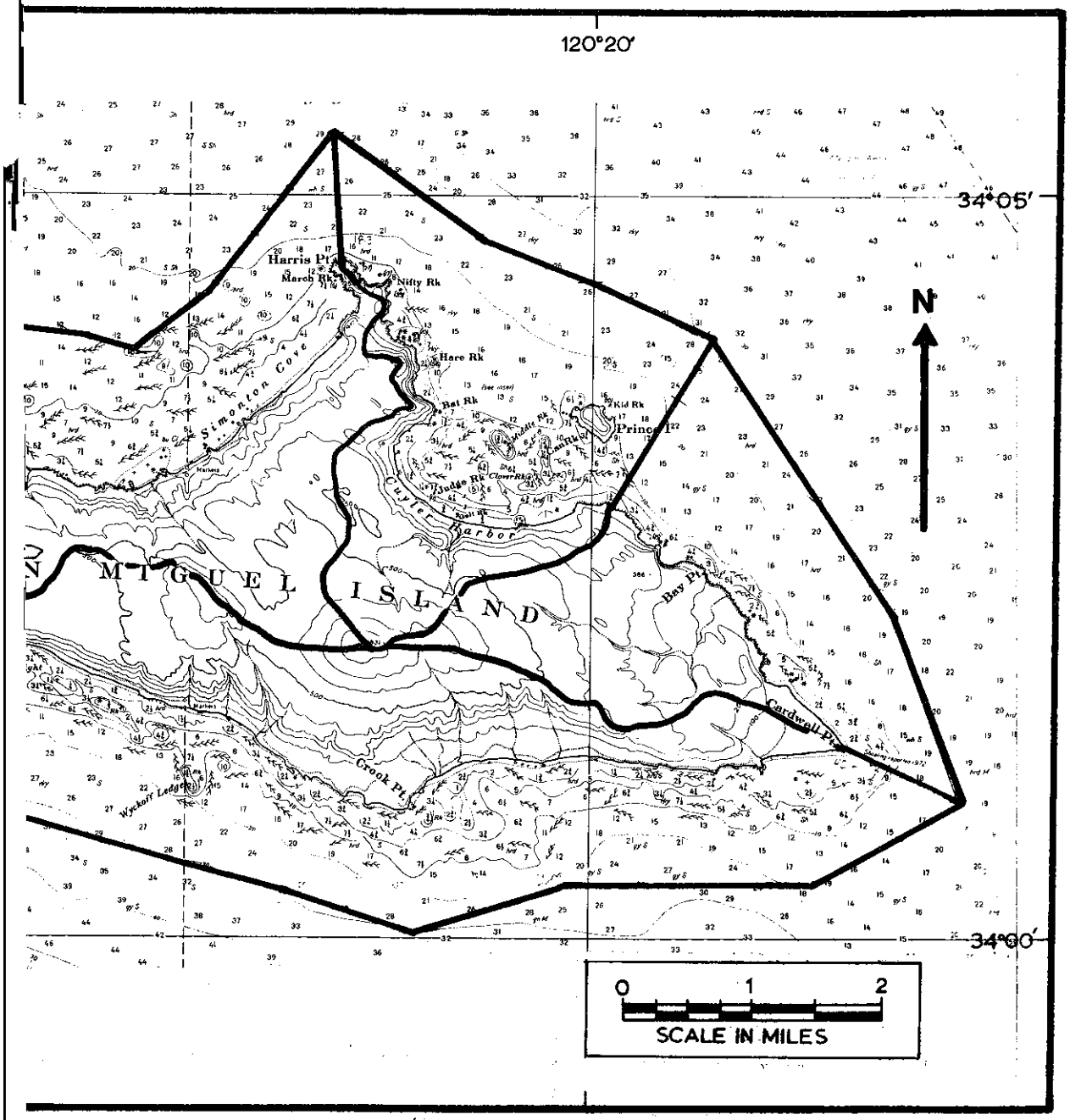


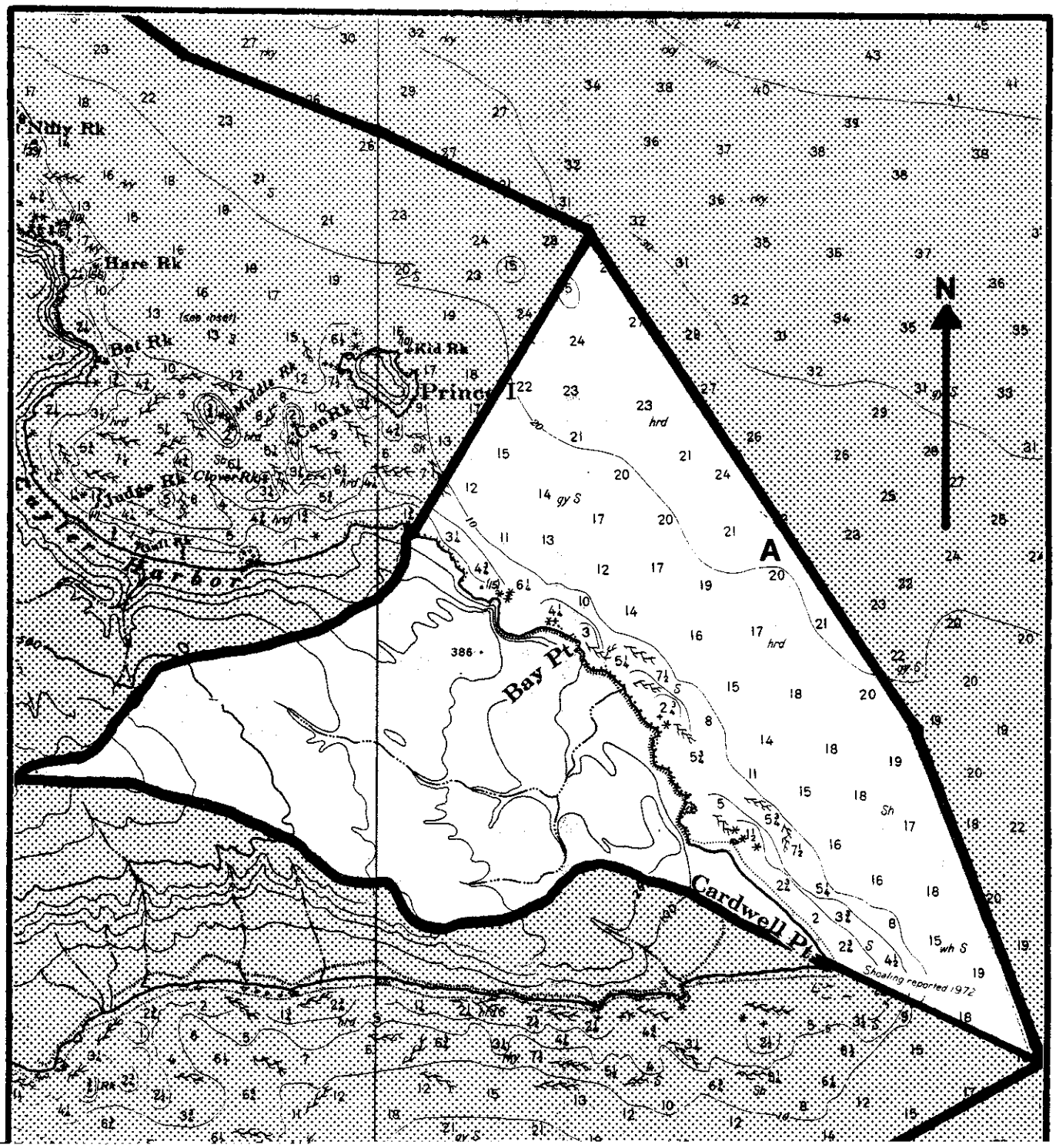
Figure 1. Location map of San Miguel Island.

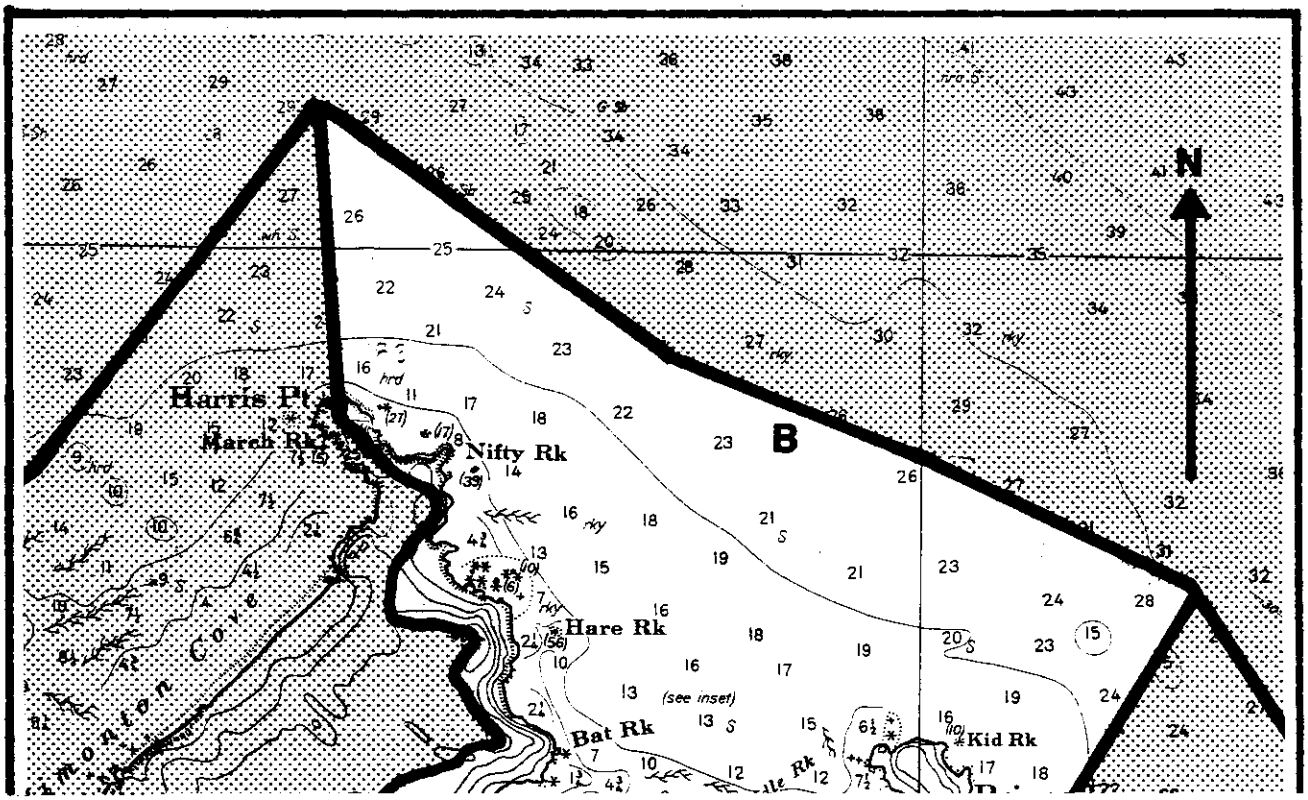


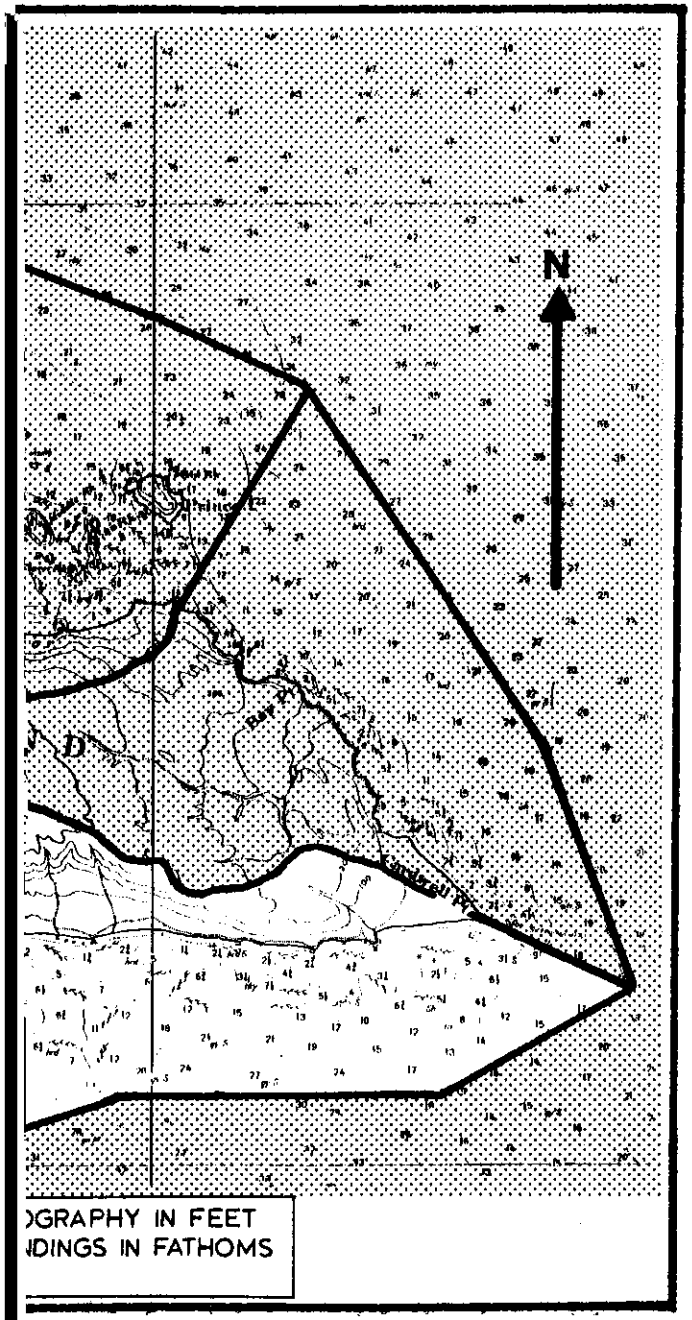
ıre 2. Subregional watershed areas.

Table 1. Proportions of watershed and nearshore areas (flat projection) of San Miguel Island.

Region	Regional Area(mi^2)	Watershed Area				Nearshore Area				Ratio N/W
		Km^2	acres	Hectares	%	Km^2	acres	Hectares	%	
A	9.9	12.6	3113	1257	49	13.0	3212	1297	51	1.03
B	11.8	12.2	3014	1217	40	18.4	4546	1836	60	1.50
C	19.6	16.9	4176	1687	34	33.8	8352	3374	66	2.0
D	6.6	7.2	1779	718	42	9.9	2446	988	58	1.38
TOTAL	47.9	48.9	12082	4879	41	75.1	18556	7495	59	x=1.5


Nilly Rk
Hare Rk
Bat Rk
Kid Rk
Middle Rk
Can Rk
Clover Rk
Upper Harbor
Bay Pt
Cardwell Pt
Shoaling reported 1972
A
N


N
B
Harris Pt
March Rk
Nifty Rk
Hare Rk
Bat Rk
Kid Rk
(see inset)


N
OGRAPHY IN FEET
NDINGS IN FATHOMS

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 island's 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 Basin 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.

broad and the greatest depth within one nautical mile of shore is only 180 ft (55 m); within three statute miles of the northern

1640 ft (500 m) within 6.75 mi (10.8 km) from shore. At a distance of 11.75 mi (18.8 km) from the southern tip of the island the depth is about 3280 ft (111 m) and this downgrade continues irregularly to the edge of the Patton escarpment.

The interisland shelf between San Miguel and Santa Rosa to the east is fairly broad and continuous at depths less than 131 ft (40 m). Sandy Point on Santa Rosa is 4.4 mi (7 km) from Cardwell Point on San Miguel. The shelf extends northwest of the island and does not exceed 656 ft (200 m) as far as 14 mi (22.4 km) offshore. Richardson Rock lies 6.6 mi (10.6 km) to the northwest of Point Bennett. North, beyond the shelf break, is the mouth of the Santa Barbara Channel, between the island and Point Conception. South of the shelf break is the upper arm of the Tanner Basin. Directly west of the island platform is the Rodriquez Seamount.

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 fine sand found along the southwest beaches. 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 Figure 9).

Currents

The California Current is the eastern boundary current of the North Pacific Gyre; it bears cold subarctic water and flows southeasterly 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

Little information is available for circulation of the nearshore waters of the southern fringe of San Miguel, although there is clearly a direct influence of California Current water in that region. Northerly flow is not indicated through the passage between Santa Rosa and San Miguel, 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 San Miguel 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 San Miguel.

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 San Miguel 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.

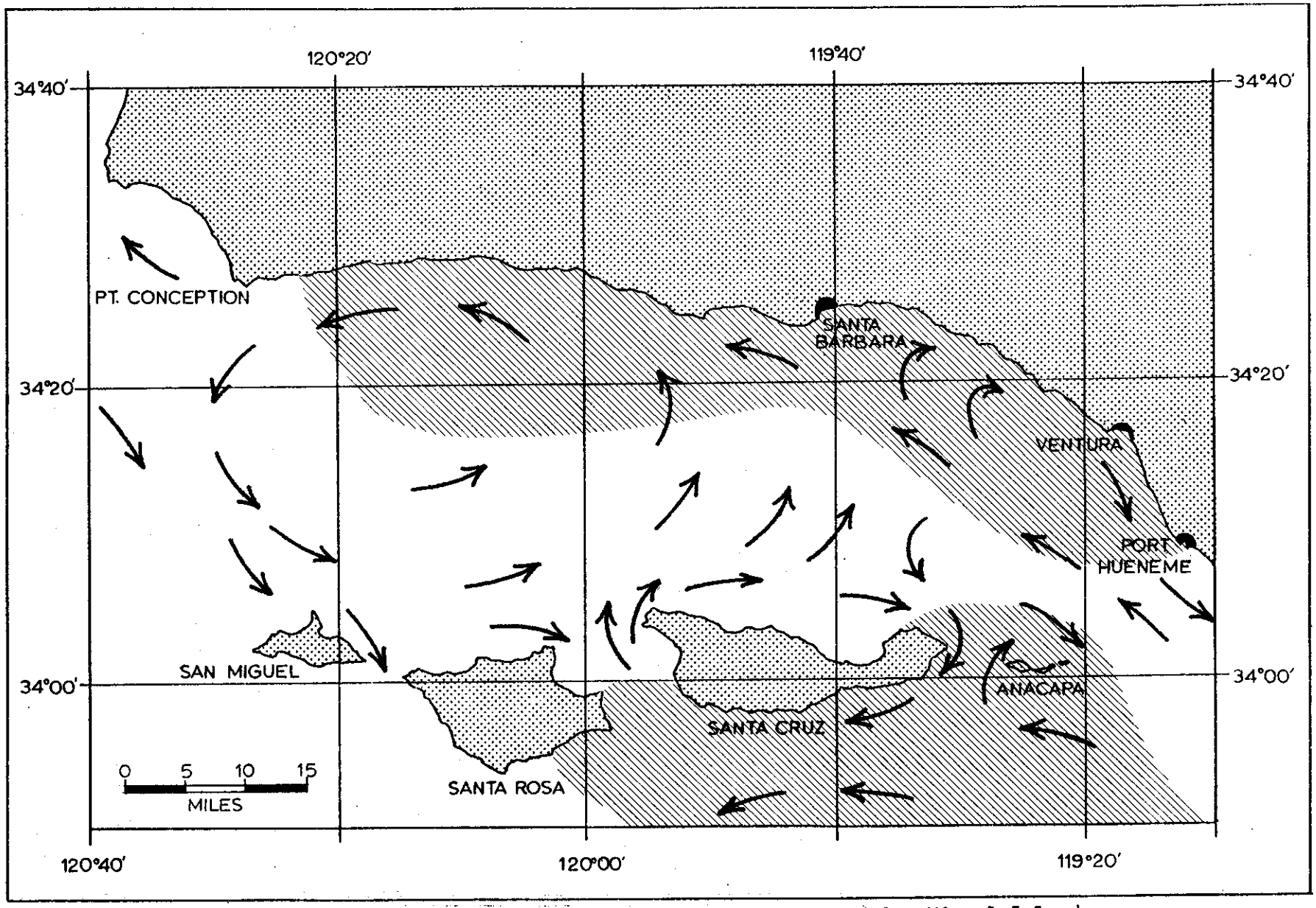


Figure 7. Surface currents and thermal fronts around San Miguel Island.

In a general sense, however, it is clear that the peripheral waters lie within a zone of extremely high productivity. Oceanographic observations in the region and satellite imagery support the generalization that upwelling centered off Purisma Point and Pt. Conception is often extended out from the upwelling center in large, plume-like structures which ramify into the entire Santa Barbara Channel region and especially may impinge upon nearshore waters of San Miguel Island. This upwelling is not accompanied by large salinity changes as in upwellings of other coastal areas.

Upwelling in the Pt. Conception region, extending into the peripheral waters of San Miguel, will be the major focus of NSF funded studies in 1981-1984, based primarily at University of Southern California. So, although little current published information is now available on oceanographic conditions in the region, the data base is rapidly expanding.

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 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 San Miguel 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° F (13° C) in winter to 65° F (18° C) in summer. Warmer temperatures occur on the southern, leeward coasts and toward the mainland east-ward. 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°/oo) than is found on the windward side (34 to 36°/oo).

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 deep water near the bottom, 2000 ft (600 m), 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 Cuyler Harber and Simonton Cove, 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 San Miguel. Turbidity along the southern coasts may flow westward when south winds or a westward gyre 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 the 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 be expected to 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 San Miguel Island has a low to moderate average level of seismic activity. The major fault in the area of San Miguel Island runs east-west, south of the island and inside the 100 m bathymetric contour. Lesser faults occur on the island itself but show no directional pattern. The island is composed chiefly of Cenozoic marine sedimentary rocks. Fault locations and seismic activity patterns are shown in Figure 8.

San Miguel Island has a coastline that consists largely of rocky bluffs, 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 interisland shelf areas, and their sediments are generally more sparse with larger particle sizes.

San Miguel is a small, low-lying, generally flat island, with two low, rounded hills at the center. Prominent northwest-to-southeast wind scars and sand deposition mark the island's western half. The periphery of the main plateau is cut by deeply eroded ravines. The sandy spit at Cardwell Point is very low and, at times, is completely submerged.

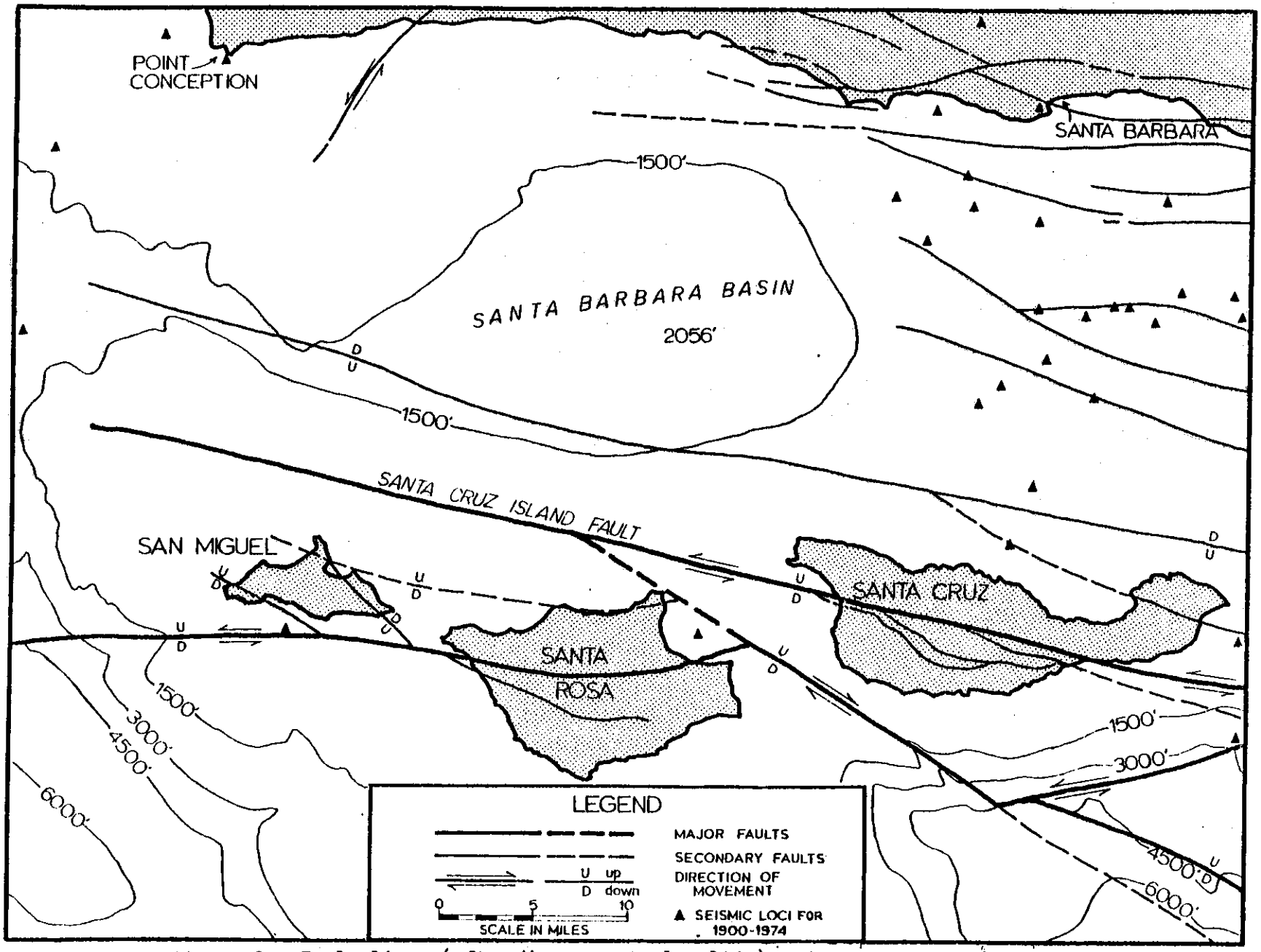


Figure 8. Fault lines (after Weaver, et al., 1969) and seismic loci (Calif. Dept. Mines and Geol., 1978).

Subtidal substrate

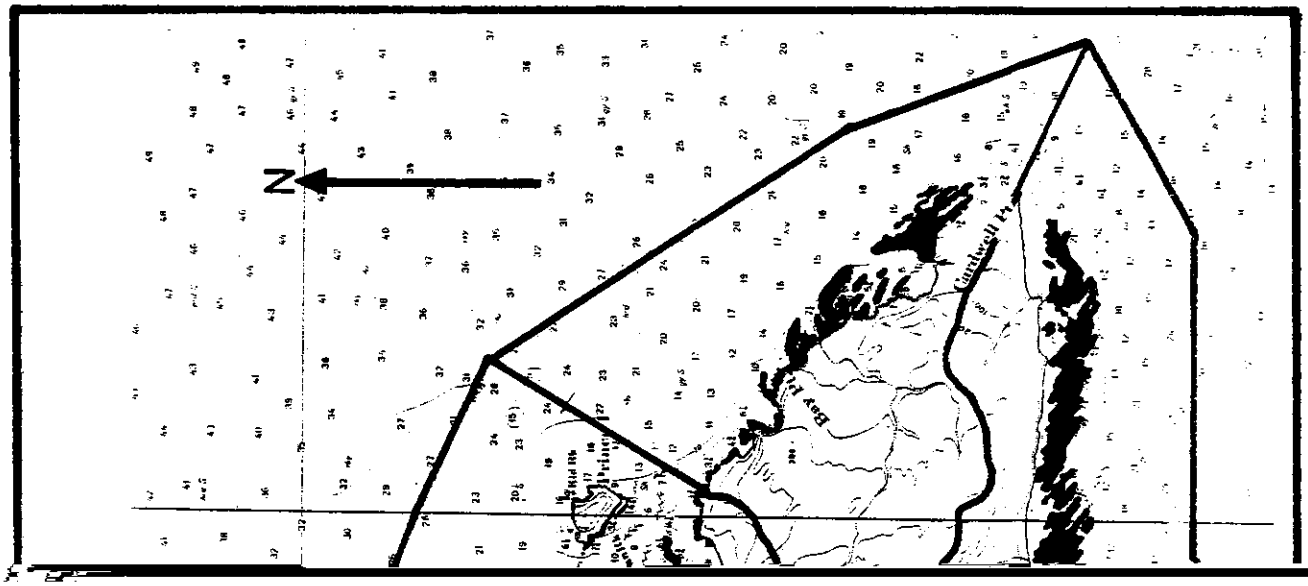
Major reef locations and their extent are indicated in Figure 9 by the dark areas representing kelp beds. Stands of Macrocystis and other brown algae occupy nearly all of the island's subtidal rocks. The aerial survey photographs show these features in greater detail. About 85% of the sediments in the Santa Barbara Basin, and thus the deep northern margin of San Miguel, 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 outermost portion of the ASBS has a subtidal substrate composed of mud. Around the island, the substrate is chiefly sand punctuated by outcroppings of rock. Along the eastern coast the rocks are volcanic, while those off the west coast, Crook Point and below Richardson Rock, are sedimentary. A broad area of shelly substrate lies off Simonton Cove and a smaller area occurs east of Prince Island.

Intertidal substrate

Area A - Cardwell Point to Cuyler Harbor. Most of the intertidal zone in this area is rocky bluff face and boulders although it begins at the southeast with a broad, white sandy beach. The upper subtidal and lowest intertidal substrate is primarily sand throughout the entire area. The width of the intertidal zone decreases to the northwest as the adjacent land slope approaches vertical; this trend is moderated in places by accumulated pieces of the cliffs which have broken off and fallen into the sea.

Cardwell Point is a low-lying, triangular sandy beach with a few small rocks at its eastern apex. The outer beach is the intertidal portion of a long, broad, submerged sandy spit. The


N
Bay Pt
Cardwell Pt

spit was shallow but definitely below water during the three seasons it was observed (fall, winter, spring), although on most maps and nautical charts it is shown as above sea level. Behind the beach on the south side is a wind and sand-eroded low hill; to the north is a sloping bluff with a low, vertical face at its base.

From Cardwell Point to a point opposite Prince Island, the intertidal zone is almost entirely rock. Just above Cardwell Point are low, flattened rock projections, bordered by a small pocket sand beach. Beyond this last sandy area is a rockbound, low shelf cut by a drainage canyon. North of the canyon mouth the shoreline grades upward to provide some of the steepest relief on the island. The intertidal margin also steepens. North of Bay Point are two small, high-walled semicircular coves, the first with many boulders in the intertidal zone at the bluff base, the second with a sandy beach.

Area B - Cuyler Harbor to Harris point. The intertidal zone in this area is mostly sand, except for Prince Island, Harris Point and occasional rocky outcrops. Wind driven sand is obviously a significant factor in the local topography, particularly at the eastern part of Cuyler Harbor. The width of the intertidal zone is broadest in the sandy beach areas, least in the rocky zones.

In Cuyler Harbor, the interisland zone is sandy beach, backed by low sand-covered slopes on the east, by eroded rocky hill margins at the center, and by a sloping rocky point at the north. In most of the harbor, only the uppermost tidal levels reach a rocky bluff base. Toward the northern end, the sand diminishes to pockets and is then superseded by rocky outcrops, and then by vertical rock faces and boulders.

The entire intertidal zone of Prince Island is a rock substrate. The zone is convoluted by cracks and fissures in the rock, by erosion cuts and by boulders. The lack of subtidal sand promotes the rich intertidal biota.

From Bat Rock to Harris Point, steep rocky walls below relatively high bluffs mark the northern extent of Area B. There are two small sandy beaches inside rocky coves but most of the sandy substrate is subtidal. Numerous small rocks and boulders occur nearshore and offshore along this stretch. Toward Harris Point the width of the intertidal zone becomes quite variable.

Area C - Harris Point to Point Bennett. This northwest facing shore receives the brunt of the prevailing northwesterly winds and has been strikingly scarred by wind and sand. Most of its intertidal zone is sandy beaches although rocky outcrops occur throughout, and the western end is mostly rock.

Simonton Cove features a long, curved sandy beach punctuated by occasional rocky outcrops. Wind driven sand has etched and shaped the sloping rise behind the beach. Only a low, rocky vertical wall backs the beach at highest tide levels.

From Simonton Cove to Point Bennett, most of the intertidal zone alternates between sandy beach and low, flat rocks with sand predominating. The intertidal zone is highly sand-scoured and biota are few. Sandy beaches are backed by low, crumbling vertical faces. The rocky areas are low and flat with few separate boulders. Castle Rock, Wescott Shoals and other offshore areas also provide a rocky substrate but are not as subject to sand scouring. The flattened rocks near Point Bennett provide ideal haul-out sites for the numerous pinnipeds which inhabit the area. Also near Point Bennett are clefts in the intertidal rock which provide protected vertical surfaces and thus some limited shelter for intertidal organisms.

Area D - Point Bennett to Cardwell Point. This leeside coast has both sandy beaches and rocky areas in the intertidal zone, with sand predominating. Sand deposition occurs throughout the area with sand driven over the low-lying land mass by the prevailing wind. The southern landside ridge provides some protection and scouring is less pronounced on this shoreline.

Adams Cove has a low, wind-swept sandy beach and is bounded to the east by flat rocky outcrops that extend to Tyler Bight, which has a curved sandy beach below a sloping ridge, then alternates between sand and low rocky substrates to the east. A sloping hill, or ridge, with a low rock face, lies at the upper tidal range of the sandy areas. The rocks occur either as outcrops surrounded by sand or as boulders and uplift at the base of bluffs.

From Tyler Bight to Crook Point, the intertidal zone consists of alternating sand and rock as described above.

Crook Point to Cardwell Point is primarily an area of sandy beaches with occasional uplifted sedimentary rock strata and crumbled rocky cliff face.

At the upper intertidal limit are either low sloping rises or short vertical rock faces. The intertidal zone is wide but depauperate because of the lack of hard substrate.

Adjacent land mass

Area A - Cardwell Point lies at the foot of a gently sloping plain with drainage flowing chiefly to the south. A low, 300 ft ridge runs behind the shoreline northward and terminates at the eastern end of Cuyler Harbor in relatively steep rocky bluffs.

Area B - Wind driven sand marks the eroded lower part of Cuyler Harbor, while the central portion is backed by the seaward flanks of several hills. The hills show considerable drainage erosion and there is a large canyon near the center and many smaller erosion ravines elsewhere. At the north end of the harbor are higher (450 ft) rocky headlands which rise fairly steeply from the intertidal level. Harris Point and Nifty Rock are individual steep hills joined by a low-lying neck.

Area C - Low, gently sloping hills comprise the land mass behind the sandy beach of Simonton Cove. Many small erosion

gullies cut the slope but predominant features are the drifts of windblown sand which extend up and over the island to Cuyler Harbor on the other side. In places where the sand is not in drifts, rocky ribs of the substrate have been scoured bare. West of Simonton Cove, the land is lower and the slope upward from the beach is even more gradual. Wind and sand scarification is even more pronounced. Toward Point Bennett the land descends to a low, flattened wind-swept plain, nearly covered with sand. Few erosion gulleys occur and runoff is obviously much reduced.

Area D - The southern, leeward shore area is generally much steeper than the windward side of the island. At the west, behind Point Bennett, is a sandy flat which abuts the base of a northwest-southeast ridge. From Tyler Bight to Crook Point is a relatively steeply angled slope that rises to the flat plateau of the island mass above. Erosion gulleys are steep and shallow, and often filled with blown sand. From the highest ground behind Crook Point, the land gradually declines to the east. Just east of Crook Point the upward slope behind the beach areas is very gentle with a low flattened area above the beach. Small canyons notch the slope and meander out on the flat to beach level. The eastern portion of this stretch has a more steeply sloped ridge until it approaches Cardwell Point. Just behind the eastern point, wind-driven sand has eroded the already low relief into a flattened plain.

Overall, San Miguel Island is a low, flat land mass with very little vertical relief. There are no major drainage patterns and the dominant features of the landscape are the scoured and drifted stripes of sand which extend across and over the island.

Climate

The overall climate of the region surrounding San Miguel Island is maritime-mediterranean with cool, wet winters and warm, dry summers. Because of its location, San Miguel is strongly

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

Region	Sandy Beach		Cliff Shore		Rocky Slope		Total Shoreline	
	km	mi	km	mi	km	mi	km	mi
A	2.4	1.5	0.5	0.3	1.9	1.2	4.8	3.0
%	49		11		40			
B[1]	3.2	2.0	4.1	2.6	1.7	1.0	9.0	5.6
%	36		46		18			
C[2]	9.5	5.9	0.7	0.4	1.7	1.1	11.9	7.4
%	80		6		14			
D	12.5	7.8	3.3	2.1	2.6	1.5	18.4	11.4
%	68		18		14			
Totals	27.6	17.2	8.6	5.4	7.9	4.8	44.1	27.4
%	62		20		18			

influenced by winds and fog derived from oceanic conditions offshore. The characteristic weather patterns of San Miguel are 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, San Miguel 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 San Miguel Island receive occasional winds from the west and southwest (Figure 10). In the Channel, west winds blow nearly every afternoon, then slacken at sundown, although at the western end of the Channel around San Miguel the winds may continue through the night then diminish at dawn. In the winter, southeast

storms occur which impact the island's southern coasts; San Miguel 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 San Miguel Island is sparse, usually occurring in the winter along with dense fog that is more persistent than on the mainland coast. San Miguel 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 differences. Average rainfall, measured over 30 years on eastern Santa Rosa Island, is about 12.5 in (32 cm) with yearly totals ranging from 3.2 in (8.1 cm) to 24.5 in (61 cm).

Air temperature at the Islands is closely related to the range of the surrounding sea temperatures. Coastal temperatures on San Miguel are strongly influenced by fog and wind. Coastal temperatures usually range between a low of 35° F(2° C) and an average high of 85° F (30° C).

The prevailing wind pattern is from the northwest or west, as described above (see Figure 10). San Miguel is exposed to the full force of the powerful, cool, northwest winds which blow off the open Pacific past Point Conception.

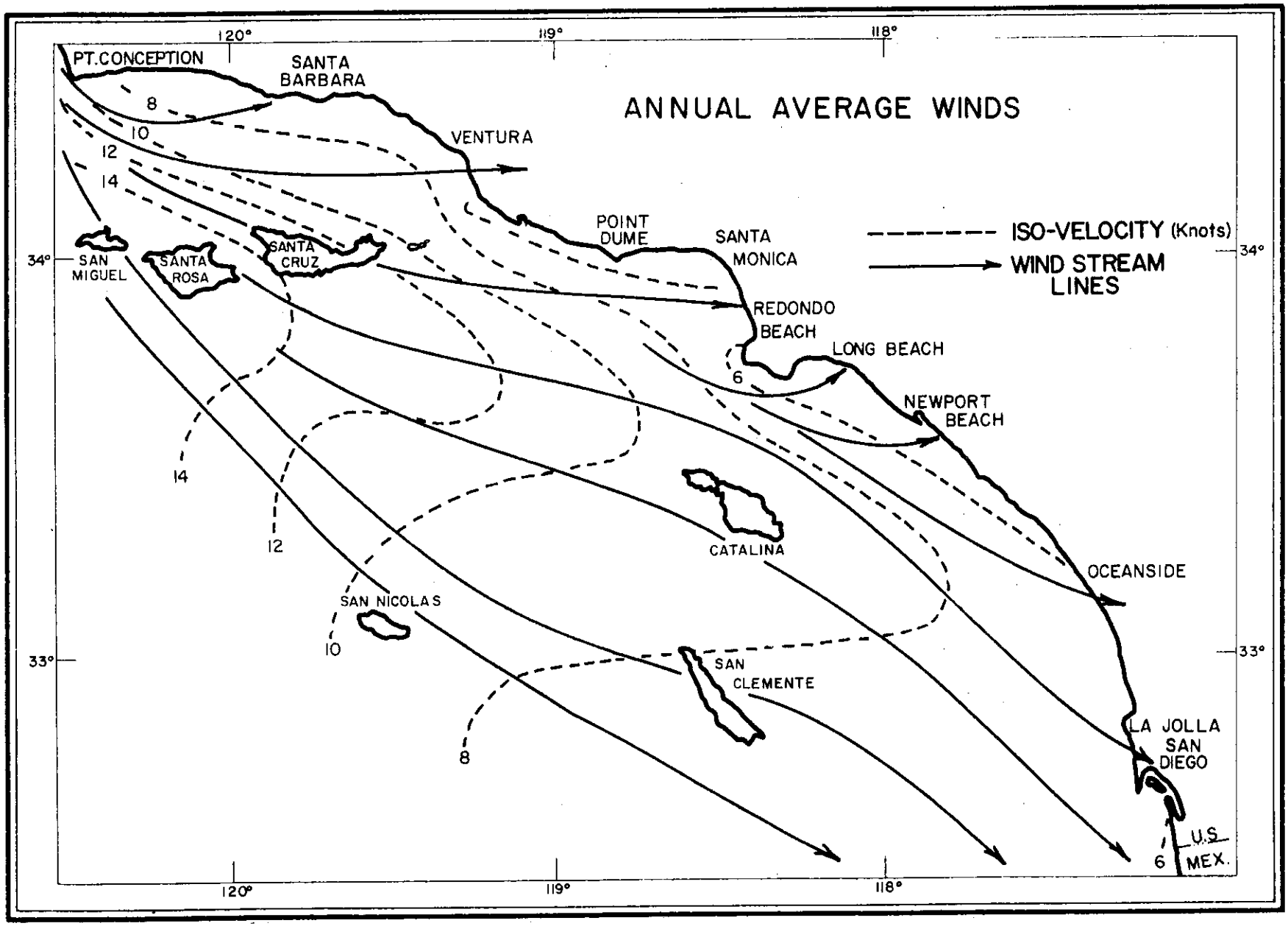


Figure 10. Wind patterns of the Channel Islands (after Hancock Foundation, 1965).

BIOLOGICAL DESCRIPTION

Subtidal biota

The subtidal biota of San Miguel are not well known. Aside from surveys conducted for the present study and anecdotal information primarily from UCSB research divers who have occasionally made dives there, no information is available regarding the subtidal area (see Figure 11).

At the subtidal survey site off Wescott Shoal, the dominant subtidal algal species, in order of relative abundance, were: Macrocystis pyrifera, Eisenia arborea, and various red algae. Along the rocky slope of the transect (see Figure 12), Anthopleura, Balanus tintinnabulum californicus, Megathura, and Strongylocentrotus were abundant. The subtidal macroinvertebrate fauna were similar to that seen at Santa Rosa Island, and typical species assemblages were noted.

The most common fishes were rockfish, Sebastes vexillaris, chrysomelas, carnatus, and, especially abundant, S. melanops, mystinus, and serranoides. The convict fish, Oxylebuis pictas, pile perch Damalicthys vacca, kelpbass Paralabrax clathratus, and sheepshead Pimelometopon pulchrum, were common.

Dominant and Common Subtidal Biotic Components - Transect 1 San Miguel (*dominant)

Macroinvertebrate

- Hydractinia
- Aglaophenia
- *Anthopleura elegantissima
- Balanophyllia
- Paracyathus
- Astrangia
- Allopora
- Spheciospongia

Macroinvertebrates, continued

- Cliona
- Tethya
- Dodecaceria
- Endysylia
- *Balanus tinntinnabulum californicus
- Styela
- Clavelina
- Cryptochiton
- *Megathura
- Serpulorbis
- Anisodoris
- Hinnites
- Zonaria
- bryozoa
- Henricia
- Patiria
- Pisaster giganteus
- Orthasterias
- Ophiothrix
- Stichopus
- Strongylocentrotus purpuratus
- Strongylocentrotus franciscanus

Fish

- Sebastes vexillaris
- Sebastes serriceps
- Sebastes chrysomelas
- Sebastes carnatus
- Sebastes miniatus
- Sebastes paucispinus
- Sebastes atrovivens
- *Sebastes melanops
- *Sebastes mystinus
- *Sebastes serranoides
- *convict fish
- lingcod
- cabezon

rubberlip perch
pile surfperch
kelp bass
opaleye
sheephead

Algae

*Macrocystis pyrifera
Eisenia arborea
reds

The absence of the island surfperch (Cymatogaster gracilis) and the blacksmith (Chromis punctipinnis) from the Wescott Shoals transect in the canopy zone suggests that nearshore conditions in the water column on the northern side of the island are fundamentally different from warmer channel island locations where these species are common. Similarly, the low densities of the sheephead, opaleye, halfmoon, and garibaldi group, and the higher incidence of commuter and inner marginal species such as the pile surfperch suggest that the community structure at Wescott Shoals is different from those of more easterly channel island subtidal habitats.

Macroinvertebrates continued

- *Hinnites*
- *Cancer antennarius*
- *Anisodoris*
- *Corynactis*
- *Stichopus*
- *Cliona*
- *Phragmatopoma*
- *Aplysia*
- *Fissurella*
- *Calliostoma*
- *Mopalia*
- *Loxorhyncus crispatus*

Fish

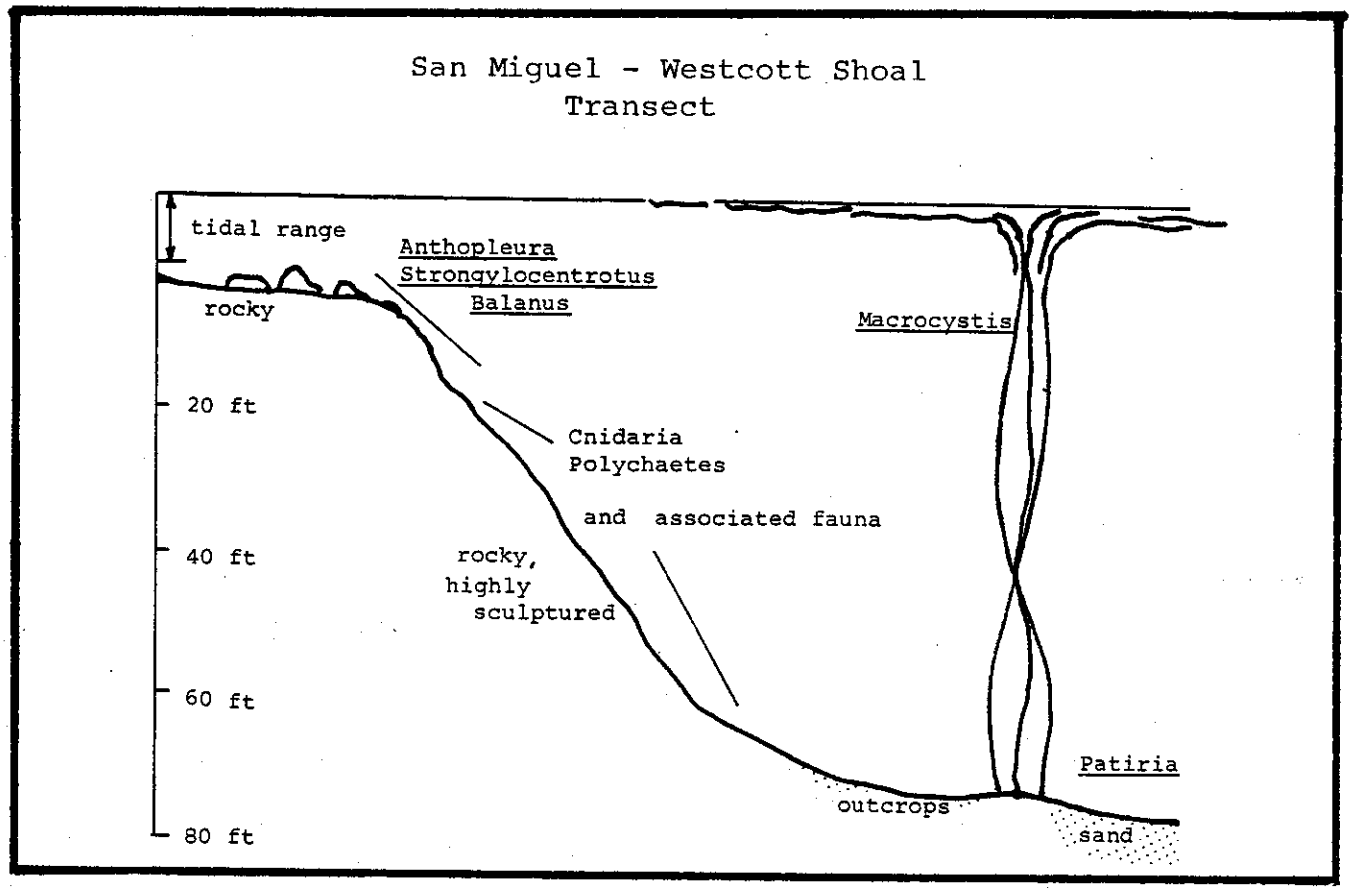
- *pile perch
- rubberlip perch
- black-spot goby
- *convict fish
- *Sebastes atrovirens*
- *Sebastes lateratis*
- **Sebastes mystinus*
- *Sebastes vexillaris*
- *Sebastes rastrelliger*
- *Sebastes auriculatus*
- *Sebastes chrysomelas*
- **Sebastes miniatus*
- *tube snout*
- *black surfperch*
- *blacksmith*
- *monkeyface eel*

Algae

- **Macrocystis pyrifera*
- **Egregia* sp.
- **Ulva* sp.
- corallines
- reds

At the Cuyler Harbor subtidal survey site, subtidal diversity was quite high. Dominant subtidal algae were: Macrocystis pyrifera, Ulva sp., and Egregia sp. Macroinvertebrates were not dominated by any one form, but echinoderms were particularly abundant. Macroinvertebrate diversity was highest at this dive site.

Among the fish observed, Sebastes melanops, mystinus and serranoides were dominant along with many species of common kelp bed fish. This transect is similar in many regards to the transect at Wescott Shoal, but is notable for the presence of monkeyface eel, black surfperch, Sebastes lateralis, rastrelliger, auriculatus, and blacksmith, and notable for the absence of cabezon, kelp bass, lingcod, Sebastes paucispinus, carnatus, and serriceps. This pattern indicates substantial community differences between the two sites and possibly a greater affinity with the "island type" fauna described by Ebeling, et al. (1980).



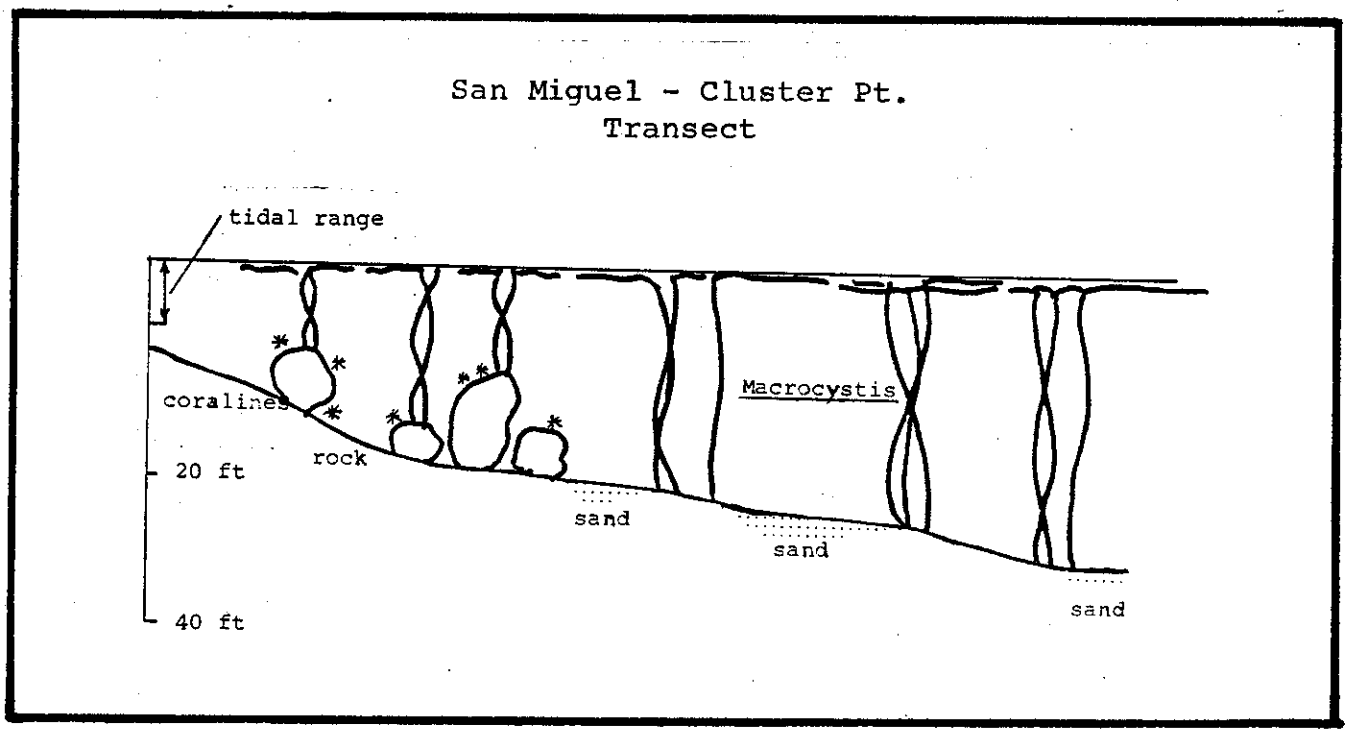


Figure 12. Subtidal profiles.

were lower, ranging from 72-79 species, while the southside analysis revealed 103-104 species. These are listed and discussed in detail by Kanter (1979). Dominant forms included Collisella seabra, limatula, pelta, and strigatella; Chthamalus dalli and fissus; Balanus glandula; Tetraclita squamosa; Pollicipes polymerus; Arabella semimaculata; Nereis mediator; Typosyllis fasciata and hyalina; Emplictonema gracili; and Paranemertes peregrina.

Analysis of community similarity of mussel beds showed that the two San Miguel sampling sites were substantially different in their structural type and biogeographic affinities. Cuyler Harbor mussel communities were most similar to mainland collections at Government Point, and island sites at Anacapa and San Nicolas Island. The Crook Point site showed greatest similarity to other island locations (Santa Rosa at Johnson's Lee and Carrington Point; Santa Cruz at Willows Anchorage and Prisoner's Harbor). These differences appear to be related to differences in oceanographic climate, and in particular to the exposure of the northside of San Miguel to upwelling water at Pt. Conception (see Figure 7).

Rocky intertidal algal flora of San Miguel have been analyzed in considerable detail by Murray, et al. (1980). San Miguel intertidal algae show strong affinity in species composition to those of Santa Rosa and San Nicolas Islands, although they are much more closely allied to the intertidal flora of San Nicolas Island. It should be stressed that, in such inter-island comparisons, station position on an island situated in a region of persistent thermal fronts may have an important impact on floral composition. The Cuyler Harbor location, according to satellite thermal imagery, lies just seaward of the major temperature break between the cool, oceanic upwelling plumes which bathe the northwestern shore of San Miguel; because it is similar in "thermal position" to San Nicolas Island (Figure 8, Murray et al., 1980), it shows similar algal community characterizations.

Studies of macroinvertebrate and macroalgal cover at the major San Miguel Island sites (see Figure 13) by Littler (1980) and Seapy and Littler (1980) has provided a significant data base for the more conspicuous members of the intertidal fauna. Their site was dominated by algal cover from Gigartina canaliculata and Pelvetia fastigata, which varied seasonally in relative abundance. Analyses included 61 macrophyte cover species and 55 macroinvertebrate species, the latter displaying the highest species diversity of all island or mainland sites studied. The community was characterized as consisting predominantly of "...perennial organisms characteristic of mature, constant communities (e.g. Pelvetia, Mytilus, Phyllospadix)" (Littler, 1980).

This observation may be interpreted as a reflection of the relatively constant thermal and nutrient conditions which prevail at San Miguel as result of its proximity to upwelling centered off Pt. Conception. The California current impinges on all of San Miguel, and is a major influence in structuring both subtidal and intertidal communities. The major features which reflect this are macroinvertebrate density and diversity and more constant and less extensive macrophyte cover.

Similarity analyses of both macroinvertebrate and macroalgal cover patterns indicate a strong affinity of San Miguel and San Nicolas Island types (Seapy and Littler, 1980), which confirms the cool water, oceanic character of the San Miguel intertidal biota.

Study observations confirmed, with regard to macroinvertebrates, the general pattern of intertidal zonation (Littler, 1980) developed from photosurvey inspection:

Zone	Dominant Type
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

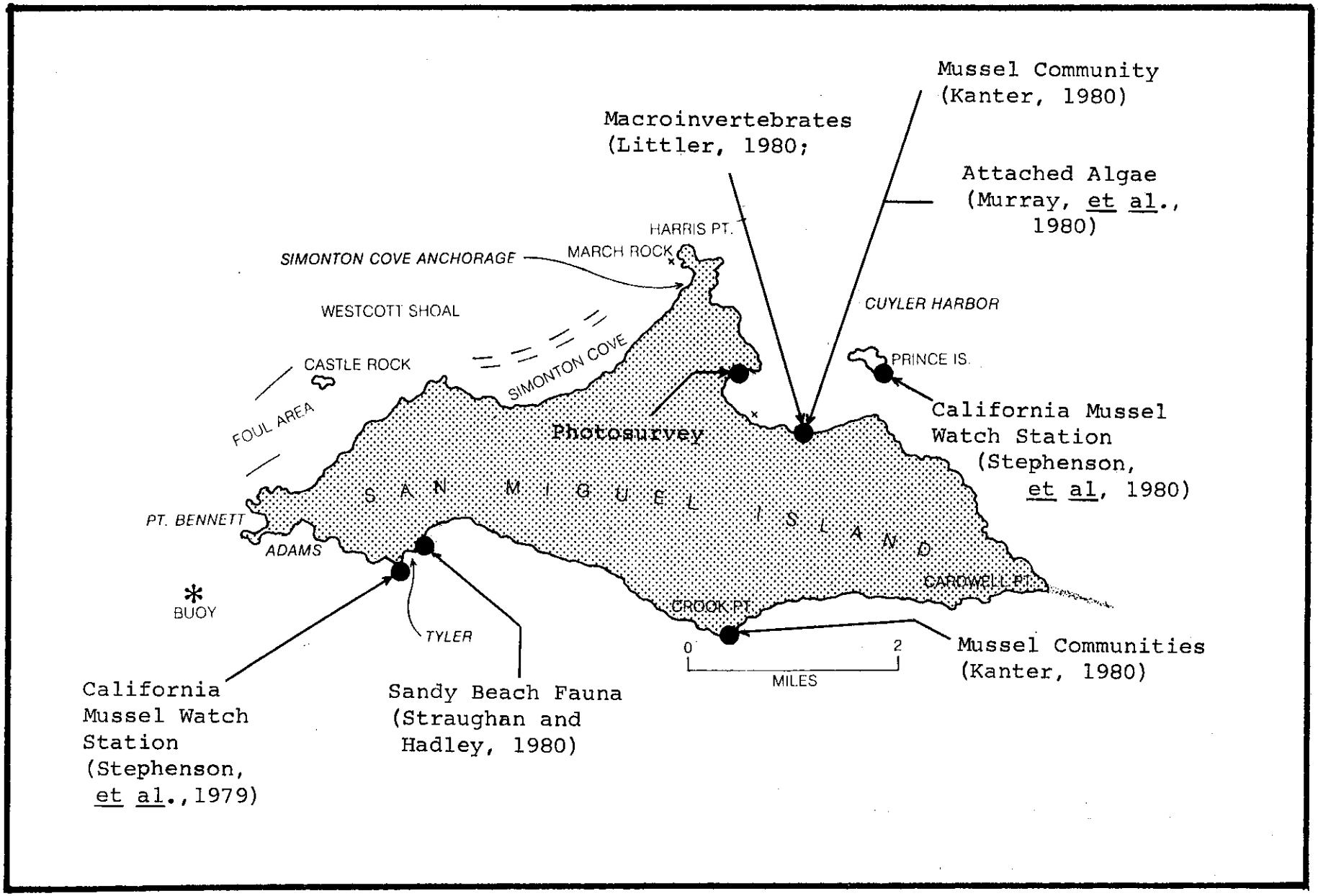


Figure 13. Intertidal survey sites.

At more exposed sites on the northern shore, encrusting coralline algae, urchins, and coelenterate species were relatively more abundant. This was less evident at the more protected site at Cuyler Harbor.

Sandy beach macroinvertebrate fauna at Tyler Bight have been studied by Straughan and Hadley (1980). Grain size data and beach slopes are indicative of its exposure to heavy surf. No tar was evident, and organic content was lower than at less exposed beaches at other California island locations. Species diversity was highest here, reaching a maximum list of 33 species in 1975-1976. This beach was notable for the predominance of Lumbrinereus zonata and Nerinides acuta, not consistently present elsewhere. Otherwise the data showed a typical species assemblage found within the Southern California region.

Land vegetation

San Miguel is lower in profile, less topographically diverse, and more subjected to wind stress than most of neighboring Santa Rosa Island. Vegetation within the coastal zone is almost exclusively limited to the coastal strand type (Munz, 1968) and mixed stands of introduced grasses and saltbush, Atriplex californica. Several springs are found within the coastal zone, but there are no known permanent watercourses. Fog is a consistent feature, and authorities presume rainfall to be quite low, similar to that of adjacent Santa Rosa Island (12"/year).

Coastal sage scrub communities merge into the basic coastal strand type at many locations, with low growing shrubs and iceplant present. The introduced iceplant (Mesembryanthemum nodiflorum and crystallinum) are common, especially on higher reaches of coastal slopes in the northern area (Area C). The shrubs Astralagus, Eriophyllum, Lupinus, and Baccharis were commonly associated with iceplant cover. In Area C, isolated stands of island Coreopsis were observed.

Unusual and endemic species occur as part of the community types discussed above. For example, Davis (1980) reported on aspects of *Malacothrix implicata*, the beach chicory, *M. incana*, and the island endemic annual *M. indecora*. Philbrick (1980) reported the grass *Elymus condensatus* on Prince Island and at Cuyler Harbor. *Lavatera assurgentiflora*, *Astragalus minguelensis* and *nevinii*, *Dudleya greenei*, *Castilleya holloleuca*, *Achillea borealis*, *Eriogonum grande grande* and island morning glory *Calyptegia macrostigia macrostegia*, complete the list of unique, endemic, or limited species present on San Miguel.

In addition, specimens of a sixth species, Arctocephalus townsendi - the Guadalupe fur seal, have also been observed in this area, although not as a breeding population. As indicated by the present survey's aerial photographs of the Point Bennett area, the aggregations of pinnipeds can be huge, comprising thousands of individuals (see Figures 14 & 15).

Specific localities associated with particular pinnipeds for haul-out, breeding and pupping are:

subregion B, Cuyler Harbor - P. vitulina, M. angustirostris
subregion C, Simonton Cove - P. vitulina, M. angustirostris
subregion C, Castle Rock - Z. californianus, C. ursinus, E. jubatus
subregion D, Richard Rock - Z. californianus, C. ursinus
subregion D, Point Bennett Rock - M. angustirostris, A. townsendi (haul out only)
subregion D, Adams Cove - C. ursinus, Z. californianus, M. angustirostris, E. jubatus
subregion D, Tyler Bight - M. angustirostris, Z. californianus
subregion D, south coast - P. vitulina, M. angustirostris

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 by some authorities as threatened.

Among non-pinniped marine mammals, six species have been reported in the nearshore waters of the San Miguel Island ASBS:

Enhydra lutris - Sea otter
Esochrichtius robustus - Gray whale
Orcinus orca - Killer whale
Lagenorhynchus obliquidens - Pacific white-sided dolphin
Phocoenoides dalli - Dall's porpoise
Delphinus delphis - common dolphin

While these wide-ranging species cannot be regarded as permanent residents of the San Miguel ASBS, their periodic appear-

ance does add significantly to the uniqueness of the overall marine community. Nine marine bird species have nesting colonies on San Miguel Island (see Figure 16):

Cepphus columba - Pigeon guillemot
Phalacrocorax penicillatus - Brandt's cormorant
Ptychoramphus aleuticus - Cassin's auklet

Endomychura hypoleuca - Xantus' murrelet
Larus occidentalis - Western gull
Phalcrocorax auritus - Double-crested cormorant
Oceanodroma leucorhoa - Leach's storm petrel
Oceanodroma homochroa - Ashy storm petrel

Their known nesting colonies are:

subregion A, Bay Point - *P. pelagicus*, *C. columba*
subregion B, Prince Island - *C. columba*, *P. penicillatus*, *P. aleuticus*, *P. pelagicus*, *L. occidentalis*, *P. auritus*, *O. homochroa*, *O. leuchorhoa*
subregion B, Bay Cove to Nifty Cove - *P. pelagicus*, *P. aleuticus*,
subregion C, Harris Point - *C. columba*
subregion C, Castle Rock - *C. columba*, *P. penicillatus*, *P. aleuticus*, *P. pelagicus*, *E. hypoleuca*
subregion D, Point Bennett - *P. penicillatus*

The San Miguel-Prince Island complex is the largest and single most important marine bird rookery in the southern California bight (Hunt *et al.*, 1980). In 1975 the estimated population of all nesting marine species on San Miguel was 24,500. The relative

Lavatera assurgentiflora - Island mallow
Astragalus miguelensis - Maritime locoweed
Dudleya greenei - Live forever
Calystegia macrostegia macrostegia - Morning Glory
Castilleja hololeuca - Paintbrush
Eriogonum grande grande - Island buckwheat
Elymus condensatus (Prince Is.) - Rye grass
Malacothrix sp. (hybrid) - Beach chicory

While not all of these forms are typical nearshore plants, the low relief of San Miguel Island allows them to be actual or potential inhabitants of the shoreside ASBS region. Because of their quasi-endemic status they should be regarded as unique components of this ASBS.

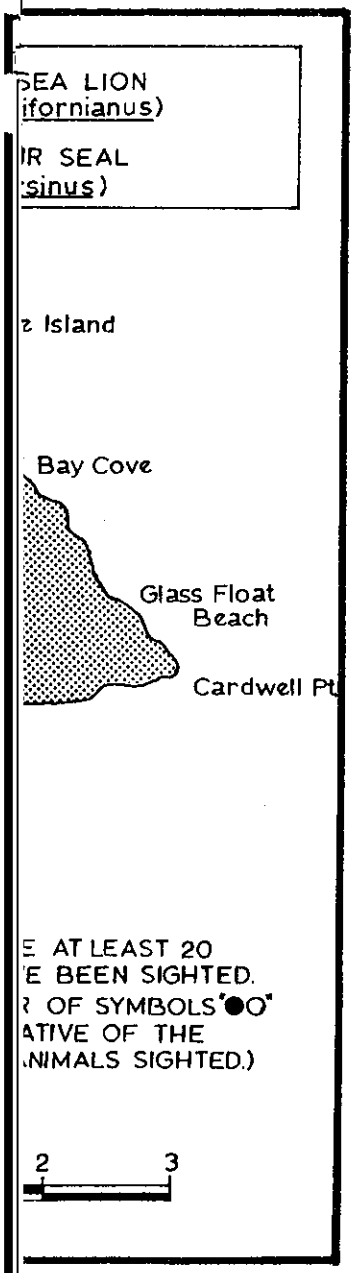
An endemic subspecies of the Channel Island Fox Urocyon littoralis littoralis is widespread and relatively abundant on San Miguel Island. This diminutive, omnivorous form of the mainland gray fox may be an occasional visitor to the intertidal zone; however, this aspect of its behavior has not been well-documented. In 1971, the island fox was classified as a rare species under the California Endangered Species Act of 1970. The population density of the foxes on San Miguel has been estimated at $7/mi^2$ (Laughrin, 1980).

The dense and abundant kelp beds (primarily Macrocystis pyrifera) off San Miguel 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 San Miguel occur off Point Bennett and Crook Point, with lesser yet still very significant beds off Judith Rock, south of Cardwell Point, off Bay Point, in Cuyler Harbor and off Harris Point.

Around San Miguel the kelp beds occur on and over rocky substrate at depths between about 20 to 80 ft. Because of the relative isolation of San Miguel, 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 San Miguel.

The hydrocoral Allopora Californica, one of the rarest species identified by the recent BLM southern California bight surveys, has been reported from San Miguel.

Calcified root castings (caliche) occur on sandy slopes above Cuyler Harbor.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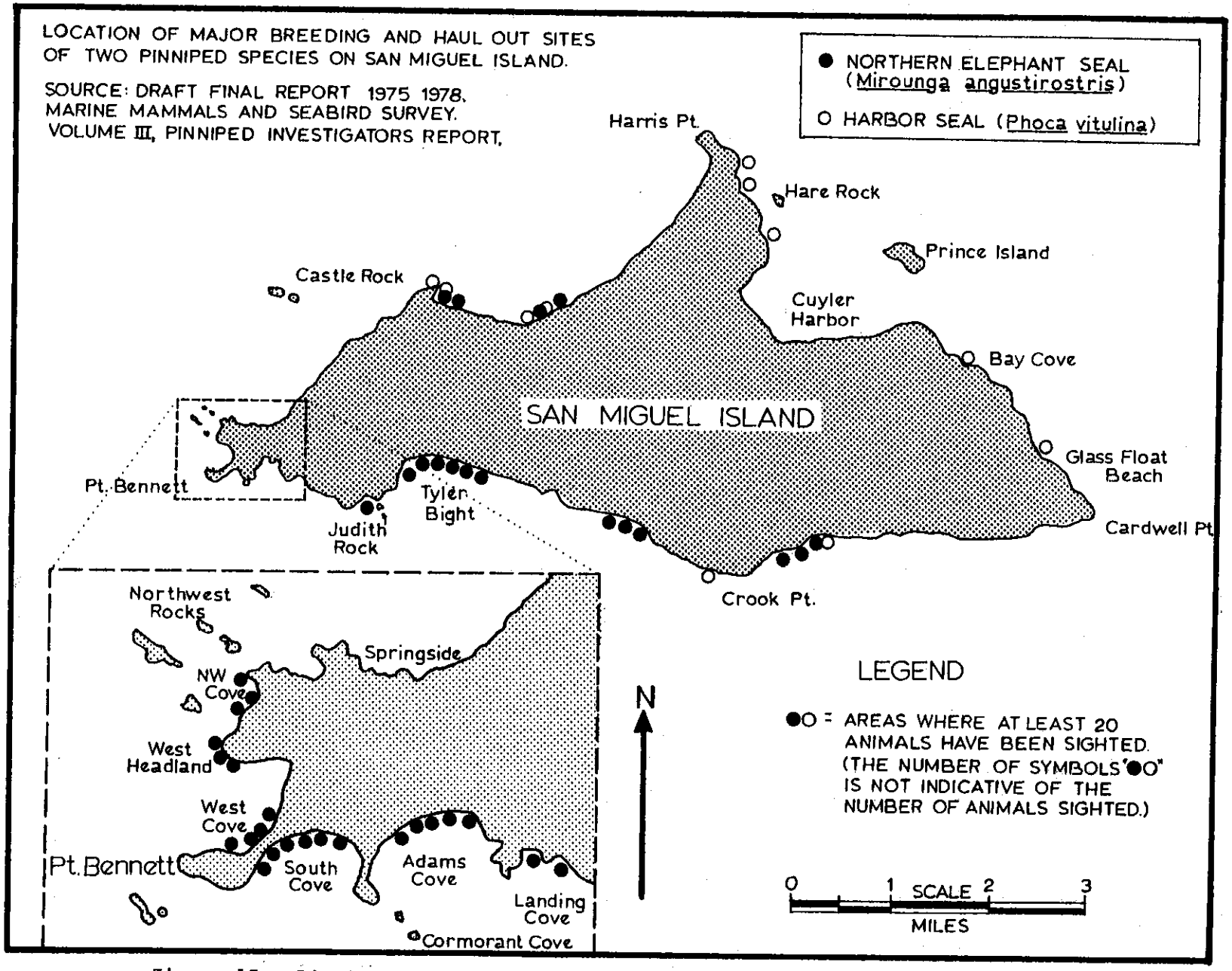
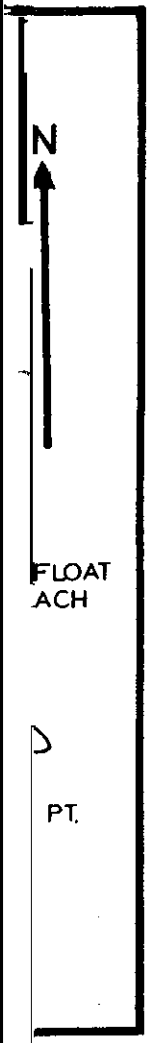


Figure 15. Pinniped rookery area: elephant seal, fur seal (after NOAA, 1979).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LAND/WATER USE DESCRIPTION

Marine Resource Harvesting

The primary commercial fishing activities within the San Miguel Island ASBS area are the collection of abalone, sea urchins, and lobster. 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 zones. 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. Commercial diving associations have sponsored an abalone seeding program near Cuyler Harbor at San Miguel.

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 San Miguel 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 commercially harvested species include bocaccio, rockfish, and mackerel. Recent yearly averages of total commercial catch from the San Miguel area have averaged about 500 tons. The most productive and heavily fished area is that off the northeast coast of San Miguel

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 San Miguel 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 San Miguel ASBS boundaries. Bed #117 lies off the south shore of San Miguel and bed #118 is off the north coast. The northern Channel Island beds provide the richest source of kelp for harvest in all of southern California.

Kelp harvesting within this ASBS 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 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 the

natural removal can dislodge the entire plant instead of just its upper canopy. Although representatives of the kelp harvesting industry have challenged a statement in the 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 are substantially reduced by harvesting, the authors of this report stand by the statement.

Sport fishing and SCUBA diving activities are extensive within the San Miguel ASBS. The majority of the sport fishing pressure is due to party boats which come from Santa Barbara, Oxnard, Ventura and Port Hueneme. Their catch levels vary from year to year but range from about 5 to 400 tons annually. The most heavily exploited species are: rockfish (chiefly Sebastes serranoides), halfmoon (Medialuna californiensis), sheephead

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 San Miguel is visited by recreational fisherman.

SCUBA divers from both party boats and commercially chartered

Municipal and Industrial Activities

There are no municipalities within one mile of the San Miguel Island ASBS. The nearest municipality is Santa Barbara, 45 statute miles from Cardwell Point.

There are likewise no industrial activities within one mile of the San Miguel Island ASBS. The nearest industrial activities are the offshore oil drilling platforms in the Santa Barbara Channel. A hut for housing research facilities, and a tent in Nidever Canyon, represent the only development on the island.

Agribusiness and Silviculture

There are no silviculture or agriculture operations within or immediately adjacent to the San Miguel Island ASBS. In the past, overgrazing by sheep had disastrous effects on the island's vegetation. Subsequent wind erosion drastically altered the island's surface. The sheep are long gone and the vegetation is recovering. Feral burros existed on San Miguel until 1975.

Government 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 (The Assessment, Appendix III, is archived at the State Water Resources Control Board).

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. Soild waste discharge from tankers and vessels larger than 150 gross tons is prohibited within the sanctuary. Benthic drilling, dredging, construction and seabed alteration are prohibited within two nautical miles of the islands. 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 petrolum 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 sanctity of the sanctuary would be protected.

Recreational Uses

San Miguel 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 and aircraft overflight tours 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 the San Miguel ASBS and it is visited with far less regularity than the other three northern Channel Islands. The nearshore regions visited most frequently by divers and fishermen are Wilson Rock, Richardson Rock and Prince Island. Recently the NPS has begun to allow ranger-accompanied, permit-only tours of portions of San Miguel Island for a low-level day use of only ten people.

Except for day-use of the beach at Cuyler Harbor, all boat landing on San Miguel is by permit only.

The mere existence of the Channel Islands National Park will undoubtedly increase the degree to which the San Miguel 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 San Miguel Island; all are coordinated by the National Park Service, 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 San Miguel 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.

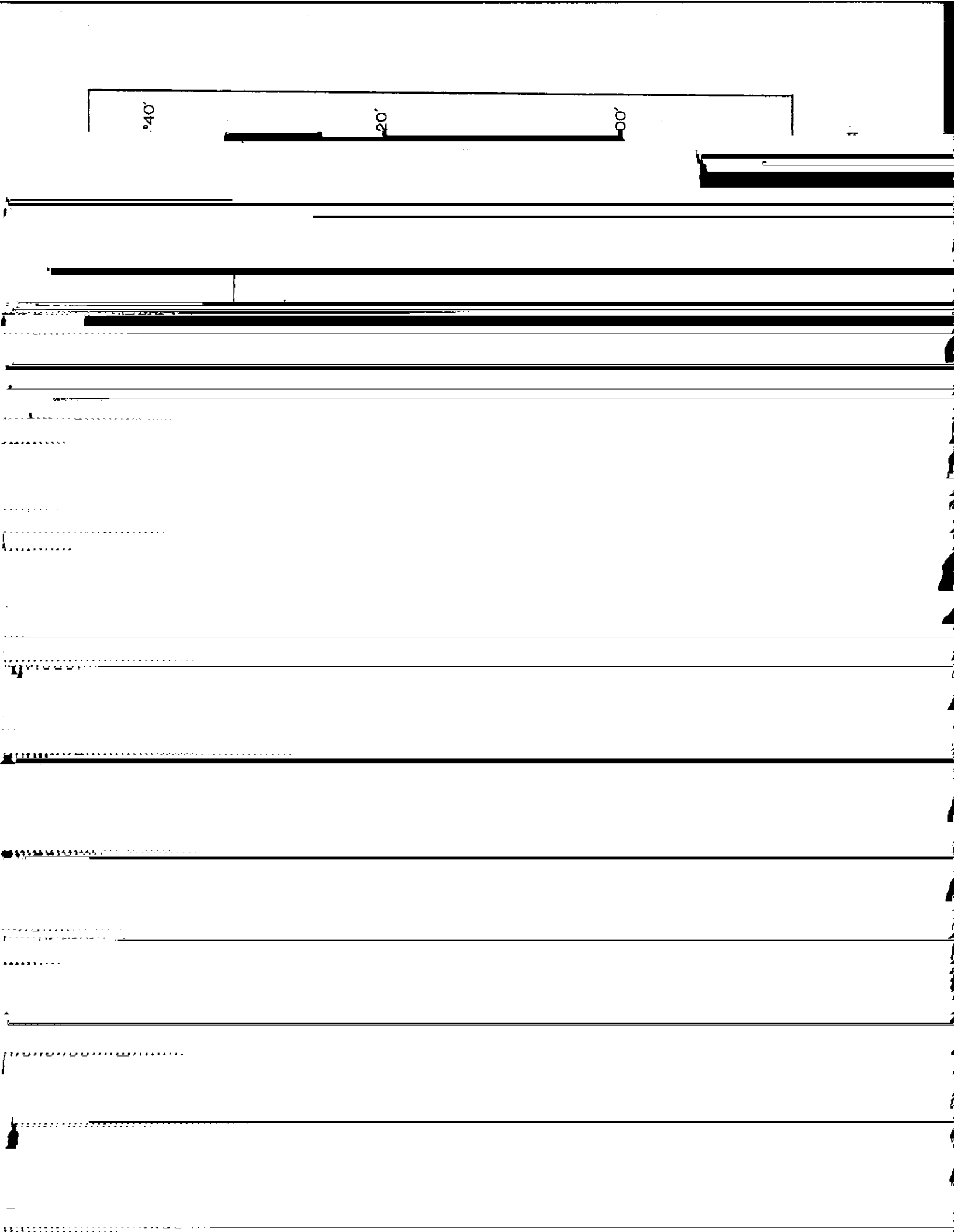
4) hydrocarbon pollution monitoring - BLM, OCZM, EPA, DOE.

5) university research - this category includes both applied reasearch, 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.

Notable recent scientific studies at San Miguel have included: BLM-sponsored seabird research (Hunt et al., 1980), pinniped surveys (Le Boeuf and Bonnell, 1980), rocky intertidal and sandy beach studies (Littler, 1980; Straughan and Hadley, 1980); Hubbs-Sea World Research Institute's study of pinniped and bird populations, and their investigations of the impact of sonic booms from the space shuttle program.

Transportation Corridors

Figure 17 shows the Santa Barbara Channel shipping lane, which approaches San Miguel Island at the west end of the Channel by about 20 nautical miles. The Channel is a major shipping route and traffic has increased substantially in recent years. Many commercial vessels use the Channel en route 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; estimates are 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.

Military Activities

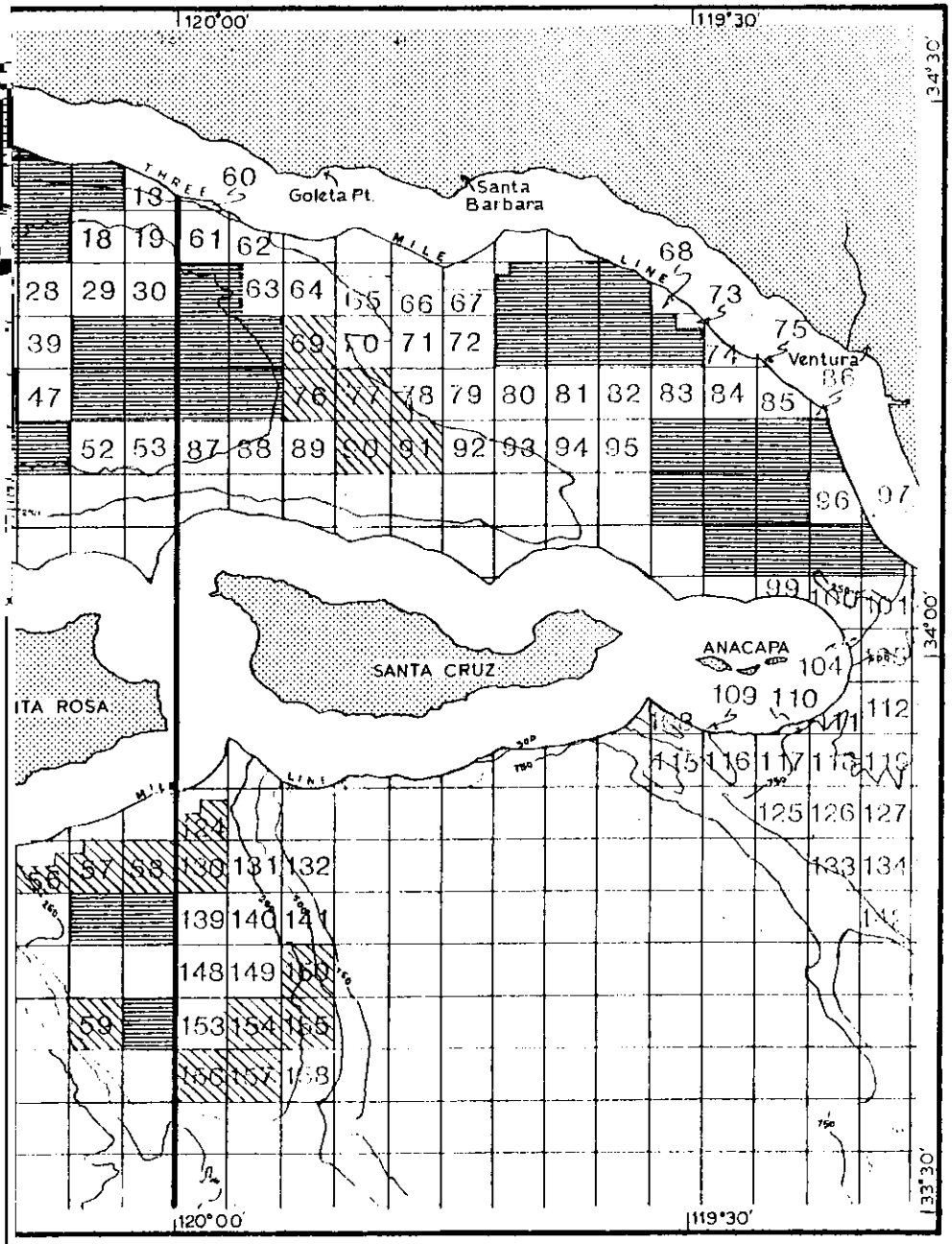
San Miguel Island is owned by the U. S. Navy, which maintains an unmanned weather station there. In addition, the Navy conducts bombing exercises centered about one mile south of Cardwell Point. About two hundred multi-plane operations take place each year. In recent years San Miguel has not been a target itself; however, the craters and damage from previous ordnance hits are widespread. A Naval Danger Zone extends three nautical miles seaward from the eastern half of the island. The U. S. Navy's Pacific Missile Range includes parts of the western and southern ASBS nearshore area. The entire ASBS area is within the overflight range of missiles from Vandenberg Air Force Base. Future impact on the ASBS can be expected from the Space Shuttle Program.

ACTUAL OR POTENTIAL POLLUTION THREATS

Point Sources

Radioactive and chemical wastes - There are no radioactive wastes within the San Miguel Island ASBS. However, about 60 miles to the south (at 33^{0} 35' N, 119^{0} 30' W in the Santa Cruz Basin) there is a radioactive waste dumpsite that was used by the Atomic Energy Commission 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.

Offshore oil development - No oil development takes place within the San Miguel Island ASBS boundaries. However, nearby operations in the Santa Barbara Channel and off the mainland coast will 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 Management sale no. 68, see Figure 18) includes areas quite close (3 miles) to the northern Channel Islands. Furthermore, the Secretary of the Interior has announced plans to open previously excluded tracts close to San Miguel Island. Development of these areas may 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



lopment lease tract localities.

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

Vessel discharges - 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 - Agricultural wastes are not present.

Oil spills and seeps - 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 geological 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 San Miguel's eastern and northern shores and the shallow water geological features of those coasts, 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 Castle Rock at San Miguel Island.

Airborne hydrocarbons - The Southern California Coastal Water Research Project (SCCWRP) has shown low flux levels of airborne DDT and PCB on San Miguel. The flux levels are highest on the northern coast, and increase on islands to the east.

Space Shuttle impact - 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. Overpressures on sonic booms will impact the islands on both launches and return flights. The return flights will pass over the islands 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 are appended to the present report (The Air Force's preliminary report, Appendix II, is archived at the State Water Resources Control Board).

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 pre-adapted 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.

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APPENDIXES I THROUGH V

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