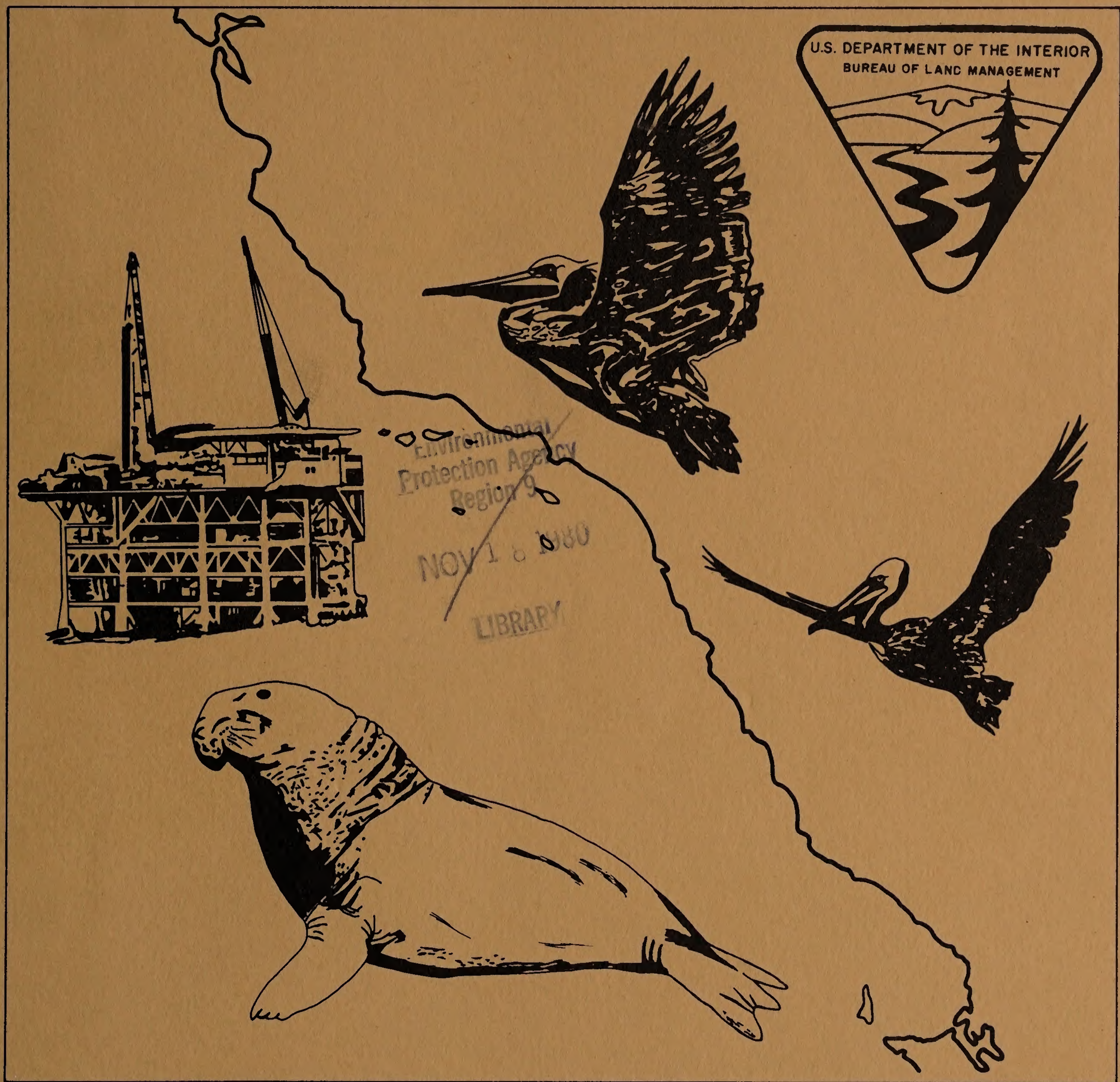
STATES DEPARTMENT OF THE INTERIOR

FINAL ENVIRONMENTAL STATEMENT

OCS SALE NO. 48 Volume I of 5



Proposed
1979 OUTER CONTINENTAL SHELF
OIL AND GAS LEASE SALE
OFFSHORE SOUTHERN CALIFORNIA

Prepared by the
Bureau of Land Management

Frank Gregg
Director

Summary

(X) Final Environmental Statement

Department of the Interior, Bureau of Land Management
Pacific OCS Office, Los Angeles, California

1. Proposed Oil and Gas Lease Sale, Outer Continental Shelf Southern California

(X) Administrative ( ) Legislative Action

2. Two hundred seventeen tracts (1,141,818 acres) of OCS lands are proposed for leasing action. The tracts are located in the following six general areas offshore Southern California: Santa Barbara Channel (544,693 acres); Santa Rosa (34,560 acres); Santa Barbara Island (23,980 acres); San Pedro Bay (116,020 acres) Tanner-Cortes (275,825 acres), Dana Point-San Diego (146,740 acres). The tracts are situated in water depths that range from approximately 25 meters to 750 meters. If implemented, this sale is tentatively scheduled to be held in June of 1979.

3. All tracts offered pose some degree of pollution risk to the environment. The risk potential is related to adverse effects on the environment and other resource uses which may result principally from accidental or chronic oil spillage and minor air quality degradation. If platform development is permitted, the development of many of the proposed tracts in the Santa Barbara Channel, San Pedro Bay and Dana Point-San Diego areas may cause degradation of the visual environment. If development is permitted in close proximity to pinnipeds and seabird rookeries, they may be disturbed sufficiently to abandon their breeding grounds. Each tract offered has received a proximity evaluation using a matrix technique to identify significant environmental impacts should leasing and subsequent oil and gas exploration and production ensue.

4. Alternatives considered:

A. Hold the Sale in Modified Form

In order to avoid various impacts of the sale as proposed, modifications of the proposal are considered including deleting one or more of the six major tract blocks, deleting certain parts of tracts to protect State oil sanctuaries and establishing buffer zones to protect pinniped and seabird rookeries and preserve the esthetic qualities of the coastal view, and deleting tracts or portions of tracts in Traffic Separation Schemes (TSS). Deep water tracts' deletions and various Marine Sanctuary deletion options are also addressed.

B. Delay Sale

Consideration is given to delaying the proposed sale until new technology is available to provide increased environmental protection.

C. Withdraw the Sale

The alternative of withdrawing the sale is considered with regard to substitutability of conservation measures, other energy sources both conventional and newly developed, and combinations of these alternatives.

5. Comments have been requested from the following:

Environmental Protection Agency

Department of Commerce
National Oceanic and Atmospheric Administration

Department of Defense

Department of Transportation
U.S. Coast Guard

Department of Energy

State of California
Director of Planning and Research
Office of the Governor

County of Santa Barbara

County of Ventura

County of Los Angeles

County of Orange

County of San Diego

County of San Luis Obispo

Department of the Interior

U.S. Fish and Wildlife Service
Geological Survey
National Park Service

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CHAPTER I

I. DESCRIPTION OF THE PROPOSED ACTION

A. Proposed Lease Sale

This proposed Federal action is a 1979 sale of oil and gas leases on the Outer Continental Shelf (OCS) in the Southern California Borderland (see Visual No. 1 and Figure I.A-1).

1. Location and Resource Potential: The proposed lease sale includes 217 tracts with an area of about 462,087 hectares (1,141,818 acres). For a complete tract list of areas for this proposed sale see Appendix A).

The U.S. Geological Survey, Conservation Division, Menlo Park, California estimated the most probable undiscovered recoverable oil and gas resources within the proposed sale tracts as follows:

Table I.A.1-1

ESTIMATED MOST PROBABLE UNDISCOVERED RECOVERABLE OIL AND GAS RESOURCES IN PROPOSED SALE AREA

Area	Oil (Million Barrels)	Gas (Billion Cubic Feet)
Santa Barbara Channel	300	300
Santa Rosa	15	23
Santa Barbara Island	10	8
Tanner-Cortes	280	419
San Pedro Bay	80	64
Dana Point-San Diego	30	45
TOTAL	715	860

Undiscovered recoverable resources are defined as those quantities of oil and gas which are reasonably expected to occur in existing favorable geologic settings but are completely undiscovered, and which after discovery can be expected to be produced under present technology and economic conditions. If exploration confirms the existence of recoverable oil and gas, such resources would be classified as reserves.

Differing assumptions regarding secondary or tertiary oil recovery techniques, and drilling and exploration technology, would affect the

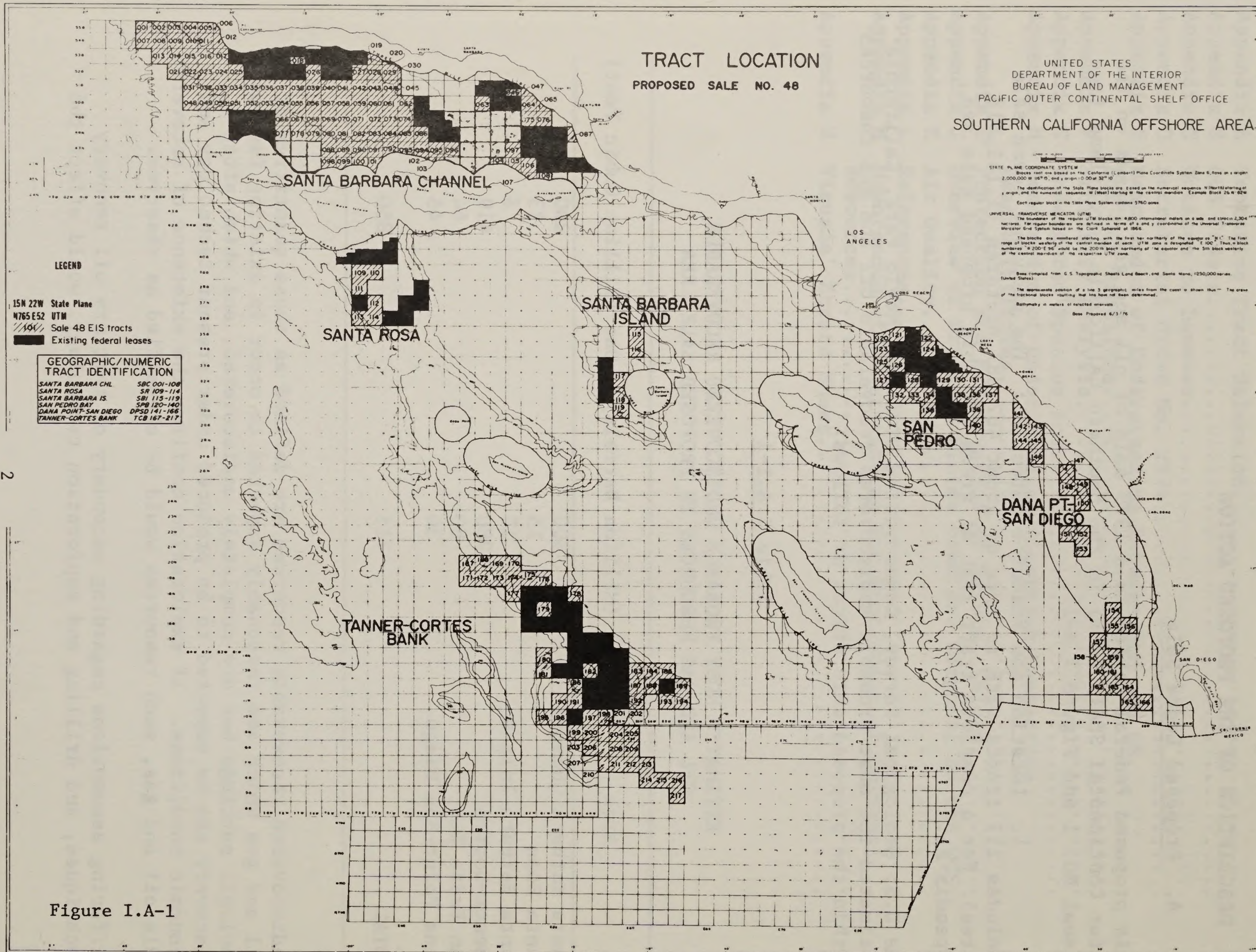

TRACT LOCATION
PROPOSED SALE NO. 48
UNITED STATES
DEPARTMENT OF THE INTERIOR
BUREAU OF LAND MANAGEMENT
PACIFIC OUTER CONTINENTAL SHELF OFFICE
SOUTHERN CALIFORNIA OFFSHORE AREA
SANTA BARBARA CHANNEL
SANTA ROSA
SANTA BARBARA ISLAND
SAN PEDRO
DANA PT.-SAN DIEGO
TANNER-CORTES BANK
LOS ANGELES
LEGEND
15N 22W State Plane
N765 E52 UTM
101 Sale 48 EIS tracts
Existing federal leases
GEOGRAPHIC/NUMERIC TRACT IDENTIFICATION
SANTA BARBARA CHL SBC 001-108
SANTA ROSA SR 109-114
SANTA BARBARA IS. SBI 115-119
SAN PEDRO BAY SPB 120-140
DANA POINT-SAN DIEGO DPSD 141-166
TANNER-CORTES BANK TCB 167-217

Figure I.A-1

estimates and, in the case of a producing field, actual recovery. Future improvement of drilling technology and exploration science could change estimates.

Additionally, changing economic and technologic conditions could appreciably affect the estimates. Planning for any offshore investment program would involve an evaluation of estimated finding and development costs, operating expenses, the price of oil and gas, taxes, depreciation, and royalty and production rates (Leeton, et al., 1973). Differing assumptions regarding the future level of these factors would affect the estimates of the recoverable resources. Similarly, a significant change in one or more of these factors at a future date could, assuming discovery, affect the amount of resources actually recovered.

In summary, estimates of resource potential are inherently speculative, and particularly so in areas where geologic information is limited and the presence of oil and gas has not been demonstrated.

2. Activities Estimated to Result From the Proposed Sale: This proposed lease sale would lead to exploration for and potential development and production of oil and gas resources. A detailed description of oil and gas operations appears in Section III.A. The following is a general summary of such operations.

Oil and gas operations begin with geophysical surveys and geological sampling programs designed to study the age, structure, and hydrocarbon potential of the area to be leased. Shallow core holes, bottom sampling and deep stratigraphic test holes provide additional geologic and geochemical information which, along with data from similar developed fields, complements and improves the interpretation of the geophysical data.

After leasing, exploratory (wildcat) wells are drilled on the best petroleum prospects as suggested by the geological and geophysical data in order to locate, delineate, and characterize hydrocarbon reservoirs. These wells are usually drilled from semisubmersibles, jackups and drillships. If commercially productive reservoirs are located, development wells are normally drilled from fixed platforms. These wells include production wells and a variety of service wells which increase the productivity of the field. The exploration phase of oil operations requires docking and onshore equipment storage, service facilities, helicopters, and attendant facilities. The development phase requires offshore and onshore hydrocarbon storage and processing facilities as well as pipelines and/or deepwater tanker ports.

The proposed lease sale would be a continuation of Federal OCS leasing offshore of California which began in 1963 and was followed by leasing in 1966 and 1968 in the Santa Barbara Channel, and OCS Sale No. 35 in 1975 in the Southern California Bight. Offshore production in State waters started in 1896.

Two oilfields, the Dos Cuadras Offshore and the Carpinteria Offshore, are currently producing in the Federal OCS of the Santa Barbara Channel. (See Visual No. 1, Current Lease Status.) The portion of the Carpinteria Offshore field that lies adjacent to the State of California tideland and submerged land area was leased by the Federal Government to prevent drainage. Section II.G.2.d.ii., Oil and Gas Industry, discusses offshore production in detail.

Resource supply, production, and transportation assumptions are based on the most probable estimates of 715 million barrels (MMbbl) of oil and 860 billion cubic feet of gas (Bcf). Maximum and minimum resource estimates are discussed and analyzed in Chapter III.F, Alternative Development Scenarios.

The most probable estimated peak production of oil for the total sale area is 219,700 barrels per day (bbl/d) or 80,200,000 barrels per year (bbl/y), and the most probable estimated peak gas production is 264,400,000 cubic feet per day (cf/d) or 96,500,000,000 cubic feet per year (96.5 Bcf/y) based on a field life of 25 years. All oil production from this proposal is assumed to back out an equal amount of imports either foreign or Alaskan from California making more oil available for other parts of the U.S. The following discusses oil and gas transportation from each area. This would occur only if oil and gas are actually found in those areas.

Oil produced in the Santa Barbara Channel is assumed to be transported by a combination of gathering lines to a pipeline to Ventura and also to offshore storage and loading facilities. It is further assumed that 30 percent of the oil would be tankered to the San Francisco area and 70 percent to the Los Angeles-Long Beach area. Gas is assumed to be piped ashore to existing facilities in the Ventura area.

Oil and gas production from the Santa Rosa and Tanner-Cortes areas is assumed to be piped ashore to the Ventura area where 30 percent would be transferred to the San Francisco area and 70 percent would be transported to the Los Angeles-Long Beach area.

Oil production from the Santa Barbara Island area is assumed to be transported by gathering pipelines to an offshore storage and loading facility and then barged to the Los Angeles-Long Beach area. Produced gas could be used to power production platform operations.

Oil and gas production in the San Pedro area is assumed to be transported by gathering lines connected to oil and gas pipelines laid to the Los Angeles-Long Beach area.

Oil production from the Dana Point-San Diego area is assumed to be transported by gathering lines to an offshore storage and loading facility and barged to the Los Angeles-Long Beach area, while gas would be pipelined ashore to existing gas lines in San Diego.

Alternative transportation scenarios such as 100 percent tankering and barging, are treated in Chapter III.F, Alternative Development Scenarios' Impacts.

The exploratory and development timetables are shown in Tables I.A.2-1 and 2. Exploratory drilling could begin during the tentative sale year (if the sale was held in the first half of the year) and continue through Year Nine. Eighty-six exploratory and 71 delineation wells are projected to be drilled.

Platform placement would begin during the fourth year after the proposed lease sale and continue through the ninth year. Platforms would probably be primarily of the welded steel type. Designs could be of the tower or template type, dependent on water depth and environmental conditions and considerations.

The development scenario assumes these platforms would be constructed in the coastal areas of California, Oregon, and Washington (or overseas) with some parts being built in the Gulf of Mexico area. The structures would be towed to the field location, set in place, and the deck structures containing the necessary facilities assembled and installed on the platform. The drilling of development wells would take place on the platforms from the fourth to the twelfth years. An estimated 630 development wells could be drilled during that 9-year period.

Subsea completions may be used in some marginal fields. A total of 71 subsea completions are assumed to be placed, with associated wells, from 1982 through 1990. The total producing wells, the sum of development and subsea completion wells, are estimated at 701 by 1990 (see Section II.H.3).

Peak oil production would occur approximately 8 years after the proposed lease sale. The productive life of the oil fields is assumed to be 25 years, and the last platforms would be removed about 40 years after initial production commenced. The 40-year spread takes into account the time differential in bringing different fields into full production.

No petroleum refineries are expected to be constructed in California as a result of the proposed sale.

a. Onshore and Offshore Facilities Development Assumptions: Many variables would affect the types and locations of facilities that could be required to support the exploration, development, and production of oil and gas resources, if discovered, and a number of facility combinations are possible. Among these variables are the policies and controls of local, regional, State and Federal governments, and of private, corporate, institutional, and industrial landholders.

Table I.A.2-1

MOST PROBABLE VALUES FOR OIL AND GAS PRODUCTION AND PRODUCING WELLS

YEAR	Annual Production Oil (MB)[a]	Annual Production Gas (MMCF)	Daily Production Oil (B)	Daily Production Gas (MCF)	Cumulative Number of Producing Wells
1979	0	0	0	0	0
1980	0	0	0	0	0
1981	0	0	0	0	0
1982	5,000	6,000	13,700	16,400	19
1983	21,100	25,400	57,700	69,600	84
1984	43,400	52,200	118,900	143,000	205
1985	68,500	82,400	187,700	225,800	367
1986	80,200	96,500	219,700	264,400	512
1987	78,800	94,800	216,000	259,700	617
1988	67,500	81,200	185,000	222,500	673
1989	53,700	64,600	147,000	177,000	695
1990	42,100	50,600	115,400	138,600	701
1991	33,700	40,500	92,400	111,000	701
1992	28,300	34,000	77,600	93,200	701
1993	24,700	29,700	67,800	81,400	701
1994	22,000	26,500	60,300	72,600	701
1995	19,800	23,800	54,300	65,200	701
1996	18,100	21,800	49,500	59,700	701
1997	16,600	20,000	45,500	54,800	701
1998	15,300	18,400	42,000	50,400	701
1999	14,300	17,200	39,300	47,100	701
2000	13,300	16,000	36,500	43,800	701
TOTAL	666,400[b]	801,600[b]			

Source: USDI, 1977.

[a]M equals 1000.
[b]This cumulative total is for 18 years of production only; production may continue for several years at a declining rate.

Table I.A.2-2

MOST PROBABLE VALUES FOR NUMBERS OF WELLS, RIG YEARS AND PLATFORMS (1979-1990)

YEAR	Number of Wells: Exploratory	Delineation	Development	Total	Subsea Compl.	Producing[a]	Number of Rig Years	Number of Platforms: Conventional[b]	Deep-Water[c]	Total
1979	6	1	0	7	0	0	1.3	0	0	0
1980	17	10	0	27	0	0	4.8	0	0	0
1981	18	15	0	33	0	0	5.7	0	0	0
1982	19	17	18	54	1	19	7.5	6[d]	0	6
1983	13	16	60	89	5	65	9.9	8[e]	1	9
1984	5	5	110	120	11	121	4.2	5	2	7
1985	5	3	143	151	19	162	14.2	2	3	5
1986	2	2	131	135	14	145	12.0	1	2	3
1987	1	1	95	97	10	105	8.5		1	1
1988		1	49	50	7	56	4.6			
1989			19	19	3	22	1.8			
1990			5	5	1	6	.5			
TOTAL	86	71	630	787	71	701	75.0	22	9	31

Source: USDI, 1977.

[a]Development wells plus subsea completions.
[b]Water depths less than 1,200 feet.
[c]Water depths greater than 1,200 feet.
[d]Includes one Santa Barbara Channel pipeline connection platform.
Includes two Tanner-Cortes pipeline connection platforms (each type) which could be incorporated with Sale 35 system.
[e]Includes two Santa Barbara Channel pipeline connection platforms. Includes two Tanner-Cortes pipeline connection platforms (each type) which could be incorporated with Sale 35 system.

In order to evaluate the biological, physical, and socioeconomic impacts of the proposed sale, it is first necessary to make certain assumptions concerning the development that would result from the proposal.

The basic most probable development assumptions for this proposed sale are shown in Table I.A.2-3.

The only new onshore facilities required as a result of this proposed sale would be four new operations bases, two in the Santa Barbara Channel area of the Ventura-Santa Barbara County coast and two in the Los Angeles-Long Beach Harbor area, each requiring 6 hectares (15 acres) of space for a total of 24 hectares (60 acres).

All site-specific facilities would be subject to all existing Federal, State, and local regulations, land use plans, policies, or controls. The location of operations bases would depend mainly upon the location of producing fields in relation to the physical environment.

Onshore operations bases are assumed to be phased into operation preparatory to development and production activity; i.e., bases would become operational in 1981.

Pipelines linking the platforms to terminals must be fabricated, and installed using pipe-lay barges. Offshore pipelines would be constructed by means of large pipe-lay barges which, it is assumed, would be similar to those utilized in the Gulf of Mexico.

The assumptions of the basic scenario (Table I.A.2-3), it must be emphasized, are not predictions of the future, but are, rather, illustrations of what could develop if all of these assumptions are correct.

The unproved nature of oil and gas resource estimates leads to the use of many assumptions in this impact analysis. Consequently, potentially affected communities should use the analysis with caution in connection with their planning activities.

3. Operating Provisions Included in the Proposed Action: Operating provisions governing the safe conduct of mineral operations and development of the OCS are administered by the U.S. Geological Survey. In addition to regulations, contained in Title 30, Part 250 of the Code of Federal Regulations, Pacific Area OCS Orders 1-12, Notices to Lessees Nos. 77-1 through 4, and stipulations are included as provisions included in the proposed actions.

The following is a brief description of each operating provision. Additional discussion, related to impacts, appears in Chapter IV, Mitigating Measures Included in the Proposed Action.

Table I.A.2-3

SUMMARY OF BASIC ASSUMPTIONS
PROPOSED OCS SALE NO. 48

Activity	This Proposed Sale
Sale offering	462,087 hectares (1,141,818 acres)
Recoverable oil (Most Probable)	715 million barrels
Recoverable gas (Most Probable)	860 billion cubic ft.
Peak production oil	219,700 bbls/day 80,200,000 bbls/year
Peak production gas	264 million/cf/day 96 billion/cf/year
Platforms	31
Exploratory wells	86
Production wells	701
Delineation wells	71
Pipelines	1,026 km (641 miles) offshore none onshore
Pipelines burial excavation volume	137,000 cu. meters (179,000 cu. yds.)
Onshore pipeline acreage required	None
Onshore oil terminal facilities number and acreage required	None
Onshore operations facilities number and acreage required	4; 6 hectares (15 acres) each
New production treatment facilities	None
Total direct land requirements	24 hectares (60 acres)
New petroleum refineries in California	None
Platform fabrication in California	10-20 (15 most probable)
New supply and support boats	0-7
Annual crude shipped by tanker or barge	Up to 70 million bbls/year
Tankers	1 at 50,000 dwt
Barges	4 at 10,000 bbl 2 at 150,000 bbl
Single buoy moors (SBM)	3
Offshore storage and treating plants (OS&T)	1 at 100,000 bbl 1 at 6,000 bbl 1 at 16,000 bbl

Source: USDI, 1977.

Pacific Area OCS Order No. 1

This Order requires all platforms, drilling rigs, drilling ships, and wells to have standard signs identifying the operator, the specific lease block of operation, and well number.

Pacific Area OCS Order No. 2

Order No. 2 concerns procedures for drilling of wells. It requires the operators to file an application for drilling which includes information on the drilling platforms or vessel, casing program, blowout prevention equipment, well control training and safety training of operators' personnel, and a list or description of critical drilling operations.

Pacific Area OCS Order No. 3

This Order is established to provide regulation of plugging and abandonment of wells which have been drilled for oil and gas. For permanent abandonment of wells, cement plugs must be placed so as to extend 30 m (100 feet) above the top and 30 m (100 feet) below the bottom of fresh water, oil, and gas zones to prevent those fluids from escaping into other strata. Portions of a well in which abnormal pressures are encountered are also required to be isolated with cement plugs. Plugs are required at the bottom of the deepest casing below which an open hole exists. Plugs or cement retainers are required to be placed 30 m (100 feet) above the top and 30 m (100 feet) below any perforation interval of the well hole used for production of oil and gas.

Pacific Area OCS Order No. 4

An OCS lease provides for its extension beyond its primary term for as long as oil or gas may be produced in paying quantities provided the operator has met the requirements for diligent development. If these circumstances should occur, the lease can be extended beyond its initial term, pursuant to Section 8(b)(2) of the OCS Lands Act and Title 30 CFR 250.11 and 250.12(d)(1). In addition, an OCS lease may be maintained beyond the primary term, in the absence of actual production, when a suspension of production has been approved by the Supervisor. Order No. 4 defines the conditions and requirements for such suspensions.

Pacific Area OCS Order No. 5

This Order sets regulations for the installation, design, testing, operation, and removal of subsurface safety devices.

Pacific Area OCS Order No. 6

This Order pertains to procedures for completion of oil and gas wells. Wellhead equipment such as casing-heads, wellhead fittings, valves and connections are specified and rating requirements are noted here. Testing procedures for wells and subsurface safety devices are also specified in the Order along with methods for multiple or tubingless completions.

Pacific Area OCS Order No. 7

Order No. 7 concerns the control of pollution to the marine environment and provides regulations for the disposal of waste materials generated as a result of offshore operations.

Pacific Area OCS Order No. 8

This Order requires that platforms, fixed structures, and artificial islands be designed with consideration for geological, geographical, environmental and operational conditions. Prior to structural approval by the Supervisor, detailed design and stress load data must be submitted to the USGS. Certification of structural adequacy by a registered professional engineer is required by the Order.

Pacific Area OCS Order No. 9

OCS Order No. 9 provides approval procedures for oil and gas pipelines on the OCS. All pipelines and related equipment must be designed and maintained with high-low pressure sensors, automatic shut-in valves, checkflow valves (to control backflow), and metering systems to detect input/ output variances (leakage). The Order also requires adequate provisions for cathodic corrosion protection, trawling compatibility, hydrostatic testing, storm scour and other environmental stress in OCS pipelines. Procedures and schedules for regular inspection of pipelines along with recording of such inspections are stipulated.

Pacific Area OCS Order No. 10

OCS Order No. 10 provides for drilling twin core holes located adjacent to coreholes drilled on the OCS under earlier California State authorization. Such holes were drilled prior to the establishment of Federal authority beyond the 3-mile limit.

Pacific Area OCS Order No. 11

This Order provides for prevention of waste, conservation of oil and gas resources, and protection of correlative rights by defining and setting standards for rates of production, production testing procedures, and joint production requirements.

Pacific Area OCS Order No. 12

The purpose of this Order is to make the records of the Department of the Interior available to the public to the greatest extent possible.

Notice to Lessees No. 77-1. "Applications for exploratory operations"

This NTL summarizes the requirements and instructions relative to the approval of applications for a permit to drill exploratory wells.

Notice to Lessees No. 77-2. "Minimum requirements for shallow drilling hazard surveys"

Minimum requirements of geologic hazard surveys, which must be conducted pursuant to 30 CFR 250.34(a), are described.

Notice to Lessees No. 77-3. "Minimum cultural survey requirements"

Describes necessary measures to be taken to identify and preserve all Federally-owned sites, structures, and objects of historic, architectural, or archeological significance as directed by Executive Order No. 11593.

Notice to Lessees No. 77-4. "Minimum requirements for biological surveys"

Requires a plan of survey to identify significant biological communities.

Stipulation No. 1. Department of Defense restriction

Requires lessee and/or operator to coordinate boat and aircraft traffic with appropriate military commander; provides for temporary suspensions of OCS operations, and requires control of electromagnetic emissions.

Stipulation No. 2. Department of Defense restriction

Indemnifies and saves harmless the United States against claim for injury or damage from space and missile testing.

Stipulation No. 3. Cultural Resources

Requires surveys to identify resources of historical or archeological significance, and subsequent protection.

Stipulation No. 4. Trawl grounds

Requires that protrusions above the sea floor, and irregular pipe surfaces, be protected by shrouds which will prevent damage to the structures, or fishing gear.

Stipulation No. 5. Areas of special biological interest

Requires prevention, to the maximum extent possible, of detrimental impact upon areas of special biological interest.

Stipulation No. 6. Transport of oil and gas

This stipulation establishes regional and state working groups, consisting of federal, state, and local government, and industry representation, to formulate regional transportation management plan recommendations.

Stipulation No. 7. Tanner-Cortes Banks

To mitigate the impacts of physical disruption and sedimentation on the significant biological communities of Tanner-Cortes Banks.

B. Leasing Process

The leasing process has been developed by the Department of the Interior to attain its objectives of orderly resource development, protection of the environment, and receipt of fair market value.

The steps involved are: 1. requests for resource reports; 2. a Call for Nominations including a request for comments; 3. an analysis of nominated areas; 4. Bureau of Land Management-U.S. Geological Survey (BLM-USGS) joint recommendations; 5. tentative tract selection; 6. Draft Environmental Statement and subsequent public hearings; 7. Final Environmental Statement (FES); 8. Secretarial Issues Document (SID); 9. notice of sale; 10. sale; 11. activity after a sale; and 12. environmental monitoring. The mechanisms of each step as they are related and will relate to proposed Lease Sale No. 48 follow:

1. Resource Reports: On March 31, 1976, the Bureau of Land Management requested information from twelve Federal agencies and the State of California State Lands Commission, describing multiple uses of and valuable resources contained within the Southern California Outer Continental Shelf area, the potential impacts of mineral operations upon resources, and possible use conflicts with potential oil and gas development. Suggestions or recommendations concerning the resolution of any conflicts between the activities of oil and gas leasing and development and the activities of other agencies in the Outer Continental Shelf area were also requested.

2. Call for Nominations: On July 16, 1976, a Call for Nominations was issued in the Federal Register, Volume 41, No. 138, for proposed OCS Lease Sale No. 48 encompassing an area off the Southern California coast from Point Conception (Santa Barbara County) in the north to the U.S.-Mexican border in the south, and ranging as far as 307 kilometers (190 miles) offshore. The area under consideration was estimated to be 5.3 million hectares (13.2 million acres) covering an estimated 2,400 partial and complete tracts. A standard tract is nine square miles or 2,331 hectares (5,760 acres). The petroleum industry was asked to identify the particular tracts on which it would like to bid if a sale were to be held.

The Call for Nominations also invited Federal, State, and local governments, industries, universities, research institutions, environmental organizations, and the general public to identify particular tracts they believed should be excluded from oil and gas leasing, or leased only under special restrictions because of conflicting resource values and environmental concerns (Figure I.B.2-1).

Information pertaining to geological, environmental, biological, archaeological, socioeconomic, and other factors also was requested. The close of nominations was September 7, 1976.

3. Analysis of Nominated Areas: Areas nominated for inclusion in proposed Lease Sale No. 48 were evaluated on the basis of: i. Nominations and past leasing history; ii. geology; iii. environmental considerations; iv. economic and use conflict considerations; and v. alternatives considered. Detailed information and analysis used to arrive at the joint BLM-USGS tract recommendations are presented below.

a. Nominations and Past Leasing History

Nominations. Both positive and negative nominations were received in response to the Call for Nominations. Positive nominations were defined as proposals for inclusion of blocks within a lease sale. Negative nominations were proposals against inclusion of blocks in a lease sale. Positive nominations were summarized as follows: Industry, represented by 17 companies, nominated 2,067,355 hectares (5,108,431 acres). Negative nominations which were specific as to block descriptions were submitted by the U.S. Fish and Wildlife Service, Los Angeles County Board of Supervisors, and the Department of Defense.

Of the total 404,498 hectares (999,515 acres) for which negative nominations were submitted, 181,792.4 hectares (454,481 acres) also received positive nominations.

In addition to specific negative nominations, a number of other negative responses were received (Table I.B.3.a-1).

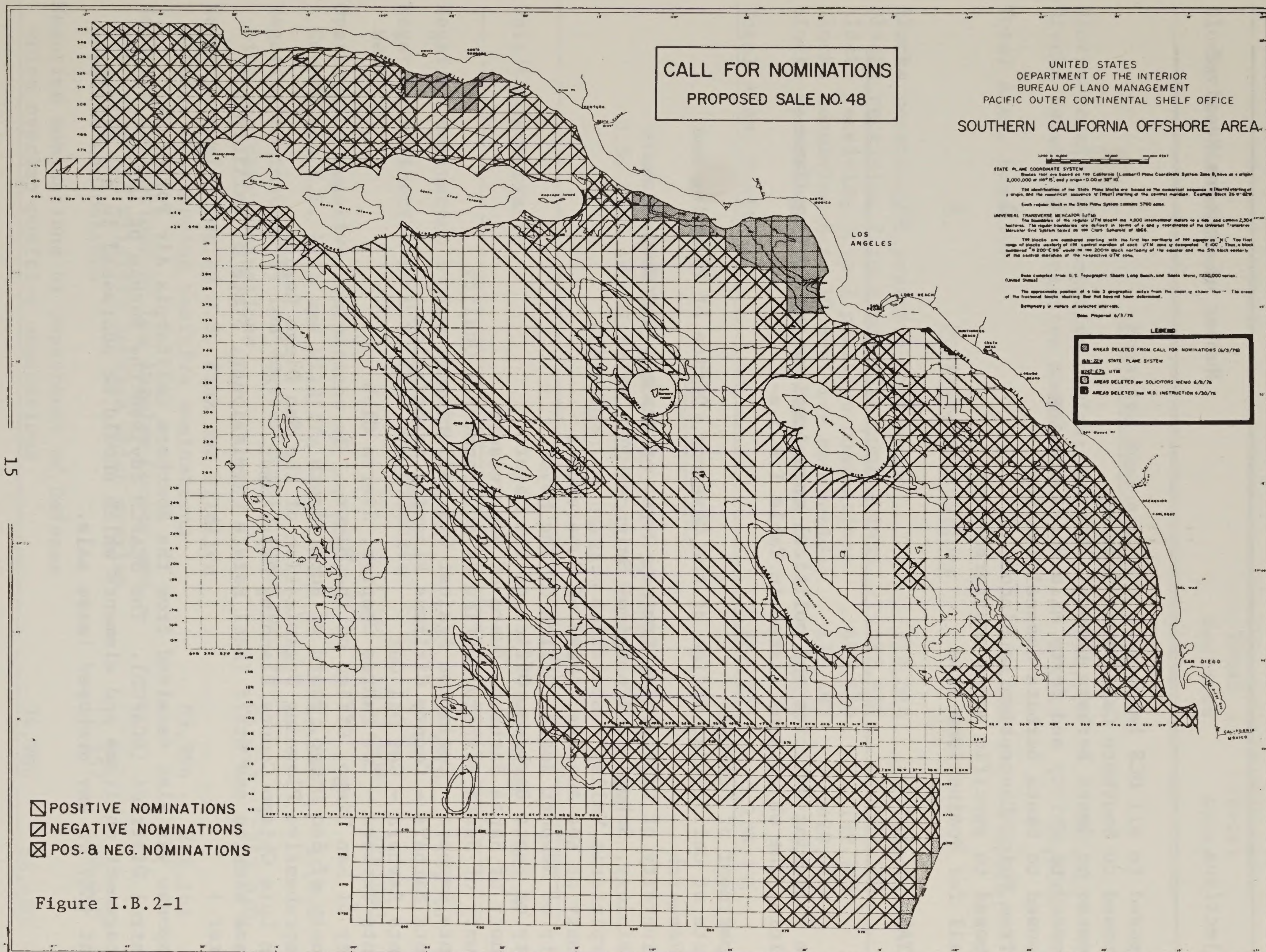

CALL FOR NOMINATIONS
PROPOSED SALE NO. 48
UNITED STATES
DEPARTMENT OF THE INTERIOR
BUREAU OF LAND MANAGEMENT
PACIFIC OUTER CONTINENTAL SHELF OFFICE
SOUTHERN CALIFORNIA OFFSHORE AREA
LEGEND
LOS ANGELES
SAN DIEGO
POSITIVE NOMINATIONS
NEGATIVE NOMINATIONS
POS. & NEG. NOMINATIONS

Figure I.B.2-1

Table I.B.3.a-1

CORRESPONDENCE RECEIVED OBJECTING TO OFFSHORE LEASING

Objections	Number of Letters Received
Opposed to all OCS leasing	1
Opposed to Southern California leasing	3
Opposed to Santa Barbara Channel leasing	32
Opposed to Thirty and Forty Mile Banks leasing	1
Opposed to Santa Barbara Channel leasing from Point Conception to Rincon	3
Opposed to specific areas scattered over Call for Nominations area	4
TOTAL	44

The following entities and political organizations were among those voicing the objections listed in Table I.B.3.a-1.

Department of Defense
State of California, Office of the Governor, Office of Planning and Research
University of California, Irvine, Dept. of Ecology and Evolutionary Biology, School of Biological Sciences
Carpinteria Valley Association
County of Los Angeles, Board of Supervisors
City of Newport Beach, Office of the Mayor
City of Santa Barbara, Office of the Mayor
County of Santa Barbara, Board of Supervisors
County of Santa Barbara, Office of Environmental Quality
Santa Barbara - Coalition Against Oil Pollution
Santa Barbara - County Citizens Planning Association
Santa Barbara - Get Oil Out
Santa Barbara - Los Padres Chapter, Sierra Club
City of San Diego, Office of the Mayor
County of San Diego, Board of Supervisors
Comprehensive Planning Organization of the San Diego Region
San Luis Obispo County Planning Department
Frank Winston and Staff (Real Estate Commissioner, State of California, ret.)

Response was also received from the Southern California Air Pollution Control District (SCAPCD). The SCAPCD advised the Bureau of Land Management on items and elements which should be addressed in any Statement (ES) on any proposed lease sale.

Table I.B.3.a-2

NEGATIVE OR POSITIVE NOMINATIONS WITHIN ENTIRE CALL AREA

Blocks and Nominations	Total Hectares	Total Acres
Negative Nominations		
Blocks receiving 1 negative nomination	390,010	963,715
Blocks receiving 2 negative nominations	14,488	35,800
Total Area, Negative	404,498	999,515
Positive nominations		
Blocks receiving 1 positive nomination	723,023	1,786,589
Blocks receiving 2 to 4 positive nominations	682,958	1,687,589
Blocks receiving 5 to 7 positive nominations	485,550	1,199,793
Blocks receiving 8 to 10 positive nominations	173,493	428,700
Blocks receiving 11 positive nominations	2,331	5,760
Total Area, Positive	2,067,355	5,108,431

Table I.B.3.a-3

NEGATIVE AND OVERLAPPING NOMINATIONS,
U.S. FISH AND WILDFIFE SERVICE, LOS ANGELES COUNTY AND
DEPARTMENT OF DEFENSE

Unit/Characteristic	Hectares	Acres
Negative nomination by Los Angeles County	287,478	710,360
Negative nomination by U.S. Fish and Wildlife Service	131,506	324,955
Overlapping negative nominations of Los Angeles County and U.S. Fish and Wildlife Service	14,488	35,800
Negative nomination by Los Angeles County overlapping positive nominations	94,017	232,320
Negative nomination by U.S. Fish and Wildlife Service overlapping positive nominations	89,906	222,161
Negative nominations by Los Angeles County and U.S. Fish and Wildlife Service which overlap positive nominations	12,157	30,040
Negative nominations by Department of Defense which overlap positive nominations	34,966	86,400

Positive nominations were evaluated on an unweighted basis because (1) the number of previous Pacific OCS sales is limited; and (2) bidding results under the new joint bidding regulations are not directly comparable to previous bidding patterns. Tables I.B.3.a-2 and 3 summarize negative and positive nominations.

Past Leasing History. Three past leasing actions have occurred within the area considered in the proposed Lease Sale No. 48 Call for Nominations. These were the 1966 Drainage Sale of OCS Lease P-0166 offshore of Carpinteria in the Santa Barbara Channel, the 71 leases issued in 1968 in the Santa Barbara Channel, and the 56 leases issued as a result of Lease Sale No. 35 held on December 11, 1975.

Drilling, discoveries, and production occurred on a number of the Santa Barbara leases.

b. Geology: On September 17, 1976 the Bureau of Land Management in Los Angeles forwarded their initial tract selection preference to USGS based upon nominations received. At that time the Bureau of Land Management requested a complete geologic and geophysical evaluation by USGS of each prospective tract. This evaluation was completed one month later and the review by USGS covered the following:

(a) Resource estimates
(b) Geological information
(c) Geophysical data
(d) Actions planned to fill data gaps
(e) Deep-water technology
(f) Problems associated with exploration and development
(g) Availability: material, equipment, personnel and capital
(h) Drainage: adjacent State lands

In the majority of cases the USGS evaluation coincided with the recommendations determined by the Bureau of Land Management's initial analysis of nominations received. The U.S. Geological Survey stated: "The tracts being considered for selection in general are considered to be oil-prone. In general, the nearshore potential traps involving young (geologically) sediments can be expected to contain primarily oil. The farther offshore potential traps involving older sediments may be somewhat more gas-prone. The probability of resource discovery will be, in general, greater for the nearshore potential traps involving a greater thickness of geologically younger sediments while the farther offshore tracts with geologically older sediments should have a lower probability of resource discovery." The USGS prioritized each tract as to resource potential and water depth in order to facilitate the evaluation process.

c. Environmental Considerations: The next step in the tract selection process involved an analysis of all areas where possible environmental impacts might occur as a result of oil exploration and development. The analysis included briefings of the Manager-POCS Office, USGS, State and local government officials and other interested groups by individual Pacific OCS Office staff members concerning their particular areas of expertise. The Southern California environmental resource categories evaluated included: (1) geology (bottom sediments, slumping and seismicity); (2) general climatology and seasonal weather patterns (visibility, winds, temperature, inversions, storms and precipitation); (3) physical oceanography (water characteristics and circulation pattern); (4) on- and offshore outdoor recreation; (5) archeological and historical factors; (6) land uses; (7) socioeconomics (population, employment, income and economic characteristics, agriculture, and refining and processing facilities); (8) transportation network; (9) air quality; (10) physical hazards (ocean cables, ship transit lanes, shipwrecks, and harbor areas); (11) terrestrial vegetation; (12) kelp beds; (13) phytoplankton and zooplankton; (14) benthos; (15) intertidal communities; (16) rare and endangered species; (17) areas of unique biological significance and marine life preserves; (18) terrestrial birds and wildlife; (19) marine and shore birds; (20) marine mammals; (21) commercial and sports shellfish; (22) finfish, including commercial finfish areas; (23) aesthetics; and (24) water quality.

Based on information developed through the BLM planning system, the above categories were analyzed for possible impacts (adverse or favorable) resulting from offshore oil and gas exploration and development. Actions or events considered to have the greatest potential for impact upon the environment were drilling, platform and pipeline placement, and oil spills.

At current levels of technology, it was determined that air quality, aesthetics, bottom stability, areas of biological significance, and unique biological areas were the major categories of environmental concern in Southern California.

Aesthetic considerations included the selection of tracts near (1) heavy population concentrations, (2) areas of high property values, (3) high-use recreation areas that have high aesthetic quality (though not currently heavily populated), and (4) areas in the National Park System or proposed additions thereto.

Areas of Special Biological Significance (ASBS) included San Miguel, Santa Rosa, Santa Cruz, San Nicolas, Santa Barbara, Anacapa and San Clemente Islands, Begg Rock, the near shore area from Mugu Lagoon to Latigo Point, portions of Santa Catalina Island, San Diego-La Jolla Ecological Reserve, Heisler Park Ecological Reserve, San Diego Marine Life Refuge, Newport Beach Marine Life Refuge, and Irvine Coast Marine Life Refuge. In addition, there are three unique island intertidal areas: one on the west coast of San Clemente Island, another on the eastern side of Santa Barbara Island (discovered as a result of the Bureau of Land Management baseline studies program), and the third on the northwest tip of San Nicolas Island.

Other areas of high environmental concern were the Tanner and Cortes Banks. Certain areas of the Tanner and Cortes Banks were described as unique biological areas as a result of the Bureau of Land Management's marine biological surveys. Parts of the banks contain communities of the rare hydro coral, *Allopora californica*. An interesting phenomenon of this area is the large size of many fish and invertebrate species living on the banks. These banks are also an important feeding area for marine mammals and birds.

The areas 4 to 5 miles offshore of Santa Catalina, Santa Cruz, and Anacapa Islands were of concern to commercial fishermen. These areas are habitats of the major commercial fish species and were, therefore, of primary importance to the commercial fishing industry. All of the above delineated areas could be susceptible to impacts as a result of oil and gas leasing activities.

Other possible concerns were the geologic hazards that may exist for the flank areas of some of the ridges. In addition to faulting, these potential hazards include slumping and possible instability of steep slopes because of potential liquefaction.

These potential hazards and the potential negative impacts of oil and gas development on aesthetics and the biology of the tracts selected will be analyzed in detail in this Environmental Statement.

d. Economic and Potential Use Conflict Considerations

Economic Considerations. The refining capacity of California and the present levels of petroleum imports into the State and the United States were analyzed. It was projected that potential production from this proposed sale would be used to displace West Coast imports. It was pointed out, however, that the West Coast would have an oversupply of oil of approximately 600,000 barrels a day by 1980 and 900,000 barrels a day by 1982 from an influx of Alaska North Slope crude oil via the Trans-Alaska Pipeline (shipped from the Port of Valdez) and increased production in the Cook Inlet. However, most of the excess oil (Alaskan crude) was projected to be transshipped to the Midwest via the proposed SOHIO Pipeline, or perhaps tankered through the Panama Canal to Louisiana or Texas and then transported via existing pipelines to the Midwest. Only 400-500 thousand barrels per day could be refined in California refineries due to the viscosity and sulfur content of Alaskan crude. It was concluded that California's refinery capacity would be adequate to process the production of crude from this proposed sale.

An assessment was made of the availability of capital, manpower, and equipment for this proposed sale and potential operations. The Western Oil and Gas Association (WOGA) confirmed this information in a letter dated May 11, 1976.

Department of Defense Potential Use Conflicts. The Navy expressed concern about areas around San Nicolas Island, San Clemente Island, Santa Barbara Island, offshore of San Diego County, and west of Forty Mile Bank. The Air Force expressed concern about possible tracts in the Santa Barbara Channel, noting the existence of missile overflights of the area originating from Vandenberg Air Force Base. Each of these concerns was discussed with the appropriate military organization.

Potential Conflicts With Commercial Fishing. Possible use conflict with the commercial fishing industry was considered. Major fishing areas include the Santa Barbara Channel and the area around the northern Channel Islands; the eastern slope of the Santa Monica Basin; San Pedro Bay and Channel (to Catalina Island); the area around San Clemente Island, which is located 60 miles west of San Diego; the area south of Santa Barbara Island, which is located 60 miles southwest of Los Angeles Harbor; offshore of San Diego; and the Tanner and Cortes Banks, which are located 90-110 miles southwest of Los Angeles Harbor and 100-110 miles west of San Diego.

Several other offshore banks are also important commercial and sport fishing and diving areas. These include Osborn Bank (south of Santa Barbara Island), Forty Mile, Thirty Mile, and the Coronado Banks located 40, 30, and 12 miles offshore of San Diego, respectively.

Special Consideration. The State of California is maintaining oil and gas sanctuaries adjoining portions of the nomination area. These areas in general terms are the Goleta Point-Santa Barbara area, the San Miguel, Santa Rosa, Santa Cruz, Anacapa, San Clemente, and Santa Catalina Islands area, the Santa Monica Bay-Palos Verdes area, and the Newport Beach to U.S.-Mexican border area (see Visual No. 1 for Oil Sanctuary locations).

In addition, and in response to the Call for Nominations for Proposed OCS Lease Sale No. 48, the State asked that a continuous 3-mile buffer zone be created parallel and adjacent to the State 3-mile boundary throughout the area of the proposed sale.

Participation and Coordination. A continuing part of the Tract Selection process was the participation and coordination of the Bureau of Land Management with other Federal agencies, State and local governments, and other interested groups or individuals. Briefings were held on tentative tract selections for proposed Lease Sale No. 48 for further environmental study in the EIS process. The comments and recommendations of each group, agency, or individual were considered along with other pertinent information to arrive at tract recommendations. The agencies and groups involved in this process are listed below.

The National Oceanic and Atmospheric Administration was briefed on the various options that the Bureau of Land Management had considered and was advised of the recommendations the Bureau of Land Management would present to its Washington Office. They offered no opposition to the proposed recommendations.

The U.S. Fish and Wildlife Service participated in the environmental briefings held on September 8, 9 and 10, 1976, and the October 5, 1976 geologic evaluation meeting conducted jointly between the Bureau of Land Management and USGS, and the December 2, 1976, BLM-USGS field office tract selection briefing.

The U.S. Coast Guard was briefed as to the various options being considered and the recommendation being submitted by BLM-USGS field offices.

State of California representatives attended the environmental tract evaluations on September 8, 9 and 10, 1976 and October 27, 28 and 29, 1976, and the joint BLM-USGS geologic tract evaluation meeting held on October 5, 1976. The State was represented by the Governor's Office of Planning and Research, the California Coastal Zone Commission, and the California State Lands Division.

Representatives of local governments, universities, and one oil company, as well as two military personnel attended the environmental tract evaluation briefings held on October 27, 28 and 29, 1976. The Cities and Counties of Los Angeles, San Diego and Santa Barbara were represented as well as the Southern California Association of Governments (SCAG). The University of Southern California and the University of California at Santa Barbara also were represented.

The U.S. Geological Survey (Los Angeles-Menlo Park) and the Bureau of Land Management, Pacific Outer Continental Shelf Office (POCS) met on October 1, 1976, to discuss initial findings and further define areas requiring additional data or clarification. On October 5, 1976, a formal joint USGS-BLM, POCS meeting was held to discuss nominations and available information (geological, biological, and use conflicts) that were used in the tract selection process.

On December 2, 1976 representatives of the following governmental units attended a BLM-USGS field office tract selection briefing: the California State Lands Division, the Governor's Office of Planning and Research, the California Attorney General's office; the Mayor's Office of the City of Los Angeles and the Los Angeles County Department of Regional Planning; the County of Santa Barbara Office of Environmental Quality; the Ventura County Environmental Resource Agency; the City and County of San Diego and the San Diego County Planning Organization; U.S. Fish and Wildlife Service; USGS (Los Angeles and Menlo Park offices) and Pacific OCS Office. The purpose of the briefing was to inform the state, local cities, and counties of the tract selection alternatives being considered by the BLM-USGS field offices for proposed Lease Sale No. 48.

On December 15, 1976 a meeting was held in Washington, D.C., on tentative tract selection for proposed Lease Sale No. 48. Those attending included state and local representatives from the San Diego County Planning Organization (CPO); County of San Diego; City of San Diego; Congressman Bob Wilson; Congressman Burgener; Congressman Van Deerlin; State of California; and various officials of USGS, BLM, USF&WS and DOI.

e. Proposed Options Considered: All blocks considered for tract selection were ranked according to priority for leasing consideration. Priority No. 1 blocks were blocks for which high bids were rejected as inadequate during Lease Sale No. 35, drainage tracts, tracts which appeared to have the best resource potential (based on currently available geologic and geophysical data) and had received high positive nominations by industry, and blocks for which locations suggested minimum military use conflicts and generally moderate environmental concern. Priority No. 2 blocks were blocks which had a fair to good resource potential, for the most part, and preliminary indications suggesting moderate use conflicts and moderate environmental concern. Priority No. 3 blocks were blocks which generally had either poor to minimal resource potential, and preliminary indications suggesting high use conflicts, or high environmental concern, or any combination thereof.

4. BLM-USGS Joint Recommendations: As discussed above, all blocks considered for tract selection were labeled Priority No. 1, No. 2 or No. 3 as to leasing potential.

After considering all factors relating to the selection of tracts for inclusion in proposed Lease Sale No. 48 for further analysis, the following joint recommendations were made by the Bureau of Land Management and U.S. Geological Survey.

All blocks designated as Priority No. 1 or No. 2 should be processed through tract selection and made the subject of an ES for proposed Lease Sale No. 48.

The choice of this option as the recommended proposal from among those previously discussed was based on the following: (1) Restriction of tract selection to only Priority No. 1 blocks would unnecessarily reduce the size and related resource development potential of this proposed sale. (2) It also appeared infeasible to delete all blocks from selections which have been negatively nominated or otherwise protested since the proposed sale would be reduced to negligible resource potential. (3) Inclusion of both Priority No. 1 and No. 2 blocks in final tract selection assured a sufficient proposed sale size as well as resource potential and block distribution pattern. This choice was strengthened by the fact that the majority of USGS higher resource-rated blocks was included in these priorities. These facts also formed the basis for the decision to recommend this alternative rather than the one which considered deletion of the Santa Barbara Channel. Industry interest in the Channel and USGS resource estimates were strong arguments in favor of inclusion. (4) The deletion of all Priority No. 3 blocks removed many of the environmental and use conflict problems associated with this proposed lease sale, although many of USGS's top-ranked tracts were in this category. An attempt to include all of the tracts identified by USGS as having significant resource potential could result in too large an offering (approximately 720,000 hectares or 1.8 million acres and as much as 3.2 billion barrels of oil and 6.59 trillion cubic feet of gas). A sale of such magnitude would tend to be counter to the goals of orderly and timely resource offerings, resource development, and receipt of fair market value.

Priority No. 3 blocks were so designated for a variety of reasons including environmental concerns, military use conflicts, low resource potential, other use conflicts, and public concern. Early deletion of these blocks was made to reduce use conflicts (such as with the fishing industry and the military) while sustaining the possibilities for leasing, exploration and development, and environmental protection of the Southern California Bight.

5. Tentative Tract Selection: On January 18, 1977, the Department of the Interior announced a list of 217 tracts totaling 462,088 hectares (1,141,818 acres) to be further considered for proposed oil and gas Lease Sale No. 48.

The Tract Selection step identifies all tracts for possible lease offering and for intensive environmental study so potential impacts can be identified and alternatives weighed. Included are tracts with conflicting nominations.

Tract Selection does not commit tracts for lease sale. Its purpose is to define the proposed lease sale for further environmental study in a site-specific EIS prior to consideration and decision on the proposal by the Secretary of the Interior. (A list of the 217 tracts selected is in Appendix A and Figure I.A-1.)

6. Draft Environmental Statement (DES) and Public Hearings: Opportunity for State participation in the OCS public hearings is routinely provided by the Bureau of Land Management. Hearings on this proposal were held in Los Angeles, San Diego, and Santa Barbara. After a review and comment period of 46 days, public hearings were conducted. These hearings were followed by an additional 15 days during which time the public continued to submit comments on the DES.

7. Final Environmental Statement (FES): The FES reflects Department of the Interior consideration of all comments received, including those from the public and Federal and State officials. The Final Statement will be submitted to the Environmental Protection Agency (EPA) for thirty days of review before the Secretary of the Interior is authorized to make a decision on holding a sale.

None of the steps outlined above constitutes a decision to hold a sale. The Call for Nominations and comments, tentative Tract Selection, Draft ES publication, public hearings, and issuance of the Final Statement are steps required for compliance with the National Environmental Policy Act and are spelled out in guidelines issued by the Council on Environmental Quality (CEQ) and Department of the Interior regulations.

8. Secretarial Issues Document: Before a notice of sale is issued, a SID is prepared for the Secretary of the Interior delineating all the options of the proposed sale including possible tract deletions.

9. Notices of Sale: A proposed Notice of Sale will be issued by the Secretary of the Interior in which he will specify what tracts should be offered and what operating restrictions should be imposed on lease purchasers. The proposed Sale Notice will be published in the Federal Register. Under the August, 1977, Proposed OCS Planning Schedule a 60-day period for State review of proposed sale notices has been added to allow States ample time to comment on pending sales before the Secretary makes a final decision on whether to hold a sale. Under the planning schedule, the proposed Notice of Sale for proposed OCS Sale No. 48 would be issued in March, 1979 and the Notice of Sale in May, 1979 (Table I.B.8-1).

10. Sale: Outer Continental Shelf oil and gas lease sales are open to the public. Under the August, 1977, Proposed OCS Planning Schedule, proposed OCS Sale No. 48 is scheduled for June, 1979.

11. Activity After a Sale: Continued formal and informal contacts with the State for future planning and discussion of onshore facilities, such as pipeline corridors, will be conducted, as well as coordination under Secretarial Order 2974.

12. Environmental Monitoring: BLM will consider environmental monitoring studies for the areas leased as a result of this sale. Each area will be evaluated on a case by case basis to design an effective monitoring program responsive to management questions. Special monitoring studies may be required for areas identified as having a special resource value. Appropriate State officials will be contacted on a continuing basis in a consulting capacity. The Bureau of Land Management will provide for a free flow of information to keep the State informed of the status of any monitoring program. The State will be informed through the Outer Continental Shelf Advisory Board, through State liaison officers, and through the activities of the Pacific Outer Continental Shelf Office.

Table I.B.8-1

PROPOSED OCS PLANNING SCHEDULE

August 1977

SALE AREA	1977					1978												1979												1980												1981											
	A	S	O	N	D	J	F	M	A	M	J	J	A	S	O	N	D	J	F	M	A	M	J	J	A	S	O	N	D	J	F	M	A	M	J	J	A	S	O	N	D	J	F	M	A	M	J	J	A	S	O	N	D
Cl Cook Inlet		N	S																																																		
42 N. Atlantic	F		P		N	S																																															
43 South Atlantic-Georgia Embayment			F		P		N	S																																													
45 Gulf of Mexico				F		P		N	S																																												
65 Eastern Gulf of Mexico						E		H			F	P		N	S																																						
51 Gulf of Mexico							E		H			F		P		N	S																																				
49 Mid-Atlantic		T						E		H			F			P		N	S																																		
48 Southern California													E		H			F		P		N	S																														
58 Gulf of Mexico			C		D		T							E		H			F		P		N	S																													
58A Gulf of Mexico		C				D			T									E		H			F		P		N	S																									
Federal/State Beaufort (near shore)			C		D				T											E		H			F			N	S																								
55 Gulf of Alaska										C		D			T										E		H			F		P		N	S																		
62 Gulf of Mexico														C		D			T									E		H			F		P		N	S																
46 Kodiak																													E		H			F		P		N	S														
52 North Atlantic																C		D			T								E		H				F		P		N	S													
53 Central and Northern California				C							D			T																			E		H			F		P		N	S										
60 Cook Inlet																	C		D			T									E				H				F		P		N	S									
56 South Atlantic-Georgia Embayment																				C		D			T										E		H			F		P		N	S								
59 Mid-Atlantic																										C		D			T								E		H			F		P		N	S					
66 Gulf of Mexico																												C		D			T							E		H			F		P		N	S			
57 Bering-Norton																					C							D			T										E		H					F		P		N	S

C - Call for Nominations
D - Nominations Due
T - Announcement of Tracts
E - Draft Environmental Statement
H - Public Hearing
F - Final Environmental Statement
P - Proposed Notice of Sale
N - Notice of Sale
S - Sale

Sales are contingent upon a reasonable assumption that technology will be available for exploration and development. A decision whether to hold any of the lease sales listed will not be made until completion of all necessary studies of the environmental impact and the holding of public hearings as a result of the environmental, technical, and economic studies employed in the decision making process. A decision may, in fact, be made not to hold any sale on the schedule.

The Department of the Interior

C. Legal Mandate and Authority

1. OCS Lands Act as Amended: In August, 1953, the Outer Continental Shelf Lands Act (43 U.S.C. 133) established Federal jurisdiction over the submerged lands of the continental shelf seaward of the State boundaries (usually three geographical miles seaward from the coastline). The States' title to submerged lands within the three-mile limit was confirmed by the Submerged Lands Act just three months earlier in May of 1953.

The OCS Lands Act charged the Secretary of Interior with the responsibility for administration of mineral exploration and development on the OCS. It also empowered the Secretary to formulate regulations so that provisions of the Act might be met.

Subsequent to the passage of the OCS Lands Act, the Secretary of the Interior designated the Bureau of Land Management as the administrative agency for leasing submerged Federal lands and the Geological Survey for supervising operations. The Department formulated three major goals for the comprehensive management program of marine minerals. These are:

(1) The orderly development of marine mineral resources to meet the energy demands of the nation.

(2) The protection of the marine and coastal environment.

(3) The receipt of a fair return for leased mineral resources.

These leasing objectives are based on legislative mandates as explained below.

(1) Orderly resource development is based on the OCS Lands Act which gives the Secretary the authority, in order to meet the demand for oil and gas, to grant leases to the highest qualified bidder(s) on the basis of sealed competitive bids.

(2) The policy of protection of the marine and coastal environment is a direct outgrowth of the National Environmental Policy Act of 1969. This Act requires that all Federal agencies shall utilize a systematic, interdisciplinary approach which will insure the integrated use of the natural and social sciences in any planning and decision-making which may have an impact upon the environment. Responses to these requirements by BLM include the formation of Environmental Assessment Teams, development of Environmental Impact Statements (EIS's), and sponsorship of contract studies. See Section 5 of the OCS Lands Act.

These studies include environmental benchmark and monitoring studies and special studies designed to provide information for assessing the effects of oil and gas operations.

(3) Receipt of a fair return has its basis in two separate mandates. 31 U.S.C., Sec. 483(a) obligates the Federal government to obtain a fair return for the interests that are leased. This is further implemented within the Executive Branch by the Office of Management and Budget Circular A-25.

2. Relationship of the Proposed Sale to the Overall OCS Leasing Program: Section 18(d)(3) of the OCS Lands Act Amendments provides interim authority, pending development and approval of a new OCS leasing program under that Act, to consider and decide whether to hold proposed OCS Sale No. 48. That Section provides that "leasing shall be permitted to continue until a new OCS leasing program is approved. The Secretary of the Interior is required by the 1978 OCS Lands Act amendments to submit a new proposed leasing program to the Congress, the Attorney General, and the Governors of affected states within nine months of September 18, 1978. The Secretary is further directed to prepare and periodically revise, and maintain the oil and gas leasing program. The leasing program is to consist of a schedule of proposed lease sales indicating, as precisely as possible, the size, timing, and location of leasing activity which will best meet national energy needs for the five-year period following its approval or reapproval. The goal of the leasing program is to provide for orderly development of OCS oil and gas resources and to maintain an adequate contribution of OCS production to the national supply in order to reduce dependence on foreign oil. During February of 1978, 7.7 million barrels per day of petroleum products were imported out of a total U.S. demand of 19.3 million barrels per day (Department of Energy Information Weekly Summary, Volume 2, No. 7, February 22, 1978). The United States has three overriding energy objectives outlined in the National Energy Plan:

- as an immediate objective that will become even more important in the future, to reduce dependence on foreign oil and vulnerability to supply interruptions;
- in the medium term, to keep U.S. imports sufficiently low to weather the period when world oil production approaches its capacity limitation; and
- in the long term, to have renewable and essentially inexhaustible sources of energy for sustained economic growth.

Full development of OCS resources is an integral part of that plan (The National Energy Plan, Executive Office of the President, Energy Policy and Planning, 1977).

An OCS leasing program does not represent a decision to lease. It represents only the Department's intent to consider leasing in certain areas and to only proceed with the leasing of such areas if it should be determined that leasing and development in such areas would be environmentally, technically, and economically acceptable.

The Department's first 5-year OCS planning schedule was released in June, 1973, calling for six OCS sales per year and opening up all frontier areas by 1978. During June 1976, the OCS Advisory Board made recommendations as to modifications of the OCS planning schedule. In January, 1977, Secretary Kleppe adopted a revised planning schedule which basically reflected the policy established in November 1975, except for changes regarding areas in Alaska which had had no previous lease sales. This 5-year schedule was later reviewed by Secretary of the Interior, Cecil D. Andrus, who thereafter, in May, 1977, decided to issue a revised planning schedule. This schedule covered the 3-year period, 1977-1979 (Table I.B.8-1).

An approximate 3-year interval is planned between any sale held in a frontier area and the tentative date scheduled for subsequent lease sales proposals in the same geologic province. Secretary Andrus said that this interval would provide for an orderly level of activity for both exploration and development and permit the use of exploratory results from one sale in making tract selection for a later sale.

The new OCS leasing program currently being developed will take into account additional environmental safeguards. This includes the provisions of the OCS Lands Act amendments regarding the circumstances in which development phase environmental impact statements will be required and the provision for a 60-day period for State review of a proposed Notice of Sale. These provisions will be applicable to this Lease Sale proposal, and any leases issued if the Sale is held.

D. Interrelationship with Other Jurisdictions, Programs and Plans

1. Federal Administration and Regulatory Responsibility

a. Department of the Interior

i. Bureau of Land Management: Authorization to lease OCS lands for oil, gas, sulphur and other minerals and to administer these leases. In addition, the Bureau of Land Management has the authority to approve applications for "common-carrier" pipeline rights-of-way on the OCS.

ii. Geological Survey: Issues OCS orders and other orders and rules as necessary to effectively supervise mineral operations on the OCS and prevent damage to, or waste of, any natural resource or injury to life or property. Jurisdiction over producer-owned "gathering" lines and flow lines on the OCS.

iii. U.S. Fish and Wildlife Service: Protection of fish and wildlife resources and their habitat in an advisory or recommendation capacity to the Corps of Engineers in the process of issuing Federal permits in navigable waters; and has responsibilities for the protection and stewardship of species covered under the Endangered Species Act of 1972 and Marine Mammal Protection Act of 1972.

b. U.S. Army Corps of Engineers: Issues permits for construction (including pipelines) on OCS and in other navigable waters.

c. Department of Energy, Federal Energy Regulatory Commission: The Department of Energy evaluates and manages the performance of leasing policies in maintaining competition, maximizing the exploitation of resources and efficiently raising government revenues. Departmental functions are to: Set production goals and rates from Federal leases; and, develop regulations for fostering competition and for the terms and conditions of the acquisition and disposition of Federal royalty interests. In addition, the Department of Energy provides support to the Leasing Liaison Committee and coordinates its leasing policies with the Department of the Interior, since DOI is mandated the responsibility of issuing and supervising Federal leases, as well as enforcing regulations promulgated by DOE. Grants certificates of convenience and necessity prior to construction of interstate natural gas pipelines; determines amounts of OCS gas purchased and transported. Section 27 of the OCS Lands Act, as amended, requires DOI consultation with DOE.

d. Interstate Commerce Commission: Grants approval of the tariff rates for transportation of oil by common carrier pipelines.

e. Department of Transportation, Office of Pipeline Safety: Establishes standards for pipeline construction, operation, and maintenance. The Department of Transportation responsibility and authority is further defined in a memorandum of understanding between it and the Department of the Interior.

f. Department of Commerce, National Oceanic and Atmospheric Administration, National Marine Fisheries Service (NMFS): Protection of marine fishery resources and their habitat, through consultation with the Corps of Engineers, in the process of issuing Federal permits in navigable waters. In accordance with the Fishery Conservation and Management Act of 1976 (16 U.S.C. 1801 et seq.) the Pacific Fishery Management Council has been established to formulate plans prescribing measures, requirements, conditions and restrictions deemed necessary to conserve and manage the fish and fishery resources off the coasts of California, Oregon and Washington. These plans are then reviewed, approved and implemented by the Secretary of Commerce.

In order to avoid possible conflicts between the conservation of fisheries and the orderly development of mineral resources on the outer continental shelf the Secretary of the Interior has requested the Fish and Wildlife representative or the Council to inform the Pacific OCS Office and the Secretary's Field Representative of any potential conflicts that may surface in the review of management plans prepared by the Council. The NMFS has responsibility for the protection and stewardship of species covered under the Endangered Species Act of 1972 and the Marine Mammal Protection Act of 1972.

g. United States Coast Guard: Establishes and regulates Traffic Separation Schemes (TSS) to prevent collisions between vessels traveling in opposing directions. The Coast Guard also has jurisdiction to enforce the Clean Water Act of 1977 on the OCS. Section 21 of the OCS Lands Act requires a joint study with the U.S. Coast Guard and other appropriate Federal agencies to determine the adequacy of existing safety and health regulations and of the technology, equipment, and techniques available for exploration and development of mineral resources on the OCS. Further, the Secretary of the Interior shall require on all oil and gas operations on the OCS the use of the best available and safest technologies which are economically feasible.

2. State Authority and Participation: Section 19 of the OCS Lands Act, as amended, requires DOI to coordinate and consult with affected State and local governments with regard to the size, timing, or location of a proposed lease sale or with respect to a proposed development and production plan.

a. OCS Advisory Board: This board was established pursuant to the provisions of the Federal Advisory Committee Act and under the authority of the OCS Lands Act of 1953. The board advises the Department of the Interior in the performance of its discretionary functions under the OCS Lands Act. These functions involve all aspects of exploration and development of OCS resources, including resource evaluation, environmental assessment, leasing, mitigation of adverse impacts, and development plans.

The Advisory Board is chaired by a person chosen by the members. Membership consists of one representative from the Environmental Protection Agency, Department of Energy, Council on Environmental Quality, and the Departments of Commerce, Defense, and Transportation. One representative from each of the 21 Coastal States is also a member of the Board.

b. OCS Drilling and Development Plans: Under these plans, the lessee will provide affected Coastal States with information on proposed onshore and offshore operations. Affected States will be given an opportunity (60 days) to review and comment on the lease development plan provided by the lessee before the lessee provides the development plans to the U.S. Geological Survey. These procedures are designed to greatly assist the States in obtaining the necessary data to carry out their own onshore community and land management planning. The procedure will allow the State(s) and Federal governments to work together in the assessment of the lease development phases and will also provide an opportunity for increased dialogue between impacted States and lessees (see earlier discussion on page 29).

Specific data requirements and components of the drilling and development plan are presently being looked at by a subcommittee of the OCS

Advisory Board, the Department of the Interior, and industry officials. Refer to the Pacific Region OCS Orders for a more detailed account of the regulations.

c. Coastal Zone Management

i. Coastal Zone Management Program: The Federal Coastal Zone Management (CZM) Act of 1972 (16 U.S.C. 1451-1464) as amended in 1976 and administered by the National Oceanic and Atmospheric Administration (NOAA) of the Department of Commerce, provides grants-in-aid to States for the development and implementation of management programs to control land and water uses in the coastal zone. In order to qualify for implementation monies, a State must develop its coastal zone management program within 4 years. The policy which the Act established is aimed at balancing protection of the coastal environment with development and economic interests.

Amendments to the CZM Act were adopted in July, 1976, providing that States which are preparing a management program under Section 305 of the Act may receive supplementary grants and loans to deal with coastal zone impacts of outer continental shelf (OCS) oil and gas leasing and other energy developments.

The CZM Act requires that Federal action within the coastal zone must generally be consistent with a State's CZM program once that program has been approved by the Secretary of Commerce. Conversely, State CZM plans must consider the national interest in facility siting. Local governments, in turn, must consider State and regional interests in the exercise of their coastal regulatory powers.

Under the consistency provision of the act, exploration and development plans of OCS oil and gas leases are specifically indicated as items which must receive consistency review by affected Coastal States with approved coastal zone management plans.

While the act allows individual States much leeway in devising management plans and allocating responsibilities to State agencies, regions, and localities, the States themselves must approve the management plans. Therefore, the types of development permitted in the coastal zone, including any that might be associated with offshore oil and gas operations in the event this proposed sale is held, can ultimately be broadly influenced by the States.

ii. California Coastal Act of 1976: Both the Federal and the California Coastal Zone Acts have the same goal: establishing a sound management program for the coastline, utilizing the coordinated efforts of all appropriate governmental agencies, with the management program based on a comprehensive coastal plan evolved through a process employing maximum public participation.

Proposition 20, the original Coastal Initiative enacted by the people of California in November 1972, called for preparation of a long-range plan for the California coastline and established controls on development while the plan was being prepared. The final coastal plan was submitted to the Governor and Legislature in the fall of 1975, and its recommendations helped form the basis for the 1976 Coastal Act. The controls of Proposition 20 (The California Coastal Zone Act of 1972) expired December 31, 1976, and the 1976 Coastal Act took effect on January 1, 1977. On November 7, 1977, the California Coastal Zone Management Program (CCZMP) was approved by the Office of Coastal Zone Management.

The 1976 Coastal Act provides for the conservation and development of California's 1,100-mile coastline. It establishes a unique state/local partnership, seeking to assure that public concerns of statewide importance are reflected in local decisions about coastal development.

The coastal zone extends three miles seaward and varying distances inland from the shoreline. In built-up areas, such as parts of San Francisco, Los Angeles, and San Diego the zone extends generally less than 1,000 yards inland. In other areas, where the cumulative impact of development on public access to the coast is of concern or where there are especially important recreational and environmental resources, the coastal zone extends farther inland, in a few places as much as five miles.

The Coastal Act enacts State policies covering such matters as public access to the coast, coastal recreation, the California marine environment, coastal land resources, and coastal development, including industrial development. Each local government along the coast (15 counties and 54 cities) will use these policies in developing its own local coastal program. These local coastal programs entail developing land use plans, zoning ordinances, zoning maps and other actions which, when combined, are intended to implement the provisions of the Coastal Act. The local coastal program covers only the parts of a city or county within the coastal zone. Over the next three years, local governments are to submit their local coastal programs to the Coastal Commissions for certification. All the programs must be certified by January 1, 1981. Prior to certification, the Regional Coastal Commissions issue or deny coastal permits for construction or development, and their decisions are appealable to the State Coastal Commission. Local governments may also choose to issue or deny coastal permits prior to certification of their local coastal programs, and their decisions may be appealed to Regional and State Commissions. The criteria for granting or denying permits by both the Commissions and local governments are the policies built into the Coastal Act.

The six Regional Commissions will be in existence until 1981 or when all the local coastal programs in their areas are certified, whichever occurs first. When the Regional Commissions expire, their representatives to the State Commission will be replaced by county supervisors or city council persons appointed by the Legislature and Governor.

Membership in the State and Regional Commissions is the same as it was under Proposition 20. There are six Regional Commissions of 12 to 16 members; half of the members of each Regional Commission are county supervisors, mayors, and city council persons, and half are citizens appointed by the Legislature and Governor. The State Commission has 15 members, of whom six are Regional Commission representatives, one from each region, and six are citizens appointed by the Governor and Legislature. These are the 12 voting members. In addition, the Secretaries of the State Business and Transportation Agency and the State Resources Agency, and the chairpersons of the State Lands Commission are non-voting members.

Other responsibilities given to the Coastal Commision under the California Coastal Act of 1976 are:

1) Map all areas of the coast where, under the standards of the Coastal Act, power plants should not be sited, and submit these to the State Energy Commission by January 1, 1978.

2) Review and certify port master plans for the four major commercial ports in California.

3) Conduct a study with the San Francisco Bay Conservation and Development Commission as to the best means of providing a unified management program for the Bay and coastline, and submit recommendations to the California Legislature by June 30, 1978.

4) Identify forest areas within the coastal zone needing special timber harvesting treatment to protect important natural, scenic or recreational resources and submit these recommendations to the State Board of Forestry by July 1, 1977.

5) Review and certify long-range development plans for major public works and State universities and colleges.

On January 31, 1978, the Office of Coastal Zone Management approved the incorporation of the California Liquified Natural Gas (LNG) Terminal Act of 1977 (SB1081), a refinement to the CCZMP. The Act, which supersedes Coastal Act section 30261(b), establishes procedures for siting an initial LNG terminal in the California Coastal Zone.

d. Pollution Control: All OCS oil and gas operations resulting from this proposed sale would comply with applicable regulations of county, State, and Federal agencies including, but not limited to, the U.S. Geological Survey, the U.S. Environmental Protection Agency, the U.S. Army Corps of Engineers, the U.S. Coast Guard, the California State Lands Commission and Division of Oil and Gas, the Regional Water Quality Control Board, and appropriate State, regional, and county air pollution control agencies depending on jurisdiction. The State and counties would have jurisdiction, for example, over portions of pipelines on State land and onshore facilities that process OCS production.

The California State Lands Commission is responsible for California tidelands to their boundary with Federal waters. The California Division of Oil and Gas reviews proposals for underground water disposal to insure that potable water sources will not be adversely affected. The waste water disposal by onshore subsurface injection would be in accordance with Section 502(6)(B) of the Federal Water Pollution Control Act (1972 amendment), and subject to approval by the California State Division of Oil and Gas. The State of California and the various counties have established air quality regulations for facilities within their jurisdiction.

i. State of California and U.S. Geological Survey Responsibilities as to Ocean Waste Discharges Arising from Oil and Gas Operations: According to the Environmental Protection Agency (EPA), under Section 402 of the Federal Water Pollution Control Act (FWPCA), permits are authorized to be issued by the Administrator (EPA). However, a State may develop and submit to the Administrator (EPA) a program for the issuance of permits for waste discharge into waters within its jurisdiction. Approval of a State program by the Administrator (EPA) does not confer upon the State the authority which the FWPCA grants the Administrator (EPA) with respect to the issuance of permits for discharge into the contiguous zone and the ocean.

If a platform is located within the territorial waters of the State of California, a State permit would be required. If however, the platform is located beyond the 3-mile limit (as would be any platforms installed as a result of Proposed OCS Sale No. 48), application must be made to the Administrator (EPA) for a permit to discharge into waters at the platform and the U.S. Geological Survey would enforce such permit requirements. OCS operators would have to comply with the applicable waste discharge regulations existing at the time production begins. Those regulations might rule out certain types of discharge or they might have effluent characteristics specifications which would be economically infeasible for certain production operations. Should this be the case, the operator would be required to propose an alternative disposal method such as subsurface injection, which would also be under stringent regulations.

ii. State of California Spill Prevention and Clean-Up Regulations: The California Fish and Game code (Section 5650) makes it unlawful under threat of criminal penalty to deposit or "permit to pass into...the waters of the State" any petroleum. The Harbors and Navigation Code (Section 133) establishes misdemeanor penalties for discharging oil from any vessel into the State's navigable waters except in case of "unavoidable accident, collision, or stranding." Section 151 of that code also establishes a civil penalty of up to $6,000 in addition to full liability for government clean-up costs for "any person that intentionally or negligently causes or permits any oil to be deposited in the water of this State." There is no State provision to establish liability for clean-up and civil penalties regardless of fault as is provided under Federal Water Pollution Control Act which also applies to State waters. Section II.H.5, Oil Spill Contingency Plans, describes all relevant oil spill contingency plans in detail.

3. Environmental Studies Program: In 1973, the Bureau of Land Management (BLM) initiated an environmental studies program for the OCS to collect data about the marine environment relative to offshore resource development. Section 20 of the OCS Lands Act, as amended, requires environmental studies to be commenced not later than six months prior to a lease sale in a frontier area and subsequent to leasing and developing of any area, additional studies shall be conducted to provide time series and trend data to identify changes in the environment. The broad objectives of the studies program are as follows: 1) provide information about the OCS environment to aid the Department of the Interior and BLM in making sound management determinations regarding the development of mineral resources on the Federal OCS as the environmental information becomes available. Such management determinations include tract selection, which initiates the EIS process; the selection of alternatives to modify the sale area or special lease stipulations to mitigate significant environmental impacts; and other decisions in the development stage such as the selection of pipeline corridors, 2) acquire impact data that may result in modification of leasing regulations, operating regulations or OCS operating orders to permit efficient resource recovery with maximum environmental protection, 3) acquire information which will contribute to current knowledge about the impact of oil and gas exploration and development on the marine environment, and 4) establish a basis for prediction of the impacts of OCS oil and gas activities in frontier areas.

BLM seeks to attain these objectives by: 1) conducting studies of any area or region included in any oil and gas lease sale in order to establish information needed for assessment and management of environmental impacts on the human, marine and coastal environments of the OCS and the coastal areas 2) conducting environmental monitoring during oil and gas exploration and development to detect changes in the marine environment and 3) conducting special and predictive studies on subjects such as oil spill trajectories, toxicity and physical processes to help interpret the results of other studies and provide additional information on impacts.

a. Southern California: In general, the BLM sponsored studies in this area are not tied to a specific lease sale proposal, but cover a broad region where more than one sale may take place. The current studies program was initiated prior to OCS Lease Sale No. 35 which was held in December, 1975.

Before starting a field sampling program, and to gather the most up-to-date information on the Southern California Bight area, BLM awarded a literature survey contract to the Southern California Ocean Studies Consortium in October, 1973. The purpose of the contract was to summarize knowledge of the area and identify data gaps related to the Southern California marine environment. This study was completed in early 1975. In December, 1974, a contract was awarded to the Southern California Academy of Sciences to conduct an open conference and workshop to provide BLM with recommendations for baseline research in Southern California, relative to offshore resource development. The recommendations and proceedings of this conference were published in February, 1975 and are available to the public from the Pacific OCS Office.

BLM has since developed various work statements based on the recommendations of the open meeting, BLM's needs, and the constraints of time and money. Following review of the work statements by the U.S. Fish and Wildlife Service, U.S. Geological Survey and the National Park Service, BLM has annnounced requests for proposals (RFPs), evaluated the proposals and awarded the contracts.

To further plan environmental studies in the area, BLM has prepared a Marine Environmental Studies Plan for the Southern California OCS area. The plan, updated yearly, describes the types of studies BLM will be considering in the future for the Southern California Bight, including special studies and long-term monitoring studies.

To date, this process has led to the award of four contracts for field and laboratory studies in the Southern California Bight and a Memorandum of Understanding with the U.S. Geological Survey (USGS) to conduct geological studies in the area. A brief description of each study is listed below.

1) Marine Mammal and Seabird Study

In March, 1975, BLM awarded a contract to the University of California at Santa Cruz and Irvine to survey and analyze marine mammal and seabird populations in the Southern California Bight. The contractor completed the second year of field studies in April 1977, and started the third year effort at that time. The draft final report is available for the first year's study. This latest information has been used in the description of marine birds and mammals in this Environmental Statement.

2) Marine Benthic, Water Column and Intertidal Study

In June, 1975, BLM awarded a contract to Science Applications, Inc. (SAI) to sample and analyze the physical, chemical and biological aspects of the benthic, water column, and intertidal environments in the Southern California Bight. Based on the recommendations of the Southern California Open Meeting, this effort was a general reconnaissance study for the first year's work. The second year's study built upon the results of the first, and intensified sampling in selected areas. A shallow subtidal diving study at Tanner and Cortes Banks was added in the second year. This large multi-disciplinary study is being conducted by several sub-contractors under SAI, including marine scientists from several universities in southern and central California. The first year's effort has been completed and the contracts are well into the second year. The third year of intertidal study started in the summer of 1977. Final reports are available for the first year's research, as well as some draft final reports for the second year's efforts.

3) Geological and Geophysical Study of Selected Areas of the Southern California Borderland

In April, 1975, BLM entered into a Memorandum of Understanding with the U.S. Geological Survey (USGS) to conduct detailed geophysical and geological studies in areas included in the tract selection for Lease Sale No. 35. This study was instrumental in evaluating some of the geological hazards for that sale area. The results of the study were published in USGS Open-File Report 75-596 in November, 1975. The USGS conducted additional geophysical surveys for proposed Sale No. 48 tracts during 1977-1978. The results of these surveys are being evaluated and will be published in a USGS Open File Report early in 1979. BLM has funded additional geological studies in San Pedro Bay and in the Dana Point-San Diego area under a USGS/BLM memorandum of understanding. The results are currently being analyzed and an Open File Report will be published in the spring of 1979.

4) Cultural Resources Literature Survey and Sensitivity Zone Mapping

In May, 1977, BLM awarded a contract to SAI to conduct a literature survey and sensitivity zone mapping of marine cultural resources in the Southern California Bight. The data from this study has been used in the preparation of this ES for cultural resources and will be used by BLM for protecting cultural resources on the Federal OCS. The final report from this study will be available from the National Technical Information Service (NTIS).

5) Air Quality Study

In April, 1977, BLM awarded a contract to AeroVironment of Pasadena, California to analyze the potential air quality impacts from specified OCS oil and gas development in the Southern California Bight. This study has been used extensively in preparing the air quality section of this ES. The final report from this study is available as POCS Reference Paper No. V, also through NTIS.

b. Central California: In September, 1976, BLM awarded a contract to Winzler and Kelley of Eureka, California, for a summary of knowledge of the central and northern California coastal zone and offshore areas. The summary included information from published and unpublished literature, ongoing research projects, planned research, and identification of data gaps in need of further study. The study was completed in August, 1977, and information in the report was used in the preparation of several sections of this ES pertaining to central California and in the development of the draft Marine Environmental Studies Plan for central and northern California.

In August, 1976, BLM awarded a contract to San Francisco State University to hold an open conference/workshop to develop recommendations for environmental studies related to OCS oil and gas development in central and northern California. The conference was held in October, 1976, at San Francisco State University and copies of the conference report are available from the Pacific OCS Office, Los Angeles. Recommendations from this conference were considered in developing BLM's draft Marine Environmental Studies Plan for central and northern California.

As a result of the release of the new OCS Planning Schedule in August, 1977, BLM will continue plans for environmental studies for central and northern California relating to proposed OCS Sale No. 53.

4. Marine Sanctuary Recommendations: Following President Carter's Environmental Message of May 23, 1977, the National Oceanographic and Atmospheric Administration (NOAA) solicited recommendations for sites as possible marine sanctuaries from both public and private sources. As a result of this solicitation, fourteen (14) recommendations were received by the NOAA office of Ocean Management (recently abolished and an Office of Marine and Estuarine Sanctuaries formed) within the central and Southern California area between Point Reyes (Marin County) and the U.S./Mexico border.

The NOAA approach to marine sanctuaries has been evolving for over a year with its current thinking, and the status of nominations being influenced by past experience and by Congressional decisions on proposed changes to the basic statute, the Marine Protection, Research and Sanctuaries Act of 1972.

NOAA now considers that a marine sanctuary must be: 1) in a special place of exceptional resources; 2) geographically defined in precise terms; 3) a protective device for an important and limited area; 4) selective and where protection is needed; and 5) not used to manage conflicting uses as its main purpose. In addition, multiple uses in a sanctuary are to be allowed.

Presently, California nominations under active considerations by the NOAA Marine Sanctuaries are:

(1) The waters near the northern Channel Islands and Santa Barbara Island, ranging from a minimum of 6 miles offshore of the islands to a maximum of 12 miles offshore (per Ms. Joann Chandler, NOAA Marine Sanctuaries Program).

(2) The waters offshore of the Monterey-Big Sur area which encompass the coastal and offshore waters from Point Sur north to Point Ano Nuevo, extending 6 miles seaward.

(3) The waters offshore of the Farallon Islands and Point Reyes area extending 12 miles seaward from the Farallon Islands and 6 miles seaward from the mainland area between Bodega Head south to Rocky Point (Marine County) and includes Tomales Bay.

The impact of these Marine Sanctuary recommendations on the proposal are analyzed and discussed in Chapter VIII (Alternatives to the Proposed Action) and in Section VII.C.10 (Impacts of Marine Sanctuary Designations).

5. International Environment: The Council on Environmental Quality's (CEQ) Guidelines on the Preparation of Environmental Impact Statements,... "requires agencies to assess the positive and negative effects of the proposed action as it affects both the national and <u>international environment</u>. The attention given to different environmental factors will vary according to the nature, scale, and location of proposed actions" (40CFR, Part 1500, Section 1500.8 (3)(i)). In light of the CEQ Guidelines BLM initiated contact, through the Department of State, with the Government of Mexico on May 11, 1977. BLM requested and has received data and information from the Government of Mexico concerning the west coast of Baja California, Mexico. This area of Mexico may be impacted by proposed OCS Sale No. 48 related activities due to possible oil spills or possible air quality impacts. This Environmental Statement, therefore, describes the Baja California Pacific Coast area and the probable impacts upon that area that may result from this proposed action. A complete description of the coordination actions taken by BLM with the Government of Mexico are described in Chapter IX, Consultation and Coordination with Others.

E. Projects and Proposals: In addition to Sale No. 48-related activity, numerous other projects and current proposals will be ongoing at the same time in the Southern California coastal areas. The basic assumptions of these projects and proposals are discussed in this section and will be used for cumulative impact analysis purposes in Chapter III, Environmental Impact of the Proposed Sale.

1. Existing Santa Barbara Channel OCS Leases: The existing 63 leases (leased in 1966 and 1968) are estimated to have 610 million barrels (bbl) of economically recoverable oil and 580 billion cubic feet (Bcf) of gas. The development of these hydrocarbon resources could require the additional placement of 18 platforms, 4 offshore facilities, 18 subsea completions, 91 miles of pipelines to shore, 115 exploratory and 440 development wells. The peak production is estimated to be 120,000 bbl per day (bbl/d) in 1985. Included in these assumptions is Exxon's proposed offshore storage and treating facility for the Santa Ynez Unit.

2. OCS Sale No. 35 Leases: Of the original 297 tracts proposed for OCS Sale No. 35, only 56 were ultimately leased. The resource estimates used in the Sale No. 35 ES have since been revised to reflect the actual leased area. The resource estimates for the 56 leased tracts is 719 million bbl oil and 997 Bcf of gas. The number of exploratory and development wells needed to fully develop that resource is 170 and 1,084, respectively. In addition, 38 platforms are expected to be placed as well as 362 miles of pipelines. (Pipelines from the Tanner-Cortes Ridge area would also be used for proposed Sale No. 48 production.) Peak production of 301,000 bbl/d is projected for 1984.

3. SOHIO Pipeline Project: SOHIO Transportation Company of California, a subsidiary of Standard Oil Company of Ohio (SOHIO), is proposing a crude oil transportation system to transport North Slope (Prudhoe Bay) Alaskan oil to the lower 48 states. In general, this oil is characterized as moderate- to high-sulphur, relatively heavy crude.

The transportation system would begin at a proposed new terminal at the Port of Valdez, Alaska, where the first Prudhoe Bay crude oil arrived in 1977 via the Trans-Alaska pipeline. SOHIO's 54 percent share of the projected 1.2 million barrels per day by 1981 of Prudhoe Bay output, a share amounting to 700,000 bbl/d is being transported to Long Beach. Transportation is by tanker, using the most feasible direct route down the West Coast to a proposed new unloading facility at Pier J in Long Beach, California. From Pier J, 500,000 bbl/d of the oil would be transported by pipeline to Midland, Texas, into existing pipelines to the midwest and Gulf coast. The Pipeline system has been approved by BLM but State and local permits are still required at this writing.

Eleven tankers would constitute the SOHIO Transportation Company fleet. Some of these tankers are presently in service; others are under construction. Four would be supertankers of the 165,000 deadweight ton (dwt) class. All would be subject to regulations of the Merchant Marine Act (Jones Act) of June 5, 1920 (USC Title 46, Sec. 883), and applicable State and Federal laws.

BLM estimates however, that 14 tankers, each making 23 round trips per year from Valdez to Long Beach, will be required to transport the oil. This means that Long Beach can expect 322 tanker calls a year or almost one each day starting in 1981. The tankers are expected to be in the 70,000 to 165,000 dwt size.

4. Elk Hills to Port Hueneme Pipeline: On April 5, 1976, the President signed the Naval Petroleum Reserves Production Act of 1976 authorizing the development of certain national petroleum reserves. The Act specifically directs the Secretary of the Navy to acquire or construct the facilities needed to ship not less than 350,000 bbl/d of crude oil from the Naval Petroleum Reserve Number 1 (Elk Hills) in the San Joaquin Valley of California to unspecified marketing terminals (MARMAC Systems Engineering, 1976). Several transportation options are being considered. One option that can affect the proposed project is shipping 250,000 bbl/d of the crude oil by pipeline to Port Hueneme, California for transshipment by tanker to east and west coast terminals. The Navy has, however, come out in favor of an Elk Hills-to-Redlands pipeline where it would tie into the proposed SOHIO pipeline to Texas. The Elk Hills-Port Hueneme route is still an option.

Proposed Tanker Fleet Routes. The Naval Petroleum Reserves Production Act requires that each proposal for sale of reserve crude oil be structured to give full and equal opportunity for acquisition by all interested parties. Acquisition by any person of more than twenty percent of the estimated annual production is prohibited. Provision is made to set aside a portion of production to small refiners.

This diversity of potential customers means that determination of tanker destinations departing from Port Hueneme cannot be made. Nevertheless, potential destinations can be identified. They include the Ports of San Francisco, Los Angeles/Long Beach, and east coast refining centers served by ships traveling via the Panama Canal. San Francisco bound tankers could be expected to depart from Port Hueneme, follow the normal coastal shipping route via the Santa Barbara Channel and, upon clearing Point Arguello, proceed directly to the San Francisco Bay entrance. The Los Angeles/Long Beach vessel traffic would parallel the anticipated Valdez tanker traffic southward, entering the harbor through either the northern Angel's Gate or the southern Queen's Gate breakwater entrance. Tankers bound for the east coast from Port Hueneme can be expected to cross the suggested northbound Santa Barbara Channel traffic lane and turn southwest to follow the southbound land or continue south to pass outside the southern Channel Islands. Once past these points, the tankers would generally follow coastal routes southeasterly to Panama. Empty tankers would return to Port Hueneme along reciprocal traffic lanes. Any involvement with Port Valdez southbound traffic would generally be limited to those tankers entering the Santa Barbara Channel near Point Conception and those tankers returning from East Coast or southern terminals that have to cross the shipping lanes at Point Fermin to reach the Ports of Los Angeles/Long Beach.

Tanker Fleet Characteristics. The Navy wharf facilities at Port Hueneme are limited to loading 35,000 dwt tankers or smaller due to the maximum harbor draft of 10.7 meters (35 feet). Typical characteristics of this class of tankers are given in Table I.E.4-1.

Table I.E.4-1

TANKER CHARACTERISTICS

Vessel Draft (feet)	35
Vessel Length (feet)	650
Vessel Capacity (barrels)	220,000
Loading Rate (barrels/hour)	20,000
Time in Port for Unloading (hours)	18

If 35,000 dwt tankers are to be used, it has been estimated (Tetra Tech, Inc., 1976) that 415 ship visits per year will be required to transport 250,000 bbl/d through Port Hueneme. The use of larger tankers will mean, of course, fewer visits. Alternately, if production rates of 250,000 bbl/d are not achieved, which is considered likely, the number of tanker visits will be less.

In this analysis, it is assumed that 35,000 dwt tankers will be used and that 125,000 bbl/d will be shipped to the San Francisco Bay Area and an equal amount to the Long Beach area. This would result in 415 tanker port calls per year at Port Hueneme. Two tankers would be needed for the Port Hueneme to Long Beach route, making a total of 208 port calls in each port and three ships would be used on the Port Hueneme to San Francisco Bay route with 207 port calls in each port.

5. Resumption of Drilling on State Tidelands Leases: To date, three proposals for a resumption of drilling on State leases have been published. One each for the Santa Barbara Channel Summerland-Carpinteria

and South Elwood offshore fields and the other for the Huntington Beach field in Orange County. The production estimates given below are based on published EIR data and may not be reached by producers.

Summerland Offshore Field. New drilling or redrilling proposed for the Summerland platforms will consist of no more than 16 new wells, 7 wells from Platform Hazel and 9 wells from Platform Hilda.

All new wells may tend to flow by natural energy in their early lives (about 6 months) but will soon have to be assisted by artificial gas-lift. Some expansion of existing lift facilities may be required to handle the new wells.

The proposed 16 new wells could account for an initial aggregate production increase of approximately 3,200 bbl/d of oil, 2,200 bbl/d of water, and 7,200 Mcf/day of natural gas. All newly produced natural gas will immediately experience natural depletion decline. The estimated productive life of the new wells is approximately 15 years.

The proposed new wells will all be drilled, utilizing conventional rotary drilling techniques and will be drilled in strict compliance with State regulatory procedures.

Carpinteria Offshore Field. New drilling or redrilling proposed for the platforms will consist of no more than 20 new wells, approximately 8 wells from Platform Heidi and 12 wells from Platform Hope.

All new wells may tend to flow by natural energy in their early lives (about 6 months) but will soon have to be assisted by artificial lift. Some expansion of existing lift facilities may be required to handle the new wells.

The proposed 20 new wells could account for an initial aggregate production increase of approximately 4,000 bbl/d oil, 2,800 bbl/d of water, and 4,000 Mcf/day of natural gas, with the rates declining thereafter to an economic limit. The estimated productive life of the new wells is approximately 15 years.

The proposed new wells will all be drilled utilizing conventional rotary drilling techniques, and will be drilled in strict compliance with State regulatory procedures.

A drilling crew of 31 people is projected to be employed from 1978 to 1981, moving from Platform Hilda to Hazel and then to Hope and Heidi. It is estimated that between 30-55 days of drilling for oil will be required.

South Elwood Offshore Field. Atlantic Richfield Company (ARCO) has proposed drilling 17 new wells from Platform Holly in the South Elwood offshore oil field in Santa Barbara County. The development plans include the construction of additional gas processing capacity at ARCO's Stretfort Unit.

The drilling of the 17 new wells would require a crew of 31 people for a period of 24 months over three calendar years from 1977 to 1979. Once the wells are drilled, an additional two platform employees and five truck drivers will be employed. With the new wells and new facilities oil production is projected to reach 18,200 bbl/d in 1979, an increase of 14,200 bbl/d above the current projection without new wells. Gas, which is currently reinjected, would be produced at 21,800 Mcf/day in 1979.

The oil is to be transported by a 19,800 dwt tanker with a capacity of 140,000 bbl's to the Los Angeles area. In 1979, the first year, 50 trips would be required. The trips would drop to 13 per year in 1984 when oil production has been reduced to 4,800 bbl/d.

Construction employment for the additional gas processing capacity is projected at an average of 50 over a 20-month construction period from 1977 to 1979.

Huntington Beach Field. Aminoil Company (formerly Burmah Oil and Gas Company) has proposed a resumption of drilling in their Huntington Beach field in Orange County. Their projections indicate that 19 wells be drilled from offshore platforms and 153 in the uplands area of the field from 1978 to 1989. Well drilling employment will average at 31 people, with an additional crew of 31 being added for one year in 1980. New production is projected to peak at 17,095 bbl/oil and 3,000 Mcf of gas a day in 1981 if the present schedule is maintained.

6. Vaca Tar Sands Thermal Recovery Project: Chanslor-Western Oil and Development Company has applied to drill 18 exploratory wells into the Vaca Tar Sands in the Oxnard Plain on Stargis Road at Wolff Road, approximately one and one half miles east of the Oxnard City limits. If the exploratory phase proves the project to have economic possibilities for production, full scale development of the tar sands could be undertaken. This could entail drilling 450 development wells. The total project could yield approximately 124,750,000 bbl of oil out of the 498,557,000 bbl of oil estimated in place. Since the oil recovered would be extremely viscous, it would require processing before transshipment by pipeline. An oil processing plant or coking facility would probably be needed at the project site.

7. Space Transportation System (STS) at Vandenberg Air Force Base, California: On January 5, 1972, the President announced that the

United States should proceed with the development of a space transportation system that would facilitate the use of outer space for human endeavor (Tetra Tech, Inc., 1976). This system, called the Space Shuttle Vehicle System, consists of a manned reusable orbiter, an expendable liquid hydrogen/liquid oxygen external tank and two reusable solid rocket boosters. The external tanks, which are roughly cyclindrical in shape, with a diameter of 8.4 meters (27.6 feet) and a length of 46.9 meters (153.8 feet) are manufactured in Mississippi and transported by ship, four at a time, through the Panama Canal to Port Hueneme, California. Here, they are rolled off the ship on their wheeled transporters and stored. When weather conditions are favorable, two external tanks are to be loaded onto a hover-craft barge and towed approximately 161 kilometers (100 miles) north via the Santa Barbara Channel to Vandenberg Air Force Base. The hovercraft has no motive power of its own, so it is towed much like a conventional barge by support craft. Upon reaching a point offshore of Surf, California, the hovercraft's fans are activated and the entire craft is towed ashore while supporting itself on a cushion of air. The external tanks are then transported by road to the launch site and prepared for launch operations. The external tanks are not recovered following the Space Shuttle launches. Thus, there is no recovery or refurbishment of them.

The solid rocket boosters, which are 3.7 meters (12.2 feet) in diameter and 44.5 meters (149.2 feet) long when assembled, are manufactured in Utah, then shipped in segments by rail to a terminal in the vicinity of the launch pad and stored until required for use. Two solid rocket boosters are used at a time. They are ignited at the launch of the Space Shuttle Vehicle and burn for approximately two minutes. They then separate from the vehicle and are parachuted into the ocean. These spent solid rocket booster casings are recovered at sea approximately 240 kilometers (150 miles) from the launch site.

Once removed of parachutes and other components, the solid rocket boosters are towed back to Port Hueneme, whereupon the casings are removed from the water, externally washed to prevent corrosion and ultimately transported back to Vandenberg Air Force Base on the hovercraft barge.

The first launch of the Space Shuttle Vehicle from Vandenberg Air Force Base is expected to occur in December, 1982. The launch rate will increase through the year 1984, until an operational limit of twenty launches has been attained.

Support Vessel Routes. Transport of the external tanks from Mississippi through the Panama Canal and to Port Hueneme will require up to five round trips annually via the San Pedro and the Santa Barbara Channels. The transshipment of the external tanks from Port Hueneme to Vandenberg

Air Force Base will require ten annual northbound hovercraft barge transits. On return trips, it can be expected that the hovercraft barges will transit the Santa Barbara Channel in the southbound coastwise traffic lane and will cross the northbound lane in the vicinity of the approach lane to Port Hueneme. As for the return of the ships from Port Hueneme to Mississippi, these will have to cross the northbound coastwise traffic lane course to Panama.

When the solid rocket boosters are recovered after the launch of the Space Shuttle Vehicles, in an impact zone southwest of the Point Arguello launch site, the booster casings will be towed in an easterly direction toward Port Hueneme. It is anticipated that the tug and tow craft used in the operation will cross the Santa Barbara Channel, both in southbound and northbound directions, to the east of Anacapa Island on a northerly course to enter the Port Hueneme fairway. This transport of the spent solid rocket boosters to Vandenberg Air Force Base will require twenty hovercraft round trips per year and will use those same routes as described in the transport of the external tanks from Port Hueneme to the Air Force Base.

8. MX Weapon System at Vandenberg Air Force Base, Santa Barbara County, California: This section describes the environmental consequences of system level testing of the MX weapon system at Vandenberg Air Force Base, CA (VAFB) including ground tests and flight tests of the MX missile from an operational basing mode as presented in the Final Environmental Impact Statement, MX Milestone II, 1978, by the Department of the Air Force.

Full-Scale Engineering Development to be conducted at one of four Candidate Siting Areas (CSAs) include: Construction of three shelters with required support facilities would disturb approximately 22 ha (55 acres). Alternatively, construction of the buried trench basing mode would require two 3.2 km (2 mi) trenches and disturb approximately 72 ha (180 acres). Two missile ejection tests may be conducted, one with an inert missile and the second using a short-burn first stage. Twenty flight tests will be launched and flown in the Western Test Range during 1983 through 1987. The reentry vehicles will be targeted into four separate target areas in the Pacific near the Marshall Islands and may be recovered after splashdown. Follow-on operational tests will be conducted by the Strategic Air Command throughout the life cycle of the weapon system.

Costs for the construction and operation of the MX test program at Vandenberg have been tentatively estimated at:

construction of facilities	$50 million
integrated testing & support systems	$90 million
test equipment	$60 million
MX flight tests	$200 million

Construction workers will number about 250 for the period of Spring 1981 through Winter 1982. These workers will tend to be transient as the combined Space Shuttle and the MX labor demand will exceed local supply. MX technical support will begin in early 1981 and increase through 1983 to 580 permanent personnel.

9. Diablo Canyon Nuclear Power Plant, San Luis Obispo County, California: The Diablo Canyon Nuclear Power Plant consists of two 1060-MW (e) pressurized water reactors and necessary auxillary equipment. The site is located on the central California coast in San Luis Obispo County about 12 miles southwest of the city of San Luis Obispo. Construc-- tion started in 1968 and both units are now complete. Start up permission for the plant is being delayed but may be granted during 1978. Operations employment is projected to be 200 people for the life of the plant.

10. San Onofre Nuclear Power Plant Additions, Orange County, California: The Southern California Edison Company is constructing Units 2 and 3 as additions to Unit 1 of the San Onofre Nuclear Power Plant in Orange County, California. Unit 2 is projected to be in operation in 1981 with 1,100 megawatts of electricity, and Unit 3 will be operational in 1983 with an additional 1,100 megawatts of electric power. Construction employment will peak at 1500 in 1979 and 1980, while operational employment will reach 200 in 1983 and continue for approximately 20 years.

11. Santa Maria Fast Frozen Food Plant, Santa Barbara County, California: Tandem Associates, a corporation of ten local growers, is planning to build a fast frozen food plant in Santa Maria, California. The construction of the plant is to be undertaken in three phases. Phase one was scheduled to be completed in 1977 and will contain 200,000 square feet of floor space and employ 400 people. Phase two would be built in 1979, adding another 200,000 square feet of floor space and employing an additional 300 people. The third phase would be constructed in 1981, again entailing 200,000 square feet of floor space and 200 additional employees. The construction of each phase will require 50 construction workers in each of the three years, 1977, 1979 and 1981. The land, building and equipment is projected to cost $84 million.

12. Proposed Liquefied Natural Gas (LNG) Facilities: The California Public Utilities Commission has tentatively recommended Point Conception (Cojo) Santa Barbara County as an onshore LNG facility.

The following offshore LNG sites are also being considered:

Beachers Bay (Santa Rosa Island)
Chinese Harbor (Santa Cruz Island)
San Pedro Point (Santa Cruz Island)
Smugglers Cove (Santa Cruz Island)
East Channel Shelf (offshore Oxnard)
Camp Pendleton offshore

Of these possible sites, only one will be approved at this time. (See Visual No. 1 for LNG Terminal Sites.) The other sites will probably not be chosen at this time but are possible sites for additional LNG terminals in the future. The Point Conception site has been studied by Arthur D. Little, Inc. The facility would be built by Western LNG Terminal Associates with a capacity of 0.9 billion cubic feet per day by 1984. The facility could be expanded at a later date to the maximum allowable 1.3 billion cubic feet per day as specified in the California LNG Terminal Act of 1977.

In terms of shipping activity, this could mean the annual arrival of approximately 190 tankers at the Point Conception site or approximately one every two days.

The Pacific Alaska LNG Company. The Pacific Alaska LNG Company proposes to construct the necessary facilities at Nikiski, Alaska, that are required to process and ship ultimately 11.2 million cubic meters (400 million cubic feet) of natural gas per day from the Cook Inlet area to meet the demands of the Southern California market. The liquified natural gas would be delivered by two cryogenic tankers to the proposed Western LNG Terminal Company facilities to be located in the Point Conception area. After vaporization, the gas would be delivered to the Southern California Gas Company (SOCAL), an affiliate of the applicant, and used in its public utility system.

In carrying liquified natural gas from Cook Inlet, Alaska to Point Conception, the tankers will traverse the Gulf of Alaska, the northeastern Pacific Ocean and the coastal waters of California. The route begins at the mouth of Cook Inlet and proceeds directly through the Gulf of Alaska into the northeastern Pacific Ocean. The route will approximately parallel the coastline for most of the journey, approaching within 595 kilometers (370 miles) of the Straits of Juan de Fuca. As the coastline turns southward, the ships will gradually approach the California coast, coming to within 137 kilometers (85 miles) of the entrance to the San Francisco Bay. The route will terminate near Point Conception.

Pacific Indonesia LNG Company. The current Pacific Indonesia LNG Company proposal is to import approximately 14.0 million cubic meters (500 million cubic feet) daily of liquified natural gas from the Republic of Indonesia to be processed at the Western LNG Terminal Company's proposed facility at Point Conception and sold to SOCAL for use in their existing public utility system.

The 15,373 km (8,300 nautical miles) marine transportation route from Indonesia to Point Conception proposed by the Pacific Indonesia LNG Company would have the tankers proceed in a easterly direction until they are in close proximity to the Southern California coastline. The tankers would enter the Santa Barbara Channel from the north, near Point Conception and proceed toward the marine terminal berth. The proposed tanker fleet characteristics are illustrated in Table I.E. 12-1.

13. Proposed OCS Lease Sale No. 53 in Northern and Central California: The Department of the Interior selected 243 tracts comprising 1.3 million acres (532,588 hectares) offshore central and northern California for intensive environmental study in a sale of Outer Continental Shelf oil and gas leases (OCS #53) proposed for February, 1981 on October 10, 1978.

The tracts are clustered in five geologic basins: Eel River Basin offshore Eureka; Point Arena Basin offshore Mendocino County; Bodega Basin offshore Sonoma and Marin Counties north of the Point Reyes National Seashore; Santa Cruz Basin north of Monterey Bay; and the Santa Maria Basin offshore northern Santa Barbara County and San Luis Obispo County. The Santa Barbara Channel was not included in the original area considered for nominations.

The tract selection area ranges seaward from the mainland as far as 27 miles. None of the tracts selected for intensive environmental study is closer than three miles from shore. The tracts selected lie in waters from 162 to 2,437 feet (50 to 750 meters) deep.

The open process of selecting areas for additional environmental study included participation and comment by officials of State and local government, commercial fishing and other industries, environmental groups, private citizens and other Federal agencies.

Industry nominated 8.4 million acres and the tracts selected for study, which will cumulate in the publication of a Draft Environmental Statement (DES), are about one-sixth the number industry nominated. Selection of tracts for further study was based on a number of considerations, including resource potential, conflicts in resource use, and environmental concerns.

In addition to environmental concerns, some Californians felt that the current West Coast oversupply of oil, with no speedy and economic means to transport it where it is needed, was reason enough to delay or cancel the proposed sale altogether.

The Department official explained, however, that with two and one half years remaining before a sale could possibly be held and an additional 5 to 7 years after that before significant development could be expected, the current situation could change greatly and both California and the Nation may need offshore California OCS gas and oil by the time it could be produced.

Interior's invitation to nominate tracts for bidding issued November 29, 1977, drew nominations from 27 oil companies and 47 comments opposing leasing, a record number for both in a frontier OCS sale. Comments were from NOAA, Forest Service, Environmental Protection Agency, National Aviation Space Agency, Department of Defense, U.S. Fish and Wildlife Service, National Park Service, three State agencies, 18 city and county governments, and from citizen groups, environmental organizations, and private citizens.

Of the 8.4 million acres nominated by industry, the Bureau of Land Management's Pacific OCS Office final consideration was high nomination interest areas, about one-third of the tracts nominated. These high interest tracts comprised 2.3 million acres.

The areas in which no tract selections were made included: waters between the Farallon Islands and the mouth of San Francisco Bay as well as offshore Point Ano Nuevo, Trinadad Head, Point Reyes National Seashore, established shipping precautionary zones, and other areas which BLM's Pacific OCS Office identified as Areas of Special Biological Significance.

These and similar areas were eliminated from consideration to bring the tract selection area to 1.3 million acres. This area will now be studied in a DES prepared by a multi-disciplinary team of scientists and other environmental speialists. A DES weighs the environmental risks and considers alternatives to leasing.

The DES will be published in April, 1980, and public hearings will be held in June, 1980, followed by a Final Environmental Statement (FES) to be published in September, 1980.

The FES is submitted to the Environmental Protection Agency for 30 days, after which the Secretary of the Interior will make a preliminary decision about the sale. If the preliminary decision is to offer tracts for sale, the decision will also include what environmental sipulations should be imposed on lease buyers. The preliminary decision will be sent to the Governor of California for a 60-day review with a request for comments and any new information which may have become available.

No final decision to have a sale will be made until all of these steps have been followed, which are in accord with the National Environmental Policy Act of 1969 (NEPA), the OCS Lands Act, guidelines from the President's Council on Environmental Quality (CEQ), and Departmental regulations. After the Governor's review is completed a final decision can be made. If it is determined to hold the sale, it could be held in February, 1981. Figure I.E.13-1 is a map of the tract selection area.

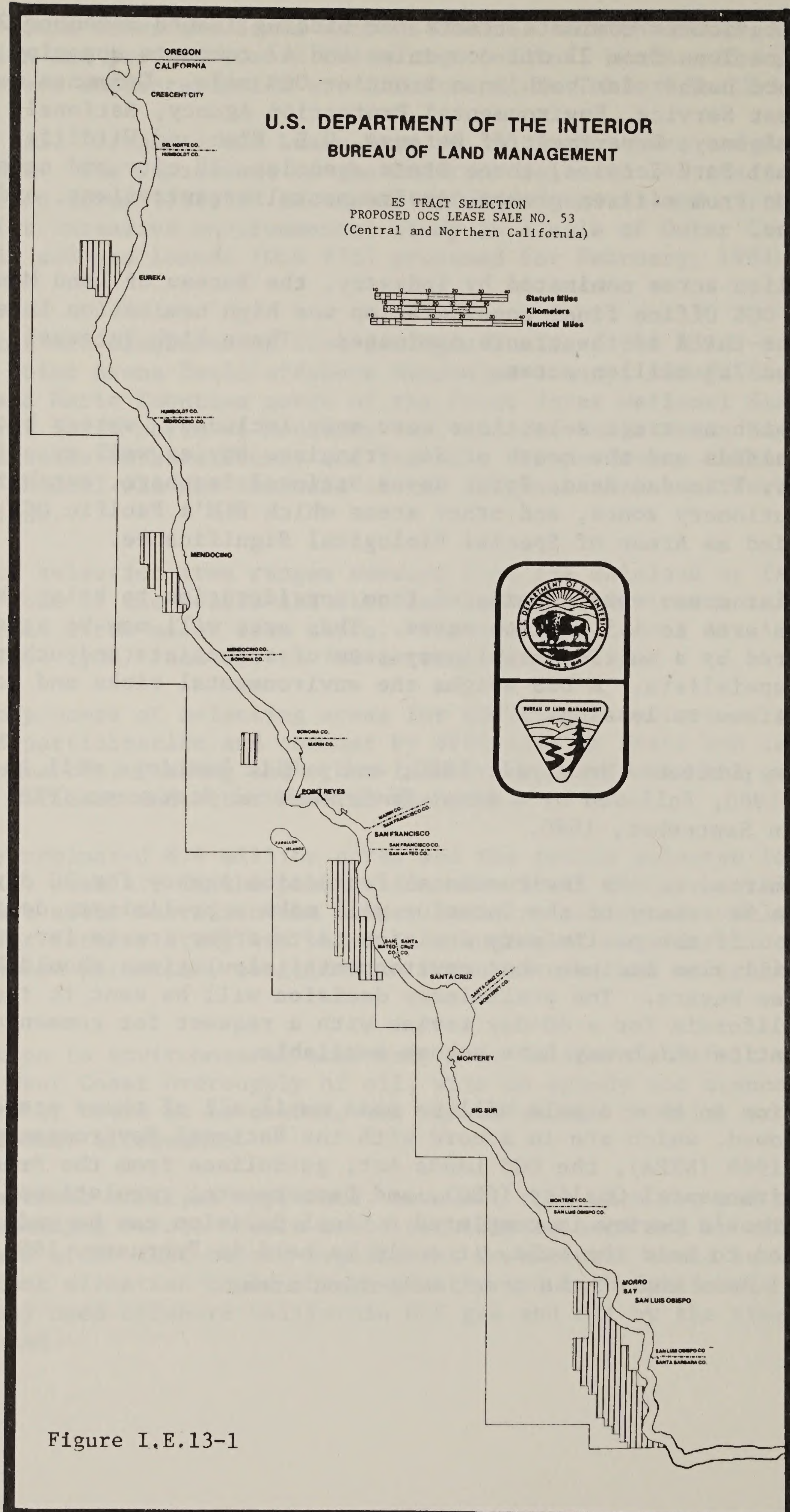


Figure I.E.13-1

Table I.E.12-1

SUMMARY OF POTENTIAL LIQUIFIED NATURAL GAS TANKER TRAFFIC

Applicant	Tanker Capacity	Fleet Size	Total Annual Trips	Liquefaction Terminals	Receiving Terminal
Pacific Alaska LNG Company	165,000 m^3	2	70	Nikiski, Alaska	Point Conception, California
Pacific Indonesia LNG Company	130,000 m^3	5	120	Republic of Indonesia	Point Conception, California

Source: Dames and Moore, 1974. U.S. Department of the Interior, 1976; U.S. Federal Power Commission, Bureau of Natural Gas, 1976. Arthur D. Little, 1978.

CHAPTER II

II. DESCRIPTION OF THE ENVIRONMENT

A. Geologic Framework

1. General: The Pacific Shelf from about San Francisco Bay southward to the approximate latitude of Natividad Island in Mexican waters (latitude 38°N to 28°N) comprises three distinct geomorphic provinces: The Coast Ranges, Transverse Ranges, and California Continental Borderland (Figure II.A.1-1). This area traverses nearly 2,000 kilometers (km) (1,250 miles) in a NW-SE azimuth and the shelf width varies from as narrow as 2 km (1.25 miles) just south of Point Sur to as wide as 280 km (175 miles) off San Diego.

a. Coast Range Province: USGS open file report 77-593 (McCulloch, et al., 1977) describes the geology, structure, geomorphic trends and petroleum potential of central and south central California. The region lies outside the principal area of analysis for Sale No. 48, therefore only a very general geologic/geomorphic description is given here.

Both the principal structural and geomorphic trends of central and south-central California are northwest in the offshore area and within this region. Two areas of thick sedimentary sequences are the probable sites for future petroleum exploration: Outer Santa Cruz Basin and Santa Maria Basin offshore.

In the area of the Outer Santa Cruz Basin, both the Cretaceous and Tertiary (Oligocene) periods of marine deposition were followed by deformation and erosion that accompanied the uplift of the structural highs and the initiation of the present basin. Relatively fine-grained sediment, primarily silt and clay with minor amounts of sand, accumulated in the basin in upper Miocene and Pliocene time.

The structural axes of the basin and the Outer Santa Cruz High plunge to the northwest, over the edge of the shelf. The sediment thickens down slope and appears to be limited along the toe of the slope by a discontinuous volcanic ridge along which the Mulberry, Guide, and Pioneer Seamounts form prominent topographic highs. Beneath the early late Miocene unconformity, the rocks are gently folded and the faults are generally high-angle with an east-dipping plane.

The Santa Maria Basin basement rocks are probably seaward extensions of a complex series similar to the Franciscan assemblage. Only limited data are available concerning the character and distribution of post-Cretaceous rocks in the basin. Strata are truncated by a Tertiary unconformity, and their distribution in the basin is thought to be limited to erosional remnants.

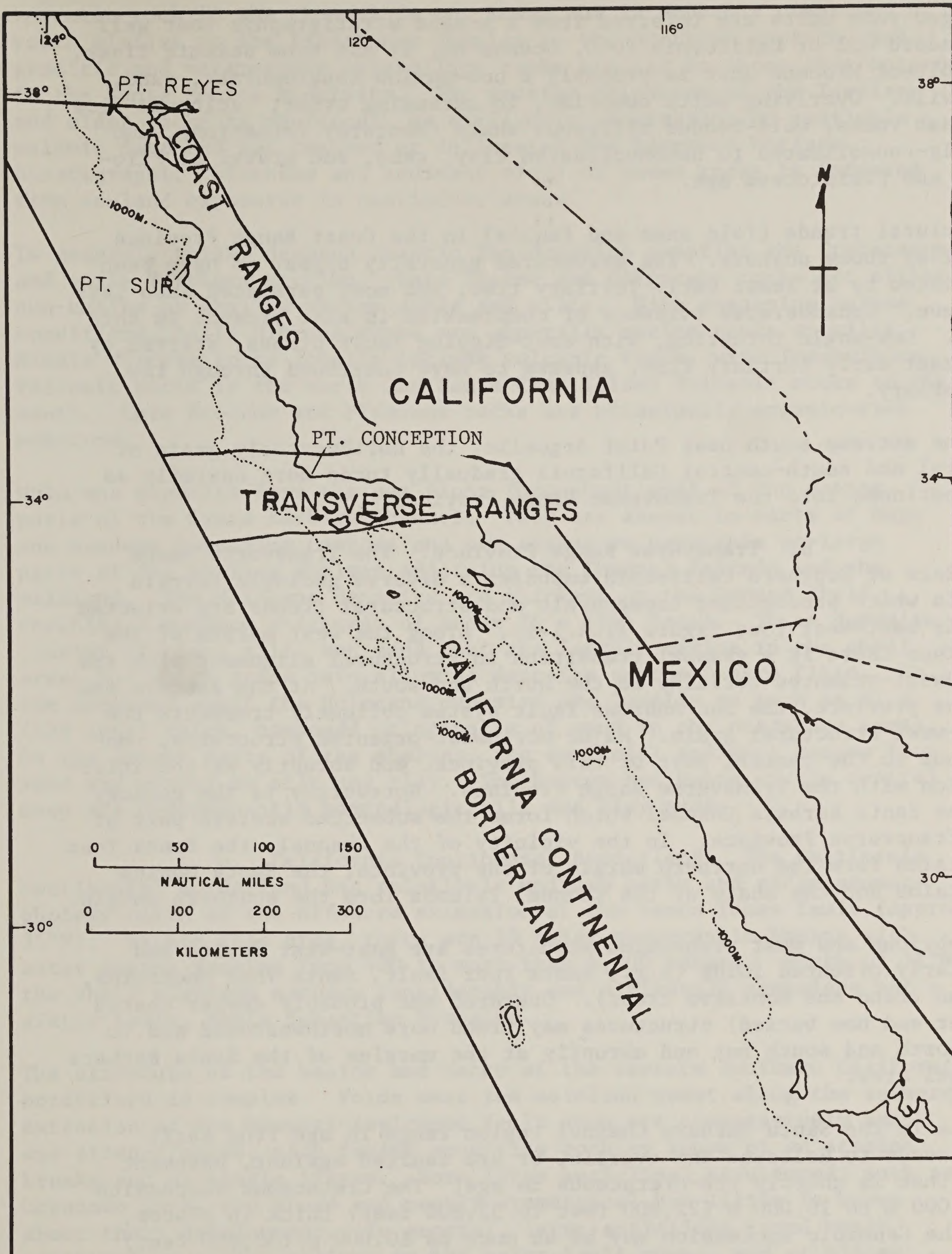


Figure II.A.1-1 Geomorphic index map for region discussed in text. (38 N. Lat. to 28 N. Lat.).

Younger rock units are inferred from a single stratigraphic test well (Standard Oil of California P060, Oceano No. 1) and from seismic lines. The oldest Miocene unit is probably a non-marine conglomerate, sand, and silt. Overlying units comprise, in ascending order; volcanic flow and ash rocks, well-bedded siliceous shale (Monterey formation), and weakly-consolidated to unconsolidated clay, sand, and gravel of Pliocene and Pleistocene age.

Structural trends (fold axes and faults) in the Coast Range Province parallel those onshore. The structures generally appear to have been initiated by at least early Tertiary time, and most persisted into late Miocene. Considerable evidence of compression is also present in this area. Low-angle thrusting, with east-dipping fault planes, started by at least early Tertiary time, appears to have continued through the Quaternary.

In the extreme south near Point Arguello, the northwesterly grain of central and south-central California gradually turns more easterly as it continues into the Transverse Range Province.

b. Transverse Range Province: The Transverse Range Province of Southern California embodies a diverse geologic terrain within which predominant topographic and structural trends are oriented nearly east-west (See Figure II.A.1-1). Along the west margin of the province there is a gradual transition in structural alignment with the northwest-oriented terrains to the north and south. At the eastern end of the province, the San Andreas fault system obliquely transects the east-west structural grain. Major northwest-oriented structures, contiguous to the central part of this province, end abruptly at the intersection with the Transverse Range Province. Noteworthy is the geology of the Santa Barbara Channel which forms the submerged western part of the Transverse Province. In the vicinity of the Channel, the Santa Ynez Mountains form the northern margin of the province; the Santa Monica Mountains and the chain of the Channel Islands form the southern margin.

The obvious and most pronounced structures are east-west faults and similarly oriented folds (e.g., Santa Ynez fault, Santa Ynez Mountains, Rincon trend and Montalvo trend). Obscured and probably deeper seated (older and now buried) structures may trend more northwestward and to the north and south but end abruptly at the margins of the Santa Barbara Channel area.

Strata in the Santa Barbara Channel region range in age from early Cretaceous to Holocene and overlie, or are faulted against, basement rock that is chiefly pre-Cretaceous in age. The Cretaceous succession is 7,000 m to 10,000 m (22,900 feet to 32,800 feet) thick in places, and the Cenozoic succession may be as much as 10,000 m (32,800 feet) thick in the northeastern part of the channel. The distribution of basement rock in the channel is not known but is probably comprised of rocks similar to the Franciscan complex in the northern portion, and granitic and metamorphic crystalline rocks similar to those that outcrop in the Santa Monica Mountains. The precise thickness of the Tertiary and older rocks is equivocal, as drill-hole penetration or available seismic data has not reached or delineated the basement horizon. Stratigraphic thickness and sediment ology of these rocks is inferred from on-land exposures in contiguous areas.

In general, thick, deepsea clastic fan deposits comprise the Cretaceous and early Tertiary section. Late Eocene and Oligocene rocks are either non-marine or shallow marine sands and silts. With deepening marine conditions, early Miocene rocks are generally marine sands or silts. Middle Miocene rocks locally include volcanic rocks, with Tranquillon Volcanic rocks to the north and Santa Cruz Island Volcanic rocks to the south. Late Miocene and Pliocene rocks are principally organic-rich mudstone.

Holocene deposits form the sea floor throughout most of the deeper parts of the Santa Barbara Channel. They are absent in parts of Mugu and Hueneme Submarine Canyons and are absent or very thin on large parts of the shallow shelves adjoining the Channel Islands and the mainland. The Holocene deposits are thickest on the Oxnard Shelf, reaching a maximum thickness of about 75 m (244 feet). These deposits consist of clay, silt, and sand that are largely marine in the shelf areas but which grade into alluvial deposits on the Oxnard Plain. On the mainland shelf the Holocene deposits are locally as much as 41 m (133 feet) thick, composed principally of sand in the nearshore areas. On the deeper parts of the shelves, the surficial sediment ranges from sand and gravel to silt and clay. The bottom sediments of the central deep are predominantly hemipelagic silt and clay muds.

c. California Continental Borderland: The California Continental Borderland has relatively uniform basin and ridge geomorphology north of the offshore extension of the Santo Tomas fault (approx. 31°N). Within this area, there are 19 major topographic basins with water depths ranging from 400 to more than 3,000 meters. South of 31°N the shelf platform narrows considerably and ultimately comprises but a single basin, Bahia Sebastian Vizcaino.

The structure of the basins and banks of the eastern Southern California borderland is complex. Folds near the mainland coast along the seaward extension of the Newport-Inglewood fault zone are comparatively small and steep-flanked, with faults occurring both as zones of en echelon breaks and as single traces. Some large anticlinal structures, such as Coronado Bank, are broad and nearly symmetrical but little is known about their development. In general, large anticlines trend west-northwest at angles oblique to the major fault zones, and at places seem to be arranged en echelon. Several are very large, symmetrical, and have low dips on their flanks.

Faults on the western part of the borderland show various kinds of faulting and have varying ages. The dominant trend is northwest, but there are three conspicuous east-west zones; one in the vicinity of the northern group of Channel Islands, another south and east of San Nicolas Island, and the third just north of 31°N (Santa Tomas fault). The ages of movement include pre-Pliocene, but more commonly they are Pliocene and Quaternary. Pre-middle Miocene thrust faults are inferred in the basement rocks of Santa Catalina Island.

In the borderland, offshore Southern California, the distribution of rock units falls within three generalized terrains; the boundaries of these terrains are probably complex fault systems. Within the eastern terrain, the strata include a high pressure-low temperature basement rock (Catalina Schist) that is intruded by Miocene plutonic rocks and overlain by volcanic rocks. Overlying or buttressing against these rock types are younger, late Cenozoic clastic rocks. Within the central terrain, the basement rock is unknown except for the basic plutonic rocks and greenstones of Santa Cruz Island. These rocks may be remnants of an ophiolite complex similar to that inferred to underlie the Great Valley Sequence of central and northern California. Cretaceous to Eocene rocks in the borderland are restricted to the central geologic terrain. Locally, these older sedimentary rocks are overlain by marine and non-marine Oligocene rocks, Miocene volcanic and volcaniclastic rocks, and younger clastic rocks. The western geologic terrain extends to the Patton Escarpment. Here the basement rock complex seems to bear similarities to the Coastal Belt facies of the Franciscan Complex (zeolite-bearing arenite and local ultramafic exotic (?) blocks). Early Miocene and younger clastic rocks fill sedimentary basins capping the basement rocks.

Rocks from the mainland coast of Baja California are rough equivalents of strata known from the Peninsular Ranges, north of San Diego. To the south, on Isla Cedros and the neighboring Vizcaino Peninsula area, spectacular exposures display complex geologic relations similar to those seen for rocks as far north as northern California.

2. Hazards: Geologic hazards in the OCS are related to seismic activity, stability of the seafloor, and shallow subsurface phenomena. Hazards related directly to seismic activity include ground shaking, fault rupture, generation of tsunamis, and earthquake-induced ground failures such as liquefaction and slumping. Faults separating either the sea floor or young (<11,000 years) sediment, as well as those associated with historical earthquakes, are considered active and therefore potentially hazardous to development. Instability of the sea floor can also result from dynamic (e.g. wave surge) and static (e.g. gravity) forces

acting independently of seismic activity. Some areas of the sea floor are prone to mass movement (e.g., slumps, slides) or other forms of sediment transport (flows, creep, or current scour). Oil and gas seeps, while not inherently hazardous, may provide clues to the location of fractured reservoir and cap rocks and shallow over-pressured gas pockets that can pose a danger to drilling operations.

a. Seismicity: Seismologic studies directed toward the identification and delineation of active faults and fault zones are presently capable only of reconnaissance scale resolution; neither the station density nor the length of record are available to specify which faults are most active. But, from the available record, it is possible to formulate some judgement about the general seismicity of the Southern California OCS and surrounding area. In tectonically active areas, such as Southern California, many hundreds of microseisms will occur daily, the magnitudes, however, are of such low order that they may be detected only by sophisticated equipment. Figure II.A.2-1 depicts a 40-year composite of earthquake epicenters for a portion of the area within proposed OCS lease sale No. 48. The highest intensity of faulting, and consequent ground-shaking in California, is not expected to occur on the OCS but rather along the San Andreas fault zone, and in the Owens Valley along the eastern front of the Sierra Nevada (Algermissen and Perkins, 1977).

Recently published maps show most of the west margin of California and the adjoining Pacific Shelf area laced with faults (See Visual No. 10) and it should be noted that numerous faults have been identified within and around the proposed lease area.

The kinematics (movement or strain history) of these faults is complex. In general terms, present strain in this area can be considered part of the San Andreas fault system, which in a large perspective is related to the interaction of the Pacific and North American global-tectonic plates.

In the central California offshore area, late Tertiary through Holocene faults are northwest oriented. These faults are generally composed of en echelon sets and show a relative movement in a right-lateral sense. A second group of faults, also oriented northwesterly, are northeast-dipping with at least a component of westward motion.

Faults in the Santa Barbara Channel area are mostly east-west oriented. High-angle faults with apparent normal and reverse separations are interspersed with those that have strike-slip components of movement (USGS, 1976). Reverse faulting is associated with north-south compressional stress and occurs along high-angle faults that dip away from the channel axis.

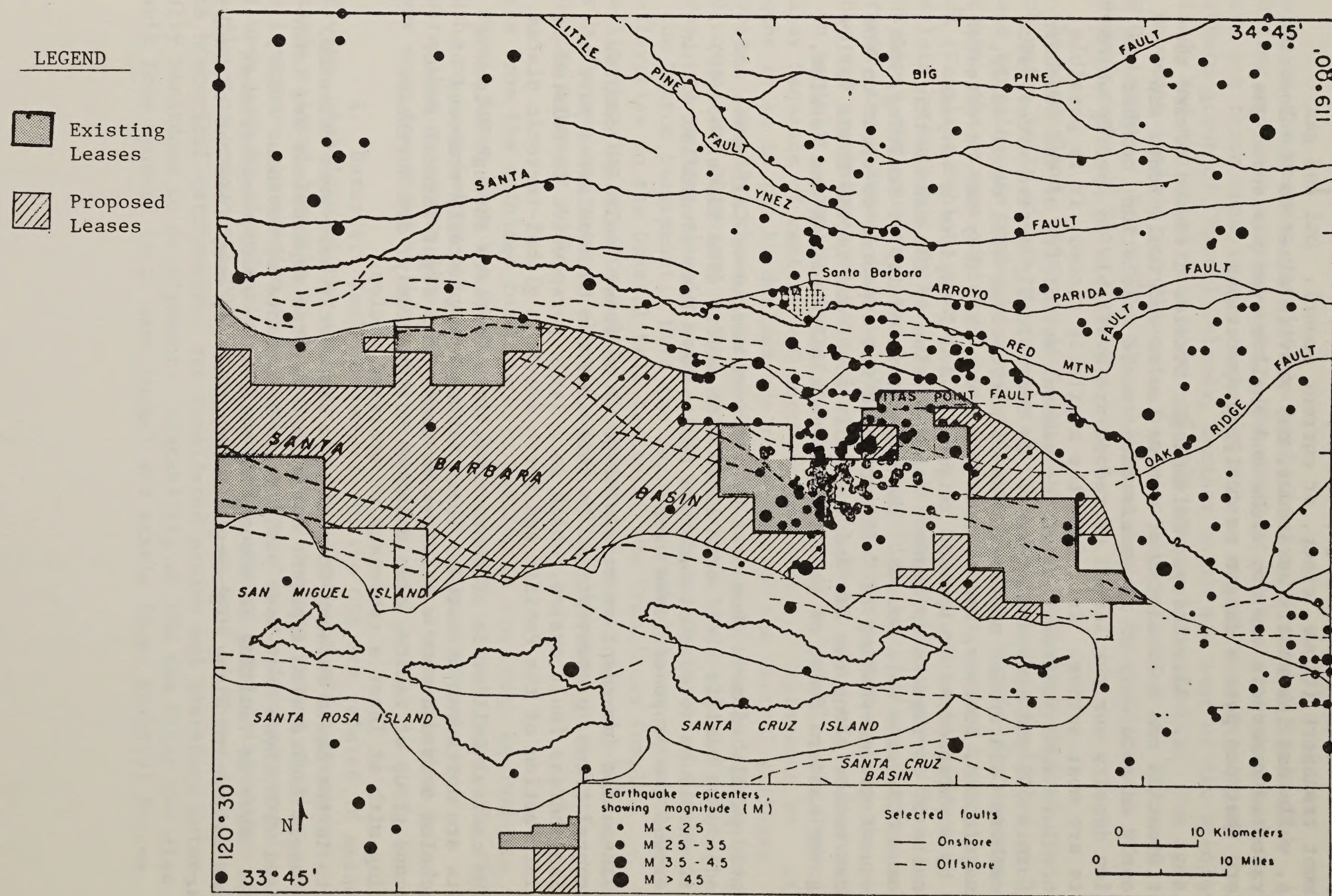


Figure II.A.2-1 Earthquake epicenters in the Santa Barbara Channel region from 1932 to 1971.

The fault pattern in the borderland area is indicated by numerous en echelon northwest-trending fault traces. Documented data for these faults is minimal, but the overall pattern is consistent with right-slip (i.e., similar to the San Andreas fault system).

b. Seafloor Instability: Many conditions giving rise to sea-floor instability are characteristic of the OCS. Among these are localized thick accumulations of unconsolidated water-saturated sediment, steep slopes, seismic and storm activity. Evidence of sediment failure resulting in downslope mass-movement (slumps, slides, flows, and creep) is common throughout areas along the mainland shelf and slope where the thickness of unconsolidated Quaternary deposits varies greatly. From available published data, major sea-floor instability appears to be localized in Santa Monica Bay, Oxnard submarine fan, and along the 500-meter isobath (Fields, Clarke, and Greene, 1977). Major areas of mass-movement, or the potential for mass-movement has been identified on tracts SRI 113, SPB 120 and 126, TCB 182-4, 188, 195, 199, 206, 215, and 216. Other forms of failure (e.g., from liquefaction, scouring) are different to detect and it has not been possible to determine their prevalence.

c. Tsunamis (Seismic Sea Waves): Tsunamis are large oceanic waves that are generated by sudden earth motion such as fault rupture, submarine volcanic eruption, or a large submarine landslide. Tsunamis' speeds decrease and wave height increases in shallow water. They can strike with a devasting force. The largest tsunami ever reported in California followed the 1812 earthquake. Wave run-up may have reached 15 m (49 feet) above sea level just west of Santa Barbara, Marine Advisors, Inc., 1965. The effects of a tsunami generated within the Santa Barbara Channel or borderland area are not well known. Strike-slip faulting probably would not generate a major sea wave, whereas oblique or vertical faulting may have this potential.

3. Petroleum Appraisal: As of January 1, 1975, the cumulative production from all onshore California coastal basins totaled 11.8 billion barrels of oil (9.9 billion barrels of oil + gas expressed as Barrels of Oil Equivalent (BOE)). The remaining oil reserves, plus indicated reserves from proven fields, are estimated at 2.3 billion barrels (API, Vol. 29, May 1975). Production from the coastal basins is more than half of all the petroleum found in onshore California. Petroleum production is concentrated in young reservoirs with 87 percent from late Miocene or younger rocks, 5.3 percent from middle Miocene, 4.7 percent from early Miocene, 2.8 percent from Oligocene, and 0.2 percent from Eocene strata.

The following tables are estimates of recoverable petroleum or petroleum production in the OCS for three areas: Table II.A.3-1, Central California; Table II.A.3-2, Santa Barbara Channel; and Table II.A.3-3, Southern California borderland. The data for the Santa Barbara Channel is more explicit by estimating recoverable petroleum per stratigraphic horizon since this area is the most heavily explored and more information is available.

Table II.A.3-1

PETROLEUM RESOURCE POTENTIAL FOR OUTER SANTA CRUZ AND SANTA MARIA BASINS[a]

	95 Percent Probability	5 Percent Probability	Statistical Mean
OIL - (billion of barrels)			
Outer Santa Cruz	0	0.98	0.34
Santa Maria	0	0.92	0.44
GAS - (trillions of cubic feet)			
Outer Santa Cruz	0	0.98	0.34
Santa Maria	0	0.92	0.44

[a]Based on cumulative production to January 1, 1975, in million barrels oil plus BOE gas (USGS Open File Report 77-593).

Table II.A.3-2

PETROLEUM PRODUCTION BY STRATIGRAPHIC AGE OF THE SANTA BARBARA CHANNEL AREA[a]

	Eocene	Oligocene	Early Miocene	Middle Miocene	Late Miocene
Eastern Basin (onshore)	18	303	6	65	1,805
Santa Barbara Channel (offshore)	1	26	253	3	166

[a]Based on cumulative production to January 1, 1975, in million barrels oil plus BOE gas (USGS Open File Report 77-593).

Table II.A.3-3

PETROLEUM RESOURCE POTENTIAL FOR SOUTHERN CALIFORNIA BORDERLAND[a]

	95% Probability	5% Probability	Statistical Mean
Oil (billions of barrels)	1.9	5.8	3.6
Gas (trillions of cubic feet)	2.2	6.3	3.9

[a]Based on volumetric and analog analytical methods (USGS Open File Report 77-593).

B. Climate

1. Surface Wind Patterns: The Southern California coastal and offshore area has a Mediterranean Dry Summer Subtropical Climate characterized by warm dry summers and mild wet winters. This is a result of Southern California's location on the southeastern edge of the Pacific High Pressure Area (U.S. Coast Pilot No. 7, 1975).

During the late spring the Pacific High strengthens and migrates northward, reaching its maximum development during the summer with its eastern edge off the coast of Oregon and California. The high, in this position, forces most of the lows that develop to follow a course northward of the United States. As winter approaches, the high weakens and migrates to the southwest allowing occasional storms to pass through the area (U.S. Department of Commerce, 1974).

The prevailing winds (Figure II.B.-1) along the Southern California coast are generally from the northwest, flowing nearly parallel with the coast and averaging between 9.3 and 18.5 km/hour (5 and 10 knots). As the coastline trends toward an east-west direction, the winds shift to a west-southwest direction (U.S. Coast Pilot No. 7, 1975).

During the spring and summer months when the high is dominant, northwest winds are strongest and most constant. Winter winds are still primarily from the northwest, but they are somewhat reduced in frequency. The weakening of the high and its southward movement allows low pressure cells which may develop to move through the area, thus modifying the wind speed and direction. When a storm approaches from the west, immediate winds are from the east and southeast, and, at times, these winds are strong and damaging. As the storm moves inland, winds veer to the south and southwest; and as the front passes, northwest and finally northeasterly winds may result. The diurnal sea-land breezes also have modifying affects on the general circulation patterns (Kimura, 1974). During the summer, the sea breeze is persistent and strong while the land breeze is relatively weak. As winter approaches, the sea breeze weakens and the land breeze is dominant (See Figures II.B-2 and II.B-3 of POCS Reference Paper No. II for detailed wind information for offshore areas). Table II.B-1 gives the percentage frequency of wind speed and direction for the offshore area from 31-36°N and the coast to 120 and 125°W (which is the area affected by Sale No. 48).

2. Precipitation: In Southern California, annual precipitation generally increases from south to north and varies with distance from the coast, elevation and topography. Approximately 90 percent of the precipitation in Southern California falls during the winter months, with the summer months being generally quite dry. Serious flooding can occur during the winter months with heavy rains and rapid runoff from the mountains and coastal slopes.

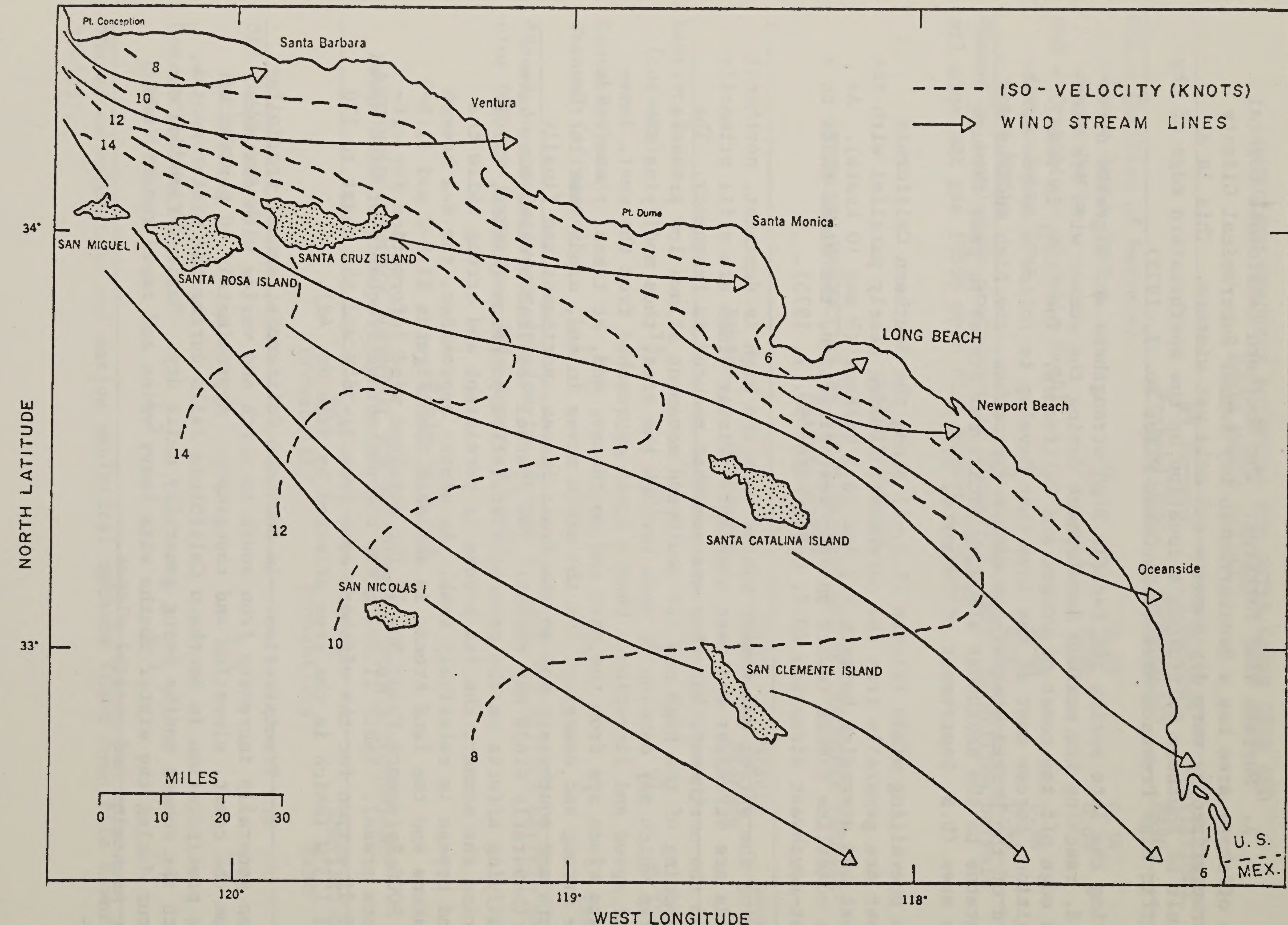


Figure II.B-1 Annual Average Wind (Source: Allan Hancock Foundation, 1965).

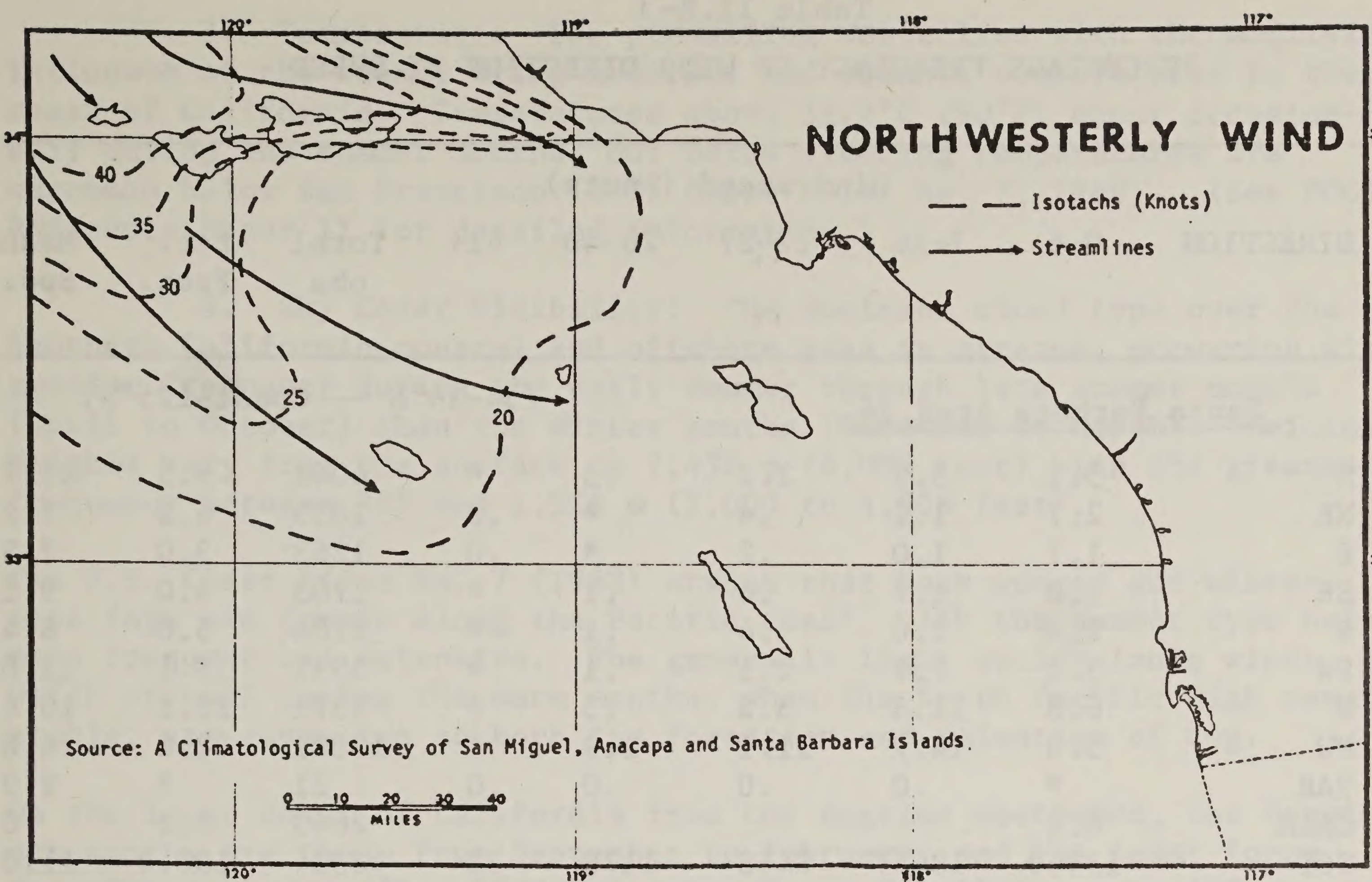


Figure II.B-2

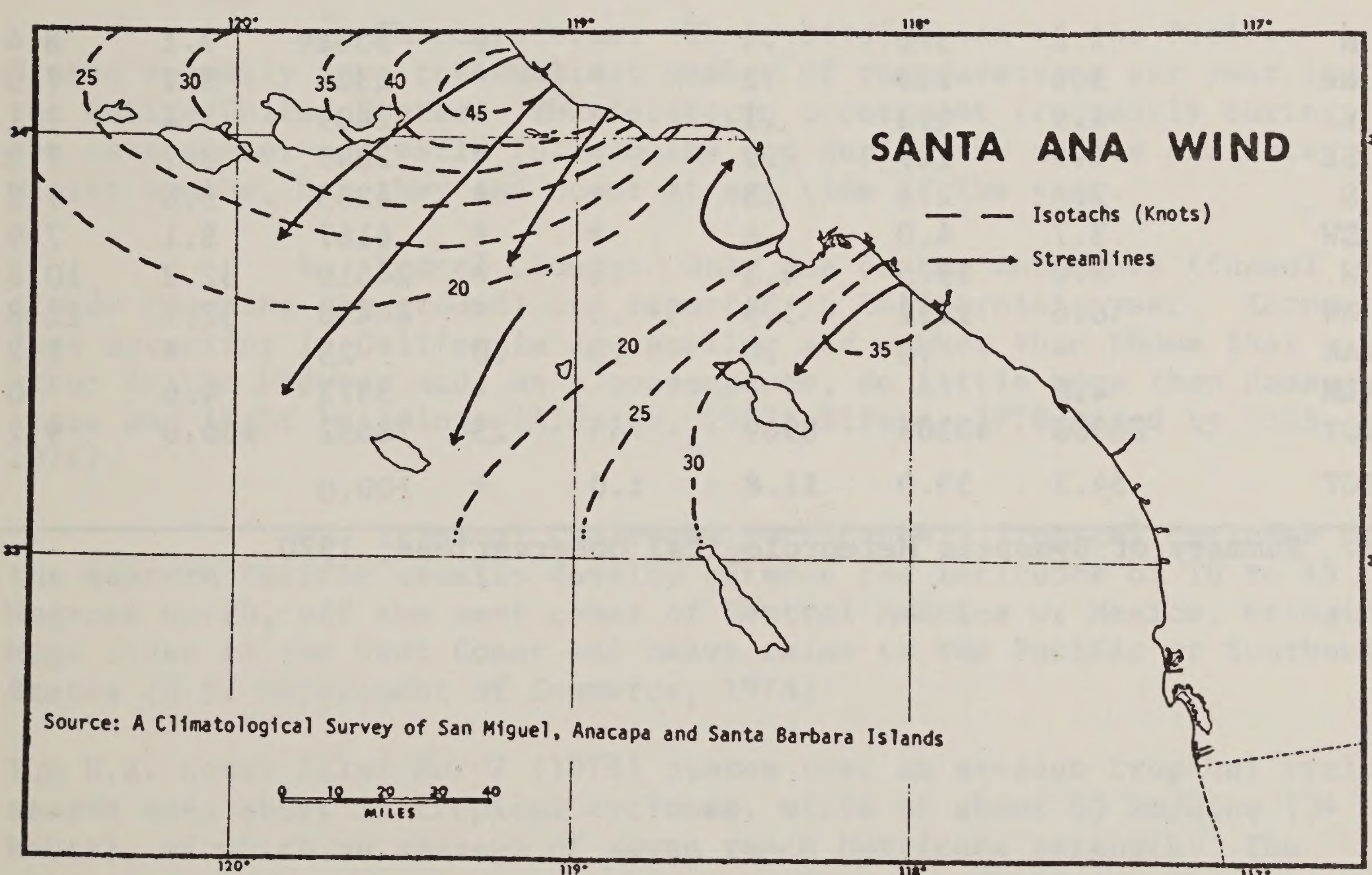


Figure II.B- 3

Table II.B-1

PERCENTAGE FREQUENCY OF WIND DIRECTION BY SPEED

WIND DIRECTION	Wind speed (knots) 0-6	7-16	17-27	28-40	41+	Total obs	Pct. Freq.	Mean Spd.
Santa Barbara Area 24					(34-36°N -- Coast-125°W)			
N	3.1	3.9	2.2	.3	*	4042	9.5	11.7
NE	2.7	1.2	.4	*	.0	1835	4.3	7.2
E	1.7	1.0	.2	*	.0	1263	3.0	7.5
SE	1.8	1.7	.4	.1	*	1703	4.0	9.1
S	2.4	2.0	.4	.1	*	2104	5.0	8.4
SW	3.2	7.7	2.1	.1	*	5531	13.1	11.0
W	6.8	11.8	3.2	.3	*	9371	22.1	10.4
NW	5.0	14.7	11.1	1.9	*	13821	32.6	14.8
VAR	*	.0	.0	.0	.0	21	*	2.9
CALM	6.2					2643	6.2	.0
TOT	13969	18687	8468	1178	32	42334	100.0	11.0
PCT	33.0	44.1	20.0	2.8	.1	100.0		
San Diego Area 22					31-34°N -- Coast-120°W)			
N	3.0	3.6	.4	*	.0	5362	7.1	8.4
NE	1.6	1.3	.2	*	*	2324	3.1	7.5
E	1.9	1.3	.1	*	*	2609	3.4	7.1
SE	1.8	1.7	.2	*	*	2849	3.7	7.9
S	2.8	2.4	.3	*	*	4285	5.6	7.8
SW	3.7	4.0	.4	*	*	6167	8.1	7.9
W	8.0	19.5	4.3	.4	*	24510	32.2	10.8
NW	6.6	19.2	5.8	.5	*	24450	32.1	11.8
VAR	*	.0	.0	.0	.0	23	*	2.2
CALM	4.6					3473	4.6	.0
TOT	26008	40309	8969	743	23	76052	100.0	9.7
PCT	34.2	53.0	11.8	1.0	*	100.0		

Source: Summary of Synoptic Meteorological Observations, 1970.

3. Temperature: The prevailing westerlies with the modifying influence of the ocean, bring moderate and equable temperatures to the coast of California. Temperatures above 32.2°C (90°F) occur occasionally during the summer months, but below freezing temperatures are uncommon below San Francisco (U.S. Coast Pilot No. 7, 1968). (See POCS Reference Paper II for detailed information.)

4. Sky Cover Visibility: The dominant cloud type over the Southern California coastal and offshore area is stratus, occurring with greater frequency during the early summer through late summer months (April to October) than the winter months (November to March). Ceiling heights vary from the surface to 2,438 m (8,000 feet) with the greatest frequency between 305 and 1,524 m (1,000 to 4,000 feet).

The U.S. Coast Pilot No. 7 (1968) states that both summer and winter type fogs are common along the Pacific coast, with the summer type being more frequent and extensive. The generally light anticyclonic winds which prevail during the warm months, when the North Pacific High remains stable, are conducive to both the formation and retention of fog.

On the lower coast of California from Los Angeles southward, the foggiest months are those from September to February, and the least foggy, from May to August (See POCS Reference Paper No. II for more information).

5. Severe Storms

a. Thunderstorms: The coastal areas of the Pacific States normally have the smallest number of thunderstorms per year in the entire United States. Thunderstorms occur most frequently during the late summer and early fall months and during the middle and late winter months, but they can occur at any time of the year.

b. Funnel Clouds: Only one or two tornadoes (funnel clouds reaching the ground) are reported in California a year. Tornadoes occurring in California are smaller and weaker than those that occur in the Midwest and, as a consequence, do little more than damage trees and light buildings (Aldrich, 1972; Elford, 1970 cited by USGS, 1974).

c. Tropical Cyclones- Hurricanes: Tropical cyclones of the eastern Pacific usually develop between the latitudes of 10 to 15 degrees north, off the west coast of Central America or Mexico, bringing high tides to the West Coast and heavy rains to the Pacific or Southwest States (U.S. Department of Commerce, 1974).

The U.S. Coast Pilot No. 7 (1975) states that an average tropical cyclone season sees about 15 tropical cyclones, winds of about 63 km/hour (34 knots), of which an average of seven reach hurricane strength. The eastern North Pacific season peaks in July, August and September. About three to five tropical cyclones can be expected each month, with an average of one or two reaching hurricane strength. Direction of travel of most west coast tropical storms is between west and north, initially. Then, after a time, depending on over-all wind patterns, they turn more toward the north and later northeast as they are picked up by the prevailing westerlies; so that they pass inland across the west coast of Mexico or Baja California, usually before reaching latitude 30 degrees.

Storms that continue westward tend to maintain their intensity since their path carries them over warm tropical ocean water. When large scale air currents deflect the storm track more toward north or northeast, the progressively cooler water over which the storm will travel gradually cuts off the supply of heat energy and the storm weakens. When sea temperature along the storm path cools to less than 23.9°C (75°F), the storm rapidly weakens to less than tropical storm intensity.

Rate of travel is usually between 14.8 and 22.2 km/hour (8 and 12 knots) when they are traveling toward west or northwest; but when they begin to veer toward north or northeast, some acceleration in forward speed usually occurs. Very heavy tropical rains and lines of thunderstorms normally accompany these tropical storms over the ocean and as they move across a shoreline. Once the storm crosses the coast, strength of the winds rapidly diminishes and the storm degenerates into an area of heavy rain and thundershowers.

The most damaging tropical cyclone to affect coastal Southern California was the storm of September 1939, with a center pressure of 971 mb and winds of 111.2 km/hour (60 knots). It dropped 5 to 10 cm (2 to 4 inches) of rain along the coastal area and inflicted severe damage in the Los Angeles area as a result of heavy wave action. However, tropical storms also caused damage in 1976, 1977, and 1978. Principal tracks of tropical storms are presented in Figure II.B-4.

6. Severe Winds

a. Northwest Winds: The northwest winds occur predominantly during the spring. They are usually associated with a high pressure buildup offshore following the passage of a low inland (Strange, unpublished, 1973). Winds frequently exceed 46.3 km/hour (25 knots), with maximum speeds of 111.2 to 120.5 km/hour (60 to 65 knots) over the northern Channel Islands area (Figure II.B-2).

b. Northeast Winds (Santa Ana): The northeast winds usually occur during the fall and winter months when a high pressure area builds up over the basin and range plateau region. Santana, or "Santa Ana", winds tend to be gusty and may reach speeds of 96.4 km/hour (52 knots). However, wind speed tends to decrease fairly rapidly with distance offshore (Figure II.B-3).

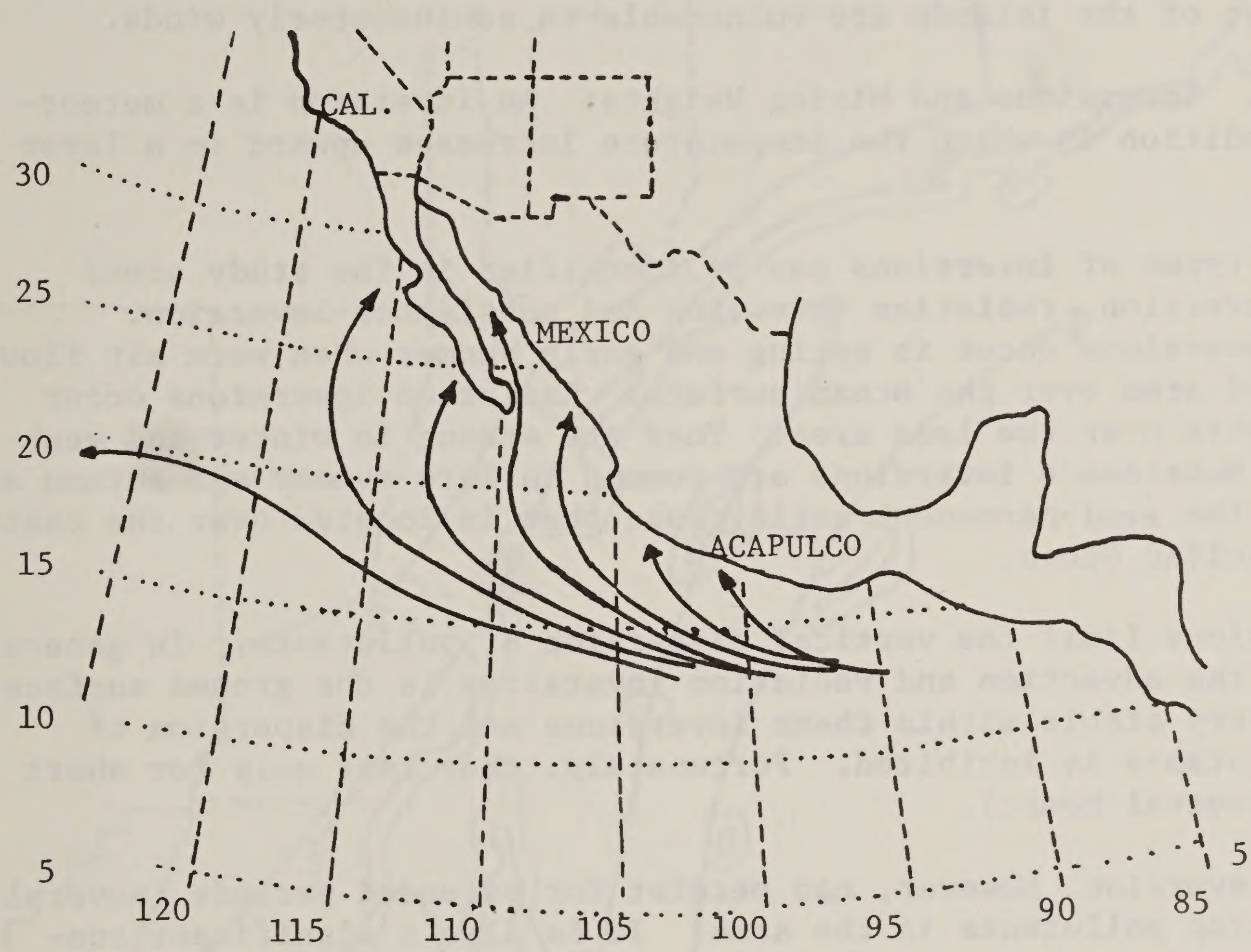


Figure II.B- 4 Favorite Tracks of Mexican West Coast Tropical Storms.

Source: Sea Boating Almanac, 1975

c. Southeasterly Winds: Southeasterlies usually occur during the winter in advance of an approaching cold front. Winds are generally less than 92.6 km/hour (50 knots): however, winds of 138.9 to 148.2 km/hour (75 to 80 knots) with gusts exceeding 185.3 km/hour (100 knots) have occurred near Point Conception (Kimura, 1974).

d. Vulnerability of the Offshore Islands to Severe Winds: Strange (unpublished 1973) states that, sometimes, San Miguel Island, the westernmost of the Channel Islands, is most vulnerable to the northwesterlies (Figure II.B-2). Other times, Anacapa Island, the closest to the coast, receives lighter northwest winds since the winds diminish as they progress southeastward. However, Anacapa is most vulnerable to the Santa Ana winds (northeasterly) (Figure II.B-3). Approximately 18 Santa Ana conditions per year are reported at Anacapa. Finally, most of the islands are vulnerable to southeasterly winds.

7. Inversions and Mixing Heights: An inversion is a meteorological condition in which the temperature increases upward in a layer of air.

Three basic types of inversions can be identified in the study area: advection inversion, radiation inversion and subsidence inversion. Advection inversions occur in spring and early summer when warm air flows from the land area over the ocean surface. Radiation inversions occur on clear nights over the land area. They are strong in winter and weak in summer. Subsidence inversions are common in late summer and autumn as a result of the semi-permanent anticyclone that is located over the eastern North Pacific Ocean.

These inversions limit the vertical dispersion of pollutants. In general, the base of the advection and radiation inversions is the ground surface. The air is very stable within these inversions and the dispersion of primary pollutants is inhibited. Fortunately, they last only for short durations (several hours).

Subsidence inversion, however, can persist for extended periods (several weeks) and trap pollutants in the area. It is also a significant contributing factor to the severe smog conditions in the Los Angeles Basin. According to Neiburger, et al (1961), the average annual base and top of this subsidence inversion are 400 m and 800 m at Point Conception and 500 m and 1,000 m at San Diego. Figure II.B. 5 shows a resultant topography of the inversion base over the Eastern Pacific during the summer months.

The mixing height is defined as the height above the surface through which relatively vigorous vertical mixing occurs. The height of the base of a subsidence inversion is an example of the mixing height. In the California Bight area, the mixing height is synonomous with the

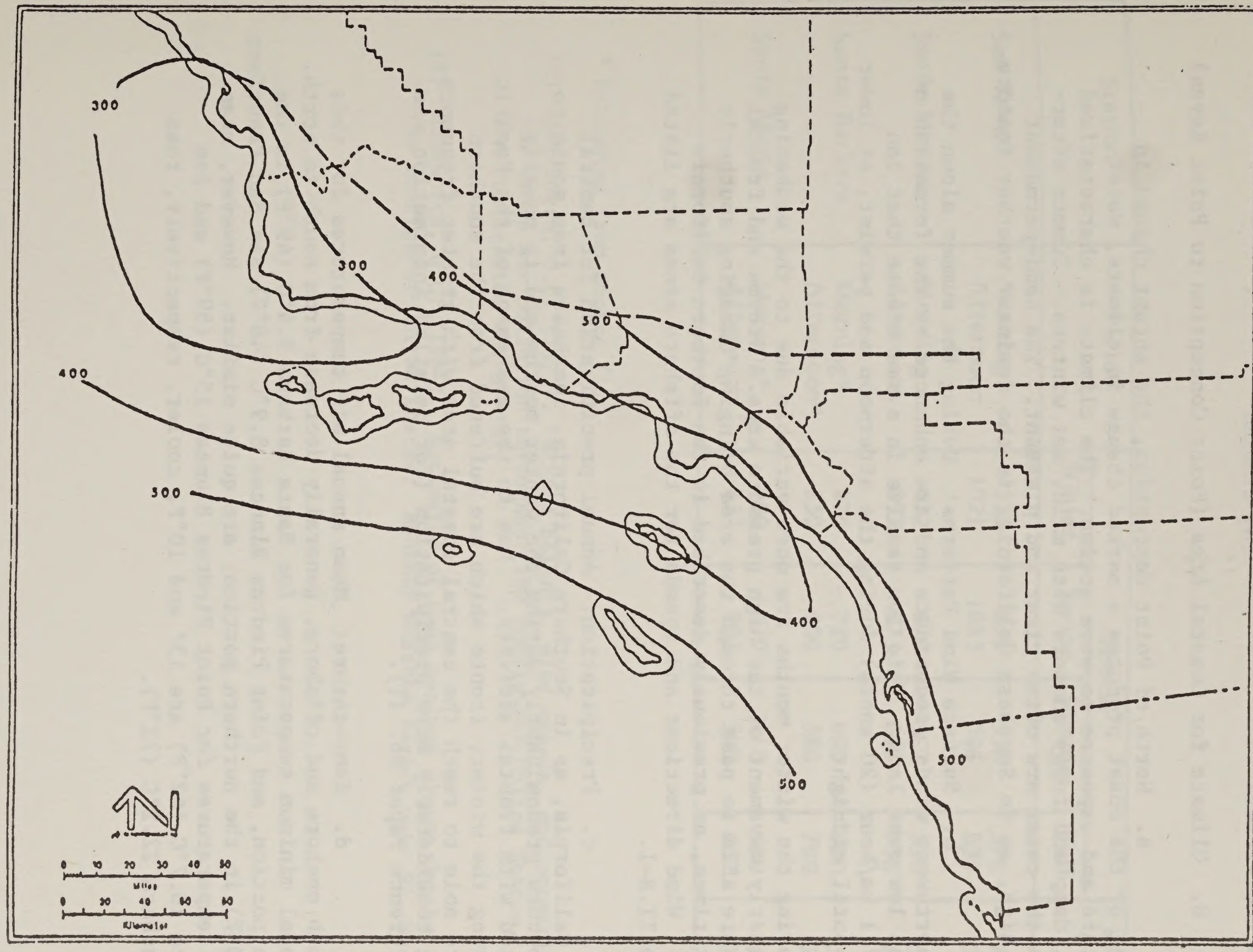


Figure II.B-5 Topography (m) of the summer inversion base off southern California in 1944.

Source: Neiburger, et al, 1961.

marine layer. In general, the marine layer is shallowest at the coast and increases in depth both landward and seaward. Table II.B-2 shows the mean seasonal and annual morning and afternoon mixing heights for four selected coastal sites. The lowest mean afternoon mixing heights occur during the summer season and the lowest mean morning mixing heights occur in the winter.

8. Climate for Coastal Area (Point Conception to Point Reyes)

a. North of Point Conception, the abrupt change in alignment of the coast produces a marked change in climate, water temperature and exposure to wave action. The climate is characterized by cool, damp and foggy summers with mild, wet winters. Summer afternoons on the coast are often clear and pleasant. The semi-permanent Pacific high, as in Southern California, is the dominant weather feature.

b. Surface Wind Patterns: During the summer along the coast, northwest winds predominate and are enhanced by the formation of a thermal low over land. This low results in a sea breeze that can reach 37.1 km/hour (20 knots) during the afternoon and persist, at lower speeds, until midnight.

Winds during the winter months are more variable due to the weakening and southerly movement of the high pressure area. Storms and frontal systems are able to pass through the area bringing damaging southerly winds at times, as previously described in the Southern California section. Wind directions and speeds for the offshore areas are listed in Table II.B-1.

c. Precipitation: Annual precipitation for central coastal California, as in Southern California, increases from south to north, occurs predominantly during the winter months and is usually associated with frontal activity. Due to the weakening of the Pacific High during the winter, fronts which are buffered from the southern coast are able to reach the central coastal area with greater frequency, bringing considerably more precipitation (for detailed information see POCS Reference Paper No. II).

d. Temperature: Mean annual air temperatures for this area, both onshore and offshore, generally decrease from south to north. Mean annual minimum temperatures for Santa Barbara 9.4°C (49°F) in the southern portion, and Point Piedras Blancas 8.9°C (48°F) and San Francisco 10°C (50°F) in the northern portion, are quite similar. However, mean maximum temperatures for Point Piedras Blancas 15°C (59°F) and San Francisco 16.7°C (62°F) are 13° and 10°F, cooler, respectively, than Santa Barbara 22.2°C (72°F).

Table II.B-2

MEAN SEASONAL AND ANNUAL MORNING AND AFTERNOON MIXING HEIGHTS (m)+

Station	Period	Season				Annual
		Winter	Spring	Summer	Fall	
San Diego	Morning	535	851	538	578	625
	Afternoon	1021	1085	566	834	877
Santa Monica	Morning	422	676	562	510	542
	Afternoon	893	973	603	798	814
Santa Barbara	Morning*	470	720	400	500	523
	Afternoon*	850	900	580	700	758
Santa Maria	Morning* #	490	670	410	500	540
	Afternoon	837	903	540	657	734

* Estimated from Source (1).

(1) Holzworth, G.C. (1972). Mixing heights, wind speeds, and potential for urban air pollution throughout the contiguous United States. EPA Publication No. AP-101.

(2) Holzworth, G.C. (1964). Estimates of mean maximum mixing depths in the contiguous United States. Monthly Weather Review vol. 92, No.5.

Table II.B-3

METEOROLOGICAL TABLES FOR SELECTED AREAS OFF SOUTHERN CALIFORNIA

METEOROLOGICAL TABLE FOR COASTAL AREA 22 OFF SAN DIEGO

Boundaries: Between 31°N., and 34°N., and from 120°W., eastward to coast

Weather elements	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sep.	Oct.	Nov.	Dec.	Annual
Wind ≥ 34 knots (1)	*	*	*	*	*	*	*	*	*	*	*	*	*
Wave height ≥ 10 feet (1)	1.4	1.8	2.3	1.2	1.3	.9	.6	*	1.0	1.3	3.0	2.5	1.3
Visibility < 2 naut. mi. (1)	3.6	3.8	2.0	2.7	1.1	2.6	2.0	1.7	2.8	3.8	2.7	4.7	2.8
Precipitation (1)	3.7	3.0	2.1	1.8	1.0	1.5	.6	*	.9	.8	3.0	3.7	1.8
Temperature ≥ 85°F (1)	0	0	0	0	0	0	*	*	*	*	*	*	*
Mean Temperature (°F)	58.1	58.0	58.1	59.0	60.1	61.4	63.7	65.7	66.0	64.3	62.1	59.9	61.4
Temperature ≤ 32°F (1)	0	0	0	0	0	0	0	0	0	0	0	0	0
Mean relative humidity (%)	76	75	76	77	78	81	85	84	82	81	78	78	80
Sky overcast or obscured (1)	20.0	21.6	21.4	27.7	37.1	49.0	46.2	41.8	28.1	29.0	19.9	20.7	30.3
Mean cloud cover (eighths)	3.7	3.6	4.0	4.3	4.9	5.6	5.5	5.4	4.1	4.1	3.6	3.7	4.4
Mean sea-level pressure (2)	1019	1018	1017	1016	1015	1013	1013	1014	1012	1015	1017	1017	1016
Extreme max. sea-level pressure (2)	1032	1032	1031	1027	1026	1025	1027	1027	1022	1023	1030	1031	1032
Extreme min. sea-level pressure (2)	997	997	1000	999	1001	999	1001	991	999	998	1005	999	991
Prevailing wind direction	NW	NW	NW	NW	NW	NW	NW	NW	NW	NW	NW	NW	NW
Thunder and lightning (1)	*	*	*	*	*	*	*	*	*	*	*	0	*

METEOROLOGICAL TABLE FOR COASTAL AREA 24 OFF SANTA BARBARA

Boundaries: Between 34°N., and 36°N., and from 125°W., eastward to coast

Weather elements	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sep.	Oct.	Nov.	Dec.	Annual
Wind ≥ 34 knots (1)	*	.6	.9	1.1	.8	.9	*	*	*	.6	*	*	.6
Wave height ≥ 10 feet (1)	7.5	7.8	10.7	16.2	11.5	8.6	5.0	5.2	3.3	7.1	8.5	9.7	8.0
Visibility < 2 naut. mi. (1)	2.2	7.0	4.4	8.3	8.1	6.5	10.6	11.7	10.7	14.1	5.6	4.5	8.1
Precipitation (1)	8.5	7.1	4.8	3.8	2.3	2.3	2.0	1.7	1.4	1.3	4.0	6.3	3.6
Temperature ≥ 85°F (1)	0	0	0	0	0	0	0	0	*	*	*	0	*
Mean Temperature (°F)	56.1	55.7	56.1	56.9	58.1	60.4	62.2	63.1	63.5	62.3	60.2	58.5	59.5
Temperature ≤ 32°F (1)	0	0	0	0	0	0	0	0	0	0	0	0	0
Mean relative humidity (%)	73	76	77	80	81	83	85	85	83	81	75	73	80
Sky overcast or obscured (1)	18.8	22.8	20.2	31.0	31.0	35.8	46.4	44.3	34.2	31.3	20.4	19.4	30.3
Mean cloud cover (eighths)	3.7	3.6	3.6	4.3	4.1	4.2	5.0	4.8	4.1	3.9	3.5	3.6	4.1
Mean sea-level pressure (2)	1019	1019	1018	1017	1016	1014	1014	1014	1013	1015	1013	1013	1015
Extreme max. sea-level pressure (2)	1034	1033	1033	1032	1028	1027	1024	1029	1023	1026	1030	1032	1034
Extreme min. sea-level pressure (2)	998	998	993	1000	1004	994	996	1000	999	996	999	999	993
Prevailing wind direction	NW	NW	NW	NW	NW	NW	NW	NW	NW	NW	NW	NW	NW
Thunder and lightning (1)	*	0	0	*	*	0	*	*	*	0	*	*	*

(1) Percentage frequency.
(2) Millibars.
* 0.0-0.5%
These data are based upon observations made by ships in passage. Such ships tend to avoid bad weather when possible, thus biasing the data toward good weather samples.

Source: U.S. Coast Pilot #7, 1976.

e. Sky Cover and Visibility: Stratus is the dominant cloud type along the central coast and occurs most often during the summer months (Table II.B-3). Ceiling heights vary but occur between 305 and 1,524 m (1,000 to 5,000 feet) 36 percent of the time along the near coastal zone (Naval Weather Service Detachment, 1971).

Notably foggy areas along this stretch of the coast are Point Arguello, Estero Bay, and Point Reyes. During the summer and fall months, visibilities at Point Arguello may drop below 0.8 km (0.5 mile) on about 10 to 20 days per month (U.S. Coast Pilot No. 1968).

Along the coast from 34°N to 36°N and seaward to 125°W, the foggiest months are July-October and the least foggy, December and January. The area from 36°N to 38°N and the coast to 125°W has October-February as the foggiest months and March-May as the least foggy (Table II.B-3).

f. Severe Storms (See Southern California section)

g. Severe Winds: Generally, along this section of the coast highest winds occur during the winter months, associated with large storm systems, and are from a southerly direction. Although northerly winds associated with the Pacific High during the spring and summer months are not as strong as the southerly winds, they are more persistent and can be damaging at times (Table II.B-1).

9. U.S. - Mexican Border to Guadalupe Island

a. The climate of northern Baja California is similar to that of Southern California. The Pacific High, as in Southern California is the dominant weather system.

Northwest winds prevail most of the year along the coast, especially during the summer months (March-October). During the winter months (November-February) winds from the southeast through the southwest occur on occasion as fronts move through the coastal area from the Pacific. At times, gale force winds with considerable precipitation may result from frontal activity.

b. Precipitation: Ensenada, in northern Baja, averages 25.4 cm (10 inches) of precipitation annually. November through April are the rainy months, with a January average of approximately 7.6 cm (3 inches). The summer months receive as little as 0.25 cm (0.1 inch) per month and sometimes none at all. Further south along the coast, annual precipitation tends to decrease and is confined predominantly to the winter months.

c. Temperature: Onshore temperatures during the summer months are in the low 70°s and decrease slightly to the mid 60°s offshore. During the winter months temperatures are in the mid 50°s onshore and increase to the high 50°s and low 60°s further offshore.

d. Sky Cover and Visibility: Ceiling heights are similar to coastal Southern California, with the greatest frequency between 305 and 1,524 m (1,000 and 5,000 feet).

Fog occurs in all seasons but mostly in the summer months, moving in during the late evening-early morning hours and usually burning off before afternoon.

e. Severe Storms: During the winter months, weather fronts often bring gale force winds and rough seas off the west coast of Baja. The summer months bring occasional tropical thundershowers. However, this usually occurs below 28°N.

f. Hurricanes: (See Southern California Section II.B.5.c).

C. Physical Oceanography

Introduction: The North Pacific Current moving eastward at approximately 40° latitude divides into two branches upon approaching the Eastern Pacific boundary. The smaller of the two branches turns northward into the Gulf of Alaska to become the Alaska Current; the large branch turns southeastward to become the California Current. The oceanic water mass adjacent to the California coast is primarily affected by the waters transported south by the California Current, modified by a countercurrent (Davidson Current) and upwelling.

1. California Current: The California Current is best described as a meandering, diffuse, southeastward flow, with short-term variations in speed that are of the same order as the mean speed itself (15 cm/sec). Although there is no true western edge to the California Current, it has been reported to extend 600 to 1,000 km (312-621 miles) offshore and is found above 100 to 500m (328 to 1,640 feet).

The California Current originates near the Canadian border and initially contains subarctic water characteristics. As this water moves southward, the surface characteristics are modified by insolation and by the effects of river inflow and exchange with other water masses, estuaries, and embayments. The flow generally follows the coastline south until it reaches the northern limit of the Southern California Borderland area at Point Conception. Here, the coastline turns abruptly toward the east, and the flow of water departs from the coast, generally continuing in a southeasterly direction. Farther south, off the coast of Northern Baja California, the main portion of the current turns toward land, and the flow divides into two branches. One branch, known as the Southern California Countercurrent, turns northward and flows through the Channel Islands, forming the inshore edge of the Southern California Eddy. The second branch turns southward and continues down the coast of Baja California. As the southern branch nears 25°N latitude, it begins to turn westward, and its waters become part of the west-flowing North Equatorial Current.

Commencing about the middle of November and extending to mid-February the Davidson Current, a northward- moving countercurrent, is the dominant inshore transporter of water and suspensates (Edmister, 1974). Throughout the year this current is present as a deep countercurrent below 200 m (650 feet) flowing to the northwest along the coast from Baja California to some point beyond Cape Mendocino (Figure II.C-1). The deep countercurrent appears to surface during this period when the north winds are weak or absent. The water mass associated with the Davidson Current is warmer and more saline than the California Current.

Upwelling is prevalent along the California coast during the period from the middle of February to the end of July. The water mass associated with this upwelling current is cold and saline.

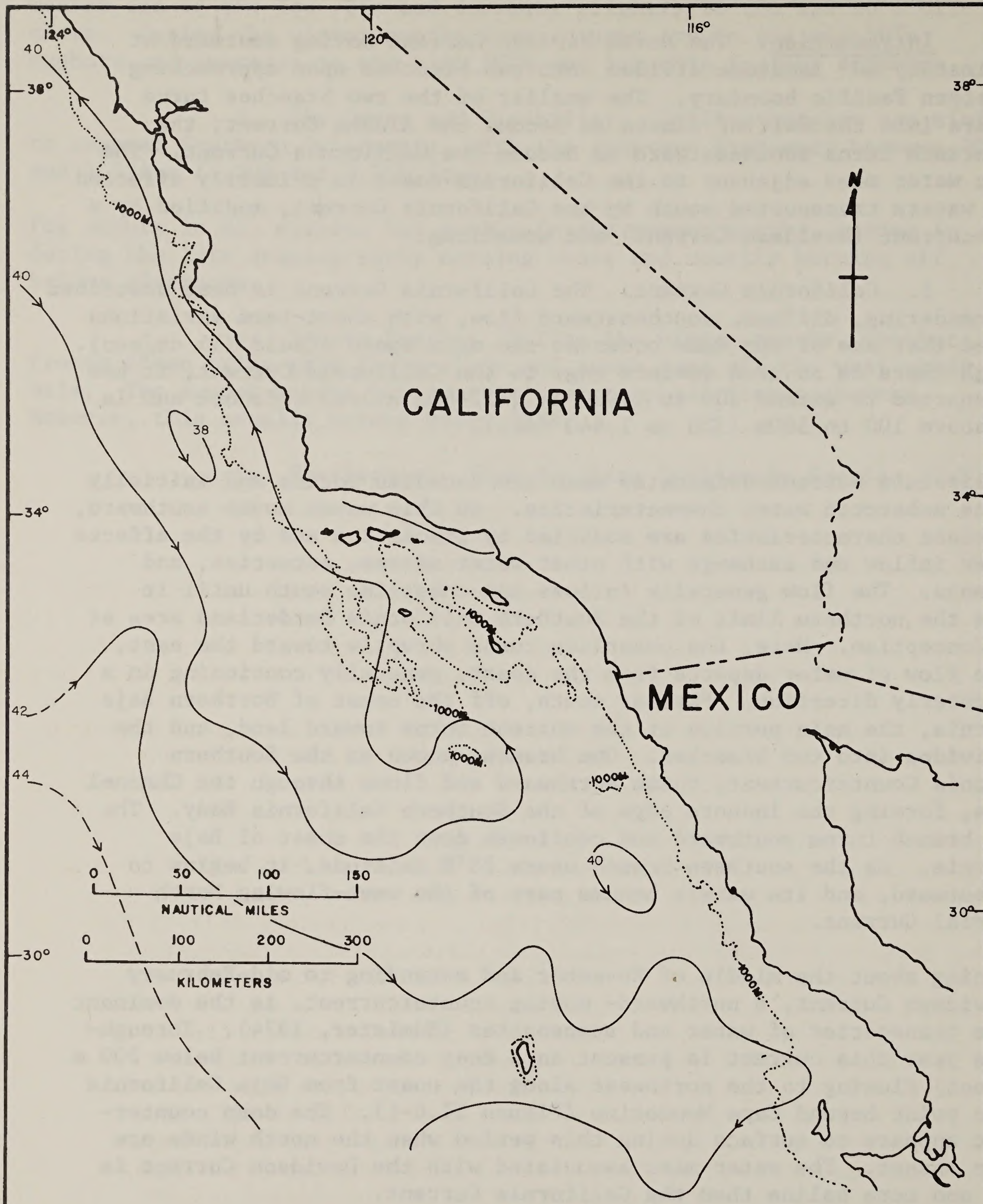


Figure II.C-1 Flow At 200-meter Depth During Oceanic Period (mean geostrophic flow, January, 1950-65).

Source: CalCofi, 1966.

Although the California Current is present throughout the year and is only modified by upwelling and the Davidson Current, it is during the Oceanic Period (July to November) that the California Current dominates the nearshore current patterns.

2. Circulation: As seen in Figure II.C-2, the southeastward flowing California Current, 100m (328 feet) depth, divides into two branches, the main portion of the current turning toward land to form the California Countercurrent. This return-flow branch known as the Southern California Countercurrent, with its axis centered over the Santa Rosa-Cortes Ridge, forms a semi-independent circulation system within the Southern California Borderland. The Southern California Countercurrent, 100 (328 feet) depth, passes by the eight islands in the Borderland, enters the Santa Barbara Channel, and is released to the north and south in the areas of Point Conception and Baja California, respectively. The Southern California Countercurrent is a nearly permanent feature of the flow pattern in this region and has been found to be well developed in winter and weak in spring (Schwartzlose, 1963). Estimates of surface speed in the Southern California Countercurrent are comparable to those observed in the California Current itself: 12 to 18 cm/sec (Sverdrup and Fleming, 1941).

At depths of 200 m (656 feet), a northwesterly flowing current is present within the Borderland (Figure II.C-1). The current flows northwest between the Santa Rosa-Cortes Ridge-Tanner Bank system and mainland and exists in the Borderland north and south of the Santa Barbara Channel Islands.

a. Surface Current Circulation: The following descriptions of the circulation within the borderland during the Davidson Current upwelling, and Oceanic periods were gathered over a five-year period (1969-1974) and thus do not provide long-term trends for the currents.

Oceanic Period (July to November): During the Oceanic Period the circulation pattern within the Santa Barbara Channel consists primarily of two gyres or circulation cells (Figure II.C-3). In the western half of the channel, there is a counterclockwise circulation cell: in the eastern section of the channel, there is a clockwise circulation cell. The counterclockwise cell appears to be driven by water entering the channel from the northwest and by the northwesterly current entering the channel to the east of the cell. The clockwise circulation cell, located in the eastern half of the channel, appears to be driven by the flow of water from the southeast. The convergence of these two cells results in a complex pattern of eddies in the area between Santa Barbara and Santa Cruz Island (Kolpack, 1971). A water parcel entering the channel may eventually circulate to all surrounding parts of the channel and be released either through sinking or discharge to the north or through the eastern (clockwise) channel cell to the south.

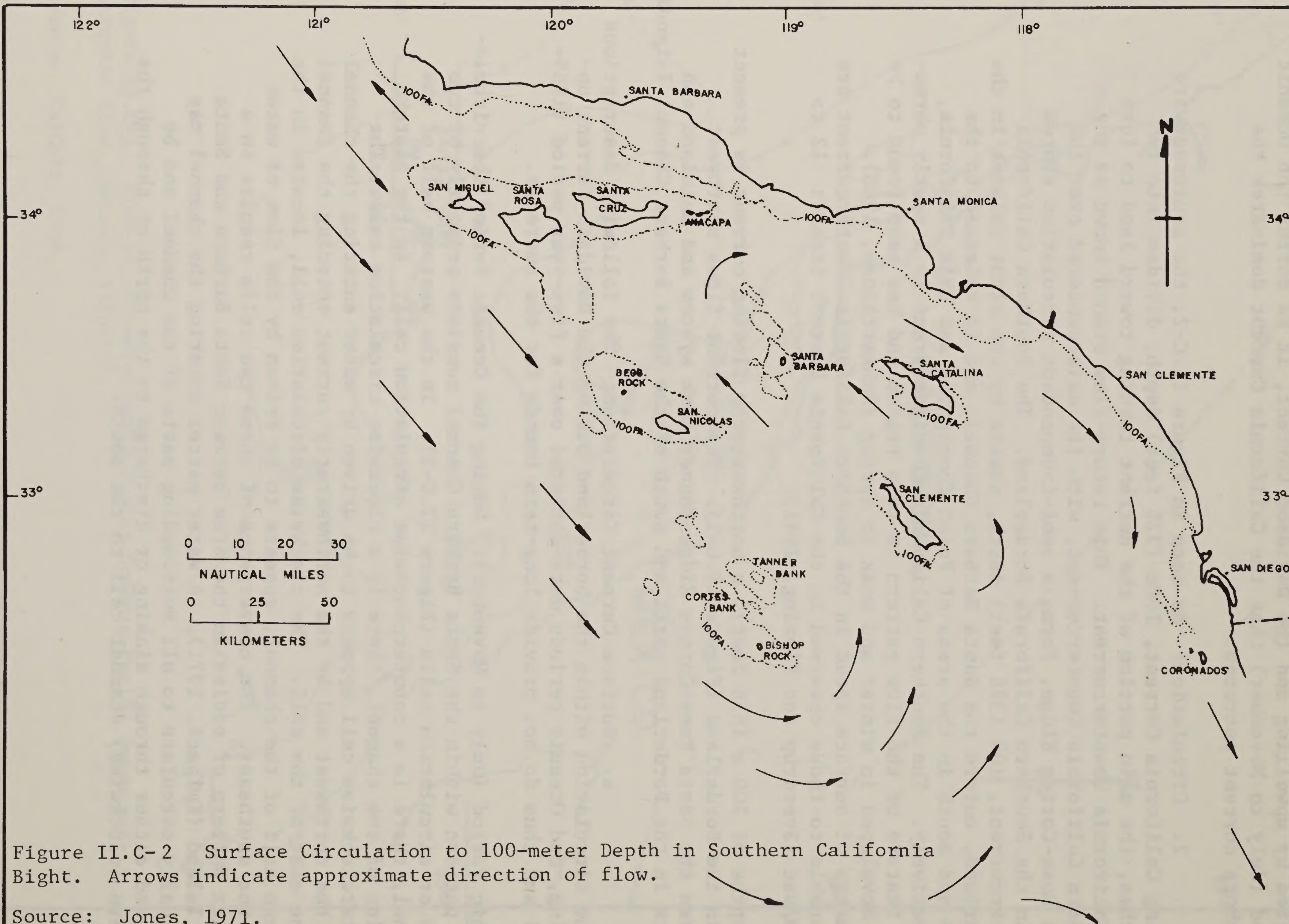


Figure II.C-2 Surface Circulation to 100-meter Depth in Southern California Bight. Arrows indicate approximate direction of flow.

Source: Jones, 1971.

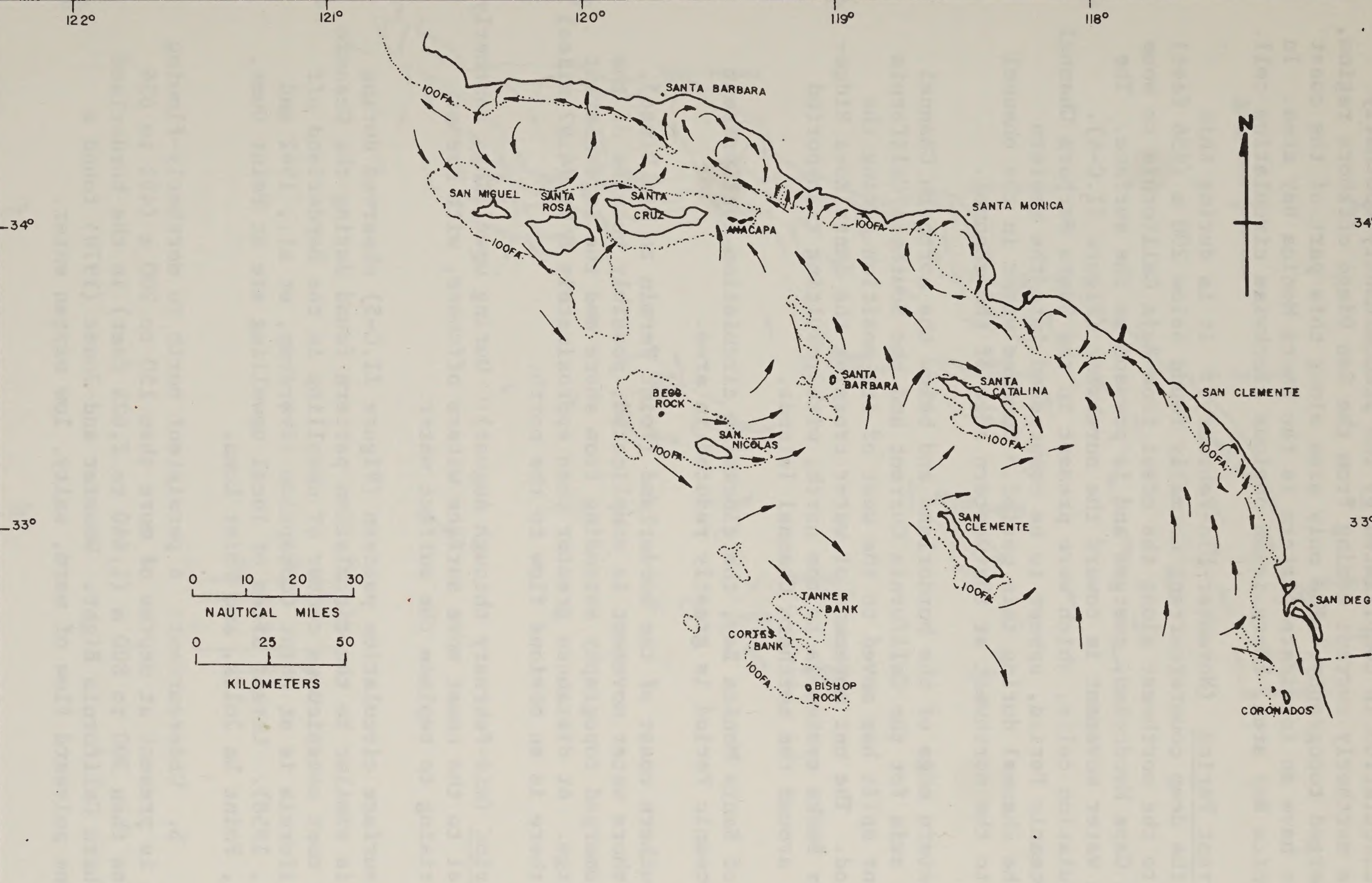


Figure II.C- 3 Generalized Southern California Surface Currents for Oceanic Period.

Source: Pirie and Murphy, 1974.

Along the coast, from below the northern Channel Islands to San Diego, the surface circulation is complicated by the predominantly southerly water flow, a northerly current coming from the San Diego offshore region, and the submerged topography. The only area along this part of the coast that does not have an intricate pattern is the Santa Monica Bay area. In the Santa Monica Bay area, there is an obvious clockwise circulation cell.

Davidson Current Period (November-Mid-February): It is during this period that the deep countercurrent normally found below 200 m (656 feet) which flows to the northwest along the coast from Baja California to some point beyond Cape Mendocino, emerges and is present at the surface. The apparent net water movement is toward the northwest (Figure II.C-4). The two circulation cells, which were present in the Santa Barbara Channel during the Oceanic Period, appear to be compressed into the eastern section of the channel during this period. Surface water in the channel is released to the northwest at the western edge of the channel.

Along the western edge of the borderland and below the northern Channel Islands, the axis for the California Current and the Southern California Countercurrent split has moved to the west of its position during the Oceanic Period. The net movement of water crossing the Santa Rosa Ridge-Cortes-Tanner Banks system is to the north, with resulting transported water pushed around the northern Channel Islands.

In the area of Santa Monica Bay, the clockwise circulation cell present during the Oceanic Period is greatly reduced in area.

Along the southern coast of the borderland (Point Fermin to San Diego), the net nearshore water movement is complicated, possibly because of the irregular submerged topography extending from shore and the intermittent river discharge. At distances greater than approximately 8 km (4.97 miles) from shore, there is an obvious flow to the north.

Upwelling Period (mid-February through August): During upwelling, northerly winds parallel to the coast move surface waters offshore, with deeper ocean water rising to replace the surface water.

The general surface circulation pattern (Figure II.C-5) observed during this period is similar to the circulation pattern found during the Oceanic Period. The most conspicuous center of upwelling in the Borderland off Southern California is at Point Conception (Sverdrup, et al., 1942 and Reid, et al., 1958). Lesser sites of local upwelling are at Point Dume, Point Fermin, Point La Jolla, and Point Loma.

b. Undercurrent: A persistent north to northerly-flowing undercurrent is present at depths of more than 150 to 200 m (492 to 656 feet) and less than 500 to 800 m (1,640 to 2,624 feet) in the borderland off the Southern California Bight. Wooster and Jones (1970) found a subthermocline poleward flow of warm, salty, low oxygen water.

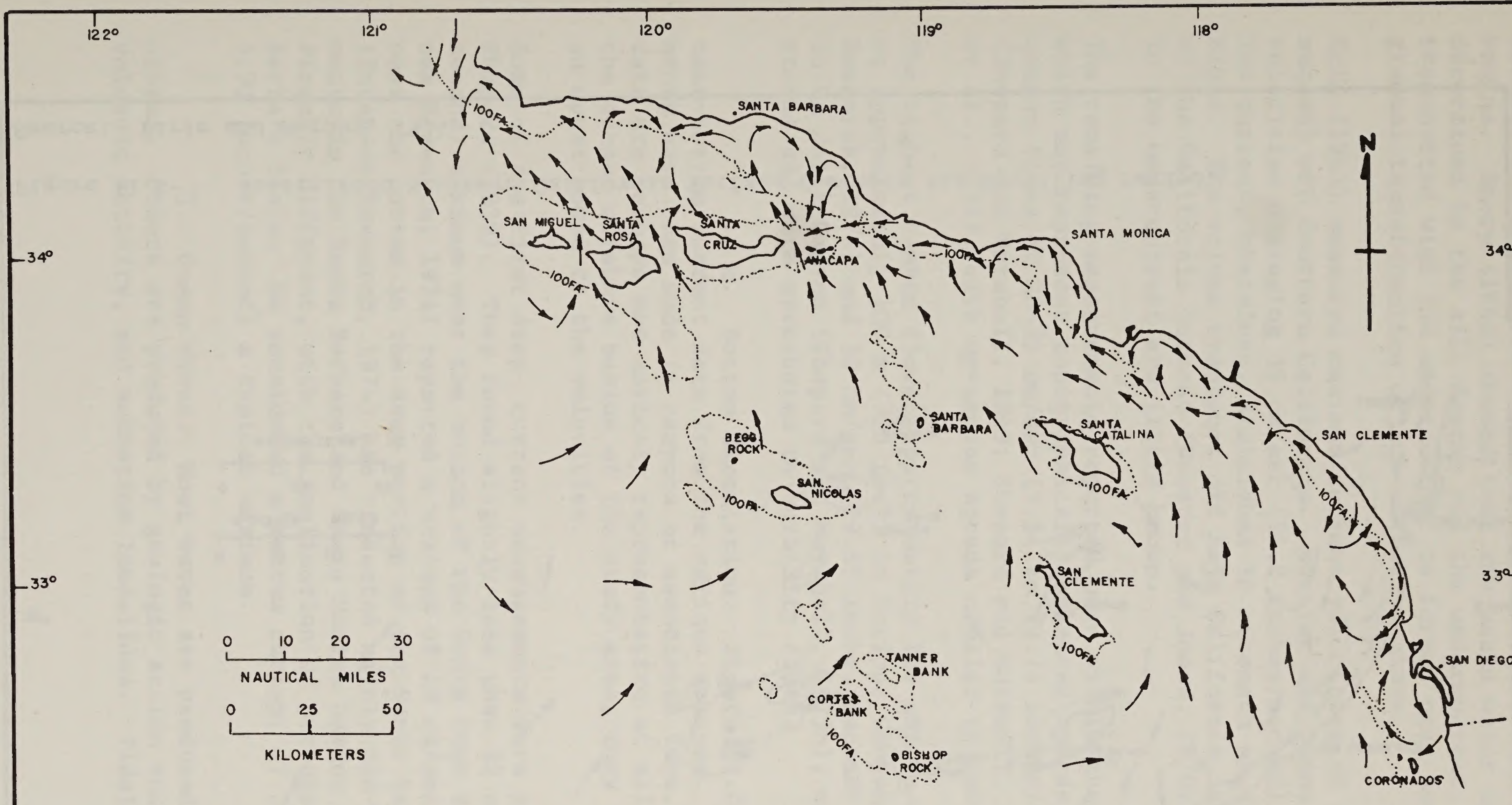


Figure II.C-4 Generalized Southern California Surface Currents for Davidson Period.

Source: Pirie and Murphy, 1974.

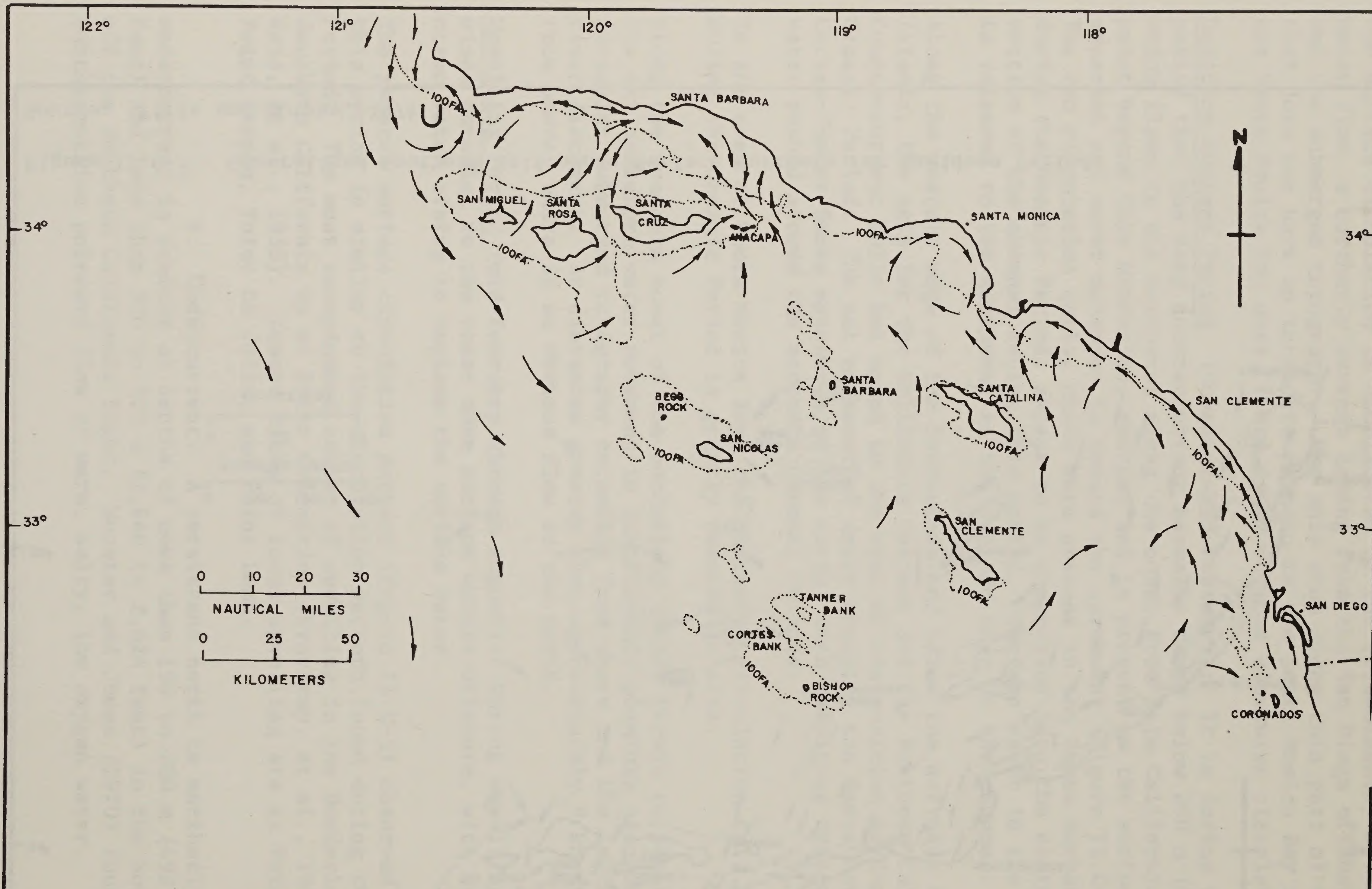


Figure II.C-5 Generalized Southern California Surface Currents for Upwelling Period.

Source: Pirie and Murphy, 1974.

The trough and ridge topography of the Southern California Borderland divides the undercurrent into sinuous streams that flow into the offshore basins. Emery (1960) showed that the basin water characteristics are determined by the sill depths and the undercurrent. The water mass transported with the undercurrent is formed near South America through gradual transformation of sub-antartic waters.

Reid (1963) measured maximum current velocities of 8 cm/sec (3.15 inches second) off Southern California. Wooster and Jones (1970) recorded velocities averaging 30 cm/sec (11.8 inches/second) off Baja California. The current, therefore, diminishes in strength as it moves north into the Bight. The volume transport off Baja California is about one-fifth that of the California Current (Wooster and Jones, 1970). Seasonal variations in the undercurrent are little known.

The remaining measurements reported were within the confines of canyons which may represent topographically-enhanced speeds. Typical maximum canyon flows of 25-35 cm/sec (9.84 to 13.78 inches/second) were reported (Shepard and Marshall, 1969; Shepard and Marshall, 1973a; and Shepard et al., 1974), with up-canyon speeds similar to down-canyon speeds.

The highest canyon flows, approximately 180 cm/sec (71 inches/second) at approximately 100 m (328 feet) in Scripps Canyon (Marshall, Intersea Research, 1974) and 50 cm/sec (19.69 inches/second) at 200 m (156 feet) in La Jolla Canyon (Shepard and Marshall, 1973b), occurred during major storms and were atrributed to turbidity flows.

c. Bottom Circulation: Figure II.C-6 summarizes maximum near-bottom current data from the various sources. Many of these measurements have been made in canyons or associated fans. While such canyon data are perhaps not entirely representative of all currents in much of the deeper offshore basins of the study area, they should tend to indicate an upper bound to the velocities.

Some of the first deep- current measurements were reported by Revelle and Shepard (1939). They found slightly less than 25 cm/sec (9.84 inches/second) maximum near the bottom of the Santa Cruz Basin. Soutar (Intersea Research, 1974) reported a maximum of 28 cm/sec (11.02 inches/second) near the bottom in the deep portion of the Santa Barbara Basin. Edgerton (Intersea Research, 1974) has conducted mainly mid-water current measurements in the Santa Barbara and Santa Monica basins and found them significantly different, with the implication of stronger currents in the Santa Barbara Basin. He considered a bottom current of 10 to 15 cm/sec (3.94-5.91 inches/second) a typical maximum.

3. Ocean Waves: Most waves are produced by winds and passing storms. Others are produced by geologic action such as earthquakes, volcanic activity, and submarine landslides. Tidal action produces

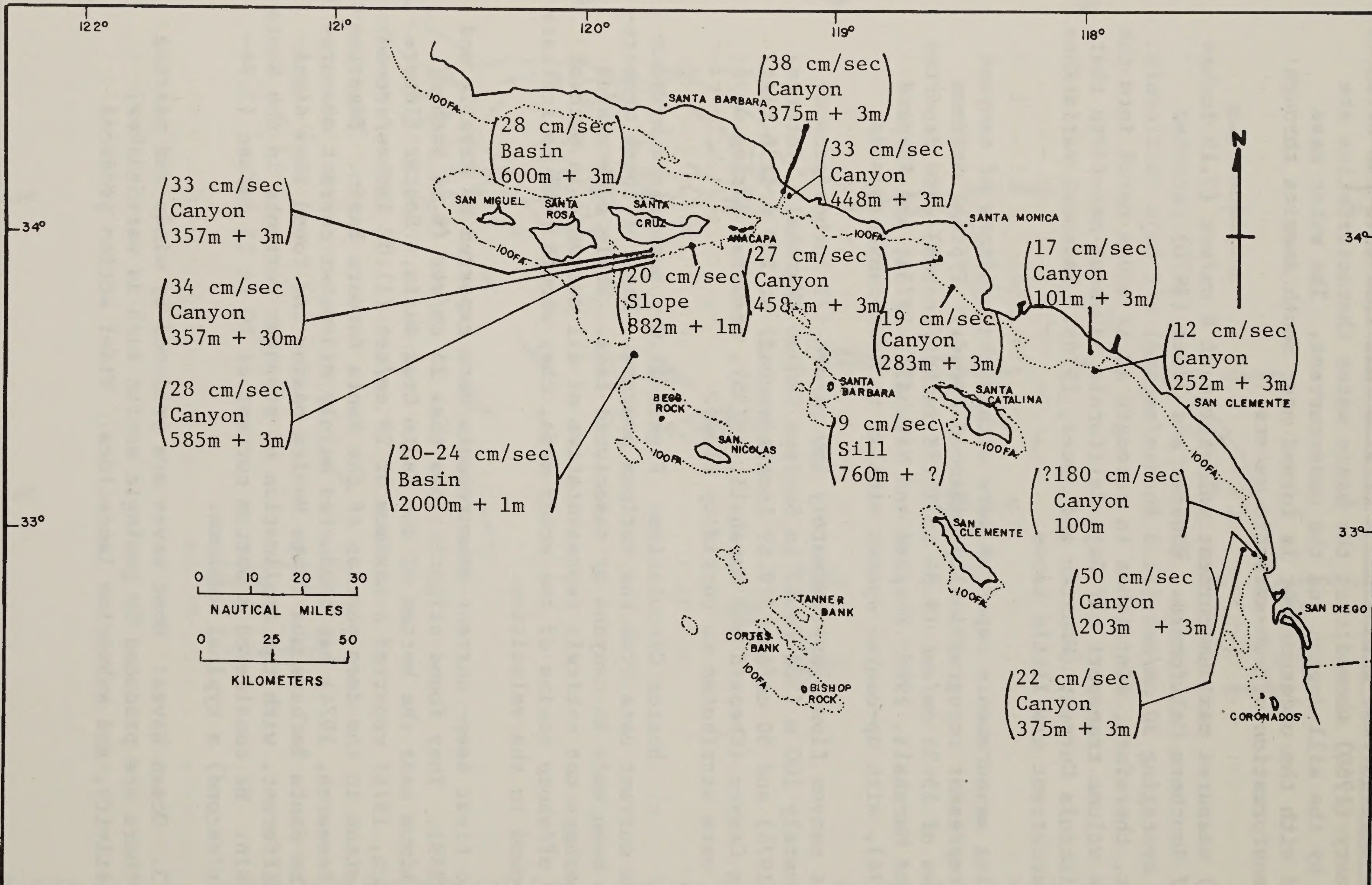


Figure II.C-6 Observed Maximum Near-bottom Currents.

Source: Compiled from various sources.

another form of wave. Waves which grow in height under the influence of the wind are referred to as wind waves or seas, and the region in which they are generated is the "fetch".

a. Wind Waves (and Swell): Once the wind waves move out of the fetch area, they are referred to as swell. In Southern California, waves are predominantly from the northwest, and swell may occur from any seaward direction. Local wave height and direction may be the result of several different wave trains moving through the area.

According to the State Water Quality Control Board (1965), the offshore islands protect nearly all of the Southern California coast to some degree from swell generated outside the coastal area. Certain portions of the coast are exposed to unlimited fetches from the west and south, but no location is exposed to swell from all possible seaward directions.

The best protected coastal area is from Point Conception to Ventura. Swell cannot approach this shoreline without being well modified by the Channel Islands or drastically refracted over the mainland shelf, except at Point Conception itself. From Ventura to Port Hueneme, swell approaching from the west arrives unchanged and sometimes has caused considerable destruction along the shore.

In the general area from Long Beach to Newport, significant swells arrive from the west and south. From Newport south to Oceanside, only swell from southerly areas arrives unhindered. The San Diego coast is the most exposed, and more or less unmodified waves may strike the shore from the south.

Because swells frequently approach Southern California from several directions simultaneously (Emery, 1958), the cause of confused wave patterns, such as those usually observed between San Nicolas Island and Santa Catalina, is readily apparent.

The protection afforded by the offshore islands is generally so complete that significant waves over the shelf are mainly formed in the local area. The restricted fetches allow only the development of low waves with short lengths and periods. Also, because the important winds are the sea breezes, the durations are normally less than 10 hours. It is only when gale winds blow from the west at 17 m/sec (38 mph) or more that high waves are formed in the local region and travel over the shelf. These are most common in the San Pedro Channel where waves as high as 7.6 m (24.93 feet) have been encountered.

In addition to surface waves, certain wavelike oscillations within the ocean are significant contributors to water mass movement. These internal waves form along density interfaces and have elliptical, orbital motion similar to surface waves, but differ in having slower phase velocities and greater amplitude. Surface oil pollution has been found to accumulate in the troughs of internal waves (Ewing, 1950). In calm weather, surface contamination inhibits the formation of ripples under light winds so that slicks appear.

The distribution and characteristics of internal waves in the Southern California Bight are important with respect to vertical mixing in the surface water and to the seasonal thermocline (Maloney and Chan, 1974). They may cause subsurface pollutants to appear at the surface and to inject random elements into field measurements.

b. Swell from North Boundary of the Pacific High: Whenever the Pacific High elongates and migrates to the south, westerly winds blowing along its north flank generate waves which arrive from the west. This situation is most common in the winter. However, the wind velocities are generally less, so that despite long fetches and durations, the swell is moderate.

c. Swell from Hawaiian Lows: These low pressure centers originate in the expanse of ocean north of the Hawaiian Islands. Winds within these depressions may at times create swell on the California coast with moderate heights (usually less than 2.5 m (8.20 feet)). Such storms occur most frequently and with the greatest strength in the spring.

d. Swell from Storms in the Southern Hemisphere: Swell often arrives from the south or southeast for long periods. This swell occurs most often in the summer when the southern winter storms are most intense and follow tracks farther to the north. These waves probably are present about two-thirds of the time, but because they are so low, the local wind waves and the more conspicuous swell from other sources mask them.

e. Swell from Tropical Hurricanes: In the summer and fall, tropical storms are likely to develop off the coast of Costa Rica. Nine-tenths of these storms travel northwest from their place of origin, but dissipate long before reaching Southern California. In 55 years only four, 1939, 1976, 1977 and 1978, entered Southern California waters with high winds and extensive damage. This swell differs from the Southern Hemisphere swell in that it has a shorter period. An estimate of one occurrence of heavy swell every four or five years from this source seems reasonable, but a frequency of once a season is possible.

f. Waves and Swell from Local Cold Front Passages: These waves are characterized by their choppiness and are always accompanied by strong winds. As they are generated within the Southern California Borderland, the sheltering influence of the points, headlands, and islands is not too evident.

Whenever the Pacific High has weakened or moved south, and a northwesterly flow prevails over the eastern margin of the Pacific Ocean, cold fronts originating in the southern Gulf of Alaska may move into Southern California. During the winter these storms may occur several times a month producing rain and moderate winds, first from the west, then from the northwest. In midsummer, owing to the protective influence of the Pacific High, only the strongest of these cold fronts reaches Southern California, and then with much-reduced activity.

4. Tsunamis (Seismic Sea Waves): Tsunamis are generated by submarine earthquakes or volcanic eruptions. On the open sea in deep water, they have a low height and will usually go unnoticed by ships at sea. They are long-period waves (from five minutes to several hours), low in height (a meter or less) and may travel at speeds well over 400 knots. However, as the wave moves to shallow water, a large wave may form, modified by coastal and bottom configurations. Most of the damage occurs at this point, usually due to rapidly rising water levels or bores rather than breaking waves.

According to the Coast Pilot No. 7 (1968), the California coast is not generally subject to severe waves, although widespread damage to shipping and to waterfront areas occurs occasionally. The wave of May 23, 1960, originating off the Chilean coast, caused several hundred thousand dollars damage to ships and docking facilities in the Los Angeles area alone. Much of the damage in the Los Angeles area, during the 1960 wave, was caused by rapid currents and the swift rise and fall of the water level which broke mooring lines and set floating docks and ships adrift.

5. Surge: Surge can be defined as water motion characterized by variations in velocity and pressure that are not necessarily periodic and may even be transient. Mechanisms responsible for the development of surge may be from atmospheric disturbances (storms) or geological events (landslides) or the interaction of waves over a shallow, high-relief bottom. When violent storms move from the ocean along or toward the coast, the sea level rises above the normal tide level.

As a surge passes through an area, extreme bottom current may be produced. This bottom surge will be a function of the height, period, and length of the waves and the bottom depth. Velocities for extreme bottom surge vary greatly according to the depth of the water. As depth decreases, surge velocity increases until the waves break. Off Southern California, there is an 80 percent chance that the greatest potential bottom surge velocity will not exceed approximately 111 to 163 cm/sec (43.70 to 64.17 inches/second) at the 20 m (65.62 feet) isobath (Riffenburg, 1973). At the 200 m (656.17 feet) isobath, it is found that there is an 80 percent chance that the greatest potential bottom surge velocity will not exceed approximately 8 to 15 cm/sec (3.15 to 5.91 inches/second).

6. Water Characteristics: Temperature and salinity are discusssed below. Additional characteristics are discussed in Section II.D, Chemical Oceanography.

a. Temperature: The ocean surface water temperature within the Southern California Borderland ranges from 12.5°C in the north to 19.5°C in the south (Emery, 1960). The long-term mean surface (10 m isobath) temperature, collected over a 13-year period (1950-1962) for the waters off California, is shown in Figure II.C-7.

The mean seasonal surface (10-m isobath) temperature range is about 3°C (37.4°F) to 5°C (41.0°F) off the Southern California coast from about Point Conception to San Diego (Lynn, 1967). Months of minimum surface temperature, within the Borderland, are February (lower section) and April (upper section). Maximum surface temperatures occur in August through October.

In contrast to the water, within the surface mixed layer, the temperature below 100 to 300 m (328 to 984 feet) may vary only about 4°C(39.2°F), 6.5 to 11°C (43.7°F to 51.8°F). In depths below 300 m (984 feet) and extending to the deep basin or off the Patton escarpment (2,000 m) (6,561 feet) the water temperature may have a range of 6°C (42.8°F), 2 to 8°C (35.6°F to 46.4°F). Daily and seasonal temperature changes are noticeable to depths of 10 to 50 m (32.8 to 164 feet). A thermocline of 3° (37.4°F) to 7°C (44.6°F) is present in this depth zone. SCCWRP (1973) observed that this shallow thermocline is better developed during the summer, probably because of the warm climatic conditions.

Cairns and Nelson (1970) measured the shallow seasonal thermocline gradients off San Diego. The larger summer thermocline results from surface heating and upwelling. The shallow seasonal thermocline oscillates greatly as a result of internal waves and tides. A small, permanent thermocline is developed at depths between 200 and 500 m (656 to 1,640 feet) where the northern and southern waters mix. The temperature drops from between 8°C (46.4°F) to 9°C (48.2°F) at 200 m (656 feet) to between 5.5°C (41.9°F) to 6.2°C (42.98°F) at 500 m (1,640 feet). This thermocline is better developed where warm southern water predominates in the surface layer.

Below the thermocline, the water temperature decreases slightly with depth. Emery (1960) found that the borderland basins are isothermal below the sill depth. The basin temperatures are the same as the undercurrent temperatures at depths that are slightly less than the sill. The monotonic drop in temperature is depicted in Figure II.C-8.

b. Salinity: The salinity is a measure of concentration of dissolved salts in water. The relative concentrations of most ions within the ocean is relatively constant, except around coastal areas

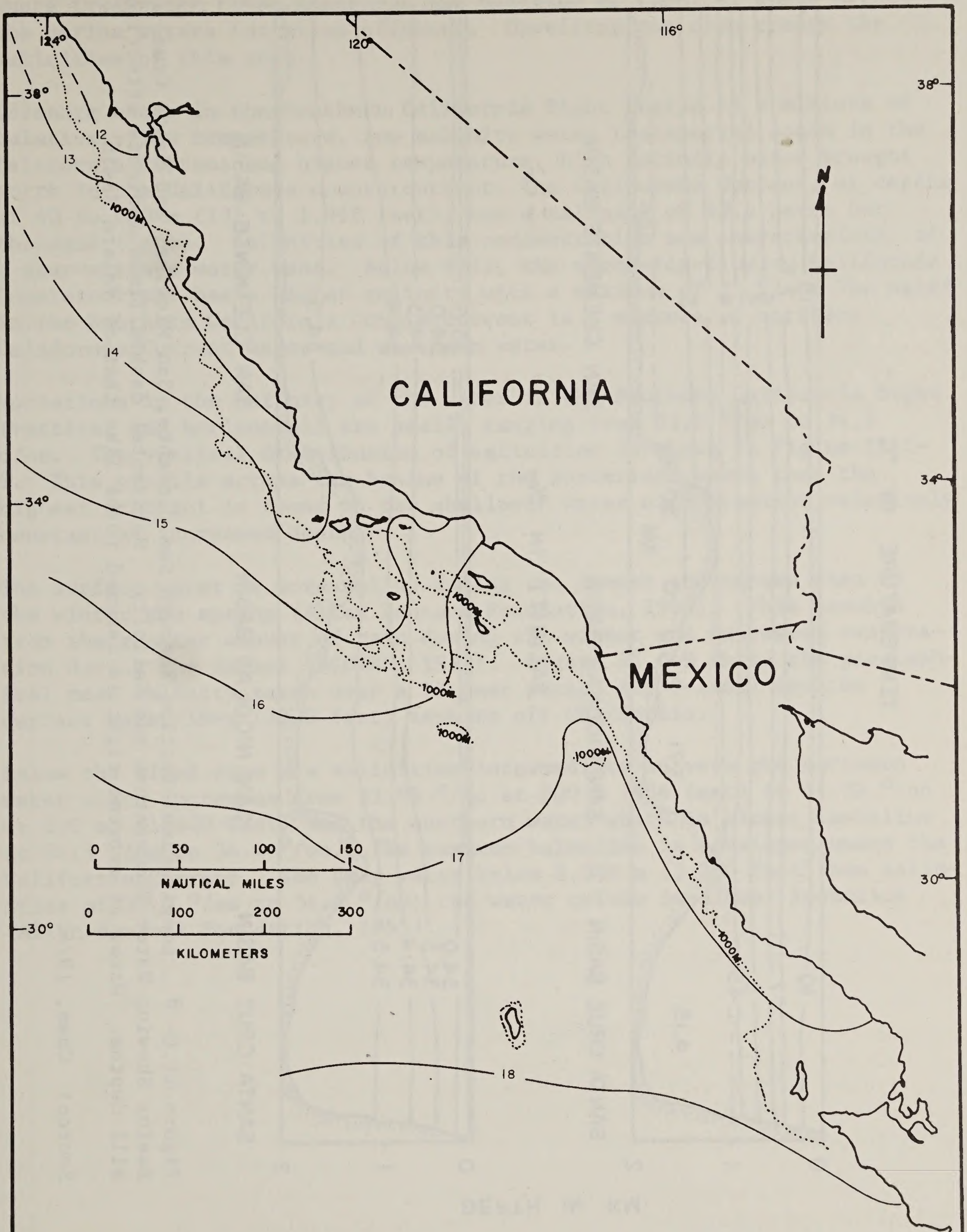


Figure II.C-7 Ten-meter Temperature (°C); 13-year Mean, 1950-62.

Source: Lynn, 1967.

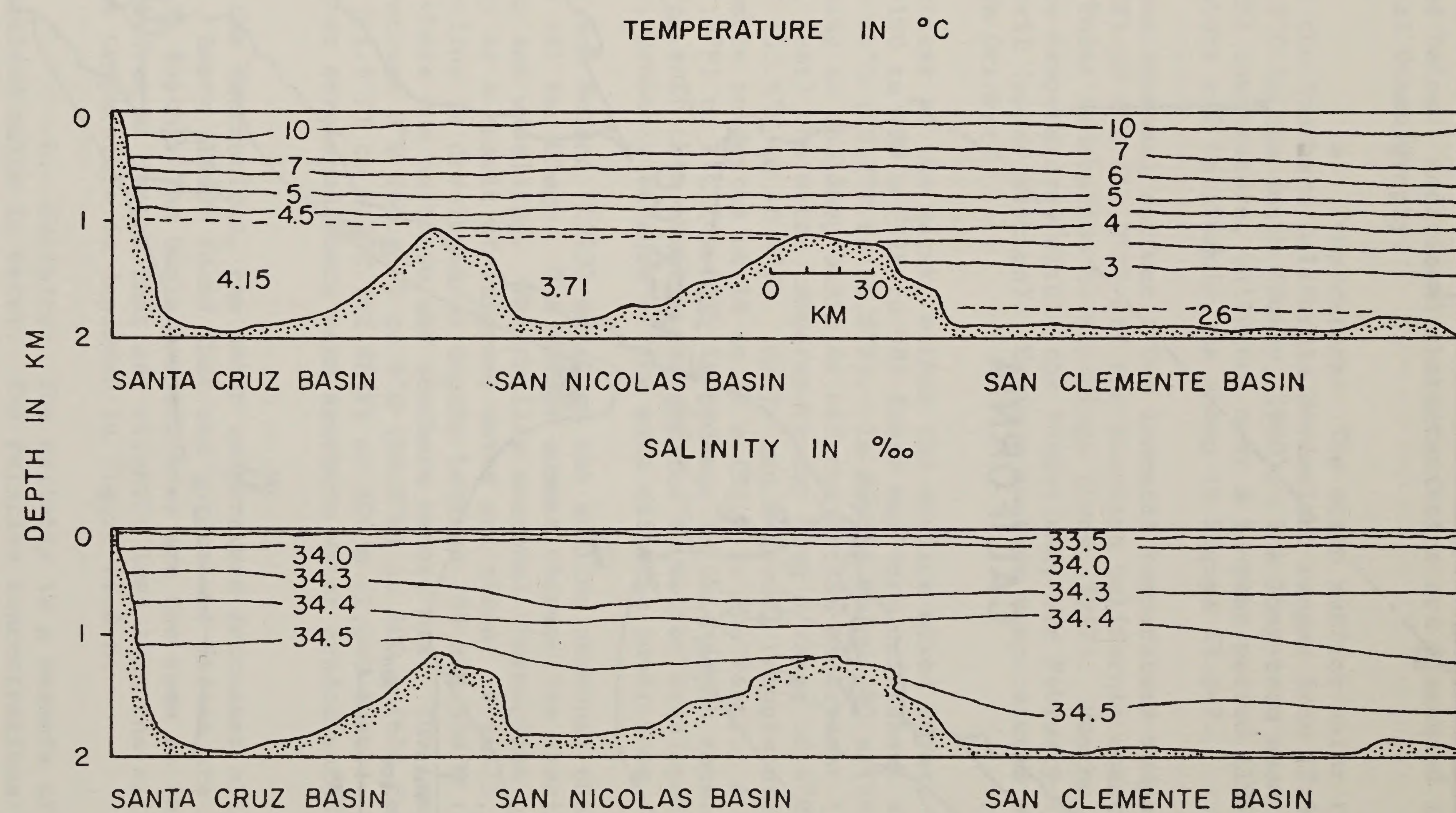


Figure II.C- 8 Longitudinal Section Through San Clemente, San Nicolas, and Santa Cruz Basins Showing Water Temperature and Salinity. Horizontal dashed lines indicate effective sill depths. Water at extreme right is assumed to be like that of Valero Basin.

Source: Chan, 1974.

where freshwater river discharge and addition of chemical salts affect the marine waters for miles offshore. Upwelling may also change the salinities of this area.

Offshore water in the Southern California Bight region is a mixture of relatively low temperature, low salinity water transported south in the California Current and higher temperature, high salinity water brought north in the California countercurrent. The California Current, at depths of 40 to 600 m (131 to 1,968 feet), has a salinity of 33.5 parts per thousand (^{o}/oo). Salinities of this concentration are characteristic of a near-surface water mass. Below this, the northerly-flowing California Countercurrent has a higher salinity with a maximum of 35 ^{o}/oo. The water in the Southern California Countercurrent is a mixture of northern California Current water and southern water.

Variations in the salinity of the water in the Southern California Bight (vertical and horizontal) are small, ranging from 33.5 ^{o}/oo to 34.5 o/oo. The vertical distribution of salinities is shown in Figure II.C-8. This profile across the basins of the Borderland shows that the highest gradient is found in the shallower water with gradient relatively constant at increased depth.

The surface water is more saline during the summer and autumn than in the winter and spring (Allan Hancock Foundation, 1965). This results from the greater amount of rain during the winter and increased evaporation during the summer (SCCWRP, 1973). Figure II.C-9 shows the geographical mean salinity taken over a 13-year period (1950-1962) for the surface water 10-m (32.8 feet) isobath off California.

Below the mixed zone are salinities intermediate between the northern water which increases from 33.85 ^{o}/oo at 200 m (656 feet) to 34.22 ^{o}/oo at 500 m: (1,640 feet) and the southern water which is almost isohaline at 34.3 ^{o}/oo to 34.4 ^{o}/oo. The maximum halocline is developed under the California Current. The deep water below 1,000 m (3,280 feet) has salinities of 34.5 ^{o}/oo to 34.6 ^{o}/oo; the water column is almost isohaline (Allan Hancock Foundation, 1965).

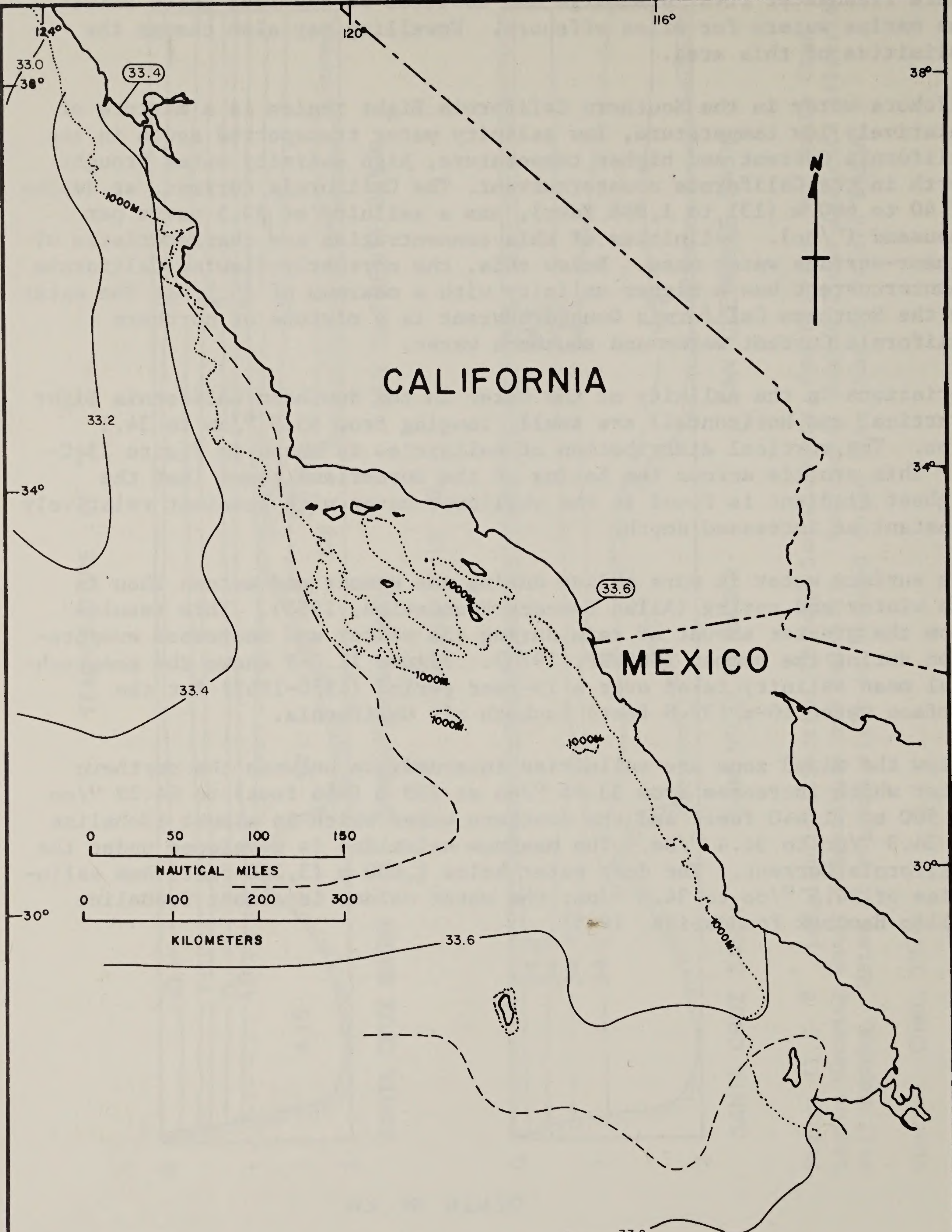


Figure II.C- 9 . Ten-meter Salinity ($^{o}/_{oo}$); 13-year Mean, 1950-62.
Interval: 0.2 $^{o}/_{oo}$.
Source: Lynn, 1967.

D. Chemical Oceanography

This section has been prepared to give the reader a general understanding of the chemistry of the Southern California Bight and adjacent waters. For more specific information, the reader should consult the Pacific OCS Reference Paper No. II or listed references.

1. Nutrients: Nutrients in sea water are chemical compounds or elements necessary for the production of organic matter. They include dissolved and particulate compounds and elements in various chemical forms that are present in very low concentration in sea water. In the surface layers of the ocean where there is enough solar radiation for photosynthesis to take place, the production of the phytoplankton depends on sufficient concentrations of inorganic nutrients such as nitrates, phosphates and silicates. Nitrogen is usually the limiting nutrient in the ocean for phytoplankton production. Generally, phosphate is not a limiting nutrient in the ocean. Although silicate can be limiting for diatoms and silicoflagellates, it is not limiting for other phytoplankton (Strickland, 1965).

Other micronutrients that have been found essential for phytoplankton production under certain conditions are trace elements (e.g., iron, manganese, molybdenum, zinc, cobalt, copper and vanadium) and vitamins (B12, thiamine, and biotin). Little is known about the distribution of these micronutrients in sea water; generally they are not the limiting nutrients in coastal waters (Strickland, 1965).

Sources of nutrients to the coastal waters off Southern California and areas to the north and south, are upwelling, waste discharge, land runoff, precipitation and the decomposition of organic matter. Upwelling is the most significant source of nutrients to the surface layers of the water column, less than 200 m (656 feet) and replenishes the nutrient supply depleted by phytoplankton growth.

a. Phosphate: The distribution of phosphate is better known than the other nutrients. Generally, phosphate values are lowest in the upper mixed layer with a sharp rise in the pycnocline increasing to a maximum value normally just below the oxygen minimum with a gradual decrease to the sea bottom. The depth of the pycnocline influences the concentration of the phosphate at depth.

Vertical distribution of phosphate observations taken over the past 20 years for Southern California and adjacent waters off central and Baja California are given in Table II.D-1. Figure II.D-1 shows location of areas given in Table II.D-1.

Table II.D-1

AVERAGE VALUES OF PHOSPHATE IN UG-AT/1 FOR WATERS OFF CENTRAL, SOUTHERN AND BAJA CALIFORNIA

	Area 20	Area 21	Area 22	Area 23	Area 24	Area 25
Surface 10 m	0.45-0.46	0.40-0.46	0.43-0.52	0.45-0.52	0.56-0.77	0.62-0.77
50 m	0.63-0.69	0.40-0.45	0.86-1.12	0.57-0.70	0.84-1.27	1.04-1.52
100 m	1.20-1.29	0.54-0.62	1.59-1.76	1.13-1.30	1.47-1.95	1.62-2.00
150 m	1.81-1.85	0.98-1.18	2.01-2.15	1.69-1.89	1.99-2.18	1.99-2.25
200 m	2.15-2.22	1.52-1.75	2.26-2.42	2.06-2.15	2.18-2.31	2.09-2.45
300 m	2.57-2.66	2.28-2.42	2.65-2.82	2.50-2.67	2.54-2.72	2.44-2.70
500 m	3.05	3.06	3.22	3.23	3.05	3.11
1000 m	3.18	3.24	3.28	3.23	3.26	3.36
2000 m		2.97	3.27	2.90	2.94 (2500 m)	3.39
Maximum Value (Depth)	3.74 (600 m)	3.74 (800 m)	3.38 (1100 m)	3.25 (700 m)	3.73 (900 m)	3.68 (800 m)

Source: U.S. Department of Commerce (1974)

Note: See Figure II.D-1 for Location of Areas.

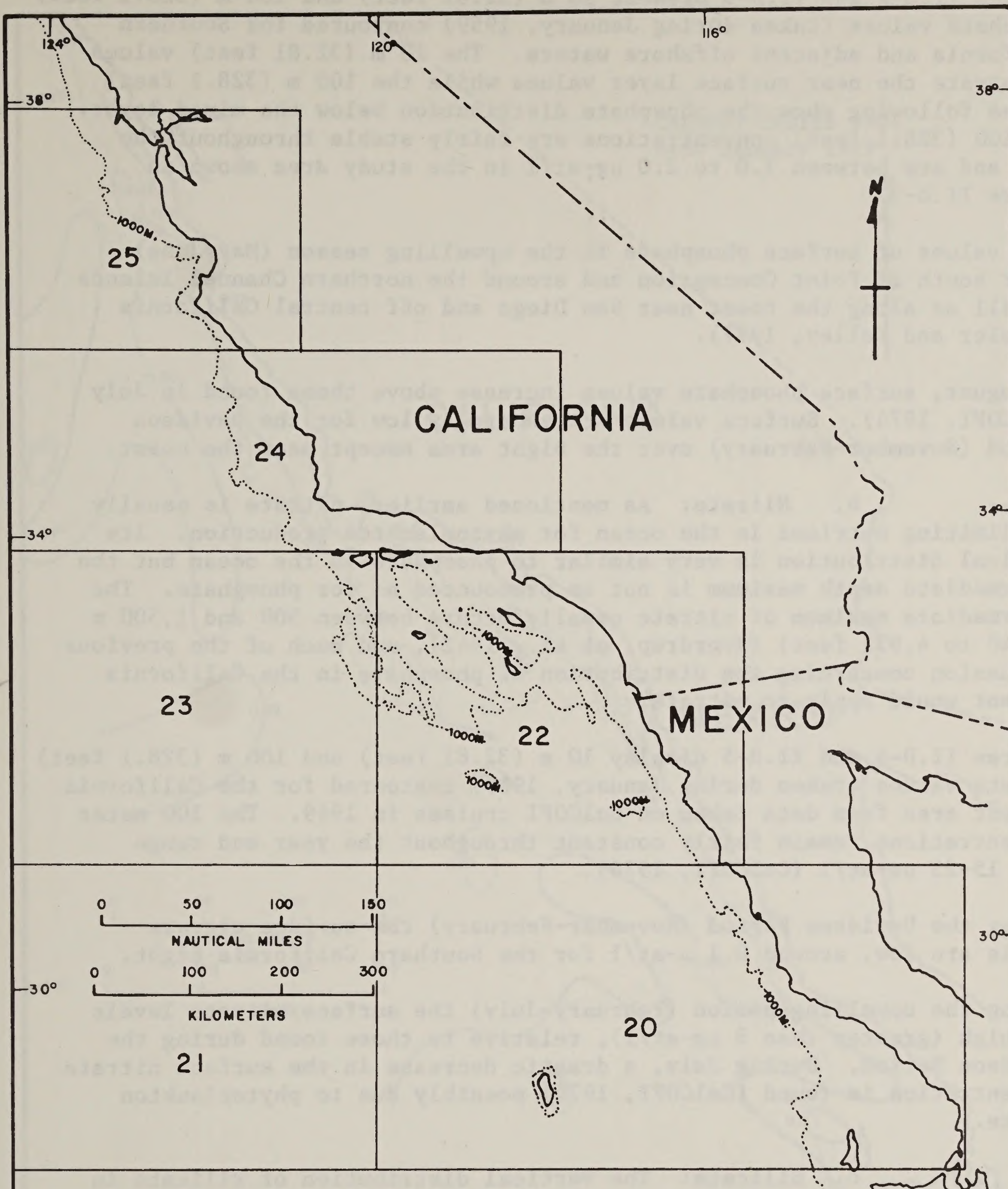


Figure II.D-1 Central, Southern and Baja California Location of Areas given in Table II.D-1.

Source: U.S. Department of Commerce, 1974.

Figures II.D-2 and II.D-3 present 10 m (32.81 feet) and 100 m (328.1 feet) phosphate values (taken during January, 1959) contoured for Southern California and adjacent offshore waters. The 10 m (32.81 feet) values illustrate the near surface layer values while the 100 m (328.1 feet) values following show the phosphate distribution below the mixed layer. The 100 (328.1 feet) concentrations are fairly stable throughout the year and are between 1.0 to 2.0 µg-at/l in the study area shown in Figure II.D-3.

High values of surface phosphate in the upwelling season (May-June) occur south of Point Conception and around the northern Channel Islands as well as along the coast near San Diego and off central California (Winzler and Kelley, 1977).

In August, surface phosphate values increase above those found in July (CalCOFI, 1974). Surface values are generally low for the Davidson Period (November-February) over the Bight area except near the coast.

b. Nitrate: As mentioned earlier, nitrate is usually the limiting nutrient in the ocean for phytoplankton production. Its vertical distribution is very similar to phosphate in the ocean but the intermediate depth maximum is not as pronounced as for phosphate. The intermediate maximum of nitrate usually occurs between 500 and 1,500 m (1,640 to 4,921 feet) (Sverdrup, et al., 1942), and much of the previous discussion concerning the distribution of phosphate in the California current would apply to nitrate.

Figures II.D-4 and II.D-5 display 10 m (32.81 feet) and 100 m (328.1 feet) nitrate values (taken during January, 1969) contoured for the California Current area from data taken on CalCOFI cruises in 1969. The 100 meter concentrations remain fairly constant throughout the year and range from 15-25 µg-at/l (CalCOFI, 1974).

During the Davidson Period (November-February) the surface nitrate levels are low, around 0.1 µ-at/l for the Southern California Bight.

During the upwelling period (February-July) the surface nitrate levels are high (greater than 8 µg-at/l), relative to those found during the Davidson Period. During July, a drastic decrease in the surface nitrate concentration is found (CalCOFI, 1974) possibly due to phytoplankton uptake.

c. Silicate: The vertical distribution of silicate in the ocean differs from phosphate and nitrate since there is no maximum at intermediate depths and the concentration increases all the way to the bottom (Sverdrup, et al., 1942). Maximum concentrations of silicate

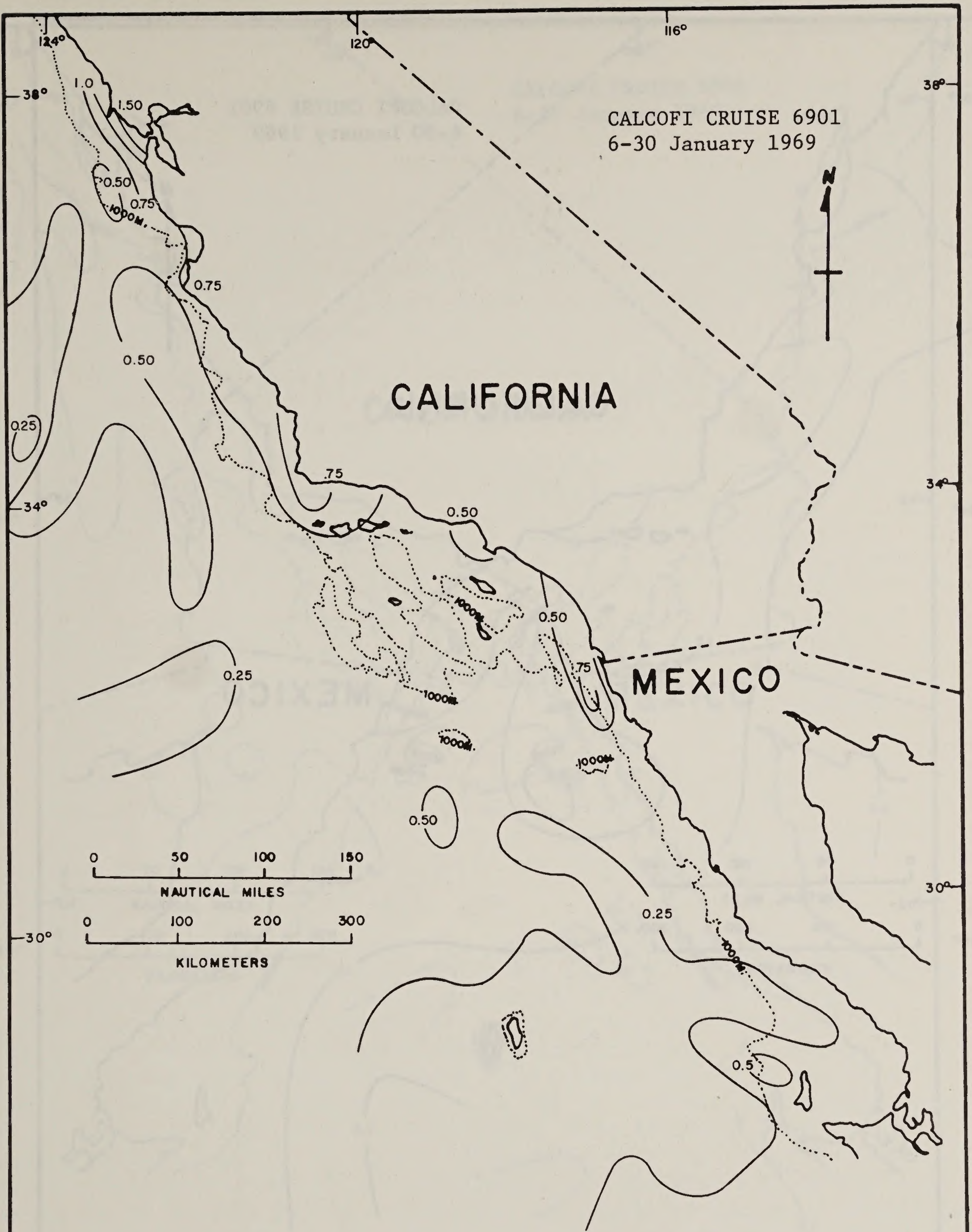


Figure II.D-2 10 Meter Phosphate-P

Source: CALCOFI, 1974 Contour Interval 0.25 µg-at/liter

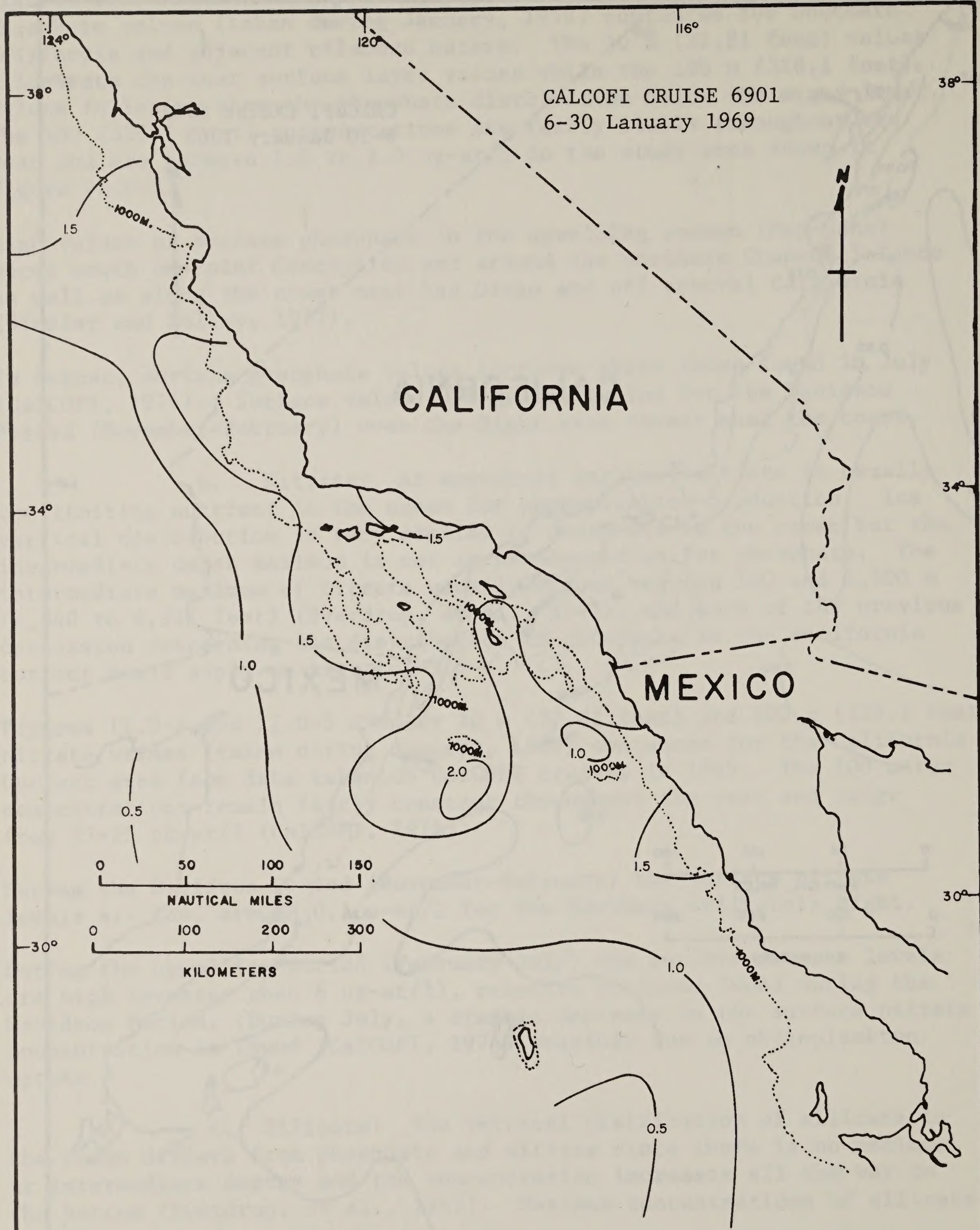


Figure II.D-3 100 Meter Phosphate-P

Source: CALCOFI, 1974. Contour Interval 0.5 µg-at/liter

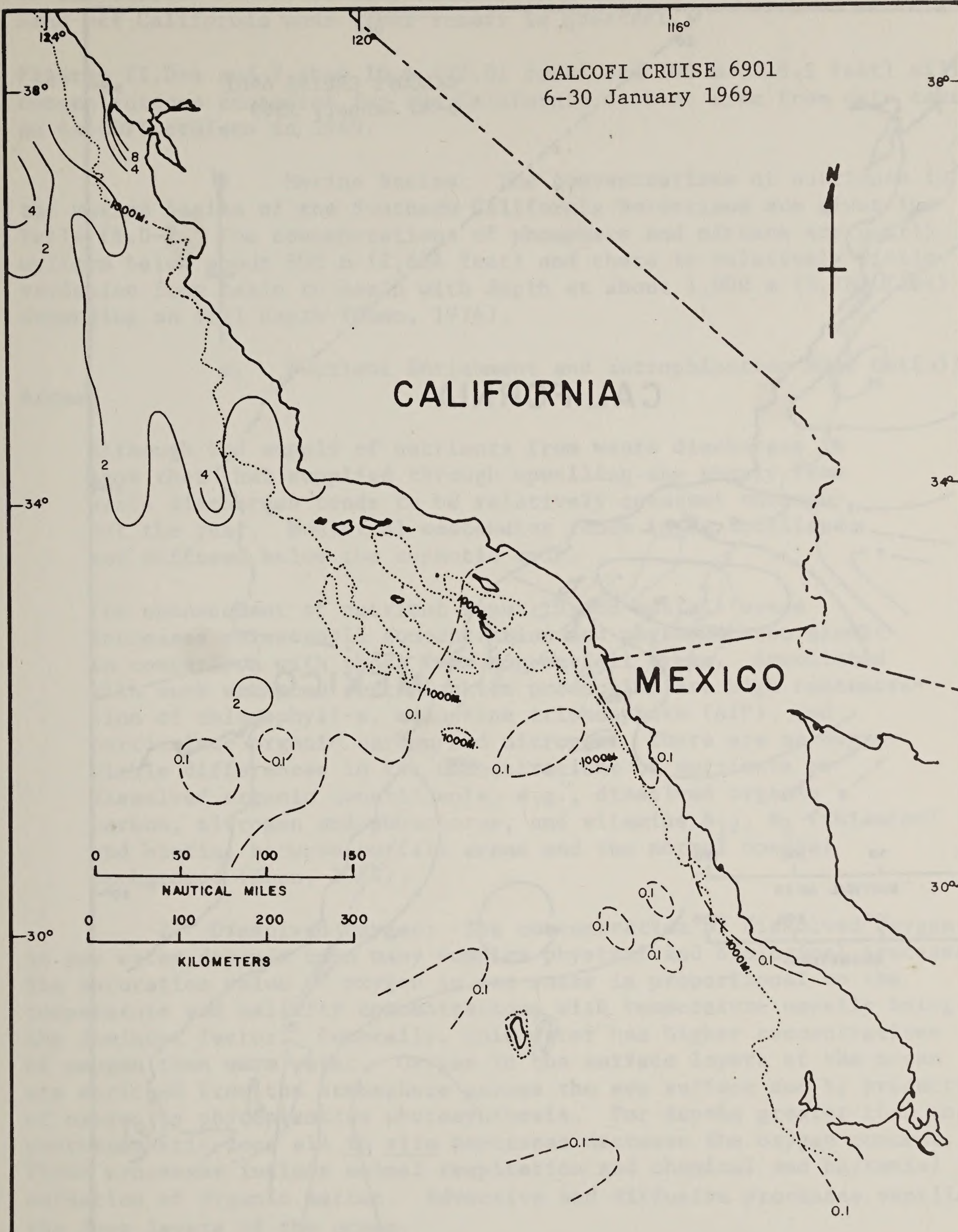


Figure II.D-4 10 Meter Nitrate-N

Source: CALCOFI, 1974. Contour Interval 2μg-at/liter

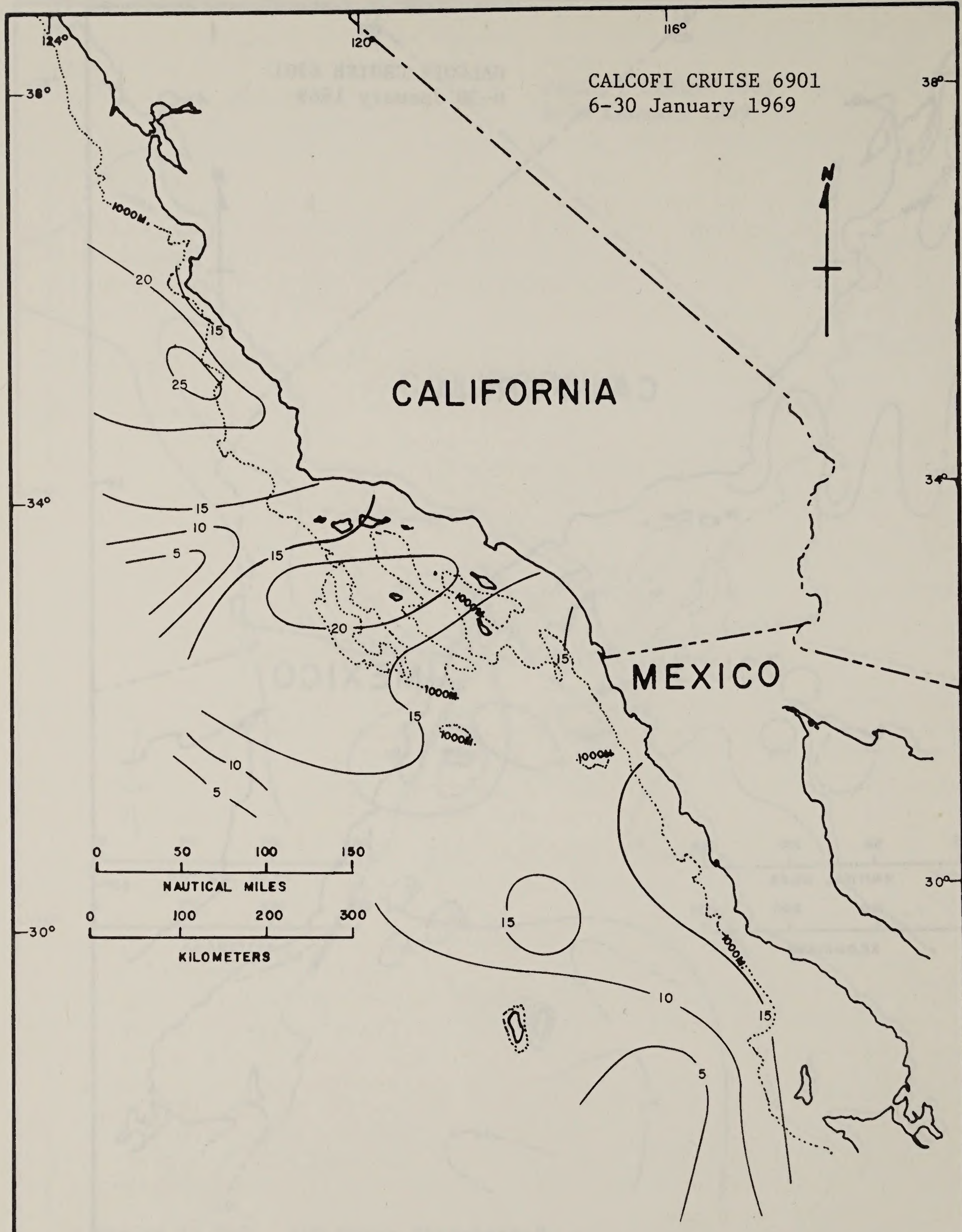


Figure II.D- 5 100 Meter Nitrate-N

Source: CALCOFI 1974. Contour Interval 5μg-at/liter in the surface waters usually occur during the winter in the coastal area off California when river runoff is greatest.

Figures II.D-6 and 7 show 10 m (32.81 feet) and 100 m (328.1 feet) silicate concentrations contoured for the California Current area from data taken on CalCOFI cruises in 1969.

d. Marine Basins: The concentrations of nutrients in the marine basins of the Southern California Borderland are given in Table II.D-2. The concentrations of phosphate and nitrate are nearly uniform below about 800 m (2,624 feet) and there is relatively little variation from basin to basin with depth at about 1,000 m (3,280 feet) depending on sill depth (Chan, 1974).

e. Nutrient Enrichment and Eutrophication Near Outfall Areas:

> Although the supply of nutrients from waste discharges is less that that supplied through upwelling the supply from waste discharges tends to be relatively constant throughout the year. Municipal wastewater tends to be localized and diffused below the euphotic zone.
>
> The enhancement of nutrient input in the outfall areas increases chlorophyll concentration and phytoplankton growht in comparison with those from non-outfall areas. Associated with such enhanced phytoplankton production are high concentration of chlorophyll-a, adenosine triphosphate (ATP), and particulate organic carbon and nitrogen. There are no appreciable differences in the concentrations of nutrients or dissolved organic constituents, e.g., dissolved organic carbon, nitrogen and phosphorus, and vitamins B_{12}, B_1 (thiamine) and biotin, between outfall areas and the normal coastal background (Chan, 1974).

2. Dissolved Oxygen: The concentration of dissolved oxygen in sea water depends upon many complex physical and biological processes. The saturation value of oxygen in sea water is proportional to the temperature and salinity concentrations with temperature usually being the dominant factor. Generally, cold water has higher concentrations of oxygen than warm water. Oxygen in the surface layers of the ocean are enriched from the atmosphere across the sea surface and by production of oxygen by phytoplankton photosynthesis. For depths greater than the photosynthetic zone all *in situ* processes decrease the oxygen content. These processes include animal respiration and chemical and bacterial oxidation of organic matter. Advective and diffusive processes ventilate the deep layers of the ocean.

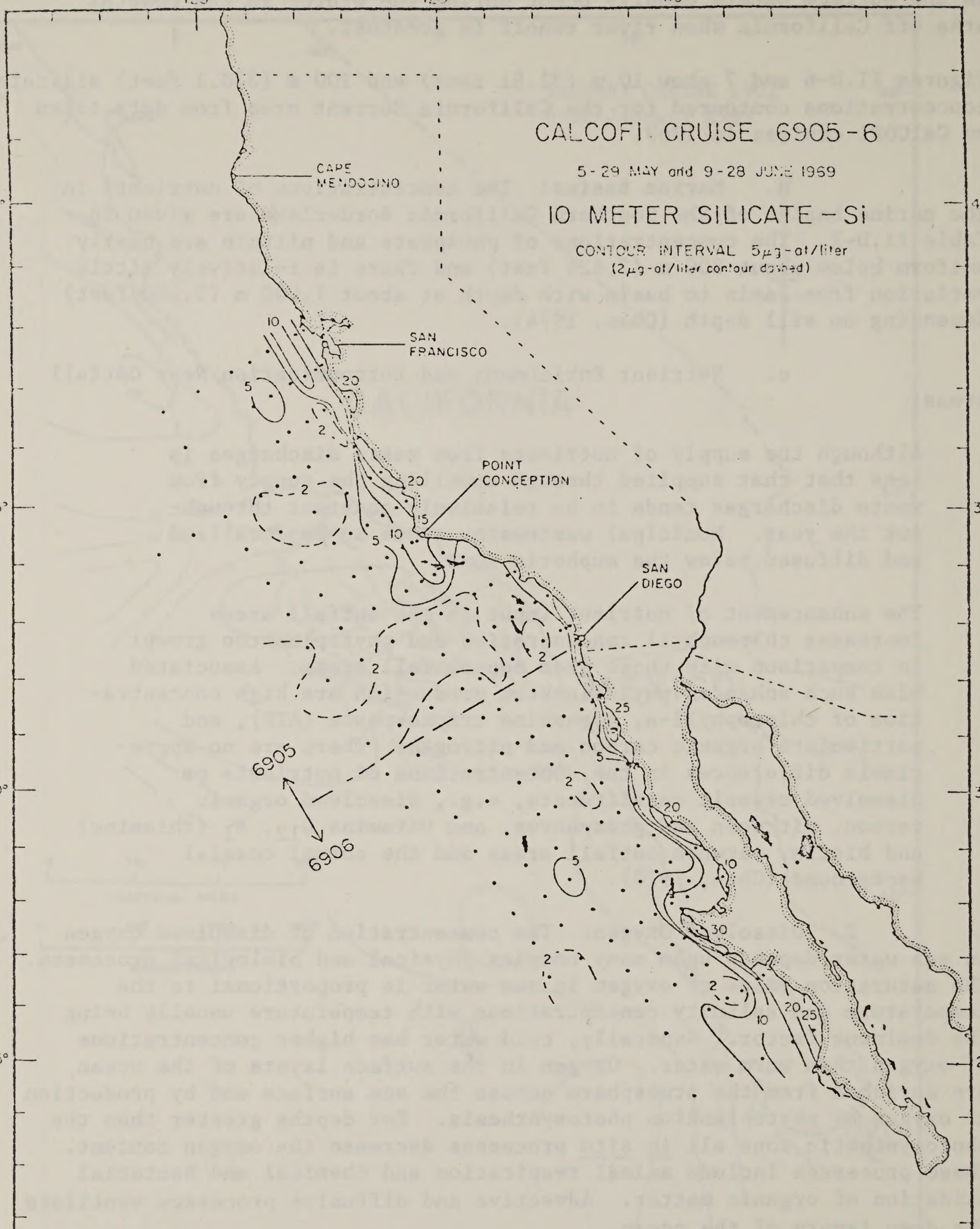


Figure II.D-6 10 Meter Silicate-Si

Source: CALCOFI, 1974.

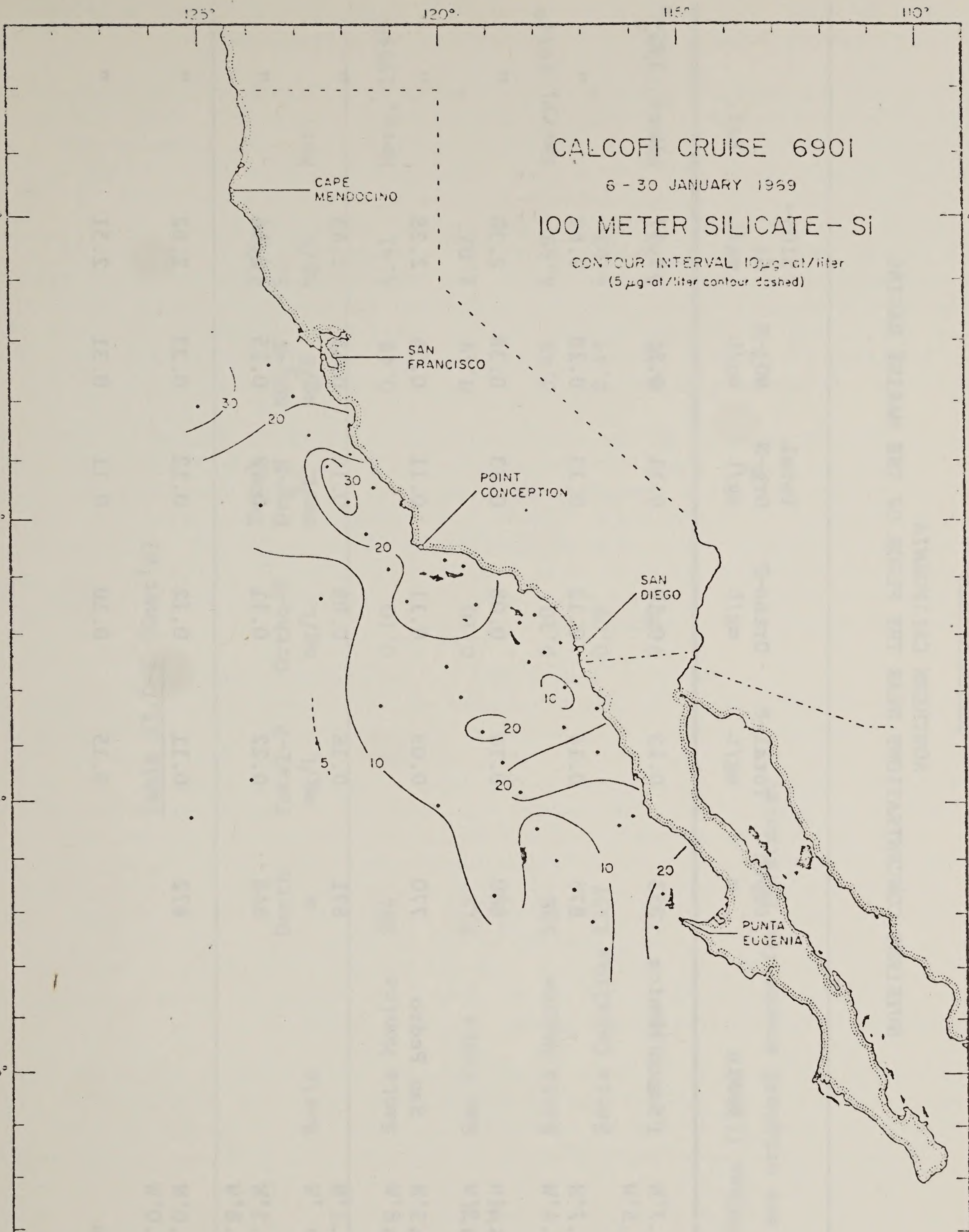


Figure II.D-7 100 Meter Silicate-Si

Source: CALCOFI, 1974.

Table II.D-2

SOUTHERN CALIFORNIA
NUTRIENT CONCENTRATIONS NEAR THE FLOOR OF THE MARINE BASINS

Location	Basin	Depth m	Total-P mg/L	Ortho-P mg/L	Total Org-N mg/L	NO_3-N mg/L	SiO_2-Si mg/L	Ref.
33°51.7'N 119°07.5'W	Santa Monica	833	0.13	0.10	0.11	0.22	2.57	Merz, 1959[a]
33°48.7'N 118°55.4'W		876	0.14	0.12	0.13	0.28	2.62	"
33°45.4'N 118°51.5'W		880	0.18	0.08	0.23	0.38	2.38	"
33°45.5'N 118°34.8'W	San Pedro	770	0.09	0.11	0.11	0.34	2.38	"
33°38.1'N 118°2. 'W		871	0.16	0.09	0.10	0.40	2.43	"
33°34.3'N 118°24.8'W		848	0.22	0.11	0.12	0.25	2.66	"
33°31.0'N 118°21.0'W		872	0.11	0.12	0.12	0.33	2.62	"
Average			0.15	0.10	0.11	0.31	2.51	"

Table II.D-2 (Cont'd)

Location	Basin	Depth m	Total-P mg/L	Ortho-P mg/L	Total Org-N mg/L	NO_3-N mg/L	SiO_2-Si mg/L	Ref.
33°45'N 118°46'W	Santa Monica	884		0.10		0.49	4.41	Merz, 1959[a]
33°29.8'N 118°22.1'W	San Pedro	915		0.10		0.49	2.02	"
	Santa Monica	938		0.10		0.49	4.49	Emery, 1954[a]
	Santa Catalina	1357		0.09		0.49	4.63	"
	E. Pacific	750		0.10		0.48	3.70	Merz, 1959[a]

Source: Chan (1974)

[a]Note: See original source for reference.

Sinking of cold, highly oxygenated water to depth in the higher latitudes of the Atlantic Ocean is the main source of this ventilation.

Within the Southern California Bight, the surface layers of the California Current are saturated with oxygen down to the thermocline. Cold, highly oxygenated subarctic water is transported south along the coast in the surface layers (less than 200 m (656 feet) depth). This water mixes with the warmer, low oxygen content equatorial water brought north at depth in the northward flowing countercurrent below 200 m (656 feet). The oxygen content of the water generally decreases with depth down to an oxygen-minimum layer found between 700 and 1000 m (2,297 to 3,280 feet). Beneath the minimum layer, there is a gradual increase in oxygen content with depth, and the oxygen content of the deep ocean waters is constant for hundreds of meters. Average oxygen values for areas off southern California (portrayed in Figure II.D-1) are given in Table II.D-3.

The rapidly decreasing values of oxygen from the surface values to the low values at deeper depth reflect the losses of oxygen by respiratory and oxidative processes transferring energy and breaking down organic matter produced in the surface layers. The oxygen-minimum layer for the Southern California Bight area is around 600-700 m (1,969 to 2,296 feet) with an average value of 0.38 ml/l. Below 700 m, (2,797 feet) the oxygen concentrations increase to 1.6-3.0 ml/l reflecting the influence of oxygen ventilation by the deeper waters.

a. Seasonal Variations: A subsurface maximum of oxygen develops in late spring and summer and continues through fall and the early winter months. It is usually found at depths corresponding to the lower part of the wind-mixed layer, around 50 m (164 feet) and is generally widespread throughout the Pacific Ocean in the summer. According to Reid (1962), the oxygen fluctuations in the upper layers of the ocean are due to seasonal variations in the thermal structure. The sequence of formation of the subsurface maximum is generally as follows: In winter, the oxygen values in the surface wind-mixed layer are fairly constant at about saturation. During the spring, the surface values begin to fall but the oxygen content at 30 to 70 m (98 to 230 feet) depth does not begin to fall until July or August. Therefore, a maximum value is found around 50 m (164 feet) from late spring to winter, nearly always slightly supersaturated (Reid, et, al., 1958).

Other seasonal features of note in the coastal waters are as follows: A decrease in the oxygen content of the surface layers is sometimes observed in local areas due to upwelling of water low in oxygen content in the upwelling season (most intense in May-June for Southern California).

Table II.D-3

AVERAGE VALUES OF OXYGEN IN Ml/1 FOR CENTRAL, SOUTHERN AND BAJA CALIFORNIA

	Area 20	Area 21	Area 22	Area 23	Area 24	Area 25
Surface (10 m)	5.38-5.64	5.33-5.57	5.49-5.88	5.47-5.83	5.53-5.94	5.75-6.11
50 m	5.33-5.46	5.57-5.62	4.52-5.12	5.40-5.63	4.68-5.25	4.65-5.33
150 m	3.00-3.72	4.37-4.52	2.43-2.77	3.31-3.46	2.47-2.79	2.62-2.88
200 m	2.21-2.35	3.44-3.52	1.84-2.17	2.63-2.73	2.05-2.28	2.21-2.42
500-1000 m	0.43-0.59	0.54-0.63	0.43-0.55	0.40-0.62	0.39-0.57	0.58-0.53
Minimum value (depth)	0.34 (600m)	0.41 (700m)	0.34 (600m)	0.40 (600m)	0.38 (700m)	0.38 (700 & 800m)
200-3000 m	1.86-2.61		1.56-	1.85-3.07	1.81-2.59	1.72-3.26

Source: U.S. Department of Commerce (1974)

Richards (1965) estimated rates of oxygen consumption off Southern California to be 1.8 ml/l/yr. at 200 m (656 feet) and 0.05 ml/l/yr. at 700 m (2,296 feet). These rates could be similar for the rest of the California Current area.

Water in the marine basins in the Southern California Borderland has approximately the same oxygen content as the water outside the basins at the same depth as the basin sills. Refer to Figure II.D-8. As shown in this figure, low dissolved oxygen occurs in the nearshore basins (Santa Barbara, Santa Monica and San Pedro) while the deeper sill depth (below the oxygen minimum layer) outer basins (Santa Catalina, Santa Cruz, San Nicholas, Tanner, West Cortes and San Clemente) have higher oxygen concentrations.

The tolerance of marine organisms to low oxygen levels varies widely. The oxygen consumption rates of some organisms are oxygen-dependent while rates for others are oxygen-independent. The oxygen concentration that causes an organism to switch from an oxygen-independent to oxygen-dependent metabolism can correlate with the organism's habitat and varies with the following factors: 1) age and stage of life cycle, 2) temperature, and 3) oxygen acclimation. For example, the sea starfish *Patiria miniata* is usually found in highly oxygenated rocky surf waters. Conversely, many bottom-dwelling molluscs exposed to low oxygen levels are metabolically independent until a low oxygen tension is reached (Vernberg and Vernberg, 1972).

3. Hydrogen Ion Concentration: The concentration of the hydrogen ion is measured on the pH scale, where a pH value of 1 is very acidic (high hydrogen ion concentration), 7 is chemically neutral, and 14 is very alkaline. The following is a summary of pH data for the Southern California Bight taken from Chan (1974).

The range of pH for the shelf water varies from about 7.5 to 8.6. The Allan Hancock Foundation showed that the pH of 65 percent of 200 water samples collected had pH of the sea water decreasing to a range of values between 7.6-7.8 (1965). High pH values at or near the sea surface are due to the equilibrium with the carbon dioxide in the atmosphere, but the maximum pH values may be caused by the photosynthetic activity of plants, which reduces the content of carbon dioxide in sea water. Below the euphotic zone, pH decreases as the concentration of carbon dioxide increases as a result of respiration and decomposition. In the oxygen minimum layer, there is a gradual increase in pH with depth.

SOUTHERN CALIFORNIA DISSOLVED
OXYGEN CONCENTRATION

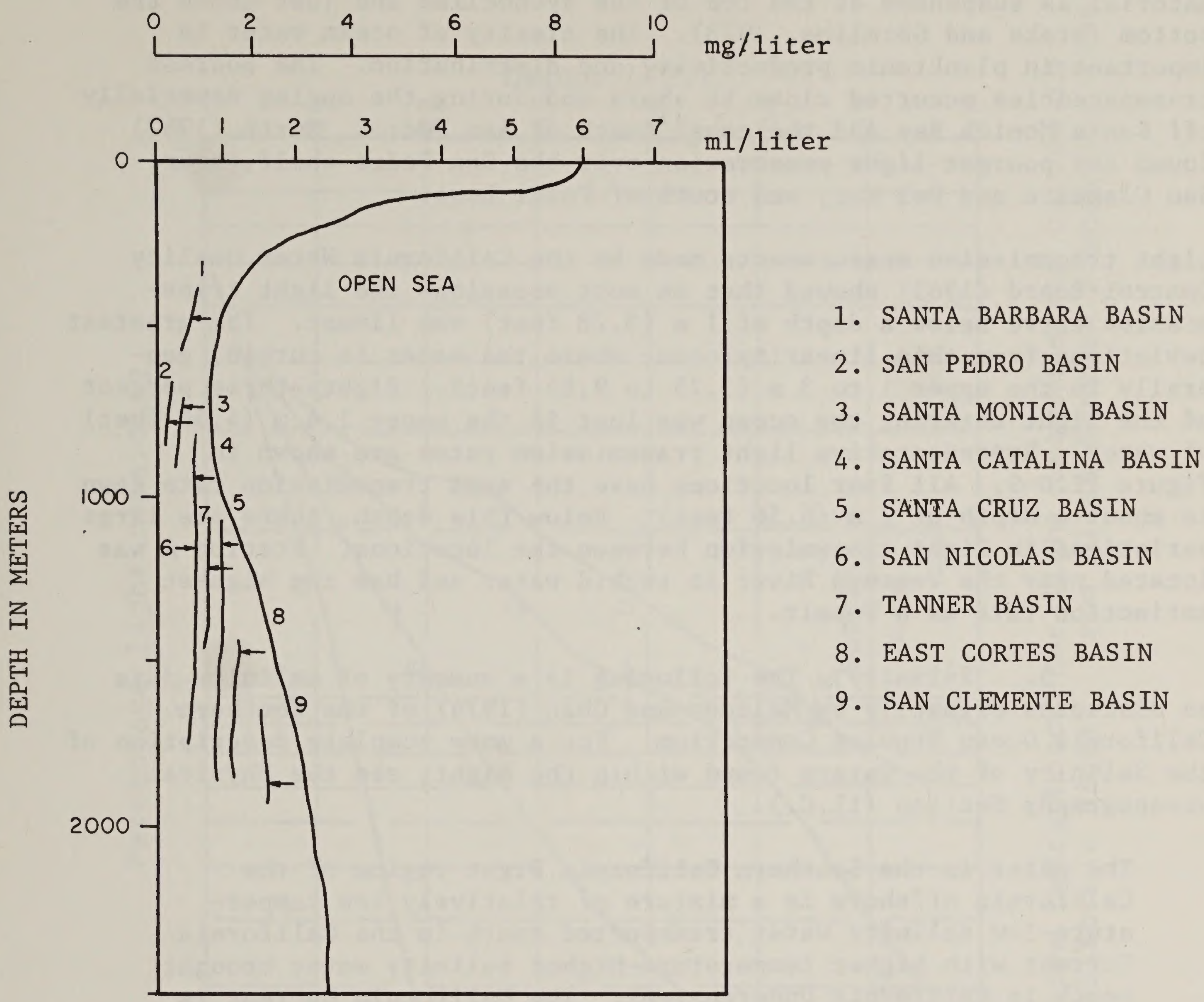


Figure II.D- 8 Oxygen versus Depth Curves for Open Sea and for Waters below Basin Sills. Arrows Indicate Sill Depths.

Source: Chan, 1974.

4. Turbidity: Turbidity consists of inorganic mineral material and organic material consisting of plankton and organic detritus. This turbidity comes from river floods, waves on coasts, plankton blooms, benthic plants and sewage outfalls. Most of the particulate material is suspended at the top of the pycnocline and just above the bottom (Drake and Gorsline, 1973). The clarity of ocean water is important in planktonic productivity and distribution. The poorest transparencies occurred close to shore and during the spring especially off Santa Monica Bay and the coast south of San Pedro. North (1962) found the poorest light penetration over the San Pedro shelf, near San Clemente and Del Mar, and south of Point Loma.

Light transmission measurements made by the California Water Quality Control Board (1965) showed that on most occasions the light transmission curve below a depth of 1 m (3.28 feet) was linear. The greatest deviations from this linearity occur where the water is turbid, generally in the upper 1 to 3 m (3.25 to 9.84 feet). Eighty-three percent of the light entering the ocean was lost in the upper 1.4 m (4.59 feet) of water. Representative light transmission rates are shown in Figure II.D-9. All four locations have the same transmission rate down to about a depth of 2 m (6.56 feet). Below this depth, there are large variations in light transmission between the locations. Station A was located near the Ventura River in turbid water and has the highest extinction rate as a result.

5. Salinity: The following is a summary of salinity data as discussed primarily by Maloney and Chan (1974) of the Southern California Ocean Studies Consortium. For a more complete description of the Salinity of the waters found within the Bight, see the Physical Oceanography Section (II.C.).

> The water in the Southern California Bight region of the California offshore is a mixture of relatively low temperature-low salinity water transported south in the California Current with higher temperature-higher salinity water brought north in California Undercurrent. The California Current is found at depths of 40 to 600 m (131 to 1,968 feet) with salinities of 23.5°/oo. Salinities of this concentration are characteristic of a near surface water mass. The northerly flowing California Undercurrent is present at depths of more than 150 to 200 m (492 to 656 feet) and less than 500 to 800 m (1,640 to 2,624 feet) in the Bight Region. It has a higher salinity than the California Current with a maximum of 34.35 °/oo. The water in the Southern California Countercurrent is a mixture of

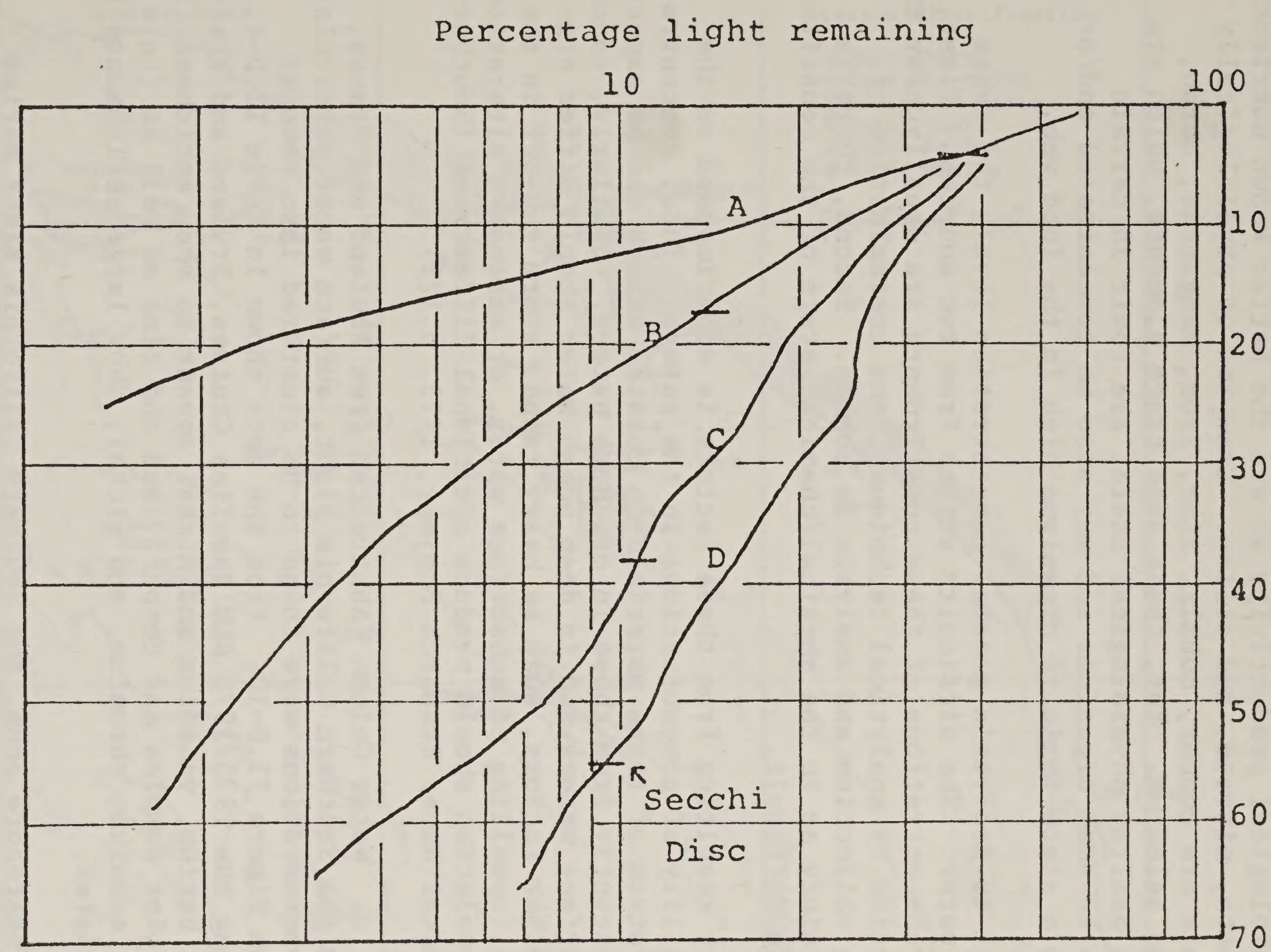


Figure II.D- 9 Representative hydrophotometer light transmission curves in Southern California Bight. From Allan Hancock Foundation (1965).

Northern California Current water and southern water. At 10 m (32.81 feet) the salinities range from 33.4 °/oo to 34.6 °/oo and are 0.1 °/oo to 0.2 °/oo greater than the California Current.

6. Trace Metals: Although trace materials such as metals are difficult to measure and are therefore less well known, many are as essential to biological productivity as are the better known nutrients such as phosphate, nitrate, and silica. Examples of physiologically essential metals are copper, cobalt, zinc, iron, manganese, boron, molybdenum, and selenium. Yet, these same trace elements, which are essential to a healthy physiological state, are toxic in certain concentrations to some organisms and may also be concentrated and/or transformed to a state toxic to organisms high in the food web.

It is difficult to ascertain general concentration levels for trace metals in sea water. The difficulty arises from two sources. First, the sea water concentrations of these constituents are usually near the limit of detection by analytical techniques, and contamination of samples during collection and analysis is common. Second, there is usually uncertainty as to the physical/chemical state of the constituent, and analysis is difficult.

The variability resulting from these factors is superimposed on the natural variability of concentrations in the waters. Total concentrations and the state of trace materials in coastal waters can be expected to vary significantly from those in offshore waters. Similarly, concentrations in surface waters and in deep ocean water should differ significantly. Other factors, such as heavy rains, storm run-off in the coastal waters, upwelling of subsurface water, or extensive alterations in plankton population should produce additional differences (Southern California Coastal Water Research Project, 1973, p.125).

a. Water Column (Abstracted from Bruland and Franks, 1977): Within the Southern California Bight, surface water particulate trace metal concentrations were found to be clustered into several groups shown on Figure II.D-10. From the data shown in Table II.D-4, collected during the 1975/1976 BLM Baseline Cruises, Bruland and Frank concluded that barium, vanadium and nickel appear to show enrichment in the Coal Oil Point samples and copper, lead and zinc as well as (to a lesser extent) cadmium, chromium, and nickel, show large enrichments in sewage particulates.

Excluding the nearshore zone, the Southern California Bight marine waters can be grouped into three areas. These include inner basins, the outer basins, and the outer banks (Figure II.D-10).

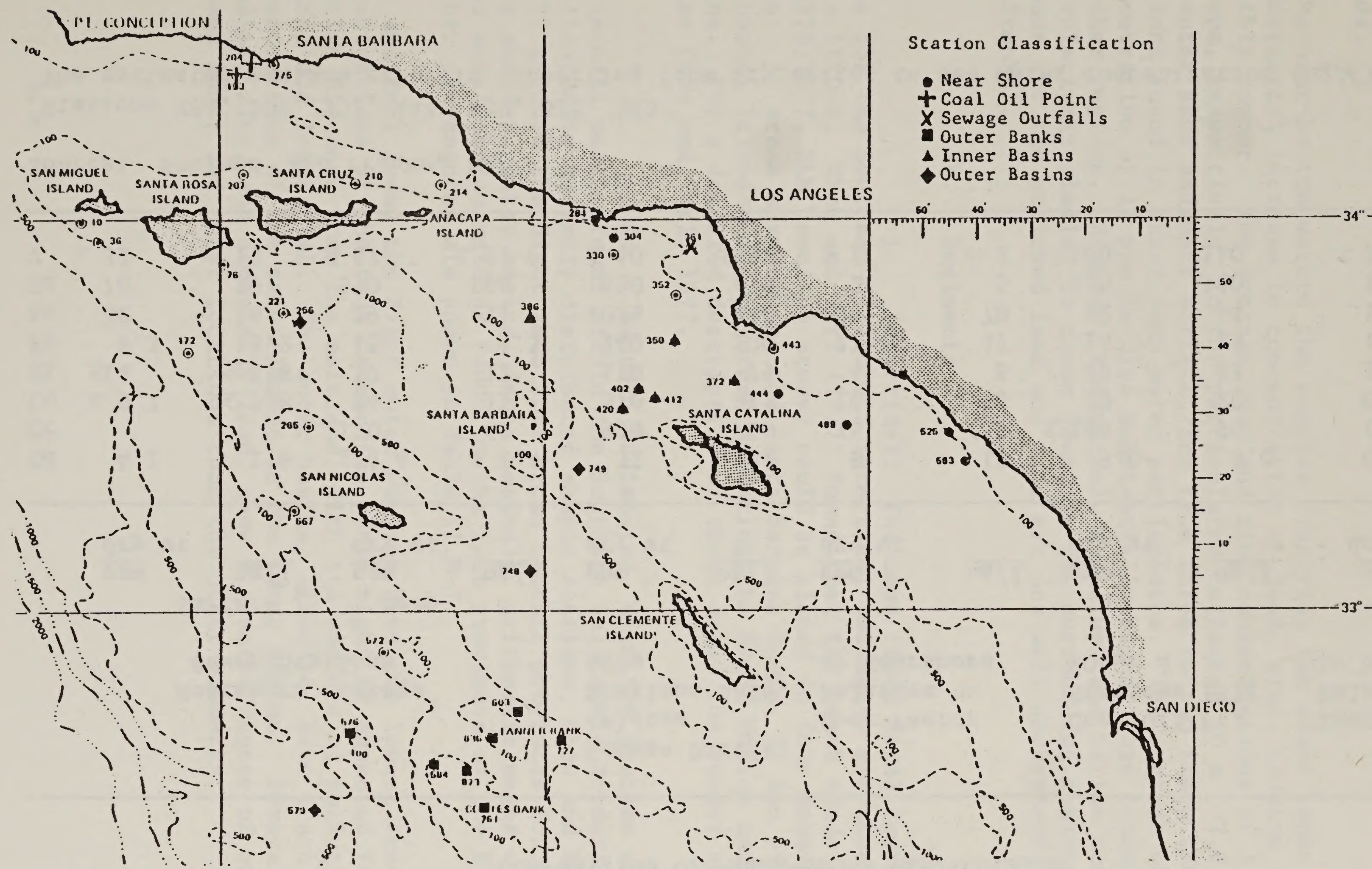


Figure II.D.-10 Southern California Borderland Water Column Cruise (41 stations) January 19-31, 1976, R/V Alexander Agassiz.

Source: Bruland and Franks 1977.

Table II.D-4

COMPOSITION OF NEAR-SHORE PARTICULATES

	Nearshore Average[a] Seven Stations: Surface ppm dry wt	Surface ng/l[b]	Deep ppm dry wt	Deep ng/l	Sewage Particulates Stations 361d, 443s: ppm dry wt	ng/l	Conc Factor Relative to Av Nearshore: ppm dry wt	ng/l	Coal Oil Pt. Stations 193d 204s, d: ppm dry wt	ng/l	Conc Factor Relative to Av Nearshore: ppm dry wt
Cd	4.1	1.6	≤ 4.4	≤ 1.4	32	27	8	18	3.0	3.0	0.7
Cr			170	62	990	780	(6)	(13)	≤ 105	≤ 90	(.6)
Cu	≤ 9.7	≤ 3.8	34	11	570	415	26	56	20	20	0.9
Ni	≤14	≤ 6.8	37	12	110	79	4	8	42	43	1.7
Pb	8.3	3.2	15	5.3	240	200	21	47	14	13	1.2
Zn	32	16	39	11	1025	940	29	70	42	44	1.2
Ba	70	29	530	160	630	470	2	5	475	460	1.6
V	≤ 32	≤ 13	≤ 67	≤ 22	≤ 60	≤ 42	∿ 1	∿ 2	100	110	≤ 2.0

Source: Bruland and Franks, 1977.

[a] Stations 284, 304, 352, 444, 488, 525, 563

[b] The estimated maximum error in converting from dry weight to sea water concentration (ng/ℓ) is ±15%

The average trace element chemical composition of the surface stations does not seem to contrast markedly between the groups (Table II.D-5). The lead concentration appears to be a factor of two or three higher in the particulates of the outer stations relative to the inner basins. However, none of the other seven elements appear to show any definite trends.

In the near-bottom waters the samples overlying the outer banks exhibit a substantial increase in concentration of lead, zinc, cadmium and possibly copper. The average lead and zinc concentrations of 130 and 150 ppm, respectively, in the particulates collected 10 m (32.81 feet) above the outer bank sediment surface, are from three to ten times the concentrations found in other deep water particulates. The average cadmium concentration of 17 ppm is also substantially higher than concentrations in other regions. However, the nickel, vanadium, and barium concentrations are relatively similar to those found in the surrounding regions. The reasons for the enriched lead and zinc are not well understood (Bruland and Franks).

b. Sediments

i. Intertidal: The mean trace metal concentrations for the Southern California intertidal sediments are shown in Table II.D-6. Chow and Earl (1977) found that the beach sands (collected in 1976/1977, BLM baseline study) could be placed in four general classifications: 1) areas surrounding the Santa Barbara Basin, 2) San Diego area, 3) Channel Islands, and 4) areas bordering the Santa Monica and San Pedro Basins. For a detailed description of these areas the reader should review Chow and Earl, 1977.

ii. Benthic Sediments: With the problem of an atypical continental margin found within the Southern California Borderland, complicated by unevenly distributed sample stations, Chow and Earl (1977) grouped the Bight into four broad benthic provinces (outer shelves, inner shelves, outer basins, inner basins). Arithmetic means of the trace metal concentrations found in the four provinces of the Bight benthic provenances are shown in Table II.D-7.

Chow and Earl found the Bight outer shelves have the lowest trace metal concentrations of the four categories, this might be expected from their relative distance from the mainland, with its sources of pollution, both natural and industrial. The outer basins, likewise, have trace metal concentrations of the same element in the inner basins. Several elements, vanadium, zinc, and especially lead, show a greater degree of enrichment between inner and outer locations than the other elements.

Table II.D- 5

TRACE ELEMENTS IN PARTICULATES AT INNER BASINS, OUTER BASINS AND OUTER BANKS

	Inner Basins 350, 372, 386 402, 412, 420				Outer Basins 256, 579, 748 749d				Outer Banks (Tanner & Cortez) 576, 584, 603 636, 673, 727, 761			
	Surface		Deep		Surface		Deep		Surface		Deep	
	ppm	ng/l	ppm	ng/l	ppm	ng/l	ppm	ng/l	ppm	ng/l	ppm	ng/l
Cd	6.9	1.8	2.6	0.5	9.6	1.1	7.9	0.6	8.3	1.7	18	1.1
Cr												
Cu	≤ 8	≤ 2.5	≤ 18	≤ 3.4	≤ 34	≤ 3.8	≤ 55	≤ 4.5	≤ 13	≤ 2.5	≤ 53	≤ 3.8
Ni	23	7	30	5.8	30	3.4	50	4.4	16	2.8	50	3.4
Pb	8.5	2.5	11	1.8	25	2.8	37	2.6	18	2.4	130	7.8
Zn	42	16	43	8.0	29	3.3	62	6.0	42	5.5	150	10
Ba	65	19	1100	160	≤ 87	≤10	1450	123	≤ 48	≤ 8.6	1010	67
V	≤ 33	≤ 10	≤ 48	≤ 9	≤ 52	≤ 6	≤ 98	≤ 8	≤ 41	≤ 6	≤ 94	≤ 7

Source: Bruland and Franks, 1977.

Table II.D-6

SOUTHERN CALIFORNIA MEAN TRACE METAL CONCENTRATIONS OF INTERTIDAL SEDIMENTS (ppm)

Beach (number of samples)	Ba	Cd	Cr	Cu	Ni	Pb	V	Zn
Mainland								
Coal Oil Point (16)	861	0.36	47.2	4.8	10.3	7.6	20.3	14.4
Outer Cabrillo (3)	1082	.37	29.0	5.8	24.1	12.5	62.7	65.0
Point Mugu (3)	906	.30	6.0	3.5	2.3	9.3	15.0	9.4
Point Dume (6)	833	.27	18.2	3.9	4.9	11.2	16.5	12.6
Torrance (5)	1182	.24	9.9	2.4	4.2	12.2	19.4	15.1
Scripps (1)	647	.30	10.0	2.7	1.3	11.0	24.0	15.0
Pt. Loma - Ocean Beach (18)	518	.32	15.0	2.3	2.2	7.6	50.1	23.3
Channel Islands								
San Miguel (2)	366	.35	8.5	5.6	7.6	11.3	13.0	6.9
Santa Cruz (3)	312	.40	40.7	21.0	31.3	5.1	72.3	44.0
Santa Catalina - Isthmus (1)	147	.20	95.0	20.0	64.0	3.7	54.0	57.0
San Nicolas (2)	762	.20	3.4	3.0	2.4	9.7	14.0	12.0
San Clemente (2)	332	.20	68.5	7.1	19.5	5.9	58.0	35.0
Average all intertidals (62)	720	.31	27.0	4.8	8.9	8.6	34.2	21.5

Source: Chow and Earl (1977)

Table II.D-7

ARITHMETIC MEANS OF EIGHT TRACE METALS IN
SOUTHERN CALIFORNIA BIGHT BENTHIC SEDIMENTS, ppm.

Element	Outer-Shelves (38 samples)	Inner-Shelves (15 samples)	Outer Basins (28 samples)	Inner Basins (65 samples)
Ba	370	835	714	686
Cd	0.52	0.57	0.80	0.93
Cr	53	56	118	119
Cu	12	15	32	39
Ni	16	19	48	38
Pb	9.1	17	13	25
V	36	62	65	97
Zn	31	54	86	101

Source: Chow and Earl (1977).

7. Organics

a. Petroleum Hydrocarbons: Characterization of the petroleum hydrocarbons in environmental samples is subject to many limitations. The term "hydrocarbon" encompasses a very broad range of compounds including alkanes, cycloalkanes (or naphthenes), alkenes, and aromatics (NAS, 1975). The essential components in any hydrocarbon molecule are carbon and hydrogen atoms, although smaller amounts of sulfur, nitrogen, oxygen, and certain metals may be present. Hydrocarbons encountered in the marine environment may originate from not only human activities (e.g., offshore drilling and production operations, oil tanker operations, coastal refineries, atmospheric transport of combustion products, coastal municipal and nonrefinery industrial wastes, and urban and river runoff) but also natural sources (e.g., biological production by organisms as well as submarine oil seeps). Distinction of environmental hydrocarbons among these various sources has only recently been attempted. (Winzler and Kelly, 1977)

i. Water Column: As part of the BLM's OCS monitoring program in the Southern California Bight, hydrocarbon levels in subsurface and near bottom seawater and particulate matter were measured in the northern channel area (Payne, et al., 1976a). Values of samples collected during January, 1976, were geographically very diverse and ranged from 0.03 x 10^{-6} g/l to 20 x 10^{-6} g/l for the dissolved fraction, and non-detectable levels (<0.002 x 10^{-6} g/l) to 2 x 10^{-6} g/l) in the particulate fraction. Values were higher in the vicinity of Coal Oil Point where known seeps exist; and lower values were obtained near the outer Channel Islands of San Miguel and San Nicolas (Winzler and Kelly, 1977).

ii. Sediments: Kaplan et at., (1977) found that from intertidal samples collected in the 1975/1976 BLM baseline study, the total hydrocarbons vary greatly throughout Southern California; (e.g. from Ocean Beach (6 to 15 μg/gm) to those from the Santa Barbara area (Coal Oil Point 8 to 30 μg/gm)). Hydrocarbon concentrations were also shown to vary as a function of tidal height, depth, and time of collections. Figure II.D-11 illustrates hydrocarbon variation for intertidal sample throughout Southern California.

Based on 64 benthic samples Kaplan, et al., (1977) collected during the 1975/1976 BLM baseline study, Kaplan was able to make the following environmental interpretation. The wide range of values found, reflects the variety of depositional environments and complexity of contributing sources. The amounts of total hydrocarbons (hexane + benzene fractions) were less than 50 μg/gm in stations located in the outer banks and ridges and areas south of Newport Beach, whereas stations located in basins in the same general location have slightly higher amounts of total hydrocarbons (50-100 μg/gm). Still higher levels of total hydrocarbons, from 200 μg/gm to as much as 1,354 μg/gm, are found in sediments at stations located in Santa Monica San Pedro basin and bay. High levels (∿600 μg/gm) of total hydrocarbons are also found in stations located near Coal Oil Point.

In comparing the amount of hydrocarbon recovered from the sediments and the water column within the Bight, the sediment and water column concentrations were found to vary widely. Although this condition exists, Reed and Kaplan (1977) found that the gas chromatographic traces consistently exhibit a similar character.

8. Synthetic Chlorinated Hydrocarbons: The major source of chlorinated hydrocarbons in the study area as surveyed by SCCWRP (1973) is primarily from municipal wastewater dischargers. Concentrations of chlorinated hydrocarbons in marine organisms have been found to be high in the vicinity of outfalls, where the effluent is ultimately diffused and mixed with the coastal seawater.

Ocean dumping is another important source of DDT and PCB in the study area. The annual emission rates were approximately 14 M tons/yr of DDT and 28 M tons/yr of PCB. The chlorinated hydrocarbon concentration in samples collected from the Los Angeles River seems to be proportional to the amount of storm flow. The concentrations of silt and chorinated hydrocarbons increase when the storm flow reaches its peak and decrease when the storm flow subsides. The flow-weight mean concentrations of total DDT, PCB and Dieldrin in storm water indicate that the total chlorinated hydrocarbons in the Los Angeles River waters are significantly higher than that from the Santa Clara, Ballona Creek and Santa Ana Rivers. The input (71-72) by surface runoff (storm water plus dry weather flow) were approximately 120 kg (264 pounds) DDT, 250 kg (551 pounds) PCB, and 31 kg (68 pounds) Dieldrin. However, the total chlorinated hydrocarbons was only 1 percent of those from the municipal wastewater discharges (SCCWRP, 1973).

The aerial fallout of chlorinated hydrocarbons is difficult to estimate. Probably the amount from dry fallout is much greater than that from rainfall washout. If the fallout rate of total chlorinated hydrocarbons is about 0.1 $\mu g/m^2/day$, with most of the material divided almost equally between DDT and PCB (McClure, 1973), the annual aerial fallout rate of chlorinated hydrocarbons would be about 2 M tons of DDT and 2 M tons of PCB (SCCWRP, 1973).

The total amount of chlorinated hydrocarbons transported by the California Current is about 5 times the other sources combined, but its concentration is about 0.01 µg/liter (SCCWRP, 1973).

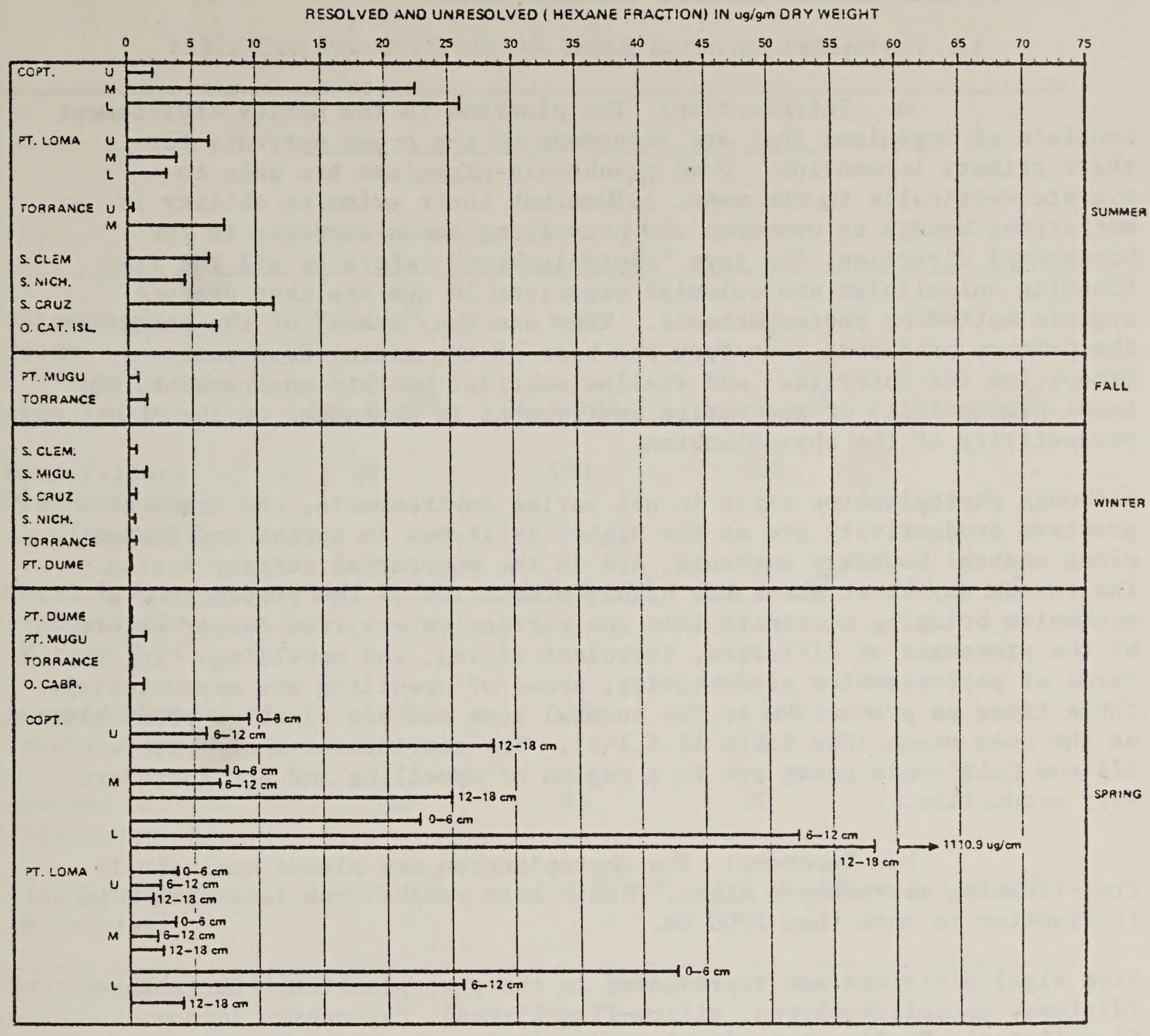


Figure II.D-11 Concentrations of Hydrocarbons from Gas Chromatograms of the Hexane Fraction of Intertidal Sediments from Various Locations, Tide Levels (Upper, Middle, Lower), Depth Intervals, and Seasons.

Source: Chow, 1974.

E. Biological Oceanography

1. Phytoplankton

a. Introduction: The plankton in the marine environment consists of organisms that are dependent on the ocean currents for their primary locomotion. Some planktonic organisms are able to migrate vertically in the water column but their swimming ability is not strong enough to overcome the prevailing ocean currents in the horizontal direction. The term "phytoplankton" refers to all the free floating unicellular and colonial organisms in the sea that produce organic matter by photosynthesis. They are the "grass" of the sea or the primary producers that form the base of the marine food chain. Except for the intertidal and shallow subtidal benthic environment, the total productivity of the marine environment is dependent on the productivity of the phytoplankton.

Although phytoplankton exist in all marine environments, the areas of greatest productivity are at the higher latitudes in spring and summer, along coastal boundary currents, and in the equatorial current system. The reason why these areas are highly productive is the presence of a mechanism bringing nutrients into the surface waters from deeper waters by the processes of diffusion, turbulent mixing, and upwelling. In terms of phytoplankton productivity, areas of upwelling are approximately three times as productive as the coastal zone and six times as productive as the open ocean (See Table II.E.1-1). The continental shelf waters off the California coast are in a region of upwelling and are therefore very productive.

b. Taxonomy: The phytoplankton are almost exclusively free-floating microscopic algae. Their size ranges from less than 2 μm in diameter to more than 2000 μm.

Five algal divisions are represented in the phytoplankton: Chrysophyta (diatoms, coccolithophores, silico-flagellates), Pyrrophyta (dino-flagellates), Euglenophyta (euglenoids), Chlorophyta (green algae) and Cyanophyta (blue-green algae). The principal members of the phyto-plankton are from the Chrysophyta and Pyrrophyta.

Tables II.E.1-2, 3 and 4 in POCS Reference Paper No. II, list phyto-plankton species found off the California coast with emphasis on central and northern California. As explained below, due to transport and mixing by currents along the entire coast, these species can be found along the whole California Coast. Generally, the tropical and south temperate species listed occur most often off southern and Baja California. The tables list 160 diatom, 112 dinoflagellate and 6 silico-flagellate species.

Table II.E.1-1

ESTIMATED PRODUCTIVITY IN THREE OCEAN PROVINCES

	Province			
	Open Ocean	Coastal Zone	Upwelling Areas	Total
Percentage of Ocean	90	9.9	0.1	100
Area (sq km)	326×10^6	36×10^6	3.6×10^5	362×10^6
Mean Primary Productivity (g C/sq m/yr)	50	100	300	
Total Primary Productivity (M tons C/yr)	16.3×10^9	3.6×10^9	0.1×10^9	20×10^9
Assumed Numbers of Trophic Levels	5	3	1.5	
Assumed Efficiency (%)	10	15	20	
Fish Production (M tons/yr)	1.6×10^6	1.2×10^8	1.2×10^8	2.4×10^8

Source: Riznyk (1974).

c. Ecology

i. Environmental Processes Affecting Phytoplankton Abundance and Productivity in California Continental Shelf Waters: Phytoplankton abundance, or standing stock, and productivity are dependent on many environmental factors such as the amount and quality of light, which is strongly influenced by water quality; the abundance and distribution of nutrients, primarily nitrogen; the stability of the water column; losses from grazing, natural mortality and the sinking of cells; temperature; and advection of water masses.

Since phytoplankton require light to produce organic matter from water and carbon dioxide, phytoplankton production occurs mainly in the upper lighted layers of the ocean, or the euphotic zone. This zone can extend to 100-150 m (330-495 feet) in depth, but in coastal waters it can be as shallow as a few meters if the water is very turbid. The supply of nutrients such as nitrogen, phosphate, silicate and some vitamins is also critical to phytoplankton production.

Along the California and Baja California coasts the important large-scale physical processes affecting the phytoplankton populations are the southerly flowing California Current with its associated counter-clockwise eddy system in the Southern California Bight, and the upwelling of nutrient-rich deeper waters along the coast. The intensity of upwelling varies seasonally, by area and from year-to-year. Upwelling is discussed in detail in Chapter II.C.1. of POCS Reference Paper No. II.

The southward-flowing California Current introduces phytoplankton species and populations to the area that are typical of colder, northern waters (subarctic species). Southern species and populations are brought into the area by the northward-flowing undercurrent below 200 m (660 feet) and the seasonal northward-flowing surface countercurrent. During the winter months, usually from November to February, the northward flowing Davidson Current extends out to 60 km (36 miles) from the California coast. This current is most strongly developed north of Point Conception along the central California coast and is found in the upper 200 m of the water column. Under certain conditions, especially in the fall with the slackening of the prevailing northwest winds, oceanic species of phytoplankton introduced from the Pacific Central Water Mass can be found in the coastal area.

Besides these seasonal changes in species composition and abundance, long term oceanographic and meteorological changes can affect phytoplankton populations over the entire area. Balech (1960) compared Allen's 1938-39 phytoplankton collections with collections made in 1957-58 during an unusually warm period off the California coast. According to Balech (1960), the most important general conclusion was that the phytoplankton populations of 1957-58 were atypical. Warm water and tropical phytoplankton species were abundantly represented in 1957-58 (largely absent in 1937-38) and the appearance of cold water forms was delayed and restricted. In December of 1957, the phytoplankton population unexpectedly took on a tropical character in spite of relatively low water temperature (Balech, 1960). Also, typically warm water forms extended far northward beyond their normal range.

Natural mortality and the sinking of phytoplankton cells contribute to variations in phytoplankton abundance, but a very important factor in controlling phytoplankton abundance or standing stock is grazing pressure by zooplankton. In north temperate seas the decline of the phytoplankton population following the spring outburst is attributed to heavy zooplankton grazing. The peak of zooplankton production usually lags behind that of phytoplankton by several weeks (Riznyk, 1977).

Generally, the seasonal succession of phytoplankton species groups in California continental shelf waters, has the following pattern: diatom blooms, or large increases in abundance, in the spring result in nutrient depletion of surface waters in the summer. Dinoflagellate and chrysophycean flagellate blooms often occur in the summer and are followed by variable autumn diatom blooms. It must be stressed that this is an oversimplified view and that blooms of diatoms or dinoflagellates can occur at irregular intervals throughout the year. Also, autumn blooms are very unpredictable (Strickland, 1967).

Consequently, one can see that phytoplankton in the study area live in a dynamic marine system subject to seasonal, year-to-year and local changes. Many of these interactions and relationships are not well understood. For example, chief among phytoplankton community characteristics is patchiness or unevenness in distribution, composition, and abundance. Both large scale (distance of several hundred kilometers) and small-scale (one to several hundred meters) differences occur in the vertical and horizontal distribution of abundance and species composition. Therefore, the patchiness of the phytoplankton communities poses formidable sampling problems and makes it difficult to establish conclusively to what extent the results of an investigation are characteristic of the area being studied. As a result, data on phytoplankton standing crop and other parameters in a particular area must be viewed with these dynamic considerations in mind.

ii. Southern California Bight: The study of phytoplankton ecology in Southern California had its inception at the Scripps Institution of Oceanography at La Jolla in 1917. In 1919, W.E. Allen began a series of daily collections at the Scripps Institute pier and at Point Hueneme 160 km (100 miles) further north. This series of collections continued for 20 years and was supplemented by pier collections from Oceanside for a period of five years and Balboa for three years (see Figure II.E.1-1 for locations). After 1938, collections of phytoplankton from cruises in the Bight supplemented the pier work.

Riznyk (1974) presented a summary of Allen's results as follows: (1) Biomass was generally greater at his northern station at Pt. Hueneme than at his southern station in La Jolla. (2) An increase in biomass

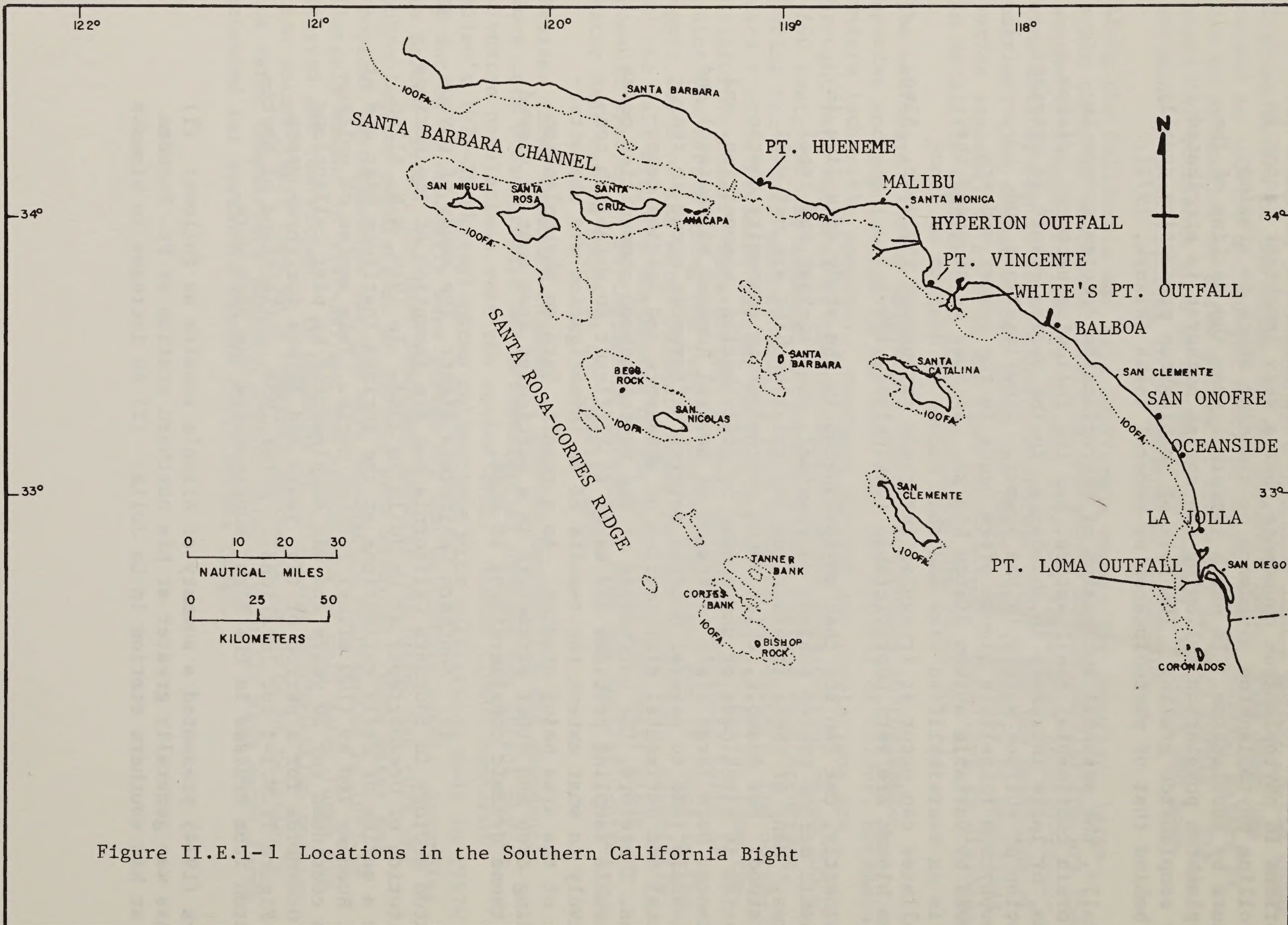
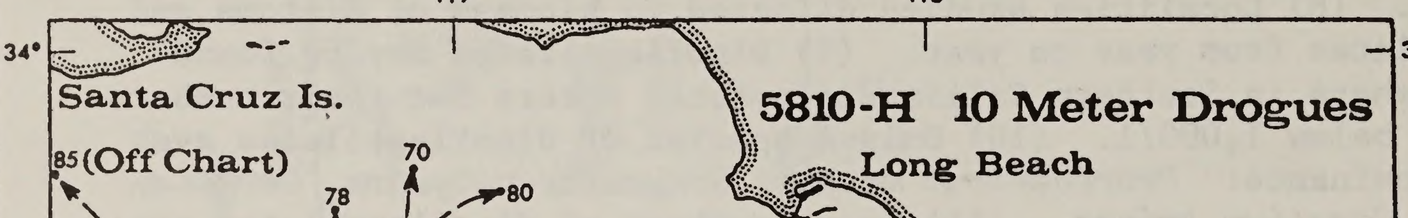


Figure II.E.1-1 Locations in the Southern California Bight began and ended a few weeks later at Pt. Hueneme than in La Jolla. (3) Initially it was thought that the biomass was greater within a few miles of shore than in oceanic waters but later it was found that this effect was only periodic. (4) Maximum numbers of phytoplankton were found at subsurface levels between 9-18 m (30 - 60 feet) in shallow water and 18-27 m (60 - 90 feet) in deeper water. (5) A correlation was noted between the nutritive influence of the Los Angeles City sewage outfall and the large population of phytoplankton near Pt. Vincente. (6) In 20 years of daily collecting only 100 species representing 41 genera were identified. Of these only 17 species were dominant, the genus *Chaetoceros* having the greatest total abundance. (7) There is considerable variability in the annual biomass of planktonic organisms in Southern California. (8) Localities studied differed in biomass of diatoms and dinoflagellates from year to year. (9) Dinoflagellates may be found almost anywhere in Southern California coastal waters but their numbers are mostly below 1,000/1. (10) Only 4 species of dinoflagellates ever obtained dominance: *Prorocentrum micans, Gonyaulax polyedra, Ceratium furca*, and *Ceratium tripos*. (11) Large numbers of dinoflagellates are confined to levels above 30 m (99 feet) and to a zone within 40 km (25 miles) offshore. (12) At Scripps pier almost every species of diatom known to occur in the East Pacific was found. (13) During a 20 year period no two years, no two weeks, and no two days were alike with regard to phytoplankton biomass. (14) The existence of productive localities 160 km (100 miles) from the shore at depths of 50 m (165 feet) has been demonstrated. (15) A lack of regularity in depth distribution was shown. (16) The annual production tends to be the greatest in the spring.

Later investigations by Sverdrup and Allen (1939) and Sargent and Walker (1948) found relations between the concentration of phytoplankton and the water masses and currents off Southern California. Sverdrup and Allen (1939) discovered that eddies in inshore waters can contain large numbers of diatoms. Figure II.E.1-2 shows some nearshore eddies off Santa Catalina and San Clemente Islands measured by 10 meter current drogues. Sargent and Walker (1948) reported that high concentrations of diatoms were associated with newly upwelled water and the California Current gyre in the Bight. They found that most of the population occurred in the center of the gyre along the Santa Rosa-Cortes Ridge.

Between 1957 and 1959, the Allan Hancock Foundation of the University of Southern California made a quantitative and qualitative study of the microplankton off the Southern California mainland shelf (Resig, 1961). The sampling program encompassed areas that were affected and unaffected by sewage outfalls. More than 60 species of diatoms representing 27 genera were recorded, but only 12 species of diatoms achieved abundance during the survey. The genus most commonly represented was *Chaetoceros*.



Drogue measurements off southern California in October 1958.

Figure II.E.1-2 Drogue Measurements off Southern California in Oct. 1958

Source: Schwartzlose and Reid, 1972.

Twelve genera of dinoflagellates were observed, the most abundant species being *Prorocentrum micans*. A high degree of variability in plankton counts resulted. Counts of cells at 30 to 40 m (99-132 feet) were alike but substantially lower than at 0 to 16 m (0-53 feet). At still greater depths the counts declined even further. These results differ from Allen's in which he noted that maximum plankton numbers occurred at subsurface depths. Differences may be due to species encountered. With regard to the dinoflagellates, the counts at 16 m (53 feet) were half that at 0-8 m (0-26 feet). The diatom numbers were found to be higher in summer than in winter (Figure II.E.1-3) and the dinoflagellate data show less dependence on the season. Viewing the data obtained, it was concluded that for no species was there a demonstrated dependence on latitude since the patterns of water movement make the Southern California shelf waters quite uniform from Point Conception to the Mexican border.

Values for phytoplankton primary production averaged for 1969 from CalCOFI data are displayed in Figure II.E.1-4 for the overall Southern California Bight area. The values are high nearshore and decrease offshore. For this one year's data in 1969, the primary production was highest in the February-March period (Owen, 1974).

Figures II.E.1-5 through 8 display phytoplankton standing stock as chlorophyll a values integrated over the upper 150 m (495 feet) of the water column for the California coast in 1969. For the Southern California Bight, values are low during the October-December period with the highest values occurring in the July-September period. For this one year's data, the standing stock was consistently high around Point Conception and the Santa Barbara Channel area. High values also occurred along the southern coast down to the Mexican border and over the Santa Rosa-Cortes Ridge area. Generally the values decrease offshore beyond the highly productive band 100-200 km (60-120 miles) along the coast.

Santa Barbara Channel: Oguri and Kanter (1971) measured the phytoplankton productivity of the Santa Barbara Channel (Figure II.E.1-1) and attempted to relate the productivity patterns to water mass distribution. In May 1969, the basin as a whole showed high productivity reflecting a seasonal bloom. Two patterns in distribution of productivity data were apparent. There was a pattern of higher inshore values, particularly along the northern shore of the eastern part of the basin. The water in the southern part of the basin, particularly west of Santa Cruz Island, was notably more productive than water to the north. This suggests that water was entering the basin at both the eastern and western ends. The highly productive water from the western

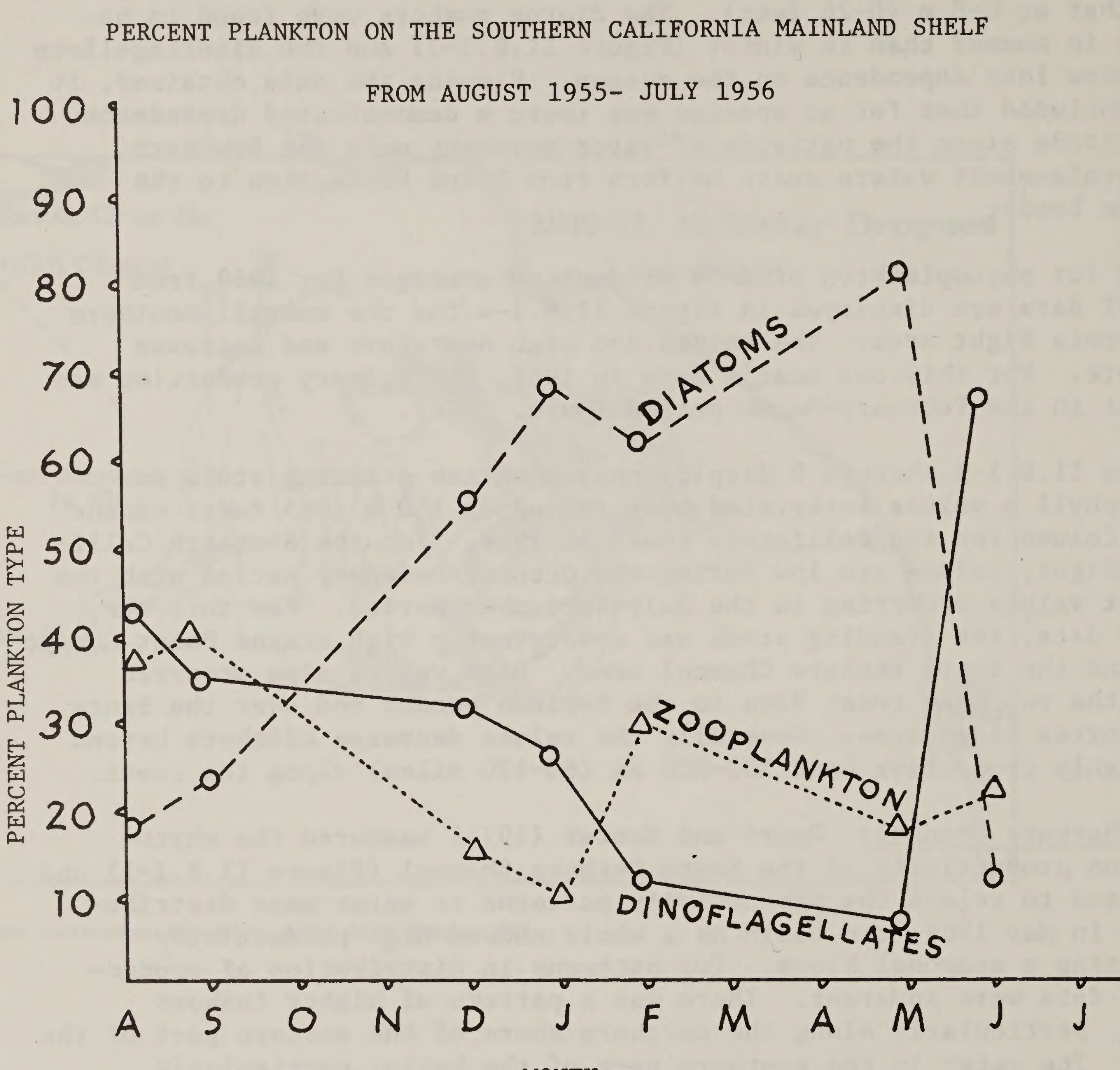


Figure II.E.1-3 Variation in three groups of plankton from August 1955 to July 1956.
Source: Allan Hancock Foundation, 1965.

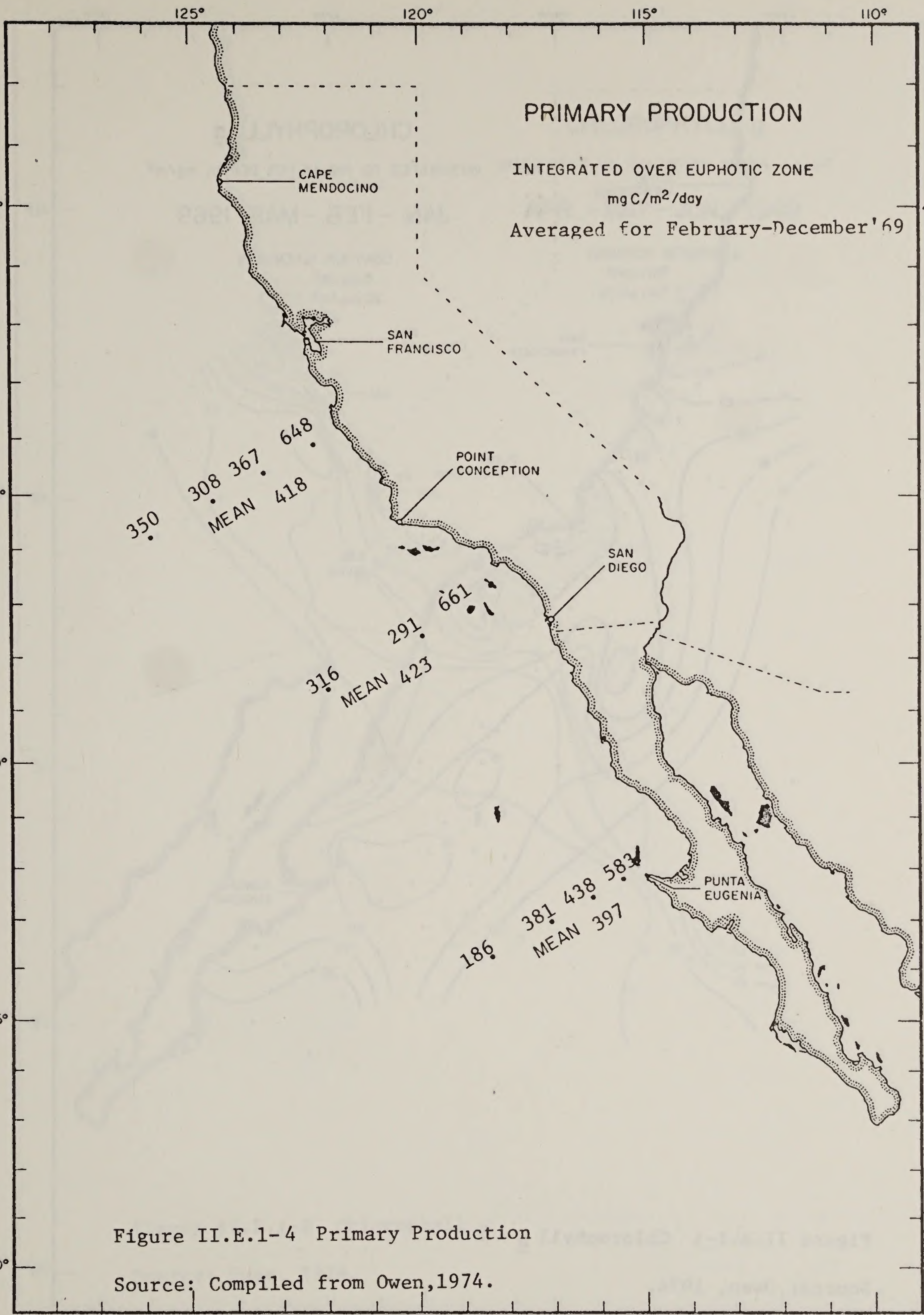


Figure II.E.1-4 Primary Production

Source: Compiled from Owen,1974.

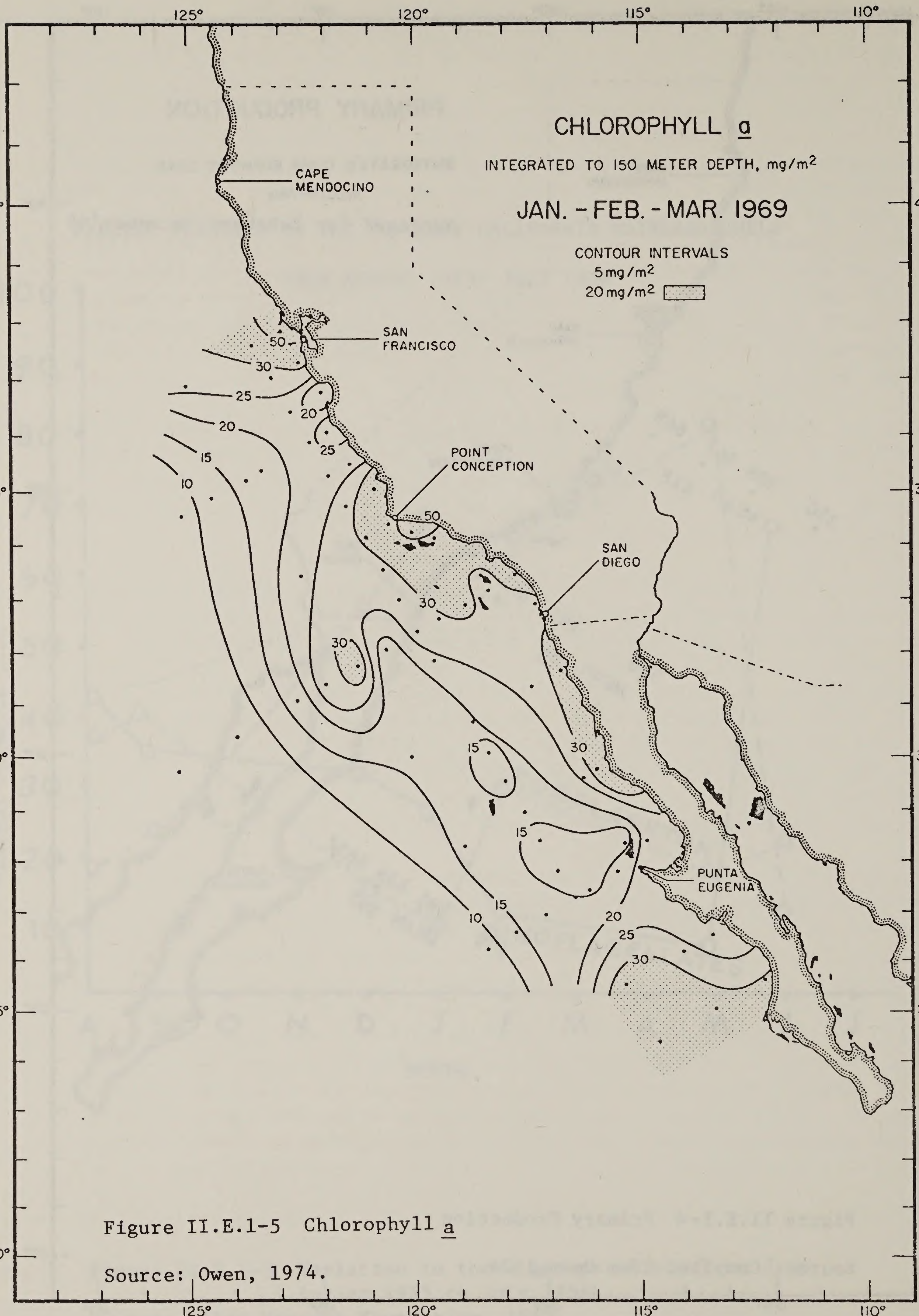


Figure II.E.1-5 Chlorophyll a

Source: Owen, 1974.

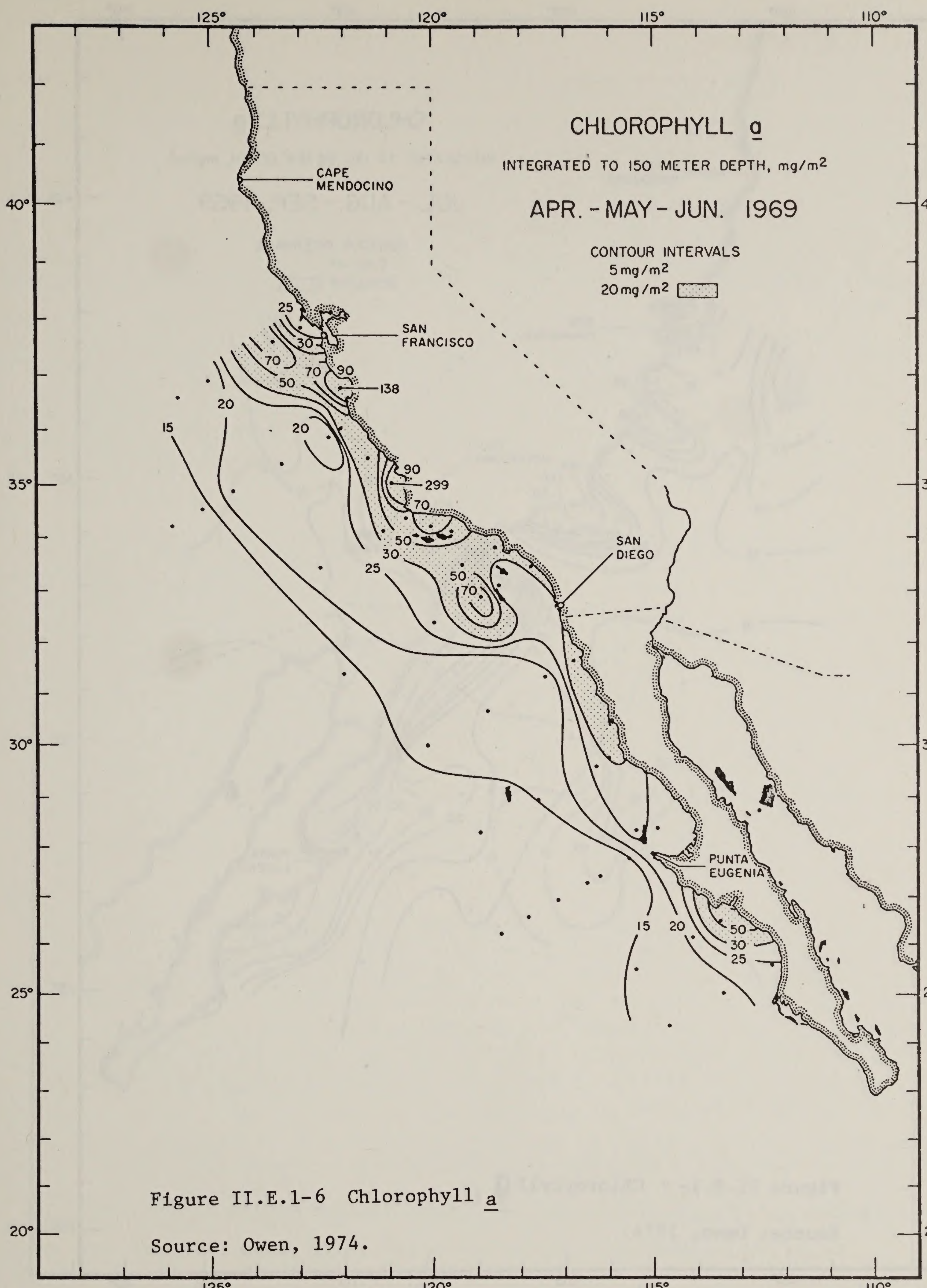


Figure II.E.1-6 Chlorophyll a

Source: Owen, 1974.

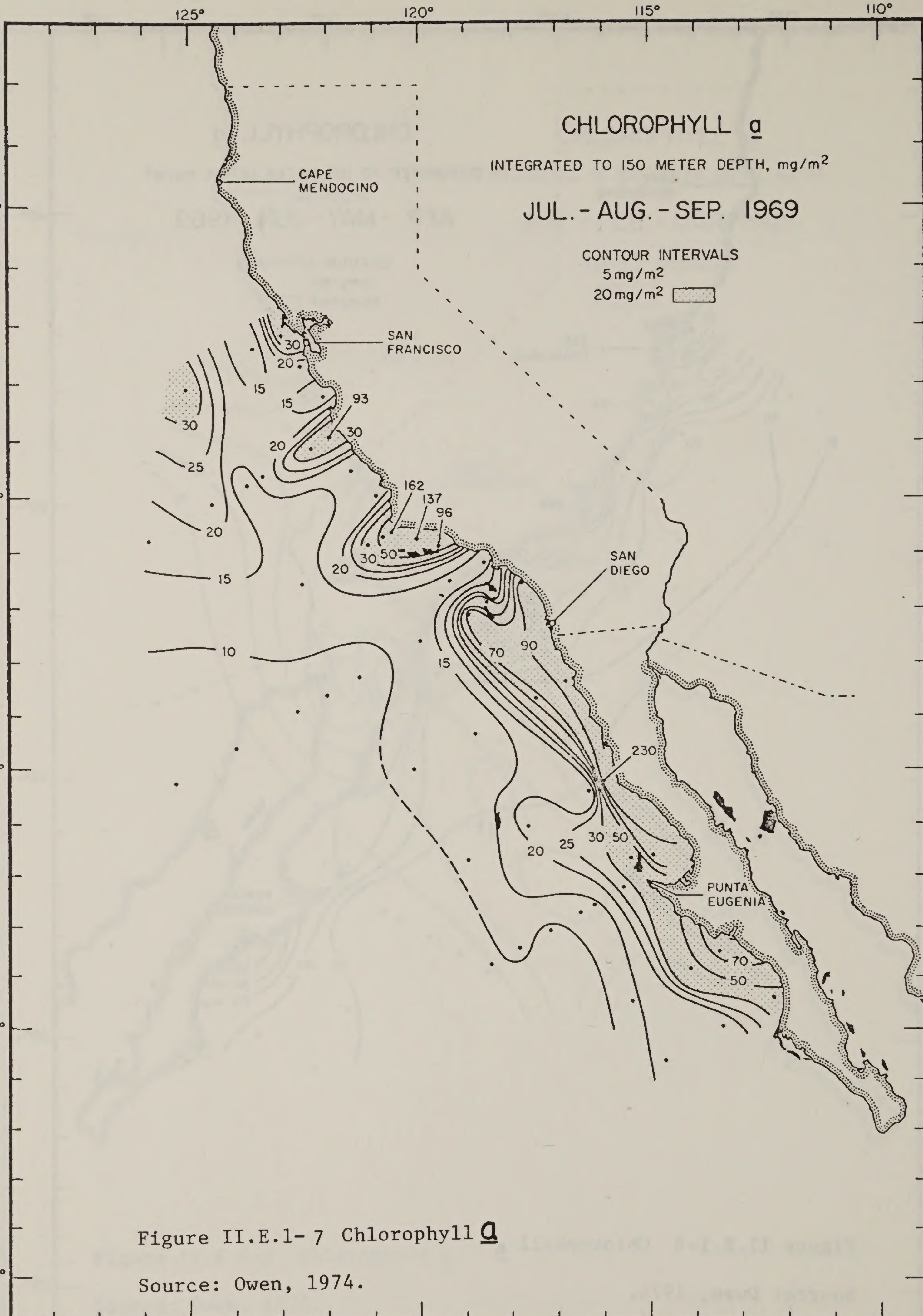


Figure II.E.1- 7 Chlorophyll a

Source: Owen, 1974.

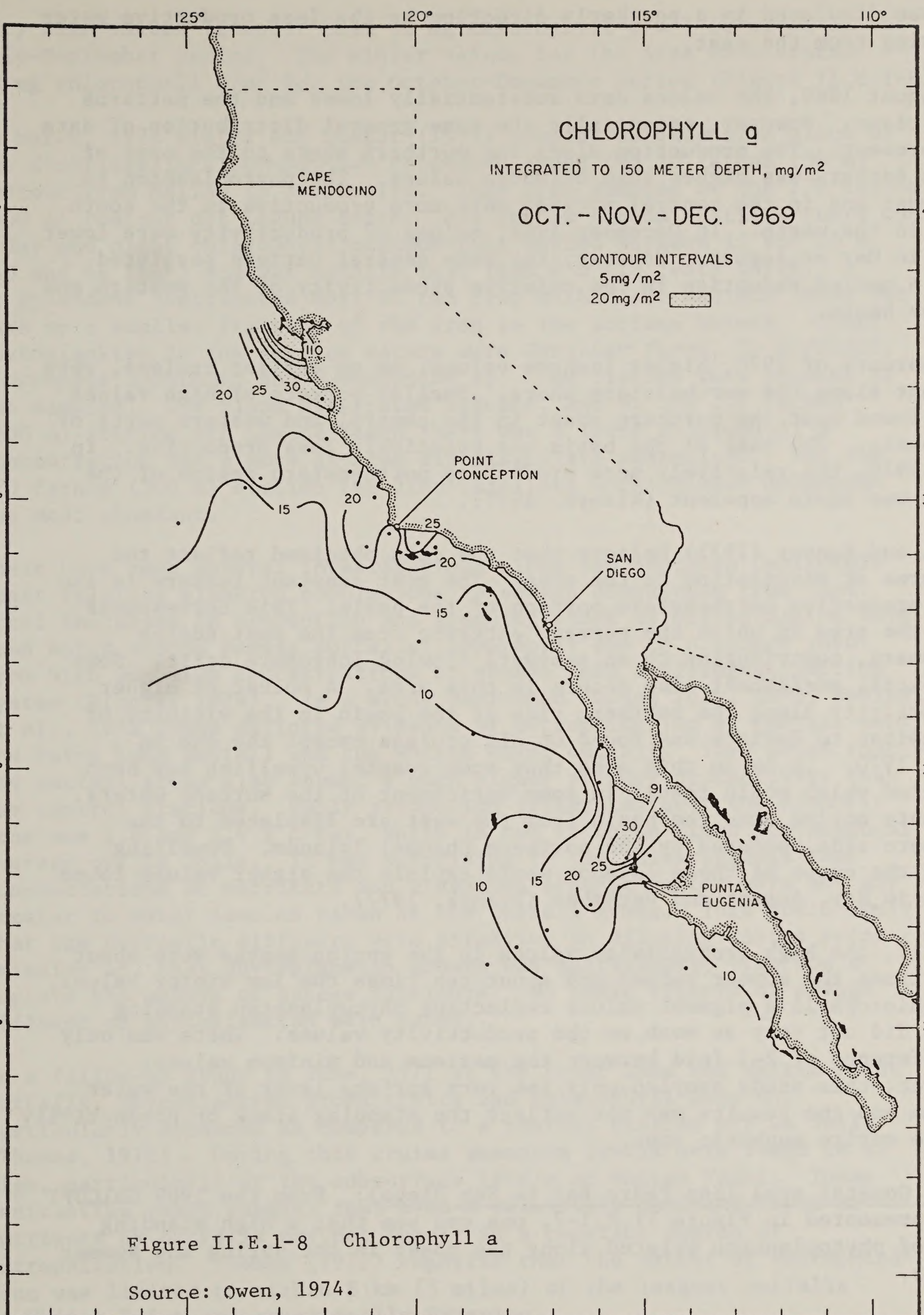


Figure II.E.1-8 Chlorophyll a

Source: Owen, 1974.

end was displaced in a southerly direction by the less productive water entering from the east.

In August 1969, the values were substantially lower and the patterns less clear. However, essentially the same general distribution of data was present. The production along the northern shore to the east of Santa Barbara was higher than offshore values. The phytoplankton to the west and in the central portion were more productive in the south than in the north. In December 1969, values of productivity were lower than in May or August. However, the same general pattern persisted with a marked reduction in the relative productivity of the western end of the basin.

In February of 1970, higher inshore values, as on earlier cruises, were present along the northeastern shore. Smaller pockets of high values were found near the northern coast in the central and western parts of the basin. The rest of the basin was relatively less productive. In June 1970, the relatively more productive northeastern region of the basin was again apparent (Riznyk, 1977).

Oguri and Kanter (1971) believe that the data obtained reflect the patterns of circulation in the area. The most constant feature is the more productive northeastern portion of the basin. This corresponds with the area in which the current entering from the east eddies northward, contributing to an eastward flowing longshore drift. Some artificial enrichment also occurs in this area. A pocket of higher productivity along the northern side of the basin in the vicinity of El Capitan to Gaviota was found on all cruises except the one in June, 1970. It is in this area that some coastal upwelling has been detected which would result in some enrichment of the surface waters. Currents moving into the basin from the west are displaced to the southern side bordered by the northern Channel Islands. Upwelling along the coast of these islands would explain the higher values found there in May, August and December (Riznyk, 1977).

Overall, the high productivity values in the spring months were about five times the summer values and about ten times the low winter values. The chlorophyll a pigment values reflecting phytoplankton standing stock did not vary as much as the productivity values. There was only a difference of 2-3 fold between the maximum and minimum values. However, this study sampled only the very surface layer of the water column and the results may not reflect the standing stock or productivity of the entire euphotic zone.

South Coastal area (San Pedro Bay to San Diego): From the 1969 CalCOFI data presented in Figure II.E.1-7, one can see that a high standing crop of phytoplankton existed along the coast in the spring and summer months.

Very high values (greater than 90 mg chlorophyll a/m^2) occurred in the July-September period. The winter values for the area were around 20 mg chlorophyll a/m^2 for the October-December period (Figure II.E.1-8).

In March, 1974 Kiefer and Lasker (1975) sampled an extensive bloom of the dinoflagellate *Gymnodinium splendens* along the 20 fathom (36 m) contour from Malibu to San Onofre. They also sampled at the 270 fathom (500 m) contour off Laguna Beach. For the 20 fathom stations there was a day and night chlorophyll maximum that varied between 15 and 20 m (50 and 66 feet) and was usually less than 4 m (13 feet) thick. *G. splendens* contributed most of the crop within the maximum layer but made up a smaller fraction of the crop in the surface waters. Other phytoplankton in the surface waters were *Ceratium furca, C. kofoidii, Dinophysis acuminata* and *Gymnodinium* sp. Few diatoms were present in the samples. The bloom dissipated seaward, and at the 270 fathom (500 m) station off Laguna Beach there was a lower chlorophyll a concentration and a more diverse dinoflagellate assemblage. For the 270 fathom (500 m) station the dinoflagellate *Cochlodinium catenatum* was most abundant.

There have been several investigations along the Southern California coast relating plankton populations to sewage discharges from land. Local increases in production and standing stock of phytoplankton have been noted around sewage outfalls, apparently due to nitrogen input from high ammonium concentrations of sewage into a nitrogen-limiting system (Riznyk, 1974). In a study performed during July, 1970, Eppley, et al., 1972 found definite evidence of eutrophication of the sea near the Point Loma outfall and the Whites Point outfall. They noted that the outfall areas also showed a much higher primary productivity than the control stations. Daily production integrated over the euphotic zone was 1.8 and 2.6 g C/day, which is two to three times the seasonal average off La Jolla. It was surprising to the investigators that concentrations of nutrients and dissolved organic matter were not any greater in water samples taken at the outfall areas. This would imply that the hydraulic diffusers were effective in diluting wastes prior to emission or, that phytoplankton growth was sufficiently vigorous to deplete the waters of excess nutrients. No toxic effects of sewage effluent on phytoplankton were noted.

In a follow-up study in June, 1971 at the Point Loma and Whites Point outfalls, phytoplankton productivity and chlorophyll were not particularly enhanced as compared to a control station off La Jolla (Thomas, 1972). During this cruise ammonium levels were found to be high, particularly at the subsurface levels at Whites Point. These contrasting years suggest that even a relatively constant input of nutrients by outfalls may not result in a constant degree of eutrophication. Thomas (1972) reported that the extent of eutrophication was limited to within 8 km (5 miles) of the largest outfalls at Whites Point and occasionally Hyperion.

Between 1958 and 1966, plankton studies were conducted in the vicinity of the City of San Diego wastewater discharge off Point Loma (Marine Advisors, 1963; Water Resources Engineers, 1965). The only organism showing a consistent decrease was *Noctiluca*, a dinoflagellate. The diatoms *Skeletonema costatum* and *Mastogloia* and the dinoflagellates *Dinophysis*, *Prorocentrum* and *Oxytoxum* all appeared to increase as a result of the discharge. *Gonyaulax* ranked high in frequency both before and after the initiation of the waste discharge.

The ecology of the coastal phytoplankton off La Jolla was studied over a five month period in 1967 by the Institute of Marine Resources at Scripps. Phytoplankton productivity was measured and the phytoplankton catalogued at three stations from 1.2 to 10.4 km (0.75 to 6.5 miles) offshore. Both standing stock and productivity depended greatly on meteorological conditions, increasing after upwelling had commenced (Eppley, et al., 1970). The seawardmost station showed the lowest standing crop, and primary production, but had the highest growth rate. Species such as *Peridinium depressum* accounted for 5-10 percent of the crop at all stations most of the time. There was a close relationship between species composition and nitrogenous nutrients (Eppley, 1970), the diatoms being clearly associated with nitrate concentrations in the water at depths where the light intensity was still high. Except after periods of upwelling, dinoflagellates and monads predominated. The major part of the plant biomass was in cells with diameters between about 10 and 50 μ and generally four species contributed an excess of 50 percent of the total cell carbon.

Kamykowski (1974) reported on an upwelling period from February 26 to March 1, 1971 at a station 1 km (0.6 mile) west of La Jolla. The station was occupied 15 times from February to April. The onset of strong west northwest winds led to a decrease in surface water temperature, and an increase in surface nutrients which was followed by an increase in chlorophyll a and the surface diatom populations. The time lag between the maximum nutrients concentrations and the maximum chlorophyll a at the surface was 6 days. Advection of the surface water mass and a decline in the strong winds transported the populations out of the area and ended the brief upwelling period.

iii. Baja California: Values for phytoplankton primary productivity averaged for 1969 from CalCOFI data as displayed in Figure II.E.1-4 for the California Current Region off Baja California are similar to the southern and central California values, being high nearshore and decreasing offshore. Similar to the Southern California Bight region, the primary productivity was highest in the February-March period for 1969 (Owen, 1974).

Figures II.E.1-5 through 8 depict phytoplankton standing stock off Baja California for 1969. Values are lowest in the October-December period for most of the water from Punta Eugenia to San Diego except for higher values off Cedros Island. The highest standing stock was in the July-September period along the whole Baja coast out to 100-150 km (60-90 miles) offshore. Once again, the values decreased offshore beyond the highly productive coastal band.

There was an extensive field investigation of the Baja California upwelling system and the biota in the upper layers of the water column during MESCAL I and II cruises conducted by the University of Washington and others in 1972 and 1973. Although most of the station locations were south of the study area around Punta San Hipolito (See Figure II.E.1-9), much of the data and observations should also pertain to the Baja Coast north of Punta Eugenia. The results of these investigations have been reported in part in Walsh, et al., (1974), Smayda (1975), Walsh, et al., (1977) and Blasco (1977).

The upwelling season along the Baja California coast starts in February-March with the most intense period generally in April-May. The MESCAL I cruise occupied stations off Punta San Hipolito for two weeks during March, 1972 or at the start of the upwelling cycle. Walsh et al., (1974) found that the upwelling was most intense within 10 km (6 miles) off shore. Over this 2-week period the maximum upwelling rate was estimated to be 10 m/day (33 feet/day). They observed that a dinoflagellate, *Gonyaulax polyedra*, dominated the phytoplankton community during this early upwelling period. Since this dinoflagellate can migrate vertically in the water column at about 1-2 m/hour (3.3-6.6 feet/hour), the investigators observed a variation in the biomass of the phytoplankton over a 24-hour period. The integrated phytoplankton biomass from 0-30 m (0-99 feet) between the period of 12:00 midnight to 6:00 a.m. was about one-half the biomass between 12:00 noon and 6:00 p.m. Therefore, the dinoflagellates were migrating to the surface layers in the morning and reaching a peak in the surface water around midday. During the late afternoon and evening they descended to lower depths perhaps following the nutrient gradients in the water column. The phytoplankton biomass showed its expected inverse relationship to nutrients, with the largest phytoplankton biomass being near the largest nutrient gradient (Walsh, et al., 1974).

Walsh, et al., (1974) suggested that the pre-upwelling food chain in the area could be: dinoflagellate phytoplankton - herbivorous copepod - carnivorous red crab - striped dolphin *(Gonyaulax polyedra - Acartia* sp. - *Pleuroncodes planipes - Lagenorhynchus obliquidens)*. During the summer months with a fully-developed upwelling system, the food chain is shorter with only three levels: diatoms - red crab - yellowfin and skipjack tuna *(Chaetoceros* and *Coscinodiscus* sp. - *P. planipes - Thunnus*

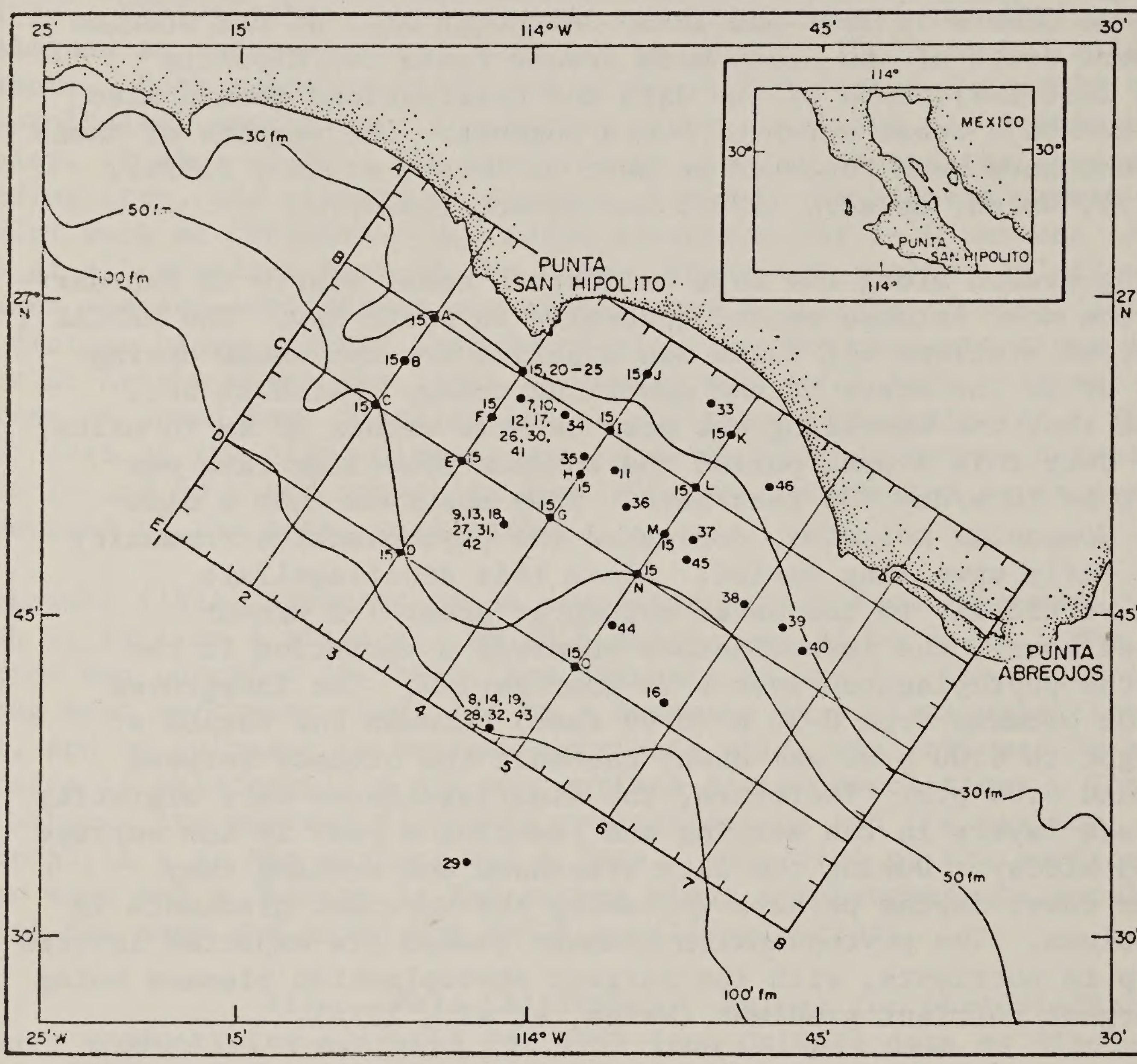


Figure II.E.1- 9 MESCAL I Stations off Punta San Hipolito. Baja California.

Source: Walsh, et al, 1974.

albacores and *Euthunnus pelamis)*. Generally, red crabs graze heavily on phytoplankton, but during grazing experiments conducted in March the red crabs ate few dinoflagellates.

During MESCAL II in April 1973 in the same area, Walsh, et al.,(1977) reported that diatoms were initially the dominant phytoplankton. However, there was a shift in dominance from diatoms to dinoflagellates and flagellates as the winds shifted and upwelling slackened. The dinoflagellates *Ceratium* sp. and *Mesodinium rubens* dominated in 1973, as opposed to *Gonyaulax polyedra* in 1972. When the winds picked up again from the northwest and upwelling strengthened, the diatoms became dominant but there was a resultant decrease in phytoplankton biomass and production (Walsh et al., 1977).

For the April 1973 cruise Smayda (1975) observed that the greater than 20 μ size phytoplankton fraction was characterized by several *Chaetoceros* species *(affinins, currisetus, debilis, didymus, socialus)* with *Coscinodiscus* sp. as co-dominant. He listed a total of 31 species for the greater than 20 μ size fraction. The mean population level ranged from about 2,100-9,800 cells/l in the upper 50 m (165 feet) of the water column. The flagellate *Phaeocystis cf. pouchetti* was also common in some samples. From these observations and other data, Smayda indicates that the diatom community in this site range is similar in the coastal waters from San Diego to the Gulf of Panama. He also states that the data from this investigation do not support the hypothesis that the abundance of the red crab is related to the *Coscinodiscus* population abundance.

iv. Central California: There have been very few investigations of the phytoplankton off the central California coast. The following discussion of the nearshore phytoplankton ecology is derived mainly from studies in Monterey Bay by Hopkins Marine Lab, Moss Landing Marine Lab and the University of Santa Cruz. Riznyk (1977) summarized the results of these studies. The results of these studies should apply to the nearshore waters along the central California coast since they generally reflect oceanographic and meteorologic conditions and events occurring over an extensive segment of the eastern North Pacific.

In Monterey Bay Balin and Abbott (1963) found that from December, when the phytoplankton are at a low ebb, the population increases to reach a peak in June and diminishes again, reaching the lowest volumes in December of every year. Increases and decreases in the phytoplankton volume were found to be related to the annual phosphate cycle. At the peak of upwelling, the genus *Chaetoceros* forms about 80 percent of the population, and four or five genera make up another 15 percent. As upwelling slackens and nutrients decline, inflows of oceanic surface water carry a number of forms characteristic of the open sea into the nearshore area. These newly introduced taxa find conditions favorable and begin to multiply rapidly. An abrupt decrease occurs in the dominance of *Chaetoceros*. With a further reduction of nutrients and a decline of temperatures during the Davidson Current period, the phytoplankton take on a mixed character as several genera show increases in relative numbers. By far the most important phytoplankton genus in Monterey Bay is *Chaetoceros*. This genus averaged about 50 percent of the catch throughout the sampling period of 1954-1960 and always dominated during the periods of peak volumes in June and July, when it typically contributed more than 80 percent of the catch. The relative abundance of the four most common genera of diatoms and dinoflagellates are presented in Figures II.E.1-10 and II.E.1-11.

A study by Welch (1967) tended to supplement the data collected in Monterey Bay by Bolin and Abbott (1963). As a result of this study, 21 individual genera were observed which included 16 diatoms and 5 dinoflagellates. The dominant form during the study period was the genus *Chaetoceros* followed by the genus *Rhizosolenia*. *Chaetoceros* is associated with cold upwelling water but is present during most of the year. *Rhizosolenia* is capable of surviving low concentrations of nutrients and appears as the dominant form when *Chaetoceros* has been suppressed. The dinoflagellate *Peridinium* occurred as the dominant form only during periods when *Chaetoceros* and *Rhizosolenia* were scarce. The occurrences and variation of other phytoplankton genera in this study is discussed in Chapter II.E.1. of POCS Reference Paper No. II.

Malone (1971) measured nannoplankton (between 2 and 20 µm) and net plankton (the larger phytoplankton fraction) primary productivity and standing crop on a seasonal basis in Monterey Bay from October 1969 to February 1971. He found that the nannoplankton accounted for 60 to 99 percent of the observed productivity and standing crops. Increases in the net plankton were found to be closely coupled with the occurrence of coastal upwelling. Net plankton productivity and standing crop exceeded that of nannoplankton only during the strongest upwelling pulses. Surface levels of nannoplankton productivity and standing stock were stable throughout the year. In contrast, net plankton productivity and standing crop varied tremendously during the year. In late March and mid June, the net plankton blooms were dominated by large-celled, chain-forming diatoms such as *Nitzschia pacifica* and *Rhizosolenia fragilissima*. When the net/nanno ratio was high (during upwelling) diatoms were more numerous than dinoflagellates, but when the ratio was low (during oceanic conditions) dinoflagellates were more numerous.

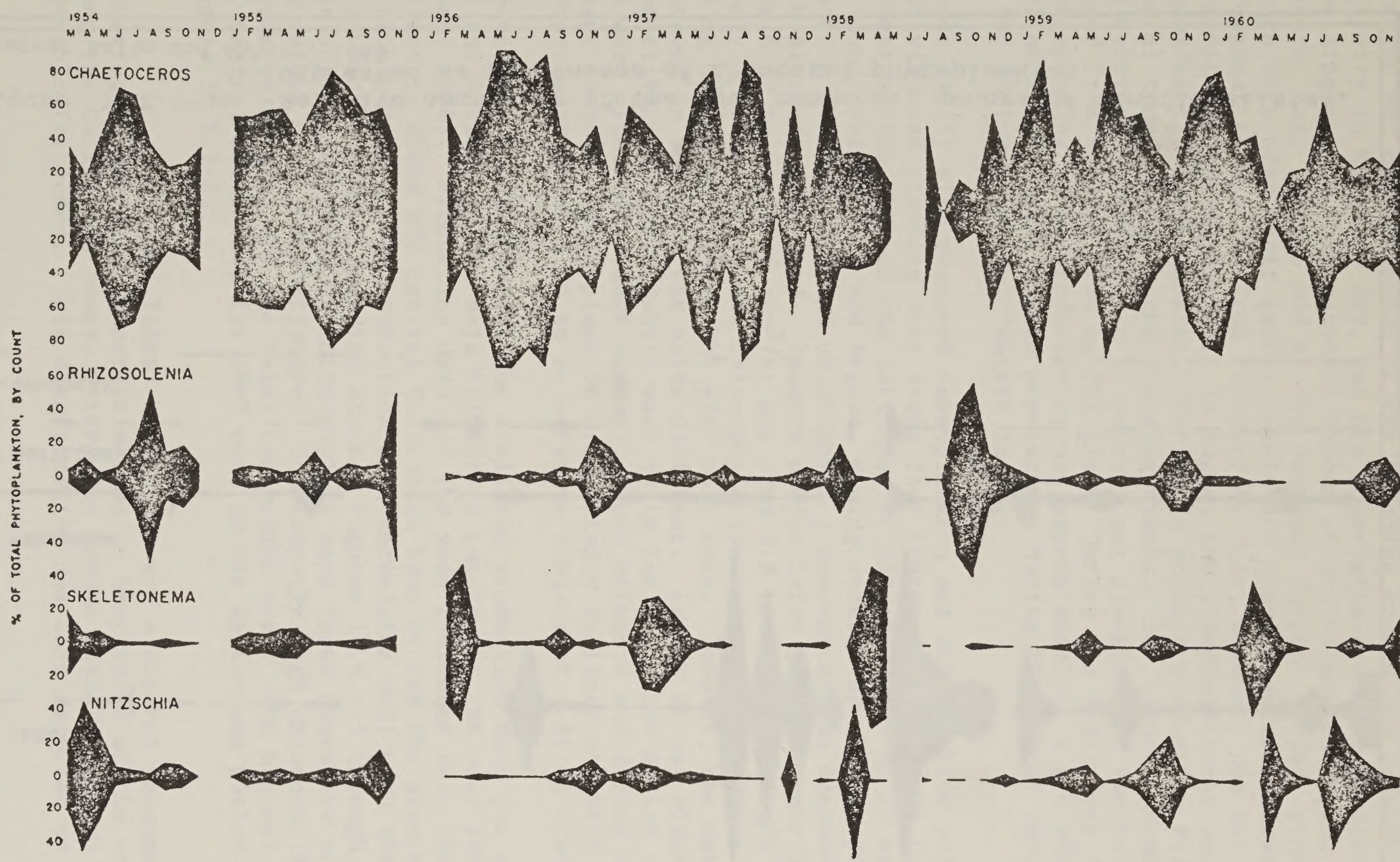


Figure II.E.1-10 Relative abundance of the four commonest genera of diatoms, expressed as percentage of the total phytoplankton

Source: Bolin and Abbott, 1963.

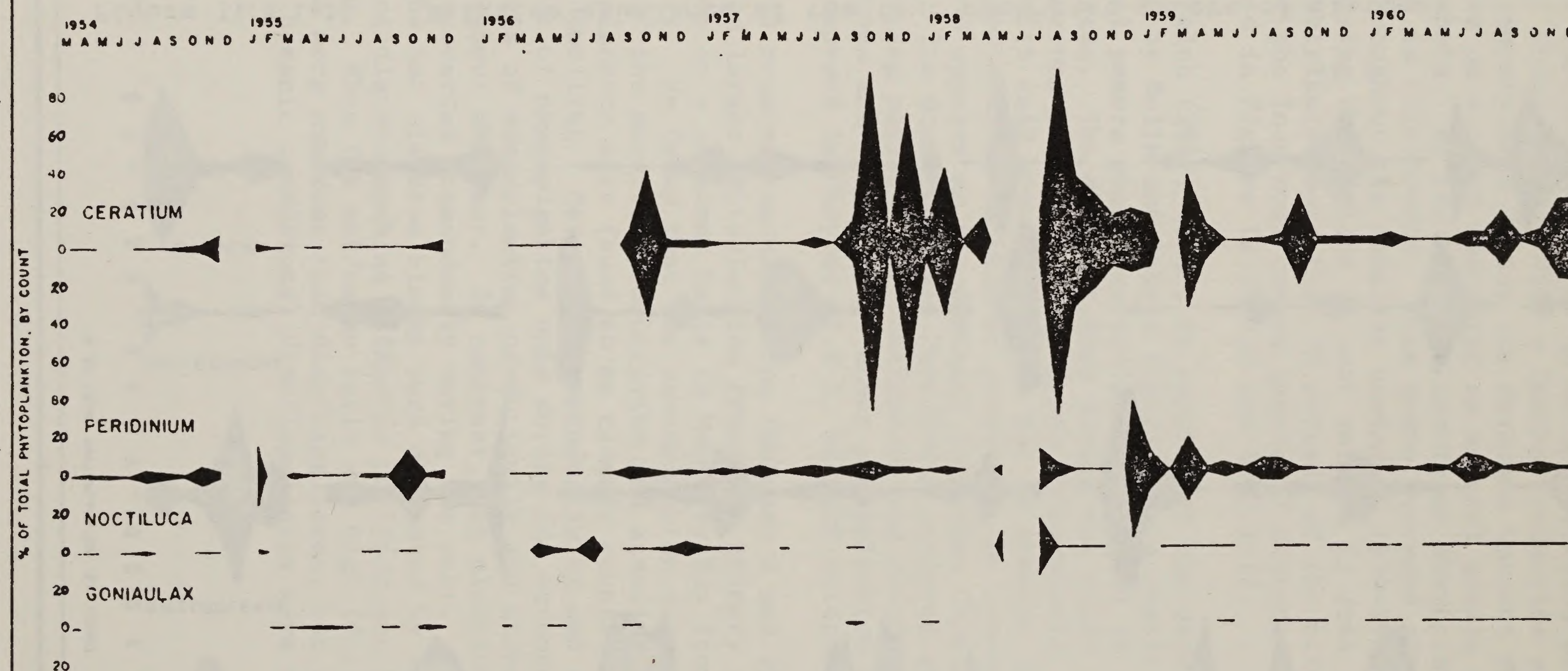


Figure II.E.1- 11 Relative abundance of the four commonest genera of dinoflagellates, expressed as percentage of the total phytoplankton

Source: Bolin and Abbott, 1963.

In a follow-up study Garrison (1976) studied the contribution of the net plankton and nannoplankton to the standing stocks and primary productivity in Monterey Bay, but his observations were restricted to the upwelling season when seasonal blooms of phytoplankton appear in Monterey Bay. At the end of the Davidson Current period, standing stocks were near their lowest levels and nannoplankton dominated. Throughout the period from February to July, however, the net plankton exceeded the nannoplankton. In August the standing stocks were again predominantly nannoplankton. Estimated primary production followed the general trend shown by the standing stocks. The highest standing stock was recorded in April with 97 percent net plankton and concentrations ranged from 4.63 to 6.88 mg Chl $\underline{a}/m^3$. During the April peak the corresponding total productivity was approximately 1.1 g $C/m^2/day$. The decline in the net plankton populations during this study corresponded to the influx of oceanic waters in July.

Malone (1971) also measured nannoplankton and net plankton primary productivity and standing crop along four transects within the California Current system between the latitudes of 35% and 50% N at 17 stations. He found that in July and August, during coastal upwelling, phytoplankton productivity and chlorophyll a concentrations decreased markedly with distance from land. Inshore productivity and chlorophyll ranged from 6.62 to 61.65 mg $c/m^3/hr$ and from 0.8 to 11.5 mg Chl $\underline{a}/m^3$ respectively. Productivity and chlorophyll concentrations offshore exceeded 1.0 mg $C/m^3/hr$ and 10 mg Chl $\underline{a}/m^3$ only once. However, the pattern observed in November was quite different. Levels of net plankton productivity and chlorophyll were quite low along the entire transect and were within the range commonly found offshore and during oceanic phases inshore. Nannoplankton productivity declined slightly from an inshore maximum of 3.20 to an offshore minimum of 1.21 mg $C/m^3/hr$.

Figure II.E.1-4 summarizes the available production data for stations off the California and Baja California coasts for the year 1969 (Owen, 1974). Production data for the year indicates that the stations nearest to shore off central California have by far the greatest production per day. The production data correlates well with the pigment data which measures standing stock. Figures II.E.1-5 through 8 show that very high values of chlorophyll a were found nearshore and very low values were found offshore. Consistently high chlorophyll a values were found off the Point Conception area. The highest values off central California for 1969 were in the April-June period (Figure II.E.1-6).

d. Red Tides: Red tides are a natural phenomenon occurring in warm and temperate waters in many parts of the world. Along the California coast, waters may become discolored with considerable frequency. This discoloration has been reported to range in color from white (Stracham, 1970) to yellow (Lackey and Clemdenning, 1963) to red (Allen, 1938). Dinoflagellates are reportedly the causative organisms responsible for discolored water even though diatom blooms could easily impart a red-brown color to the water.

Red tides usually seem to occur when surface nutrients are extremely low and there is a shallow thermocline (a sharp gradient of water temperature with depth). During a red tide, as many as 50 million dinoflagellates may occur in a liter of sea water (Carlisle, 1968). As these large numbers of cells die and decay in the surface waters, they can deplete the oxygen in the surface layer and cause kills of fish and invertebrates. This effect is most pronounced in bays and harbor areas with restricted mixing and circulation. Red tides often take place in California waters during the summer following diatom blooms. They generally occur within a narrow strip of water along the coast out to 5 km (3 miles) and in water less than 20 m (66 feet) deep (Carlisle, 1968).

Localized red tides occur along the Southern California and Baja California coasts almost every year (SCCWRP, 1973). More than 15 large blooms have been documented since 1894 and reported in the literature. In 1945, a large fish kill took place between San Luis Obispo and Los Angeles Harbor. Organisms affected by this wide-spread red tide included anchovy, halibut, sharks, rays, guitarfish, octopi, sea cucumbers, crabs, mussels, barnacles and lobster. These severe fish kills are rare.

The much publicized mussel poisoning along the central California coast is due to the dinoflagellate *Gonyaulax catenella*. In the cooler waters north of Point Conception, mussels and other mollusks can concentrate the toxin by ingestion of large numbers of this organism (Sommer, et al., 1937). The toxin is stored in the mollusk's liver. The California Department of Public Health places a quarantine on harvesting mussels during the warmer months of the year, May 1 through October 31, because of the danger of consumers being poisoned. This organism does not cause red tides in the warmer waters south of Point Conception.

In Southern California, since 1964 a number of observations have been made on red tides by the Food Chain Research Group of the Institute of Marine Resources in La Jolla (Holmes et al., 1967). Table II.E.1-2 in POCS Reference Paper No. II, presents a list of red tide blooms observed by this group. Five blooms occurred in La Jolla Bay between May, 1964 and December, 1966. Organisms responsible for these blooms were *P. micans*, *G. polyedra* and unidentified species of *Gymnodinium* and *Cocholdinium*. During the day, the organisms appeared in discrete patches that dispersed at night. The patches ranged from one to several hundred meters long and from 50 to 100 m (165-380 feet) wide to very large areas of several km long and 0.5 to 0.75 km (0.3-0.5 miles) wide. The patches formed each day after about 10:00 a.m. and dissipated by 4:00-7:00 p.m. One bloom was decimated by zooplankton grazing. Usually the red water disappeared suddenly, within a week or less, with new water moving in and out of the bay. A steep shallow thermocline was shown to be associated with the blooms. Maximum cell concentrations were 20 x 10^6 cells/liter in May, 1964.

G. polyedra is non-toxic to fish as long as it is in a healthy condition. When this organism decomposes, fish are killed as a result of an oxygen deficit (Clendenning, 1959). Man-made harbors in Southern California have increased the threat of fish kills. The reduced circulation has resulted in semi-stagnant conditions which create virtual fish traps during intense dinoflagellate blooms. At times the dissolved oxygen levels are reduced to zero during the time when the bloom is decaying. The problem is compounded by the decay of dead fish which uses up more oxygen. The fish and invertebrates probably suffocate since the dinoflagellate species causing the red tide are not known to be toxic (Carlisle, 1968). The absence of the mussel poisoning species *Gonyaulax catenella* has been established for several samples of red tide water in Southern California waters.

Blasco (1977) reported on a red tide that occurred during the seasonal onset of upwelling off Baja California. The dominant species were *Gonyaulox polyedra, Ceratium furca, Prorocentrum micans, Ceratium dens, Gonyaulax digitale* and *Gymnodinium* sp., with *G. polyedra* being three times as abundant as all the other dinoflagellates combined. The maximum cell concentrations were 70 x 10^4 cells/l. The *Gonyaulax* concentrations were highest within 10 km (6 miles) of shore. The dominance of *Gonyaulax* was related to the increase in nitrate in the euphotic zone and the low concentrations occurred when the surface temperature rose and the water column became less stable.

2. Zooplankton: This discussion of zooplankton in the California Current is based on the literature surveys of Holton, Leatham and Crandell (1977) and Seapy (1974) with revisions made as necessary. For a more detailed discussion of zooplankton in the California Current, refer to Chapter II.E.2 in POCS Reference Paper No. II. Zooplankton in enclosed bays and estuaries are discussed in Chapter II.F.1 of this environmental statement.

a. Introduction: Zooplankton, or animal plankton, are a diverse group of plant and animal eaters in the ocean with limited swimming ability. Like the phytoplankton, the zooplankton are dependent on the ocean currents for their primary means of transport. There are both permanent and temporary members of the zooplankton community. The permanent members, such as chaetognaths ("arrow-worms"), euphausids (shrimp-like crustaceans), copepods (small crustaceans less than a few mm in size), and larvaceans, complete their entire life cycles in the plankton. The seasonally abundant temporary representatives, such as hydromedusae ("jellyfish") and the eggs and larvae of many fish, shell-fish and bottom-dwelling invertebrates, complete only a part of their life cycles in the water column. Both components of the zooplankton are vital for the transfer of energy from the phytoplankton and other lower levels of the marine food web to the higher levels including fish, birds and marine mammals.

Zooplankton have a large variety in species, form, size and habitat. In the California Current System, there are estimated to be at least 546 invertebrate zooplankton species and about 1,000 vertebrate species of fish larvae (Kramer and Smith, 1972). There are representatives from nine different animal phyla and twenty-three major taxa. Zooplankton range in size from a mature six-foot jellyfish to single cell microscopic protozoa such as the foraminiferans and radiolarians. Copepods, tiny crustaceans usually less than 4 mm in length, are generally the major component of the zooplankton. Members of each phylum can be found in both estuarine and oceanic waters. Habitats range from shallow tidepools and bays to ocean depths of at least 6,000 m (19,800 feet) (Holton, Leatham and Crandell, 1977).

Most of the data for zooplankton in the study area off California and Baja California come from the on-going CalCOFI (California Cooperative Oceanic Fisheries Investigation) program initiated in 1949. Zooplankton and fish larvae data have been collected from a series of stations off the coast with 1 m (3.3 feet) nets down to a depth of 140 m (462 feet) (Figure II.E.2-1). Only the upper layer of the water column has been intensively sampled during this 28-year program. Since the mesh size of the CaCOFI plankton net is 0.6 mm (0.02 inches), only the larger forms of the zooplankton are collected and analyzed. In the CalCOFI data, two appreciable forms of bias are present: day-night differences

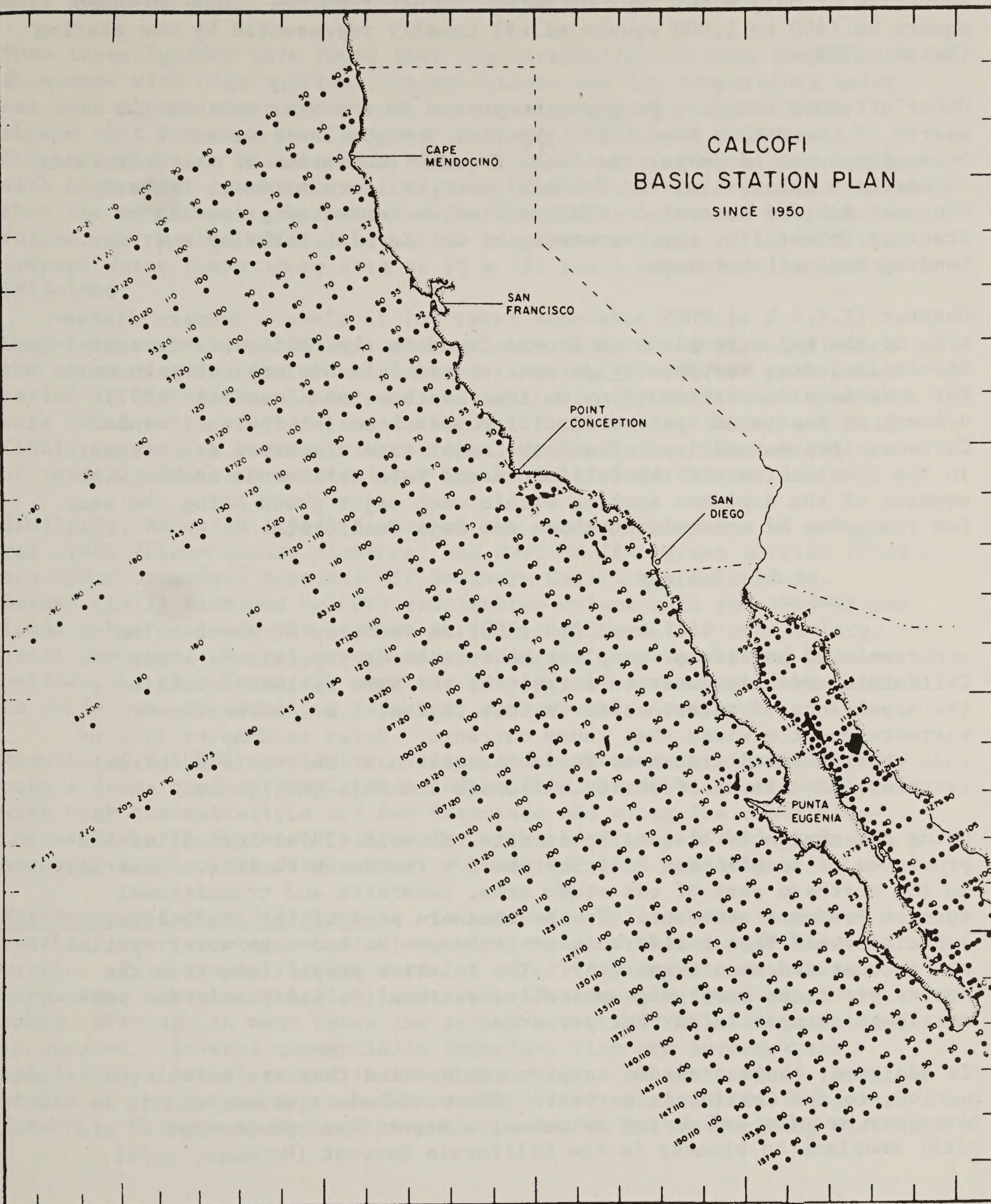


Figure II.E.2-1 California Cooperative Ocean Fisheries Investigations (CalCOFI) Basic Station Plan Since 1950.

Source: Fleminger, 1967.

and the normal patchiness of the plankton. Because of patchiness, defined as a non-random grouping of organisms, a sample may be representative of only a few tens of meters rather than the 1,024 to 4,096 square km (400 to 1,600 square miles) usually represented by one station (Smith, 1971).

Other offshore sampling programs conducted in the area include the research of the Marine Food Chain group at Scripps Institution of Oceanography at La Jolla; the Allan Hancock Foundation of the University of Southern California; the University of California, Santa Barbara; Monterey Bay and Central California Studies conducted primarily by Stanford University, the University of California, Berkeley and Moss Landing Marine Laboratory.

Chapter II.E.2.b of POCS Reference Paper No. II gives a summary discussion of the major zooplankton groups found in the California Current System including representative species and life history, when known. For more detailed information, Holton, Leatham, and Crandell (1977) present an annotated species list of zooplankton for the California Current. Representatives of all the major taxa discussed are present in the zooplankton off the California and Baja California coasts with several of the dominant species within each major group being the same for the areas of central, Southern and Baja California.

b. Ecology

i. Areal Distribution Patterns Offshore: The occurrence of particular zooplankton species or populations along the California coast is governed largely by the same factors determining the appearance of water masses in this region, i.e., advection or currents and the winds that cause currents. Refer to Chapter II.C of this environmental statement for a discussion of the various current patterns and seasons offshore California and Baja California.

Using all available biogeographic data, McGowan (1974) identified six provinces of zooplankton distribution for the North Pacific. Generally, in the northern part of one study area, subarctic and transitional species are more abundant. To the southern part of the study area, especially off Baja California, central species and warm water species are encountered more frequently. The relative proportions from the source provinces vary geographically, seasonally, and yearly due primarily to changes in current patterns.

In addition, there are some zooplankton species that are endemic, or native, to the California Current. These endemic species tend to be nearshore species and do not represent a significant proportion of the total zooplankton biomass in the California Current (McGowan, 1974).

Some examples are the chaetognath, *Sagitta bierii*; the copepod, *Eucalanus bungi californicus*; and the hyperid amphipod, *Hyperietta stebbingi*. The most abundant squid, *Abraliopsis felis*, is also an endemic.

Some investigators have found that the correlation of high zooplankton abundance with high nutrient concentrations and low temperature water has been a consistent trend over a long time period. Reid (1962) showed that for each year between 1949 and 1960 in the California Current, plankton volumes were high with low water temperatures and low with high water temperatures. Figures II.E.2-2, 3 and 4 provide evidence that the centers of greatest plankton abundance, expressed by plankton volume, correspond well with the low temperature range of 12-15°C for average water temperature data at 10 m (33 feet) depth for the period 1951-1960.

Long-term meteorological and oceanographic changes can also influence the areal distribution of zooplankton. During the 1957-59 warm water period in the California Current, several normally warm water species were found north of their usual ranges. For example, Berner and Reid (1961) reported a reversal in the usual seasonal distribution pattern of the salp *Doliolum denticulatum* in the California Current.

Similarly, Radovich (1961) described the unusual abundance of pelagic red crabs (*Pleuroncodes planipes*) and East Pacific green turtles (*Chelonia mydas agassizii* Bocourt) off Southern California in 1957-58. Bernal (1977) examined CalCOFI zooplankton volume data for 1949-69 and found large peaks in the biomass in 1950, 1953 and 1956 over a large areal coverage. Bernal hypothesized that the three peaks and two low periods, or five "events", over the twenty-year period could be related to variations in upwelling intensity and advection patterns.

Results of CalCOFI zooplankton volume and biomass determinations indicate a dense band of zooplankton 160 km (100 miles) wide off California with high concentrations off San Francisco and along the Santa Rosa-Cortes Ridge in Southern California. Figures II.E.2-5 through 8 show seasonal zooplankton displacement volumes for 1958 and 1959.

Nearshore-Offshore Differences. In nearshore waters, the larvae of benthic invertebrates and fish are more abundant than in offshore waters. For example, larval forms of intertidal organisms such as barnacles, mussels, starfish, and crabs are commonly found close to shore, although in many cases the actual extent of their distributions is unknown. Several commercially important fish and invertebrate species have larval stages in nearshore waters. These include larval stages of the Dungeness crab (*Cancer magister*), pink shrimp (*Pandalus jordani*), *Crangon* shrimp and several species of bottom-dwelling flatfish.

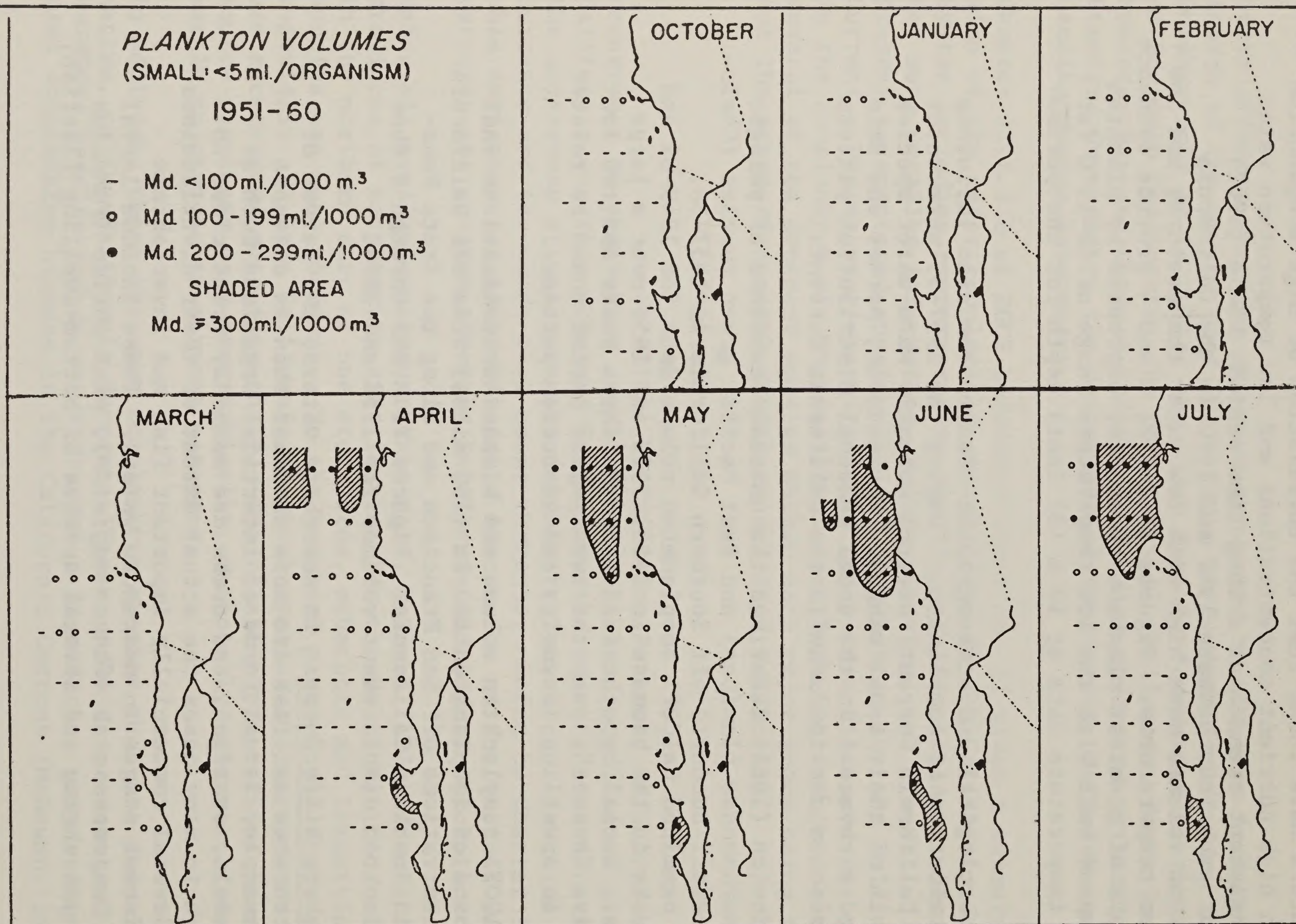


Figure II. E. 2-2 Medians of plankton volumes consisting of organisms less than 5 ml collected on survey pattern of California Cooperative Oceanic Fisheries Investigations (CalCOFI), 1951-60.

Source: Kramer and Smith (1972)

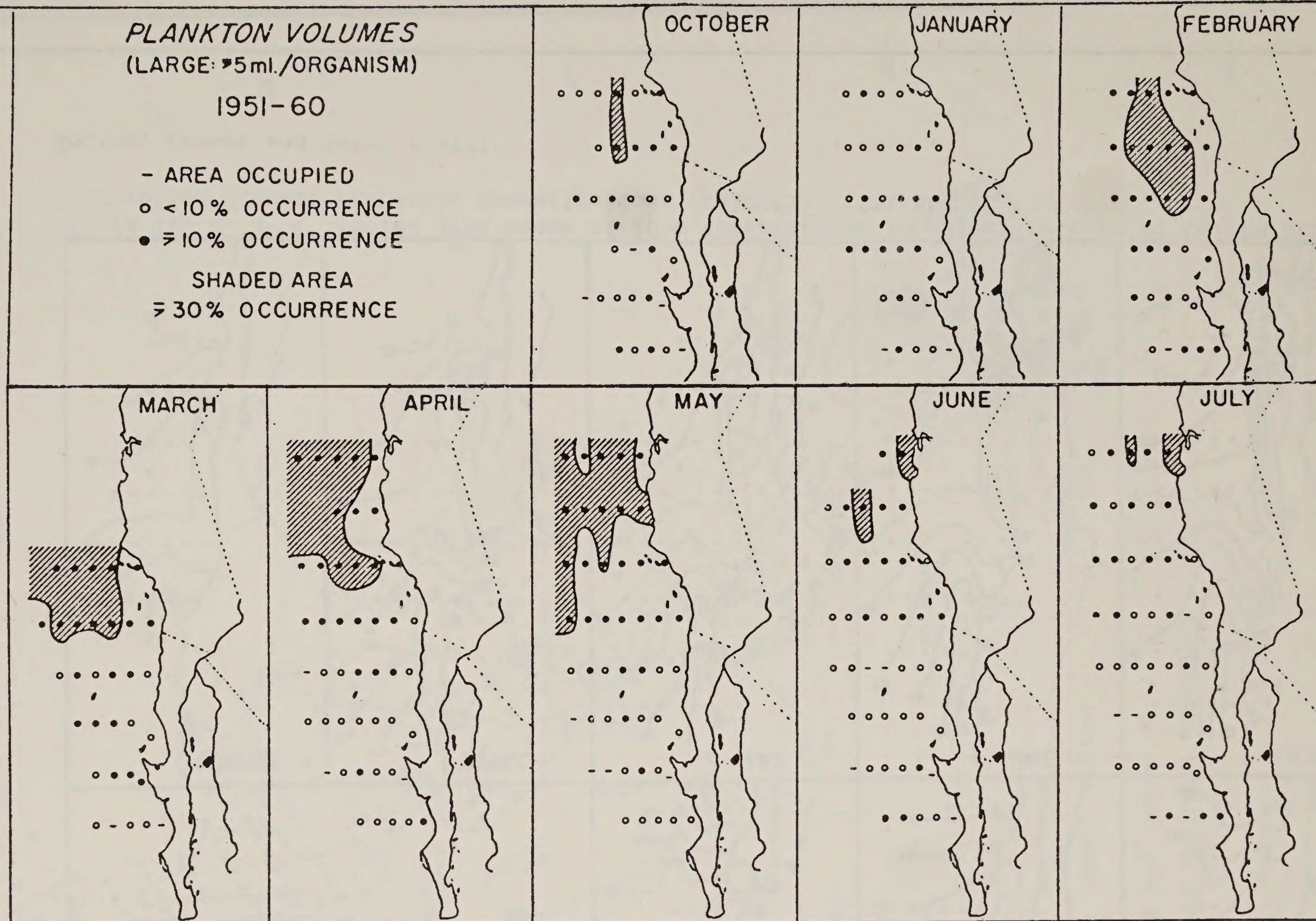


Figure II. E. 2-3 Percent occurrence of plankton volumes, consisting of organisms equal to or greater than 5 ml, collected on survey pattern of California Cooperative Oceanic Fisheries Investigations (CalCOFI), 1951-60.

Source: Kramer and Smith (1972)

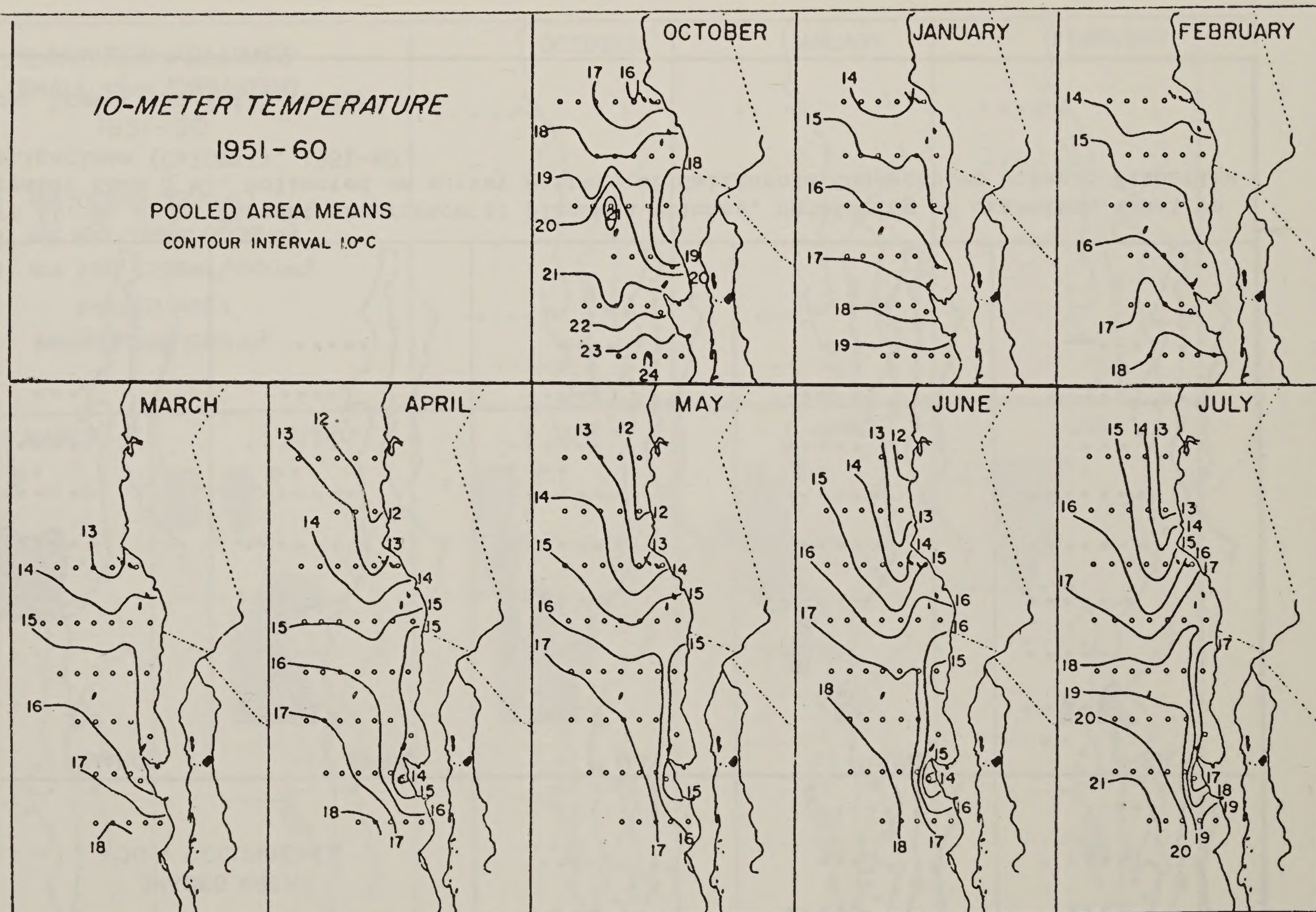


Figure II. E. 2- 4 Pooled area means of 10-m temperatures in survey pattern of California Cooperative Oceanic Fisheries Investigations (CalCOFI), 1951-60.

Source: Kramer and Smith (1972)

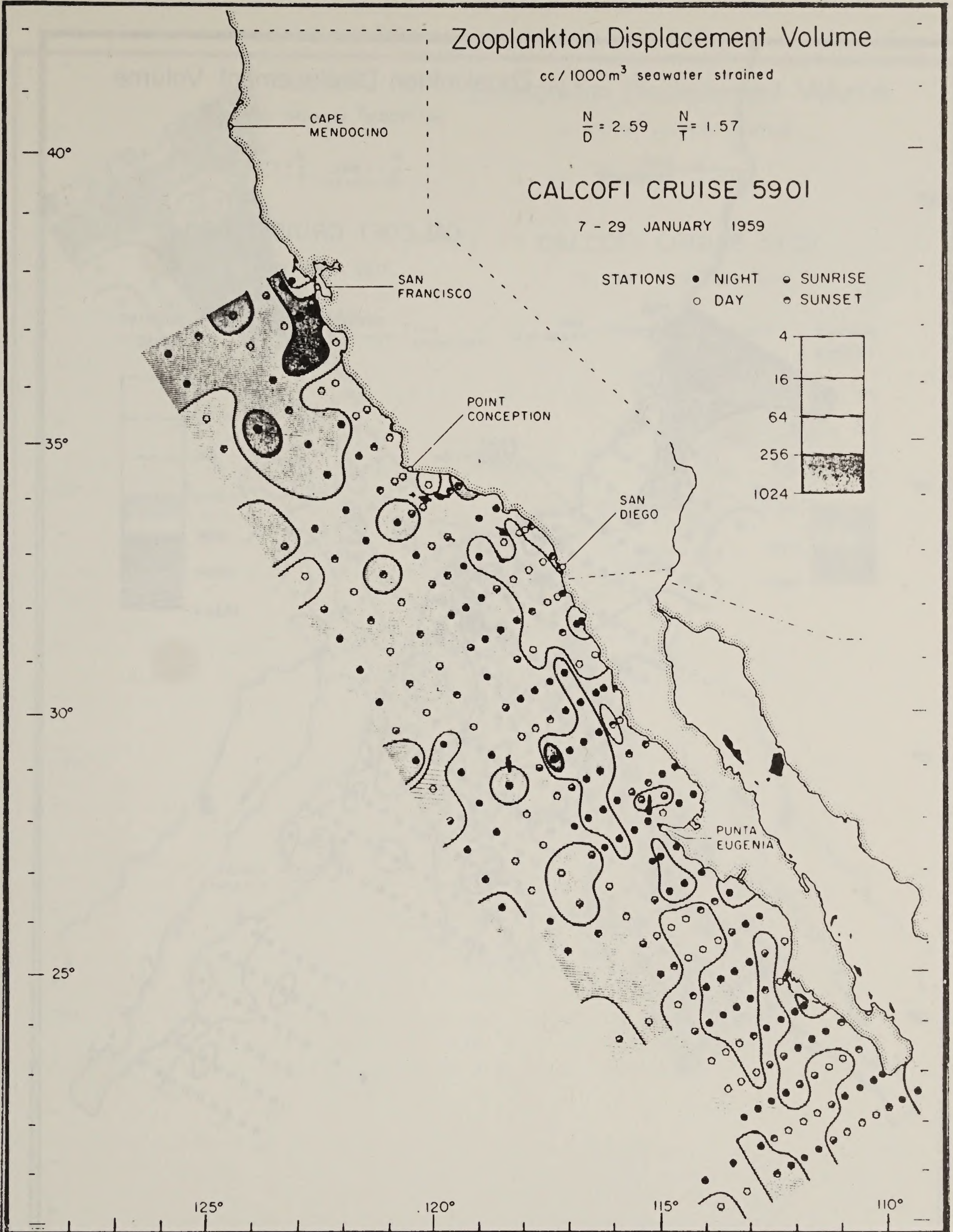


Figure II.E.2-5 Zooplankton Displacement Volume,7-29 January, 1959.

Source: CalCOFI Cruise 5901, 1959.

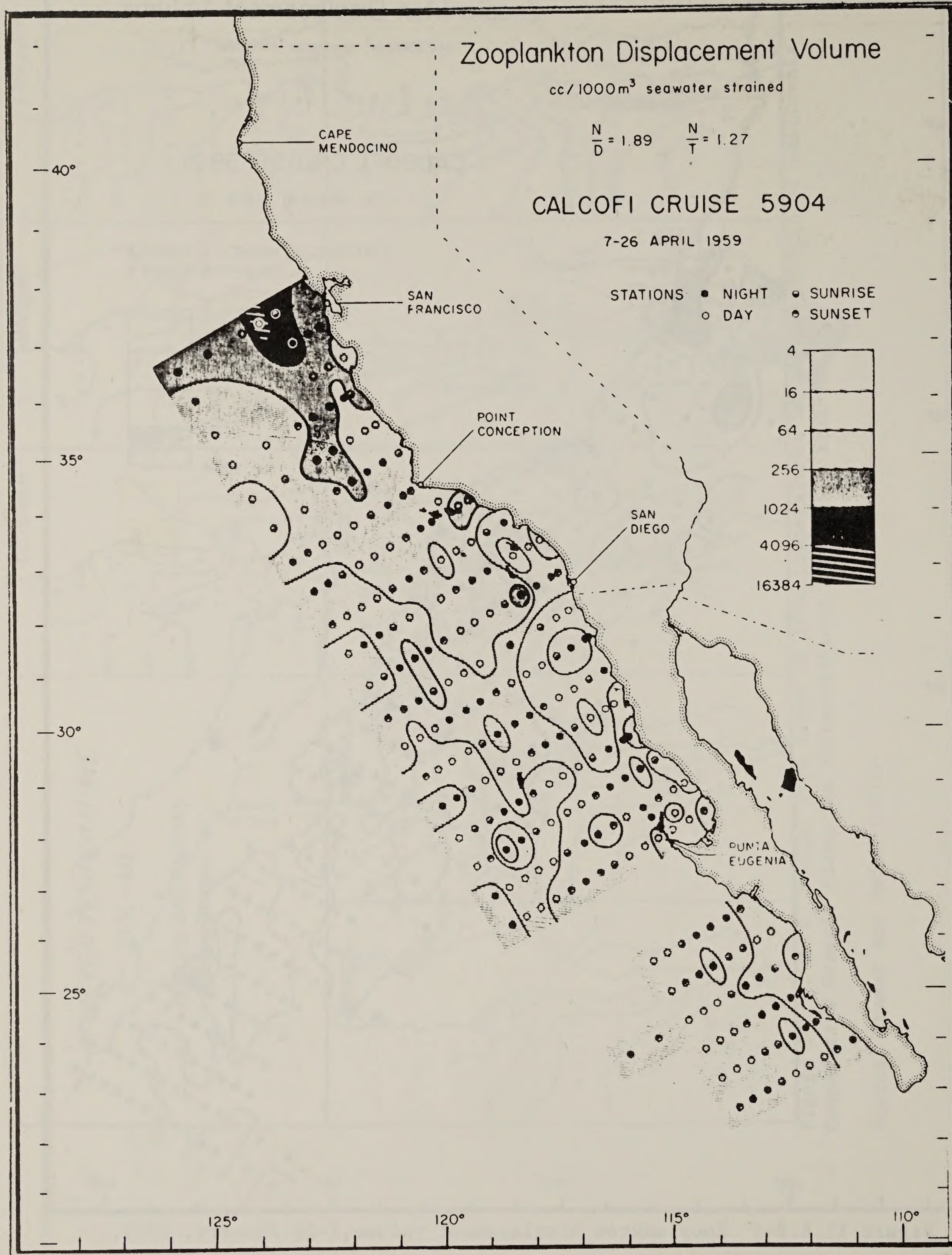


Figure II.E.2-6 Zooplankton Displacement Volume, 7-26 April, 1959.

Source: CalCOFI Cruise 5904, 1959.

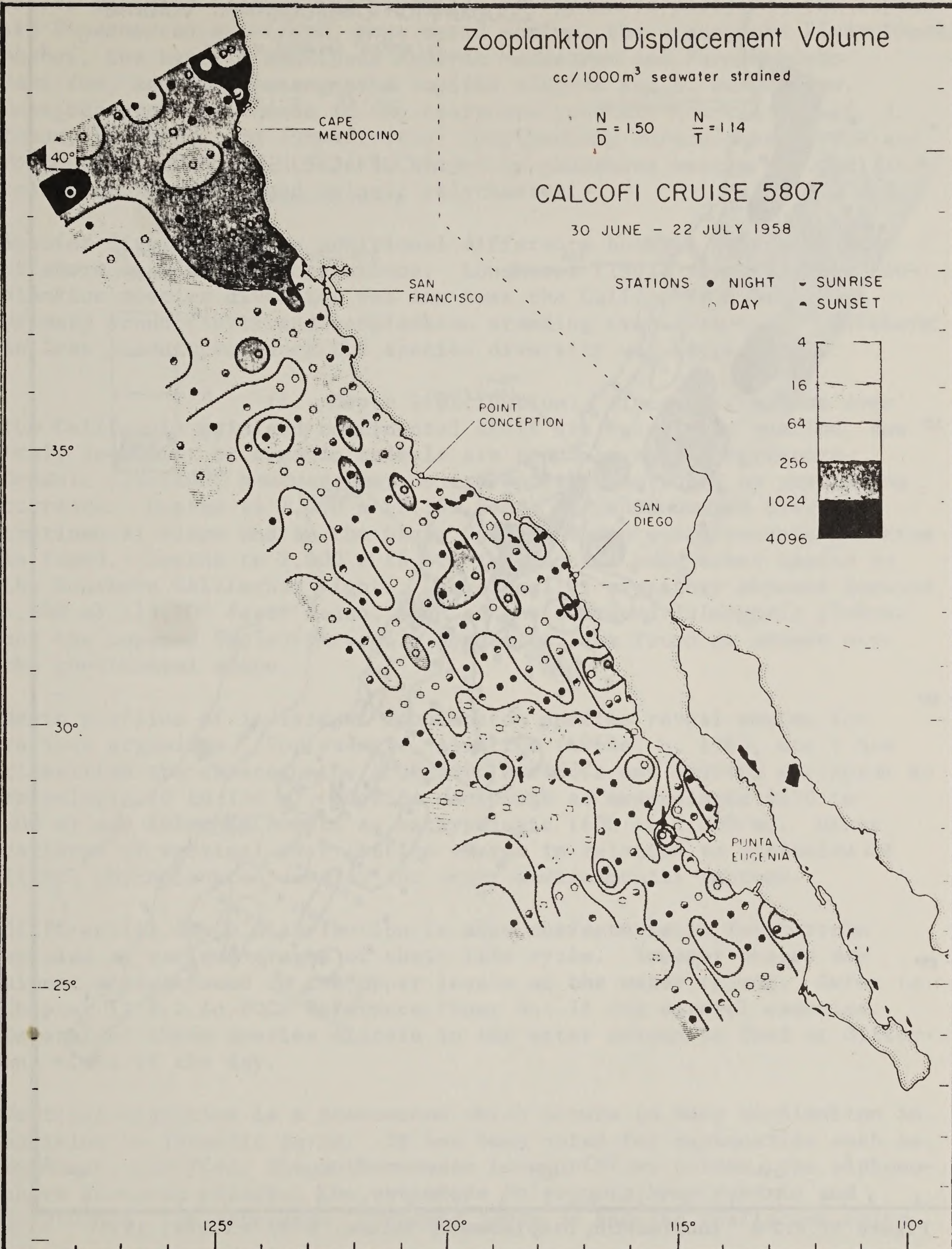


Figure II.E.2-7 Zooplankton Displacement Volume, 30 June-22 July, 1958. Source: CalCOFI Cruise 5807, 1958.

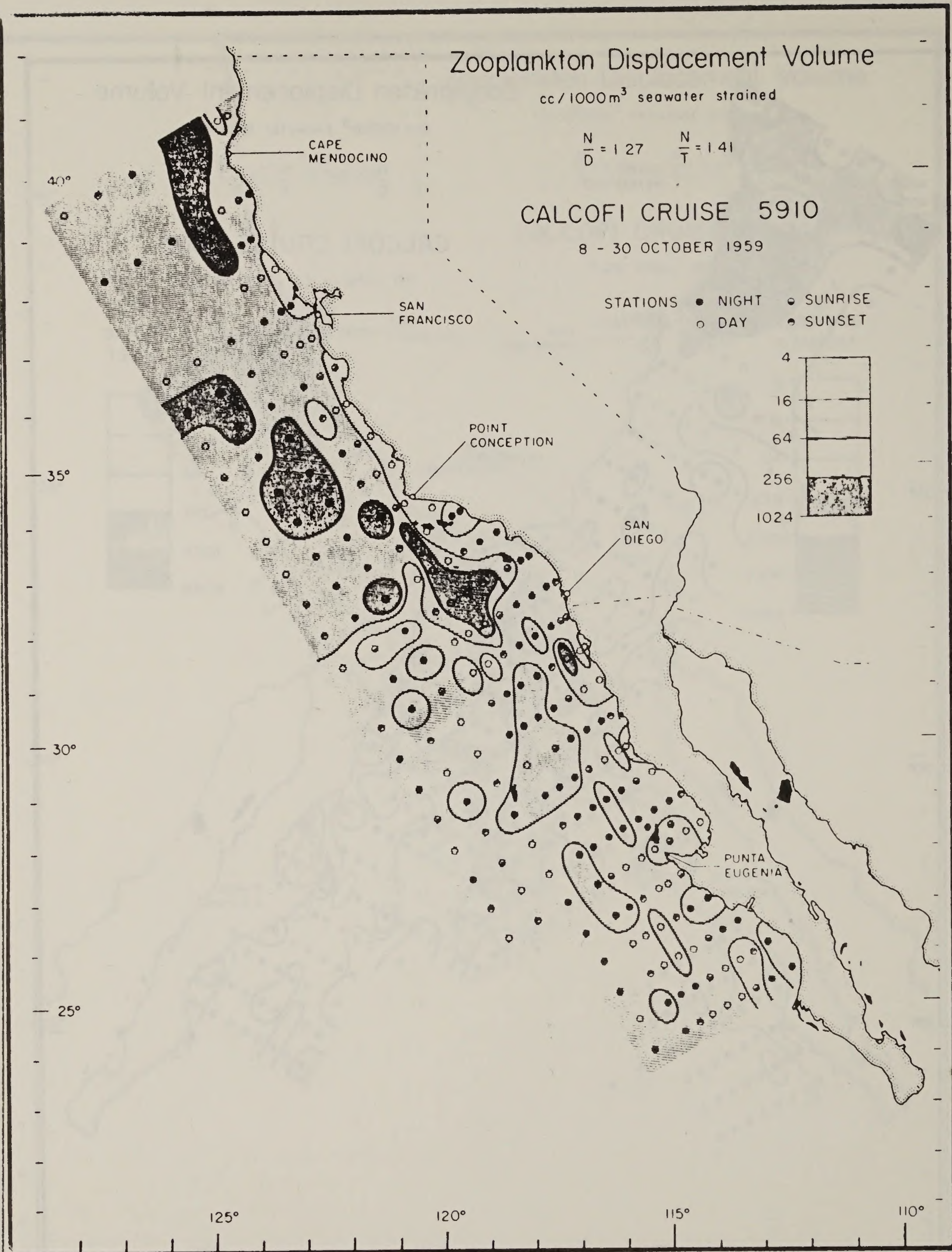


Figure II.E.2-8 Zooplankton Displacement Volume, 8-30 October, 1959.

Source: CalCOFI Cruise 5910, 1959.

Non-commercial invertebrate species which are abundant in nearshore waters include: larvae and juveniles of *Euphausia pacifica*, the euphausid *Thysanoessa spinifera*, most mysid shrimp, the ctenophore *Pluerobrachia bachei*, the hyperid amphipods *Hyperia medusarum* and *Parathemisto pacifica*, and the chaetognaths *Sagitta elegans* and *S. euneritica*. Copepods probably common in the nearshore zone are *Acartia clausi, A. tonsa, Epilabidocera (amphitrites) longipedata, Paracalanus parvus* and *Tortanus discaudatus*. Rare to absent in nearshore waters are thaliaceans, cephalopods, and pelagic polychaetes.

Species diversity is an additional difference between nearshore and offshore zooplankton populations. Longhurst (1967) reported that zooplankton species diversity was low near the California coast where primary productivity and zooplankton standing crop were high. Offshore in less productive water the species diversity was higher.

ii. Depth Distribution: Since most waters over the California mainland continental shelf are relatively shallow, few truly deepwater or oceanic animals are found in nearshore waters. Oceanic plankton, however, may be transported shoreward by prevailing currents. Depths to 1,000 m (3,300 feet) are encountered over the continental slope and in the Santa Barbara Basin where oceanic plankton is found. Depths to 2,000 m (6,600 feet) occur over other basins in the Southern California Bight. Occasionally, migratory abyssal (around 4,000 m) (13,200 feet) fauna, such as the ostracod *Halocypria globosa* and the copepod *Scolecithricella abyssalis*, are found in waters over the continental slope.

Depth profiles of individual zooplankton species reveal maxima for various organisms. For example, Alvarino (1964a, b, 1965, etc.) has classified the chaetognaths *Krohnitta subtilis* and *Sagitta scrippsae* as epipelagic (0 to 150 m), *Sagitta decipiens* as mesopelagic (150 to 600 m) and *Eukronia hamata* as bathypelagic (600 to 1,000 m). Other patterns of vertical distribution emerge in relation to variables of light, phytoplankton density and other environmental factors.

Differential depth distribution is also characteristic for certain species at various stages of their life cycle. Younger stages are almost always found in the upper levels of the water column. Refer to Chapter II.E.2 in POCS Reference Paper No. II for several examples. Several of these species migrate in the water column to feed at different times of the day.

Vertical migration is a phenomenon which occurs in many zooplankton in addition to juvenile forms. It has been noted for euphausiids such as *Euphausia pacifica*, the anthomedusae *Leuckaritiara octona*, the siphonophore *Roseacea plicata*, the ostracods *Halocypria brevirostris* and *H. globosa*, the heteropod *Carinaria japonica* and the thaliacean *Salpa* *fusiformis*. A large number of copepod species migrate including those from the genera *Euchirella, Haloptilus, Lophothrix, Pleuromamma,* and *Calanus*. Species of protozoans, chaetognaths, pelagic polychaetes, cladocerans, pteropods and larvaceans also complete vertical migrations (Hardy, 1965). Vertical migrators may cover distances as far as 1,000 m (3,300 feet) during a 24-hour period, although distances of a few hundred or tens of meters are more common. Generally, the vertical migrators are most abundant in the upper layer of the water column at night and are at deeper depths during the day.

The reasons for vertical migration have been postulated as food and completion of a life cycle. For example, the copepod *Calanus* feeds on its nocturnal visits to the surface, but its egg laying is also nocturnal. Eggs are released primarily between midnight and 4 a.m. in near surface waters. The young are not vertical migrators. It isn't until the 10th of 12 life stages when *Calanus* is nearing sexual maturity that the copepod begins its nocturnal migrations.

The most recent investigation of vertical distribution and migration in the study area is by Youngbluth (1976) who determined the density, vertical range, and daily vertical movement of total zooplankton and euphausiid populations in the central region of the California Current during a period of coastal upwelling, July to August, 1970. Daily vertical movement among euphausiid populations, particularly *Euphausia pacifica* tended to be more pronounced in offshore waters. This behavior was interpreted to suggest that although assemblages of zooplankton are strongly structured by physical factors, some species alter their vertical distribution and daily migration presumably in response to the prevailing food supply.

iii. Marine Food Web Relationships: Zooplankton abundances are strongly correlated with phytoplankton growth. During early spring, light levels and plentiful nutrients churned up by winter storms and the onset of upwelling cause the rapid growth (termed a "bloom") of the phytoplankton. Following the phytoplankton bloom a rise in zooplankton levels begins slowly, peaking in early June. Zooplankton grazing pressure exerted upon the diatoms and flagellates is credited for the summer crash. Zooplankton numbers soon decrease. During autumn, the first storms again recycle nutrients into the surface waters while there is still enough light to cause a secondary phytoplankton bloom. Zooplankton, too, increase, producing another generation before subsiding into a winter low.

Generally, the fall increase in zooplankton is dominated by permanent plankton such as copepods, ctenophores and hyperid amphipods. Although numerically dominant during spring, permanent planktonic organisms are joined by the temporary members of the plankton. For many benthic invertebrates and some commercially important species, spring is the major reproductive period. Fish larvae, crab and shrimp zoea often reach peak numerical abundances during spring. By July, most have left a planktonic existence behind. However, in the waters off Southern California several species spawn throughout the year and these peaks are not as prominent in the plankton. Increasing biological evidence indicates that the Southern California Bight has a distinct eddy (current). Much of this surface water may recirculate in the Bight for 4 to 6 months with longer periods for the deeper water. This counter-clockwise flow may maintain a resident community of not only zooplankton, but phytoplankton associated with them (See Figure II.E.2-8a).

The above discussion gives the generalized relationship between zooplankton and phytoplankton. As was pointed out in the introductory material, the study area is greatly influenced by advective processes which at times produce patterns very different from the "typical" patterns presented for temperate latitudes. When upwelling and the resulting nutrient increase are imposed on the system, the so-called summer crash may become the period of highest productivity.

Interrelationships between phytoplankton and zooplankton and intra-relationships of zooplankton are far more complex than those of the plant and animal communities on land. Herbivorous copepods exert a selective pressure upon the larger cell sizes in the phytoplankton (Richman and Rogers, 1969). Such selective grazing influences the cell size distribution of a single phytoplankton species as well as community structure. Excretory products from the copepods can also influence phytoplankton dynamics.

Zooplankton are not easily placed in a single food web level. Omnivorous species are numerous. For example, some species feed primarily on phytoplankton but they may also feed upon zooplankton protozoans and small crustaceans. Young stages of *Arcatia* copepods are herbivorous, but acquire omnivorous habits as adults (Parsons and LeBrasseur, 1970). Several zooplankton species in groups such as chaetognaths, copepods and euphausids prey upon other zooplankton species (Sullivan, 1970). In addition, investigators have found that some copepods and euphausid shrimps are effective predators on larval fish in the surface waters of the California Current (Lillelund and Laslow, 1971 and Theilaiker and Lasker, 1973).

Research on the prey and predators of commercially important fish larvae in the California Current has found that newly hatched northern anchovy larvae are dependent upon phytoplankton for their food source after they absorb the yolk sac and start feeding. During the first few days, or perhaps up to a week after feeding, the size range of phytoplankton required is around 30-50 μ. During the first few days after yolk absorption, anchovy larvae have a higher food density requirement than at any other time in the larval stage. As the larvae grow, they capture larger prey and are dependent on copepods and other zooplankton (Hunter and Thomas, 1973; Hunter, 1972; Lasker, et al., 1970; Arthur, 1956).

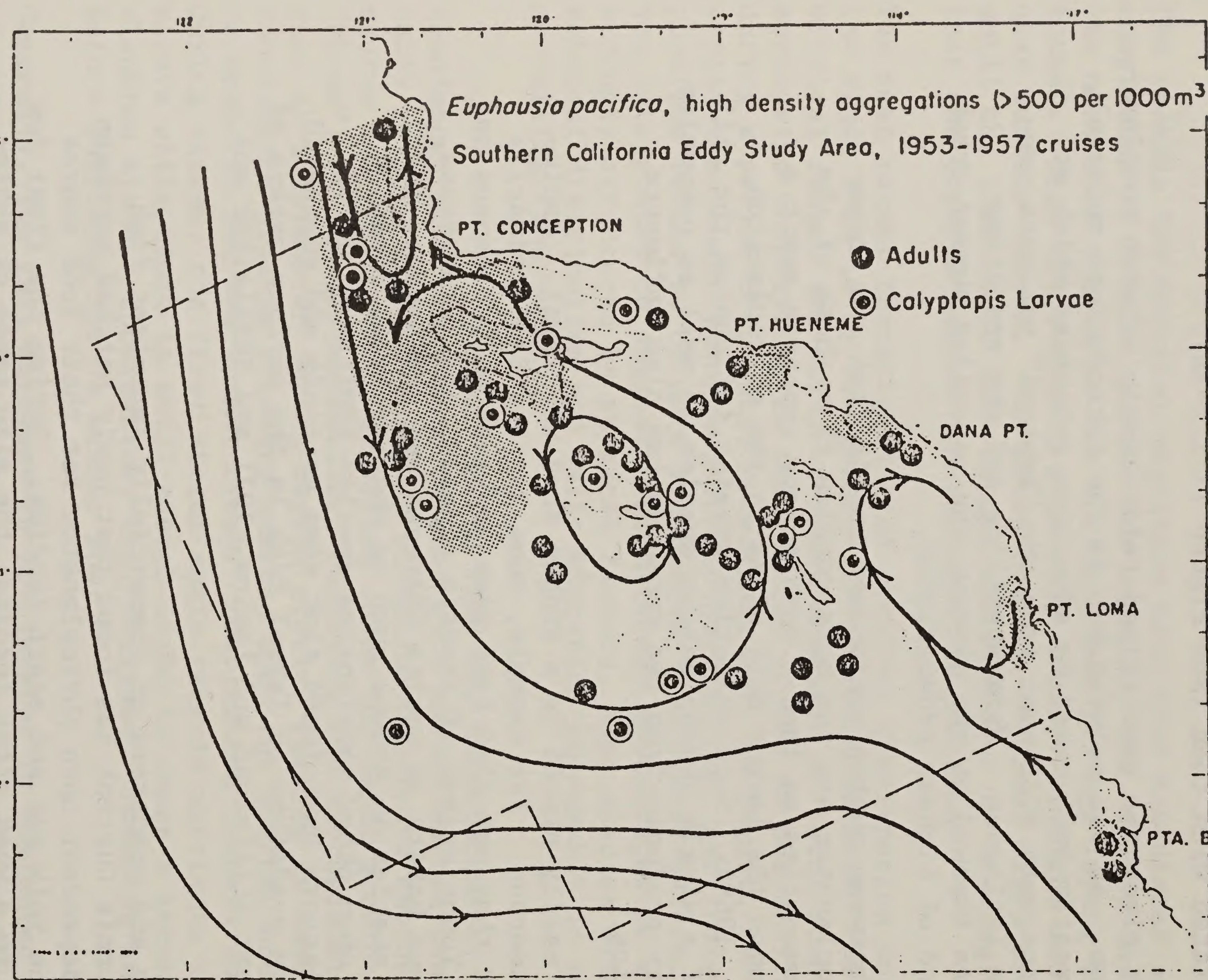


Figure II.E.2-8a Shows a generalized circulation pattern for the "Southern California Eddy" (from E. Brinton, SIO, unpublished). This current picture is based on data from the CalCOFI Atlases. It shows both the rapid southward-moving westerly current and the slower counter-clockwise eddy in the nearshore region between Pt. Conception and San Diego. The nearshore region is an important nursery and breeding area for zooplankton, such as *Euphausia pacifica*. The shaded portions show areas of upwelling which bring nutrients to the surface waters, providing the basis for increased productivity at all levels of the marine food chain (phytoplankton, zooplankton, etc.).

Along with the shift in prey from phytoplankton to zooplankton for anchovy larvae, the larger larvae migrate into the surface layers of the water column at night to feed. Hunter and Sanchez (1976) reported that at night over 50 percent of anchovy larvae greater than 11.75 mm (0.5 inches) examined from plankton samples collected in the California Current were taken in the upper 10 m (33 feet) of the water column. During the day, the upper 10 m contained less than 10 percent of the larvae greater than 11.75 mm. In addition, about 50 percent of the larvae less than 11.75 mm occurred in the upper 10 m, but no obvious difference existed between day and night samples (Hunter and Sanchez, 1976).

Both laboratory and field studies demonstrated that anchovy larvae 10 mm (0.4 inches) standard length and larger inflate their swim bladders each night and deflate them in the day. Maximum night levels of inflation were attained two hours after the onset of darkness and typical day levels occurred about two hours after the onset of light. Laboratory experiments indicated that larvae fill their bladders at night by swallowing air at the water surface. The vertical distribution of sea-caught larvae suggested that they migrate to the surface each night to fill their swim bladders (Hunter and Sanchez, 1976). According to data examined by Ahlstrom (1959), about 98 percent of anchovy larvae collected in plankton tows occur above 56 m (185 feet) and 49 percent are above 8 m (26 feet).

c. Distribution and Abundance of Zooplankton in the California Current

i. Southern California Bight: Long term averages of zooplankton standing stock in the Southern California Bight presented in Figures II.E.2-2 and 3 and Figure II.E.2-9 show that the peak of zooplankton abundance in the upper 140 m (462 feet) of the water column occurs in the spring and summer months with lowest abundance in the winter months (Kramer and Smith, 1972). The abundance data indicate that 64-256 cc/1,000 m^3 of zooplankton by volume were present over most of the Southern California Bight during February to July with a 1,024 cc/ $1,000^3$ patch offshore. A large patch of lower volume (16 to 64 cc/ 1,000 m^3) occurred over much of the Bight in October and January. However, abundance data for one year presented in Figures II.E.2-5 through 8 show the great variety of abundance both over the area and between the seasons for a given year. In 1959, the largest abundance of zooplankton recorded in the Bight area was in October centered over the Santa Rosa-Cortes Ridge.

McGinnis (1970) made observations of the zooplankton of the eastern Santa Barbara Channel from May, 1969 to March, 1970. Samples were collected in the upper 5 m (16.5 feet) of water at eleven stations which were sampled monthly. The monthly average standing crop was

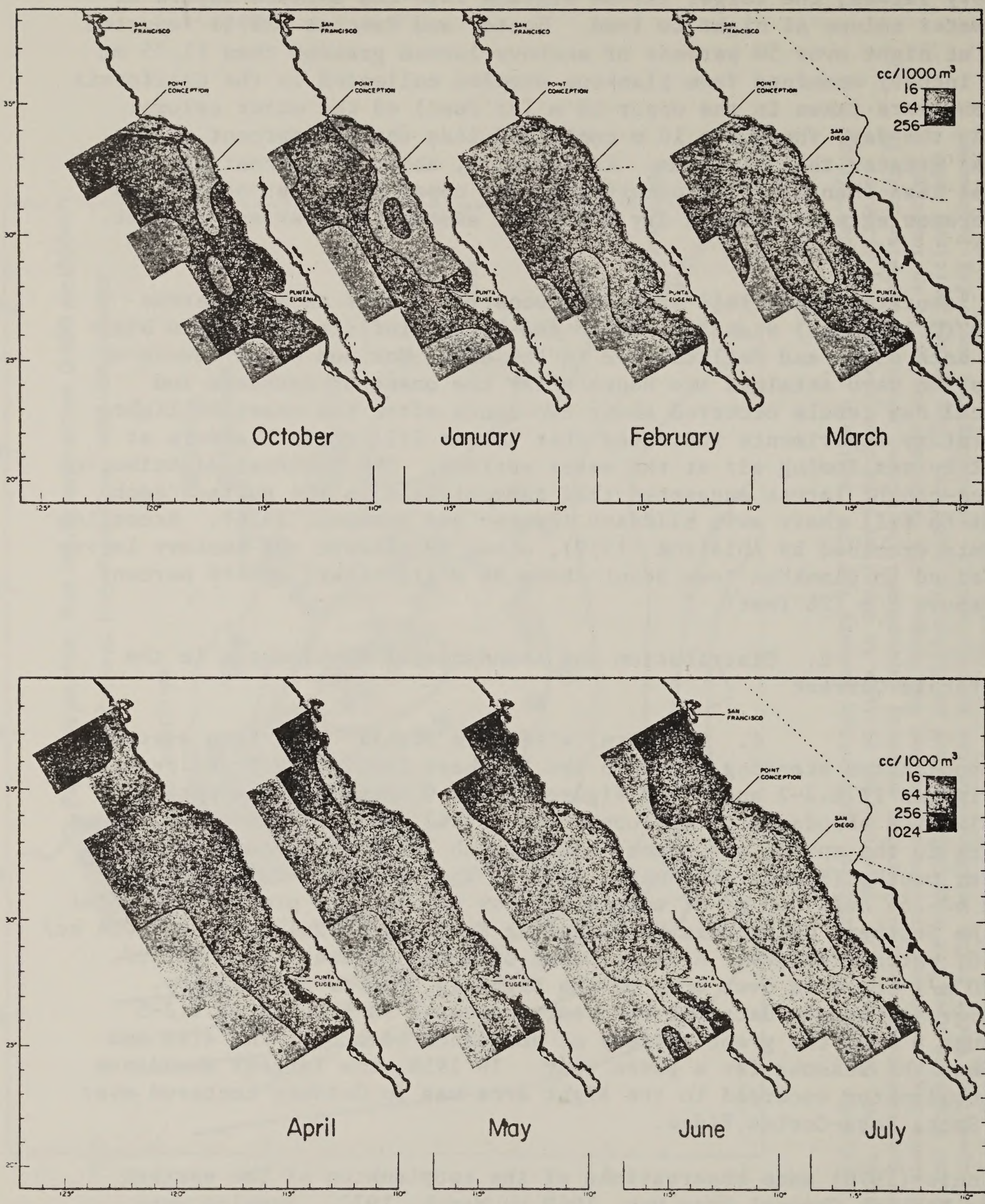


Figure II.E.2-9 Median Zooplankton Volumes (cc/1000 m^3; large organisms removed) 1951-1960.

Source: Smith, 1971.

lowest in September and highest in January. The epipelagic copepod *Labidocera trispinata* appeared to be breeding throughout the year. Unusual blooms of the thaliacean *Doliolum denticulatum* and the cladoceran *Penilia avirostris* occurred.

Hobson and Chess (1976) reported on the trophic interactions among fishes and zooplankton nearshore at Santa Catalina Island, California. Plankton samples were collected at depths midway between the surface and the bottom, in 10-15 m (33-50 feet) of water, and near the bottom. Calanoid copepods were the most numerous group in the zooplankton and the major species were *Acartia tonsa* and *Calanus pacificus* with others present including *Candacia* spp., *Clausocalanus* sp., *Ctenocalanus* sp., *Euchaeta* sp., *Labidocera* spp., *Lucicutia* sp., *Metridia pacificus*, *Paracalanus* sp., and *Rhincalanus nasutus*. The major cyclopoid copepod was *Coryceus* sp., but *Oithona* sp. was also present. Other taxa best represented in the samples were radiolarians, cladocerans, euphausiid larvae, chaetognaths, and fish eggs.

As part of a pre-operational monitoring program for the Long Beach Generating Station, zooplankton were sampled from three depths at 12 stations during 1974 and 1975 (Environmental Quality Analysts, Marine Biological Consultants, Inc., 1976). The zooplankton in Long Beach harbor was dominated by pelagic copepods, most of which were calanoids or cyclopoids. Larval forms of benthic invertebrates were also abundant with barnacle stages (nauplii) the most common. Zooplankton abundance ranged from $130/m^3$ in June at one station to $13,063/m^3$ in March. Zooplankton concentrations increased from January to a yearly maximum in March, decreased to minimal concentrations in April through June, and increased again in July. After the July seasonal peak, concentrations declined through September then increased to a seasonal peak in November and declined slightly in December. Two coastal temperate species, *Acartia tonsa* and *Paracalanus parvus* dominated the calanoid copepod population throughout the year.

Checkley (1977) related the egg production of the copepod *Paracalanus parvus* off Southern California to the available supply of food. Although the abundance of females was independent of the concentration of phytoplankton, the rate of production of eggs by females was positively correlated with phytoplankton abundance. Although these findings cannot be extrapolated to other species, or even to *P. parvus* in other areas, they do indicate the danger of making any assumption about the effect of phytoplankton on zooplankton.

Seapy (1974) reviewed invertebrate zooplankton taxa and abundances for the Southern California Bight in detail. A summary of the common organisms and remarks about their distribution is presented in Table II.E.2-1. Refer to Section II.E.2.b in POCS Reference Paper No. II for a description of the taxonomic groups.

Table II.E.2-1

MAJOR ZOOPLANKTON TAXA IN THE SOUTHERN CALIFORNIA BIGHT

Major Taxa	Common Species	Distribution Remarks
Coelenterates (Cnidaria)	Poorly known for the area.	
Ctenophores	*Pleurobrachia bachei*	Common in nearshore plankton.
	Beroe sp.	Reported from south of the area. Densities of less than 50/10,000 m^3 of water in the upper 110 m (363 feet).
Chaetognaths	*Sagitta euneritica, S. bierii, S. minima, S. enflata*	No seasonability pattern or inshore-offshore difference in abundance.
Polychaetes	*Vanadis formosa*	Offshore distribution (200 km) (120 miles).
	Torrea candida	
	Tomopteris elegans	Can be extremely abundant.
	Travisiopsis lobifera	Cold water form.
Mollusks		
- Pteropods	*Limacina helicina*	
- Heteropods	*Atlanta peroni, Atlanta* sp. *Carinaria japonica*	
- Cephalopods	*Abraliopsis felis, Gonatus onyx*	
Crustaceans		
- Copepods	*Libinocera trispinosa*	Dominant in surface samples in Santa Barbara Channel. Maximally abundant in November (McGinnis, 1971).
	Acartia tonsa	
	A. clausi	Abundant in summer months.
	Calanus helgolandicus	All stages abundant in May-June.
	Rhincalanus nasutus	Juveniles abundant in July-August. Adults abundant in May-June.
	Oithona similis	Most abundant cyclopoid copepod from samples off Scripps.

Table II.E.2-1 (Cont.)

Major Taxa	Common Species	Distribution Remarks
- Amphipods	*Vibilia armata*	Captured at surface at night; at 200 m (660 feet) in the day.
- Cladocera	*Penila avirostris*	Maximally abundant in December, 1969 in Santa Barbara Channel (McGinnis, 1971).
	Evadne nordmanni, *Podon polyphemoides*, *Evadne spinifera*, *E. tergestina*	Abundant in July-August, 1968 in nearshore waters off La Jolla.
- Euphausids	*Euphausia pacifica* *Nematoscelis difficilis* *Nyctiphanes simplex* *Stylocheiron longicorne* *Thysanoessa gregaria* *T. spinifera*	Listed in order of abundance over Southern California Bight.
- Decapods	*Sergestes similis*	Recorded from 650 m (2,145 feet) trawls.
Thaliacea	*Doliolum denticulatum*	Abundant in nearshore waters in summer.
	Dolioletta dgegenbauri *Cyclosalpa bakeii* *Pegea confoederata* *Salpa fusiformis* *Thalia democratica*	

Source: Compiled from Seapy (1974).

Ahlstrom (1959, 1965, 1969) summarized information on the extensive CalCOFI collections of fish eggs and larvae in the California Current. The distribution of fish larvae is highly dependent upon the spawning areas of the parents and the hydrographic conditions prevailing in the area. Because most of the coastal waters are transported in either a northern or southern direction, larvae spawned in coastal areas tend to be retained there (Richardson and Pearcy, 1977). Figures II.E.2-10 through 14 display seasonal fish larvae and egg distribution data for the California Current for several important species. The distribution and abundance of fish larvae and eggs vary by season over the Southern California Bight depending on the species. For some species, for example, the northern anchovy and the several species of rockfish, larvae occur throughout the Bight area during most of the year.

In the CalCOFI data twelve larval types (species or genus) comprised 90-93 percent of all larvae collected. The northern anchovy (*Engraulis mordax*) and Pacific hake (*Merluccius productus*) represented 40-60 percent of the catch. Larvae of deep sea pelagic fishes composed 20-40 percent of all larvae taken in CalCOFI cruises from 1955 to 1960. Of the deep sea pelagic fishes, three families represented 90 percent of the deep sea fishes and were the most important species in offshore oceanic waters. These were the larvae of the myctophid lanternfishes, the gonostomatid lightfishes and the deep sea smelts (Bathylagidae) (Ahlstrom, 1969). Ahlstrom (1965) found larvae of subarctic species in winter and spring and those of subtropical species in the warmer summer months.

Table II.E.2-2 summarizes the most probable depth range and temperature range for abundant species of fish eggs and larvae in the California Current. Notice that several of the species have been captured in the surface waters and that the most abundant depth range of the eggs and larvae of the commercially important northern anchovy, jack mackerel and pacific mackerel and also the pacific sardine are in the surface layer of the water column. The data was compiled from Ahlstrom (1959).

ii. Baja California: The zone of high abundance for zooplankton off Baja California does not extend as far offshore as in the southern California Bight area (See Figures II.E.2-5 through 9). A center of high zooplankton biomass can be observed around Punta Eugenia, probably due to the upwelling and rich phytoplankton crop in the area.

Beers and Stewart (1969) sampled the zooplankton including the microzooplankton in the upper 100 m (330 feet) off San Diego to Isla Guadaloupe. The microzooplankton were defined for their study as all animal plankters that pass through a 202 μ mesh net. They found that microzooplankton volumes in the upper 100 m comprised 21-26 percent of the total zooplankton volume. Protozoans accounted for 95 percent or

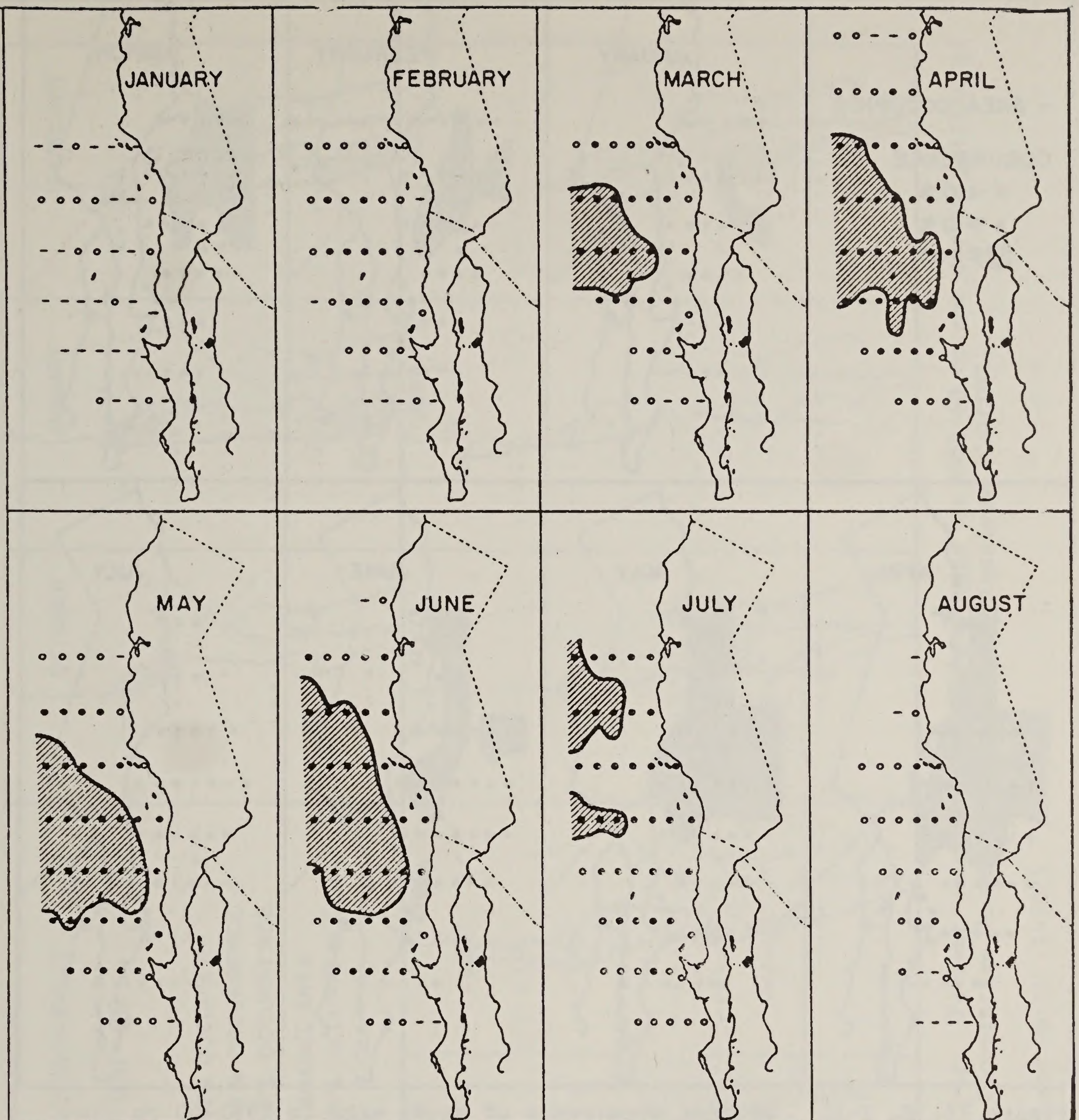


Figure II.E.2-10 Percent occurrences of jack mackerel larvae in 1951-60 on the survey pattern of the California Cooperative Oceanic Fisheries Investigations (CalCOFI). Each line, circle or dot represents a pooled statistical area. (o) - less than 10% occurrence; (•) - equal to or greater than 10% occurrence; shaded area - greater than 49% occurrence; (-) - area occupied with no occurrences.

Source: Kramer and Smith (1970a).

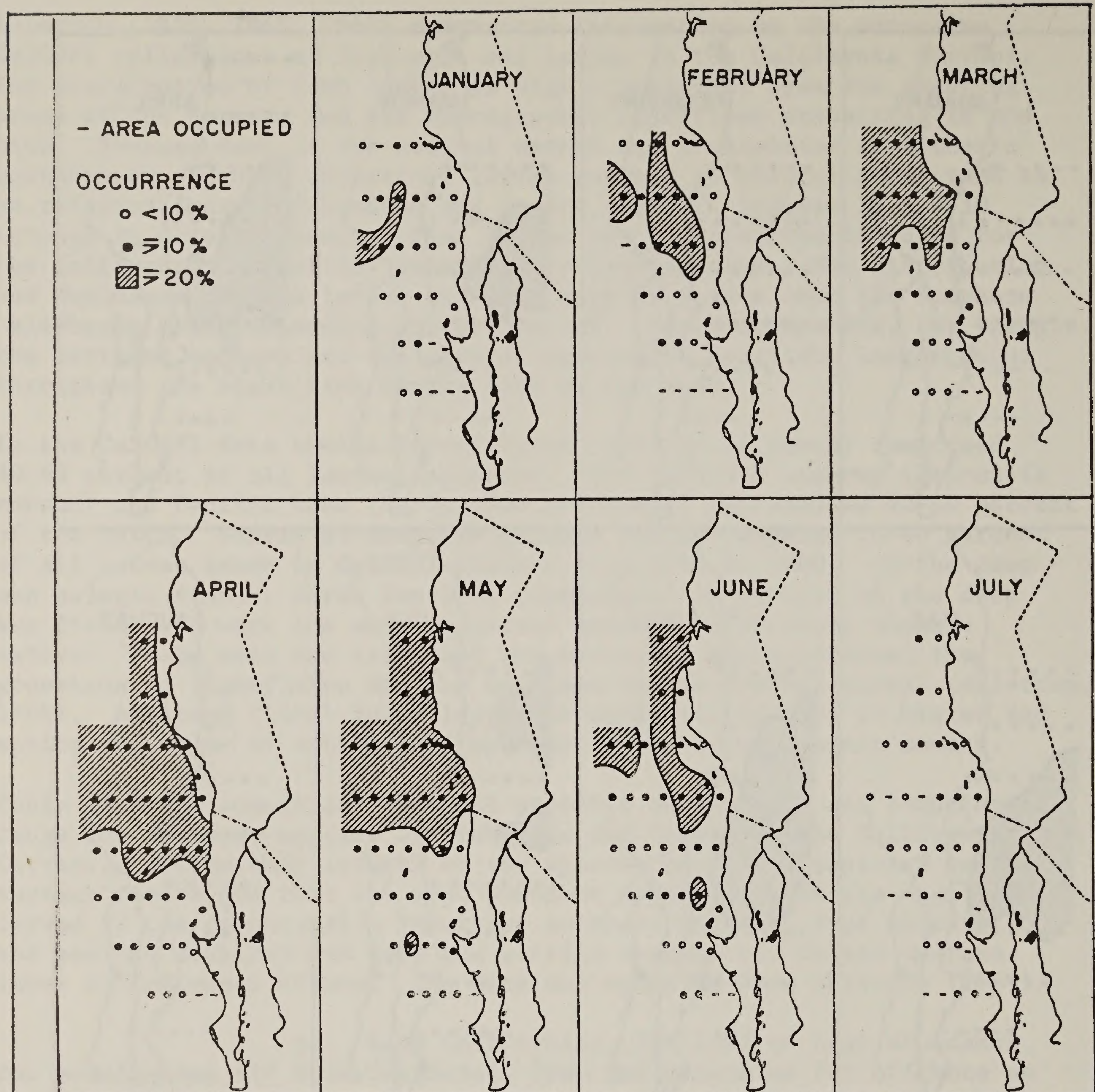


Figure II. E. 2-11 Percent occurrence of saury eggs in 1951-60 on the survey pattern of the California Cooperative Oceanic Fisheries Investigations (CalCOFI)

Source: Kramer and Smith (1970b)

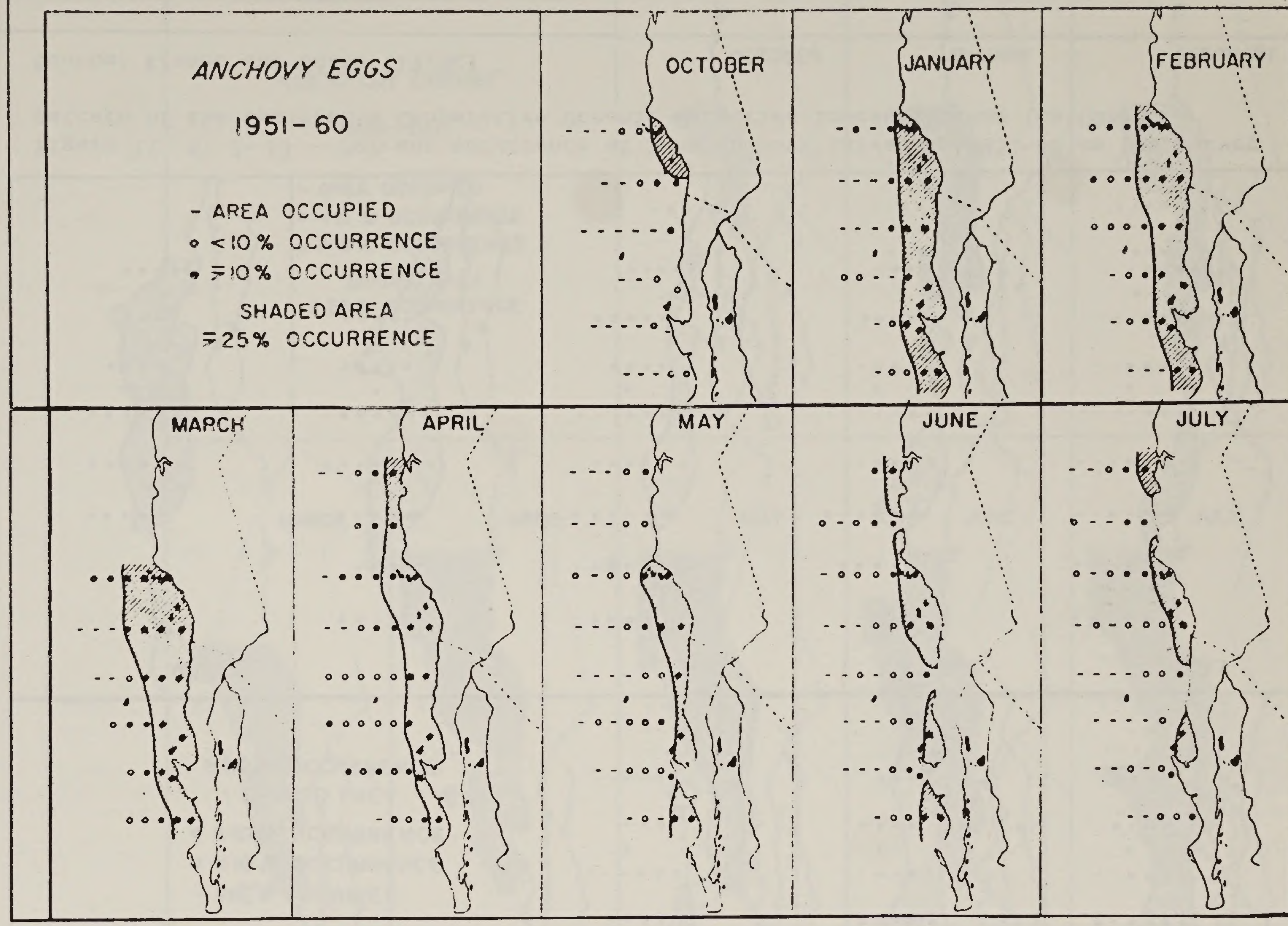


Figure II. E. 2-12 Percent occurrence of Anchovy eggs in 1951-60 on the survey pattern of the California Cooperative Oceanic Fisheries Investigations (CalCOFI).

Source: Kramer and Smith (1970c)

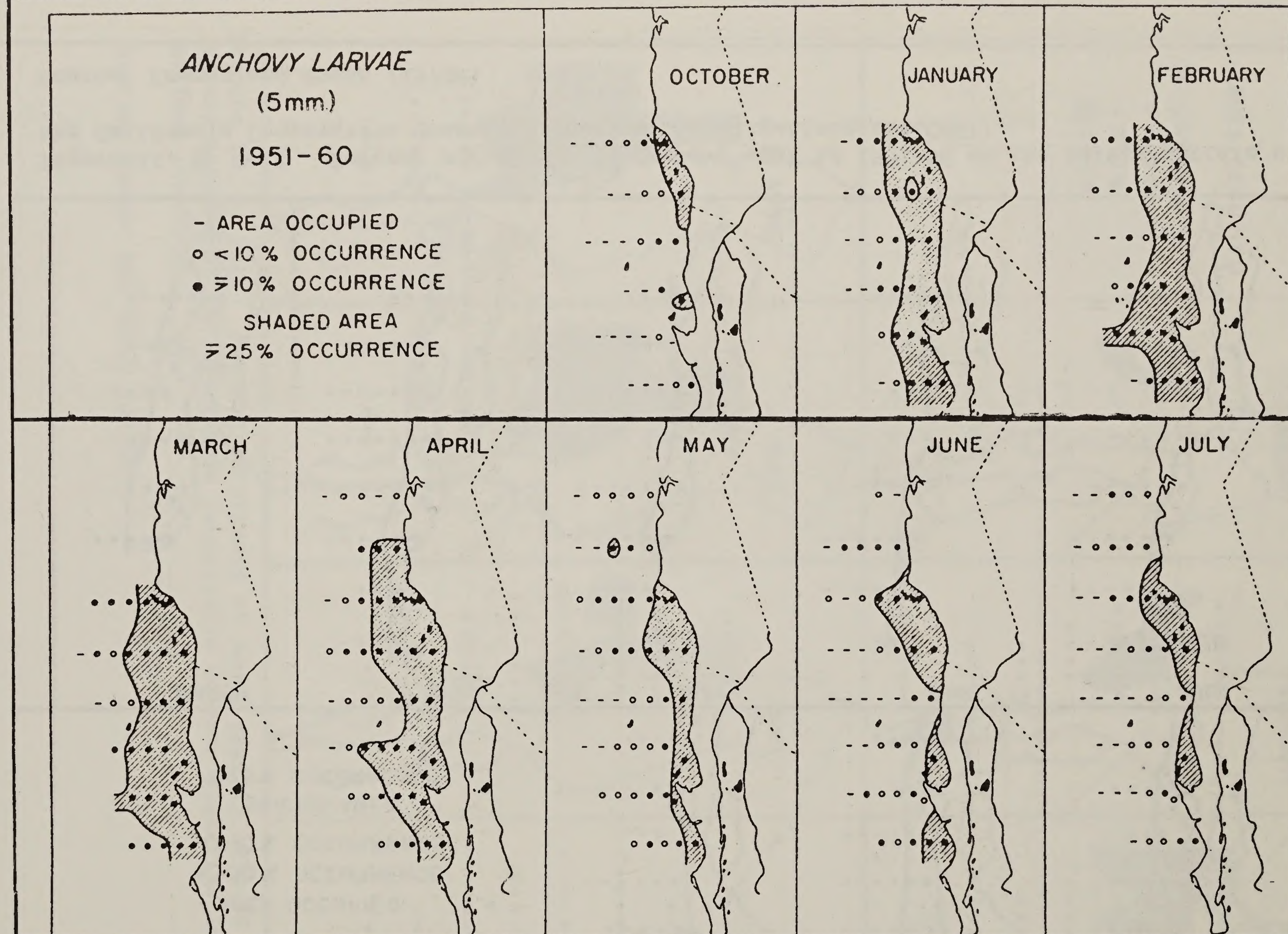


Figure II. E. 2- 13 - Percent occurrence of 5-mm anchovy larvae in 1951-60 on the survey pattern of the California Cooperative Oceanic Fisheries Investigations (CalCOFI).

Source: Kramer and Smith (1970c)

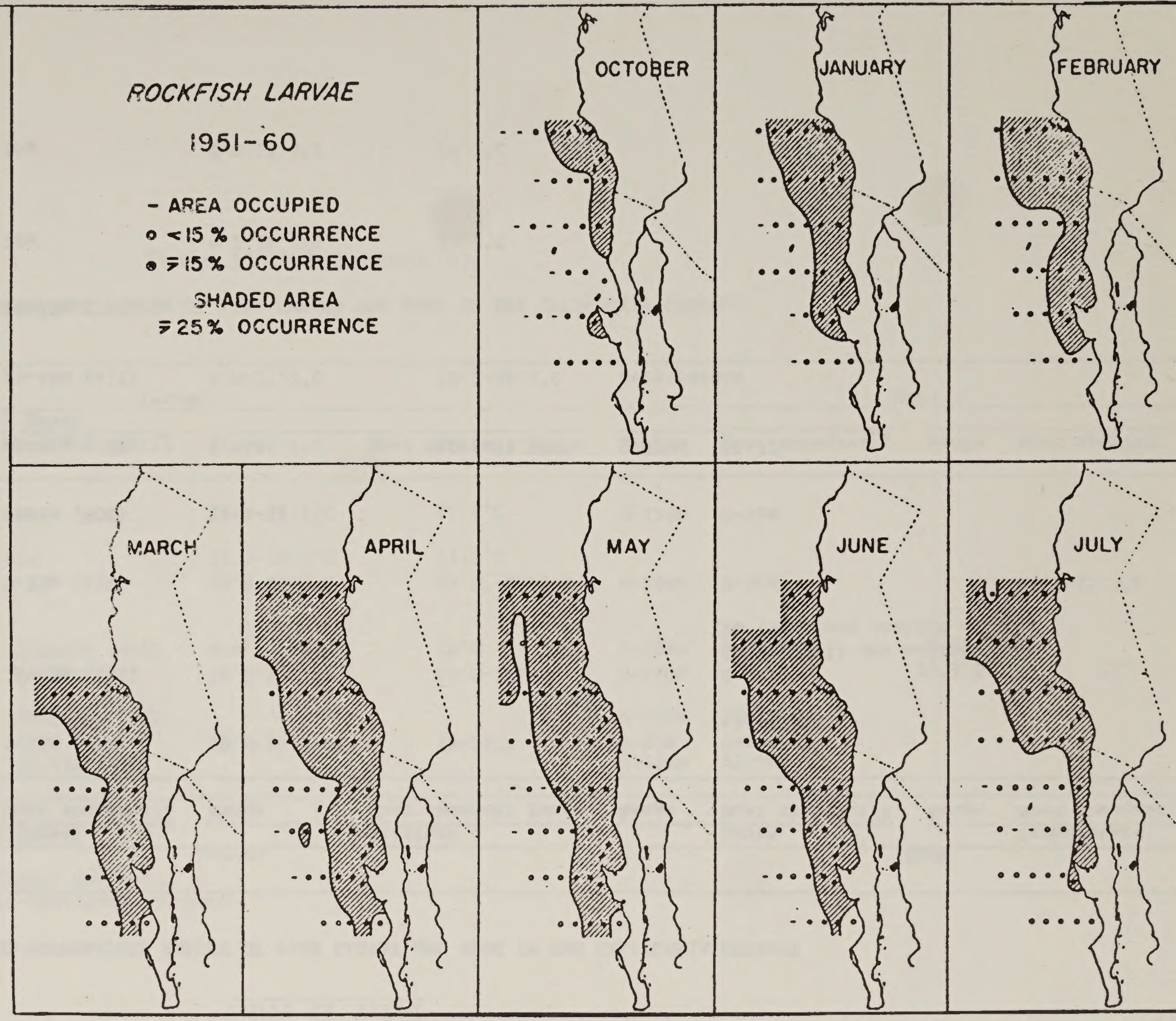


Figure II. E. 2- 14 Percent occurrence of rockfish larvae, Sebastes spp. in 1951-60 on the survey pattern of the California Cooperative Oceanic Fisheries Investigations (CalCOFI).
Source: Kramer and Smith (1971)

Table II.E.2-2

DEPTH AND TEMPERATURE RANGES OF FISH LARVAE AND EGGS IN THE CALIFORNIA CURRENT

Species	Larvae				Eggs			
	Depth		Temperature		Depth		Temperature	
	Range	Most abundant/%	Range	Most abundant range	Range	Most abundant/%	Range	Most abundant range
Pacific sardine (*Sardinops caerulea)*	0-96m	0-23m (47%)	10.9-19.7°C	13-17°C	0-82m	Surface 42m (23%)		
Northern anchovy[a] (*Engraulis mordax)*	0-125m	24-48m (46%)	10.0-19.7°C	14.0-17.4°C	0-140m	0-30m 2-20m (90%) one station 2m (86%) one station		
Jack mackerel (*Trachurus symmetricus)*	0-122m	0-23m (41%)	13.0-16.9°C	14.0°-15.9°C	0-140m	0-50m		14.0-15.7°C
Pacific mackerel (*Pneumatophorus diego)*	0-66m	0-23m (80%)	14.1-17.1°C		0-128m	0-41m		
Hake[b] (*Merluccius productus)*	0-200m	65-88m (48%)	8.7-15.7°C	10.6-15.0°C	0-200m	56-72m		
Rockfish (*Sebastodes sp.)*	0-105m	24-48m (41%)	9.0-17.2°C	10.2-16.1°C	Oviviparous			
Sand dabs (*Citharichthys sp.)*	0-88m	24-48m (71%)						
Lanternfish (Myctophids) (*Lampanyctus leucopsarus)*	8-105m	28m	9.7-16.1°C	13.2°C				
(*Tarletonbeania crenularis)*	28-138m	56m	9.0-13.4°C	10.7°C				

Table II.E.2-2 (Cont'd)

DEPTH AND TEMPERATURE RANGES OF FISH LARVAE AND EGGS IN THE CALIFORNIA CURRENT

	Larvae				Eggs			
	Depth							
Species	Range	Most abundant/%	Range	Most abundant Range	Range	Most abundant/%	Range	Most abundant Range
(Lampanyctus mexicanus)	2-138m	41m	13.3-16.1°C	15.2°C				
(Lampanyctus ritteri)	2-105m	41m	11.2-16.1°C	14.5°C				
Deep sea smelts:								
(Leuroglossus stilbius)	0-275m	122m(?) (44%) 56-72m(?)	8.6°-16.6°C	10°C	0-285m	56-72m	8.6°-15.3°C	12°
(Bathylagus wesethi)	41-215m	89-122m (50%)			0-215m	72-105m		
(Vinciguerria lucetia)	0-105m	24-48m (47%)			5-121m	41-56m		

Source: Compiled from Ahlstrom (1959).

[a]Most abundant fish larva in California Current.
[b]Second most abundant fish larva in California Current.

more of the microzooplankton by numbers with the ciliates being the dominant forms. Average protozoan volume was 3.0 mm^3/m^3 with a range of 1.4-4.7 mm^3/m^3. The major protozoan taxa were foraminiferans, radiolarians, tintinnids and "ciliates other than tintinnids".

Haury (1976) in another study off Baja examined the scale of zooplankton patchiness off Isla Guadeloupe. He found patches of zooplankton stratified in 10-20 m (33-66 feet) sections vertically in the water column and on the scale of 100's of meters horizontally. Haury concludes that physical factors such as internal waves and turbulence are important factors for this distribution as well as vertical migration of the zooplankton.

Longhurst, Lorenzen and Thomas (1967) reported that only a few zooplankton species dominated the upwelling system off Baja California. Filter-feeding copepods made up 91.5 percent of all individuals and the euphausid *Nyctiphunes simplex* and an unidentified mysid comprised a further 8.6 percent. The copepod *Calanus helgolandicus* dominated the copepod fraction, with 76.7 percent of all individuals. They observed that swarms of *Calanus* were denser than background concentrations by a factor of almost 100.

During a March, 1972 cruise off Punta San Hipolito, Walsh, et al.,(1974) observed that *Calanus helgolandicus* was the dominant copepod at the end of March. *C. helgolandicus* is the dominant herbivorous zooplankton in the summer months. The authors hypothesized that the pre-upwelling food chain was longer during the spring than in the summer months when upwelling was well-developed. The pre-upwelling food chain probably consisted of: dinoflagellates - herbivorous copepod - carnivorous red crab - striped dolphin. In the summer months, the food chain was shortened to: diatoms - red crab - yellowfin and skipjack tuna.

Walsh, et al., (1977) listed mean zooplankton biomass for the area studied off Punta San Hipolito as 115 mg dry wt/m^3 for an April, 1973 cruise and 60 mg dry wt/m^3 for the March, 1972 cruise. Pelagic red crab biomass was given as 1.7g wet wt/m^3 for April, 1973 and 7g wet wt/m^3 for March, 1972.

In a paper given at the 1977 Annual CalCOFI Conference in La Jolla, Barrera and Silva (1977) gave a preliminary report on the reproduction of the northern anchovy off Baja California. They observed a winter-spring spawning peak and a lesser peak in late summer to fall.

iii. Central California: According to long-term records, zooplankton standing stock is highest off central California in June and July inside a wide band of high abundance extending along the entire coast (see Figure II.E.2-9). However, Figures II.E.2-5 and 6 for a single year's data show a denser patch off San Francisco Bay in January and April. The enrichment of the surface waters off San Francisco Bay with the high runoff of the Sacramento River system in winter and spring replenishes the surface nutrient supply and enriches the phytoplankton growth. This, in turn, could contribute to maintenance of the dense zooplankton patch in the area.

There are very few studies of the zooplankton off central California except for the CalCOFI data base and studies centered in Monterey Bay. The following synopsis of zooplankton studies in Monterey Bay by Holton, Leatham and Crandell (1977) should be representative of other parts of the central California coast.

Bigelow and Leshe (1930) reported that Monterey Bay zooplankton is composed of species from oceanic or nearshore temperate waters with little influence from either tropical or arctic waters. The deep water close to shore in the Monterey Canyon brings deep water forms such as the pelagic polychaete *Tomopteris elegans* (Dale, 1957). Other deep water forms which undoubtedly occur are the copepods *Gausia princeps, Paraeuchaeta* sp., *Pleuromama* sp. and *Heterorhabdus* sp.

A study of the nearshore central portion of Monterey Bay in August, 1975 (Environmental Research Consultants, Inc., 1976) reported a drop in chlorophyll a followed by an increase in phaeo-pigment (present in copepod fecal material). This was interpreted to indicate an increased zooplankton standing crop and grazing pressure. It is probable that *Acartia tonsa* was the copepod responsible for this interpreted zooplankton peak. Studies to the south (Environmental Quality Analysts, Marine Biological Consultants, Inc., 1976) confirmed the importance of this warm water nearshore copepod. Typically in temperate latitudes, there is a seasonal alternation between *A. tonsa* and *A. sp. (= clausi)* (Conover, 1956). CalCOFI data (Fleminger, 1964) show high numbers of *A. tonsa* for the region of the California coast which includes Monterey Bay during the summer and fall of 1958. In this same period *A. sp. (= clausi)* appeared only briefly north of San Francisco. However, this was an atypical warm water year which may not reflect the true seasonal pattern for these two species.

The best sources of information on species distributions for Monterey Bay are the CalCOFI Atlases mentioned above. Station 50 in the CalCOFI basic station plan is located in Monterey Bay. Although it has been occupied since 1950, it has not been included every year on CalCOFI cruises. Also, analyses for specific taxa have not been completed. Chapter II.E.2 of POCS Reference Paper No. II lists the important species reported from Station 50 in Monterey Bay by season.

3. Benthos Including Intertidal Organisms

a. Southern California

i. Subtidal Macrobenthos

Introduction. Invertebrate benthos is covered in greater detail in the BLM (1975) Sale 35 EIS which is largely based on a paper by Bright (1974). The benthic algae and grasses covered by Murray (1974) are also included in the same EIS and POCS Reference Papers Nos. II and III.

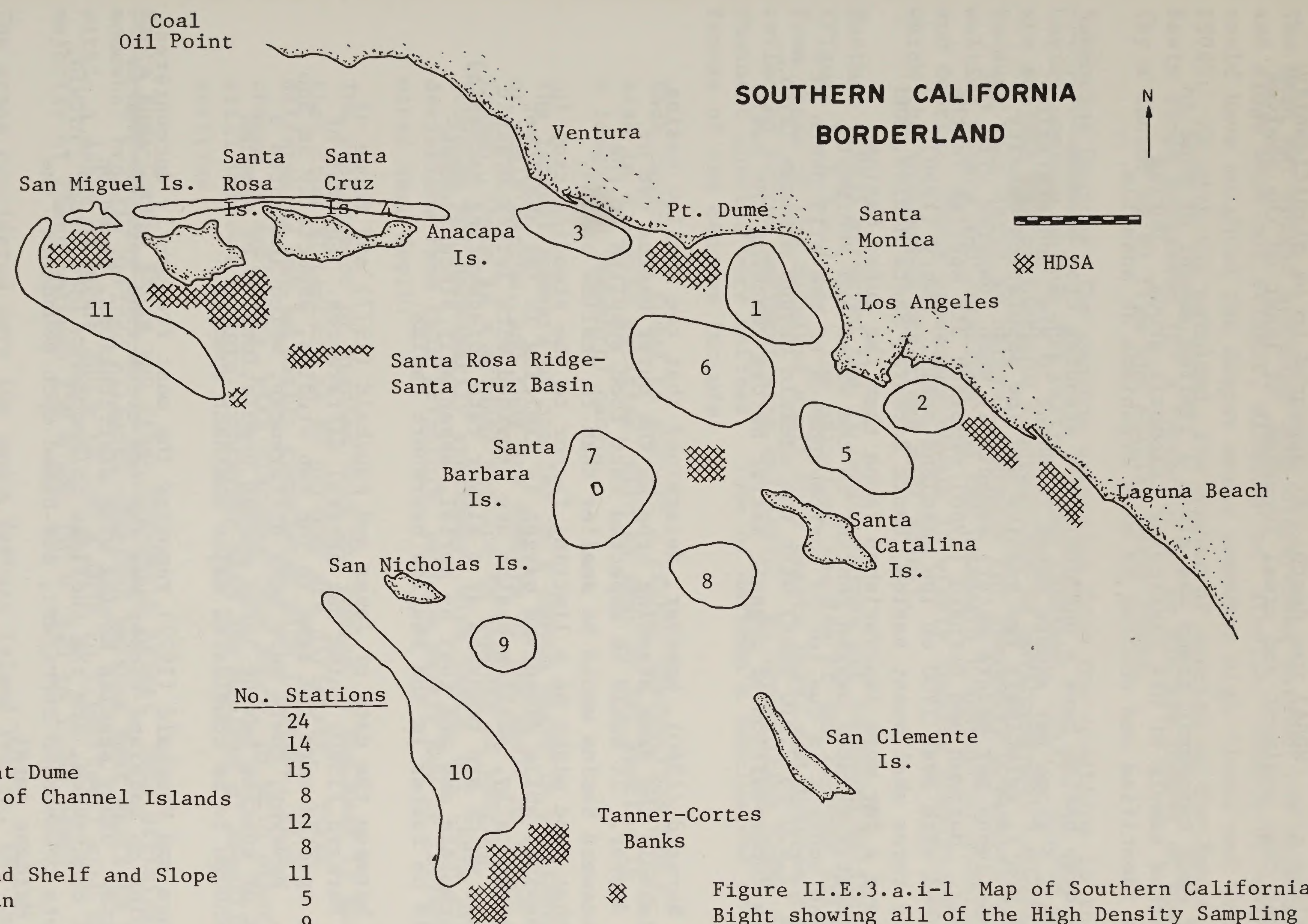
Emery (1960) divided the Southern California offshore area into the mainland shelf (from the mainland coast to the 100 m or 300 feet contour line) and the continental borderland (from the 100 m contour line to the Patton Enscarpment 50 to 150 miles offshore).

The benthos of the California Bight is extremely complex, consisting of many species and assemblages, and is difficult to summarize. Some of the reasons for this complexity are: 1) the numerous available habitats allowed by the topography of the continental borderland consisting of islands, deep basins, submarine canyons, and the resulting sediment complexity, 2) the relatively stable temperature and salinity conditions favors a biologically accommodated system consisting of many species (Sanders, 1968), and 3) the bight area is a biogeographic transition zone between the Californian and Oregonian Provinces with the division line at Point Conception (Valentine, 1966). Because the water temperatures and other factors are often typical of both provinces, the Bight has species of the northern Oregonian Province, the California Province as well as species which are only found in Southern California Bight. Valentine (1966) for example, reported 180 species of Bivalvia and Gastropodia alone had a north-south geographic range of only 60 miles within the bight area.

Most of the major benthic habitats within the bight have been sampled. The principal studies have been Hartman and Barnard (1960) of the basins, Hartman (1963) cf the canyons, Allan Hancock Foundation (1965) and Jones (1969), of the mainland shelves. The benthos of the island shelves, until recently, were apparently only reported from ten samples taken near Santa Catalina Island (Mattox, 1955). Rocky bottoms have been studied at one location off Corona del Mar (Pequegnat, 1963, 1964 and 1968) and at Tanner-Cortes Banks by BLM personnel.

During 1975, BLM sponsored a subtidal soft bottom benthic survey with seven intensively sampled areas including the mainland shelf, island shelves, a basin and their respective slopes and recorded the associations of the areas (Visual No. 7 shows all but two of the areas). A more extensive sampling grid was utilized (Figure II.E.3.a.i-1), but the associations of the lower density sampling areas were not reported (Jones and Fauchald, 1976).

Jones and Fauchauld (1976) indicated the single most important environmental variable governing the distribution of species, within nearly every high



	No. Stations
Santa Monica Bay	24
San Pedro Shelf	14
Shelf north of Point Dume	15
Island Shelf North of Channel Islands	8
San Pedro Basin	12
Santa Monica Basin	8
Santa Barbara Island Shelf and Slope	11
Santa Catalina Basin	5
San Nicolas Basin	9
Southern Santa Rosa-Cortes Ridge and Slope	23
Northern Santa Rosa-Cortes Ridge and Slope	13

Figure II.E.3.a.i-1 Map of Southern California Bight showing all of the High Density Sampling Areas and Low Density Sampling Areas.

density sampling area (HDSA) was depth. It appeared to be significantly more important than sediment and areal location, at least on the shelves and slopes.

An expert of each taxomonic group was given a limited amount of time to examine a sorted sample of his particular taxonomic group. During this time he identified and counted as many organisms as possible.

Basins. The deep basins have a uniformly low standing crop biomass (ranging from 1.5 grams per square meter to about 50 g/m^2 and averaging from 3 to 12 g/m^2), relatively few species and low population density (11 to 120 specimens per square meter) especially when compared with the mainland shelf. Hartman and Barnard (1960) reported 317 species in the basins compared with over 1700 on the mainland shelf. Emery (1960) indicated the three shallowest basins, Santa Barbara, Santa Monica, and San Pedro, have a far more impoverished fauna than the outer basins because of greatly reduced oxygen content in the water and sediments. The low oxygen content is due to: 1) correspondence of the sill depth at 500 to 700 m (1,650 to 2,310 feet) with the oceanic oxygen minimum layer, and 2) little decomposition of organic matter before reaching the basin floors.

Hartman and Barnard (1960), however, determined that the shallow basins have approximately the same standing crop as the outer basins two or three times deeper. It would be expected that food supplies to the deeper and seaward basins would be smaller than to shallow basins, suggesting that food might be a limiting factor to the standing crop in the deeper basins, while dissolved oxygen is limiting in the shallower basins. Theoretically, shallow basins are provided with larger organic food supplies, which are reworked at a slower rate (discounting bacteria) and thus accumulate and are lost by burial, especially since sedimentation should be faster in the shallow nearshore basins.

Comparisons between the data of Jones and Fauchald (1977) and those of Hartman and Barnard (1960) point out several differences. Several of the dominant species were the same in the two studies, especially in San Pedro Basin. However, there were many differences, which indicated a general lack of species having large enough populations to be sampled frequently enough to be considered major dominant species.

Slopes. Jones and Fauchald (1977) reported the most frequently encountered benthic species on mainland slopes was the ice cream cone worm *Pectinaria Californiensis*. Other species having wide distributions, based on frequency of occurrence, are the shelless *aplocophoran Limifossor fratula*, the polychaete *prionospio cirrifera*, and based upon abundance, the bamboo worm Maldane sarsi.

The mean net weight standing crop differences between the mainland shelf and slope were not evident, although an "atypical" sample or samples could have weighted the deeper areas somewhat high (Jones and Fauchald, 1976). As with the mainland, the number of species on the Santa Cruz Basin slope decreased (by a factor of 3) as did the number of specimens (by a factor of 4) from the shallow water fauna.

Submarine Canyons The canyons extending from the coastline to the deep basins contain unique and varied fauna (Hartman, 1963). Canyon habitats are subject to considerable fluctuations in environmental conditions because they serve as natural channels for shoreward movements of upwelling waters and organisms and for downward transport of runoff, sand, and debris. These processes result in widely varying conditions, to which the indigenous organisms must adjust.

Hartman (1963) surveyed the 13 large canyons off Southern California (Figure II.E.3.a.i-2). The principal species of the canyons differed from those of the mainland shelf only meters away, and species composition reflected bottom sediment size and depth. No communities based on dominant species were defined. Some of Hartman's conclusions on the faunas of the canyons include:

> Each canyon is found to support a richly diversified fauna, high in specific entities, with as many as 262 species in a longshore (Newport) canyon.
>
> The largest numbers of species in a canyon occur in shallowest, or shelf depths, and they are members of the shelf or slope fauna. There is a gradual decline in numbers of species (through not necessarily specimens) with depth, but there are deviations from this principle, perhaps partly due to factors other than depth.
>
> The replacement of species from one canyon to the next is such that from 30 percent to 60 percent are different. These differences may be partly correlated with latitude, with change in sediments, with distance from shore, or with other, still unknown factors, concerned with the biology of specific entities.

Santa Rosa-Cortes Ridge and Other Mid-Depth Areas: This division is a somewhat broadly defined category combined because most stations were within a depth of about 200 m to 500 m (656 to 1,640 feet) with the majority of these between 250 m and 350 m (820 to 1,148 feet).

The areas considered were the Santa Barbara Island region, the Catalina Island HDSA, Santa Rosa-Cortes Ridge North, Santa Rosa-Cortes Ridge South, and the shallow and intermediate zones of the Santa Rosa Ridge-Santa Cruz Basin HDSA. The only species approaching a representative

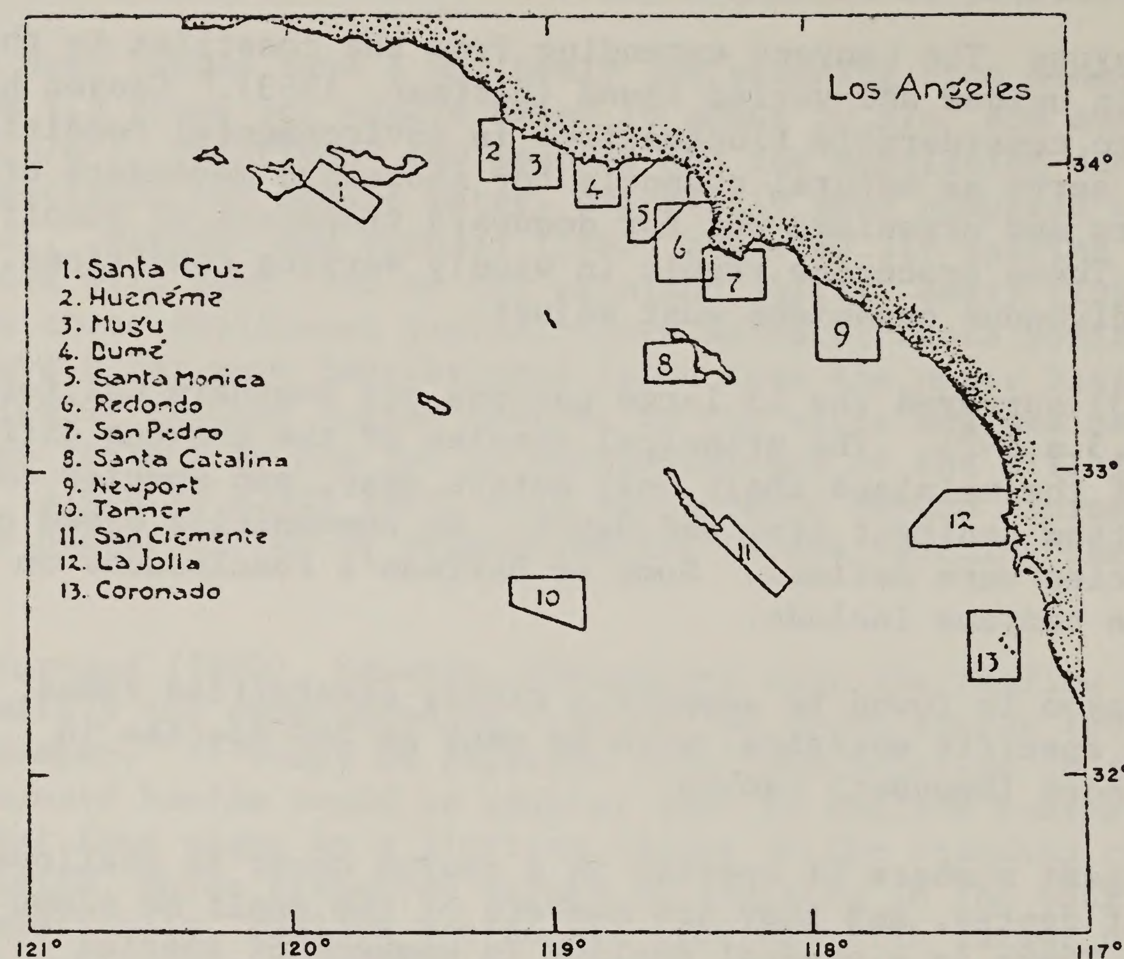


Figure II.E.3.a.i-2. Index map showing the locations of the thirteen submarine canyons biologically sampled.

Source: Hartman (1963)

species for these areas are the brittlestars *Amphipholis squamata* and *Amphipholis pugetana*.

In the Santa Rosa-Cortes Ridge near Tanner Banks, a mallusca considered to be a living fossel was collected during the BLM study. The class Monoplacophora was, until 1950, considered extinct. The specimen collected during the BLM study was the first collected off California and in relatively shallow waters anywhere.

Island Shelves. Most of the island shelves sampled during the BLM study (Figure II.E.3.a.i-1) had a rather large number of species having over a 50 percent frequency and many even over a 75 percent frequency which indicates these species do characterize the areas or at least are widely distributed within them. An abbreviated list of the principle species from all these areas is shown in Table II.E.3.a.i-1. Many of the species on this list are also extremely important on the mainland shelf particularly the polychaete *Lumbrineris* sp. and the bivalve *Parvilucina tenuisculpta* (Table II.E.3.a.i-2). The only important species, in terms of frequency, on the island shelves which is not important on the mainland shelves, is the amphipod *Aoroides columbiae*.

One noticeable difference between the northern island shelves and the mainland shelves is the greater number of microcrustaceans on island shelves. This was particularly evident at the 8 stations to the north of the Channel where the relative dominance of crustaceans was over 67 percent compared to approximately 20 to 30 percent on the mainland shelves. Data on the number of species and specimens indicate there may be no significant difference between the island and mainland shelves. Data on the number of species and specimens indicate there may be no significant difference between the island and mainland shelves.

Mainland Shelf. The mainland shelf extends from shore to a depth of approximately 300 feet (about 100 meters) and comprises 6.2 percent of the area from shore to the Patton Enscarpment (Allan Hancock Foundation, 1965).

This is the only benthic area of the EIS which has received extensive coverage in another study (Allan Hancock Foundation, 1965, commonly called the state study) as well as the BLM study). Nonetheless the results are somewhat difficult to compare due to differences in the sampling gear leading to slightly different types of sediment samples.

The mainland shelf extends from shore to a depth of approximately 100 m (300 feet) (Allan Hancock Foundation, 1965). The average standing crop biomass of the benthic macrofauna was 356 g/m^2 (0.65 pounds/yards^2) was reduced to about 250 g/m^2 (0.46 pounds/yard^2) with the exclusion of the samples dominated by the worm *Listriolobus pelodes* off Santa Barbara. Emery (1960) reported a variation in the standing crop of the mainland shelf to be 40 to 4,000 g/m^2. (0.08 to 7.3 pounds/yard^2) Jones and Fauchald (1976) (Table II.E.3.a.i-3) reported the range of the averages

Table II.E.3.a.i-1

MOST FREQUENTLY OCCURRING SPECIES ON ISLAND SHELVES

	Frequency	
	Ratio	Percentage
Lumbrineris sp. polychaete	61/92	66.3
Aoroides columbine amphipod	59/92	64.1
Parvilucina tenuisculpta bivalve	54/92	58.7
Euphilomedes carcharodonta Ostracod	49/92	52.2
Tellina carpenteri bivalve	42/92	45.6

Source: Jones and Fauchald (1976) and SAI (1976).

Table II.E.3.a.i-2

MOST FREQUENTLY OCCURRING SPECIES ON MAINLAND SHELF

	Mean No./ Area	Frequency Ratio	Percentage
Lumbrineris sp.	3.8	79/98	80.6
Parvilucina tenuisculpta bivalve	7.0	69/98	70.4
Axinopsida serricata snail	5.6	67/98	68.4
Amphiodia urtica brittle star	10.0	59/98	60.2
Pectinaria californiensis Polychaete	2.1	51/98	53.1
Heterophoxus oculatus Amphipod	2.4	52/98	52.0
Euphilomedes carchorodinta Ostracod	5.7	49/98	42.9
Tellina carpenteri bivalve	1.3	42/98	42.9

Source: Jones and Fauchald (1976) and SAI (1976).

Table II.E.3.a.i-3

NUMBER OF SPECIES, SPECIMENS AND WET WEIGHT
STANDING CROP OF HIGH DENSITY SAMPLING AREAS IN THE CALIFORNIA BIGHT

Faunal Association	No. Species Range	No. Species $\bar{X}$	No. Specimens Range	No. Specimens $\bar{X}$	Mean Standing Crop (g/m^2) of Area
Huntington-Laguna Beach HDSA					
Shallow-Water Shelf Fauna (1)	36-65	49	108-360	263	
Transitional, or Slope Fauna (2)	21-27	24	39-67	50	
Deep-Water Fauna (3)					
3A	9-12	11	21-55	38	151.9
3B	8-14	11	13-24	20	
A & B	8-14	11	13-55	29	
Point Dume					
Shallow-Water Fauna (1)	54-70	66	120-331	236	
Intermediate Fauna (2)	14-18	16	17-36	27	118.3
Deep-Water Fauna (3)	5-12	8	5-34	17	
Coal Oil Point					
Shallow-Water, Inshore Fauna (1)	38-75	51	117-261	167	
Deep-Water, Offshore Fauna (2)	4-24	13	11-32	20	226.4
Santa Catalina Island					
Depth Range					
225-481 meters	19-38	28	31-146	65	72.0
532-851 meters	13-18	15	14-21	18	
Santa Rosa Ridge-Santa Cruz Basin					
Shallow-Water Fauna (1)	34-53	42	61-196	102	
Intermediate Fauna (2)		4		5	38.1
Slope Fauna (3)	12-14	13	23-25	24	
Basin Fauna (4)	10-18	14	32-152	70	

Table II.E.3.a.i-3 (Cont.)

Faunal Association	No. Species Range	No. Species $\bar{X}$	No. Specimens Range	No. Specimens $\bar{X}$	Mean Standing Crop (g/m^2) of Area
	San Miguel Island				
Shallow-Water Fauna (1)	58-79	69	124-202	171	
Intermediate Fauna (2)	51-74	61	108-188	159	104.8
Deep-Water Fauna (3)	20-76	37	47-230	123	
	Santa Rosa Island				
	21-127	64	81-810	237	124.0
	Cortes-Tanner Banks				
Bank Tops (1)	25-54	35	42-157	100	61.7
Trough Between Banks (2)	13-48	30	33-128	102	

Source: Jones and Fauchald (1977).

on the three mainland shelf areas to range from $1469/m^2$ to $214\ g/m^2$, (2.7 to 0.39 $pounds/yard^2$) slightly less than that reported by the "state survey".

In a detailed examination of 176 samples collected in the 1956-60 Allan Hancock Foundation survey, 1,473 different benthic invertebrates were identified, 63.5 percent of these were identified to species; 24.9 percent to genus, and 11.6 percent only to higher taxonomic categories. Polychaetes (segmented annelid worms) were the most widely distributed group, outranking any other group in species, numbers, and total weight. Nearly half (35 percent) of all specimens counted were polychaetes; 532 species were identified, and the average concentration was 1,424 organisms/sq.m. Crustaceans, especially phoxocephalid amphipods, accounted for about 25 percent of all specimens but because of their small size, seldom comprised more than 5 percent of the biomass. They were the second largest group, with 419 species and a mean concentration of $1,352/m^2$. Echinoderms (brittle stars, for example) form a major group on the shelf in depths greater than 10 m (33 feet). Within this group, 64 species, with an average concentration of 523 organisms/sq.m, were identified. The small red brittle star *Amphioda urtica* was the most abundant single species, being found in 85 percent of all samples at depths greater than 10 m (33 feet) averaging 400 individuals per m^2 square meter. Molluscs (clams and snails) constituted the fourth group in order of abundance, with 408 species and an average concentration of 368 organisms m^2.

Bivalve molluscs were usually so small that they contributed only a small amount to the biomass, even though they were weighed with their shells. The Echiuroid worm *Listriolobus pelodes* was not widespread, but heavily concentrated in the fine sediment area near Santa Barbara. The Brachiopod *Glotlidia albida* was found in 60 percent of the samples. The above groups accounted for over 90 percent of the benthic biomass, and the majority of the species that were collected.

Jones and Fauchald did not report biomass of the various taxonomic groups by depth assemblage (Table II.E.3.a.i-3), so are not directly comparable. However, they did report that unlike the state study, echinoderms had the largest percentage of biomass at all three areas, ranging from nearly 40 to 50 percent.

Near Santa Barbara (Allan Hancock Foundation, 1965) reported the vast majority of specimens both in numbers and biomass (80 percent) consisted of the echiuroid worm *Listriolobus pelodes*. This species remained dominant in 1969, (Fauchald, 1971) but was greatly reduced as compared to the early 1960's at the time of the Allan Hancock Foundation Study.

The Los Angeles County Sanitation District (1976) reported a huge increase in the population off Palos Verdes near the Whites Point sewage outfall. They first became abundant at an intermediate distance of several miles from the outfall, then after a couple of years the populations increased near the outfall.

The reason for the buildup of large populations in an area is not fully understood. Allan Hancock Foundation (1965) attributed the large populations to extremely fine sediment, but the recent findings by the L.A. Sanitation district indicated that fine sediment and high organic matter may be instrumental in some population buildups, provided the level of toxicants of the sediments are below a certain level.

Comparison of the most commonly occurring species reported in the State study (Jones, 1969) and the BLM study indicates fairly good agreement in the two studies on the mainland shelf. The only very common species of the BLM study not also abundant in the State study was the bivalve *Parvilucina tenuiseulpta*.

When considering the assemblage in its entirety, the area is not nearly as homogenous as the cluster analyses of Jones and Fauchald (1976) indicates, but under similar conditions of depth, sediment type, distance from the mainland coast, etc., certain species tend to be found in fairly relatively high number of individuals, particularly on the central mainland coast. In terms of frequency, the polychaete *Lumbrieneris* sp. was most frequently collected, but the brittle star *Amphiodia urtica* was the significantly more numerically abundant than any other species. The 60 percent frequency of occurrence in the BLM study was somewhat less than the 85 percent frequency in the state study, although a wide distribution of this species occurred during both studies.

The deep water fauna of the Huntington-Laguna Beach and Point Dume HDSA did not reveal an obvious correlation between the most frequent and abundant species of the areas nor were many species present with much frequency. The gastropod *Mitrella permodesta* and bamboo worms (*Maldane* spp.), and to a far lesser extent, the bivalve *Mysella compressa* were the only species relatively common to both areas.

Tanner-Cortes Banks. Jones and Fauchald (1976) divided the soft bottom of Tanner-Cortes Banks into a bank top assemblage and a bank-trough assemblage. *Amphiodia urtica* and *Parvilucina teniusculpta* are also relatively important here. Recent analysis by Jones (personal communication) indicates that these assemblages are significantly different from the other HDSA assemblages of the bight. The highly productive and unusual hard bottoms of the banks are of even greater interest, however, and are discussed in Section II.F.5.

Benthos - Shallow Water Soft Bottom. Shallow subtidal sandy bottoms are relatively harsh environments for benthic organisms due to an unstable bottom which shifts due to wave action, having few hiding places, or attachment substrate for sessile organisms. These conditions prevent an extremely diverse assemblage in comparison with a kelp bed or a shallow rocky area.

Species of this habitat typically include types that have adapted to the shifting sands such as those that occupy transient or relatively permanent deep burrows, as the long-neck clams, or that can burrow quickly, as the sand crabs *Blepharipoda)*, or that construct flexible tubes, as *Loimia medusa*, or that are spindle-shaped as the lancelet *Branchiostoma*, the polychaetes *ophelia* and *Nephtys*, and *Sipurnculus*, a peanut worm (Allan Hancock Foundation, 1965).

As part of the "State Survey" during the late 1950's the Allan Hancock Foundation (1965) reported that although in depths of 3 to 9 m (10 to 30 feet) there were far fewer species, the number of individuals were not greatly reduced in comparison with deeper bottoms on the mainland shelf.

The abundance of polychaete worms did not appear to be less than on deeper, silter bottoms. Usually, the inshore sand bottom fauna was dominated by the species *Prionospio malmgreni*, *Nephtys caecoides* and *Goniada littorea*.

Nematodes were very abundant off Santa Barbara, Carpinteria, and south of San Diego.

Crustaceans were greatly decreased in number of specimens in comparison with offshore bottoms. The reduction was on the order of 4.4 times (1,350/sq. meter offshore versus 310/sq. meter inshore). The most abundant species were *Diastylopsis tenuis*, *Paraphoxus epistomus*, *Mandibulophoxis unicirostratus*, and *Paraphoxus bicuspidatus*.

Mollusks also decreased in frequency of specimens from an average of 470/sq. meter on offshore bottoms to an average of 180/sq. meter nearer shore. The most abundant was the small clam, *Tellina buttoni* which was considered an important co-dominant with the polychaete *Priomospio malmgreni*.

Echinoderms were also greatly reduced in comparison with the offshore areas. Nearly half of the samples analyzed lacked echinoderms. The most abundant species off Huntington Beach, Oceanside and San Diego was the sand dollar *Dendraster excentricus*.

Shallow sand bottoms dominated by *Dendraster excentirus* appear to be fairly widespread along the California Bight. Merrill and Hobson (1970) covered an area from Estero de Punta Banda, Baja California to Mendocino County, California; Turner, et al., (1965) covered the area offshore San Elijo Lagoon in San Diego County; and Egstrom (1975) surveyed Los Angeles County. Very few areas are without at least some reef or hard bottom areas scattered among sandy bottoms. Only Zuma Beach, Malibu Beach and possibly the Carbon area in the north and Redondo Beach and most of Torrance Beach in the south have shallow bottoms 220 m (60 feet) comprised entirely of sand. They found extensive sand dollar beds in many sandy areas.

One of the more comprehensive studies conducted in the Bight is the unpublished study by Morin at Zuma Beach. Morin (personal communication, 1976) divided the area into three zones based upon the principal species present. Zone 1, beginning at about 10 feet (3 m) and extending to a depth of 20 feet (6 m) was characterized by the pismo clam *Tivella stultorum*, the sea pansy *Renilla kollikeri* and its predator the pansy nudibranch *Armina californica*. Near the shoreward edge of this zone, were relatively large populations of the purple olive snail *Olivella biplicata*. Zone 2 occurring roughly between 20 feet and 30 feet (6 m - 9.1 m) was the sand dollar dominated zone where densities of over 400 individuals/m^2 were reached. Sand dollars so completely dominated this zone that, except for starfish and crab predators, a parasitic snail and several species of barnacles and hydroids primarily attached to the sand dollars tests, they were the only major species occupying the bottom.

Merrill and Hobson (1970) reported densities as high as 1,044 individuals/m^2 at Zuma Beach. They also reported the bed to be extensive, extending horizontally along the coast for (5.8 km) (3 miles) and from 15.2 m (50 feet) to 91.4 m (300 feet) wide.

At slightly quieter deeper depths where sand is disturbed less by surge, more species having a more equal numerical dominance were found. The principal relatively nonmobile fauna were the tube anemone *Pachycerianthus fimbriatus*, the tube dwelling work, *Diopatra armata* and the sea pen *Stylatual elongata*. Other species characteristic of this zone were the snails *Neverita (Polynices) (altus* and *Megasurcula carpenteriana*, and brittle stars of the genus *Amphiodea*. Somewhat more common at these deeper depths although they also occurred throughout all zones were the crabs *Randallia ornata* and *Cancer gracilis*.

Morin indicated the food web of the shallow sandy subtidal was essentially planktonic-detrital based. The pismo clam *(Tivela)*, other rarer clams and many of the small crustaceans are filter feeders and consequently consume plankton. Sand dollars and sea pens apparently consume plankton and detritus, sea pansies *(Renilla) consume detritus*, while the some-opportunistic tube worm *Diopatra consumes detritus*, larger organic material such as algae, etc, and small crustacea. These, in turn, are preyed upon by carnivores, including starfish, crabs, fish and the somewhat specialized pansy nuidibranch *(Arminia* sp.) preying upon sea pansies.

Merrill and Hobson (1970) in their comprehensive paper on sand dollar populations of California and northern Baja list the geographic range of *Dendraster excentricus* to extend at lease from Hecate Staits, central British Columbia to Bahia Almejas, Baja California. It occurs in bays, tidal channels, protected outer coasts and exposed outer coasts. Although sand dollars were often common on sand patches between eel grass *Zostera* marina beds in bays, they were far more abundant in the channel entrances of bays. On the outer coast, they assume far higher population densities on protected outer coasts (up to 1,386/m^2) than on the exposed outer coasts sampled north of Point Conception.

Benthic Foraminifera. As part of the BLM study of the Southern California Bight Douglas, et al., (1977) sampled microbenthic foraminifera (Figure II.E.3.a.i-3). Both number of species and standing crop (number of live specimens/cm^2) were higher in warm water temperature months (summer) than during cold water months (winter). This was particularly so at mid-water areas where as much as a 10-fold warm water increase was recorded. The greatest number of species were collected in a few isolated basins while the lowest number of species were found at the outer banks and ridge areas as well as areas having low dissolved oxygen. The highest standing crop values were recorded in the deepest parts of the inner basins while the inner mainland shelf outer basins generally had low values.

Depth was an extremely important variable, particularly for the standing crop whose contours roughly paralleled bathymetric contours of the area.

Five communities of foraminifera can be defined as presently living in the sampled area of the Southern California Bight. The communities have been defined as geographically limited, recurrent associations of species. While membership in a particular community need not be exclusive, most species achieve their maximum abundance and occurrence in only one association. Four of the communities are predominately found in the shallow water (less than 15 m (49 feet) of the mainland and insular shelf, and the offshore banks and ridges. They are the *Nonionella-Eggerella* Community, the dominant association of the mainland shelf; the *Cassidulina-Hanzawaia* Community, the dominant association of the insular shelf and shallow banks; the *Buccella-Cibicides* Community, present on offshore banks and ridges; and the *Bolivina-Trochammina* Community, a cosmopolitan association of species found throughout the borderland (See Figure II.E.3.a.i-4 and Table II.E.3.a.i-4).

A single community, the *Epistominella-Suggrunda* Community, is found in deep water environments below the shelf edge. Its definition is based almost entirely upon samples from the two nearshore basins, the Santa Monica and San Pedro Basins. Evidence from other sources indicates that other foraminiferal associations are present in the middle and outer basins of the borderland. A principal feature of the *Epistominella-Suggrunda* Community is its occurrence in low oxygen environments, where the oxygen content falls to below 0.3 ml/l. (Minimum values in San Pedro Basin are near 0.09 ml/l.) Maximum abundances of the dominant species of the community are recorded in the deeper portions of the nearshore basins.

Basically, the shallow water communities of both the inner and outer borderland are found in water of northern origins with high temperature, low salinity, and high oxygen content, and on substrates with a medium to coarse grain size, varying carbonate content, and a low organic carbon content. Foraminiferal communities of the slope and basin are found in water of southern origin, with low temperature, high salinity, and low oxygen content; and on substrate with a fine grain size, low carbonate content, and high organic carbon content.

Table II.E.3.a.i-4

ENVIRONMENTAL ATTRIBUTES OF GEOGRAPHICALLY RESTRICTED COMMUNITIES

Community	Geographic Distribution	Biotope/ Habitat	Water Depth (m)	T°C	%	°2 ml/1	Mean Phi	% CRB	% ORGC
1. *Nonionella-Eggerella*	Coal Oil Point to Newport.	Mainland continental shelf (insular shelf).	20-200	10-13	33.65-33.71	3.2-4.8	3.5-4.5	3.2-11.9	0.9-1.0
2. *Cassidulina-Hanzawaia*	Northern Channel Islands, Santa Rosa Ridge to Tanner Bank.	Insular shelf, bank top.	20-200	8.4-11.5	33.6-33.9	2.3-3.9	2.9-3.1	24.6-36.0	0.6-1.1
3. *Buccella-Cibicides*	Santa Rosa-Cortes Ridge, Santa Catalina Ridge.	Deep bank and ridge.	100-400	8.5	33.9	2.0	3.2	34.3	1.4
4. *Epistominella Suggrunda*	Middle-inner Borderland.	Slope and inner basins (middle basins).	200-1800	5.2-6.7	34.32	0.8-0.15	5.8-7.3	3.5-8.2	2.6-3.6

Source: Douglas. et al., (1977).

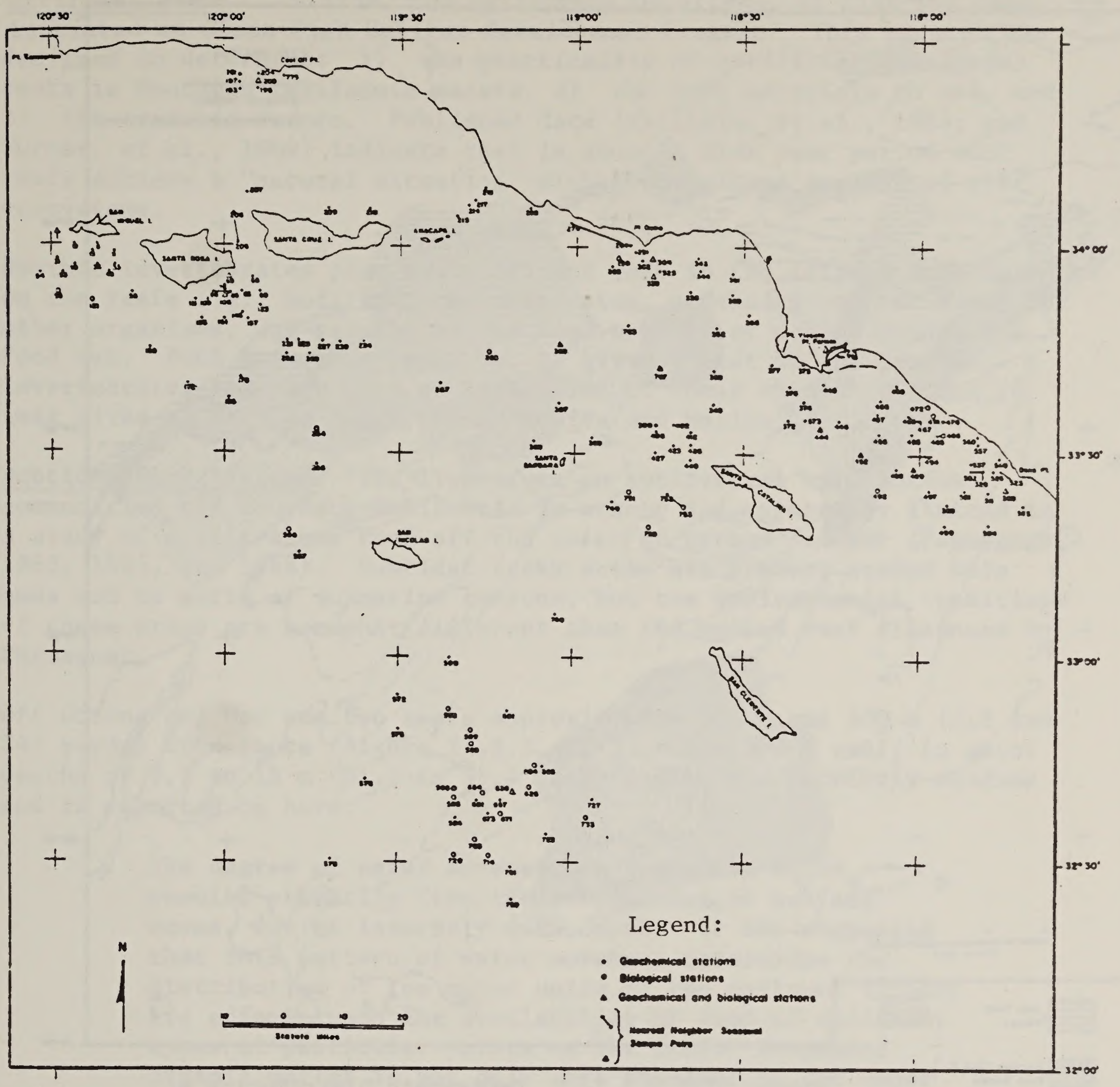
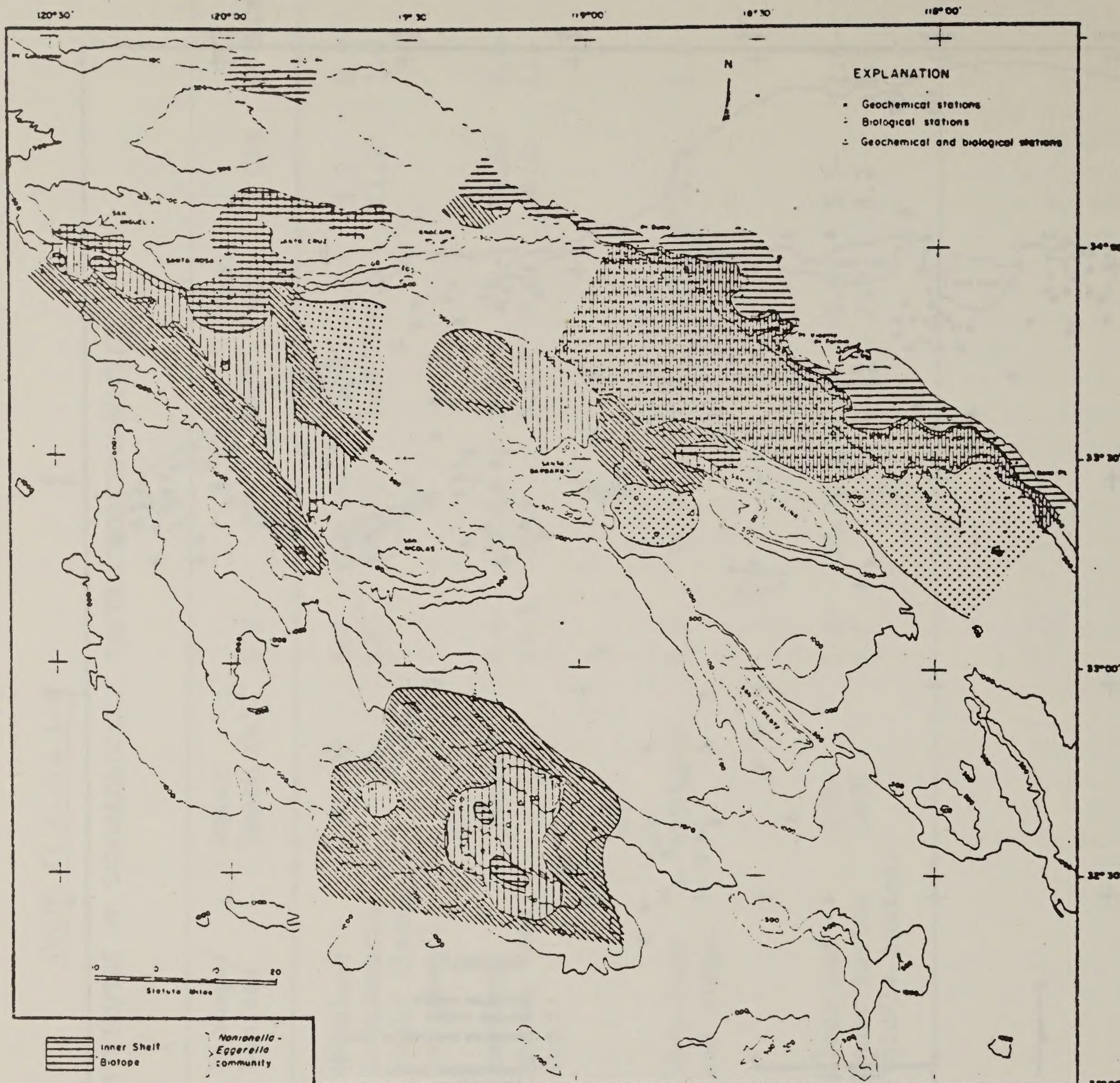


Figure II.E.3.a.i- 3 Distribution of Sample Stations of Foraminifera. Geochemical samples refers to samples collected by either a geochemical box core, Soutar/Van Veen geochemical grab sampler or prototype Van Veen geochemical grab sampler. Biological samples refers to samples collected by a modified N.E.L.-Reineck box core. Samples indicated as seasonal pairs were collected in the opposite season and were used for analysis of temporal variation in foraminifera.

Source: Douglas et al. (1977).



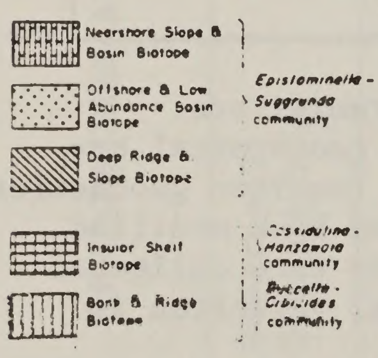


Figure II.E.3.a.i- 4 Geographic Distribution of Communities and Biotopes Based on Cluster Analysis of Live Populations in Total Sample Set (186 Samples).

Legend:

- Geochemical stations
- Biological stations
- Geochemical and biological stations

Source: Douglas et al. (1977).

Artifical Reefs. In 1958, the California Department of Fish and Game initiated an Ocean Fish Habitat Development Program. This program was designed to determine: 1) the practicality of artificial (man-made) reefs in Southern California waters, 2) the best materials to use, and 3) the economic return. Published data (Carlisle, et al., 1964; and Turner, et al., 1969) indicate that in about a five year period such reefs achieve a "natural situation" with fluctuations typical of reef ecosystems.

Benthic invertebrates play a significant role in the initial succession on the reefs e.g., modifying the substratum, providing cryptic areas for other organizms, and serving as the food source for others within the food web. POCS Reference Paper No. II gives a list of the benthic invertebrates together with an indication of their abundance found in test sites at Hermosa Beach, Santa Monica and Malibu, California.

Subtidal Hard Bottoms. The literature on sublittoral hard bottom communities off Southern California is scanty and apparently limited to a study of a silt-stone reef off the coast of Corona del Mar (Peguegnat, 1963, 1964, and 1968). Subtidal rocky areas are present around kelp beds and on parts of submarine canyons, but the environmental conditions of these areas are somewhat different than the raised reef discussed by Peguegnat.

Off Corona del Mar are two reefs approximately 200 m and 500 m (218 and 545 yards) from shore (Figure II.E.3.a.1-5). The 500 m reef, in water depths of 9.5 to 18 m (31.3 to 59.4 feet) depth, was intensely studied and is reported on here.

> The degree of water movement on the reef, which results primarily from the propagation of surface waves, varies inversely with depth. It was suggested that this pattern of water movement determines the distribution of the major units of the epifauna through its effects upon the availability of food of different types at particular points on the reef. Suspended organic matter is not only more abundant on the upper levels of the reef, but its rate of delivery to crust-forming organisms is enhanced by turbulence. Disposition of organic materials removed from the upper part of the reef is facilitated by the sharp reduction in degree of water movement along the lower sides and bottom of the reef.

The depth differential of the reef was great enough to involve vertical temperature difference of as much as 6°C. The part of Reef 500 above the thermocline exhibits faunal affinities to southern epifaunas, e.g., in regard to densities of the rock oyster *Chama pelluoida* and associated species, whereas other species with northern affinities, such as *Henricia leviuscula*, occur only at the reef base and are absent from the shallower Reef 200.

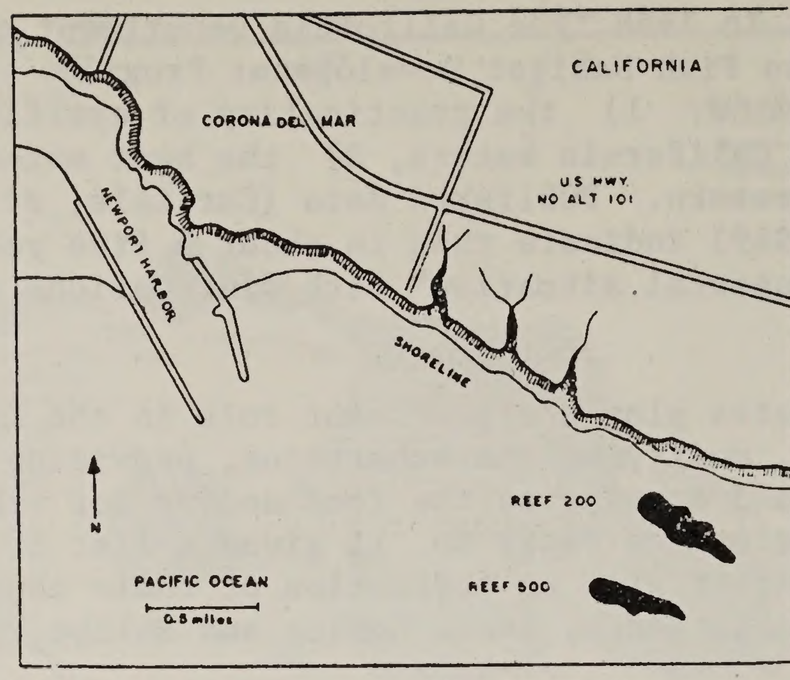


Figure II.E.3.a.i- 5 Location of the submarine rock reefs under study in relation to the city of Corona del Mar (Orange County), Newport Harbor, and the shore.

Source: Pequegnat (1964).

Between 300 and 400 described species of macroscopic invertebrates distributed among 12 phyla lived on the reef complex, which has a surface of only $1,385m^2$, including a meter-wide strip of soft bottom encircling the rock. Moreover, about 90 percent of the invertebrates and more than half the fishes included in this study were confined to, or are directly dependent upon, the $1,200m^2$ of rocky substratum.

In general, the predominant species in the upper 2 zones are sessile suspension feeders, which form thick incrustations that form biotopes for large numbers of small sessile and motile species. In the lower zones, on the other hand, the predominant species tend to be motile scavengers and deposit feeders; and the incrustations that are present are thin and formed by single species. These zones, together with their general depth limits along the transect where the sampling was done, are: Reef-top Zone, 9.5-12.5 m, where the important epifaunal features is an incrustation formed by the rock oyster *Chama pellucida*; the Mid-reef Zone, 12.5-14.5 m, which supports a thick growth of calcareous ectoprocts; the Reef-base Zone, 14.5-16.5 m, where large sea urchins and depositfeeding sea cucumbers predominate; and the Mixed-bottom Zone, 16.5 m, which is located on the adjacent sea bottom of sediments and rock slabs and which supports a mixture of infaunal and epifaunal species.

There was a general top-to-bottom decline in biomass, number of species and individuals. These relationships as well as vertical changes in feeding types are numerically illustrated on Table II.E.3.a.i-5 and 6.

A high productive and unique hard bottom community was reported by this office to occur on Tanner and Cortes Banks. For details of this area, see the "Unique Environment" Section (II.F.5).

ii. Rocky Shore Intertidal Communities: Approximately 20 percent of the Southern California mainland coast has rocky shores. This is in sharp contrast with the offshore islands which, with the exception of San Nicolas Island, have predominately rocky shores (California Department of Fish and Game, 1973). The shoreline classification of the Southern California counties are shown in Table II.E.3. a.ii-1.

Visual No. 2 shows the locations of sandy beaches and was taken from Corps of Engineers and Dames and Moore (1971).

A more detailed discussion of the intertidal is presented in POCS Reference Papers, Nos. II and III.

Littler, et al., (1977) reported on the first year study of the BLM sponsored study on six island and four mainland rocky intertidal sites (Figure II.E.3.a.ii-1).

A total of 447 taxa was recorded during the year from all 10 study areas. The number of macrophyte taxa (22)) was about equal to the number of macroinvertebrate taxa (227). Over half of the macrophytes recorded were Rhodophyta (Red algae) but Phaeophyta (brown algae) (especially *Egregia menziesii*) was the major contributor of biomass. Gastropods, of the macroinvertebrates, contained by far the most taxa (97).

Biological cover in the rocky intertidal is of primary ecological significance because space (and light) are often limiting resources (Connell, 1972). Major macrophytic cover throughout the 10 Southern California Bight stations was contributed predominantly by the blue-green algae (overall mean of 20%), the red algae *Corallina* spp. (9%), the red alga *Gigartina canaliculata* (8%), the brown alga *Egregia menziesii* (6%), and two tracaeophytes *Phyllospadix* spp. (4%). Most of these were important at many of the sites, except for *Philospadix* spp. which was abundant only at Coal Oil Point and San Nicolas Island (the two sites most affected by sand), while blue-green algae were important at all sites except these two sites. In terms of cover, the dominant macro-invertebrates were the anemone *Anthopleura elegantissima* (3% overall cover), the mussel *Mytilus californianus* (2%), and the barnacles *Chtamalus fissus/dalli* (2%). These four were present at all sites; however, *A. elegantissima* was predominant only at the sand affected Coal Oil Point and San Nicolas Island.

Table II.E.3.a.i-5

COMPARATIVE BIOLOGICAL AND PHYSICAL DATA ON THE EPIFAUNAL ZONES OF REEF 500

Zone	Area (m2)	Depth (m)	No. of species with max. pop. in zone	No. of species in zone	Mean of species per 0.1 m^2 plot	Numerable species 0.1 m^2	Individuals per cm^2 Reef 200	Individuals per cm^2 Reef 500
Reef top	550	9.5-12.5	131	189	89	65	1.40	2.55
Mid-reef	400	12.5-14.5	87	144	80	47	0.86	0.95
Reef base	250	14.5-16.5	51	114	49	32	0.37	0.32
Mixed-bottom	185	16.5-18.5	31	47	23	23	0.03	0.06

Source: Pequegat (1968).

The last 2 columns compare the number of individuals cm^2 of reef surface on Reef 200 with Reef 500.

Table II.E.3.a.i-6

DISTRIBUTION OF DRY-WEIGHT BIOMASS ON REEF 500 BY ZONES AND BY PRINCIPAL FEEDING TYPES[a]

Feeding Types	Reef-Top g/m^2	Reef-Top % wt.	Mid-Reef g/m^2	Mid-Reef % wt.	Reef-Base g/m^2	Reef-Base % wt.	Mixed Bottom g/m^2	Mixed Bottom % wt.	Mean Wt.
Suspension-feeders	2238.4	86.4	1120.4	79.6	202.5	53.9	55.6	31.9	904.2
Carnivores	219.8	8.5	128.0	9.1	53.9	14.3	25.0	14.3	106.7
Scavengers	122.8	4.8	117.1	8.3	45.1	12.0	63.3	36.3	87.1
Herbivores	4.1	0.2	37.6	2.7	63.3	16.9	6.6	3.8	27.9
Deposit-feeders	0.1	0.1	4.5	0.3	10.9	2.9	24.0	13.7	9.9
Totals	2585.2		1407.6		375.7		174.5		

Source: Pequegnat (1968).

[a]The marked drop in total biomass between the mid-reef and reef-base zones is accounted for in part by lack of water movement and by feeding activities of sea urchins that destroy settling larvae.

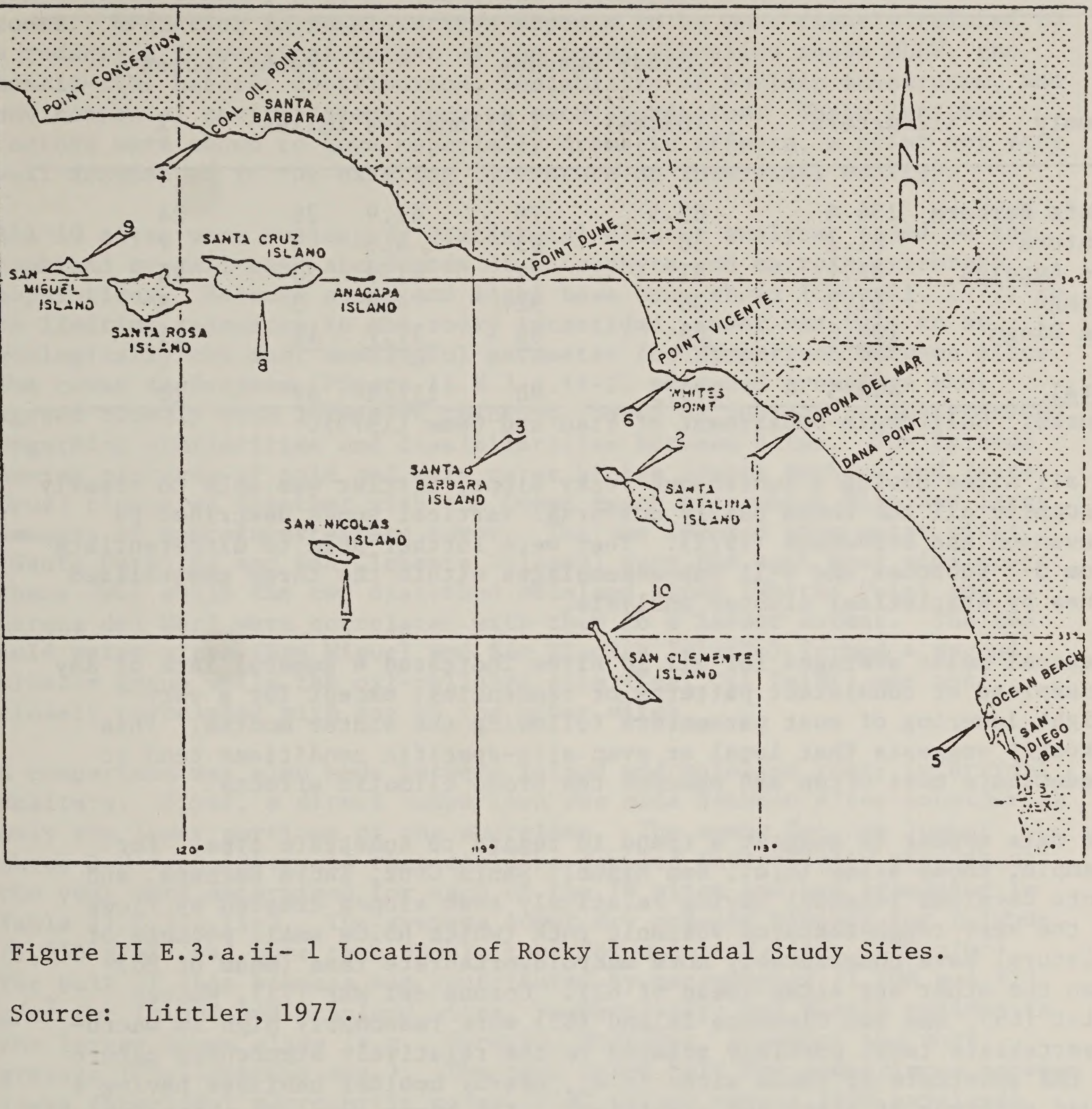


Figure II E.3.a.ii- 1 Location of Rocky Intertidal Study Sites.

Source: Littler, 1977.

Table II.E.3.a.ii-1

SHORELINE CLASSIFICATION OF SELECTED SOUTHERN CALIFORNIA

	Sandy Beaches			Rocky Shores		
County	Kilometers	(Miles)	%	Kilometers	(Miles)	%
Santa Barbara	134.4	83.5	76	41.9	26	24
Ventura	61.2	38	93	4.8	3	7
Los Angeles	82.1	51	77	41.9	26	24
Orange	61.2	38	92	4.8	3	8
San Diego	104.6	65	85	17.7	11	15
Total	443.5	275.5	80	111.1	69	20

Source: California Department of Fish and Game (1973).

On all sites having a continuous rocky slope, Littler was able to clearly recognize all the three nearly universal vertical zones described by Stevenson and Stevenson (1972). They were further able to differentiate from 3-7 subzones and 6-11 sub-assemblages within the three generalized zones by statistical cluster analysis.

Seasonal means averaged for all 10 sites indicated a general lack of any widespread or consistent patterns or tendencies, except for a very slight lowering of most parameters following the winter months. This strongly suggests that local or even site-specific conditions tend to predominate most often and obscure the broad climatic effects.

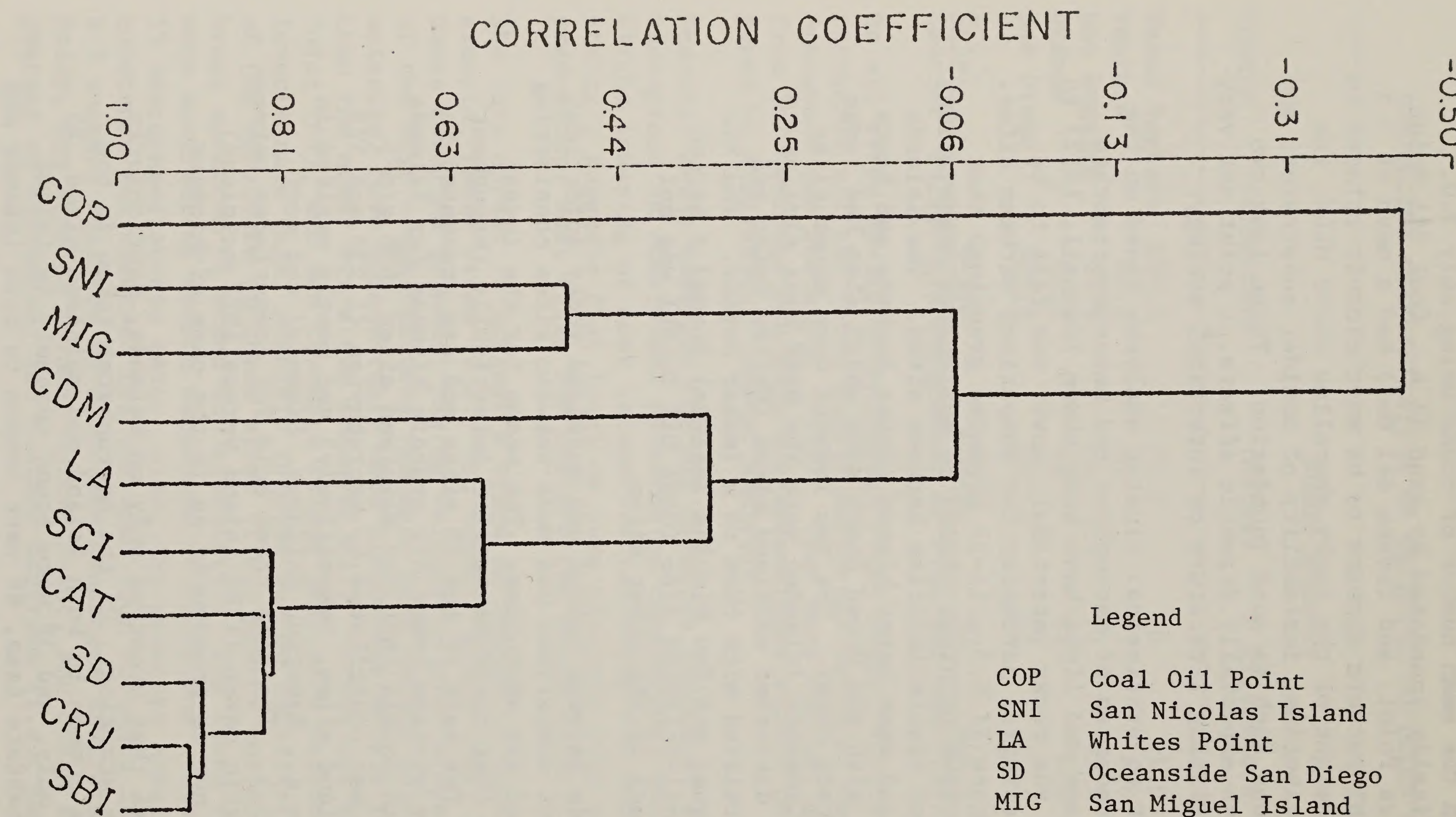
The data appear to suggest a trend in regard to substrate type. For example, those sites (i.e., San Miguel, Santa Cruz, Santa Barbara, and Santa Catalina Islands) having relatively even slopes created by flows of the very rough-textured volcanic rock (which holds small pockets of moisture) have considerably more macroinvertebrate taxa (mean of 80) than the other six sites (mean of 62). Corona del Mar (71), Whites Point (69), and San Clemente Island (65) were reasonably high in macroinvertebrate taxa, possibly related to the relatively structured nature of the substrate at these sites (i.e., nearby boulder habitats having a broad spectrum of sizes and stability). The three remaining sites which were entirely of smooth sandstone or siltstone contained a mean of only 55 macroinvertebrate taxa. Also, the greatest zonal complexity and constancy was observed for the same four volcanic island sites (mean of 6.5 zones), followed by siltstone/sandstone habitats (i.e., Coal Oil Point, San Nicolas Island, Whites Point, and Ocean Beach) which had an average of 4.2 zones, and boulder habitats (i.e., Corona del Mar and

San Clemente Island) with the mean number of zones being only 3.0. Sites shown to be periodically inundated by sand (i.e., Coal Oil Point, San Nicolas Island, Whites Point, and Corona del Mar) had a mean of 3.5 zones. Reduction in zonal pattern appears to be most closely related to a reduction in vertical height of the rocky shoreline above MLLW, the mosaic-like habitat distribution, instability of boulder substrates, and environmental perturbations such as sand inundation. These last two factors were shown to have especially dramatic effects, a point not very well documented in the existing literature on intertidal ecology.

All 10 sites were subject to statistical cluster analyses based on the combined overall mean abundances of macrophyte and macroinvertebrate populations. Because space and light have been shown (Connell, 1972) to be limiting resources in the rocky intertidal, cover was felt to be ecologically the most meaningful parameter for comparison between sites. The cover dendrogram (Figure II.E.3.a.ii-2) produced groupings that agreed closely with intuitive opinions (based on subjective observation) regarding similarities and dissimilarities between sites. The islands having mixtures of cold and warm water biotas (Santa Barbara and Santa Cruz) clustered together with the Ocean Beach site which also had large amounts of macroinvertebrate cover. The two leeward warm water sites (Santa Catalina and San Clemente Islands) were the next most similar to these two; while the two disturbed mainland sites (Whites Point and Corona del Mar) were correlated with them to a lesser extent. The two cold water sites (San Miguel and San Nicolas Islands) formed a second cluster group while the oil-polluted site (Coal Oil Point) was not closely correlated with any of the other sites.

A comparison was also made between island and mainland rocky intertidal habitats. First, a direct comparison was made between sites considering only the lower portions of the shoreline. The means for the lowest three 1.0 feet intervals that could be sampled intertidally throughout the year were determined for each of the 10 sites and are presented in Table II.E.3.a.ii-2. The average lower dry organic biomass for islands (1,355 g/m^2) was more than double that for mainland sites (620 g/m^2). The bulk of this biomass was contributed by macrophytes (1,238 and 527 g/m^2 for island and mainland sites, respectively) and mostly resided in the larger brown algae (e.g., *Egregia, Halidrys, Eisenia)* and surf grasses *(Phyllopspdix* spp.). The same trend held for comparisons between lower intertidal macrophytic cover (118% island versus 102% mainland) but the differences were not as pronounced as in the case of biomass.

The higher numbers of taxa that occurred only on islands, particularly of macroinvertebrates are striking. Of the macrophytes taken in the quadrat samples, 117 were common to both island and mainland sites, 25 were from mainland sites only, and 39 were found uniquely in island samples. For macroinvertebrate taxa, 86 were common to both islands and mainland, 33 were only in mainland samples, and 86 were sampled only from islands.



Legend

COP	Coal Oil Point
SNI	San Nicolas Island
LA	Whites Point
SD	Oceanside San Diego
MIG	San Miguel Island
CDM	Corona Del Mar
CRU	Santa Cruz Island
SBI	Santa Barbara Island
SCI	San Clemente Island
CAT	Santa Catalina Island

Figure II.E.3.a.ii-2 Dendrogram Display of Differential Clustering of All 10 Study Sites Using the Combined Cover Values.

Source: Littler, 1977

Table II.E.3.a.ii-2

MEAN YEARLY MACROPHYTE (M) AND MACROINVERTEBRATE FOR SELECTED SITES (I) DRY ORGANIC BIOMASS (G/M^2) AND COVER (%) COMPARISONS BETWEEN SITES AVERAGES FOR THE THREE LOWER 1.0 FT. INTERVALS

Sites	Biomass (g/m^2) M	I	Combined	Cover (%) M	I	Combined
Corona del Mar	300	3	303	97	61	158
Santa Catalina Island	2591	34	2625	164	18	182
Santa Barbara Island	1213	120	1333	114	19	133
Coal Oil Point	381	192	573	103	5	108
Ocean Beach	466	123	589	107	20	127
Whites Point	961	52	1013	103	8	111
San Nicolas Island	1334	87	1421	86	27	113
Santa Cruz Island	409	275	684	90	19	109
San Miguel Island	730	181	911	99	19	118
San Clemente Island	1152	2	1154	158	2	160
Island Mean	1238	116	1355	118	17	136
Mainland Mean	527	92	620	102	24	126

Source: Littler (1977).

There were 15 macrophytes and 13 macroinvertebrates that occurred in samples at all 10 of the study areas (Table II.E.3.a.ii-3), while another somewhat smaller group (6 macrophytes and 12 macroinvertebrates) were sampled at 9 of the 10 sites. The site where most (66%) of these otherwise ubiquitous macrophytes did not occur was Whites Point. There were two other sites where certain widespread macroinvertebrates also were not sampled; Coal Oil Point where one-half of these dropped out and San Clemente Island where one third were uniquely absent.

Coal Oil Point samples, on the other hand, contained the largest number of macrophyte taxa (9) found only at one site, while Corona del Mar and San Nicholas Island had the fewest (2). Santa Cruz Island had far more site specific macroinvertebrates (27) and San Nicolas Island (3) has the least followed by Coal Oil Point and San Miguel Island (4). This leads Littler to hypothesize that the presence of oil may act at Coal Oil Point to eliminate certain widespread species while providing a unique habitat for other more uncommon forms.

Samples could not be obtained from the upper vertical zones at one of the six island sites (i.e., San Nicolas Island) and three of the four mainland sites (i.e., Coal Oil Point, Whites Point, and Corona del Mar) because of sand inundation.

While extensive algal turf communities were prevalent in the middle to low intertidal zones at nearly all sites, the island turfs were comprised of larger and more robust populations (mostly coralline algae) with epiphytes. Mainland turf communities tended to be lower-growing, more compact, and often heavily coated with a predominance of fine, filamentous epiphytes. The exception on the mainland is Ocean Beach (with a robust coralline turf containing foliose algal epiphytes), a site that apparently has received little environmental degradation over the last three decades, since the biota there closely approximated that found (Stephenson and Stephenson, 1972) at nearby Bird Rock and a rocky platform north of Scripps pier during 1947.

The consistency of the intertidal communities and the sampling sites of the mainland and islands has not been determined. Present BLM baseline studies are attempting to determine this, particularly for the islands.

Mussel Community: Straughan and Kanter (1977) conducted a three-dimensional study of mussel (*Mytilus californianus*) communities at six of the same locations surveyed by Littler (Figure II.E.3.a.ii-1). These included two mainland locations (Coal Oil Point, and Ocean Beach, San Diego) and four islands sites (San Miguel, Santa Cruz, San Nicolas and Santa Barbara Islands).

The mussell beds surveyed during this study supported an extremely rich fauna. Together, they contained (consecutively) 346 species from twelve phyla. The lowest number of species from a single set of samples (1,500

Table II.E.3.a.ii-3

SPECIES COMMON TO ALL 10 SITES
SHOWN ON FIGURE II.E.3.a.ii-5

Macrophytes	Macroinvertebrates
Benthic Diatoms	*Acamea (Collisella) pelta*
Blue-green algae	*Acmaea (Collisella) conus*
Bossiella orbigniana ssp. *dichotoma*	*Acmaea (Collisella) digitalis*
Ceramium eatonianum	*Acmaea (Collisella) limatula*
Corallina officinalis var. *chilensis*	*Acmaea (Collisella) strigatella*
Corallina vancouveriensis	*Anthopleura elegantissima*
Egregia menziesii	*Chthamalus fissus*
Gelidium coulteri	*Chthamalus dalli*
Gelidium pusillum	*Cyanoplax hartwegii*
Gigartina canaliculata	*Littorina planaxis*
Gigartina spinosa	*Mytilus californianus*
Lithophyllum proboscideum	*Pachygrapsus crassipes*
Petrospongium rugosum	*Pugettia producta*
Pterocladia capillacea	*Tetraclita squamosa rubescens*
Pterosiphonia dendroidea	

Source: Littler (1977).

cm^2) was 41 (San Miguel Island) and the highest was 78 species (Santa Cruz Island). This high number of species probably exists due to the three dimensional structure of the mussel beds. This provides area for attachment directly to the mussels for some species, traps sediments, thus, providing another habitat for other species, and provides shelter from dessication, predators, surge force, etc., for all species.

Three phyla, the Annelida, Mollusca, and Arthropoda, combined to contribute over 70 percent of the mussel community species. These organisms occupied a wide range of habitats within the bed and probably exploited an equal variety of food resources. However, the natural history of most species found in the mussel bed remains unknown, and their respective niches for exploitation of food and habitat resources, in many cases, can only be inferred from consideration of morphological characteristics.

The most informative results were obtained from community classification analysis and discriminant analysis. The classification analyses of mussel bed community revealed three major patterns. The patterns corresponded to unique species assemblages associated with the different geographic mussel bed samples. These included:

- Species groups ubiquitous in all mussel beds examined.
- Species groups which distinguished island from mainland mussel beds.
- A unique species assemblage from San Miguel Island that distinguished this area from the other island localities.

The species from both mainland and island localities included in the most common species groups were quite comparable overall and were predictable occupants of any mussel beds sampled from the Southern California area. These species included the sea anemone *Anthopleura xanthogrammica,* the gooseneck barnacle *Pollicipes polymerus*, the gastropod *Tegula funebralis* and the limpet *Collisella stringatella (=Acmaea stringatella).*

The ubiquitous species for the island localities when sampled alone included the species mentioned above (from both mainland and island localities) and the crab (Pachygrapsus crassipes, and the *limpet Collisella pelta (=Acmaea pelta).*

The second major pattern from the classification analysis was produced by the primary normal dendrogram split which separated island from mainland localities.

The major split in the normal dendrograms suggested that two distinct faunal provinces had been sampled. Point Conception, California, has long been regarded as the dividing line between northern and southern mainland provinces (Light 1970; Johnson and Snook, 1967). The current patterns occurring in the area under study (Figure II.E.3.a.ii-3) suggest that planktonic larvae may be carried to the island localities from

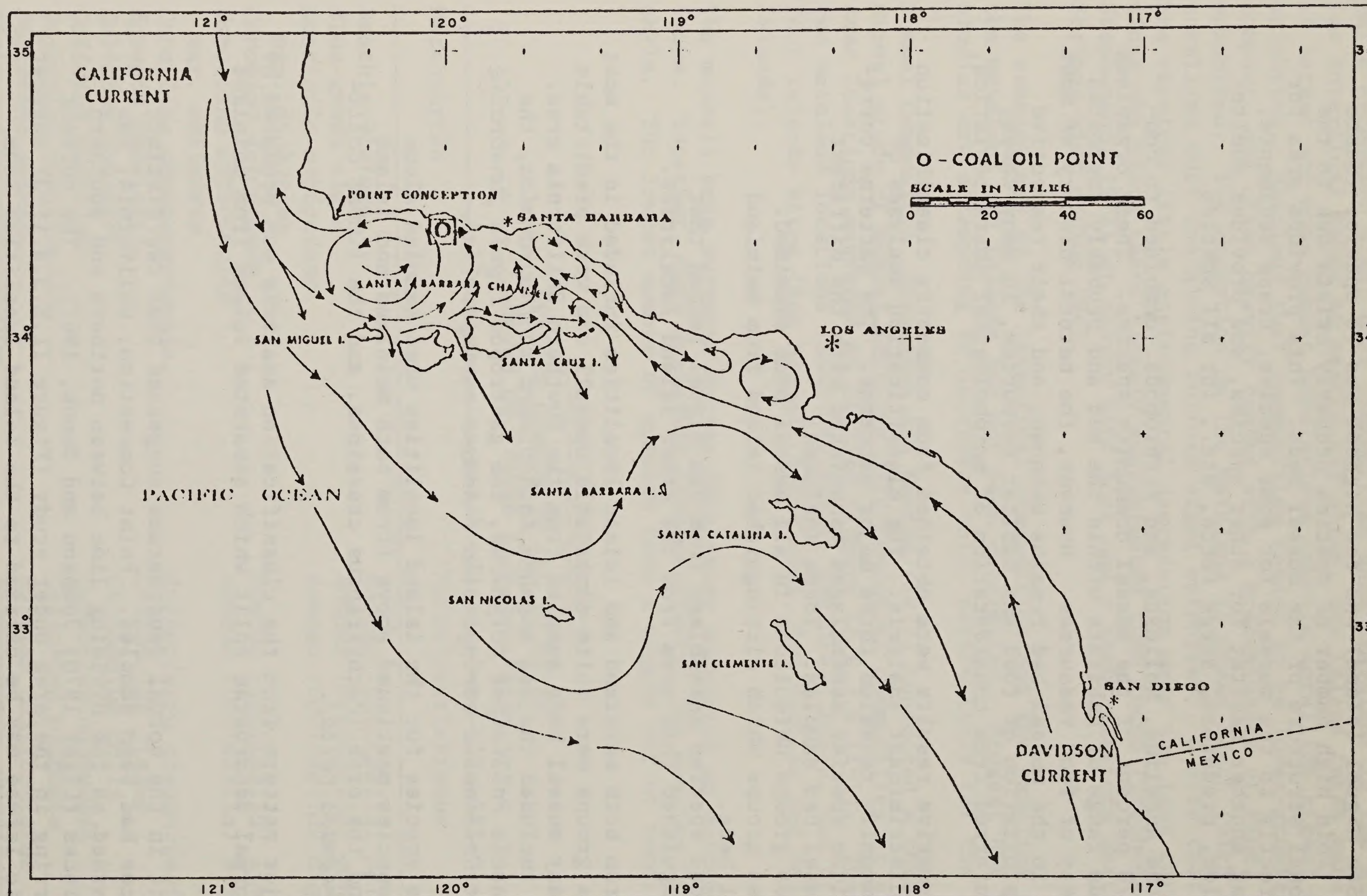


Figure II.E.3.a.ii-3 Generalized Current Patterns of the Pacific Ocean from Point Conception to San Diego, California.

Source: Straughan and Kanter, 1977.

source areas in the northern (colder water) province. The mainland areas are exposed to currents originating in warmer southern areas which may carry planktonic larvae from these areas. Although Littler (1977) noted a similar difference between the mainland and island sites he reported the island communities reflected geographical differences.

The mussel communities from both mainland and island localities displayed no obvious overall seasonal changes. Ubiquitous species common to all mussel beds in the classification analyses remained relatively constant in numbers throughout the year. Species groups which characterized specific localities only changed slightly in composition throughout the year.

The most important mussel bed structural attributes provided habitats for the associated community and included sediment and coarse fraction features. Food-related resources provided by the mussel bed were secondarily important.

Stephenson and Stephenson (1972) surveyed the rocky intertidal in the La Jolla region and compared it to that of the Monterey Peninsula (see POCS Reference Paper Nos. II and III). The area surveyed was similar to the Ocean Beach area surveyed by the BLM Littler study giving an opportunity to compare results at the widely separated period of 30 years.

iii. Sandy Beach Intertidal: Approximately 80 percent of the Southern California mainland coast has sandy beaches. Approximately 134.4 km (83.5 miles 76 percent of Santa Barbara County's shoreline is classed as sandy beach. The shoreline classification of the remaining Southern California counties are tabulated in Section II.E.3.a.ii and Visual No. 2 shows the locations of sandy beaches and was taken from Corps of Engineers and Dames and Moore (1971).

The environment of the exposed sandy intertidal is considerably less stable than that of the rocky intertidal. Every wave on a sandy intertidal beach moves a great deal of sand.

Organisms on surf-swept sandy beaches achieve protection from wave shock by burrowing (burying) themselves in the sand. That sandy beaches have limited populations, is not unexpected.

Because of the continued restructing of sandy beaches, the number of individuals per species varies greatly from year to year. There is, however, a characteristic group of animals which lives just below the low tide line or within the sand between the tide lines. A few even live higher up the beach in burrows or beneath organic debris. Some of these organisms are active only at night or on cloudy days, others remain hidden in the sand.

The most important mirofauna species expected to occur within most of the beaches are the amphipods *Synchelidium* sp., the *Eubostorius* sp., and the cumacean *Cyclastis* sp.

Accounts dealing with sandy areas are few. Patterson (1974) sampled nine beaches between Coal Oil Point and Doheny State Park for a year at two-month intervals. The degree of exposure is an important criterion in this type of environment; she described Coal Oil Point as being semi-sheltered and both Hope Ranch and Carpenteria as moderately exposed areas.

Two distinct areas of beach fauna were isolated, an upper and lower zone. No specific species or groups of species delineated the middle zone which appears to be a transitional zone or part of a continuum.

The most complete geographic coverage was done during the BLM sponsored study by Straughan (1977). Fourteen sandy beaches and three slough sites were selected as study areas in an attempt to represent the broad range of physiographic types in the Southern California Bight (Figure E.3.a. iii-1).

A total of 240 living faunal species and 8 plant species were observed among the sandy-beach and marsh study sites. The greatest number of species (96 over all seasons, all methods) were observed at Twin Harbors, 45 of which were unique to the site. The fewest species (2) were recorded at Point Dume and Point Mugu. Fifty-three species were collected among mainland beach sites. The number of species collected on island beaches was 119 including Twin Harbors, but 47 excluding that site. Species collected in the slough sites numbered 144.

As pointed out by Parr (CPO Comments and personal communication), many individuals and certain important species are not retained in the 1.5 mm mesh and are not recorded in the results. This is particularly true of amphipods, cumaceans and worms.

No species were recorded at all sites. *Emerita analoga*, the common sand crab, was the most obiquitous species. It was recorded at all beach sites except those on Santa Catalina Island. Beach hoppers, *Orchestoidea corniculata, Orchestoidea benedicti* and *Orchestoidea* juveniles, were found on all island and three mainland beaches. The isopod, *Exocirolana chiltoni*, was recorded at all island beaches except Twin Harbors site. Blood worms, either *Euzonus dillonesis* or *Euzonus mucranata*, were found at all island sites except those at Santa Catalina Island.

Figure II.E.3.a.iii-2 depicts the profile of a typical beach studied during the first year of effort; the four zones of Allen (1976) have been superimposed. Data from the upper, middle and lower box stations showed that the upper beach is normally dominated by the amphipod beach hoppers of the general *Orchestoidea* and *Orchestia*. These animals remain in the moist sands above high tide during day and emerge to feed at night. The sand crab *Emerita analoga* dominates the lower high tide and mid tide zones. Its habit of following the tides as it feeds on dinoflagellates, other minute organisms and small plant particles produces a broad tidal

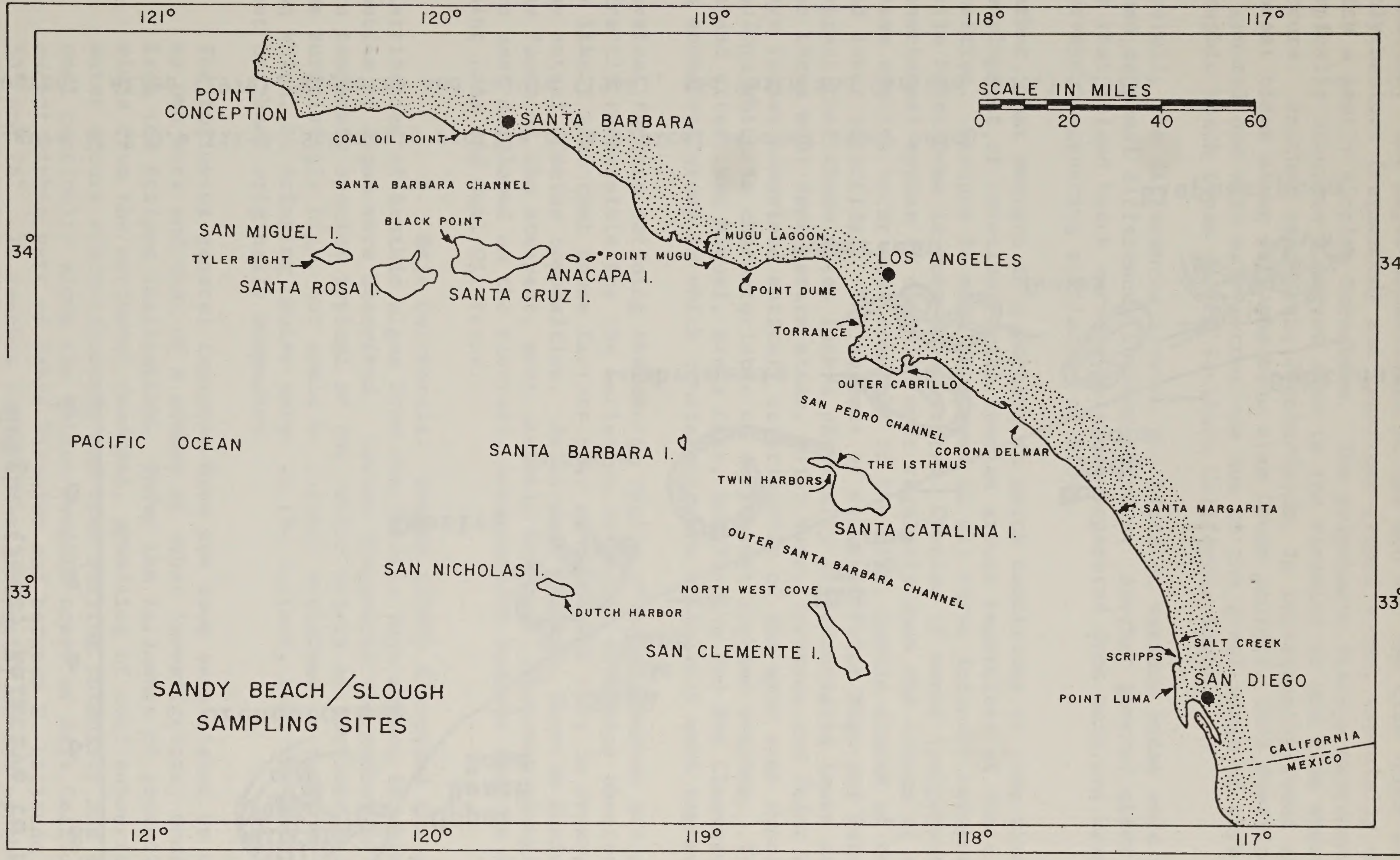


Figure II.E.3.a.iii-1 Map showing the Location of the 17 Sandy Beach and Slough Sampling Sites. The Arrow Indicates the Location of the Site.

Source: Straughan (1977).

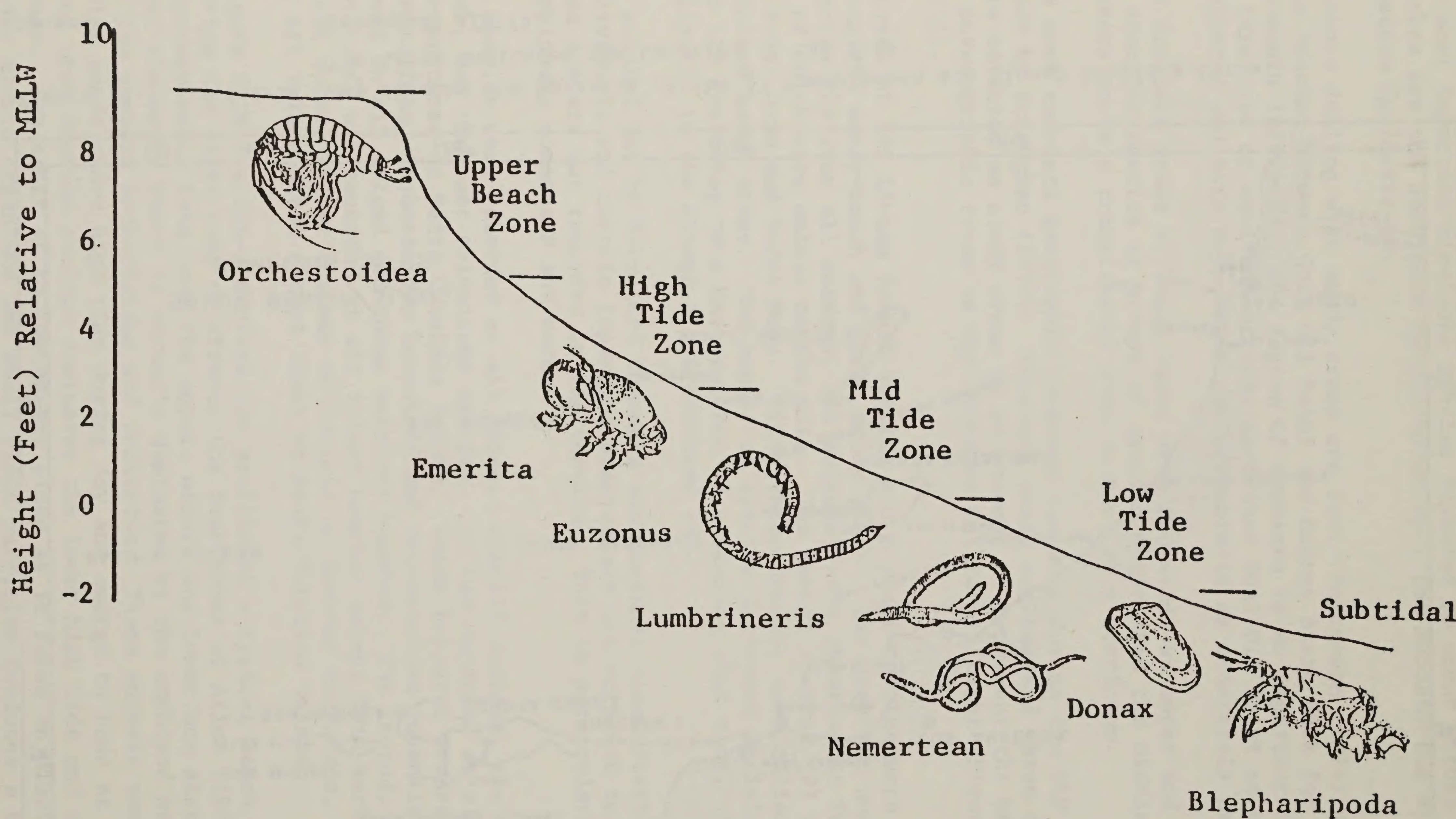


Figure II.E.3.a.iii-2 Schematic profile of a typical exposed sandy beach.

Source: Allen (1976), Ricketts and Calvin (1968), and Smith and Carlton (eds.) (1975).

zonation. The major inhabitants of the mid and low tide zones are polychaetous (segmented) and nemertean (round worms, especially on beaches with a gently sloping foreshore. The polychaete *Euzonus mucronata* typically occupies a narrow zone in the vicinity of mid tide where it occurs. Another sand crab, *Blepharipoda*, is infrequently found at the lowest tides along with the bean clam *Donax gouldii*. This description is a general one with many exceptions due to the great range of physiographic beach types in the Southern California Bight.

Overall, the differences between the biota of various sites were greater than seasonal differences between surveys. Another general observation is that island beach surveys were not separated from mainland beach surveys, suggesting similarity of biota.

Rather, what emerges is a pattern in which conditions at some sites favor development of relatively rich species groups regardless of their geographic position. Scripps is most developed in all three infaunal categories while Point Dume is most depauperate. Species of worms (polychaetes, nemerteans) appear to diminish most regularly down the column of sites. These species occur most commonly in the flat, gentle slopes of the middle and lower intertidal. The absence of worms at Point Mugu and Point Dume suggest that these sites lack a physically differentiated lower zone. The three most depauperate sites, Point Mugu, Torrance and Point Dume, have faunas comprised entirely or primarily of the sand crab *Emerita analoga* which is characteristic of surf-swept exposed beaches. The island sites, San Miguel, Santa Cruz, San Nicolas and San Clemente, form an anomalous group in which crustaceans are relatively well represented.

Physical factors defining the energy regime of sandy beaches are probably directly responsible for the variation in biotic diversity observed. It is likely also that these factors play an important role in determining the actual species composition. As already related, *Emerita* dominates the fauna of the steepest, most unstable beaches. The worm associations are best developed on the flattest, most regular beaches such as Scripps, Point Loma and Coal Oil Point.

b. Baja California: Dawson (1960) discussed the geographic distribution of benthic algae from the Pacific Baja region in which 357 species of algae were described. Dawson discovered the number of northern temperate species typical of the cooler waters of Southern California was surprisingly high, but could be largely explained in terms of upwelling which, by bringing cooler water to the surface, kept the water cooler that had been originally suspected.

> The following general features have now been established by both my own work and that of a number of other investigators, mostly from the Scripps Institution. Under the influence of prevailing winds from the northwest quadrant, upwelling of cold subsurface water occurs discontinuously and with varying intensity and seasonal continuity along the entire Pacific coast of Baja California, except within part of Bahia Vizcaino and between N. Latitude 24° 50' and 26°. It reaches its greatest intensity on the south of the series of headlands between Punta Baja and Punta Descanso on the far northwest coast.

The islands of Pacific Baja California provide a further range of ecological conditions from those of the mainland. Isla Guadalupe, far west of the influence of coastal upwelling, shows in its high proportion of warm water algal elements the effect of latitudinal warming entirely unlike cold Punta Baja, the nearest mainland point to the east. The *Macrocystis-Egregia* flora does not occur. Islas San Benito, however, where a combination of the cooling influences of upwelling and of warming from insolation obtained shows a marine flora closely similar to that of La Jolla 300 miles to the north. Isla Cedros also shows in its various parts marine climatic differences reflecting the mixed influences of cooling and warming factors.

Throughout the areas of upwelling along Pacific Baja California, and in proportion to the influence of upwelling as opposed to the warming influences of insolation, one finds the characteristic algal species of Southern California extending southward. In areas of intense upwelling and strongly depressed temperatures, the intertidal flora more closely resembles that occurring north N. Latitude 34° in California and includes species not otherwise known to occur intertidally south of central California. To the south of Baja Rosario, warming influences tempering the upwelling cold gradually eliminate some cold water elements and permit the occurrence of a flora much like that of Southern California. At Islas San Benito, 82 percent of the species are common to La Jolla, California. The California extension, associated with beds of *Macrocystis*, continues south in the upwelling areas to as far as Punta Abreojos. Farther south, *Macrocystis* apparently occurs only sporadically.

Local diversities of ecology are so great that one may easily be misled on the character of the flora of an area by having made too few observations. Thus, an algologist working in the vicinity of Cabo San Lucas is struck by the scarcity of algae on the granitic rocky shore. Only a handful of species are found, and the whole area suggests an impoverished flora. Yet, only a few miles away at Cabeza Ballena, on a volcanic substrate, and under the influence of apparently more favorable circulation, a richly diversified flora occurs in which nearly a hundred entities may be found. Along Pacific Baja California, the algal flora shows relatively inconspicuous seasonal fluctuation. Many prominent species are present continuously throughout the year although many minor variations in floral composition occur with seasonal growth and decline of individual species.

Soule (1960) and Garth (1960) both reported a somewhat analogous situation with the northern component of ectoprocts bryozoans and brachyuran crabs, respectively, as they both extend further to the south on the west coast of Baja than in the Gulf of Califonia (Figure II.E.3.b-1). This is because there is no upwelling of cold water in the Gulf of California.

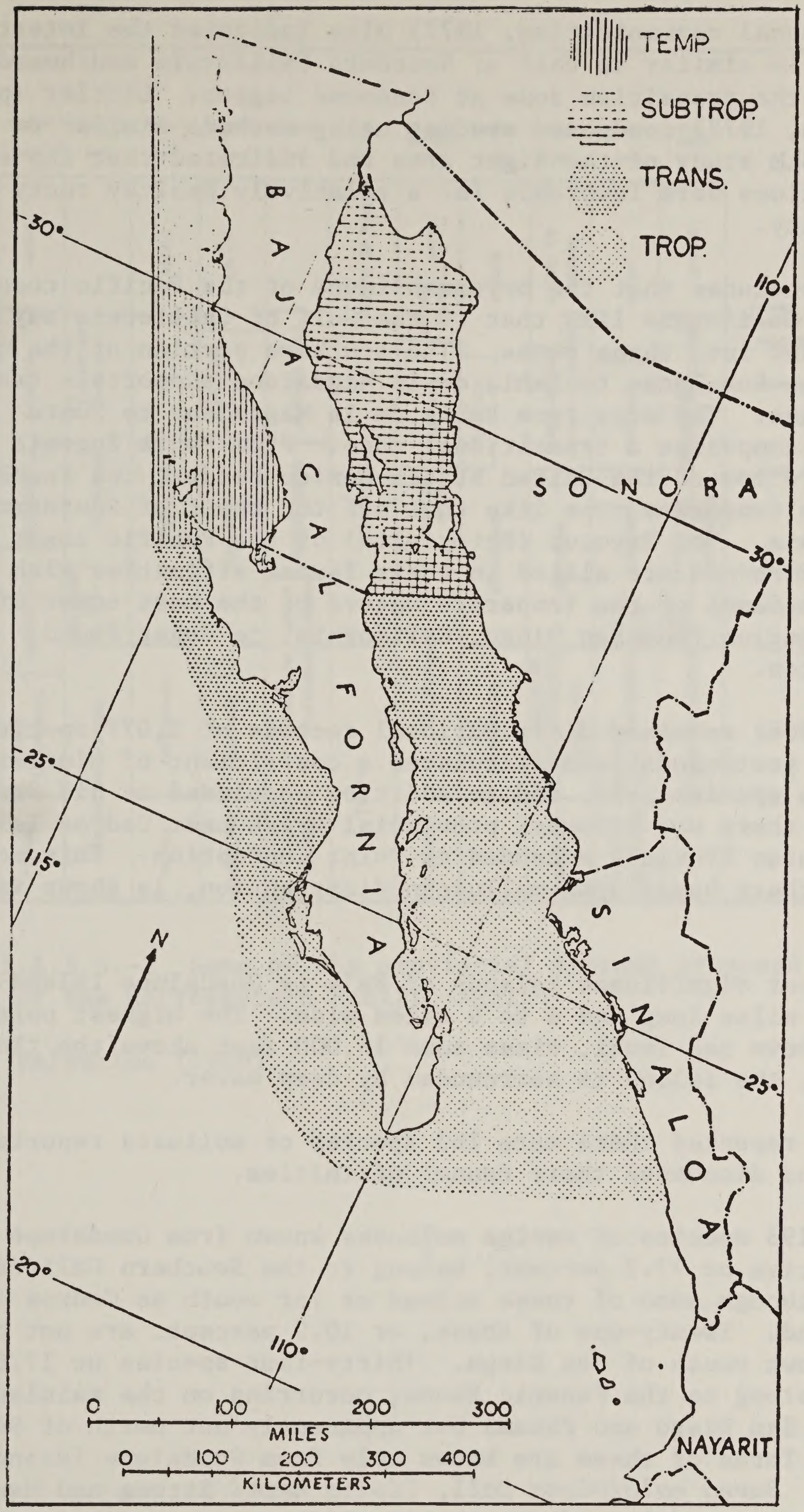


Figure II.E.3.b - 1
Zonation of littoral ectoprocts along the coasts of Baja California.

Source: Soule (1960).

Wolfson (personal communication, 1977) also indicated the intertidal of Pacific Baja is similar to that of Southern California southward to the beginning of the transition zone at Scammons Lagoon. Littler (personal communication, 1977) conducted studies using methods similar to those used in the BLM study of the Bight area and indicated that the environmental conditions were favorable for a relatively healthy rocky intertidal community.

> Soule concludes that the bryozoan fauna of the Pacific coast of Baja California like that of the Gulf of California may be subdivided into three zones. The southern portion of the coast from Cabo San Lucas to Bahia de la Magdalena supports a tropical type fauna. The area from Bahia de la Magdalena to Punta Eugenia comprises a transitional zone. From Punta Eugenia northward toward the United States-Mexico border, the fauna is the warm temperate type like that off the coast of Southern California. The Bryozoa (Ectoprocta) of the Pacific coast of Baja California are allied in their faunal affinities with the bryozoan fauna of the temperate waters of the west coast of North America from San Diego, California, to Puget Sound, Washington.

Valentine (1966) examined distributional records of 2,077 species of bivalves and gastropods, and calculated a coefficient of similarity for each latitude species pair, and in addition concluded as did Soule with bryozoa that there was a faunal provincial break near Cedros Island. This Californian Province extended to Point Conception. This scheme, along with others based upon molluscan distribution, is shown in Figure II.E.3.b-2.

One of the most significant islands of Baja is Guadalupe Island. The island is 22 miles long and 4 to 6 miles wide. The highest point, 4,257 feet above sea level, rises some 16,000 feet above the floor of the ocean. Thus, the island is surrounded by deep water.

Chase (1958) reported there were 193 species of mollusca reported from the island and discussed their faunal affinities.

> Of the 193 species of marine mollusks known from Guadalupe Island 149 species or 77.2 percent, belong to the Southern California Fauna, though some of these extend as far south as Cedros Island or beyond. Twenty-one of these, or 10.9 percent, are not otherwise known south of San Diego. Thirty-four species or 17.6 percent, belong to the Panamic Fauna, occurring on the mainland between San Diego and Panama but apparently not north of San Diego. Three of these are known only from Guadalupe Island and Panama: *Bursa calcipicta Dall, liotia heimi* Strong and Hanna *Grenella megas* dall. (Distributional data are mostly from Keen (1937).

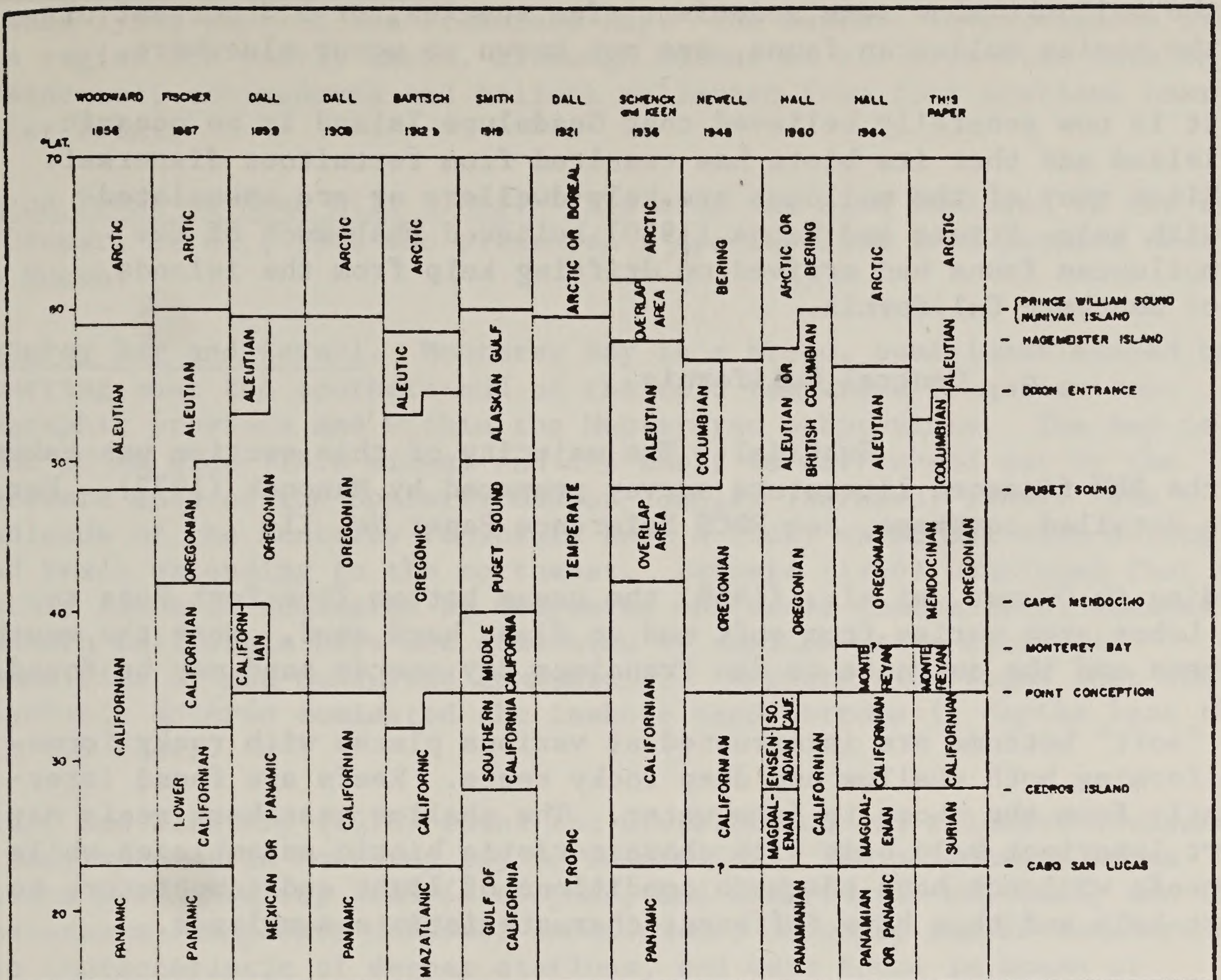


Figure II.E.3.b.-2 Some of the provincial systems proposed for Mollusca of the northeastern Pacific shelf.

Source: Valentine (1966).

As with the other terrestrial and marine biota of Guadalupe Island, the mollusks show some endemism. Ten species, or 5.2 percent of the marine molluscan fauna, are not known to occur elsewhere.

It is now generally believed that Guadalupe Island is an oceanic island and that its biota has resulted from fortuitous dispersal. Since many of the molluscs are kelp dwellers or are associated with kelp, Strong and Hanna (1930) believed that much of the molluscan fauna had arrived on drifting kelp from the islands of Southern California.

c. Central California

i. Subtidal: The majority of this section was taken from the BLM financed literature survey prepared by Hancock (1977). For a more detailed coverage, see POCS Reference Paper No. II.

According to Odemar, et al., (1968) the ocean bottom from Fort Ross to Point Lobos area varies from soft mud to fine, hard sand. Near the mouths of rivers and the entrance to San Francisco Bay coarse sand may be found.

These "soft" bottoms are interrupted at various places with rocky formations forming both shallow and deep rocky reefs. Reefs are found intermittently from the shore to deep water. The shallow nearshore reefs may support luxuriant kelp beds with characteristic biotic assemblages while deep reefs will not have adequate conditions of light and temperature to support kelp and thus have different characteristic assemblages.

The biota inhabiting the lowest tide zone of the rocky shoreline continues subtidally and contributes significantly to the biota of the nearshore rocky reefs. Many of the same crabs, starfish, molluscs, sponges, hydroids, tunicates, anemones, and algae are found on nearshore rocky reefs. Where light, temperature, and other sea conditions are suitable, luxuriant kelp beds occur, extending from the sea floor to the surface where a kelp canopy forms. These kelp beds are comprised of bull kelp, giant kelp, or combinations of both. See Kelp beds (Section II.F.2).

Most of the bottom within the study area ranges from mud to fine, hard-packed sand. These ocean sediments support a rich invertebrate fauna.

The benthic fauna of the Mainland Shelf of this region has been poorly studied, consisting of the early work of the U.S. Fisheries steamer Albatross and the four stations in each subsection of coastline taken in The Odemar, et al., 1968 survey. These studies do not add significantly to the knowledge of the benthic communities of the region.

Point Reyes to Pigeon Point. The Farallons are an important group of islands lying west of San Francisco Bay. The benthic invertebrates from this region are poorly known, although Odemar et al. presented data on the crustaceans, echinoderms and molluck collected from four stations near Piller Point.

Pigeon Point to Sand Hill Bluff. This area was also included in the study of Odemar, et al., 1968 who presented a species list from samples near Ano Nuevo.

Monterey Bay and Carmel. Monterey Bay is a broad, semi-lunar shaped bay occurring near the southern end of the cold temperate Oregonian zoogeographic province and within the Montereyan subprovince. The bay is about 30 km wide (18.6 miles) and its shelf is narrow and cut by the shoreward ends of the Monterey Canyon complex (Barnard, 1966). The headlands of the Monterey Peninsula have a rocky substrate with a long sand beach extending to the northeast. Barnard (1966) concluded that the benthic fauna is dominated by deepwater ophiuroid communities, whereas Southern California bays are dominated by shallow-water ophiuroid communities or non-ophiuroid communities. Barnard also found that the *polychaete Nothria* dominated the inshore sand bottoms in depths less than 30 m (99 feet).

Oliver and Slattery (1976) found the distribution and relative abundance of many species in Monterey Bay to be similar. The polychaete worms *Amaeana occidentalis, Nothria elegans,* and *Lumbrineris nr. luti;* and the crustaceans *Paraphoxis daboius, Euphilomedes oblonga,* and *E. carcharondonta* were characteristic of deeper stations, and were found in areas of increasing substrate stability on the ridge. The worms *Dispio uncinata, Scoloplos arminger, Onuphius erimita,* and *Paraphyoxus (sic) lucubrans;* cumaceans; and the mollusk *Olivella* were characteristic of shallow stations, and were found in areas and decreasing substrate stability. A crustacean *(Euphilomedes longiseta)*, a mollusk *(Tellina modesta),* and the sand dollar *(Dendraster excentricus)* were characteristic of stations of intermediate depths, and were found in areas of intermediate substrate stability.

The study of McLean (1962) in the Carmel area focuses on the near coast in the region of Granite Creek, which is 14.5 km (9 miles) south of Carmel. The scuba collections were made over a two-year period. Two subtidal zones were identified and described. The immediate subtidal zone (Calliathon Zone) occurs to a depth of 3m (9 feet). It has few conspicuous invertebrates.

Large sessile forms seem unable to compete for space with the dense growth of *Calliathron cheilosporiodes;* however, a few intertidal forms do occur in crevices. The abundant animals were *Eudistylia polymorpha* and the bryozoan *Hippodoplosia insculpta.*

The deeper subtidal zone *(Peterygophora Zone)* occurs beginning at 6 m (19.8 feet) is dominated by *Laminaria setchellii*. In this zone, McLean described a profusion of sponges and tunicates, such as the orange sponge *(Tethya aurantia californica)*, the anemone *Corynactis californica* and the solitary coral *Balonophyllia elegans*. Sessile animals are most abundant on vertical rock surfaces below 6 m. On the vertical granite walls are found the dark blue sponge *Hymenamphiastra cyanocruypta* and the red anemone *Tealia lofotensis*. In the *Pterygophora Zone*, the holdfasts of *L. setchelli* and *Pterygophora californica* provide important microhabitat for many small animals. The important large invertebrates are *Anthopleura xanthogrammica*, the gumboot chiton *Crypochiton stelleri* and the bat star *Patiria miniata*. *Strongylocentrotus fransiscanus*, the usually common red sea urchin was absent.

Point Sur to Point Conception. The stretch of coast from Point Sur to San Simeon is characteristic of an open coast area. The shelf is narrow, thus deep waters occur close to shore. Information concerning the area Point Sur to San Simeon is sparse. Burge and Schultz (1973) evaluated the marine fauna and flora in the vicinity of Diablo Canyon, see (Table II.E.3.C.5-1) in POCS Reference Paper No. III.

ii. Rocky Shore-Intertidal

Central California. The relative amount of rocky intertidal shoreline as compared to sandy beaches is shown in the Table II.E.3.c.ii-1.

Table II.E.3.c.ii-1

COMPOSITION OF SHORELINE IN CENTRAL CALIFORNIA
FOR SELECTED COUNTIES

	Miles		Percent	
County	Rocky Shores	Sandy Beach	Rocky Shore	Sandy Beach
Marin	34	36	49	51
San Mateo	25	31	45	55
Santa Cruz	20.5	20.5	50	50
Monterey	87	24	79	22
San Luis Obispo	54	39	58	42
Santa Barbara	26	83.5	24	76

Source: California Department Fish and Game (1973).

As evidenced from the above, much of the coast of central California is rocky, particularly compared with Southern California. With the exception of Monterey County, the coast between Point Reyes and Point Conception consists of approximately 50 percent rocky shores. Offshore rocks or stacks which also significantly increase the area available to rocky intertidal organisms.

The Monterey Bay area, particularly Pacific Grove, probably has the most productive intertidal communities in the State. This area, in fact, may be somewhat atypical of the coast of central and northern California because of its particularly lush biota.

Stephenson and Stephenson (1972) surveyed the general area, including Point Lobos and conducted a more comprehensive study at Pacific Grove, at the Hopkins Marine Laboratory and indicated the tremendous adaptation of organisms to the powerful wave shock of the area. The coast is irregular, also providing many sheltered areas where adaptation to the wave force is not so critical.

Stephenson and Stephenson summarized the vertical zonation as follows:

> The intertidal zonation of this region shows all the usual widespread features, though modified by local conditions. The supralittoral fringe has a typical population of periwinkles, limpets, and high-level isopods. Although a continuous black zone is rarely seen, irregular patches of blackening are fairly common.
>
> The midlittoral zone is markedly divided, in the more sheltered places, into upper and lower subzones. The upper of these had the usual population of barnacles and limpets, with relatively few, and mostly small, algae. The lower subzone is heavily carpeted by a dark brownish turf composed of a mixture of rather small species, primarily rhodophyceans. In many places, this turf has a sharply defined upper limit. Accompanying the turf are certain large algae. Where wave action is stronger, this turf is replaced by a pink growth of lithothamnia and corallines, or by growth of other red algae, overgrown, in places, by *Postelsia*.
>
> The infralittoral fringe is essentially a laminarian zone. In many places, it is unusual in appearance because of the steepness of the rocks, on which the laminarians, many of them very long and trailing, hang like a drapery. The holdfasts of the laminarians may continue into the lower midlittoral, particularly those of *Egregia*, whose long streamers may be seen among the lower midlittoral turf even in sheltered areas.

For a more complete coverage of this area see POCS Reference Paper No. II.

Less than 161 km (100 miles) south of Point Lobos is the Diablo Cove (Figure II.E.3.c.ii-1) area located midway on a 20.9 km (13 miles) rocky shore area separated by 16.1 km (10 miles) to the north and 48.3 (30 miles) to the south from other shores by sandy beaches. Burge and Schultz (1973) claim recruitment comes entirely from within the area itself rather than from other coastal areas. The most common intertidal invertebrates are listed in Table II.E.3.c.ii-2 (Gotshall, et al., 1974).

Information concerning the stretch of coast from Point Sur to San Simeon is limited.

Table II.E.3.c.ii-2

COMMON INTERTIDAL INVERTEBRATES
IN DIABLO COVE, CALIFORNIA

North Diablo Cove Intertidal Area - Protected

Epiactis prolifera
Pugettia producta
Fissurella volcano volcano shell limpet
T. funebralis & brunnea
Henricia leviuscula

North Control Intertidal Area - Semi-protected

Epiactis prolifera
Acmaeids
T. funebralis & brunnea
Fissurella volcano
Holiotis cracherodii
M. californianus

Source: Gotshall, et al., (1974)

iii. Sandy Beach Intertidal: In 1968, the California Department of Fish and Game undertook a survey of the marine environment from Fort Ross, Sonoma County to Point Lobos, Monterey County (Odemar, et al., 1968).

Sandy beaches of the protected outer coast were rather barren of intertidal life. They are not colonized by the animals of the surf-swept open beaches, as these animals probably will not tolerate the more sheltered conditions.

Three species are characteristic for this habitat. They are: 1) the giant beach hopper, (*Orchestoidea corniculata*), 2) a smaller beach hopper, (*O. bendicti*), and 3) a lugworm, (*Arenicola*). Mole crabs, various species of polychaetes, and clams were also found.

The sandy beaches of the open coast, while not as barren as the smaller, protected beaches of the outer coast, were still not as densely populated as rocky shores.

The most characteristic inhabitants of these beaches were the great beach hopper, the mole crab, *Emerita analoga*, the Pismo clam, *Tivela stultorum* and a razor clam (*Siliqua patula*). Other forms include isopods and worms.

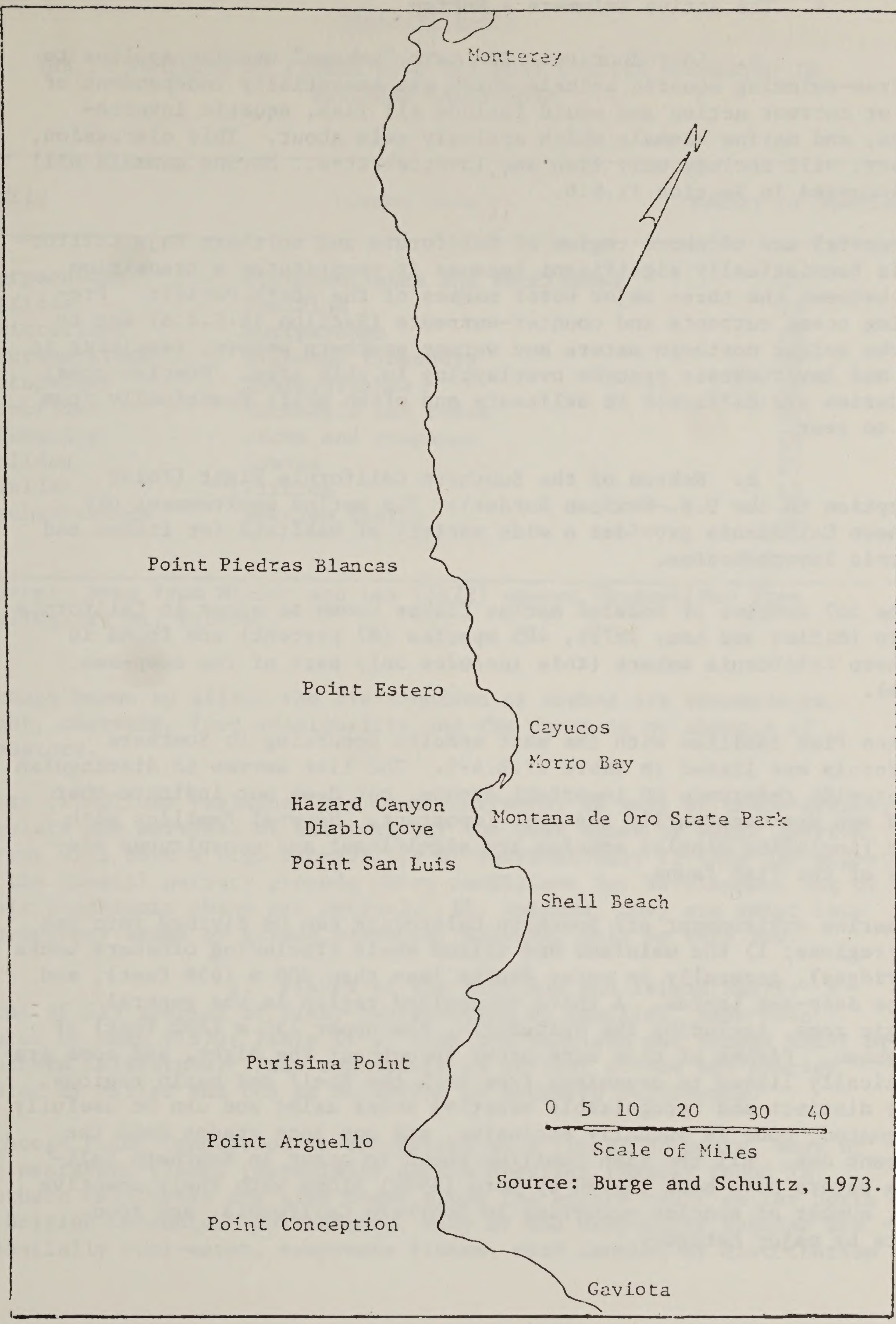


Figure II.E.3.c.ii-1 California Shoreline from Monterey to Santa Barbara

4. The Active Swimmers - Nekton

a. Introduction: The term "nekton" usually applies to all free-swimming aquatic animals which are essentially independent of wave or current action and would include all fish, aquatic invertebrates, and marine mammals which actively swim about. This discussion, however, will include only fish and invertebrates. Marine mammals will be discussed in Section II.E.6.

The coastal and offshore region of California and northern Baja California is faunistically significant because it constitutes a transition zone between the three major water masses of the north Pacific. Prevailing ocean currents and counter-currents (Section II.C.2.a) act to mix the colder northern waters and warmer southern waters, resulting in fish and invertebrate species overlapping in this area. Precise zonal boundaries are difficult to delineate and often shift drastically from year to year.

b. Nekton of the Southern California Bight (Point Conception to the U.S.-Mexican Border): The marine environment off Southern California provides a wide variety of habitats for fishes and nektonic invertebrates.

Of the 562 species of coastal marine fishes known to occur in California waters (Miller and Lea, 1972), 485 species (87 percent) are found in Southern California waters (this includes only part of the deep-sea fauna).

The ten fish families with the most species occurring in Southern California are listed in Table II.E.4-1. The list serves to distinguish and provide reference to important groups, but does not indicate that these ten are necessarily the most important. Several families with fewer (including single) species are significant and conspicuous elements of the fish fauna.

The marine environment off Southern California can be divided into two main regions; 1) the mainland and island shelf (including offshore banks and ridges), generally in water depths less than 200 m (656 feet), and 2) the deep-sea basins. A third recognized region is the general pelagic zone, including the epipelagic, the upper 150 m (492 feet) of the ocean. Fishes of this zone occur throughout the Bight, and some are trophically linked to organisms from both the shelf and basin regions. While distinct and recognizable adaptive zones exist and can be usefully designated, none is mutually exclusive, and one zone grades into the adjacent one. All the fish families known to occur in Southern Califonia waters have been listed by Horn (1974) along with their adaptive zone, number of species occurring in Southern California, and food habits by major category.

Table II.E.4-1

THE 10 FAMILIES OF FISHES WITH THE MOST SPECIES OCCURRING IN SOUTHERN CALIFORNIA

Family	Common Name	Number of Species
Scorpaenidae	Scorpionfishes and rockfishes	55
Cottidae	Sculpins	34
Embiotocidae	Surfperches	18
Pleuronectidae	Righteye flounders	18
Myctophidae	Lanternfishes	16
Scombridae	Mackerels and tunas	14
Carangidae	Jacks and pompanos	13
Gobiidae	Gobies	13
Clinidae	Clinids	12
Carcharhinidae	Requiem sharks	12

Source: Data from Miller and Lea (1972) except Myctophidae from Ebeling, et al. (1970b).

Factors known to affect the distribution of fishes are temperature, light, currents, food availability and the presence or absence of predators.

Sette (1960) has explained how ocean currents, as well as temperatures, regulate the survival of sardines off the west coast of North America. Larvae will have a high probability of survival only if they can migrate to the coastal nursery grounds where conditions for development out of their planktonic phase are optimal. If, instead, they are swept into non-nursery areas by strong currents, survival will be very low.

i. Fishes of the Mainland and Island Shelf: A total of 213 species of fish, representing 66 families, have been listed by Horn (1974; Table II-4) from the mainland and island shelf of Southern California. This represents 44 percent of the 485 species listed by Miller and Lea as occurring in Southern California.

Although Point Conception is recognized as a faunal boundary, many of the nearshore fishes (especially bottom-dwelling fishes) found in Southern California are also found along the entire coast as far north as British Columbia. Furthermore, many of the deep-water species are essentially cool-water, temperate fishes, with centers of distribution lying to the north of the Southern California Bight. Therefore, a distinct Southern California fauna does not occur below the thermocline or in the deeper waters of the coastal shelf (SCCWRP, 1973).

A review of recent data by Allen and Voglin (1976) of the Southern California Coastal Water Research Project (SCCWRP) suggests that fish abundance, biomass, numbers of species, and diversity increase in the Southern California Bight as one approaches San Pedro Bay from Santa Barbara in the north and San Diego in the south. Although these regional differences in abundance and diversity are felt to be "real" they are also felt to reflect differences in gear and fishing techniques (Allen and Voglin, 1976).

Based upon the results of 303 collections made by SCCWRP during a trawl survey between 1969 and 1972, Dover sole (*Microstomus pacificus*) was the most frequently occurring species off Palos Verdes and in San Pedro Bay, hornyhead turbot (*Pleuronichtthys verticalis*) was most frequent at Port Hueneme, speckled sanddab (*Citharichthys stigmaeus*) and plainfin midshipman (*Porichthy notatus*) in Santa Monica Bay, and Pacific sanddab (*Citharichthys sordidus*) the most frequently encountered off Santa Catalina Island. Generally, each area seemed to be characterized by certain principal species.

The most abundant fish in the SCCWRP sample was the speckled sanddab followed by the Pacific sanddab, the dover sole, and the stripetail rockfish (*Sebastes saxicola*). Together, these four species accounted for almost 50 percent of all the coastal fishes captured in the 303 SCCWRP trawls. Twenty species accounted for slightly over 90 percent of all fishes captured.

Differences in frequency and abundance ranking found in the SCCWRP survey indicate that certain species are not uniformly distributed over the shelf but occur in distinct concentrations.

In their analysis of over 2,400 samples taken between Santa Barbara and San Diego and near some of the offshore islands, Allen and Voglin (1976) found the greatest diversities between Palos Verdes and Dana Point (San Pedro Bay) with the lowest occurring to the north off Oxnard and to the south off Point Loma. However, as they point out, the data for each area were collected at different seasons with different combinations of vessels and trawling gear. Thus, firm conclusions can not yet be drawn on interareal diversity.

Using recurrent group analysis, SCCWRP (1973) recognized a set of species groups of nearshore bottom-dwelling fishes. The analysis showed that about one-fifth of the 121 species captured in the 1969-1972 surveys appeared in statistically significant associations. The groups are listed in Figure II.E.4-1, the first species named in each group list being the dominant member of the group. The distributions of the five recurrent groups were all within Santa Monica and San Pedro Bays.

The groups may or may not represent complete fish communities since the data were collected by a single method, trawling (in the daytime only), which has an apparent selectivity for smaller and less mobile species. However, the recurrent group analysis completed by SCCWRP does, at a minimum, identify species that are very frequently found together in nature and that, therefore, apparently select similar environmental conditions. Similar recurrent group analyses are not available for other particular habitats in the shelf environment.

In an examination of soft-bottom fish communities Allen (1974) has shown that species living together usually fill different feeding roles.

The feeding role is thought to be an ecological unit above the species level and is important to an understanding of community organization, one that is sensitive to nutrient-related environmental differences (Allen, 1975). The major feeding roles of soft-bottom fishes of Southern California are shown in Figure II.E.4-2. The relative abundance of these feeding roles in each of three geographic locations in Southern California are shown in Figure II.E.4-3. Figure II.E.4-4 shows the relative abundance of species filling the sanddab feeding role as depth increases.

The northern anchovy (*Engraulis mordax*) occupies a central and important position in the trophic structure of Southern California waters. They are a pelagic schooling fish and one of the most abundant species in the region. They have been considered to be indiscriminate, chiefly daytime, filter feeders accepting either zooplankton or phytoplankton but also feeding on small fishes (Frey, 1971). However, Loukashkin (1970) showed that zooplankton was usually far more abundant than phytoplankton in anchovy stomachs and concluded that large copepods and euphausiids were the most important food items. Anchovies, along with squids, red crabs and lantern fishes are preyed upon heavily by most predatory species in California waters (Frey, 1971). Pinkas, Oliphant, and Iverson (1971) concluded that the role of the northern anchovy is singularly outstanding as the dominant food item for three important sport and commercial fishes (Pacific bonito, albacore, and bluefin tuna) along the Southern California coast.

Leong and O'Connell (1969) found that the anchovy fed on small planktonic larval crustaceans (nauplii) by filtering, but captured the larger adults (greater than 3.7 mm or 0.14 inch long) individually by directed biting (particulate feeding) when each food was presented separately. Food biomass was accumulated more rapidly by biting than filtering.

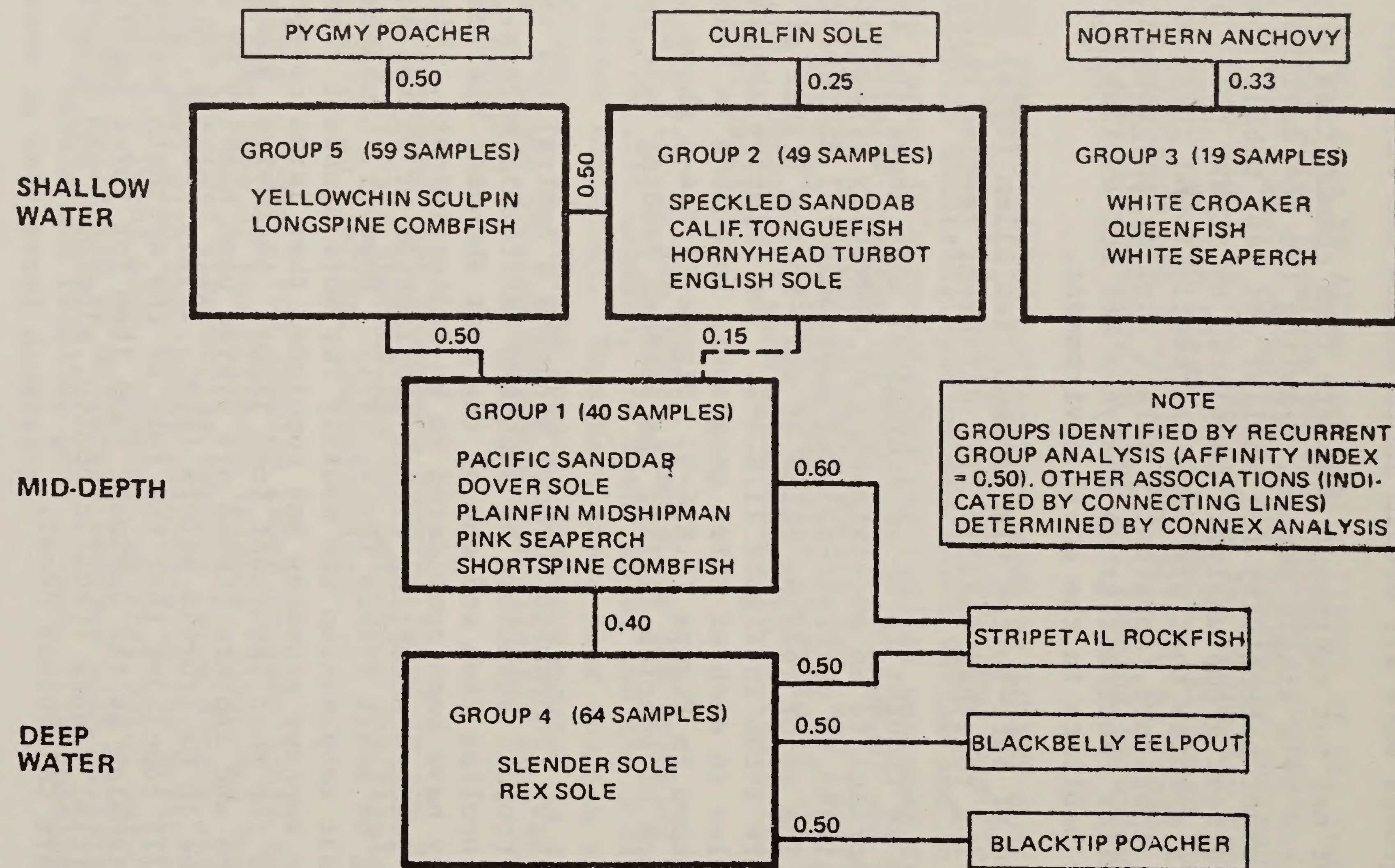


Figure II.E.4-1 Species associations of Southern California nearshore benthic fishes during a study by the Southern California Water Research Project, 1969-1972 (adapted from Mearns, 1974).

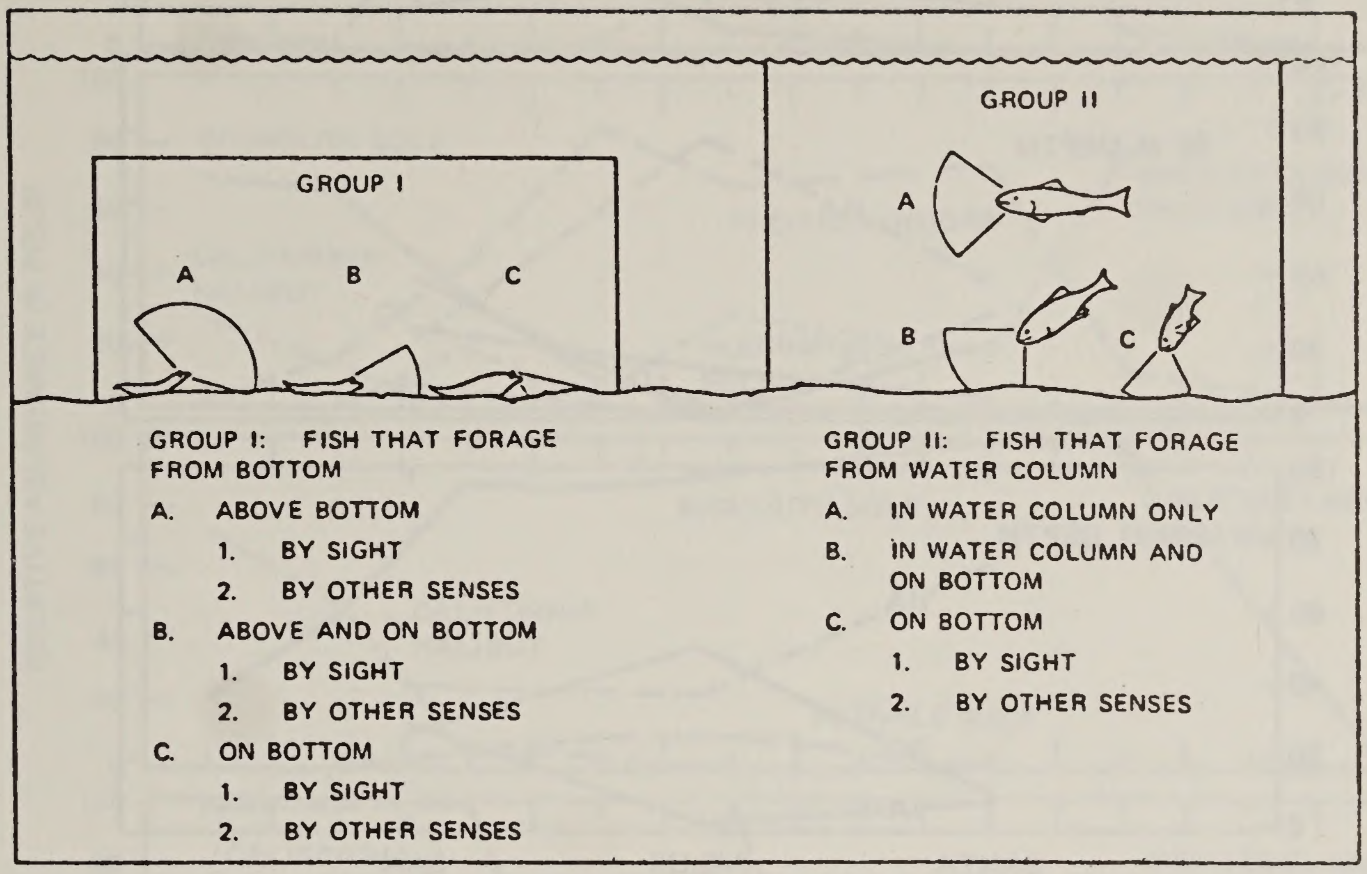


Figure II.E.4-2 General types of demersal fish foraging behavior (Source: Allen, 1975).

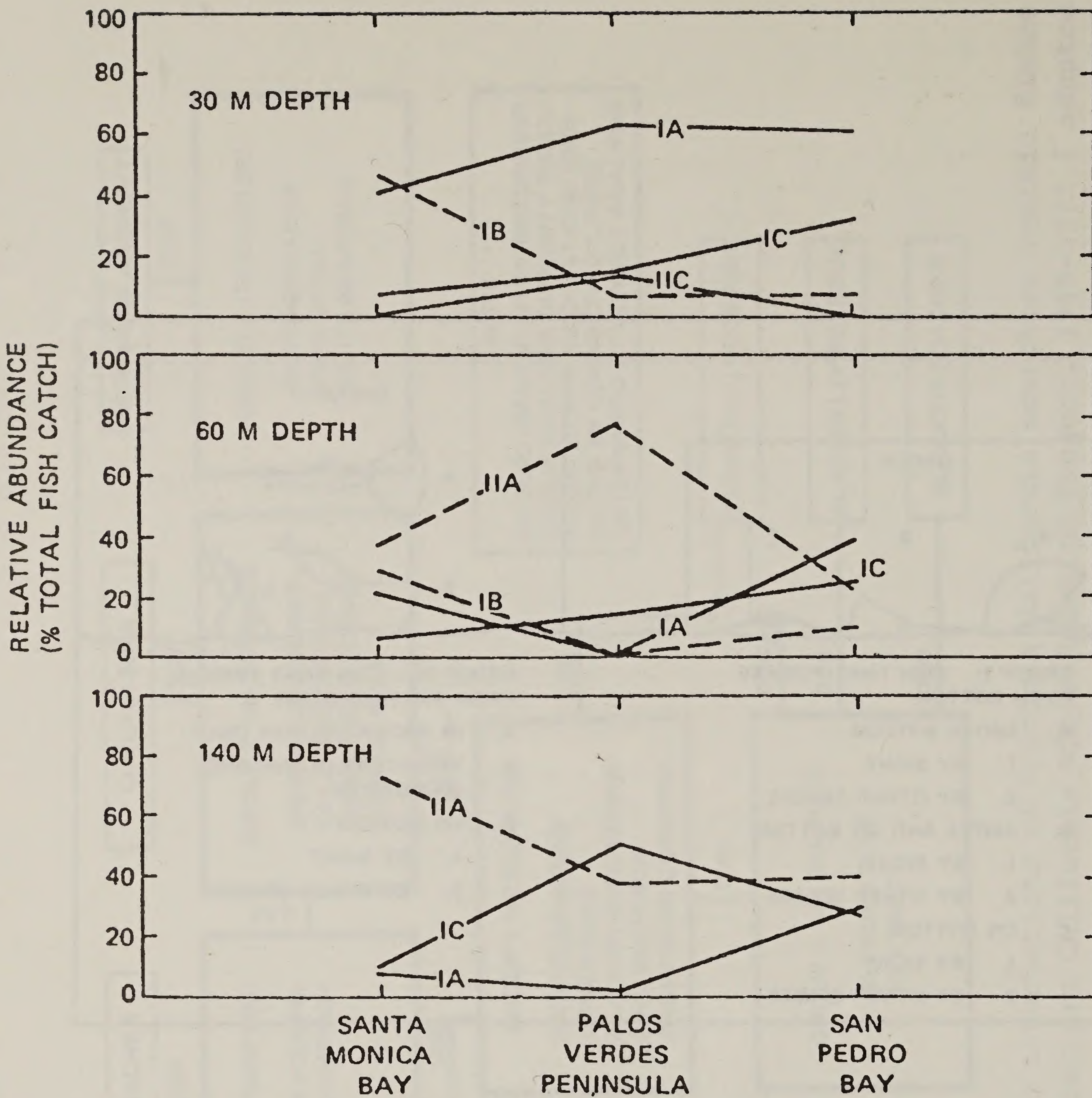


Figure II.E.4-3 Relative abundance of demersal (benthic) fish feeding roles in each of three geographic regions in Southern California (IA, IIA, etc. refer to groups in Figure II.E.4-2: Source; Allen 1975).

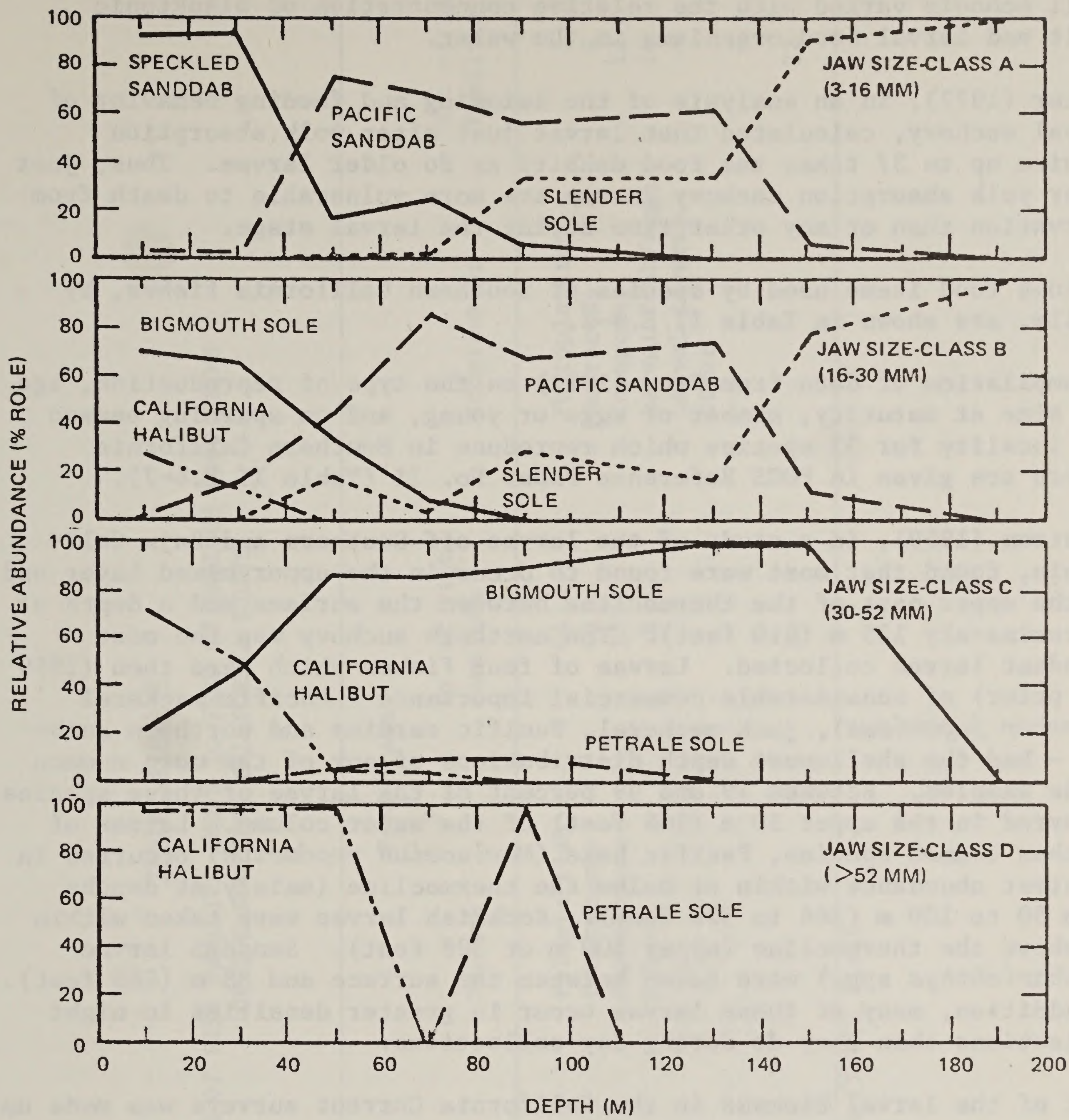


Figure II.E.4- 4 Depth distribution of species filling the sanddab feeding role in Southern California coastal waters (Source: Allen, 1974).

O'Connell (1972) found that the ratio of biting to filtering activity in small schools varied with the relative concentration of planktonic adult and larval food organisms in the water.

Hunter (1972), in an analysis of the swimming and feeding behavior of larval anchovy, calculated that larvae just after yolk absorption require up to 37 times the food density as do older larvae. Thus, just after yolk absorption anchovy larvae are more vulnerable to death from starvation than at any other time during the larval stage.

Various food items used by species of Southern California fishes, by family, are shown in Table II.E.4-2.

A compilation of data from Frey (1971) on the type of reproduction, age and size at maturity, number of eggs or young, and on spawning season and locality for 33 species which reproduce in Southern California waters are given in POCS Reference Paper No. II (Table II.E.4-7).

Ahlstrom (1959), in a study of the larvae off Southern and Baja California, found that most were found to occur in the upper mixed layer and in the upper part of the thermocline between the surface and a depth of approximately 125 m (410 feet). The northern anchovy was the most abundant larvae collected. Larvae of four fishes which were then (1959 and prior) of considerable commercial importance - Pacific mackerel (*Scomber japonicus*), jack mackerel, Pacific sardine and northern anchovy - had the shallowest depth distributions of any of the more common kinds sampled. Between 79 and 99 percent of the larvae of these species occurred in the upper 50 m (164 feet) of the water column. Larvae of another common species, Pacific hake (*Merluccius productus*) occurred in greatest abundance within or below the thermocline (mainly at depths from 50 to 100 m (164 to 328 feet). Rockfish larvae were taken within or above the thermocline (upper 100 m or 328 feet). Sanddab larvae (*Citharichthys* spp.) were taken between the surface and 88 m (288 feet). In addition, many of these larvae occur in greater densities in night collections than they do during day collections.

Most of the larval biomass in the California Current surveys was made up of only about 25 species.

Generally, because of their pelagic existence, larval occurrences of many Southern California fish species are widespread throughout the Bight and waters off northern Baja.

Kelp Beds: Southern California kelp beds provide a distinct and important habitat for fishes and generally encourage the development of a rich associated fauna. Kelp serves as a food source, as shelter, and an attractant for fishes, but was found generally not to be a habitat

Table II.E.4-2

NUMBER OF FISH FAMILIES KNOWN TO FEED ON VARIOUS FOOD ITEMS OF THE SOUTHERN CALIFORNIA BIGHT

Food Items					
Benthos	No. of Fish Families	Nekton	No. of Fish Families	Zooplankton	No. of Fish Families
Algae	11	Pelagic fish	44	Phytoplankton	1
Demersal fish	32	Crustaceans	40	Ostracods	4
Mollusks	23	Cephalopods	17	Copepods	12
Crustaceans	38	Other	8	Larval fish/eggs	14
Polychaetes	20			Larval inverts.	6
Echinoderms	9			Other	7
Other	5				
Total	54		64		22

Source: Adapted From Horn, 1974 (Table 11-3).

requirement nor did it increase species diversity significantly. It does contribute to greater standing crops of fishes, but bottom topography was considered a more important attractant.

Fifty-seven fish species have been recorded associated with kelp beds, and a mean value for standing crop of resident kelp-bed fishes has been estimated at 350 kg/ha (313 pounds/acre) (Quast, 1968b and c).

Kelp bass (*Paralabrax clathratus*), California sheephead (*Pimelometopon pulchrum*), and blacksmith (*Chromis punctipinnis*) were the most frequently encountered species in kelp beds of the San Diego region, while near Point Conception, off Gaviota, kelp bass, topsmelt (*Atherinops affinis*), and kelp perch (*Brachyistius frenatus*) predominated. Within the Southern California area community dominance changes geographically, the kelp bass being the only dominant species at both northern and southern extremes of the area.

Quast (1968c and d) made an extensive study of the food habits of 45 species of kelp-bed fishes. Based on a utilization index he calculated the five main food items of kelp-bed fishes as: 1) gammarid amphipods, 2) crabs, 3) algae, 4) shrimp other than pistol shrimp, and 5) polychaetes. Thirty-three other food categories were also listed.

Bays and Estuaries: The bays and estuaries considered here are those with restricted openings to the ocean (semi-enclosed) and include Mission Bay, Newport Bay, Anaheim Bay and Alamitos Bay. These are distinguished from the more open coastal bays such as San Pedro Bay and Santa Monica Bay which are included as part of the mainland shelf proper.

Although the semi-enclosed bays and estuaries are in proximity to human activity and generally considered to be important as nursery grounds for larval fishes, surprisingly little information is available on their fish fauna. Data on distribution, seasonality, trophic relationship, reproduction, and relative importance as nursery grounds are scattered and incomplete. The extent of information is largely represented by tentative species lists.

Man-Made Habitats: The Southern California marine region is adjacent to a major population center, and in the course of human activity both accidental and deliberate processes have either provided habitats previously absent or have altered existing ones.

Harbors formed by breakwaters constructed of rock or other hard material slow the water movement and affect other changes which make them in some ways similar to semi-enclosed natural bays (i.e., protected from the open ocean) and which makes it possible to recognize them as distinct fish habitats. Two harbor areas in Southern California are significant in this regard. These are King Harbor at Redondo Beach and Los Angeles-Long Beach Harbor.

Studies based on five years of diving observations show that King Harbor is extremely rich in numbers of species. It has been suggested that much of the faunal richness may be associated with thermal diversity supplementing the newly created man-made heterogeneity of the harbor (Stephens, 1972). The varied temperature regime is due to hot water effluent from the Edison plant and cold upwelling from Redondo Canyon.

Based on 76 trawls made in the Los Angeles-Long Beach harbor, Stephens, et al., (1974) found that the fish density was the highest recorded locally (one fish/8.9 m^2 {95.6 ft^2}) and that diversity and richness approximated values recorded for similar depths outside the harbor. Anchovies and young white croakers made up 69 percent of the catch and their abundance (both plankton feeders) probably reflects the nutrient enrichment of the harbor. Stephens, et al., (1974) estimated the standing crop of fishes in the harbor to be between 700,000 and 1,600,000 kg (1,543,220 to 3,527,360 pounds) and the annual productivity at 56 percent of the standing crop.

Other Artificial Structures: Carlisle, Turner, and Ebert (1964) in a period from May 1958 to December 1960, observed a total of 86 species of fish around a variety of artificial structures including offshore oil drilling installations and reefs composed of deliberately placed car bodies, a streetcar, quarry rock, and concrete shelters. All structures appeared to serve as fish attractants. Populations grew from a few scattered fishes to several thousand semi-residents. Deeper water towers attracted pelagic schooling fishes and several species of rockfish not associated with the inshore areas. Typical species of inshore sites were kelp fishes, croakers, and small sharks. In both areas surfperches were the dominant fishes. Generally, changes in habitat brought about by establishing offshore oil drilling installations were beneficial in that they served to attract fishes. However, fish populations at the artificial sites increased rapidly for the first year and then exhibited fluctuations apparently correlated to temperature, season, or other natural factors (Carlisle, Turner, and Ebert, 1964).

Turner, Ebert, and Given (1969) studied artificial reefs composed of quarry rock, a streetcar, 14 automobile bodies and 44 concrete shelters over a period from August 1960 to January 1965. Concrete shelters attracted the largest number of fishes. Surfperches and serranid basses were dominant during the first two years of reef life and, with time, decreased in dominance while resident species such as cottids, gobies, damselfish and others increased. Within about five years a natural situation was reached and the plant and animal populations exhibited fluctuations typical of reef ecosystems. The authors concluded that the artificial reefs can be made into productive fishing areas with fishing success on the reefs two to three times that recorded for nearby natural reef areas.

The locations of existing artificial reefs within the Southern California Bight are illustrated in Figure II.E.4-5.

ii. Fishes of the Deep-Sea Basins: The deep-sea fishes are members of a rather distinctive fauna which live part or all of their lives in waters several hundred to thousands of meters deep. These "deep-sea" fishes are generally small (300 mm or 11.8 inches long, or less), black or dark with silvery reflective sides and frequently with luminescent organs.

The heterogeneity and transitionality of the Southern California deep-water environment result in a relatively diverse fish fauna for the region. Horn (1974) lists 30 families and 93 species of midwater or deep-sea fishes. To arrive at a single, reliable figure for the number of species of deep-sea fishes is both difficult and somewhat artificial because of the transitional and dynamic character of the environment and its fish communities.

Fitch and Lavenberg (1968) felt that two deep-sea families, the Myctophidae and Gonostomatidae, are the two most abundant fish groups in the world oceans. This generalization probably holds for Southern California waters as well. The five principal deep water families for the region in terms of numbers of species are: 1) Myctophidae (lantern fishes), 16 species; 2) Melamphaidae (bigscales), 9 species; 3) Sternoptychidae (Hatchetfish), 7 species; 4) Gonostomatidae (Lightfish), 6 species; and 5) Bathylagidae (deep-sea smelts), 5 species. The species most frequently encountered by Ebeling, et al., (1970a; 1970b) were *Leuroglossus stilbius*, a mesopelagic bathylagid, and two mesopelagic myctophids, *Stenobrachius leucopsarus* and *Triphoturus mexicanus*. Paxton (1967) also concluded that *S. leucopsarus* and *T. mexicanus* were the predominant myctophids in his study.

Based on studies of larval distribution and abundance in the California Current region, Alhstrom (1955, 1965, 1969) has shown that three deep-sea pelagic families, the Bathylagidae, Gonostomatidae, and Myctophidae, contribute significantly to the total of all fish larvae collected. In a summary of relative abundance of larvae in 1955-1958 CALCOFI surveys (Ahlstrom, 1965), four deep-sea species in the above three families consistently ranked among the 12 most abundant larvae collected.

In a distributional analysis of 14 species of lanternfishes (*Myctophidae*) in the San Pedro Basin, Paxton (1967) recognized five distributional patterns. He indicated that temperature and light were the most

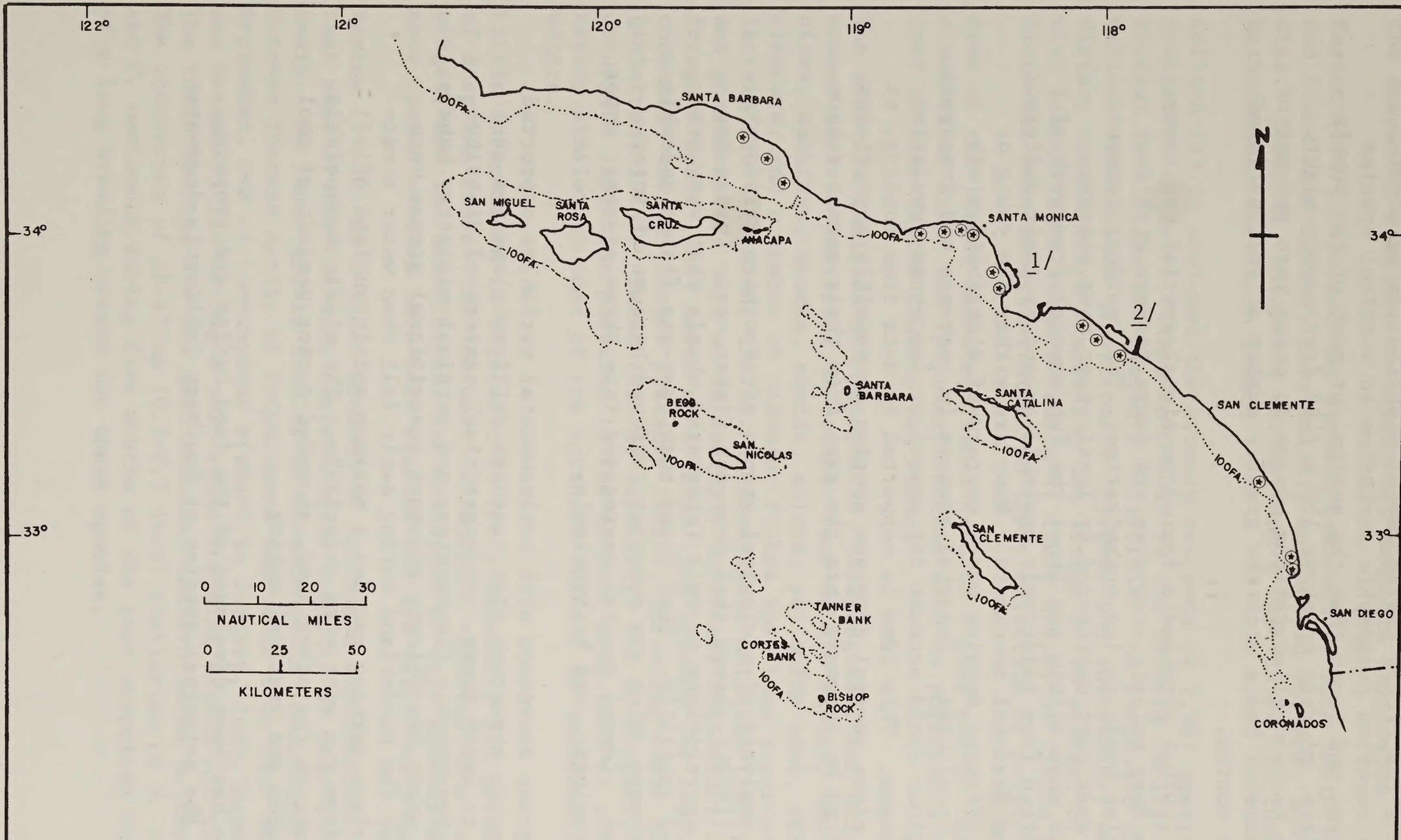


Figure II.E.4- 5 Artificial fishing reefs located within the Southern California coastal area. 1/ a total of 4 reefs occur between Hermosa Beach and Redondo Beach (approx. 3½ miles distance); 2/ a total of 4 reefs occur off of Huntington Beach (approx. 2 miles distance). Depth ranges from 40 - 120 feet (Source: Calif. Dept. Fish Game, Artificial fishing reefs chart, 1977).

important ecologic determinants of vertical distribution and that the shallow thermocline restricted the nocturnal distribution of eight species. He also reported geographic variation in vertical species composition patterns and found that the entire, or most of the populations of ten species, migrate to above 150 m (492 feet) every night. Active or passive horizontal migrations appear to occur into and out of the basin on a seasonal basis with the greater number of species found during the winter months.

Ebeling, et al., (1970a) proposed a four-dimensional spatial and temporal model of the deep pelagic ecosystem off Santa Barbara with four resident communities basic to its organization. The resident communities are for the most part unaffected by local water mass changes. Transitory species move within and about the fundamental framework of communities and often form relatively unstable groups by their different kinds of daily and seasonal movements. Many are either the young of shelf species or offshore species whose centers of distribution are distant from the local area. Seasonal changes in currents and transport from outlying regions could account for annual or long-term population and community changes. This idea is supported by data from Ebeling, et al., (1970b) who cites several deep-sea species as possible expatriates (i.e., fishes wafted by currents into the area from their normal reproductive ranges).

In a statistical analysis of ecological groups off Southern California Ebeling, et al., (1970b) showed that deep-sea fishes occur in patches either as random aggregations or well integrated shoals that vary temporally as well as spatially. They found that deep-sea fishes assemble into ecological groups which are somewhat confused because of interaction and overlap. Common species segregated into three groups: upper mesopelagic, mesopelagic, and bathypelagic.

Correlations of group abundance with environmental variables supported inferences from group structure that Southern California species assemble according to depth zones, zoogeographical centers of distribution, seasonal oceanographic fluctuations and vertical migratory behavior. Members of upper mesopelagic offshore transitional groups were most abundant over the borderland during early fall when water stratification and surface warming reached a maximum and intrusions of tropical waters from the west were detectable. The middle mesopelagic transitional group, on the other hand, abounded during periods of cool surface temperatures and vertical mixing.

A general picture has been developed of the food habits and trophic relationships of the principal species of Southern California deepwater fishes.

Table II-3 in Horn (1974) includes the food habits by major category of the deepwater families occurring off Southern California.

Paxton (1967) examined the stomach contents of nine lanternfish species and found crustaceans, particularly euphausiid shrimps, made up the main diet. Copepods, sergestid shrimp, and a few fishes (including two bathylagids) were also found.

Collard (1970) analyzed the stomach contents of 1,087 specimens of 42 species of midwater fishes collected in the Eastern Pacific including several localities off Southern California. He concluded that although various crustaceans (principally copepods and euphausids) were the major dietary constituents comprising the forage of 95 percent of all specimens with identifiable stomach contents, these deepwater fishes had diverse diets and were nonpreferential in their selection of prey.

Some of the larger midwater fishes feed on fishes and/or cephalopods and a number of shelf and epipelagic fishes such as rockfishes and tunas feed to some degree on deep-sea fishes.

The deep-sea families of Myctophidae, Bathylagidae, and Gonostomatidae assume central positions in oceanic food webs. Whales, seals, porpoises, seabirds, sharks, squids, salmon, yellowfin tuna, skipjack tuna, albacore, and a number of midwater fishes have been reported to prey on lanternfishes (Paxton, 1967b). According to Ahlstrom (1969), myctophids and gonostomatids fill an exceedingly important ecological role as forage fishes. They serve as a vital link between the zooplankton community and the larger predator fishes, including tunas and billfishes (Ahlstrom, 1969). These fishes, especially the myctophids, appear to occupy an important position in the trophic structure of offshore, basin waters similar to that of the northern anchovy in shallower, inshore waters.

Little information is available on the prespawning and spawning behavior of deep-sea fishes off Southern California. However, the development stages, and the distribution and abundance of eggs and larvae of the more common species have been studied and are fairly well known.

Paxton (1967b) in a brief account of myctophid reproduction, indicated that nine of the resident lanternfishes breed in or near the San Pedro Basin. He found gravid females of *Stenobrachius leucopsarus* from October through April, of *Triphoturus mexicanus* from June through September, and of *Lampanyctus ritteri* in January, June, August, October and December, indicating a year-round breeding season for the species. The three species are the most abundant lanternfishes in the basin. The occurrence of 15-17 mm (0.5-0.7 inch) postlarvae of *S. leucopsarus* and *T. mexicanus* during five months of the year supported the hypothesis of a long breeding season for these species.

In terms of percentage contribution to total number of larvae collected in surveys off California and Baja California, the most abundant lanternfishes were *Triphoturus mexicanus* (36.9%) *Stenobrachius leucopsarus* (22.7%), *Diogenichthys laternatus* (12.0%) and *Lampanyctus ritteri* (4.6%) (Moser and Ahlstrom, 1970). For strictly Southern California waters, Moser and Ahlstrom showed that in terms of average occurrence the principal myctophid larvae were *S. leucopsarus* (40.6%) *Protomyctophum crockeri* (23.9%), *L. ritteri* (23.0%), *T. mexicanus* (22.2%), and *Tarletonbeania crenularis* (15.2%). *S. leucopsarus* was the most abundant lanternfish larvae in Southern California.

Ahlstrom (1965) showed that four lanternfishes, *S. leucopsarus, T. mexicanus, L. ritteri,* and *T. crenularis*, the gonostomatid, *Vinciguerria lucetia*, and the bathylagid, *Leuroglossus stilbius*, all had parts of their larval distribution in Southern California waters. Of these species, *L. stilbius* had the highest concentration of larvae in the region.

The deep-sea pelagic fishes commonly have their eggs and larvae distributed in the upper 150 m (492 feet) of the water column providing, along with daily vertical migration, an ecological link with other adaptive zones in Southern California waters. Ahlstrom (1959) found that lanternfish larvae were seldom taken in the upper 23 m (75 feet). Ahlstrom also showed that about one-ninth as many larvae were taken in the 131 to 262 m (429 to 859 feet) interval as in the 0 to 131 m (0 to 429 feet) interval.

iii. Pelagic Fishes: Table 11-11 in Horn (1974) provides a mixed list of 80 species in 30 families, all of which are pelagic to a certain degree in Southern California. Because they frequently occur in more than one of the adaptive zones or habitats discussed above, no strict categorization has been made. The Southern California Bight offers both nearshore (coastal) and offshore (high seas) environments and the habitat diversity is partially illustrated in this list of fishes. More than 50 percent of the 80 species listed by Horn (1974) are rare, and almost 75 percent are either rare or uncommon based on an occurrence evaluation of common, uncommon, and rare by Miller and Lea (1972).

An airborne monitoring system has recently been used to assess the abundance of some pelagic fishes off Southern and central California (Squire, 1972). Pacific bonito (*Sarda chiliensis*), and yellowtail (*Seriola dorsalis*), were observed in greater frequency and quantity during the day whereas the northern anchovy, jack mackerel, and Pacific mackerel (*Scomber japonicus*), were observed in greater frequency and quantity at night. Pacific barracuda (*Sphyraena argentea*) was observed in greater quantity at night but more frequently during the day. The study also showed that between 1963 and 1969 indices of apparent abundance declined for jack mackerel, Pacific mackerel, Pacific sardine, Pacific bonito, Pacific barracuda, and yellowtail but increased slightly for the northern anchovy. The index was found to closely follow estimates of total abundance for the Pacific mackerel, a species for which reliable estimates of total abundance are available.

In 1966, the California Department of Fish and Game began routinely surveying the smaller pelagic fish resources off Southern and Baja California. A report of these surveys from 1966 through 1973 has been given by Mais (1974). Results showed that the northern anchovy by far dominates all other species in terms of biomass (2 to 6 million tons) and abundance, with the Southern California-Northern Baja California area containing the bulk of the resource (about 65%). The greatest concentrations occur within 20 miles of the mainland coast between San Diego and Santa Barbara. Behavior and availability studies of the anchovy indicate its vulnerability to commercial fishing varies from year to year as well as seasonally, and the common schooling behaviors are unfavorable for effective harvest using current methods (see Section II.G.1.d.i). As a result, only a small portion of the total population is harvestable at any particular time (Mais, 1974). These surveys also found the distribution of jack mackerel to be patchy, with nearly all significant concentrations located at a limited number of rocky banks (Cortes Bank) and island coasts (Santa Catalina and San Clemente Islands).

As mentioned earlier, many of the pelagic fishes inhabiting Southern California waters migrate between various parts of the Pacific Ocean, or at least wander extensively throughout the Bight. The northern anchovy, for example, has been found to migrate northward from Southern California to Monterey Bay. Southward migrations apparently occur from San Francisco Bay, Monterey Bay, and Morro Bay into the Bight, and from the Bight to the coastal waters off northern Baja California (Messersmith, 1969). Albacore migrate in a circum-pacific pattern between the eastern and western Pacific margins.

iv. Nektonic Invertebrates: Many of the larger planktonic invertebrates, particularly crustaceans, have such well-developed swimming abilities that they border on being nektonic. These major groups, including the cephalopods, euphausids and decapods, are covered in Section II.E.2.

Another group of invertebrates which do not exactly fit into the neat plankton-nekton-benthos classification are those (epibenthic or demersal) which spend much of their time associated with the bottom, but part of their time, often during the night, in the water column as weakly swimming nekton. Many species fit into this category, particularly mysids and representatives of other crustacean groups. True nektonic invertebrates are less well studied and well known than are the fishes. Borderline or true nektonic invertebrates of commercial or recreation importance in California and which occur in Southern California waters are: Ocean shrimp, *Pandalus jordani*; Bay shrimp, *Crago* spp.; Spot prawn, *Pandalus* spp.; Pelagic red crabs, family Galatheidae; and market squid, *Loligo opalescens*.

Most important to the pelagic ecosystem, however, are pelagic red crabs belonging to the decapod family, Galatheidae. In the recent pelagic surveys conducted by the Department of Fish and Game, this species was shown to represent the longest latent resource readily harvestable (Mais, 1974). However, most of this resource is located in Mexican waters within 12 miles of the western coast of Baja California. Occasionally, strong counter currents (such as the Davidson) bring large quantities of these crabs north of their normal range. The center of abundance appears to be between Cedros Island and Magdalena Bay, Baja California (Mais, 1974).

c. Nekton of Northern Baja California (U.S.-Mexican Border to Punta Eugenia): The marine environment off northern Baja California is somewhat different from that of Southern California. The continental shelf is relatively narrow and deep basins, such as those characteristic of the Bight, are lacking.

A wide variety of contrasting environments occur in close proximity to each other, offering an opportunity for species mixing that would not ordinarily occur. In the vicinity of Ensenada, cold-water species occur which are perhaps more characteristic of central California than Southern California. However, in other areas of northern Baja warm-temperate species common to Southern California are abundant. Subtropical species generally appear in increasing numbers south of San Quintin Bay while the southern part of Vizcaino Bay is almost entirely subtropical in composition (North, 1976).

Unfortunately, detailed information describing the nekton of northern Baja California is scarce. Most of the information available for the area has been obtained through surveys of the California Cooperative Fisheries Investigations (CALCOFI) or through California Department of Fish and Game commercial or sport fishing catch records for this area.

Generally, most of the major fish and invetebrate nekton of the northern Baja coastal and offshore areas have been discussed in the preceding section.

d. Nekton of Central California (Point Conception to Point Reyes): The central California shelf is relatively narrow, barely more than 2 km (1.24 miles) wide in some places and extending to over 40 km (24.85 miles) wide in others. Deep-sea basins are lacking, although several submarine canyons impinge upon the shelf which, along with the occurrence of the continental slope relatively nearby, result in a somewhat extensive deep-sea fauna.

Of the 562 species of coastal marine fishes known to occur in California waters (Miller and Lea, 1972 plus 1976 addendum) 396 species, in 118 families, are found in central California waters. This does not include, however, the many deep-sea fishes which are found along the continental slope.

The ten fish families with the most species occurring in central California waters are listed in Table II.E.4-3. Like Southern California, several families with fewer species are significant faunal elements (i.e., *Eugranlidae* (anchovies), *Salmonidae* (salmon and trout), *Scombridae* (tuna)).

Table II.E.4-3

THE TEN MOST SPECIOSE FAMILIES OF FISHES IN CENTRAL CALIFORNIA

Family	Common Name	Number of Species
Scorpaenidae	Scorpionfishes and rockfishes	57
Cottidae	Sculpins	41
Myctophidae	Lanternfishes	21
Pleuronectidae	Righteye flounders	18
Embiotocidae	Surfperches	18
Cyclopteridae (Liparidae)	Snailfish	16
Zoarcidae	Eelpouts	14
Gobiidae	Gobies	13
Stichaeidae	Pricklebacks	12
Clinidae	Clinids	12

All species known to inhabit central California waters have been listed by DeWitt and Welsh (1977) along with adaptive zones. This, however, is by no means a complete list since many of the deep-sea species are virtually unknown.

i. Fishes of the Mainland Shelf: The environment of the central California shelf and its adjacent shoreline area is characterized by: 1) a rugged sea bottom that offers a diversity of habitats, 2) wind and current patterns that cause inshore and offshore upwelling of nutrient-rich deep water, 3) kelp beds that support an abundant variety of life, 4) rocky tide pool areas interspersed with short or extensive sandy beaches, and 5) estuary and associated wetland areas, including six major bays, and lagoons. In addition, an extensive coastal stream system develops northward that is vital to the maintenance of the coastal system as a whole. These streams directly affect the coastal area with respect to anadromous and estuarine fishes and the general productivity of the area (California Coastal Zone Conservation Commission, 1975).

The fishes of the shelf are for the most part benthic (bottom dwellers). The shallowest areas include the intertidal zone. The subtidal habitats include shallow and deep reefs, kelp beds, sandy bottoms, and the soft-bottom habitats generally encountered away from shore.

Some of the more common fishes found over the sandy or soft-bottom habitats include the surfperches (Embiotocidae), flatfishes (Pleuronectidae and Bothidae), skates (Rajidae), and sea bass (Serranidae).

Rockfish (Scorpaenidae), seaperch (Embiotocidae), greenlings (Hexagrammidae), and gobies (Gobiidae) are perhaps the more common species associated with rocky reefs and kelp beds. In addition, the juveniles of many species common to other habitats are found here.

Kelp beds are most often associated with rocky bottom habitats, although they do occur over sandy bottoms as well. Most fishes congregate in bottom areas near the rocky substrate or in the region of the canopy with the stipes offering protection.

The shoreline of the central California coast consists of several habitat types. The distributions of shore fishes in these habitats are determined by the same forces which create the habitats (e.g., degree of wave shock, bottom type, and tidal exposure).

Fish diversity is generally low on rocky headlands because of wave shock, lack of plant life, and lack of cover. Sandy beaches are generally considered to be suboptimal habitat for most fishes because of the lack of cover, protection from waves, and less obvious food resources. In actuality, sandy beaches may support a wide variety of small epifaunal or infaunal organisms which support fish life. Fishes such as sand lance (*Ammodytes*), sand fish (*Trichodon*), several flatfishes, and several surf perches are characteristically found in this habitat.

Protected coastal areas (protected by kelp beds, an offshore reef, or in the lee of rocky headlands where wave force is dissipated) are often particularly rich in fish species. Such sites include Halfmoon Bay, portions of Monterey Bay, and Diablo Cove. Because of moderate wave action, silt is not deposited, and sandy or rocky shores are characteristic. Where bottoms are rocky, luxuriant growths of algae are often found, enhancing the carrying capacity for fishes which feed or breed in these areas, or use them as nursery areas.

Generally found on the protected coast, or rocky portions of large bays, rocky intertidal habitats deserve special mention. California has a particularly well developed rocky intertidal fish fauna. Several families; e.g., sculpins (Cottidae), pricklebacks and gunnels (Stichaeidae, Pholidae), clingfishes and snailfishes (Gobiesociadae, Liparidae), and gobies (Gobiidae) have achieved a high degree of adaptation to life in this habitat type. These fishes must deal with extremes in temperature and salinity variations, wave shock, terrestrial and aquatic predators, "red tides", diseases, and man. To cope with solar radiation and mechanical shock in an abrasive environment, most intertidal fishes have firm flesh, thick skin which may or may not be heavily scaled, small eyes, low fins with thick membranes, reduced head spination, a variety of camouflage techniques, and a general increase in dermal melanin (Rosenblatt, 1963).

Central California estuaries by virtue of their intimate connections with both marine as well as freshwater habitats serve an important role as a part of the migration route of a number of anadromous fishes, many, if not most of which have high recreational and/or commercial value; e.g., salmon, striped bass, sturgeon species, and American shad (Fry, 1973). Thus, the regular estuarine inhabitants such as three-spined stickleback, staghorn sculpin, and starry flounder, all species which exhibit a strong degree of tolerance for varying salinities, represent a very small portion of the list. The bays, sloughs, and rivers of central California, generally, have a very low number of permanent estuarine species.

Anadromous fish begin their life in freshwater, use the estuarine environments as juveniles, either to feed or merely as a passage to the open ocean, and then feed as immature adult fish in either estuaries or in the open ocean until sexually mature. On attaining sexual maturity, they return to freshwater or to the highly diluted upper areas of estuaries to spawn. Some forms invariably die after spawning (Pacific salmon, *Oncorhynchus* spp.). Some have a high mortality associated with spawning (anadromous trouts, *Salmo* spp.) while others can return to the sea in large numbers after spawning under natural conditions (striped bass, *Roccus saxatilis*; American shad, *Alosa sapidissima*; and the sturgeons--family, Acipenseridae).

By far the most significant anadromous fishes to the central California area are among the salmon and trout (family Salmonidae). Particularly important are the King (chinook) salmon, *Oncorhynchus tshwaytscha*, and the steelhead rainbow trout, *Salmo gairdneri*. Two additional important non-salmonids are the striped bass, *Roccus saxaitilus*, and the American shad, *Alosa sapidissima*. Both these latter species were successfully introduced into California waters from the east coast. Table II.E.4-4 is a summmary of anadromous fishes of central California and their geographic ranges. Major anadromous fish spawning streams are shown in Figure II.E.4-6. While at sea, the distribution of California's anadromous fishes is not well understood. Most species appear to disperse broadly over the continental shelf waters.

ii. Fishes of the Continental Slope and Submarine Canyons: This region includes the continental slope from a depth of 200 m (656 feet) to the abyssal plain (the sea floor at its deepest realm) which may be 2,000 m (6,562 feet) deep or more.

Many fishes which inhabit this region are members of families present on the continental shelf. There are chimaeras, sharks, skates and flatfishes whose form is not appreciably different from their shallow-water cousins. Other species such as spiny eels (not Acanthidae) or tripod fishes (Benthosaurus, Bathysaurus) are not found in the lesser depths. Compared to the flimsy-bodied gelatinous midwater fishes of this region, the benthic species are generally larger, well muscled, with well organized sensory organs and swim bladders which allow them to hover or swim up off the bottom (Marshall 1966). This increase in size and organization may be the result of increased food resources in the form of benthic invertebrates, as well as a response to an environment which is concentrated in two rather than three dimensions.

Characteristic of the slope and abyssal plain fishes are the rattails (Macrouridae). At least nine species of rattails inhabit the depths off California. The macrourids are, in many regions, the dominant fishes on the slope and abyssal plain, both in numbers and biomass (Pearch and Ambler, 1974). Off northern California, *Coryphaenoides acrolepis*, a smaller, black rattail, is fished commercially and sold as "grenadier." Macrourids feed on a wide variety of benthic crustaceans, echinoderms, and fishes.

The snailfishes, Liparidae, are characteristic of the abyssal fishes. One species, the blacktail snailfish, *Careproctus melanurus*, lives at or near the bottom, being most abundant on a muddy substrate. Apparently, several other species inhabit similar substrates since they have been collected by shrimp trawlers. A few scattered reports indicate that snailfish feed on polychaete worms, small crustaceans, tiny clams, and similar items. Occasionally, snailfish remains have been found in the stomachs of such bottom-feeding predators as hake, arrowtooth flounders, and rockfish (Fitch and Lavenberg, 1968).

Table II.E.4-4

A SUMMARY OF THE GEOGRAPHIC RANGES OF ANADROMOUS FISHES OF CENTRAL CALIFORNIA

SPECIES	Geographic - Range	
	Ocean	Streams, Bays and Deltas
Pacific lamprey	Southern California to Alaska	Ventura River northward: enters unblocked streams
River lamprey	San Francisco Bay to S.E. Alaska	Sacramento River stream only
White Sturgeon	Ensenada, Baja California, to Gulf of Alaska (rare south of Monterey)	Sacramento - San Joaquin River system, including San Francisco Bay. Found in Russian River
Green Sturgeon	Ensenada, Baja California to Bering Sea (rare south of Monterey)	Sacramento - San Joaquin system, Eel, Mad, Klamath and Smith Rivers
American Shad	Ensenada, Baja California to Alaska (uncommon south of Monterey)	San Francisco northward; Sacramento - San Joaquin system, Russian, Klamath, Eel Rivers
Sea-Run Brown Trout	Sacramento River system north to Vancouver Island, B.C.	Sacramento, Klamath, Trinity Rivers. One probable has been reported from each; Scott Creek & San Lorenzo River (Santa Cruz Co.).

Table II.E.4-4 (Cont.)

SPECIES	Geographic - Range Ocean	Streams, Bays and Deltas
Steelhead Rainbow Trout	Northern Baja California to Bering Sea	Occasionally enters the Ventura River. Regularly occurs in suitable streams from San Luis Obispo County northward.
Pink Salmon	La Jolla to N.W. Alaska	Sacramento River and Russian River, although major runs occur in streams north of California
Silver (Coho) Salmon	Northern Baja California to Bering Sea (rare south of Monterey)	Northern Monterey Bay northward
King (Chinook) Salmon	San Diego north to Bering Sea. Abundant from Monterey northward	Enters streams from San Francisco northward
Chum Salmon	Southern California to N.W. Alaska (rare off California)	Reported from San Lorenzo River north. A small regular run occurs in Sacramento River
Sockeye Salmon	Central California to northern Bering Sea	Reported from Sacramento River north, but are rare

Table II.E.4-4 (Cont.)

SPECIES	Geographic - Range: Ocean	Geographic - Range: Streams, Bays and Deltas
Longfin Smelt	San Francisco north to Prince William Sound	San Francisco Bay complex Sacramento - San Joaquin Delta, lower Eel River, Humboldt Bay, and Smith River
Northern Three-spine Stickleback	Monterey Bay north to Bering Sea	San Lorenzo River, Santa Cruz County, northward
Striped Bass	Northern Baja California to British Columbia	Sacramento - San Joaquin River system

Source: Fry, 1973.

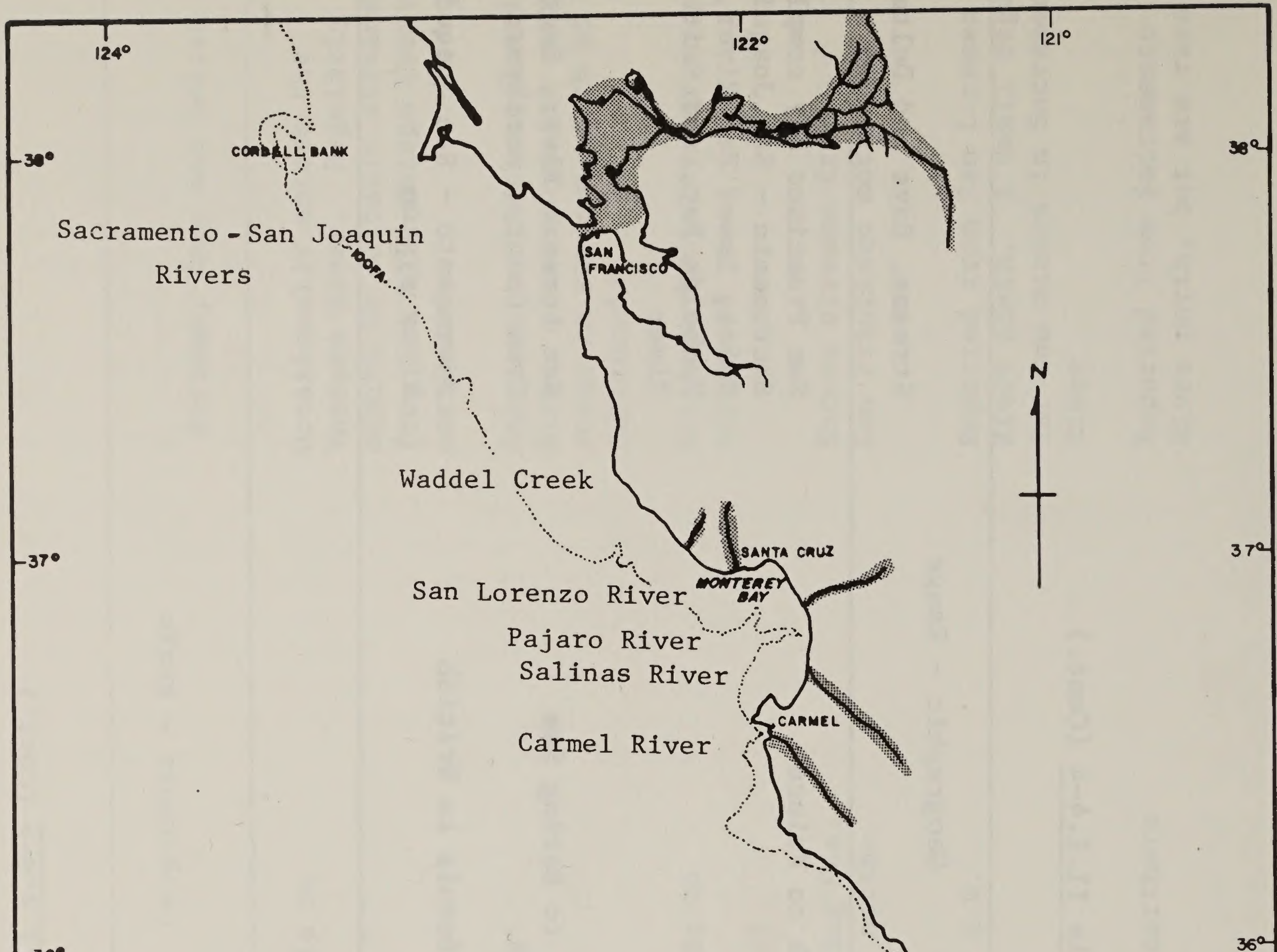


Figure II.E.4-6 Major anadromous fish spawning streams of the central California area.

Many species of eelpouts (Zoarchdae) are found in the benthic region, especially over soft bottoms. At least 14 species are known from central California waters. Generally bottom dwelling fish, eelpouts are found over sandy mud or mud substrates in depths ranging from 9 to 2,133 m (30 to over 7,000 feet). One species, the twoline eelpout, *Bothrocara brunneum*, was found to feed on a variety of bottom organisms. No information suggests that eelpouts are eaten by predators.

iii. Pelagic Fishes of the Central California Shelf: Although some epipelagic fishes are taken on their migration routes far out at sea (i.e., albacores) the majority are taken over or very near the continental shelf, largely in regions of upwelling. In these zones of coastal upwelling, phytoplankton, such as various species of diatoms, form long chains which are large enough to be eaten by a variety of commercially valuable fishes. Important to note is that a zooplankton trophic level and its associated energy loss is skipped in this very short food chain. These large food morsels are eaten by herrings, anchovies and similar forms which possess long, slender gill rakers capable of straining plankton from the water. These fishes form vast schools which often support tremendous numbers of predators including man. This algae-fish food chain is very different from the systems which characterize most other marine food chains (webs). Naturally, these abundant concentrations of fishes attract migrating predators, including, tunas, mackerels, and salmon.

Many of the meso- and bathypelagic fishes of the central California region also occur off Southern California and have already been discussed.

The lightfishes or bristlemouths (Gonostomatidae) and lanternfishes (Myctophidae) are numerically the most abundant fishes in the mesopelagic zone (Fitch and Lavenberg, 1968). Lanternfish are highly prominent in the plankton off central California. Though none are large, their sheer numbers make them important consumers of smaller marine organisms as well as food for larger fishes.

iv. Nektonic Invertebrates: As mentioned earlier, many of the larger planktonic invertebrates have such well developed swimming abilities that they border on being nektonic. These major groups are covered in Section II.E.2.

The major invertebrate species of central California which are either borderline or true nekton during some part of their life cycle include: market squid, *Loligo opalencens*; Pacific Ocean shrimp, *Pandalus jordani*; Dungeness crab, *Cances majista*; Oysters, *Crassostrea spp.*; and the California mussel, *Mytilus californianus*. Detailed discussions of these animals were included in Section II.E.3.b.

e. Diseases and Environmental Stress Affecting Marine Fishes: As more information becomes available about environmental factors in the sea, the important role of diseases and parasites in affecting the abundance of marine fishes becomes more evident. Causative agents of various diseases affecting fish can be either: 1) viral or neoplastic (tumors), 2) bacterial, 3) fungal, 4) protozoal, 5) helminthic, or 6) crustacean.

The intimate relationship of tumors and pollutants has been established by a number of studies (Young (1964), Cooper and Keller (1969), McArn and Wellings (1971), Mearns, Allen, and Sherwood (1973), Mearns and Sherwood (1974), and Stich, Action, and Forrester (1976)). From these studies, it can be said that tumors are: 1) found mainly, but not exclusively in bottom-dwelling species, 2) they have a focal distribution within the population, and 3) the focus of the geographic distribution is in most, but not all cases, associated with urbanization and industrialization.

In studies conducted by the Southern California Coastal Water Research Project (SCCWRP) tumors were found on four flatfish species, dover sole, *Microstomus pacificus*, slender sole, *Lyopsetta exilis*, hornyhead turbot, *Pleuronichthys verticalis*, and California tonguefish, *Symphuns artrcanda*, in five Southern California areas surveyed. Disease incidence within the Southern California Bight appear to be highest on the Palos Verdes Shelf, decreasing in both directions, north and south.

Protozoal diseases are perhaps the best known and also most serious among marine fishes. The most significant effect of the protozoal diseases is their harmful effect on the population density and growth of economically important species. Also of great importance are economic losses due to protozoan invasions into muscle, which cause the fish to become partially or entirely unusable in the commercial catch. However, the low level effect could be even more detrimental to the commercial catch. The host organism does not need to be killed for the parasite to be detrimental. For example, in a large population, a slight growth rate reduction could add up to a large economic loss (since commercial catches often have a minimum size limit).

Helminths (trematodes, cestodes, acanthocephalns, and nematodes) are common parasites of marine fishes. Larvae, found in the flesh and viscera, are usually the most pathogenic stage. The effects include growth retardation, tissue disruption, metabolic disturbances, and death with heavy infestations (Sindermann, 1970; Margolis, 1970). The adults are generally found in the alimentary canal. The state of knowledge in helminthic diseases of marine fishes is very limited. This scant knowledge is very evident in the commercially important species. Economic effects are also impossible to judge. Generally, infected fish are discarded.

Crustacean parasites on marine fishes are important parasites of the skin and gills. They are among the largest parasites of fish and can cause considerable damage to their hosts, act as intermediate hosts themselves, and open the way for secondary microbial infections.

Crustacea are commonly parasitic on commercially valuable species of fish. Their diversity and abundance allows for many parasitic species to develop. The crustacean parasites that settle on the skin are less important than those which live on the gills. The latter can cause serious damage: tissue damage, inflammation, retardation of growth, loss of weight, anemic response, and, in heavy infestations, fatalities. The lesions, resulting as a mixture of parasite damage and host response, are portals for secondary invaders (bacterial, fungal, etc.). The secondary infections can, and do in many cases, result in death.

Chlorinated Hydrocarbons and Trace Metals in Fishes: In an analysis of chlorinated hydrocarbons and trace metals in the tissues of fishes, SCCWRP (1973a) found the highest DDT and PCB (polychlorinated biphenyl) values in muscle tissue of Dover sole in specimens collected near the Whites Point, Hyperion, and Orange County outfalls. These values were significantly higher than those found at Santa Catalina Island and in areas to the northwest towards Point Hueneme. In a comparative survey during 1974-1975 although a decrease in the upper limit of total DDT concentrations were found, there was no statistical difference from the earlier survey (McDermott and Heesen, 1975).

Lasker (1973) found DDT concentrations in the abundant Myctophid, *Stenobrachius lencopsarus*, to be highest in specimens collected near Santa Monica Bay and much lower in areas further away from the bay and the site of DDT discharge, the Whites Point outfall.

Young and McDermott (1974), of SCCWRP, report that approximately 75 percent of the composite samples of muscle tissue from Dover sole collected during 1971 and 1972 trawls between Redondo Canyon and the western entrance of the Los Angeles harbor exceeded the maximum total DDT concentration (5 mg/wet kg) allowable by the U.S. Food and Drug Administration in seafood.

To further determine the concentrations of DDT in the flesh of other fish of the region, SCCWRP analyzed the flesh of several other species associated with the benthic food web of the Palos Verdes shelf (Young and McDermott, 1974). Their results indicate a substantial percentage of the fish still contained excessive concentrations of DDT.

The overall average concentrations of metals in Dover sole collected off Southern California were within the general ranges of concentrations reported for other Pacific and Atlantic areas (SCCWRP, 1973).

5. Marine and Shorebirds

a. Point Conception to Mexico: A variety of terrestrial and marine birds are associated with the Southern California Bight and coastal area. The following text briefly summarizes more detailed information found in POCS Reference Paper No. II, Norris, et al, (1976), and California Department of Fish and Game (1973).

Coastal Habitats. Within the area of the Southern California coastal zone, various habitat types may be found which support coastal bird populations. These include: 1) uplands, 2) sandy beaches, 3) rocky shores, 4) offshore rocks, and 5) wetlands (marshes, sloughs and bays).

Much, if not most, of the upland habitat within the coastal zone has been developed. What little remains is shown in Figure II.F.4-1 (see Section II.F.4). Hawks, pigeons, quail and many other species of game and song birds inhabitat these areas. Despite the fact that many of these species also occur in inland areas, without the necessary habitat, those populations which do exist in the coastal zone would be in jeopardy.

Many miles of the Southern California shoreline are made up of sandy beaches (see Section II.G.1.f.i). During the summer months, heavy human use of the beaches has substantially reduced their value as habitat for birds. However, during the offseason for bathers, and at those beaches which may be inaccessible, this type of habitat provides feeding and nesting areas for many bird species. Some shorebirds that are supported by those habitat include the long-billed curlew, semi-palmated plover, American golden plover, black-billed plover, snowy plover, whimbrel, marbled godwit, sanderling, western sandpiper, and the least sandpiper. The least tern, an endangered species, has had to alter its nesting habits and move to less favorable sites because of heavy beach use. Many of the above species are still able to use the beach habitat for feeding and resting during early morning and evening hours.

The precipitous cliffs and irregular topography of rocky shore areas provide extensive nesting and feeding habitat for birds. The locations of these areas are illustrated in Visual Map No. 2. Some of the more common species associated with this habitat include the black oyster-catcher, black turnstone, ruddy turnstone, spotted sandpiper, surfbird and western gull.

Many of the offshore rocks within the Southern California coastal zone provide nesting and/or roosting sites for a variety of marine and shorebirds. Some of these rocks are: Bass Rock and rocks off Point Mugu (Ventura county); Flat Rock Point and Portuguese Point

Table II.E.5-1

WETLANDS OF THE SOUTHERN CALIFORNIA AREA

	Name	County	Type of Habitat in Acres
1.	Goleta Slough	Santa Barbara	Marsh, 260
2.	Carpinteria Marsh (El Estero)	Santa Barbara	Marsh, 150; mudflat, 35, water 15
3.	Goleta Point Marsh	Santa Barbara	Marsh, 25; water, 35
4.	Mugu Lagoon	Ventura	Marsh, 1,420; mudflat, 500; water 250
5.	Santa Clara River	Ventura	Marsh, 40; water, 20
6.	McGrath Lake	Ventura	Marsh, 5; water, 15
7.	Ventura River	Ventura	Marsh, 5; water, 5
8.	Bixby Slough	Ventura	Wetlands (undifferentiated), 200
9.	Ballora Creek Marsh	Los Angeles	Wetlands (undifferentiated), 20
10.	Colorado Lagoon	Los Angeles	Wetlands (undifferentiated), 15
11.	Anaheim Bay	Orange	Marsh, 480, mudflat, 40; water 370
12.	Bolsa Bay	Orange	Wetlands (undifferentiated), 1,500
13.	Upper Newport Bay	Orange	Marsh, 200; mudflat, 650; water, 500
14.	San Diego Bay	San Diego	Marsh, 360, mudflats, 600; water, 11,000; Salt ponds, 1,400
15.	Mission Bay	San Diego	Marsh, 20; water 2,340
16.	Santa Margarita Lagoon	San Diego	Wetlands (undifferentiated), 600
17.	Tijuana River	San Diego	Wetlands (undifferentiated), 400
18.	Agua Hedionda Lagoon	San Diego	Wetlands (undifferentiated), 300
19.	San Diego River	San Diego	Wetlands (undifferentiated), 250
20.	Batiquitos Laggon	San Diego	Wetlands (undifferentiated) 600
21.	San Elijo Lagoon	San Diego	Wetlands (undifferentiated), 500,

(Los Angeles County); Bird Rock and Rocks off Point Loma (San Diego County). The greatest significance of these offshore rocks is that they provide relatively undisturbed marine and shorebird habitat close to heavily populated areas.

The most significant marine and shorebird habitat found within the Southern California borderland are the coastal wetlands (marshes, sloughs, and bays). Large numbers of shorebirds, waterfowl, and other water-associated birds are dependent upon wetland habitats. In addition, these areas provide important feeding and resting areas for migratory species. Table II.E.5-1 lists some of the important wetland areas of Southern California. In addition to providing habitat for literally hundreds of coastal bird species, several of these wetlands provide habitat for various rare or endangered species. These species are covered in more detail in Section II.F.6.

Fluctuations in population levels are to be expected as these birds migrate along the Pacific Flyway. Peak numbers of birds are expected in the fall and winter. Some species such as the brown pelican and double-crested cormorant are found year-round in the area, while others such as the migratory black brandt, ashy petrel, sooty shearwater and canvasback duck are found seasonally. Seasonal occurrence of species in the Bight during 1975-76 is given in Norris, et al., (1976).

Perhaps the most conspicuous and numerous avian group found in the proposed OCS lease areas is the pelagic (open ocean) seabirds. This group consists of such species as shearwaters, petrels, murrelets, auklets and gulls. Some of these birds spend most of their lives on or above the open ocean habitat, coming ashore only in selected spots on the Channel Islands and offshore rocks to breed and nest (see Visual Map No. 8).

<u>Seabird Colonies of the Southern California Islands</u>. The islands off Southern California provide habitat for over 38,000 breeding seabirds (Norris, et al., 1976). These seabirds are scattered throughout the eight islands; however, San Miguel-Prince and Santa Barbara Islands are the major rookeries. The largest and most diverse seabird rookery is located on the San Miguel-Prince Island complex (Table II.E.5-2). At present, eight species of seabirds nest here, although eleven species have been recorded historically. Visual Map No. 8 and Table II.E.5-2 indicate the locations of the major seabird colonies. POCS Reference Paper No. I provides additional information on the marine birds of the Southern California Bight.

b. Baja California, Mexico: The avifauna of Baja is comprised of approximately 352 species. Although a few of the more exotic forms exist in Baja, most species are common to Southern California and other parts of the southwestern United States.

The majority of seabirds encountered in the Baja area breed on offshore rocks and islands just as in the Southern California area. Due to latitudinal change, the breeding seasons generally occur earlier in the year than in the Southern California area with many of the species dispersing northward after the breeding season.

Isla de Guadalupe. There have been about 60 species of birds recorded on Guadalupe Island (Bostic 1975). Of these, nine were endemic; and of those, five have become extinct since 1900. Only the house finch, rockwren and junco still occur in large numbers, while the Guadalupe Island kinglet is localized and in danger of becoming extinct. The major shore and seabirds of Guadalupe Island are: Brandt's cormorant, double crested cormorant, black turnstone, wandering tattler, western gull, Manx shearwater, Leach's petrel, Xantus' murrelet and Craveri's murrelet.

Isla San Benito. This group of three islands, characterized by a diversity of habitat, low levels of human disturbance, proximity to the mainland, and shallow surrounding waters help make these islands attractive breeding areas for such seabird species as Manx shearwater, Cassin's auklet, Xantus' murrelet, Craveri's murrelet, Leach's, black and least petrels, and brown pelicans. West and east San Benito are the favorite nesting places for Cassin's auklet, Xantus' murrelet, and the black and least petrels. Breeding activities of the alcids take place at night during the late spring and summer months.

The osprey is also a resident of San Benito and can be found nesting from January to mid-March. Brown pelicans and cormorants are also common on middle and east San Benito. In addition, some fifteen species of shorebirds have been recorded, including oystercatchers, plovers, and sandpipers. Only nine species of land birds are known, including three sparrows.

Isla Cedros. Cedros Island is another major breeding island for brown pelicans and gulls, including Herman's, California, western, Herring, and glaucous-winged. Also present are most of the species listed for Guadalupe and San Benito.

Isla San Martin. This is one of the truly nearshore islands of Baja, and due to its proximity to San Quintin Bay, 5-10 km west (3.1 to 6.2 miles), several more coastal species such as western grebe and

Table II.E.5-2

KNOWN MARINE BIRD COLONIES LOCATED IN THE SOUTHERN CALIFORNIA BIGHT
(PT. CONCEPTION-MEXICAN BORDER)

Reference No. on Visual	Nameplace	Breeding Species	Estimated Population 1975-76
1	Castle Rock (San Miguel Is.)	Pigeon Guillemot	80[a]
		Brandt's Cormorant	432[a]
		Cassin's Auklet	NC
		Pelagic Cormorant	30[a]
		Xantus' Murrelet	50
2	San Miguel Is.	Pigeon Guillemot	280[a]
		Pelagic Cormorant	62[a]
		Brandt's Cormorant	84[a]
3	Prince Is. (San Miguel Is.)	Western Gull	1,200[a]
		Cassin's Auklet	20,000[a]
		Brandt's Cormorant	1,720[a]
		Pigeon Guillemot	400[a]
		Dougle Crested Cormorant	40-80
		Ashy Storm Petrel	NC
		Pelagic Cormorant	100
4	Santa Rosa Is	Pigeon Guillemot	100
		Pelagic Cormorant	10
		Brandt's Cormorant	400[a]
5	Gull Is. (Santa Cruz Is.)	Cassin's Auklet	138[a]
		Western Gull	62[a]
		Brandt's Cormorant	46[a]
		Pelagic Cormorant	34[a]
6	Scorpion Rock (Santa Cruz Is.)	Western Gull	200
		Brown Pelican	80[a]
7	Anacapa Is.	Western Gull	200-6000[a]
		Brown Pelican	424[b]
		Pigeon Guillemot	8
		Pelagic Cormorant	2
		Brandt's Cormorant	2
		Xantus' Murrelet	2

Table II.E.5-2 (Cont'd)

Reference No. on Visual Map No. 8	Nameplace	Breeding Species	Estimated Population 1975-76
8	Santa Barbara Is.	Pigeon Guillemot	120[a]
		Western Gull	2,234[a]
		Xantus' Murrelet	2,000[a]
		Brandt's Cormorant	54[a]
		Double Crested Cormorant	4[a]
		Pelagic Cormorant	2[a]
9	San Nicolas Is.	Western Gull	1,400[a]
		Brandt's Cormorant	730[a]
10	Ship Rock (Catalina Is.)	Western Gull	NC
11	Bird Rock (Catalina Is.)	Western Gull	50-60[a]
12	Castle Rock (San Clemente Is.)	Brand't Cormorant	2[a]
13	Northwest Rock (San Clemente Is.)	Western Gull	62[a]
		Brandt's Cormorant	24
		Xantus' Murrelet	2

Sources: Bell, R. and J.R. Ally, 1972. Fish and Wildlife Resources Relationships and Water Quality Requirements. Task DF and G-2, Water Quality Planning Program, California Department of Fish and Game.

(NC = No Count Available)

[a]Norris, K. et al., 1976. The Abundance and Distribution of the Marine Birds and Mammals of the Southern California Bight.

[b]Anderson, et al., 1976.

merganser occur. The island is also important for Brandt's cormorants, brown Pelicans, and around eleven species of shorebirds (Bostic, 1975).

c. Point Conception to Point Reyes: Like the Southern California Bight, a variety of terrestrial and marine birds are associated with the coastal area of central California. The types of habitats which can be found are: 1) uplands, 2) sandy beaches, 3) rocky shores, 4) offshore rocks, and 5) wetlands. The only islands which occur within this section of the coast are the Farallons, west of San Francisco and Ano Nuevo Island off Ano Nuevo Point (San Mateo County).

Most of the coastal upland habitat in the central California area consists of the woodland-brushland biome (see Figure II.F.4-3). For the most part, this habitat supports upland game birds, raptors, and song birds found in island extensions of the biome. Several unique sand dune areas are found in the vicinity of the Santa Maria River (Santa Barbara County), Dune Lakes and Oso Flasco Lake (San Luis Obispo County), and Moss Landing (Monterey County), which support large populations of quail and band-tailed pigeons.

Sandy beach habitats, found along much of this coast, provide feeding and nesting areas for many shorebirds including the long-billed curlew, semi-palmated plover, American golden plover, black-billed plover, whimbrel, sanderling, western sandpiper and the least sandpiper. Heavy human use of much of the beach area limits the birds use to early morning or evening hours.

The extensive rocky shore and cliff areas of the central coast provides nesting and feeding habitat for such species as the black oyster-catcher, black turnstone, ruddy turnstone, spotted sandpiper, surfbird and western gull, and offer resting areas for a variety of seabirds that forage in the offshore waters.

Coincident with the rocky shoreline are numerous offshore rocks of high value as nesting and resting sites for a wide variety of seabirds. Birds inhabiting these rocks are protected from human disturbance by an ocean buffer zone and include such species as Brandt's commorant, double crested cormorant, pelagic cormorant, bald eagle, western gull, glaucous-winged gull, herring gull, California gull, ring-billed gull, mew gull, common murie, pigeon gullimot, and the marbled mirrelet. Breeding bird surveys have been conducted for many of these rocks by the California Department of Fish and Game (1973). Figue II.E.5-1 shows the locations of many of these offshore rocks.

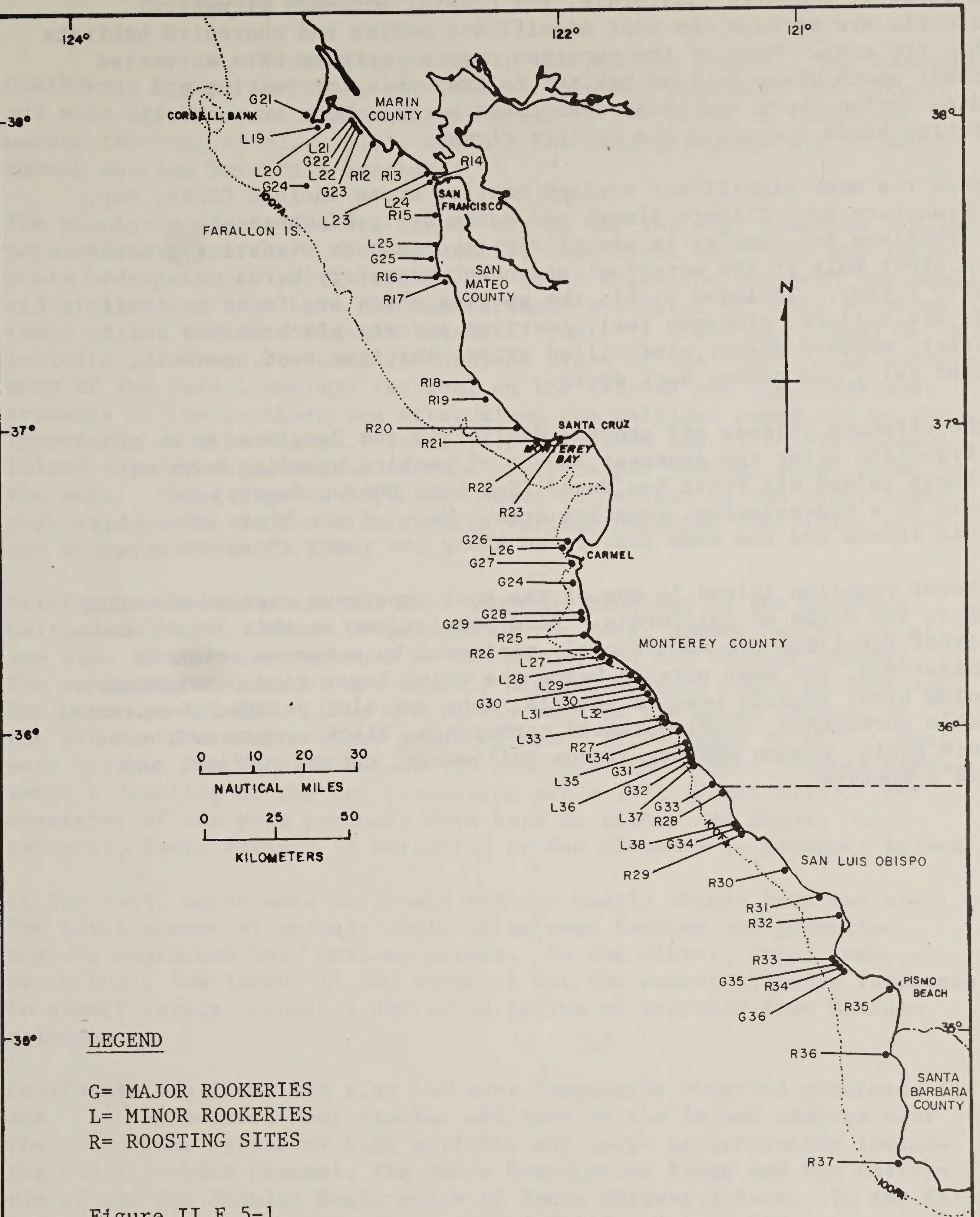


Figure II.E.5-1
Important Seabird Areas-Point Conception to Point Reyes

Source: California Department of Fish and Game

Like those of Southern California, the coastal wetlands of central California are perhaps the most significant marine and shorebird habitats within the area. Many of the numerous coastal streams have estuaries at their mouth where wetland habitat is available for nesting and feeding marine shore and water associated birds. Many are used by migrating birds traveling the Pacific Flyway.

Perhaps the most significant wetland habitat areas include Drakes Bay, San Francisco Bay, Elkhorn Slough and Morro Bay. Of these the San Francisco Bay complex is singularly important as wintering grounds for a great bulk of the waterfowl and other migratory birds using the Pacific Flyway. Included within the species which are found in these areas are mallard, cinnamon teal, American avocet, black-necked stilt, killdeer, western grebe, pied-billed grebe, American coot, gadwall, clapper rail, and canvas back ducks.

Of the offshore islands off central California the Farallons west of San Francisco offer the greatest amount of seabird breeding habitat. Ano Nuevo Island off Point Ano Nuevo (San Luis Obispo County) is classed as a non-breeding, roosting area. Many of the birds occurring on this island are the same that occur along the rocky shore mainland.

Southeast Farallon Island is one of the most important seabird breeding sites in the State of California. Bird populations on this Island and the other Farallons are continuously monitored by numerous research organizations, the most notable being the Point Reyes Bird Observatory. Breeding birds include Leach's petrels, ashy petrels, pelagic cormorants, Brandt's cormorants, double-crested cormorants, black oyster-catchers, western gulls, common murres, pigeon guillemots, tufted puffins, and Cassin's auklets.

6. Marine Mammals

a. Point Conception to the Mexican Border: The Southern California Bight, including the Channel Islands, possesses the largest and most diverse marine mammal population of the world in temperate waters (Norris, et al., 1975). Within the area approximately 32 marine mammal species have been recorded.

The pinnipeds (seals and sea lions) are by far the most numerous. Major populations of northern elephant seals, California sea lions and harbor seals breed and pup yearly within the Bight while the northern fur seal and Steller sea lion have the southernmost extension of their breeding range on the northern Channel Islands. Table II.E.6-1 and Visual No. 8 indicate the known breeding and haulout areas of the Bight. The occurrence of the rare Guadalupe fur seal on the islands and the occasional presence of the southern sea otter along the mainland coast add to the importance of this region. Table II.E.6-2 shows the 1975-1976 Channel Island population estimates for the six pinniped species which occur in the area. These figures represent about 84 percent of the total Bight population. The months within which various pinniped activities occur are shown in Table II.E.6-3.

California sea lions are the most abundant pinniped in the Southern California Bight. About 90 percent of the total number hauled out at any time of the year are seen on San Miguel and San Nicolas Islands. The remaining 10 percent are equally divided between Santa Barbara and San Clemente Islands. They are rarely seen on the other islands of the Bight. The entire Bight produced about 15,000 pups in 1975. Most were born on San Nicolas Island (49 percent); the number counted represents a doubling of the pup production since 1971 (Odell 1972). The remainder of the pups produced were born on either San Miguel (42 percent), Santa Barbara (5 percent), or San Clemente (4 percent) islands.

In the fall, males move northward and are nearly absent from the area. The total number of animals declines as some females and juveniles migrate southward into Mexican waters. In the winter, total numbers reach their low (about 15,000 animals) but the number of males increases to summer levels, probably due to an influx of migrants from Mexican colonies.

California sea lions are also the most frequently observed pinnipeds at sea. In the summer, many females are seen on the island shelves near the rookeries. Areas of high activity and large concentration include the Santa Barbara Channel, the Santa Rosa-Cortes Ridge and the eastern rim of the San Nicolas Basin south of Santa Barbara Island. In the fall and winter, numbers at sea decrease and California sea lions are

Table II.E.6-1

PINNIPED ROOKERY AND HAULOUT AREAS OF THE SOUTHERN CALIFORNIA BIGHT
(PT. CONCEPTION-MEXICAN BORDER)

Reference No. On Graphic	Nameplace	Species Present	Activity
1	Richardson Rock (San Miguel Is.)	*Zalophus* *Callorhinus*	Breeding-Pupping Breeding-Pupping
2	Castle Rock (San Miguel Is.)	*Zalophus* *Callorhinus* *Eumetopias*	Breeding-Pupping Breeding-Pupping Breeding-Pupping
3	Point Bennett Rock (San Miguel Is.)	*Arctocephalus*	Haulout only
4	Point Bennett Adams Cove (San Miguel Is.)	*Callorhinus* *Zalophus* *Mirounga* *Eumetopias*	Breeding-Pupping Breeding-Pupping Breeding-Pupping Breeding-Pupping
5	Simonton Cove (San Miguel Is.)	*Phoca* *Mirounga*	Breeding-Pupping Breeding-Pupping
6	Cuyler Harbor Area (San Miguel Is.)	*Phoca*	Breeding-Pupping
7	Sandy Point-Blockhouse Beach (Santa Rosa Is.)	*Phoca*	Breeding-Pupping
8	Beechers Bay (Santa Rosa Is.)	*Zalophus*	Breeding-Pupping
9	Fraser Point (Santa Cruz Is.)	*Zalophus*	Breeding-Pupping
10	Arch Rock East (Santa Cruz Is.)	*Phoca*	Breeding-Pupping

Table II.E.6-1 (Cont.)

Reference No. On Graphic	Nameplace	Species Present	Activity
11	Scorpion Anchorage (Santa Cruz Is.)	*Phoca*	Breeding-Pupping
12	Kinton Point South/Morse Point (Santa Cruz Is.)	*Phoca*	Breeding-Pupping
13	Gull Island (Santa Cruz Is.)	*Zalophus* *Phoca*	Breeding-Pupping
14	Anapaca Island	*Zolophus* *Phoca*	Breeding-Pupping Breeding-Pupping
15	Goleta Beach (Mainland)	*Phoca*	Haulout
16	Standard Oil Pier (Mainland near Carpentira)	*Phoca*	Haulout
17	Burmah Beach (Mainland)	*Phoca*	Haulout
18	Point Mugu (Mainland)	*Phoca* *Zalophus*	Haulout Haulout
19	Elephant Seal Beach (San Nicolas Is.)	*Zalophus* *Mirounga*	Breeding-Pupping Breeding-Pupping
20	Santa Barbara Island	*Phoca* *Zalophus* *Mirounga*	Breeding-Pupping Breeding-Pupping Breeding-Pupping

Table II.E.6-1 (Cont.)

Reference No. On Graphic	Nameplace	Species Present	Activity
21	Church Rock/China Point (Santa Catalina Is.)	*Zalophus* *Phoca*	Haulout only
22	Eel Point-Mail Point (San Clemente Is.)	*Zalophus* *Phoca* *Mirounga* *Callorhinus* *Eumetopias*	Breeding-Pupping Breeding-Pupping Haulout Haulout Haulout
23	Coronodas Islands (Mexico)	*Zalophus* *Phoca* *Mirounga*	

Source: Norris, et al., 1976
Siva, 1976

Table II.E.6-2

CHANNEL ISLANDS PINNIPED POPULATIONS, 1975-76
(PEAK COUNTS ON LAND DURING BREEDING SEASON)

Islands	California Sea Lion (*Zalophus*)	Northern Elephant (*Mirounga*)	Northern Fur Seal (*Callorhinus*)	Harbor Seal (*Phoca*)	Steller Sea Lion (*Eumetopias*)	Guadalupe Fur Seal (*Arctocephalus*)	Island Total
San Miguel	18,559	6,990	1,212	400	19	1	27,181
San Nicolas	16,535	1,261		255			18,051
San Clemente	1,847						1,847
Santa Barbara	1,788	126		4			1,918
Santa Cruz	25			195			220
Santa Catalina	17						17
Santa Rosa	3			336			339
Anacapa				100+			100+
Total Pop.	38,774	8,377	1,212	1,290+	19	1	49,673+

Source: Norris, et al., 1976

Table II.E.6-3

APPROXIMATE TIMES OF PINNIPED ACTIVITY

Species	On Land	Pupping	Breeding	Nursing
Northern fur seal	May to about 15 November	Late May to Mid-August	Late May to late August	Late May to about 15 November
Northern sea lion	May through November [a]	June	June	June to November A few may nurse all year
California sea lion	All year	June	June to July	June to November. A few all year
Northern elephant seal	All year except when feeding	Late December to late February	January to mid-March	Late December to mid-March
Harbor seal	All year	March April	April May	March to May
Guadalupe fur seal	A few all year			

Source: U.S. Dept. of the Interior, (Geological Survey) 1976.

[a]A few may be on land at any time.

more widely distributed in the Bight. Use of northern waters such as the Santa Barbara Channel decline somewhat; use of the southern waters such as Tanner-Cortes Banks and San Clemente Ridge increases. The number of California sea lions at sea at any time of year is equal to about one-third of the population on land.

The California sea lion is afforded protection by both the United States and Mexican governments thoughout its range and continues to increase in numbers.

Northern elephant seals (*Mirounga angustirostris*) are present on rookeries at all times of the year but their number and composition, with respect to sex and age, varies in a consistent and predictable manner. The highest numbers are observed on rookeries in late January and during the month of May. The winter population on land consists of breeding males, breeding females and newborn pups. The spring population consists primarily of juveniles, 1½ to 4½ years of age.

San Miguel Island is the second largest rookery in the entire breeding range and it is the largest rookery in the Bight. Approximately 16,600 elephant seals are associated with colonies in the Bight. This is approximately 35 percent of the species' total estimated population size. All colonies in the Southern California Bight have grown rapidly in recent years and the colonies on San Miguel and San Nicolas Islands can be expected to continue to increase in size.

Elephant seals show a preference for breeding on sandy beaches but this substrate, alone, is not a sufficient condition for attracting breeding animals. Several islands in the Bight that have sandy beaches are not frequented by elephant seals. Elephant seals are rarely observed at sea. The few animals observed do not appear to concentrate in any particular area. Many elephant seals disperse to other islands and rookeries a few months after birth. Movement is primarily in the northward direction and is most obvious during the first years of life. Thereafter, the number dispersing declines with age. Adults rarely move from one rookery to another unless the two rookeries are situated close together. Southern California rookeries receive immigrants from Mexican rookeries and send out immigrants to northern California rookeries. There is some interchange between rookeries within the Bight. Many immigrants breed in their new locations.

The northern fur seal (*Callorhinus ursinus*) is one of the most abundant pinnipeds in the world although not within the Southern California Bight. A breeding colony was established on San Miguel Island in the early 1960's. One group breeds on sandy beaches at the western end of the island and the other group breeds on a rocky islet north of the western end of the island. In 1975, approximately 600 pups were produced here. The total population has increased dramatically since 1968, when approximately 100 animals were counted and 40 pups were produced.

In winter, migrants are observed in large numbers along the California coast beyond the edge of the continental shelf, notably west of San Miguel Island. Northern fur seals are also seen within the Bight, primarily along the Santa Rosa Ridge and over the San Nicolas Basin near Tanner Bank.

Harbor seals (*Phoca vitualina*) are extremely shy, wary and secretive. The numbers observed on land vary seasonally. In 1975, there were about 1,400 animals on land in the late spring and early summer, when breeding occurs. At other times of the year, the numbers seen averaged at about 400 animals. This species was widely distributed at all times of the year. Herds are observed repeatedly in the same specific areas on most of the islands in the Southern California Bight. The largest numbers are consistently seen on Santa Rosa Island and San Miguel Island. Newborn pups were observed in May and June of 1975 in many of the locations where these animals hauled out at other times of the year. Pups are precocious and highly mobile shortly after birth. Pup production for 1975 was about 300 animals, or 20 percent of the population. Harbor seals are rarely seen at sea. Sixty-one percent of the animals sighted in the 1975-76 study were observed in the Santa Barbara Channel.

The Steller sea lion (*Eumetropias jubata*) population in the Southern California Bight has declined precipitously since the 1930's and is very low at present. A few individuals (less that 20) were seen throughout 1975 on San Miguel Island. The Steller sea lion population in the Bight is in a precarious state and bears close watching.

The Guadalupe fur seal (*Arctocephalus townsendi*) is recovering slowly from near extinction. This species breeds only on Isla de Guadalupe, Mexico, and the total population number is estimated to be less than 1,000 animals. Occasional sightings of single individuals in the Southern California Bight have been made in recent decades. Most of the animals have been on San Miguel Island in the summer. Three male Guadalupe fur seals were seen in 1975: one on San Miguel Island, one on San Clemente Island, and one at sea south of Santa Rosa Island.

The cetaceans (whales, porpoises, and dolphins) while less commonly seen are nonetheless present in the thousands (Norris, et al., 1976). The majority of the populations consist of the smaller dolphins and porpoises. However, several of the major great whale species pass through the area. Included in this group are seven endangered species (See section II.F.6).

The 26 or more species of cetaceans appear to occur in three major faunas, separated longitudinally. The inshore group consists of such species as the common dolphin, Pacific bottlenose dolphin, white-sided dolphin, Dall porpoise, Minke whale, gray whale, and pilot whale. The second group is the continental shelf group composed of Risso's porpoise, right whale porpoise, various beaked whales, blue whale, sei, sperm and humpback whales. The third group is the far-offshore group normally confined to the open ocean of the central Pacific gyre and is composed of species such as the false killer whale; pygmy killer whale, pygmy sperm whale, euphrosyne or long-beaked dolphin and the rough-tooth porpoise. Within the bight, aerial and shipboard sightings during 1975-76 indicated the common dolphin, whitesided dolphin and pilot whale as the three most commonly sighted species (Norris, et al., 1976).

b. Baja California, Mexico: The offshore area of Baja is similar to that of the Southern California Bight in that there are several prominent offshore islands with their associated shallow water areas which are conducive to the occurrence of marine mammals.

The pinniped populations, composed of California sea lions, northern elephant seals, harbor seals and Guadalupe fur seals, number around 35,000 animals (Table II.E.6-4). Figure II.E.6-1 illustrates the occurrence of pinnipeds along the Baja coast and islands. Guadalupe, San Benitos and Cedros are the three most important islands for pinniped rookery areas.

The cetacean population is varied, consisting of most of the species which occur in the Southern California Bight. Population estimates are few and incomplete.

c. Point Conception to Point Reyes: Point Conception appears to serve as the geographic boundary for abrupt distributional changes that exist for several marine mammal species. Although some species are known to migrate north or south of this point, their breeding ranges may be only marginal past Point Conception. Examples of this are the California sea lion which does not generally breed north of Point Conception and the Steller sea lion which does not breed south of Point Conception in any substantial numbers.

As one proceeds up the coast, there are numerous rocks and islets which are used as haulout and breeding areas by pinnipeds (Figure II.E.6-2); of these, there are two major areas of pinniped use: Ano Nuevo Island and the Farallon Islands. Ano Nuevo Island lies approximately 101 km (63 miles) south of San Francisco and one-half mile off Point Ano Nuevo in San Mateo County.

Table II.E.6-4

ESTIMATED PINNIPED POPULATIONS OF BAJA CALIFORNIA, MEXICO AND ASSOCIATED ISLANDS[a] (1968-77)

Island	California Sea Lion	Northern Elephant Seal	Harbor Seal	Guadalupe Fur Seal
Los Coronados	200+	130	64	b
Todos Santos	b	b	b	b
San Martin	280	2	236	b
San Geronimo	b	b	b	b
San Benitos	7930	2460	1	b
Cedros	6402	207	62	b
Guadalupe	822	9494	b	470+
Natividad	3648	20	236	b
Mainland Coast	1570	b	b	b

Sources: Le Boeuf, B. J. 1977
Brownell, R. S., et al., 1974
La Boeuf, B. J., et al., 1975
Mate, B. R., 1977
Norris, et al., 1976

[a]Estimated total population based on off season counts, 1977

[b]Unknown

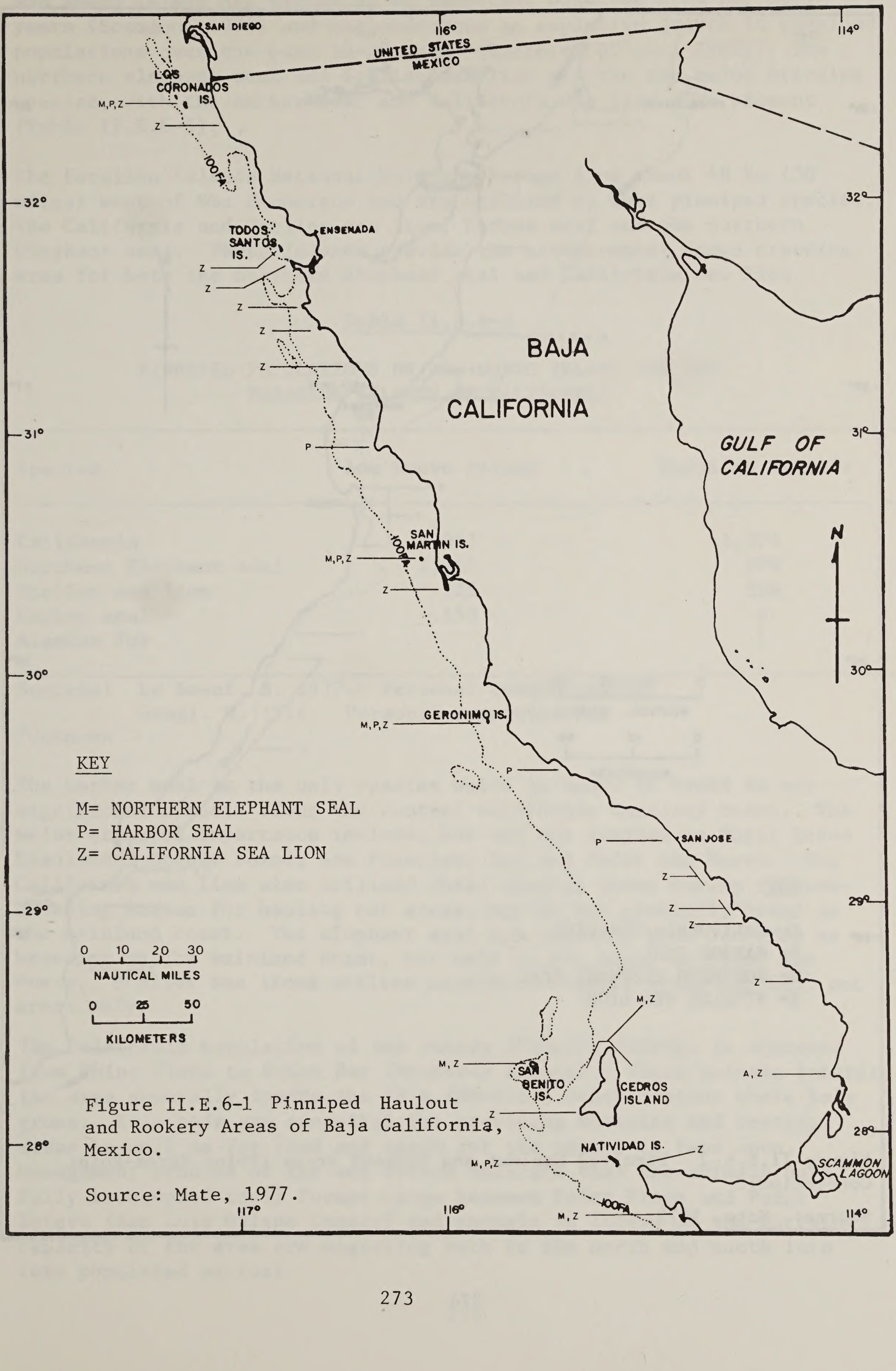
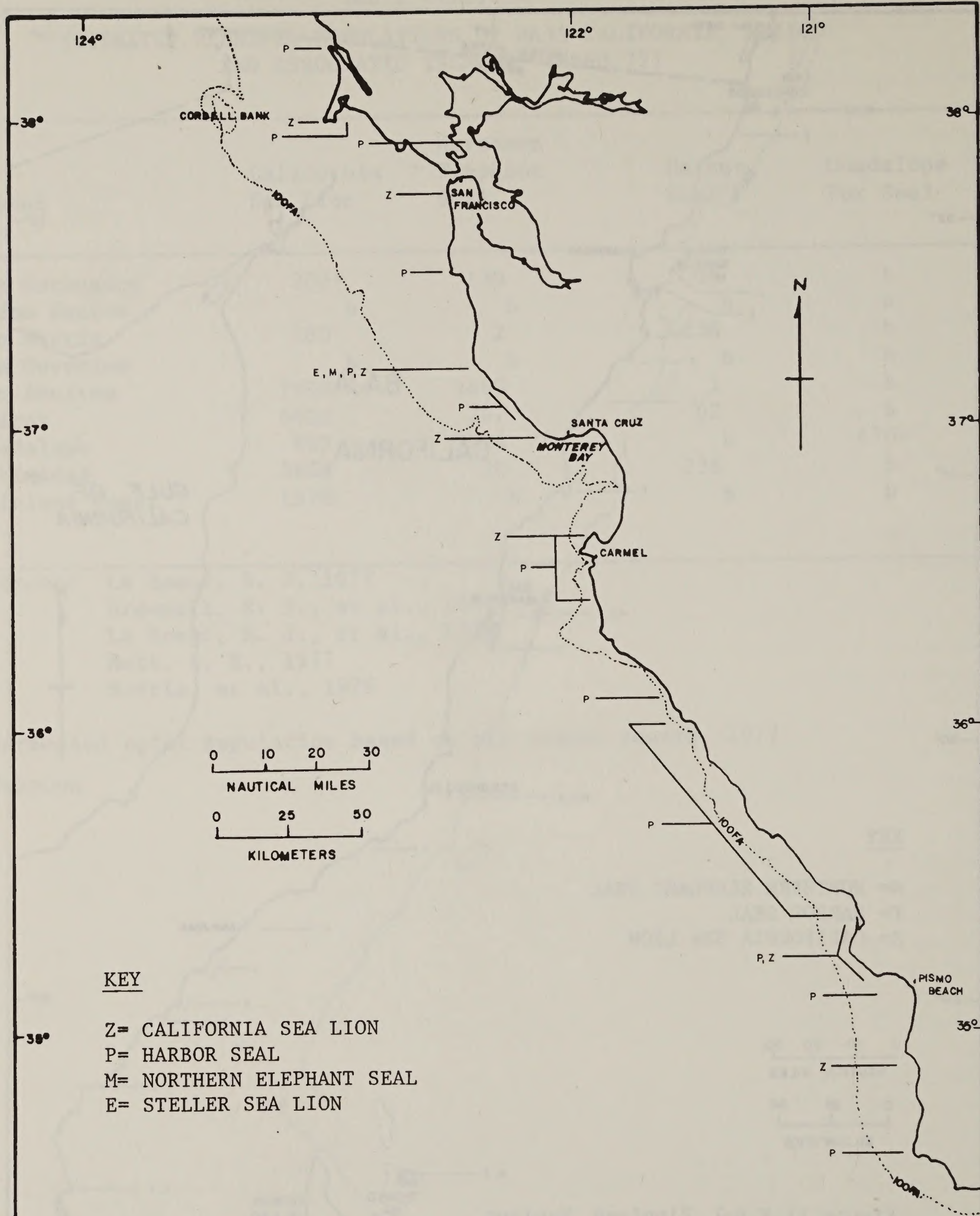


Figure II.E.6-1 Pinniped Haulout and Rookery Areas of Baja California, Mexico.

Source: Mate, 1977.



KEY

Z= CALIFORNIA SEA LION
P= HARBOR SEAL
M= NORTHERN ELEPHANT SEAL
E= STELLER SEA LION

Figure II.E.6-2 Pinniped Haulout and Rookery Areas (Point Reyes-Point Conception).

Source: Mate, 1977.

Ano Nuevo Island has served as an important pinniped area for many years (Scammon, 1874) and has undergone an explosive growth in pinniped populations over the past 10-20 years (Radford, et al., 1965). The northern elephant seal and Steller sea lion are the two major breeding species, with the harbor seal and California sea lion also present (Table II.E.6-5).

The Farallon Islands National Wildlife Refuge lies about 48 km (30 miles) west of San Francisco and are utilized by four pinniped species, the California and Steller sea lion, harbor seal and the northern elephant seal. These islands provide the northernmost known breeding area for both the northern elephant seal and California sea lion.

Table II.E.6-5

PINNIPED POPULATIONS OF ANO NUEVO ISLAND AND THE FARALLON ISLANDS OF CALIFORNIA

Species	Ano Nuevo Island	Farallon Islands
California	3,817	1,374
Northern Elephant seal	2,314	300
Steller sea lion	725	216
Harbor seal	153	a
Alaskan fur		1

Sources: Le Boeuf, B. 1977. Personal communication.
Osugi. K. 1976. Personal communication.

[a]Unknown

The harbor seal is the only species which is known to breed in any significant numbers along the central California mainland coast. The major areas of importance include, but are not limited to Point Reyes headlands, Double Point, San Francisco Bay and Point Ano Nuevo. The California sea lion also utilized these coastal areas during the non-breeding season for hauling out areas, but do not presently breed on the mainland coast. The elephant seal has recently been recorded as breeding on the mainland coast, but only on one beach at Point Ano Nuevo. Steller sea lions utilize scattered coastal areas for haul out areas only.

The California population of sea otters (*Enhudra lutris)* is centered from Point Pinos to Point Sur (Monterey County). These animals inhabit the area generally inside the 18 m (60-foot) depth contour where kelp grows. Kelp beds are essential for providing whelping and resting areas as well as for food and cover for the otters to feed upon. Management studies of the sea otters indicate that the animals have fully reoccupied their former range between Point Pinos and Point Estero (San Luis Obispo County) and animals in excess of the carrying capacity of the area are migrating both to the north and south into less populated sectors.

F. Important Marine Associated Habitats

1. Marshes, Bays and Estuaries

a. Southern California

Introduction. There are 19 major coastal embayments in Southern California. Only three of them have remained relatively unaltered, Anaheim Bay, Upper Newport Bay, and Tijuana Estuary.

The biota of Anaheim Bay are comparatively better known and probably represent a possible flora and fauna of the Southern California coastal embayments before alteration. Several species of fish utilize the bay for spawning and nursery grounds, and a great many species of birds use it as nesting, feeding, and shelter areas.

The following was shortened from Ju-Shey Ho (1974); more detail is presented in POCS Reference Papers Nos. II and III.

California is notable in having coastal embayments developed on a smaller scale than its counterpart area of the East Coast, which stretch their total coastline almost in the same latitudinal range as California. This is particularly true of the coast of Southern California, where, because of arid climate and rather recent geological setting, there is no large river entering the sea. Consequently, the bays on the coast of Southern California are necessarily small, the largest one being San Diego Bay. Furthermore, the absence of a coastal plain in Southern California has restricted the development of salt marsh to small areas fringing sheltered bays and lagoons.

The bays considered here are those tracts of water extending into the land and remaining connected to the sea only by a restricted, narrow entrance. Rivers in Southern California are seasonal streams and in their natural state are sealed off at their mouths by beach deposits during the dry seasons. Most of the so-called "bays" are actually abandoned mouths of the major streams, such as San Pedro Bay, Upper Newport Bay, and Anaheim Bay, or separated from the sea by spits and tombolos, such as Lower Newport Bay, Mission Bay, and San Diego Bay.

Several small lagoons in San Diego County are not periodically flushed by tide. One of them, the Buena Vista Lagoon, has been completely separated from the sea for so many years that its salinity (3.0-6.5°/₀₀) is much lower than other embayments of Southern California. Consequently, its fauna and flora are mixed with some freshwater types (Carpelan, 1964). All other embayments have a mean salinity of about 32.5°/₀₀.

Salt marshes are tracts of land in the bays, estuaries, or lagoons that are covered with halophytes and subject to periodic flooding by the tide. The striking feature of the marsh environment is the great variation in values of the parameters known to affect the occurrence and development of animal populations. In the marsh of Mission Bay, for instance, Phleger and Bradshaw (1966) have recorded considerable diurnal and seasonal variation in pH, oxygen, water temperature, and salinity. These variances are related to tidal flushing, air temperature variation, sunlight duration, and marsh plant metabolism.

The great influx of residents to Southern California during and following World War II, resulted in substantial alteration of the natural state of the southland; nearly all of the bays and lagoons have been modified by the activities of man through construction of marinas and breakwaters, building of roads and railroads, dredging of channels, diversion of rivers, and use for waste disposal. Of the existing embayments Mugu Lagoon, Upper Newport Bay, and Tijuana Estuary are some of the few major embayments that still remain in a relatively unaltered condition (Figures II.F.1.a-1 through 4).

Estuaries and lagoons support animals recruited principally from the sea. Many neritic animal species use these areas as a nursery ground before migrating to the open sea (Vernberg and Vernberg, (1972). For example, shallow-water fishes such as the California halibut, the Pacific staghorn sculpin, the deepbody anchovy, and the gray smoothhound are known to use Anaheim Bay as nursery habitats. Some permanent dwellers of Anaheim Bay that complete their life cycle in the bay are the topsmelt, the California killifish, the arrow goby, and the diamond turbot.

However, with a profound alteration of coastal wetlands in Southern California, to what extent they still serve as a nursery and feeding ground for neritic animals has not been determined. It is known that the fully developed commercial and residential marina-complex in Mission Bay has destroyed most, if not all, wildlife values there (Speth, 1969). Studies on the benthic animals of Anaheim Bay by Kawuling and Reish (1975) have demonstrated that the density of benthic polychaetes showed striking differences between the dredged and the undredged areas.

i. Vegetation and Zonation: The salt marshes of the Pacific coast of North America are very uniform in their type of vegetation (Chapman, 1960). Their flora are characteristic in containing relatively fewer species and their ecological succession is generally simpler than that found in other regions, such as the East and Gulf coasts. In Southern California this is particularly true; it perhaps reflects the small size and relatively recent establishment of the marshes (MacDonald, 1969).

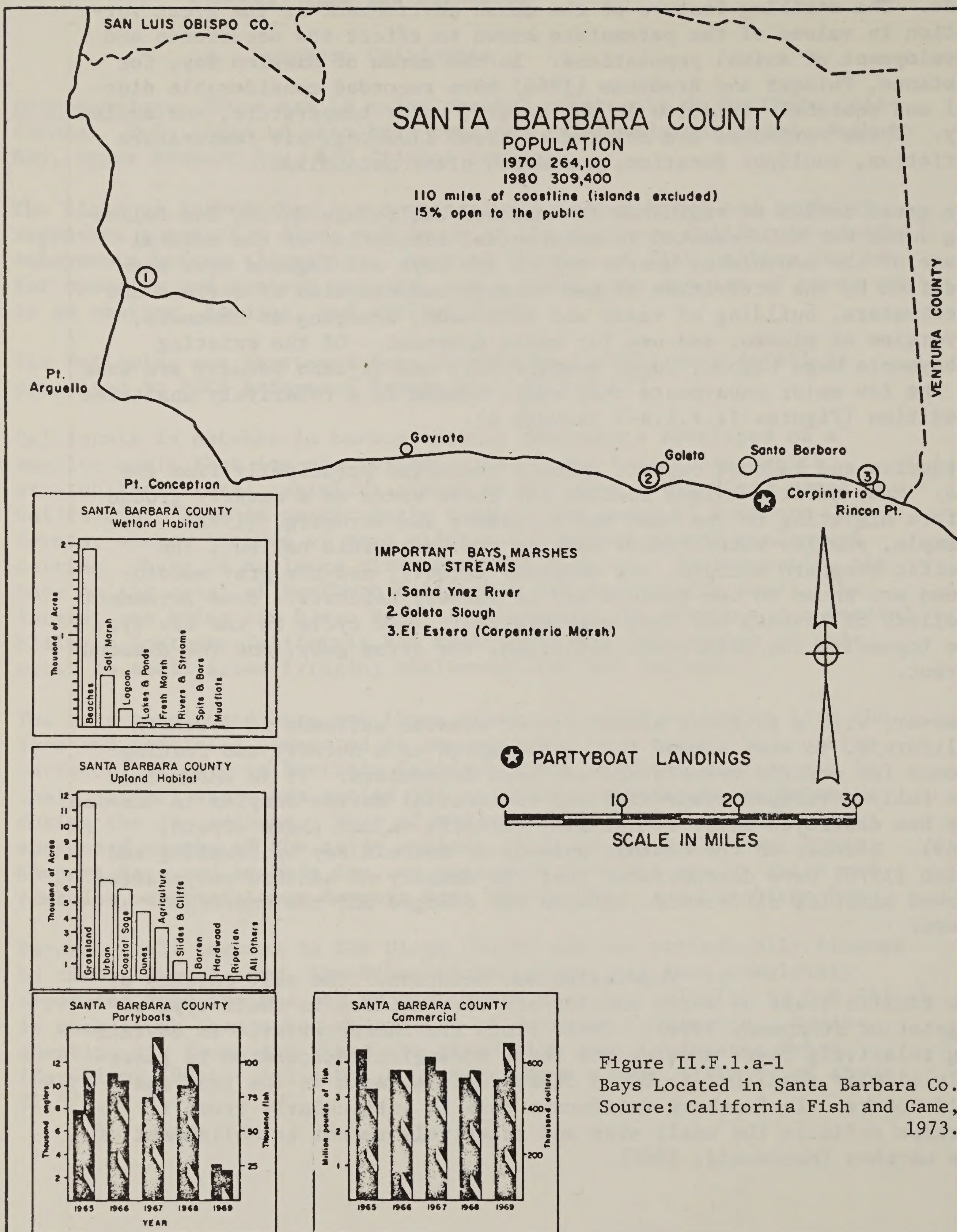


Figure II.F.1.a-1
Bays Located in Santa Barbara Co.
Source: California Fish and Game, 1973.

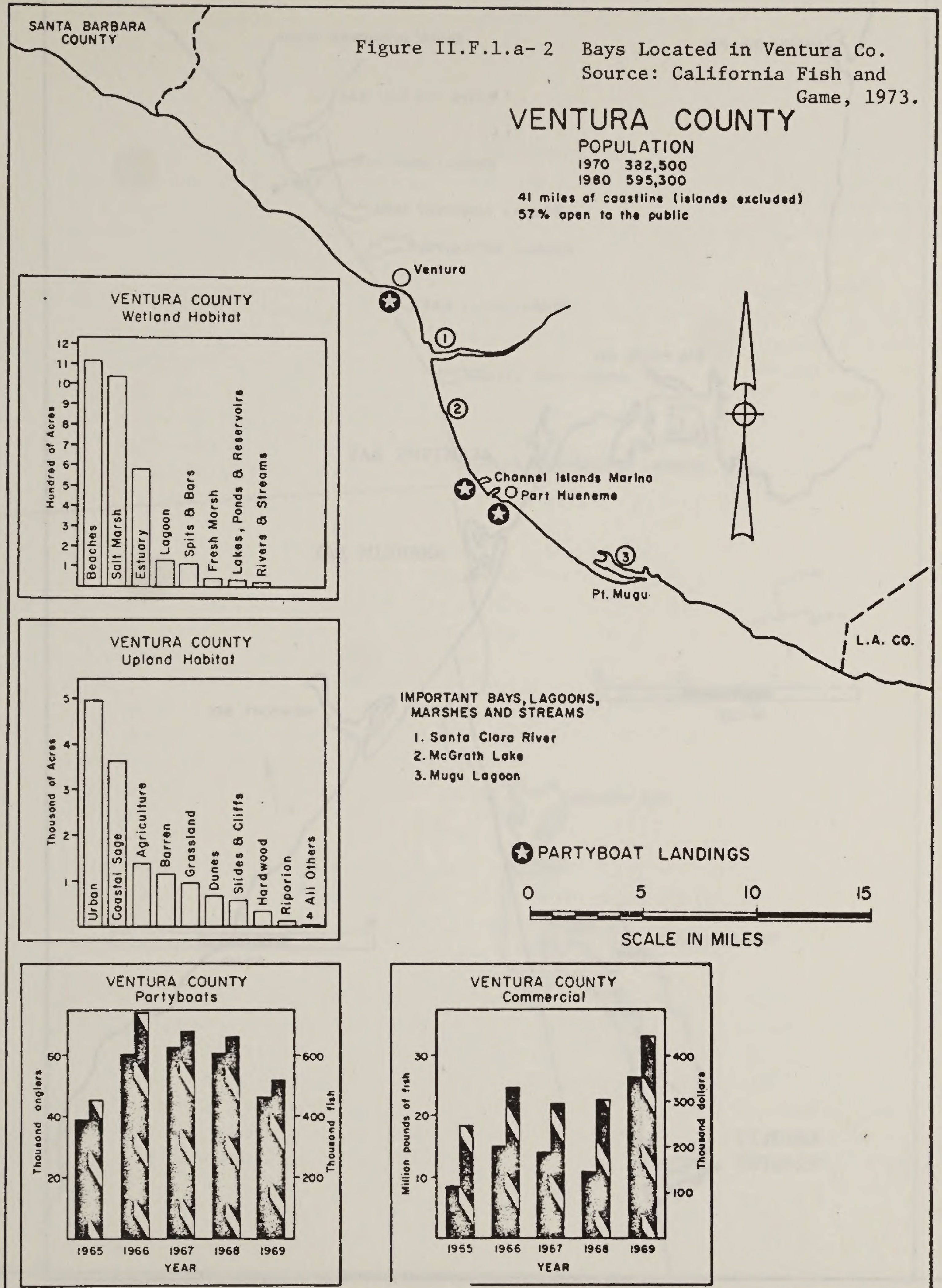


Figure II.F.1.a-2 Bays Located in Ventura Co. Source: California Fish and Game, 1973.

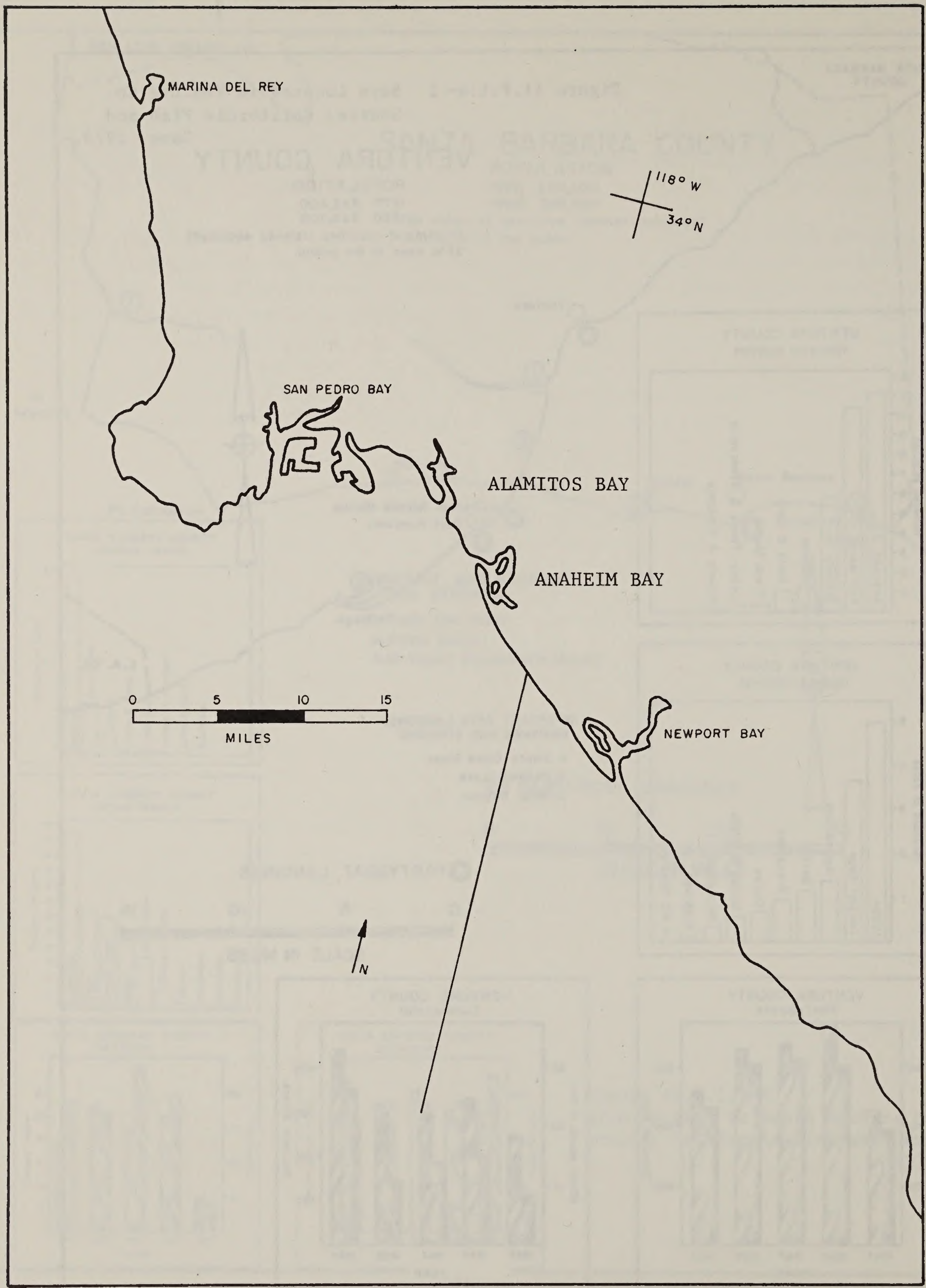


Figure II. F.1.a-3 Bays located in Los Angeles and Orange Counties.

Source: HO (1974)

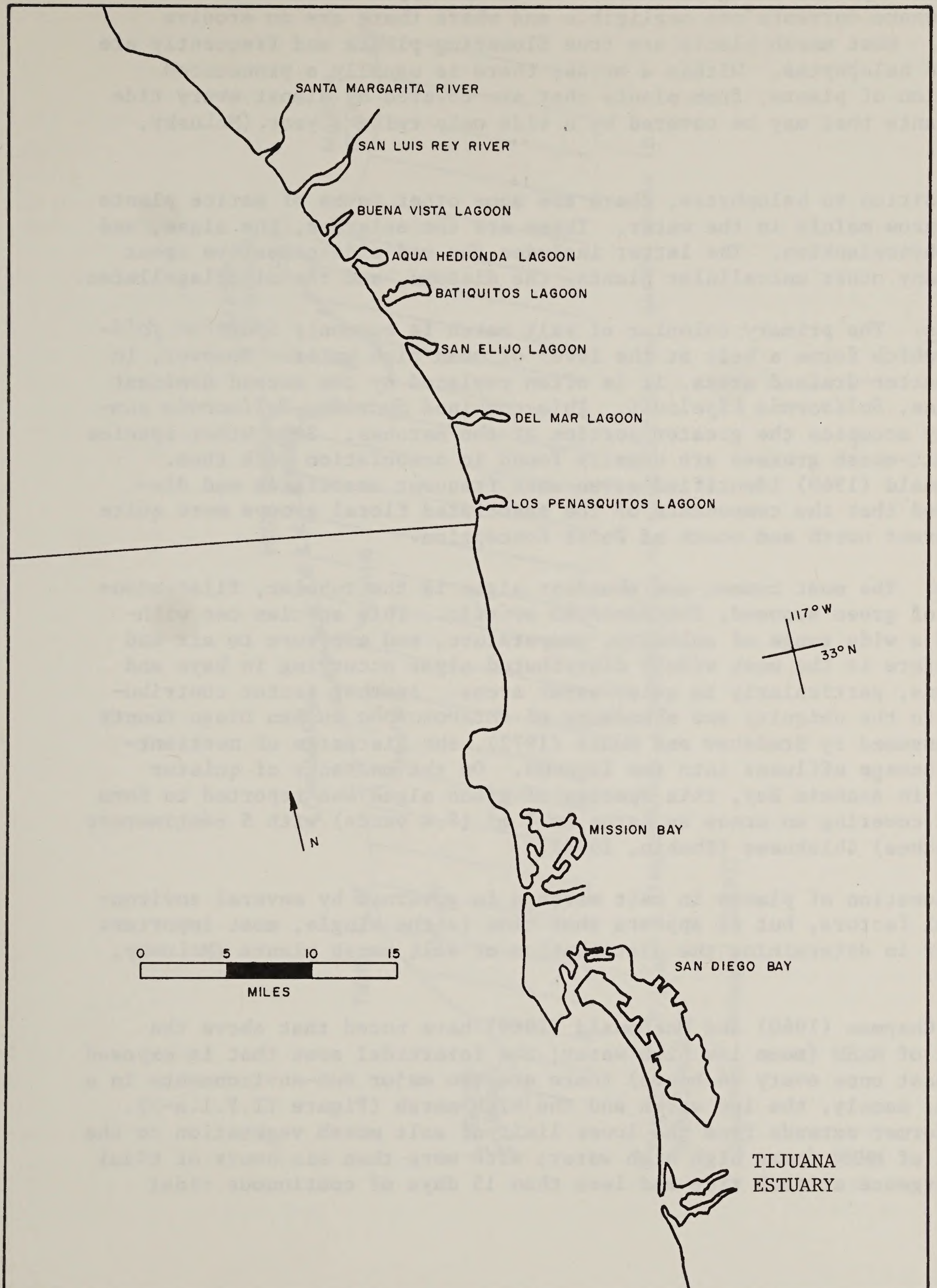


Figure II.F.1.a-4 Bays located in San Diego County.

Source: Ho (1974)

The marsh plants are generally found in the upper intertidal areas of bays where currents are negligible and where there are no erosive waves. Most marsh plants are true flowering plants and frequently are called halophytes. Within a marsh, there is usually a pronounced zonation of plants, from plants that are covered by almost every tide to plants that may be covered by a tide only twice a year (McLusky, 1971).

In addition to halophytes, there are some other forms of marine plants that grow mainly in the water. These are the eelgrass, the algae, and the phytoplankton. The latter includes the red tide causative agent and many other unicellular plants, the diatoms, and the dinoflagellates.

Plants. The primary colonist of salt marsh is commonly *Spartina foliosa*, which forms a belt at the level of mean high water. However, in the better-drained areas, it is often replaced by the second dominant species, *Salicornia bigelovii*. This combined *Spartina-Salicornia* community occupies the greater portion of the marshes. Some other species of salt-marsh grasses are usually found in association with them. MacDonald (1969) identified seven most frequent associates and discovered that the components of the associated floral groups were quite different north and south of Point Conception.

Algae. The most common and abundant algae is the tubular, filatemtous form of green seaweed, *Enteromorpha crinita*. This species can withstand a wide range of salinity, temperature, and exposure to air and therefore is the most widely distributed algae occurring in bays and lagoons, particularly in quiet-water areas. Another factor contributing to the ubiquity and abundance of *Enteromorpha* in San Diego County is, assumed by Bradshaw and Mudie (1972), the discharge of nutrient-rich sewage effluent into the lagoons. On the mudbanks of quieter water in Anaheim Bay, this species of green algae was reported to form a mat covering an areas as large as 7 m^2 (8.4 yards) with 5 centimeters (2 inches) thickness (Shubin, 1975).

The zonation of plants in salt marshes is governed by several environmental factors, but it appears that tide is the single, most important factor in determining the distribution of salt marsh plants (McLusky, 1971).

Both Chapman (1960) and MacDonald (1969) have noted that above the level of MLHW (mean low high water; the intertidal zone that is exposed at least once every 24 hours) there are two major sub-environments in a marsh, namely, the low marsh and the high marsh (Figure II.F.1.a-5). The former extends from the lower limit of salt marsh vegetation to the level of MHHW (mean high high water; with more than six hours of tidal submergence at each tide and less than 15 days of continuous tidal

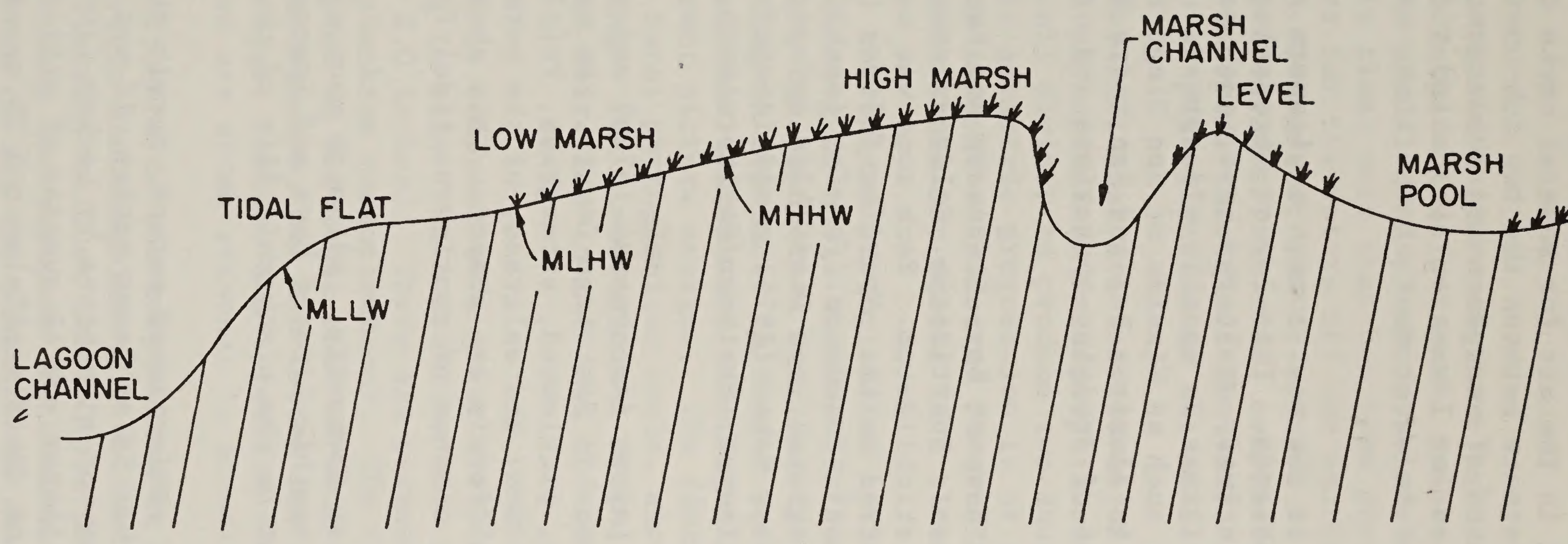


Figure II.F.1.a - 5 Diagrammatic cross-section of tide levels and marsh zones in Mission Bay.

Source: Phleger (1970)

emergence), and the latter includes the zones between the levels of MHHW and EHW (extreme high water; with less than six hours of tidal submergence and may be exposed in the air for several weeks or even months). Thus, the major difference between the two sub-environments is the frequency and the duration of emergence and submergence. The area between MLHW and MLLW (mean low low water) is called tidal flat, and the land there is submerged in water most of the time, except during extremely low tides.

The eelgrass, *Zostera marina*, is the most common angiosperm growing on the permanently inundated marshlands. This lowest vegetative zone is called the Zosteretum. In relatively unaltered bays, such as Anaheim and Upper Newport Bays, the eelgrass is usually widespread. However, in substantially altered bays, such as Mission or San Diego Bays, it is reduced to small patches; and in Alamitos Bay and San Pedro Bay, this species has disappeared because of dredging operations and other activities of man.

Above the Zosteretum, in Upper Newport Bay, Stevenson and Emery (1958) identified five additional zones: Spartinetum, Salicornietum, Suaedetum, Monanthocloetum, and Distichlidetum. Each zone was named after the dominant species that occurred in it: *Spartina foliosa* (cordgrass), *Salicornia bigelovii* (pickleweed), *Suaeda californica* (seablite), *Monanthochloe littoralis* (shoregrass), and *Distichlis spicater* (saltgrass). However, in Anaheim Bay, Baker (1975) could identify only three additional zones: Spartinetum, Batietum/Salicornietum, and Distichlidetum.

It is noted that in San Elijo Lagoon (Anonymous, 1972b) and other periodically closed small lagoons in San Diego County, the typical salt marsh grasses, e.g., cordgrass, pickleweed, arrowgrass, *Triglochin maritima*; saltwort, *Batis maritima*; and eelgrass, of the permanently submerged zones in Southern California are absent. This absence is apparently associated with the absence of continuous tidal flushing in these lagoons.

ii. Plankton Community: Although many studies and surveys have been made on the benthic life of bays and lagoons, only a few works have been carried out on the planktonic life of the same water bodies.

Estuaries and bays, with their semienclosed nature, permit the maintenance of a plankton community that is at least native, if not strictly endemic (Riley, 1967). A survey of microbiota by Lackey (1967) reported 57 species of dinoflagellates and 41 species of ciliates from San Diego Bay, and 49 species of dinoflagellates and 23 species of ciliates from Mission Bay, but only 25 species of the former and four species of the latter were common in both bays, in spite of the entrances of the two bays being only about 11.2 kilometers (6.94 miles) apart.

Another characteristic feature of the plankton community in estuaries and bays is its large volume but small number of species. As in Anaheim Bay, the annual mean plankton volume was 0.451 ml/m^3, which is about two to six times more than has been previously reported for plankton volumes for the waters off the Southern California coast (Howey, 1971). However, of the 12 species of copepods that occurred in the bay, one species, *Acartia tonsa*, comprised an average of 89.6 percent of all copepods throughout the year. Bothwell (1971) reported a low diversity of phytoplankton in the small Goleta Point Marsh.

Diatoms and dinoflagellates are the two major groups of phytoplankton. Reproduction in phytoplankton is accomplished chiefly by binary fission in which each cell divides to produce two daughter cells. This population increase by geometric progression is of great ecological importance, since it enables a rapid response to favorable growing conditions and in certain circumstances may result in a bloom, such as red tides.

In Mission Bay, the annual phytoplankton cycle was characterized by a major bloom occurring in April and May (Fairbanks, 1969). During the rest of the year, the population remained fairly constant with the smallest occurring in September in deeper water and January at surface water. However, when diatoms and dinoflagellates are examined separately, a different picture emerges. The diatom cycle appeared very similar to the total phytoplankton cycle, except with less pronounced April-May peaking. The dinoflagellate cycle, however, reached two peaks during the year, one in the fall and another greater one in the spring.

The zooplankton is composed of a great array of micro-and macroscopic animals ranging in size from a fraction of a millimeter to 30-50 millimeters (1.2 to 2.0 inches). There are permanent plankton (holoplankton) and temporary plankton (meroplankton). The former are those animals completely adapted to a pelagic mode of existence, like copepods, mysids, and chaetognaths, and the latter are the transitory floating stages such as eggs, larvae, and juveniles of the benthos and nekton. The meroplankton are often seasonal in occurrence and abundance.

The major constituents of the zooplankton in Mission Bay include: *Noctiluca* (holozoic dinoflagellates), *Heliocladus* (radiolarians), tintinnids (ciliates), mollusk larvae, polychaete larvae, barnacle larvae, cladocerans, and copepods (Fairbanks, 1969). Copepods are the major constituents of all the plankton at all depths throughout the year in Mission Bay. The copepod is also the major constituent of zooplankton in Anaheim Bay and generally in most other bay environments.

Although *Noctiluca* is one of the major constituents of zooplankton in Mission Bay, it was not recorded at all by Lackey and Clendenning (1965) from San Diego Bay, where more than 100 species of dinoflagellates and more than 30 species of colorless zooflagellates are known to occur.

In Anaheim Bay and Mission Bay, the peak of zooplankton population occurs mainly in the winter and spring months. This is attributable to the early appearance of larvae of the benthic invertebrates along the California coast (Painter, 1966; Sowby, 1973).

iii. Benthic Community: Since the flora of the benthic community have been discussed (Section a.i), this section is devoted to the fauna.

Microbenthos. The microbenthos includes bacteria, blue-green algae, and most of the Protozoa. Bacteria are both benthic and planktonic and have as much influence on the distribution of other plants and animals in the marsh and bay as have temperature, salinity, nutrient concentration, and other physical and chemical parameters (Hedgpeth, 1957).

Bacteria are important, on the one hand, in decomposing dead organic matter which supplies necessities of plant growth, such as nitrates, phosphates, carbon dioxide, etc., and, on the other hand, in serving as food for the various bottom-dwelling animals. Zobell and Felthm (1942) have noted that bacteria are much richer in the water and mud of a bay than in the waters of the open sea.

The benthic foraminifera of marsh areas in Mission Bay have been extensively studied by Bradshaw (1968), Phleger (1970), and Phleger and Bradshaw (1966). About 25 species are found in Mission Bay marshes. They are separated into two distinguishable fauna, a high-marsh and a low-marsh. The former assemblage consists of purely agglutinated species (with sand or silt tests) and the latter of several calcareous species. This faunal zonation of high-and low-marsh forms is, as in the case of vegetal zonation, related to elevation, amounts of tidal flooding, and exposure (Phleger, 1970). The standing crops of these foraminifera vary greatly, but generally, the largest stocks are found in the high marsh and the smallest, on the tidal flats (Figure II.F.1.a-5).

Meiobenthos. Nematoda and Copepoda are the most abundant and frequently encountered meiobenthos. The nematodes generally occur in greatest number in the top 5 centimeters (2 inches) of sediment. Large populations of nematodes have been found living in the interstitial water within mud and sand in the bays of Southern California (Frey, Hein and Spruill, 1970; Reish, 1968, 1972), but species identifications were not given in the studies. Although this is perhaps the most abundant group of animals of all benthos, it is also the least studied.

It is important to mention that an as yet undescribed cephalocarid crustacean has been found in Anaheim Bay. So far, only one intact specimen has been collected from the intertidal mud flats near Hog Island in the bay (Lane, 1975). Since several subsequent attempts to find this crustacean from the bay have been unsuccessful and only a few specimens ever have been found in the stomach contents of arrow gobies in the bay, this cephalocaridean could be one of the rarest meiobenthos living in Anaheim Bay. The cephalocarids are the most primitive living crustacean and to date only three genera and eight species are known to exist. A systematic study of this new Cephalocarida is underway.

Macrobenthos. The invertebrate macrobenthos in a bay can be suspension feeders, detritus feeders, or predators, but the vertebrates, mainly benthic fishes, are largely carnivores. The feeding habits of macrobenthos are known to be closely related to the sediment types (Carriker, 1967). The detritus feeders predominate in areas of slow currents in bays that have silt deposition; the suspension (filter) feeders exceeded detritus feeders in all areas of bays where the grain size is of fine sand (0.1-0.25 mm); and the largest standing stock of predators occur in high energy environments where the sediment size surpasses fine sand and the contents of clay and organic matter are generally low.

According to Kauwling and Reish (1975), the polychaete diversity is about equal in the four studied embayments of Southern California, i.e., Los Angeles-Long Beach harbors, Alamitos Bay, Anaheim Bay-Huntington Harbor, and Newport Bay.

Thirteen species and two genera of polychaetes are commonly encountered in the bays. These taxa were so prevalent that one could probably describe the benthos of any Southern California embayment as being characterized by several or all of them. However, many less frequently occurring species were collected from only one area, especially from the upper reaches of each embayment (Reish in Barnard and Reish, 1959).

The single most common polychaete species in Southern California's bays and harbors is probably *Capitita ambisita* which was found in all studies and usually in substantial numbers. A cosmopolitan species of polychaete, *Capitella capitata*, was discovered by Reish (1955) to be an indicator of pollution in the Los Angeles-Long Beach harbors.

The most common amphipods occurring in Newport Bay are (Barnard and Reish, 1957); *Amphideutopus oculatus*, *Acuminodeutopus heterurupus*, *Rudilemboides stenopropodus*, and *Paraphoxus* sp. Although none are endemic to Newport Bay, a certain degree of "nativeness" is observed. They are not found in any abundance on the coastal shelves bordering the bay, and the several common species of *Ampelisca*, *Paraphoxus*, and *Photis* and other open-shelf amphipods are either missing or occur only as strays in Newport Bay.

MacDonald (1969a, b) made a quantitative study of mollusks occurring in the marsh area of Mission Bay. He found that the creek fauna contained more variable species-composition than the marsh. A comparison with other marsh mollusk faunas of the Pacific Coast shows that the most abundant species, *Assiminea translucens*, in the Mission Bay marsh is the major gastropod of the Pacific Coast. The next abundant species, *Cerithidea californica*, which does not occur to the north of Point Conception, is close to its northern edge of distribution. The California horn snail, *C. californica*, is also abundant in Anaheim and Newport bays.

The standing crop of the marsh mollusk fauna in Mission Bay, indicated by biomass (dry weight in gram/m^2), remained almost constant but that of the creek fauna showed a marked seasonal variation, being highest in the summer. This variation results from changes in the abundance of *C. californica* and may reflect a seasonal migration of this species to lower elevations for breeding purposes.

The cosmopolitan species of mussel, *Mytilus edulis*, is very abundant in quiet-water of bays where there is hard substrate. It is one of the major fouling organisms occurring in the harbor. The community of *Mytilus edulis* is rich in epifauna. In Alamitos Bay, Reish (1964b) identified five species of algae, 22 species of ectoprocts, and six species of tunicates associated with this bay mussel. A direct relationship between the number of associated species and water temperature was observed; the warmer the water, the greater was the diversity of species composition.

The populations of sand dollar, *Dendraster excentricus*, occurring in the sand flat areas of Mission Bay Channel and Tijuana Estuary were studied by Niesen (1969). A comparison with the offshore population (of La Jolla Shores) indicated that there were differences in population size and size structure; the bay population was larger (about 25 individuals per 0.1 m^2), remained stable with little fluctuation in size structure, and consisted of relatively larger robust individuals (65.7 $\pm$ 0.85 mm).

As part of the BLM baseline studies, Straughn (1976) sampled three intertidal marsh areas, Salt Creek, Santa Margarita Bay, and Mugu Lagoon. Twin Harbors at the Isthmus of Santa Catalina Island also was sampled, but was somewhat unusual probably because its open communication with the sea allowed the occurrence of species typical of both the open ocean, sandy beaches, and semi-enclosed bays.

The marsh or slough sites appeared to be governed by different factors, perhaps including greater dependence on biotic interactions. Each of the three sloughs appeared to have a characteristic species complement.

The observed range of salinities reflects changing exposure to seawater intrusion of freshwater inflow from water courses and runoff.

Vertebrates. Anaheim and Newport bays are the only two embayments in Southern California where a systematic survey on the fish has ever been attempted. A total of 68 species were recorded from Anaheim Bay by Klingbeil, Sandell and Wells (1975), and Dixon and Eckmayer (1975), and 61 species from Newport Bay by Bane (1968) and Frey, Hein and Spruill (1970). As expected, the fish fauna of these two bays are comparable, with more abundant species generally being common to both bays. Very few species that are common in one bay are uncommon in the other. All fishes recorded from the bays are not, in the strict sense, benthic forms. Some fishes, like flatfish and goby, are true macrobenthos; others, like killifish, topsmelt, and surfperch, although not strictly benthic in occurrence, are closely associated with substrate in that they all feed on benthic invertebrates.

iv. Permanent Dwellers and Seasonal Visitors:

Most of the animals living in the bays and lagoons are recruited originally from the sea. They enter the bay either as adults to spawn, mate, or feed or as larvae to settle down. Nektonic species (mostly fish) can move in and out of the embayment independently of the tidal current, but meroplankton rely entirely on the tidal current for their immigration and emigration. In Southern California bays and lagoons, salinity characteristically does not constitute an important factor in controlling the recruitment of neritic members. The constricture of the bay mouth is particularly important in limiting the immigration and emigration of meroplankton.

The permanent dwellers are the major members of the bay community, which consists of all of the sessile invertebrates, the infauna, the tubicolous animals, and some fishes typically found in the bay.

The sand dollar, *Dendraster excentricus*, is a permanent dweller of the bays. Several populations were observed by Niesen (1969) for a year in San Diego regions. The species composition of these beds seems to reflect the locality of the population, e.g., the anthozoan coelenterates and asteroids are associated only with the open shore beds but not with the estuarine beds.

Four of the seven most common teleosts fishes recorded from Anaheim Bay are permanent dwellers in that bay. They are the topsmelt, *Atherinops affinis*; the California killifish, *Fundulus parvipinnis*; the arrow goby, *Clevelandia ios*; and the diamond turbot, *Hypsopsetta guttulata*.

Fish which use Anaheim Bay for nursery or spawning grounds are the California halibut *Paralichthys californicus* (Haaker, 1975), the Pacific staghorn sculpin *Leptocottus armatus* (Tasto, 1975), the deepbody anchovy, *Anchoa compressa* (Klingbeil, 1962) and the comon elasmobranch, *Mustelus californicus* (Sandell, 1973).

The marshlands and mud flats of bays and lagoons attract many species of birds. These areas are an excellent habitat for residential birds and ideal resting and feeding area for migratory shorebirds and water birds. More than 150 species of birds have been seen in Anaheim Bay, 158 species in Upper Newport Bay, about 200 species in Buena Vista Lagoon, and 128 species in San Elijo Lagoon (Carlberg, 1940; Speth, 1969). Based upon the 1967-68 census conducted by the California Department of Fish and Game, a conservative estimate of close to 4 million bird-days-use was calculated for Upper Newport Bay. The shorebirds accounted for 74 percent of this use and the ducks for the other 26 percent. The greatest use was found to occur from mid-September to April.

v. Productivity and Coastal Ecology: The inshore areas such as shallow seas, bays, lagoons, and estuaries are generally very productive. In favorable circumstances, net primary productivity may be comparable to a tropical rain forest (Mann, 1973). The bottom frequently supports a rich fauna, with benthic invertebrates alone often amounting to a standing crop biomass in excess of 100 grams of protoplasm (mainly pelecypods, polychaetes, and crustaceans) in each square meter of mud bottom (Russell-Hunter, 1970). Maintenance of such a large production of benthos in the shallow areas of the sea is made possible through the abundance of food and nutrient in the areas.

The rich benthic invertebrate fauna in the shallow areas, in turn, serve as food for the demersal fishes and shorebirds. In his quantitative study on the diamond turbot of Anaheim Bay, Lane (1975) estimated that for growing one gram of protoplasm, the turbot needs to consume 8 grams of polychaetes, clam siphons, and crustaceans combined.

b. Baja California: In the Baja California region, considered by this Environmental Statement, apparently the only bay which has received extensive biological coverage is Bahia de San Quintin. Seemingly similar to the semi-enclosed bays of the arid Southern California region, it was relatively nonpolluted in 1960, particularly when compared to the highly altered bays of the Southern California portion of the Bight. This offered an excellent opportunity for a study of an unaltered bay in its natural condition.

Barnard (1963) describes the bay:

> Bahia de San Quintin lies at the shoreward edge of the Santa Maria Plain, a relatively featureless flatland west of the Santa Maria escarpment which trends north and south about 5

miles east of the ocean and impinges on the coast just south of Bahia de San Quintin. The northern part of the plain devolves onto rolling hills, which are green with vegetation only during a short time of the winter-spring. Rainfall is scarce, probably less than 4 inches per year and often perhaps less than 2 inches. The low scrub vegetation belongs to the Californian phytogeographic area (Wiggins 1960, map). The southwestern edge of the Santa Maria Plain is clearly dominated visually from distances as great as 30 miles by a group of cinder cones molding the complex topography of the bay itself.

The salinity of Bahia de San Quintin, as would be expected, is relatively uniform and the same as normal seawater, with the very slight increase at the upper reaches of the bay of no apparent biological importance.

Bahia de San Quintin is a shallow bay, about 85 percent of the eastern arm lying in depths of 6 feet or less at mean high water. Depths greater than this occur in channels that are strongly differentiated from the shallow bay flats by sharp depth changes.

According to Reish (1963), the faunal affinities of the bay are clearly related to Southern California bays and harbors, particularly with respect to the polychaete worms. Many polychaetes had definite sediment relationships.

Probably because of the shallow bottom of the bay and the nutrient supply obtained from upwelling (nutrients from land drainage most probably are minimal, particularly when compared with those in regions of higher rainfall), much of the bay has substantial populations of benthic algae.

Dawson (1963) conducted the algae survey and reported the dominant vegetation to consist of two kinds: 1) marine flora consisting of extensive beds of eelgrass, *Zostera marina*, covering many acres of mud flats which are only slightly submerged at low tide; 2) a salt marsh flora of extensive development along nearly half of the low-lying margins of the bay subject to tidal flooding. Some of the features of these two vegetations which are seldom contiguous, but usually separated by broader or narrower bands of barren, sandy, or muddy flats exposed at low water, are taken up in turn. Distributions of these vegetative types in Bahia de San Quintin are shown in Figure II.F.1.a-6. Many of the species of the marsh flora are the same as those reported by MacDonald (1969) as characteristic of Southern California.

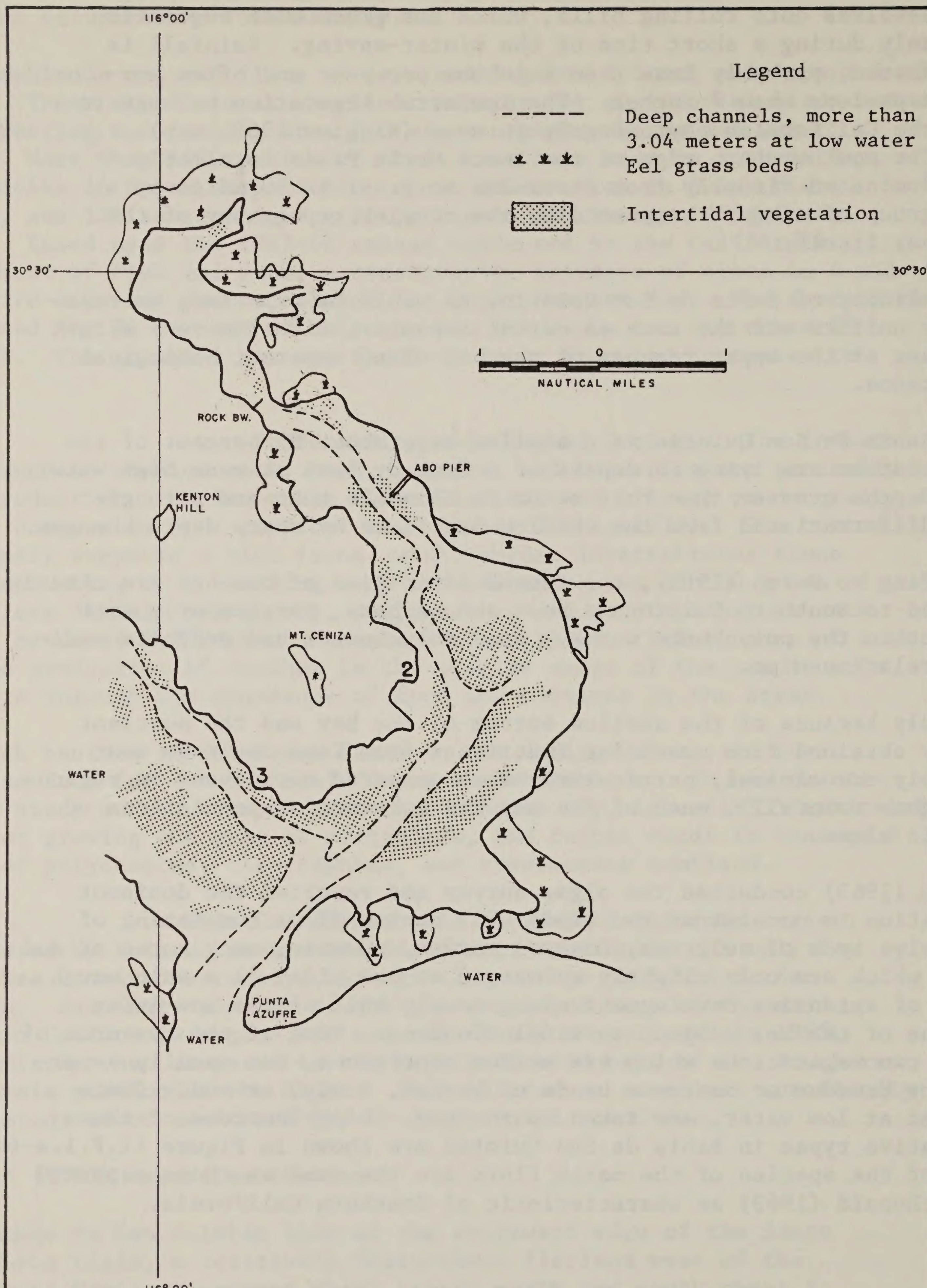


Figure II. F. 1. a.-6 Bahia De San Quintin, Distribution of Eel-Grass Beds - April, 1960. Bahia San Quintin showing Zostera beds as observed and photographed at low water level, April 1960.

Source: Dawson (1963)

Over 95 percent of the marine vegetation of Bahia de San Quintin consists of eelgrass, *Zostera marina*. This plant forms broad, dense stands occupying that greater part of the muddy bottom of the bay which is neither exposed at lowest tide levels, nor submerged to depths exceeding 3 m (10 feet) at high water. The best developed beds occur in the middle parts of the bay on flats which carry 0.3-1 m (1-3 feet) of water at lowest tide.

Compared to the preponderance of *Zostera*, the algal vegetation of the bay is inconspicuous. Nevertheless, several species occur in moderate abundance. Fifteen of the 30 identified algae species are of cosmopolitan or wide-spread distribution in the warm-temperate northern hemisphere and are to be expected in almost any such confined body of water as Bahia de San Quintin.

c. Central California: Each major habitat group of the bays and estuaries will be covered separately. For more detailed information of each of these groups, refer to these sections. The estuarine habitat, including lagoons, sloughs, and salt marshes, ranges in size from the immensely large San Francisco Bay to the relatively small lagoon on the campus of University of California, Santa Barbara. These areas receive fresh-water from upland drainage which then intermixes with seawater, giving a brackish condition. These estuarine ecosystems are among the most productive in the world.

i. Plankton Community: The majority of this section was taken from Riznyk's (1977) and Holton, Leatham, and Crandell's (1977) contribution to the BLM sponsored literature survey of northern and central California. Except for San Francisco Bay (see POCS Reference Paper No. II) very little plankton work has been done in central California estuaries.

A study of phytoplankton population fluctuations was done in Morro Bay but for a limited period of two months (Leeds, 1975). It was the intent of this study to indicate numerical relationships in the abundance of phytoplankton, zooplankton and bacteria. It was noted that when the numbers of zooplankton increase, the numbers of phytoplankton decreased. On each occasion, plankton was collected from early morning to late afternoon. Table II.F.1.c-1 presents the average numbers of organisms per cc at the four stations within the bay. A variety of phytoplanktonic taxa were collected and identified but the diatoms and the blue-green algae were most prevalent.

ii. Benthic Community: The following account of estuarine benthic plants and animals comes from Hancock (1977) and Hardy (1977).

Table II.F.1.c-1

NUMBERS OF PLANKTON/CC IN MORRO BAY AT EACH SAMPLING STATION AND SAMPLING DATE. FIGURES ARE AVERAGES OF FOUR VALUES

	April 21	May 5	May 27
Target Rock Station			
Phytoplankton	0.466	0.198	3.166
Zooplankton	0.011	0.027	0.009
Bacteria	7425	975	351
Harbor Master's Dock			
Phytoplankton	0.373	0.306	3.101
Zooplankton	0.014	0.011	0.069
Bacteria	5402	1715	402
Public Launch			
Phytoplankton	0.308	0.559	3.346
Zooplankton	0.009	0.023	0.023
Bacteria	2462	1130	406
Chorro Creek Station			
Bacteria	7020	915	291

Source: After Leeds (1975).

Point Reyes is a most prominent headland and is bounded on the east by Drakes Bay, a protected open embayment with an irregularly shaped estuary, Drakes Estero, opening into the bay.

Summarizing the bays of central California, Odemar, et al., (1968) indicated each type of shore has an assemblage of specific forms not found elsewhere, mingled with animals that occur almost anywhere, and a few strays from neighboring environments. Bays and estuaries provide relatively quiet waters and protection from the surf along the shoreline. Within the study area, these conditions are found within Drakes Estero, Bolinas Lagoon, San Francisco Bay, to a limited extent in Half Moon Bay, and Elkhorn Slough near Moss Landing. Rocky shores, sandy beaches and mud flats occur in these areas.

Protected Rocky Shores. On rocky shores in bays and estuaries there are some animals and plants that occur on the open coast plus some that, because of no wave shock, have moved up from deeper water.

Others will be unique to these protected rocky shores. Barnacles, mussels, crabs, starfish, rock boring clams, tube building worms, anemones, hydroids, and bryozoans are among the animals found here. The biota consists of forms that are adapted to attach, bore, or if foragers, to cling to the rocky substrate.

Limpets and periwinkle snails are among the animals found at the highest tide line. The common barnacle *(Balanus glandula)* is found here also, as are bay mussels, hermit crabs, the purple shore crab, cancer crabs, the common starfish (*(Pisaster ochraceus*), and pink starfish (*P. brevispinus*). Native oysters are common to this habitat as well as predatory drilling snails.

<u>Protected Sand Flats</u>. Protected sand flats are sparsely inhabited above the zero tide line but subtidally competition is keen. Sand dollars, crabs, several snails (notably the moon snail and purple olive), clams such as shrimp (*Crago nigricauda*) also prefer a sand substrate. All sand dwellers are burrowers, at least to some extent. Attaching sessile animals and algae are excluded from shifting sand bottoms.

<u>Mud Flats</u>. The mud flats present different problems of respiration and food gathering in addition to lack of attachment sites. Starfish and urchins being skin breathers are unsuited to this habitat and other rocky shore animals also find no suitable habitat here.

The common shore crab of the mud flats in the study area is the mud crab. Burrowing anemones and sea pens are found here as are the burrowing shrimps (*Callianassa* and *Upogebia*). Mud snails may occur in abundance foraging over the surface of the mud flats. Abundant mud flat clams include the gaper, Washington, and softshell clams. The razor clam (*Tagelus*) and bentnose clam also live in this habitat. The urechid worm (*Urechis caupo*), a sipunculid (*Sipunculus nudus*), and numerous other species of worms are found here, also.

<u>The Salt Marsh Vegetation</u>. Hardy (1977) gives an account of salt marshes of California. The salt marshes of northern California probably extend over somewhat less than 229 square kilometers, with more than 55 percent of this area in San Francisco Bay.

MacDonald and Barbour (1974) have surveyed the beach and salt marsh vegetation along the Pacific Coast between Point Barrow, Alaska and Cabo San Lucas at the southern tip of Baja California. They define coastal salt marshes as areas that occur on shorelines sheltered from excessive wave action, typically around the margins of lagoons, bays, and estuaries, or behind barrier spits and islands. There, vegetated portions of the upper intertidal zone are usually carpeted with a dense cover of phanerogams occasionally interspersed with macroalgae. On the Pacific Coast, this zone usually runs from the mean low high water mark upwards to a level which is more difficult to define but usually coincides with the extreme high water line. The vegetation is usually restricted to a small number of halophytes, usually less than 10, but rarely as many as 20 species per site. As salinities decrease with fresh water inflow, or as human disturbance increases, upland species become more common and the diversity of marsh flora rapidly increases. If we follow the floristic changes which occur from the north towards the south, there is a major break in the area between Cape Franko, Oregon and San Francisco Bay. Several northern species begin to drop out and new forms are joined by *Spartina foliosa*, *Frankenia grandiflora*, and *Limonium californicum*.

The salt marsh vegetation of California has been treated in some detail by Mason (1957). The marshy areas around Morro Bay, Moss Landing, San Francisco Bay, Tomales Bay, Humboldt Bay, and Bodega Bay provide extensive areas for the growth of halophytic (salt loving) plants. Two species of Salicornia (pickle weed or glass wort), *S. virginicia* and *S. europea*, may be abundant. The commonest halophytic grass in the salt marshes and sandy flats of northern California is *Distichlis spicata*. This is a perennial plant consisting of extensive creeping rhizomes with spiny, somewhat stiff leaves arising in dense colonies. It normally grows at the margins of marshes or above normal high tide line on the shore where only unusually high water may cover it.

The California cord grass *Spartina foliosa* grows 0.3 to 1 m ((1 to 3 feet) in height, usually in marsh waterways where the tide rises to about half its height or more. *Frankenia grandiflora* grows as a low bush 10.2 to 40.6 cm (4 to 16 inches) tall and forms noticeable pink flowers. Like *Distichlis*, it inhabits salt marsh margins where the soil is infrequently covered with salt water.

Eel Grass. Eel grass *Zostera marina* is found on flats ranging from almost pure sand to very soft mud. Eel grass beds support a characteristic group of animals that live on the blades, about the bases, and in the substrate among its roots. Included in the animal assemblages are snails, hydroids, nudibranchs, clams, and polychaete worms. The matted roots of eel grass prevent the substrate from being readily washed away, thus providing homes for less nomadic animals than live on shifting sand flats.

The morphology and development of the marine seagrass *Zostera marina* was treated in depth by Setchell (1929). *Zostera marina* follows a seasonal succession of growth, reproduction and dying-back of parts. In the variety *latipholia*, rhizomes become separated and in a few years become very numerous, each representing a new individual through disjunction of both the older rhizome segments and the erect flowering segments. These activities of both vegetative and reproductive growth are confined to water temperatures from 10 to 20°C, with vegetative growth primarily from 10 to 15°C, and reproduction and maturing of the fruits from 15 to 20°C. As the water temperature rises above 20°C, the rhizome and leaves cease to grow and the older portions of each die and slowly disintegrate. This quiescence is termed "heat rigor" and continues through the downward progression of temperature from 20 to 10°C.

Elkhorn Slough. Elkhorn Slough is a rather large slough in the Moss Landing area of the bay. As nature's classroom, it has been the site of many classical marine biological investigations. Most of the studies of this area are unpublished student papers. It appears that a comprehensive quantitative study of the area has not been published (Hancock, 1977).

iii. Estuarine Fish: The information on the fishes of the estuarine section comes from DeWitt and Welsh (1977). Central California's coastline is poor in true estuarine environments. The major bays in the survey area, from north to south, are Drakes, as well as Bolinas Lagoon, the San Francisco Bay complex, Monterey, Morro, and San Luis Obispo Bays. The latter three bays are rather broad coastal indentations (bights) having true estuarine habitats restricted to small river or creek mouths along their perimeters. The balance of the list consists largely of marine embayments which lose a large portion of their water with each falling tide. Species composition of these embayments is not unlike the near-shore fauna found outside them. The fishes in Humboldt, Monterey and Morro Bay exhibit a strong affinity with the nearshore and pelagic fauna. In Monterey Bay, estuarine forms are limited to Elkhorn Slough and the mouths of the Pajaro and Salinas rivers (Kukowski, 1972).

The role of central California's bays and estuaries as nursery areas is not well known. The few larval fish surveys undertaken in California's nearshore waters have documented the presence of many species of ichthyoplankton (fish larvae). Nonetheless, we are far from understanding the role that river mouths, coastal lagoons, and embayments play in the early life history of economically important species. Due to the highly seasonal nature of precipitation, estuarine conditions may exist in river mouths only briefly each year. A salt wedge with its associated estuarine forms may penetrate coastal streams during the dry season; however, as soon as the often torrential fall rains begin, the strong outpouring of freshwater tends to obliterate the estuarine conditions that may exist. Fine silts, which are characteristic of the bottom's many nursery areas, are scoured from river mouths by these increased flows. Furthermore, in the northern portion of the State, river silts are often largely inorganic sediments not conducive to productivity.

POCS Reference Paper No. II presents a list of fish species which have been collected at eight estuarine habitats in northern California. The regular estuarine inhabitants such as three-spined stickleback, staghorn sculpin, and starry flounder, all species which exhibit a strong degree of euryhalinity, represent a very small portion of the list.

2. Kelp Beds

a. Southern California: The giant kelp or *Macrocystis*, identified by having many floats (pneumatocysts), extends from Sitka, Alaska to Point Abrevjas, Baja California, but does not form extensive forests north of Ana Nueva. The bull kelp or *Nereocystis*, having a single float from which orginate numerous lamina or blades, extends from Alaska to Santa Barbara, but forms forests only north of Point Conception (Smith, 1969; Bell and Ally, 1972). Despite similarities, there are enough life history and "life style" differences to effect significantly dissimilar ecological needs and relationships. Most significant of the life history differences is that *Nereocystis* is an annual and the forest composed of this species is almost completely replaced every year while *Macrocystis* is a perennial and the individual plants of the forests tend to remain for periods of over a year. For more detailed information see POCS Reference Paper No. II.

The Giant Kelp *Macrocystis*. Unless otherwise indicated, the information for *Macrocystis* was taken from North (1971) who conducted his studies in Southern California.

The distribution of the giant kelp in Southern California is shown in Visual No. 2. These data are from the BLM sponsored study reported by Hodder (1977) conducted in 1975.

The plant kingdom has a slightly different life cycle than does the animal kingdom, involving an alteration of two different life stages called gametophyte and sporophyte. Particularly in larger species, these stages consist of different morphological forms, the sporophyte being the larger and longer lived in kelp. The life history of *Macrocystis* has been developed in the laboratory with confirmation of some of its phases in the field, although the gametophyte generation has apparently never been found in the field.

The life history of *Macroscystis* consists of a large, long-lived (from 1 to 6 years) sporophyte plant and a microscopic short-lived (several months) gametophyte plant. Except for some asexual reproduction of one species in a limited geographic range, this sexual life cycle is necessary for the propagation of the species. The completion of the life cycle in Southern California requires 1 year in optimal environmental conditions and probably somewhat longer under other conditions.

North (1971) determined that kelp closest to an outfall disappears first and further regression spreads from this center. This pattern was the principal evidence suggesting a relationship between waste discharge and kelp disappearance. The most likely cause of widespread deterioration appeared to be turbidity, but direct evidence is lacking. As suggested by Frey (1971), once deterioration of kelp areas has begun in polluted areas, reestablishment of kelp by natural mechanisms is nearly impossible so long as the pollutants continue to be released into the area. Conditions associated with sewage outfalls have lead to the establishment of large sea urchin populations. The urchins not only destroy the remaining kelp through grazing but keep young plants from becoming established. Once the kelp is gone, the urchins are able to survive by living off the sewage discharge nutrients. The urchins can apparently absorb 50 percent of their minimum daily nutrient requirements from the surrounding water. This ability allows large urchin populations to continue to exist in areas that formerly contained kelp beds. Kelp beds can and have been restored by human transplanting and management, however.

Many environmental factors influence the distribution of *Macrocystis* beds. On a geographic level, temperature is the most important, but in local areas substrate, surf, and depth are the most important. Although kelp is limited to rocky substrate at exposed areas of heavy surf, it becomes established on a sand or mud substrate in relatively quiet waters where danger of burial by sediment shifts is small. Holdfasts of adult kelp can withstand some smothering, but stipes are sensitive to being enclosed or covered by silt. Shifting sediments are more of a hazard to juveniles which have small holdfasts that are easily buried.

The inner limit of a kelp bed often appears to be controlled by wave action. In calm, protected areas *Macrocystis* beds occur as shallow as 2 or 3 m (6 to 9 feet) or even appear intertidally. Along open coasts, the inner limit usually is at depths of 5 to 10 m (5.5 to 10.1 yard).

The role of competitors in limiting the inner distribution of *Macrocystis* beds appears less important than that of surf, but no doubt has some influence. The algae shoreward to *Macrocystis* beds are characterized by having superior attachment mechanisms which can withstand wave action. In Southern California, this area is dominated by the feather-boa kelp *Egregia* while surf grass *Phyllospadix* sp. is often dominant in still shallower water.

The outer limit of kelp beds is probably determined by light intensity at the bottom. In turbid waters, beds are limited to depths of 15 to 20 m (16.3 to 21.9 yards) while in clear waters they often occur at depths of 25 to 30 m (27.3 to 32.8 yards). The fact that the outer edge of kelp beds is typically even, whereas the inner edge is usually irregular, has caused the hypothesis that a single, fairly constant factor limits have a single large pneumatocyst which apparently prevents excessive submergence and allows the fronds to remain in the optimal light zone. In Southern California, this niche may be occupied by *Pelagophycus*, a species which does best in areas of substantial current. In central California, this niche often is occupied by *Nereocystis*.

As discussed by North (1971) cyclical fluctuations in *Macrocystis* beds do not follow a single, well-defined pattern. He listed three kinds of regular changes, non-regular changes and lack of changes. The latter occurs only from Santa Barbara to Point Conception on sandy bottoms.

Associated Flora and Fauna. According to North (1971) the niche filled by *Macrocystis* includes at least five roles:

1) Primary producer of organic matter.
2) Provides shelter and crevice environments.
3) Provides substrate for encrusting organisms.
4) Shades the bottom, giving rise to two separate effects:
   a. Modifies vegetation by affecting photosynthesis.
   b. Attracts animals that avoid bright light.
5) Competes with water in radiant energy adsorption by means of a flotation mechanism.

Dawson (1966) emphasized that kelp forests contain associated algae throughout, although, as North (1971) has indicated, they are greatly reduced compared to hard-bottom areas outside the beds.

Although kelp beds look very much alike at the surface, there are usually striking differences on the sea floor, and the composition of associated algal species varies with location in accord with environmental factors including substrate, exposure, upwelling, temperature, depth, etc. (Dawson, 1966). Particularly where the surface canopy is not extremely thick (McFarland and Prescott, 1959) or in open patches within the bed, there occurs a multilayered vegetative cover (Dawson, 1966) which is very broadly similar to a multilayered tropical forest. Below the thin surface canopy Dawson described an intermediate layer consisting of species that are stalked or tree-like having heavy, erect stipes which hold the fronds off the bottom. The third or bottom layer consists of short forms of brown, green and red algae in varying degrees of profusion and array of forms. Dawson (1966) indicated jointed corallines are the most ubiquitous, growing both outside and in the deep shade of the canopy. Crustose calçareous corallines occur as pink layers on bottom rocks and often cement together pebbles, shells, and sand to form nodules and areas of rough pavement which can increase the suitable area for kelp attachment.

Another habitat is attachment on the kelp itself. Epiphytic algae receive stiff competition from encrusting annuals and are confined primarily to senile tissues of the kelp.

The "hard" substrate created by kelp plants greatly increases the habitat available to filter feeding animals (invertebrates). Phytoplankton are captured by sessile filter feeding invertebrates which encrust the solid surfaces in kelp beds. Unlike many other large brown algae, including *Nereocystis*, and *Pelagophycus*, which concentrate the laminal surfaces in one region of the water column, the *Macrocystis* assemblage is unique because the phytoplankton can be intensively utilized by sessile invertebrates from the surface to the bottom. This is because *Macrocystis* has large surface areas for attachment at all levels.

An extensive list reported by North (1971), of invertebrates associated with a kelp bed includes over 625 species. The 74 invertebrates considered by North to be common are summarized in POCS Reference Paper No. II. A total of over 810 kinds of organisms are associated with kelp beds in Southern California and northern Baja California, including 128 species of macrophytes (20 common). Quast (1968) listed 57 species of fishes. The majority of these species may not have an obligatory relationship with giant kelp, but they utilize every conceivable nook and crevice of the plant and adjacent area, thereby greatly increasing the total habitat available to them.

Because the lifespan of a kelp blade is only 2 to 4 months the sessile fauna colonizing these surfaces are also short lived. These species are primarily forms that settle, develop, and reproduce rapidly.

The heavy shade of the sea floor created by the kelp canopy causes a drastic reduction of the standing crop of shorter algae. This barren substrate becomes overgrown with sessile invertebrates, frequently clustered on top of each other to depths of 10 to 20 cm (3.9 to 7.8 inches). Because of the more enduring substrate, longer-lived species are found. The holdfast, with its labyrinth of substrates, provides a very important habitat on the sea floor.

Prominent filter feeders in kelp beds, in their usual order of importance, are bryozoans, especially *Membranipora*; hydroids; crustaceans; tunicates; and sponges. Also usually present, particularly on the bottom, are bivalves, gorgonian corals, and polychaete worms.

b. Baja California: The location of the major kelp areas is shown in Figure II.F.2.b-1. There is some evidence from both observations and transplanting experiments that kelp south of

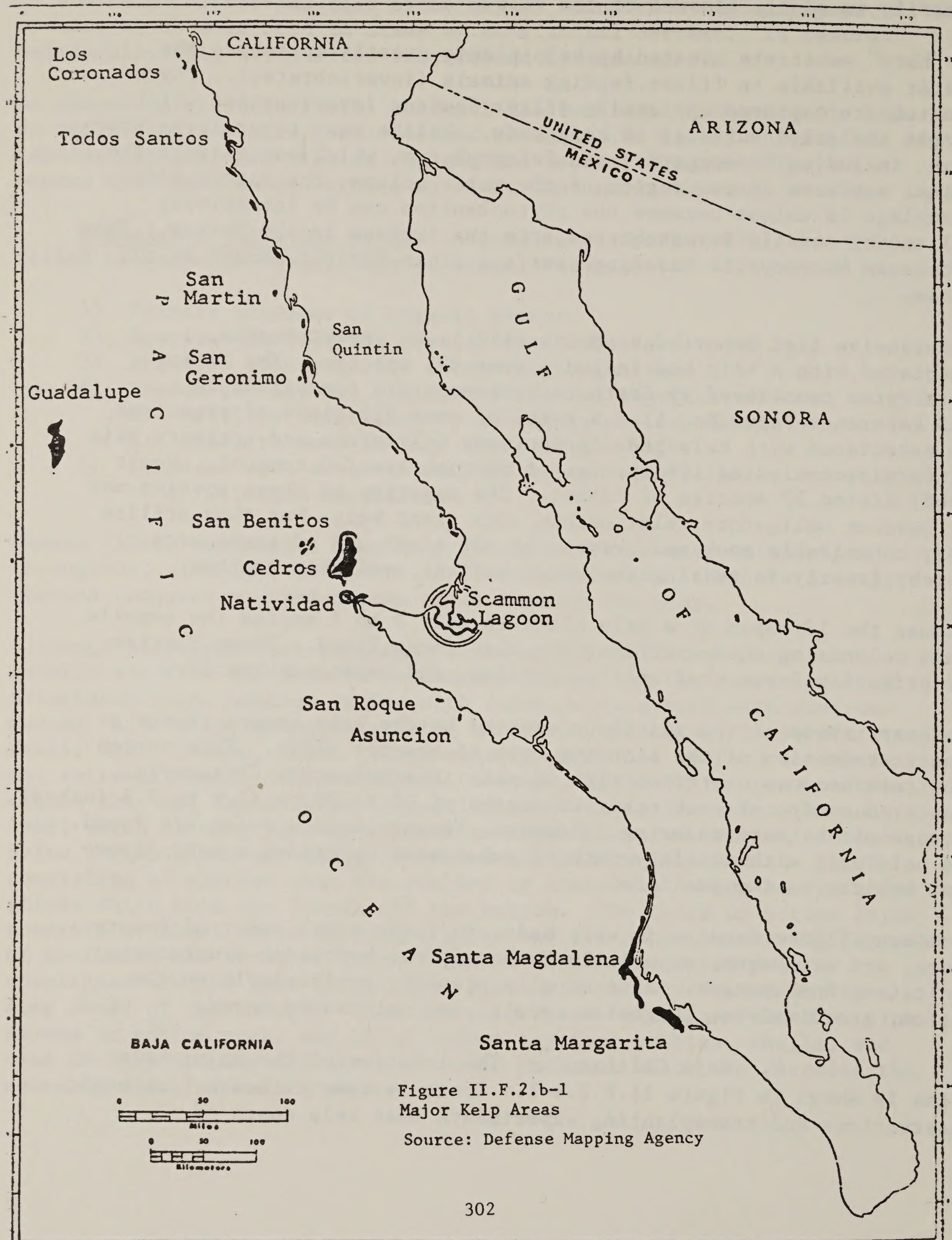


Figure II.F.2.b-1
Major Kelp Areas
Source: Defense Mapping Agency

San Diego has a somewhat higher water tolerance than the 66°F (18.9°C) which causes sloughing in California Bight populations.

The associated flora and particularly fauna probably remains pretty much the same as that of the Bight, at least until the Cedros Islands are reached. At this latitude, some recent workers (Hall, 1964 and Valentine, 1966) have reported a biogeographical transitional zone between the Californian and Panamian provinces. The division line between the major provinces, however, lies farther to the south (27°N) at Cape San Lucas. See Section II.E.3.b. for further discussion.

c. Central California: Two species form kelp forests in California and have overlapping forest forming ranges in central California.

The location of kelp beds is shown in Figure II.F.2.b-2 and was taken from Bell and Ally (1972). The beds of this area were classified as sparse kelp bed areas rather than discrete beds as indicated in the Southern California kelp map. In reality, although all notated areas represent habitat areas where kelp have occurred at various periods, they may not actually contain kelp throughout an area at any specific moment. *Macrocystis* beds, however, can be considered as fairly stable and should be fairly well represented in most areas indicated in Figure II.F.2.b-2.

The associated organisms are often different species north of Point Conception but are essentially ecological equivalents occupying the same niche having similar environmental requirements.

The algae shoreward to *Macrocystis* beds are characterized by having superior attachment mechanisms which can withstand wave action. In central California, this area is dominated by the brown algae *Cystoseira*. *Cystoseira* tends to be replaced by the feather-boa kelp *Egregia* in Southern California, although according to Burge and Schultz (1973) *Egregia* also can be important in central California. Also occupying this position in central California is the bull kelp *Nereocystis* which can be found dominating the *Cystoseira* zone, as well as depths typical of *Macrocystis*. Surf grass *Phyllospadix* sp. is often dominant in still shallower water. The species occurring past the outer edge of the *Macrocystis* zone is often occupied by *Nereocystis*, presumably because its large pneumatocyst allows the fronds to remain in the optimal light zone. *Nereocystis*, therefore, can be a competitor in both the inner and outer margins of *Macrocystis* beds north of Point Conception.

Below the thin surface canopy, the intermediate layer is comprised of *Laminaria andersonii*, *Peterygophora* sp., and *Desmarestias* sp. which are

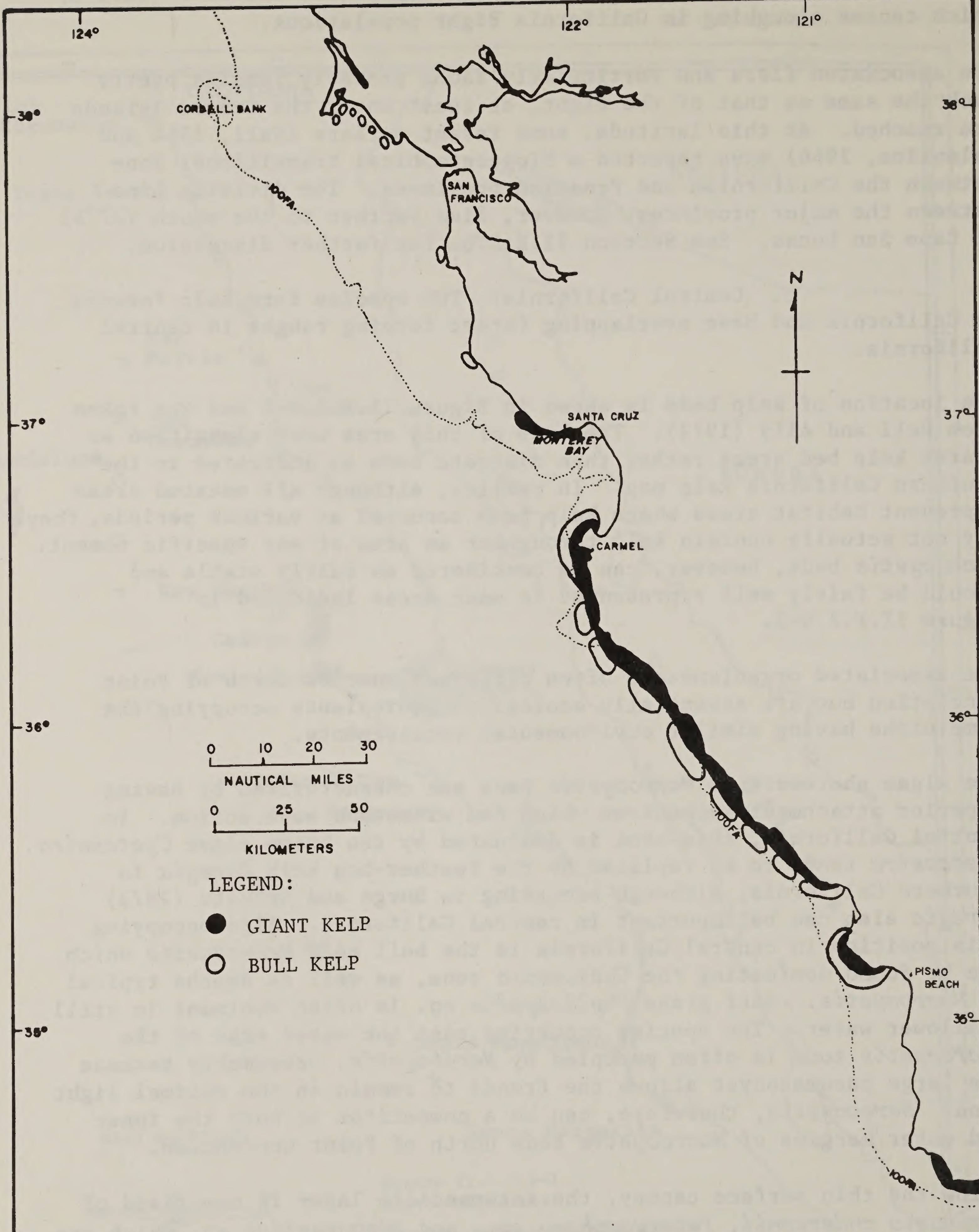


Figure II.F.2.b-2 Distribution of Kelp in Central California

Source: Bell and Ally, 1972.

the predominate species of the intermediate layer. *Cystoseira* and *Nereocystis* may represent the smaller and larger extreme of this group in certain habitats. These intermediate layer species change to *Eisenia, Laminaria farlowii, Desmarestia herbacea, D. Munda* and *Pterygophora* in Southern California.

The third or bottom layer is comprised of the same general forms as indicated above for Southern California.

The Bull Kelp *Nereocystis luetkeana*. Bull kelp does not form kelp forests south of Point Conception; and north of Cape Mendocino is sporadic in occurrence and may only form forests in shallow water during the summer (DeMartini, personal communication). Its two most ecologically significant differences compared to giant kelp are its annual life cycle and the fact that all its blades originate at the same level from a single large pneumatocyst. The shorter life cycle would tend to decrease the number of longer-lived sessile benthic invertebrates located under the forest, particularly associated with the holdfasts, and increase the competition for space with algae during the period of the year when the kelp are at their lowest abundance. This would be particularly true in clear or shallow waters. Since the fronds originate at only one level in the water column, the vertical area available to sessile corroding algae and invertebrates is reduced in comparison with *Macrocystis* which has fronds containing numerous blades throughout the water column.

Burge and Schultz (1973) observed *Nereocystis* beds in the Diablo Cove region. Dense *Nereocystis* beds developed to depths of 40 feet after which coralline red algae dominated the hard bottoms.

Nereocystis is an annual, but tends to be nearly biannual in the southern part of its range in the warmer water of most of central California.

Burge and Schultz (1973) studied the life history of *Nereocystis* in the Diablo Cove area of central California. The sporophyte generation normally occurred in mid spring (late March or early April) and the first pneumatocysts usually reached the surface in May. The sporophytes grew at a rate of 13 to 16 cm (5.1 to 6.3 inches) a day until reaching the surface after which growth slowed and eventually ceased.

The first Pacific storms during October or November initiated the kelp bed decline. Although a small number of the population lasted over the winter (from 1 to 5 percent were still present the following spring) the majority did not survive, and the bottom became littered with stipes during late fall, winter, and early spring.

3. Channel Islands

Introduction: Between Point Conception and the Mexican border are eight islands, referred to as the Channel Islands. They are usually broken into a northern group consisting of San Miguel, Santa Rosa, Santa Cruz and Anacapa and a southern group, Santa Barbara, San Nicolas, Santa Catalina and San Clemente (Figure II.F.3-1). The following section is a unit description of these islands.

San Miguel Island, 48 km (30 miles) south of Point Conception, is part of Santa Barbara County but is under the control and jurisdiction of the U.S. Navy, but, through agreement with the Department of the Interior, is administered by the National Park Service. It is sixth in size, 3,600 ha (9,000 acres). The National Park Service intends to open the island to the public, on a limited basis. However, these plans have not been formalized yet. Visitors will be closely supervised by Park Rangers.

Santa Rosa Island lies to the east of San Miguel. It is also part of Santa Barbara County but is privately owned and used extensively as a cattle and sheep ranch. The public is not allowed ashore. It is second in size, 22,000 ha (55,000 acres).

Santa Cruz is the largest of the Channel Islands, 24,800 ha (62,000 acres), and is east of Santa Rosa Island. Like the two islands above, Santa Cruz is part of Santa Barbara County. Most of the island is privately owned and used primarily for ranching. The public is not allowed in the privately owned areas, although the Nature Conservancy has purchased a portion of the island for public use. Also, the University of California at Santa Barbara maintains a research station on the island.

Anacapa Island consists of three separate islands, West, Middle and East Islands. These islands are so close, however, that they are generally referred to as being one. Anacapa is seventh in size, 280 ha (700 acres). A Coast Guard lighthouse is located on East Island. Along with Santa Barbara Island, Anacapa makes up the Channel Islands National Monument, administered by the National Park Service. Camping is allowed on East Island and visitors are allowed on Middle Island. West Island has been designated a Research Natural Area and has restricted access.

Santa Barbara Island is the smallest island with only 260 ha (650 acres). It is part of Los Angeles County. A ranger station and lighthouse are located on the northeast side. Camping is allowed on most of the island.

Santa Catalina Island is thira in size, 19,200 ha (48,000 acres), and is also part of Los Angeles County. It is privately owned except for the City of Avalon and a small adjacent area. Avalon is the only city in the Channel Islands; the population is 1,600. Avalon is a popular resort, particularly for yachtsmen. Another community has been built at the Isthmus, population about 100. A large marine science laboratory is operated at the Isthmus by the University of Southern California.

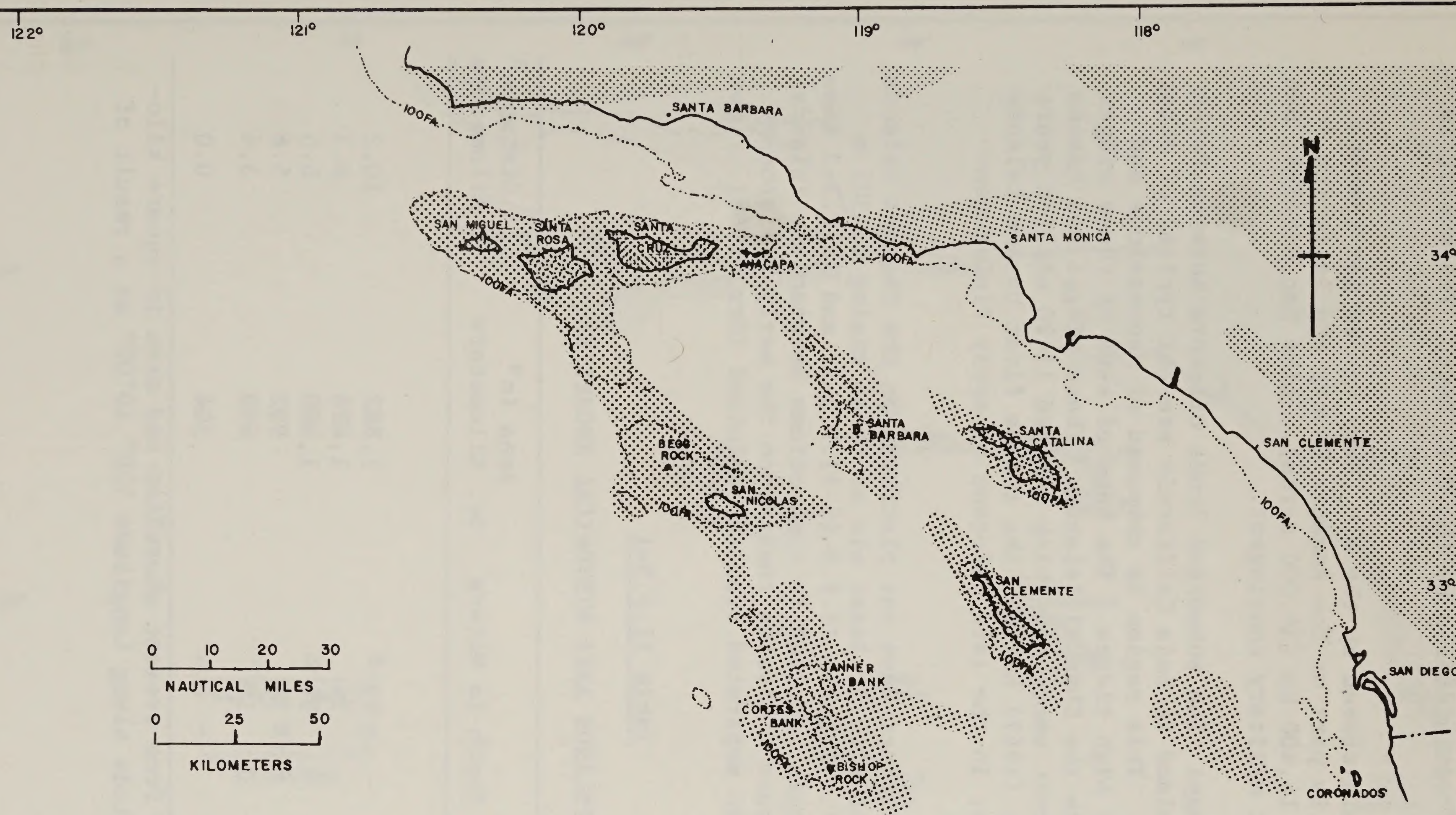


Figure II.F.3-1 Suggested generalized paleogeography of the California borderland and adjoining mainland during the late Pliocene and early Pleistocene. Small dots indicate land areas, large dots submarine ridges.

Source: Orr, 1968.

San Nicolas is fifth in size, 5,600 ha (14,000 acres), and is the furthest from shore, approximately 112 km (70 miles). It is part of Ventura County, but is owned and administered by the U.S. Navy. The public is not allowed ashore.

San Clemente is also administered by the U.S. Navy and is not open to the public. The island is part of Los Angeles County and is fourth in size among the islands, 14,400 ha (36,000 acres). Like San Nicolas, San Clemente has a permanent military contingent.

a. Geology: The submerged lands offshore between Point Conception and Cedros Island in Baja California are not typical of other continental shelf areas. This region is composed of depressions and deep basins separated by high ridges. The tops of some of these ridges break the surface to form the Channel Islands. These ridges and basins are the product of tectonic emergence which started 11-20 million years ago. Valentine and Lipp (1967) believe the ridges first became islands 2 to 3 million years ago, in the late Pliocene or early Pleistocene period.

There are at least 17 distinct wave cut platforms on the Channel Islands and the adjacent mainland with at least six of these rising to 305 m (1,000 feet) (Orr, 1968). Figures II.F.3-1, II.F.3-2, and II.F.3-3 show how these sea level changes resulted in connections between the islands and the mainland. Evidence indicates that since the early Pleistocene era the islands have been separated from the mainland (Orr, 1968). (See Table II.F.3-1.)

Table II.F.3-1

CHANNEL ISLANDS AREA HISTORICAL SHORELINE

Years	Depth in Meters	Area in[a] Sq. Kilometers	Distance[a] in Kilometers
Before Present (B.P.)			
18,000	93	1,882	10.2
16,000	74	1,425	8.3
13,000	56	1,160	6.5
11,800	37	952	5.6
9,500	19	699	3.6
Present	0	504	0.0

[a]Distance in kilometers from present shoreline and area in square kilometers of different periods along Longitude 120° 10'00" as a result of sea level changes.

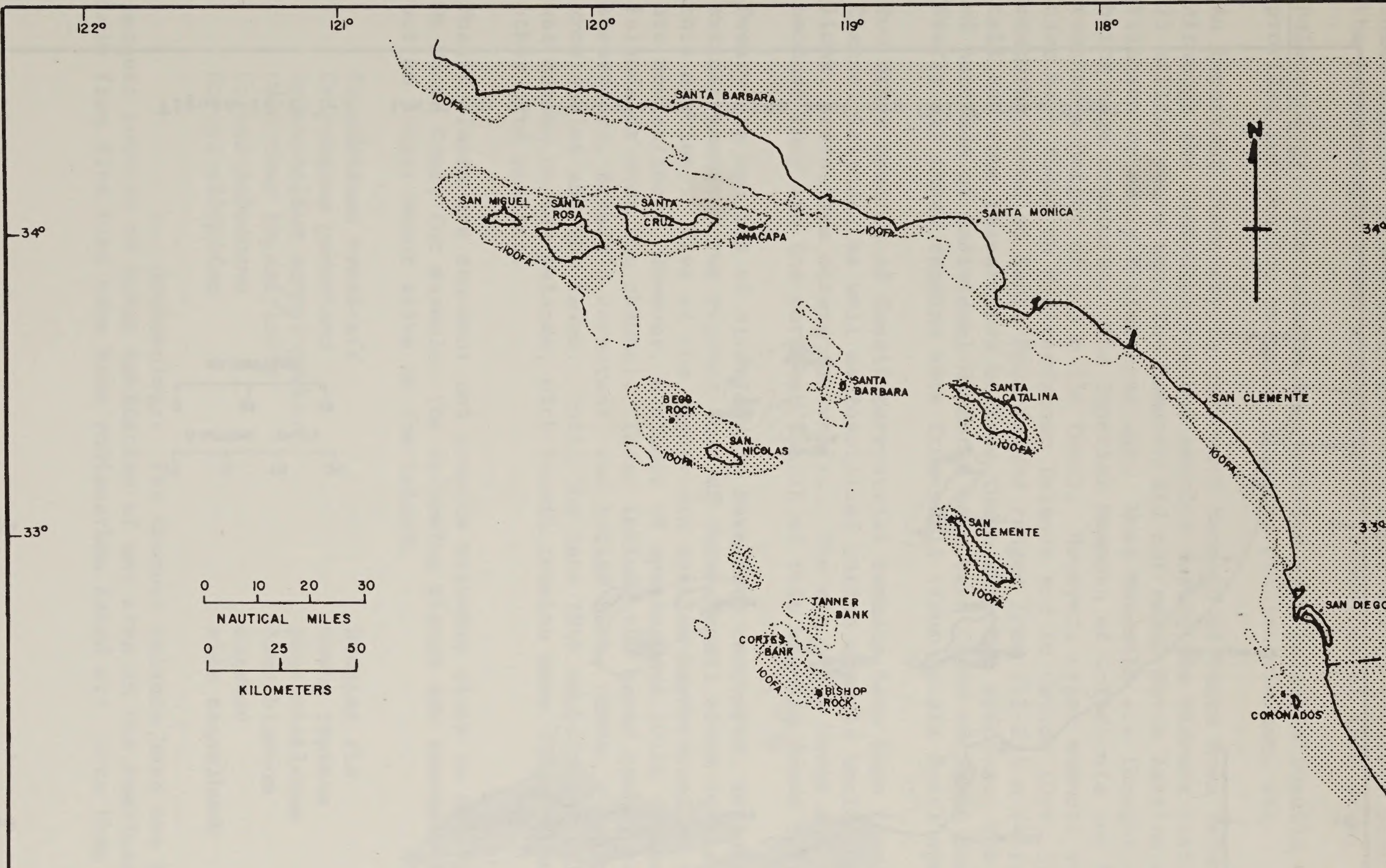


Figure II.F.3-2 Suggested land areas (dots) of the California borderland and adjoining mainland during lowered sea levels of the medial Pleistocene.

Source: Orr, 1968.

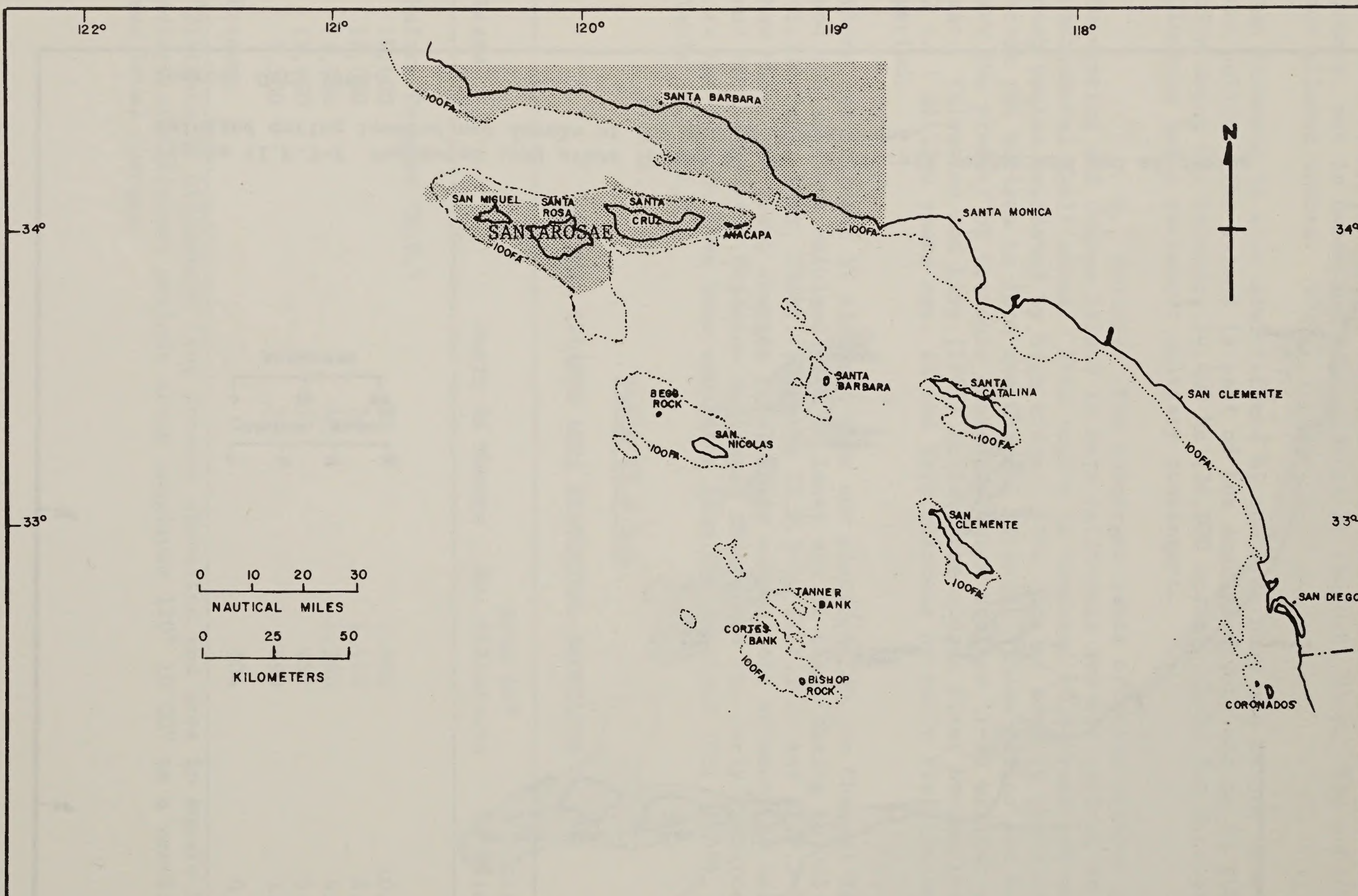


Figure II.F.3-3 Location of "Santarosae" in the Southern California Bight

These changes in sea level are very important to consider when studying the palentological and archaeological resources of this area.

Paleontology. The islands have yielded many valuable fossils which have provided information on paleo-climate, prehistoric man, etc.

An important discovery is the dwarf Mammoth of Santa Rosa Island. Although the Mastodons reached America during the Miocene period, about 25 million years ago, the Mammoth did not reach North America until late Pliocene or early Pleistocene age. Most Mammoths are thought of as being huge creatures. The Imperial Mammoth of California and Mexico reached a height of 4.3 m (14 feet). However, pygmy mammoth remains have been found on Mediterranean Islands and in Ceylon (Orr, 1968). The mammoths found on Santa Rosa Island ranged from 1.2-2.4 m (4 to 8 feet) tall and some researchers believe there were two species. The remains of hundreds of individual Mammoths have been found on Santa Rosa. Nearly all these remains were from small (four to six foot) specimens.

Two other species of fossil terrestrial mammals have been found on the Channel Islands, as well as fossilized marine mammals including sea lions, seals, sea otters and whales. The sea otter bones are important because they are the earliest fossil of this species found (Orr, 1960).

Twenty-six species of bird fossils have been recovered, including the extinct gannet *Morus reyanus* (one of three fossil sites in the U.S. for this species). Five of the twenty-six species represented as fossils are now extinct. However, a number of species are still common in the islands or over the channel. These include the eared grebe, sooty shearwater, Brandt's cormorant, red tailed hawk, Cassin's auklet, rhinoceros auklet and the raven. Until the late 19th century the bald eagle was common on the islands, with fossil remains more common than most other bird species.

Fossil plants are abundant and provide valuable clues to the paleoclimate. On Santa Cruz, for example, the following plants are abundant as fossils but no longer occur alive on the island.

Pseudotsuza menziesii	Douglas fir
Cripressus goveniana	Guwen cypress
Arceutholium campylopoduns	pine mistletoe
Ceanothus thyesifloris	blue blossom
Cornus pubescens	dogwood
Garrya elliptica	silk tasselbush

b. Archaeology: The Channel Islands have one of the longest records of human habitation of any area in the Americas. Materials from fire pits have been radiocarbon dated at: more than 37,000 years (UCLA-749; Berger and Libby, 1966 in Orr 1968), 29,700 ± 3,000 years (L-290R; Broecher and Kulp, 1957 in Orr, 1968), 27,000 ± 800 years (UCLA-746; Berger and Libby, 1966 in Orr, 1968) and 16,700 ± 1,500 years (M-599, Crane and Griffin, 1958 in Orr, 1968). The material used to obtain these dates included charcoal and burned mammoth bones. The most ancient human remains were radiocarbon dated at 10,000 ± 200 (L-650; Olson and Broecher, 1961 in Orr, 1968). Although human remains have not yet been found with the most ancient fire pits, the number of these pits and types of burned animal bones associated with them leave very little doubt that men were living on the Channel Islands 30,000 years ago. Orr (1968) divides the prehistoric island peoples into four major groups or cultures.

Mammoth Eaters. From 30,000 to 10,000 Before Present (B.P.) the climate was cooler and more moist. The sea level was lower, the northern islands were connected, and only about four miles separated them from the mainland. The increased land area supported numerous mammoths. Orr (1968) goes on to say "...there were probably very few people. These lived by the seashore, now submerged, and utilized marine life as well as mammoths for their diet. Their tools were simple and crude, as no suitable material for making good stone tools occurred on the island. They probably hunted mammoth on the highlands, driving them down the canyons to be slaughtered.... From 18,000 B.P. on, the climate warmed and sea level rose, reducing the grazing ground of the mammoths which, with the increase in human population, became extinct, forcing man to rely entirely on marine life and plant foods."

Dune Dwellers. There are no radiocarbon dates between 10,000 B.P. and 7,500 B.P. The climate was warmer and drier and large dunes existed on the island(s), starting about 7,500 B.P. "Sometime prior to 7,500 years ago, a group of people that we call the Dune Dwellers occupied many of these dunes and left midden refuse...unlike the later Canalino culture, the people made burials in clean sand...seventeen sites on Santa Rosa Island are considered definitely of this culture...our greatest knowledge is limited to the period between 7,500 and 6,800 years ago..." Orr (1968). This dune dwelling period is called the Early period and lasted until about 6,000 years ago. Few stone artifacts have been found, but the presence of obsidian and quartz crystals indicates trade with the mainland. The dominant shell is the red abalone. Some fish and marine mammal bones are also present. Many of the fish were very large, up to ten feet.

Highlanders. Between about 6,000 and 4,000 years ago the climate was much more moist and the highlands were forested with oak, Catalina cherry, elderberry and so on. These people lived in semi-subterranean houses. The house pits that have been found averaged 1.8 to 2.4 m (6 to 8 feet) across. More than 100 such village sites have been discovered. The lack of shells and bone, combined with the presence of numerous mortars, indicate these people probably had a predominately vegetable diet, although the earliest radiocarbon dated circular fishhook (5,400 to 4,800 B.P.) was recovered from a Highlander site. Flat rubbing stones and Canalino type projectile points make their first appearance at these sites. "Whether the Highlanders represent an influx of seed and root gatherers from the mainland or were only another phase of the fishermen and shell gatherers of the Dunes, or whether they represent an early nonmarine phase of the Canalino culture can only be decided when we have more data..." Orr (1968).

Dune Dweller (Late). The sea level rose and the climate became warmer and drier around 4,000 years ago. As the forests disappeared the people returned to fishing, shell gathering and marine mammal hunting. Unlike the Early Dune Dwellers, these people used mortars and pestles profusely. Among other tools and ornaments used by the Late Dune Dwellers were: bone tube beads, steatite pipes of unique angle design, stone bowls, shell ornaments and Gypsum Cave type points. Black abalone and California mussels were the predominant shell food.

Canalino. A distinct change in the culture occurred about 2,500 years ago. D. B. Rogers, 1929 (in Orr 1968) called this the Canalino culture or Channel People. These people had a marine oriented culture and lived on the Channel Islands, in a narrow belt along the mainland and a short distance into the major valleys. Their villages were large, with 70 or more closely packed houses. The houses were round, 4.9 to 5.5 m (16 to 18 feet) in diameter, thatched with eel grass. Waste was discarded next to the houses with the resulting middens often surrounding the houses to a depth of 3.1 m (10 feet). Every type of modern shell is found in these middens with black abalone, California mussel, and chione predominating. All marine mammals were utilized, with whale vertebrae made into bowls and longer bones used in house construction. Birds provided food and their bones were used as awls. Fish, ranging from giant black sea bass to smelt, are also abundantly represented in the middens. Little vegetable food seemed to be used; there were few mortars or pestles. The Canalino built plank canoes calked with asphalt. Although the canoes lacked a keel, stern or bow ports and ribs, a replica tested by Orr seemed very seaworthy. Only three petroglyphs (rock carvings) have been found on all the Channel Islands.

Cabrillo (1542) was the first known white man to meet the Canalinos. By 1786 there were many otter and seal hunters along the California coast. Spanish, American, British and Russian hunters brought syphilis, smallpox, diptheria, scarlet fever, measles and tuberculosis to the area. These diseases were new to the Canalinos and were one of the prime causes of their extinction. The last native Channel Island Indian is believed to have died in 1883.

c. Marine Flora and Fauna: The islands are important for four main reasons:

1) They are astride a major biogeographical break. This break, or coastal species composition change, is thought to be due to the ocean temperature characteristics of the cold south moving California current. Extensive upwelling along the central and northern California coast contributes large amounts of cold water to the south moving California current. At Point Conception the coast turns abruptly eastward, while the current continues in a southeasterly direction which results in the current being further offshore. The inshore water and southern part of the Bight is predominantly bathed by the warmer Southern California counter current. The results of these two current patterns are that San Nicolas, San Miguel and the western half of Santa Rosa are bathed by the cold California current. The flora and fauna are characteristic of central California. Santa Cruz, Santa Barbara, Anacapa and the eastern half of Santa Rosa receive both cold California current water and warm counter current water. The consequences are a flora and fauna with much diversity and many species characteristic of the north and the south. San Clemente and Santa Catalina are influenced primarily by the counter current and therefore their flora and fauna are typically warm temperate species.

2) The Channel Islands possess the largest and most diverse temperate water pinniped community in the world. "Major populations of the northern elephant seal *Mirounga angristerostris*, the California sea lion *Zalophus californianus* and the harbor seal *Phoca vitulina* pup and breed each year on the rocks and beaches of the Channel Islands. In addition, the northern fur seal *Callorhinus ursinus* and the Steller sea lion *Eumetopias jubata* have the southernmost extension of their breeding range in these islands." (Norris, et al., 1975). The endangered Guadalupe fur seal *Arctocephalus townsendi* is also present on the islands.

3) The hydrocoral *Allopora californica* is only known from nine localities in the Southern California Bight. Six of these are on the Channel Islands.

4) About 40 percent of all the kelp beds in the Southern California Bight occur around the Channel Islands. These kelp beds are some of the most highly developed submarine forests in the world. Over 800 plant and animal species are known to be associated with these kelp beds including many valuable sport and commercial species.

d. Terrestrial Flora: The vegetation of the Channel Islands in general is composed of coastal sage scrub with chaparral and oak woodland occurring on the large islands of Santa Rosa, Santa Cruz, San Clemente and Santa Catalina. Stands of closed cone pines, *Pinus* *torreyona* and *Pinus miricata* (confined to Santa Rosa), occur on Santa Cruz and Santa Rosa. (*Pinus torreyona*, as well as a number of other plant species endemic to the Channel Islands, are included on the California Native Plant Society's list of rare species.) Because of the moderating effects of the sea and a greater rainfall, the islands have a milder and wetter climate than the immediately adjacent mainland areas. This is reflected in both the vegetation and the animal composition of the islands.

Raven (1967) summarizes the flora of the Channel Islands by listing the plants endemic to the Channel Islands and stating that of all the islands, San Nicolas is perhaps the least diverse ecologically, that San Clemente has the highest number of endemics; and that San Miguel and Anacapa have the least number of endemics (Table II.F.3-2).

Table II.F.3-2

ENDEMIC PLANTS OF THE CHANNEL ISLANDS

Island	Number of Native Species, Subspecies and Varieties	Number of Endemic Species, Subspecies and Varieties
Santa Cruz	420	7
Santa Rosa	340	3
Santa Catalina	375	3
San Clemente	233	11
San Nicolas	120	2
San Miguel	190	-
Anacapa	70	-
Santa Barbara	40	1

Source: Raven (1976).

The flora of Santa Cruz, Santa Rosa and Santa Catalina Islands are relatively similar to those prevalent on the mainland at the present time, whereas those of San Clemente consist of mixtures of various elements present on the mainland past, as well as distinctive endemics that may have evolved in situ. The floras of the four smaller, recently submerged islands are much poorer in endemics which is consistent with their recent arrival from nearby islands and from the mainland in relatively recent time (Raven, 1967).

e. Terrestrial Fauna: The herpetofauna (amphibians and reptiles) of the Channel Islands has been reviewed by Savage (1967) who cites nine different species for the Northern Channel Islands. He includes two species of salamanders, one species of frog, three species of lizards, and three species of snakes. The Southern Channel Islands were credited with two species of salamanders, one species of frog, four species of lizards, and five species of snakes totaling 12 different species. The majority of the species are found on the adjacent mainland with only two endemics, the genus of lizard (*Klauberina* - endemic to San Nicolas, Santa Barbara, San Clemente) and the salamander species *Batrachoseps sp.* - endemic to Santa Cruz (Savage, 1967).

The Channel Islands provide habitats for a variety of terrestrial and marine related bird species. On-going research is being funded by BLM and conducted by Norris, et al. Eleven species of marine oriented birds breed on the Channel Islands. These are: brown pelican (endangered), double crested cormorant, Brandt's cormorant, pelagic cormorant, western gull, pigeon guillemot, Xantus' murrelet, Cassin's auklet, ashy storm petrel, Leach's storm petrel, black storm petrel.

Johnson (1974) listed endemic avifauna, citing 18 subspecies representing 13 species. Johnson states that the degree of observed endemism due to insular evolution is striking and that the divergent evolutionary trend is towards individuals with darker or greyer plumage, heavier bills, and heavier tarsi.

A comparison of early avifauna records shows that the species composition of the islands does change. This change may be due to invasion of new species from the mainland, human activities encroaching upon breeding areas, arrival or extinction of competitive or predatory species, disappearance or decrease of native habitats, introduction of a new species and natural species extinction.

The presently known land mammal fauna of the Channel Islands totals 34 species (Von Blocker, 1967) which includes the sea otter, a rare visitor. Of these 34 species, 14 are native to California with the remainder being introduced species. One species *Urocyon littoralis* (the Island Fox) is endemic to the Channel Islands and has been classified as a rare animal under authority of the California Endangered Species Act (Laughrin, 1973).

The Island Fox inhabits six of the eight Channel Islands. There is a different endemic subspecies for each island: San Miguel- *U.l. littoralis*, Santa Rosa- *U.l. santarosae*, Santa Cruz- *U.l. santacruzae*, San Nicolas- *U.l. dickeyi*, Santa Catalina- *U.l. catalinae*, San Clemente- *U.l. clementae*. Laughrin (1973) states that all of the island fox populations appear to be normal and healthy with the exception of the Santa Catalina Island Fox, *Urocyon littoralis catalina*, which may prove to be endangered.

The most common mammal of the Channel Islands is the deer mouse (*Peromyscus maniculatus spp*), of which there is a separate subspecies listed for each of the eight islands. Deer mice frequent every type of habitat on the islands from the ocean beaches to the tops of the highest mountains and scavenge a variety of seeds, leaves, twigs, insects and littoral debris.

Probably the rarest of the mammals associated with the Channel Islands is the sea otter (*Enhydra lutris*). The sea otter of California is recognized as a separate subspecies *Enhydra lutris nereis*, distinguished from its northern relative *Enhydra lutris lutris* by a larger size and a more brownish coloration (Von Bloeker, 1967). The original range of the sea otter extended from the northern islands of Japan, through the Aleutians, and down the coast of North America to Baja California. Its range was more or less continuous with kelp beds, its prime habitat.

During the 18th and 19th century it was virtually exterminated south of Alaska and dangerously threatened in the remainder of its range. Finally in 1911, the sea otter was given its first complete protection under the "Fur Seal Treaty" signed between the United States, Great Britain, Russia and Japan. This has since been supplemented by both Federal and State laws dating back to 1913. In California the sea otter population is presently making a comeback, but is restricted to the coast of Monterey and San Luis Obispo counties, a portion of which has been designated as the California Sea Otter Game Refuge (from Carmel River in the north, and south to Santa Rosa Creek).

Various sightings of sea otters in the Channel Islands area have been made in recent years. In 1954, biologists saw two at San Miguel Island and one was reported off of Anacapa in the 1950's by Fish & Game Wardens (Daugherty, 1966). Other sightings have occurred in the Channel Islands in recent years near San Miguel, San Nicolas and San Clemente (Von Bloeker, 1967; Bortholomew, 1967). There is definitely no large resident population of sea otters within the Channel Islands, but the increase in frequency of sightings and the existence of a breeding population, a little to the north, holds promise for a possible reestablishment of the sea otter into its former range.

The Channel Islands are important environmentally in that their relative inaccessability has in general preserved many of the natural ecosystems from total human encroachment. They are not pristine in the sense of our National Wilderness Areas, but they are relatively untouched compared to the metropolitan sprawl of the adjacent mainland.

Man in the past has changed the ecology of the islands, from the decimation of the sea otter population to the introduction of goats, sheep, and cattle which have affected the indigenous flora and fauna of the islands. The feral house cat, present on all of the islands, undoubtedly has played a part in the disappearance of various bird species. The introduction of halogentated hydrocarbons (DDT etc.) into the marine food chain has played havoc with the reproductive capability of such bird species as the brown pelican (*Pelicanus occidentalis*) Jehl (1973), and the double crested cormorants (*Phalacrocrax auritis*) Grass, et al., (1973). However, the Channel Islands do provide habitats for many of the animal and plant species native to Southern California, but presently absent on the adjacent mainland. Efforts are underway to protect the existing island biota and in some instances to restore native flora and fauna (National Park Service, Channel Islands National Monument).

4. Mainland Terrestrial Biomes

a. Point Conception to Mexican Border: In this discussion, biomes are being used to delineate the land vegetation rather than small patchily distributed plant communities. The latter are smaller entities within the larger more inclusive vegetation biomes. A generalized account of the terrestrial wildlife will be correlated with the vegetation biomes. An overview of vegetation biomes of the Southern California borderland is shown in Figure II.F.4-1.

The Woodland-Brushland Biome is variable with three vegetation types; California chaparral, forest vegetation, and riparian woodland, often intermixed within very close geographical areas (Bureau of Land Management, 1973). Some of the biome exists as a sub-climax stage of the coniferous forest; the forests having originally been destroyed by forest fires, timbering, and other man-made alterations.

The vegetation, though variable, is typically adapted to withstand summer periods of drought. The most prevalent vegetation association, comprising about 50 percent of the biome, is California chaparral occurring predominantly in the drier areas having a maximum of 28 cm (11 inches) of precipitation a year. The most common plants of the chaparral include: chamise, toyon, several species of *Ceanothus*, manzanita, and scrub oak. These plants often times occur in densities which make the areas impenetrable by all but small animals.

The forest vegetation type generally consists of scrub oak, island oak, toyon, ironwood manzanita, and chamise.

Another common vegetation type is the riparian woodland (associated with stream or river courses, lake or tideland). Common plants are willows, alders, blackberry, creek dogwood, blue elderberry, nettles, various ferns, and cottonwood.

Because the mainland woodland-brushland biome is so widespread and has such a wide variety of vegetation, the wildlife is also represented by a long list of species. No one species, however, is unique to any one vegetation type or representative of the biome. The dominant mammal of the biome is the California mule deer. The mule deer is found near the coast in Santa Barbara and Ventura counties. The blacktailed deer is common throughout the remainder of the area.

Some large mammals of California's woodland and brushlands are the cougar, black bear and coyote. Others are the gray fox, spotted and striped skunks, bobcat, jack rabbit, California ground squirrel, pocket gopher, raccoon, gray squirrel and opossum. The Western fence lizard and rattlesnake are among the common reptiles.

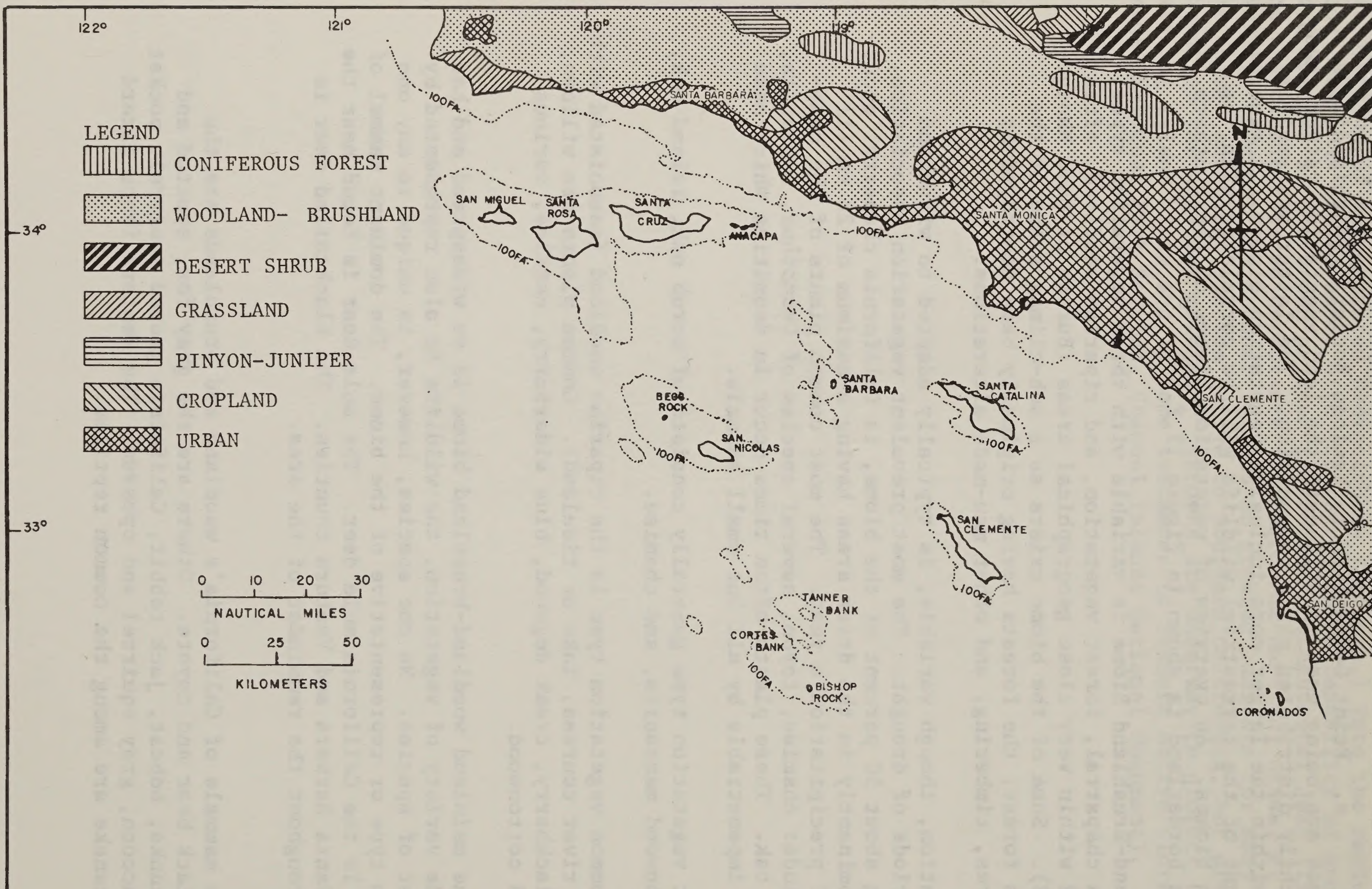


Figure II.F.4-1 Vegetation of Southern California Coast.

Source: Bureau of Land Management, California State Office

The species using the woodland-brushland habitat which are threatened with extinction are the California condor, Southern bald eagle, and peregrine falcon.

The grassland biomes of Southern California vary from tall dense grasses to low sparse grass. Most of the native grasses (commonly the bunch-grass type) have been replaced by introduced species such as wild oats. The species composition is varied from area to area depending on soil and water conditions.

The species on the Channel Islands are apparently similar to those of the mainland, although Laughrin (1973) reports several endemic species (species located only on these islands). On the steep walls and cliffs of island canyons, but out of reach of the persistent goats, precariously remain some of the unique and interesting island endemics such as the tree dandelion (*Manzothamun blairii*), island snapdragon (*Galvezia*), island buckwheat (*Eriogonun giganteun*), and monkey flower (*Mimulus flemingii*). A complete discussion of San Clemente's flora is given by Raven (1967). (See Section II.F.3.)

The animals of the mainland grassland biome are much the same species which occur in the woodland-brushland biome except that there are fewer deer and no black bears or cougar. Another exception is a greater variety of rodents, burrowing animals and raptorial birds.

Dames and Moore (1973) list amphibians, reptiles and mammals typical of the Santa Barbara region (POCS Reference Paper No. I). Various ecological information about the species is included. The Riparian Oak Woodlands and Chaparral are included in the Woodland-Brushland Biome in Figure II.F.4-1. Near Long Beach, adjacent to Anaheim Bay at Bolsa Chica, Dillingham Corporation (1971) listed the amphibians, reptiles and mammals present during 1970 (POCS Reference Paper No. I).

b. Baja California: The majority of the Baja California peninsula lies within the Vizcaino-Magdalena Desert which is a sparsely populated area of broad valleys and outwash plains, scattered boulder-strewn granite hills, and low mountain ridges with steep escarpments. Broad volcanic tablelands, lava flows and cinder cones are intermixed and tend to break up the monotony of the landscape. Scattered widely throughout the region are but a few large springs with no streams of any substantial flow reaching the sea (Jaeger, 1957). Rainfall occurs in winter mid-altitude storms and summer rains which may vary from tremendous downpours to very meager drizzles and may be separated by extensive dry periods.

Even under these severe conditions there has developed a very specialized and abundant flora. The flora of Baja California is derived from two sources. The northwest coastal area as far south as El Rosario contains species common to areas of the north, while the southern two-thirds of the peninsula has a flora derived, for the most part, from the adjacent arid tropical mainland of Mexico. In traveling southward from the international boundary to Scammon's Lagoon, there are two rather noticeable changes in flora. The first is at Rio Rosario where the ciro (candle) plants (*Idria calummaris*) and cardon (elephant tree) (*Pachycormus discolor*) first occur. On south to near Punta Prieta, there is a noticeable enrichment of the vegetation. The second decided change occurs near the 28th parallel, just south of El Arco where numerous southern arid-tropical plants such as Palmer's fig (*Ficus Palmeri*) and palo blanco (*Lysiloma candida*) appear. Other conspicuous cacti include the light-green-flowered cochal (*Myrtillocactus cochal*), the devil cactus (*Lemaireocereus eruca*), the cholla (*Opuntia cholla*) and the dark colored pitahya agria (*Machaerocereus gummosus*) which is closely related to the organ pipe cactus found in southern Arizona. There are various tree-like forms such as the elephant tree, fan palm and wild fig, and scattered shrubs like ocotillo mixed across the landscape.

In addition to the dry rocky desert areas, there exist sand dunes and salt marsh areas around some of the larger lagoons such as Scammons. Here exists a flora more similar to that found near San Diego. Typical species include beach verbena, salt bush, iceplant, salt grass, pickleweed and cord grass.

There exists a division of three regions in accordance with the predominant vegetative types discussed above (Figure II.F.4-2): the Chaparral Region with vegetation similar to Southern California; the Colorado Valley (Bajo del Colorado), a microphylous desert in which *Larrea tridentata* and *Franceria dumosa* predominate - it has components of "sandbrush" and small trees among which *Prosopis juliflora* (bitter mesquite) and other Leguminosae of the genus *Cercidium* are prominent. There exists a great abundance of ephemeral herbaceous vegetation that appears after the winter rains. The Vizcanino Region (Region de Vizcaino) which is a sarcophylous desert where plants with succulent leaves of the genus *Agave* and the perennial "subbrush" of *Franceria chenopodofilia* predominate. There are other species that outline the physiognomy of the area, such as *Yucca valida* (wild date), which is found growing in deep soils; *Idria columaris* (Saguaro cactus), which is very abundant; also present is: *Pachycorumus discolor*, which is located on rocky slopes; distinctive of the area are *Fouquieria peninsularis* ("Adam Wood"), *Pachycereus pringlei* (giant cactus), *Agave shawii* and *Vizcainea genicultata*. In alkali soils or those containing saltpeter are found *Atriplex policarpa* and *Lycium californicus*.

The vertebrate fauna of the Baja area includes many genera common to the southwest deserts of the United States (POCS Reference Paper No. I).

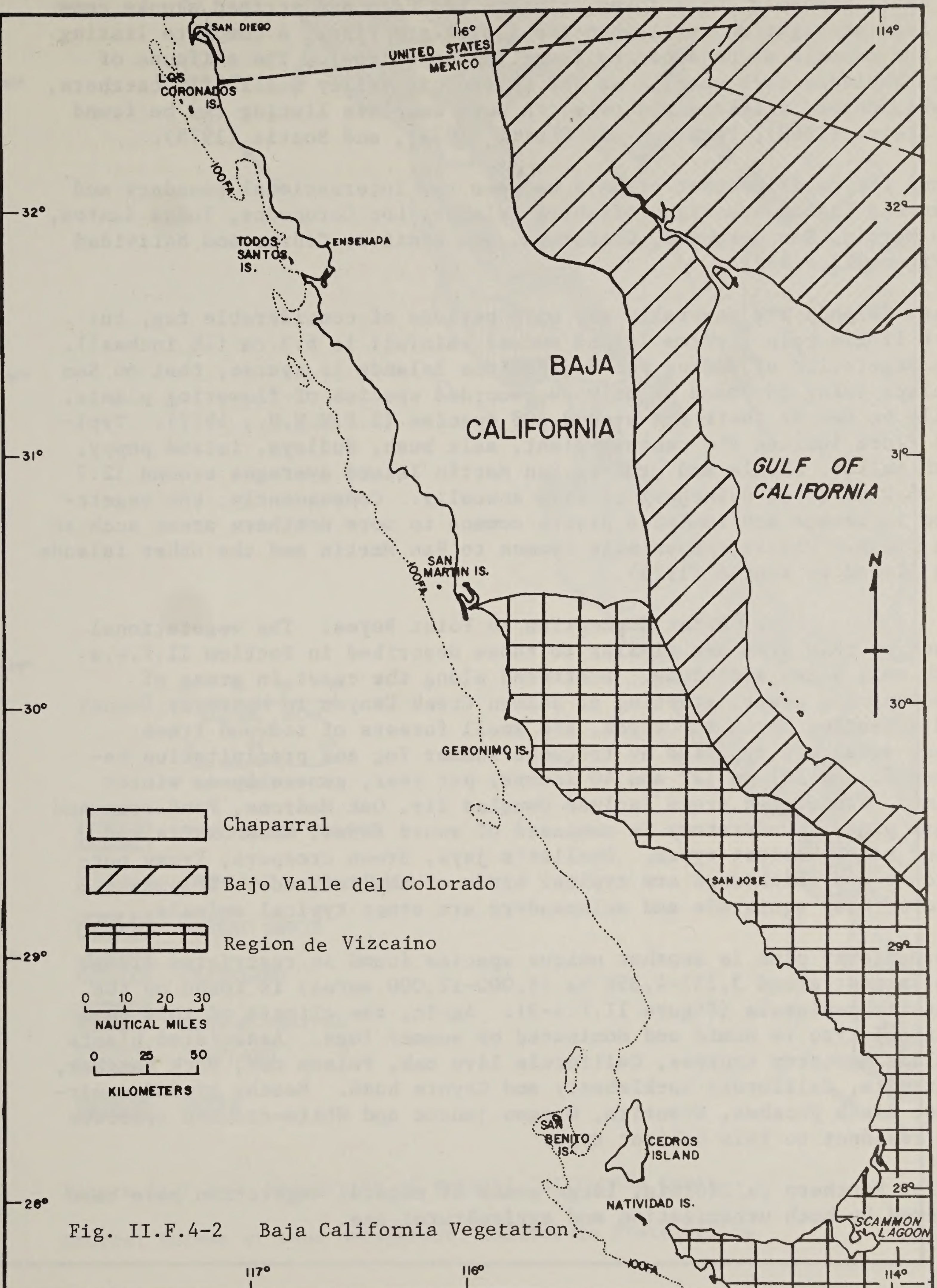


Fig. II.F.4-2 Baja California Vegetation.

Kit foxes, coyotes, jack rabbits and wood rats are frequent near springs or small streams. Gray foxes, ring-tailed cats and striped skunks come to feed at night on dates when the fruits are ripe. A complete listing of the mammals of Baja can be found in Huey (1964). The avifauna of Baja includes such species as the California valley quail, fly catchers, hawks, doves, flickers and owls. A more complete listing can be found in Stager (1960), Peterson and Chalif (1973), and Bostic (1975).

Along the Pacific coast of Baja between the International boundary and Scammons Lagoon are eight offshore islands; Los Coronodos, Todos Santos, San Martin, San Geronimo, Guadalupe, San Benitos, Cedros and Natividad ((Figure II.F.4-2).

These islands are generally dry with periods of considerable fog, but with little rain (Cedros Island annual rainfall is 6.3 cm {2½ inches}). The vegetation of Cedros and San Benitos Islands is sparse, that on San Benitos being composed of only 40 recorded species of flowering plants, while on Cedros there are around 208 species (S.D.M.N.H., 1977). Typical flora include the century plant, salt bush, dudleya, island poppy, bush mallow, cholla and others. San Martin Island averages around 12.7 to 15.2 cm (5 to 6 inches) of rain annually. Consequently, the vegetation is denser and includes plants common to more northern areas such as San Diego. Plants and animals common to San Martin and the other islands are listed by Bostic (1975).

c. Point Conception to Point Reyes: The vegetational zones of this area are similar to those described in Section II.F.4.a with only a few additions. Scattered along the coast in areas of frequent fog cover, starting at Salmon Creek Canyon in Monterey County and extending north to Oregon, are small forests of redwood trees. These areas are typified by frequent summer fog and precipitation between 55 and 101 cm (22 and 40 inches) per year, generally as winter rains. Associated trees include Douglas fir, Oak Madrone, Ponderosa and Sugar pines. Understory is composed of sword ferns, moss oxalis and other moist habitat types. Steller's jays, Brown creepers, Pygmy nuthatches and chickadees are typical birds of the redwoods. Chipmunks, shrews, Gray squirrels and salamanders are other typical animals.

The Monterey pine is another unique species found in restricted areas. The largest stand 3,237-4,856 ha (8,000-12,000 acres) is found on the Monterey peninsula (Figure II.F.4-3). Again, the climate of this vegetational type is humid and dominated by summer fogs. Associated plants include Monterey cypress, California live oak, Poison oak, Mock heather, Manzanita, California huckleberry and Coyote bush. Beechy ground squirrels, Black phoebes, Wrentits, Oregon juncos and White-crowned sparrows are resident to this habitat type.

As for Southern California, large areas of natural vegetation have been altered by both urbanization and agricultural use.

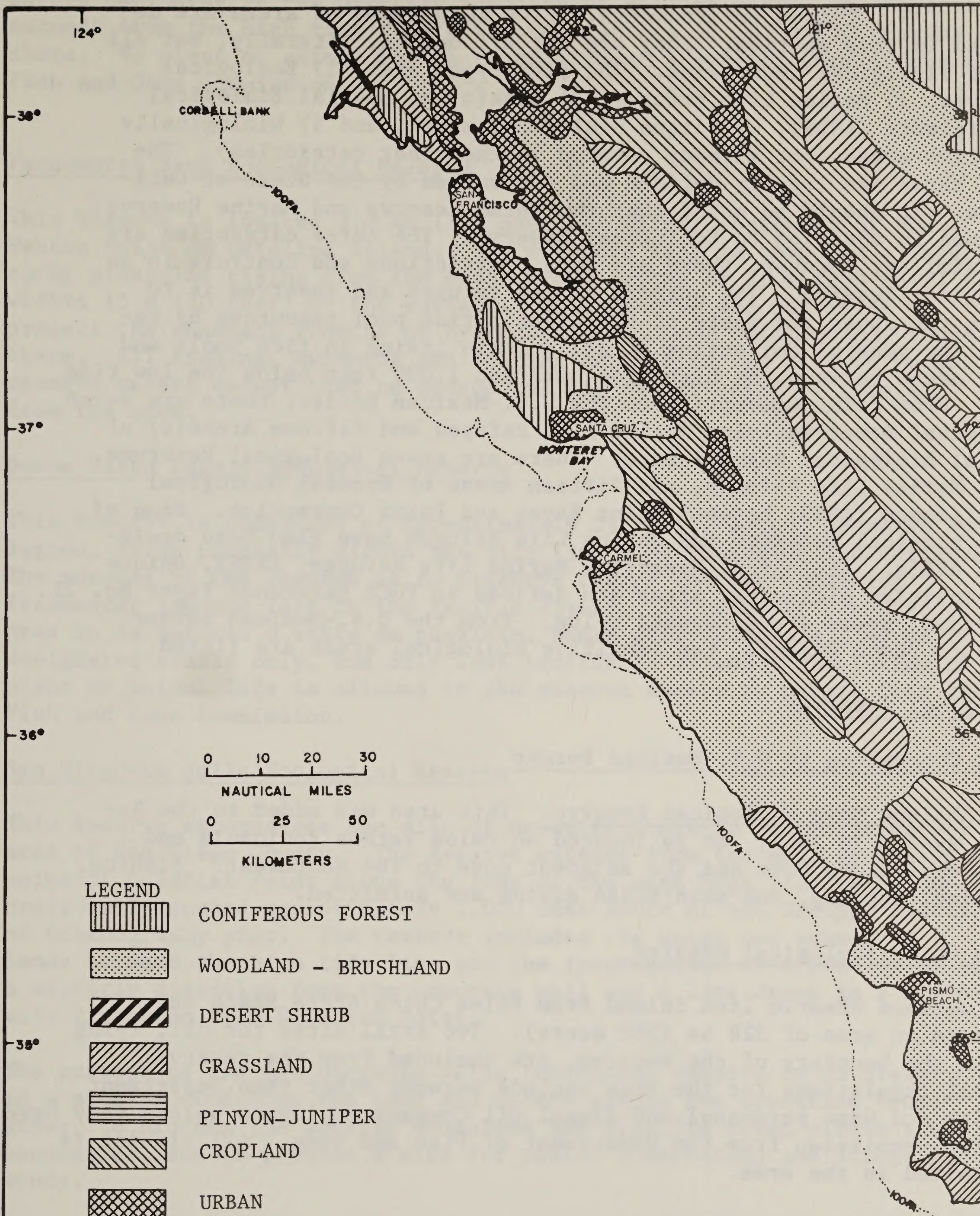


Figure II.F.4-3 Vegetation of Central California Coast.

Source: Bureau of Land Management, California State Office.

5. Unique Environments: Five main types of areas are described in this section. They are not all unique, literally, but all are of biological importance. The five types are: 1) Ecological Reserves, 2) Marine Life Refuges, 3) Area(s) of Special Biological Significance (ASBS), 4) unique biological areas, and 5) biologically sensitive areas (not already covered in the other categories). The first three are legally defined and controlled by the State of California. It should be noted that the terms Reserve and Marine Reserve are used in addition to Ecological Reserve. The three categories are very similar; however, there are more restrictions and controls in an Ecological Reserve. The purpose of the refuges and reserves is to reduce the abuse and waste of the State's tide pool resources by restricting general collecting of all animals living in tide pools and other areas between the high tide mark and 1,000 feet below the low tide mark. From Point Conception to the U.S.-Mexican border, there are seven Ecological Reserves, nine Marine Life refuges and fifteen Areas(s) of Special Biological Significance. There are seven Ecological Reserves, three Marine Life Refuges, and fifteen Areas of Special Biological Significance (ASBS) between Point Reyes and Point Conception. Some of the Ecological Reserves and Marine Life Refuges have also been designated ASBSs. Ecological Reserves, Marine Life Refuges, ASBSs, unique and sensitive biological areas are defined in POCS Reference Paper No. II. Individual areas are discussed below. From the U.S.-Mexican border, south to Punta Eugenia, ten sensitive biological areas are listed.

Ecological Reserves

Point Conception to U.S.-Mexican Border

Abalone Cove Ecological Reserve. This area was added to the Reserve system in 1977. It is located on Palos Verdes Peninsula and includes Abalone Cove and the adjacent cove to the southwest. Fishing, swimming, surfing, and skin/SCUBA diving are permitted.

Bolsa Chica Ecological Reserve

This wetland Reserve lies inland from Bolsa Chica State Beach and includes an area of 228 ha (563 acres). Two drill sites for oil, lying within the boundary of the Reserve, are excluded from the reserve. Special regulations for the area exclude persons other than Department of Fish and Game personnel and Signal Oil Company employees unless they have written permission from the Department of Fish and Game. All fishing is prohibited in the area.

Heisler Park Ecological Reserve

This Reserve lies within the Laguna Beach Marine Life Refuge. It includes the southeast 730 m (800 yards) of shoreline and adjacent waters beginning at the westerly boundary of Heisler Park. The Reserve extends from the high tide line out to a distance of 183 m (200 yards) offshore. No plant or animal may be taken without a special permit from the Fish and Game Commission.

Farnsworth Bank Ecological Reserve

This Reserve is located 3.0 km (1.6 nautical miles) southwest of Ben Weston Point on Catalina Island. The offshore bank is composed of sheer rocky pinnacles rising from the ocean floor depths of 76 m (250 feet) to within 15 m (50 feet) of the surface. This Reserve was set aside to protect the abundant growths of hydrocoral, *Allopora californica*, found there. All fishing, swimming and boating activities are allowed in the reserve waters except that no hydrocoral may be harvested or removed from the area.

Buena Vista Lagoon Ecological Reserve

This Reserve is comprised of approximately 29 ha (71 acres) of marsh and lagoon, lying partially within the city limits of Oceanside and Carlsbad. The purpose of the reserve is to preserve one of the few remaining freshwater lagoons left in the Pacific Flyway. In order to preserve the area in as natural a state as possible, human activities are limited to designated trails only, and only foot traffic is allowed. No taking of plant or animal life is allowed in the reserve except by permit from the Fish and Game Commission.

San Diego-La Jolla Ecological Reserve

This Reserve encompasses one mile of ocean frontage in the La Jolla Bay area of San Diego County. The Reserve extends from the most northerly point of Goldfish Point along the line of the mean high tide to a concrete wall located approximately 1,000 feet south of the Scripps Institution of Oceanography pier. The reserve includes the water and submerged lands between the high tide line and the intersection of a line drawn in a westerly direction from the concrete wall and a line drawn in a northerly direction from Goldfish Point.

The purpose of the San Diego-La Jolla Ecological Reserve is to preserve in a natural condition the land and waters within the specified boundaries, to protect the aquatic organisms and wildlife found within these boundaries, and to provide a site for public observation and scientific study.

The taking of fish for sport, commercial, or any other purpose is prohibited except by permit from the Fish and Game Commission. Swimming, boating, and other aquatic sports are permitted, if those activities do not harm or disturb marine plants, marine life, geological formations, or archeological artifacts. Boats may be launched and retrieved only in designated areas and may be anchored within the reserve only during daylight hours.

Point Loma Reserve

No plant or invertebrate marine life may be taken in those waters administered by the superintendent of Cabrillo National Monument, in waters less than 3 m (10 feet) deep.

Marine Life Refuges

Point Fermin Marine Refuge

This Marine Life Refuge lies to the north of Long Beach Harbor in the San Pedro area of the City of Los Angeles. It encompasses approximately one mile of ocean frontage and consists of the land and ocean waters bounded by the mean high tide and the State waters for a distance of 183 m (200 yards) below low-tide mark, in an area lying between the easterly extension of 40th Street and the southerly extension of Gaffey Street at Point Fermin. Within the boundaries of the Refuge, lobster, bonito, rockfish (*Sebastes*), mackerel, perch, kelp bass, sand bass, spotted bass, corbina, croaker, and halibut may be taken by the holders of a valid California sport fishing license. All other fish and forms of aquatic life are protected and may not be taken without a written permit from the Department of Fish and Game.

Newport Beach Marine Life Refuge

This Refuge is located just south of the entrance to Newport Harbor and encompasses 0.8 km (one-half mile) of ocean frontage. It includes the land and waters between the high tide line and offshore for a distance of 61 m (200 feet) between the eastern city limit of Newport Beach and Poppy Avenue in the City of Newport Beach.

Irvine Coast Marine Life Refuge

This Refuge is located in the area between the eastern city limit of the City of Newport Beach and the extension of the northwesterly city limit of the City of Laguna Beach. Included in the refuge are the State tidelands along this three and one-half mile stretch of coast and the State waters for a distance of 183 m (200 yards) offshore from the ordinary high tide line.

Laguna Beach Marine Life Refuge

A one and one-half mile stretch of the Orange County coast has been designated as the Laguna Beach Marine Life Refuge. This Refuge is bounded on the north by McKnight Drive and on the south by an extension of Aster

Street in the City of Laguna Beach and extends from the high tide line out for a distance of 183 m (200 yards) into the Pacific Ocean.

South Laguna Beach Marine Life Refuge

This Refuge encompasses one-half mile of ocean frontage. It includes the area from a point about one-half mile south of Aliso Beach Pier, to an extension of Eagle Rock Way in the City of South Laguna, and from the mean high tide line 183 m (200 yards) offshore.

Niguel Marine Life Refuge

This Refuge begins on the south edge of Three Arch Bay and continues down the coast along the mean high tide line for a distance of two miles to the north boundary of Dana Point Marine Life Refuge. The Refuge includes the waters and submerged lands offshore for a distance of 366 m (400 yards).

Dana Point Marine Life Refuge

This Refuge extends southward for almost one mile from the Niguel Marine Life Refuge to the Dana Point Harbor jetty and includes the waters and submerged lands offshore to a distance of 366 m (400 yards) into the Pacific Ocean.

Doheny Beach Marine Life Refuge

This Refuge begins at the east breakwater of the Dana Point Harbor and extends down the coast along the line of the mean high tide to the easterly boundary of Doheny Beach State Park, a distance of approximately one mile. Also included are the waters and submerged lands offshore at a distance of 183 m (200 yards).

San Diego Marine Life Refuge

This Refuge extends from the northern boundary of the San Diego-La Jolla Ecological Reserve up the coast along the line of the mean high tide for a distance of one mile. It also includes the waters and submerged lands offshore for a distance of 305 m (1,000 feet). Only licensees of the Regents of the University of California and officers, employees and students of the University are authorized to take, for scientific purposes, invertebrates or specimens of marine plant life without a written permit from the Department of Fish and Game. In all other cases, these organisms are protected and may not be collected without a written permit from the Department.

Areas of Special Biological Significance

The designation of Areas of Special Biological Significance (ASBS) by the State Water Resources Control Board established a series of areas along the coast of California wherein the State and regional boards maintain natural water quality conditions through applicable legislative authority and administrative measures.

"ASBS are those areas containing biological communities of such extraordinary, even though unquantifiable value, that no acceptable risk of change in their environments as a result of man's activities can be entertained" (California Water Resources Control Board Staff Presentation, 1973).

The Southern California ASBS's are:

San Miguel Island, Santa Rosa Island, Santa Cruz Island, San Nicolas Island, Begg Rock, Santa Barbara Island, Anacapa Islands, San Clemente Island and Santa Catalina Island, including the following subareas:

Subarea 1	Isthmus
Subarea 2	North end of Little Harbor to Ben Weston Point
Subarea 3	Farnsworth Bank
Subarea 4	Binnacle Rock to Jewfish Point

Mugu Lagoon to Latigo Point
Heisler Park Ecological Preserve
Newport Beach Marine Life Refuge
Irvine Coast Marine Life Refuge
San Diego-La Jolla Ecological Reserve
San Diego Marine Life Refuge

Unique Biological Areas

The word unique is defined as "being the only one of its kind" (New College Edition, The American Heritage Dictionary, 1976). Is the presence of a single, rare species in a marine community sufficient to qualify the entire community as unique? Can unusual sizes of species or their relative proportions qualify a community as unique? There is no consensus among marine biologists as to what constitutes a unique marine community. However, for this discussion we will consider areas in California and Baja California unique on the basis that the assemblage of organisms is highly unusual and/or unusually large sizes and densities of certain organisms are present. It should be noted that some experts consider the entire Southern California Bight, from Point Conception to Cedros Island, Mexico, a unique area because of the physical conditions present.

Only one other comparable area, geologically, is found (West Africa) where the continental borderland is crisscrossed with deep troughs, basins and ridges and subjected to comparable current conditions (See Sections II.A and II.F.3).

The unique biological areas in Southern California are:
1) San Miguel Island, 2) San Nicolas Island (north end), 3) Tanner Bank and Cortes Bank, and 4) Castle Rock (San Clemente Island).

San Miguel Island and San Nicolas Island are discussed in detail in Sections II.E.3, II.E.4, II.E.5, II.E.6 and therefore will only be discussed briefly here.

(1) San Miguel Island is the northernmost Channel Island and is the focal point in the Southern California Bight for pinnipeds (seals, sea lions). No other temperate area in the world supports such a large and diverse pinniped community. Northern elephant seals *(Mirounga anguistirostris)*, California sea lions *Zalophus californinus*, harbor seals *Phoca vitulina*, northern fur seals *Callorhinus ursinus*, Stellar sea lions *Eumetopias jubata* and Guadalupe fur seals *Arctocephalus townsendi* are all found at San Miguel (Norris et al., 1975). In addition to the pinniped community, the water around the island supports a very rich association of algae, invertebrates, and fishes.

(2) During BLM Baseline Studies on San Nicolas Island, unusually large tide pools were found. These large, deep pools contain very rich floral and faunal associations.

(3) Tanner Bank and Cortes Bank are located approximately 179 km (111 miles) and 186 km (116 miles) west and west, southwest of San Diego, These banks are the shallowest portions of the Santa Rosa Cortes Ridge which stretches from San Miguel Island on the north past San Clemente Island on the south. Water depths greater than 1,800 m (5,900 feet) separate the banks from the mainland. Depths between them are about 200 m (656 feet). The areal extent of Tanner Bank and Cortes Bank, at 60 m (197 feet), is approximately 769 ha (1,900 acres) and 2,914 ha (7,200 acres), respectively. Both banks have high relief rocky bottoms. Tanner Bank's shallowest point is 25 m (82 feet), Cortes Bank's is 1 m (3 feet). These banks, therefore, act as the outermost islands of distribution for California shallow water benthic organisms.

The Pacific OCS office conducted a series of biological surveys on these banks and the following is taken from the subsequent report (Smith, 1976).

Tanner Bank and Cortes Bank were judged to be of biological significance for many reasons. 1) The abundance and health of the organisms is execptional. 2) The presence of the hydrocoral *Allopora californica* is significant; its abundance and important place in the community make the banks unusual. 3) There is an unusual assemblage of organisms. Many species that dominate mainland and island marine communities are either absent or rare, while species which are absent or rare along the mainland and around the islands are very abundant. 4) The banks serve as important feeding grounds for large numbers of California sea lions, *Zalophus californianus* and many species of sea birds. Other points which are peculiar to the individual banks are: Cortes Bank is the home of large numbers of spiny lobsters *Panulirus interruptus* and abalone *Haliotis* sp.; Tanner Bank has the highest recorded densities of chestnut cowries *Cyprae spadicea* and sheephead fish *Pimelometopon pulchrum*. These banks are the last remaining area in California with large numbers of giant seabass *Stereolepis gigas*. Baseline studies funded by BLM have tentatively identified 94 new species on the banks. Many of these species are new to the world, not just Southern California. Special note should be taken of the discovery of an extremely rare monoplacophoran mollusc *Neopilina* sp. This group of molluscs was thought to have become extinct since Cambrian time (500 million years ago) until, ten were discovered alive in 1952.

(4) Castle Rock is located off the northern end of San Clemente Island (the entire island is an ASBS). The subtidal area around Castle Rock supports the densest beds of the hydrocoral *Allopora californica* known in Southern California. In addition, there is a rich association of other marine animals and plants.

Biologically Sensitive Areas

All the areas discussed above, under the headings of Ecological Reserves, Marine Life Refuges, ASBS's and Unique Biological Areas are biologically sensitive. Several other areas of particular biological sensitivity, with respect to oil and oil related impacts are listed below. These areas (including those listed above) have one or more of the following characteristics (Siva, 1976):

1) "High biological productivity. A highly productive habitat is usually the source for repopulation of surrounding areas. If such an area is disrupted, a disproportionate part of the area's population would be affected. Estuaries are examples of such highly productive habitats."

2) "High ecological significance. If a habitat has particular food-chain importance, its disruption would affect not only its residents, but its users as well..." the disruption of the Tanner and Cortes Banks would affect the sea lions and birds which use the area as a feeding ground.

3) "Unique features or areas." "... disruption could significantly affect this uniqueness."

4) "Vulnerability to oil pollution. Some habitats are very vulnerable to damage from oil spills or clean-up activities."

The areas discussed by Siva (1976) are:

1) Pt. Conception has undisturbed rocky intertidal communities on the biogeographic boundary between Southern and central California.

2) Burmah Beach is a significant harbor seal, *Phoca vitulena*, night time haul out area.

3) Goleta Slough is a large wetlands and marsh important to many birds as a feeding/nesting area.

4) Goleta Rocks is a day time haul out area for harbor seals.

5) Carpinteria Marsh (El Estero) is a large wetlands, marsh and tidal flat, especially important to birds.

6) Standard Oil Company Pier, Carpinteria, is used as a haul out area by harbor seals.

7) Santa Clara River mouth is an important wetlands, marsh, tidal flat and sand dune area.

Mexico

Some of the biologically sensitive areas between the U.S.-Mexican border and Punta Eugenia are listed below. The information was obtained from Gordon Chan (personal communication).

Locality	Important Marine Resources
1. Islas de Los Coronados area between Coronado del Sur and Coronado del Medio Lat. 32° 26' Long. 117° 16'	Small population of the giant sea bass, *Stereolepis gigas*. Large sea bird rookery.
2. Isla San Martin Hassler Cove Lat. 30° 30' Long. 116° 0'	Giant spider crabs, *Loxorhynchus crispatus*, leg span 0.8 m (31 inches), in 15 m (50 feet) of water. Important cormorant rookery.
3. Roca Ben Seamount Lat. 30° 25' Long. 116° 3"	Large beds of the giant sea mussels, *Mytilus californianus*. Average length 22.5 cm (8.9 inches). Thick populations

	of large hydrocoral, *Allopora californica*, average height 27 cm (10.6 inches). Many species of fish and invertebrates--with optimum density of species at 25 m (82 feet).
4. Johnston's Seamount also known as the "breakers" Lat. 30° 23' Long. 116° 3'	Magnificent densities of fish and invertebrates perhaps the richest in species diversities south of Monterey, California. Giant sea mussels, *Mytilus californianus*, average length 23 cm (9.0 inches). Significant population of the spiny lobster, *Paniluris interruptus*, also dense populations of the rock jungle, *Hinnites giganteus*. Large density of hydrocoral, *Allopora californica*, average height 33 cm (13 inches). Optimum density of species at 27 m (89 feet).
5. Isla Guadalupe east side of the island	A very large elephant seal *Mirounga angustirostris* rookery. Norris, et al., (1976).
a. northeast anchorage Lat. 29° 8' Long. 118° 16'	
b. Punta Cono Lat. 29° 2'	Remnant rookery population of the Guadalupe fur seal, *Arctocephalus philippii townsendi*.
6. Isla San Geronimo Lat. 29° 48' Long. 115° 44'	Largest rookery of sea birds in the eastern Pacific waters. Large population of cormorants and brown pelicans. Guano up to 38 cm (15 inches) thick in some areas.
7. Sacramento Reef south of Isla San Geronimo Lat. 29° 46' Long. 115° 43'	Many shipwrecks on this large, low profile reef. Thick population of giant spiny lobsters, *Paniluris interruptus*, many reaching up to 4.5 kg (10 pounds) in size. Dense population of horn Sharks, *Heterodontus francisci*, some up to 1.5 m (4.9 feet) in length.
8. Scammon's Lagoon Lat. 27° 40'	The favorite winter breeding grounds of the grey whale, *Eschrichtius glaucus*.
9. Islas San Benito Lat. 28° 18' Long. 115° 35'	Large populations of elephant seals and sea lions. Important abalone fishery, *Haliotis fulgens*.

10.	<u>Isla Cedros</u> Bahia del Sur Lat. 28° 6' Long. 115° 17'	Large populations of elephant seals and sea lions. Important abalone fishery, *Haliotis fulgens*. Also large size *Octopus sp.*, at Cabo San Augustine, with arm spans 1.5 m (4.9 feet).

<u>Point Reyes to Point Conception</u>. The following list includes Ecological Reserve/Preserves Marine Life Refuges and sensitive biological areas. All these locations are also designated ASBS's by the State.

Ecological Reserves/Reserves:
1) Point Reyes Headland Reserve
2) Duxberry Reef Reserve
3) James V. Fitzgerald Marine Reserve
4) Point Lobos Ecological Reserve
5) Estero de Limantour Reserve
6) Morro Rock Ecological Reserve
7) Pismo Beach Ecological Reserve

Marine Life Refuges:
1) Pacific Grove Marine Gardens Fish Refuge
2) Hopkins Marine LIfe Refuge
3) California Sea Otter Refuge

Sensitive Biological Areas:
1) Farallon Islands
2) Ano Nuevo Point and Island
3) Carmel Bay
4) Julie Pfieffer Burn Underwater Park
5) Mouth of Salmon Creek

6. Rare, Threatened or Endangered Species: The Endangered Species Act of 1973 established two categories of endangerment: 1) endangered species - those species in danger of extinction throughout all or a significant portion of their range..., and 2) threatened species which are species likely to become endangered within the foreseeable future throughout all or a significant portion of their range....

The State of California has adopted the following definitions.

> (a) "Endangered animal" is an animal of a species or subspecies of birds, mammals, fish, amphibia, or reptiles, in immediate jeopardy from one or more causes, including loss of habitat, change in habitat, overexploitation, predation, competition, or disease.
>
> (b) "Rare animal" is an animal of a species or subspecies of birds, mammals, fish, amphibia or reptiles that, although not presently threatened with extinction, is in such small numbers throughout its range that it may be endangered if its environment worsens.

Among the species listed, 28 are considered as endangered and 3 as rare. There are presently 8 threatened species known to occur in the Southern California area.

Seven of the 8 species of whales listed as endangered by the U.S. Fish and Wildlife Service (1976) occur in the area of the proposed sale. The gray whale is the only species which migrates extensively through the sale area (Visual No. 8), although the humpback whale is present during the winter around San Miguel, San Nicolas and San Clemente Islands.

Five endangered plant species occur on the Channel Islands. In addition, there are over 80 threatened or endangered plant species proposed as additions to the Federal Endangered Species list. A species list is provided in POCS Reference Paper No. II.

a. Point Conception-Mexican Border: The Southern California area between Point Conception and the Mexican border is inhabited or visited by over 20 rare, threatened or endangered faunal species as listed in Table II.F.6-1. These species have been designated by either or both the State of California (1976) and the U.S. Fish and Wildlife Service (1977).

Table II.F.6-1

RARE OR ENDANGERED ANIMALS POINT REYES - MEXICAN BORDER

Species	California Coastal & Interior Distribution	Breeding Season	Estimated California Population	Status Trend	Migratory	Age at Maturity	Nest or Breeding Data	Number of Nesting or Breeding Sites in California
California Condor *(Gymnogyps californianus)* (3,22)(A,B)[a]	San Luis Obispo Co.; Sespe-Piru area of Ventura and Los Angeles Co.; Santa Barbara Co.	Oct-May	60$\pm$ (40 adults)	Endangered: decline	Yes- Non-breeders northward Mar-Apr	6 yrs.	No nest: lay eggs on floor of caves or rocky ledges. (solitary)	16-20 nests
American Peregrine Falcon *Falco peregrinus anatum)* (1,12)(A,B)[a]	13 territories along coastal Calif. between Oregon and Mexico		30$\pm$ (16 adults)	Endangered: decline	Yes-	2 yrs.	Scrape on ledge high on cliffs or rocks (solitary)	8+
Southern Bald Eagle *(Haliaeetus l. leucocephalus)* (1,8,22)(A,B)[a]	Mainly in interior Calif. Some found along the coast		53$\pm$ (36 adults)	Endangered:			Sticks high in tree or ledge usually w/some shade. (solitary)	18
California Brown Pelican *(Pelecanus occidentalis californicus)* (10,11,13)(A,B)[a]	Statewide along coast. Breeding only on Anacapa Island and Scorpion Rock in So. California	Feb-Aug	1500$\pm$ in Calif.	Endangered: increase	Yes- North after breeding		Sticks on ground or *Coreopsis*. (colonial)	3$\pm$
San Clemente Loggerhead Shrike (*Lanius ludovicianus mearnsi*)	San Clemente Island			Endangered				
San Clemente Sage Sparrow (*Amphispiza belli clemente*	San Clemente Island			Threatened				

Table II.F.6-1 (Cont'd)

Species	Distribution	Breeding Season	Estimated California Population	Status Trend	Migratory	Age at Maturity	Nest or Breeding Data	Number of Nesting or Breeding Sites in California
California Least Tern (*Sterna albifrons browni*) (5,6,7,22)(A,B)[a]	San Francisco Bay to Mexico (Breeding)	Apr-Sept	1200	Endangered: stable	Yes-south in winter Oct-Mar	5 yrs.±	Mud flat bare sand-gravel area (colonial)	25±
Light-footed Clapper Rail (*Rallus longirostris levipes*) (14,22)(A)[a]	Goleta Slough south to San Quintin Bay, Baja	Feb-courtship Mar-nesting June-eggs	250	Endangered:	No	Ca. 2 yrs. spring after hatching	Nest in clumps of *Salicornia*. (solitary)	13±
Belding's Savannah Sparrow (*Lasserculus sandwichensis beldingi*) (17,22)(A)[a]	Goleta Slough south to Imperial Beach in San Diego, Co.		2200	Endangered: (State listing)	No			11
California Black Rail (*Laterallus jamaicensis coturniculus*) (1,4,22)(A,B)[a]	Salt marshes from Tomales Bay south to Baja, Mexico	April-May		Rare (State):	Some (late summer and fall)	Ca. 2 yrs.	Cupped nest in reeds on ground or elevated above high tide line	
California Clapper Rail (*Rallus longirostris obsoletus*) (14,22)(B)[a]	Salt marshes of San Francisco Bay, San Pablo Bay, Napa Marsh and Elkhorn Slough	March-July		Endangered: decline	No		Nests in pickleweed, cardgrass or gumweed in tidal sloughs	
Aleutian Canada Goose (*Branta Canadensis leucopareia*)	Coastal Calif. South to N. San Francisco Bay	Spring	900+	Endangered:	Yes		Nest in Aleutian Chain	0

Table II.F.6-1 (Cont'd)

Species	Distribution	Breeding Season	Estimated California Population	Status Trend	Migratory	Age at Maturity	Nest or Breeding Data	Number of Nesting or Breeding Sites in California
Blue Whale *(Balaenoptera musculus)* (15)(A,B)[a]	Offshore West Coast	Winter	1,700 (N.Pacific)	Endangered: decline	Yes- north (summer) south (winter)	10 yrs.		0
Fin Whale *(Balaenoptera physalus)* (15)(A,B)[a]	Offshore West Coast	Winter	17,000 (N.Pacific)	Endangered: decline	Yes- North (summer) south (winter)	6-12 yrs.		0
Gray Whale *(Eschrichtius gibbosus)* (15,18)(A,B)[a]	Offshore West Coast	Nov-Dec	11,000	Endangered: stable	Yes- north (summer) south (winter)	5-11 yrs.	Southern Baja, Mexico (Nov-Dec)	0
Humpback Whale *(Megaptera novaeanglinae)* (15)(A,B)[a]	Offshore West Coast	Oct-Mar	2,500 (ocean-wide)	Endangered: stable	Yes- north (summer) south (winter)	6-12 yrs.	Oct-Mar	0
Pacific Right Whale *(Eubalena glacialis japonica)* (15)(A,B)[a]	Offshore West Coast		220 (N.Pacific)	Endangered: stable	Yes- north (summer) south (winter)			0

Table II.F.6-1 (Cont'd)

Species	Distribution	Breeding Season	Estimated California Population	Status Trend	Migratory	Age at Maturity	Nest or Breeding Data	Number of Nesting or Breeding Sites in California
Sei Whale (*Balaenoptera borealis*) (15)(A,B)[a]	Offshore West Coast	Winter	9,000 (N.Pacific)	Endangered: stable-decline	Yes-north (summer) south (winter)	6-12 yrs.		0
Sperm Whale (*Physeter catadon*) (15,19)(A,B)[a]	Offshore West Coast	Spring-summer (5 mos.)	699,000 (ocean-wide)	Endangered: stable	Yes-north (summer) south (winter)	♀ 8-11 yrs. ♂ 10 yrs.		0
Guadelupe Fur Seal (*Arctocephalus townsendi*) (22)(A)[a]	Offshore West Coast San Miguel Island	pupping (May-July)	2-5 (Calif)	Rare (State) 1200± in Mexico (increasing slowly)	Some north in summer	5-7 yrs.	Breed on Guadelupe Island, Mexico	0
Island Fox (*Urocyon littoralis*) (9,22)(A)[a]	All Channel Islands except Anacapa and Santa Barbara	Feb-May		Rare (State): stable	No	2 yrs.±	Use any available structure for den	
Morro Bay Kangaroo Rat (*Dipodomys heermani morroensis*) (16)(B)[a]	South side of Morro Bay	Mar-August	3,000±	Endangered: decline	No	2 mo.±	Morro Bay (solitary)	Only at Morro Bay
Salt Marsh Harvest Mouse (*Reithrodontomys raviventris*) (1,22)(B)[a]	Marsh areas of San Francisco and San Pablo Bays	Year round		Endangered: decline	No		Birdlike nest above ground in thick grass or weeds	
Southern Sea Otter (*Enhydra lutris nereis*) (1,16,21)(A,B)[a]	Santa Cruz south to Avila Beach	Year round (peak in May)	1,700+	Threatened: increase	No (only local movements)	2+ yrs.	Breed at sea	

Table II.F.6-1 (Cont'd)

Species	Distribution	Breeding Season	Estimated California Population	Status Trend	Migratory	Age at Maturity	Nest or Breeding Data	Number of Nesting or Breeding Sites in California
Leather-backed Turtle (*Dermochelys coriacea schlegeli*) (1,20)(A,B)[a]	Tropical and sub-tropical seas of west coast; some stray as far north as Vancouver Is., British Columbia	Year round with peak in May-June		Endangered: decline	Some: north in summer		Eggs buried in sand on beaches at nights: (solitary)	0
Hawksbill Seaturtle (*Eretmochelys impricata*)				Endangered				0
Olive Ridley Sea Turtle (*Lepidochelys olivacea*)				Threatened				0
Loggerhead Seaturtle (*Caretta caretta*)				Threatened				0
Green Seaturtle (*Chelonia mydas*)				Threatened				0
Alameda Striped Racer (*Masticophis lateralis euryxanthus*) (20,22)(B)[a]	**Contra Costa and Alameda Counties**	**Spring** (Apr-May)		**Rare: decline**	**No**		**Usually in** brushy areas	
San Francisco Garter Snake (*Thamnophis sirtalis tetrataenia*) (20,22)(B)[a]	San Mateo County	Spring (Mar-May)	1,000±	Endangered: decline	No		Usually in marshes, sloughs or meadows	
Santa Cruz Long-Toed Salamander (*Ambystoma macrodactylum croceum*) (20,22)(B)[a]	Santa Cruz County at four locations	Early Spring	5,500±	Endangered: decline	No (only local movements)	1-2 yrs.	Breed under logs, rocks, etc. near ponds	
Island Night Lizard (*Klauberina riversiona*)	San Clemente Island			Threatened: Stable				
Thicktail Chub (*Gila crassicanda*) (22)(B)[a]	Coyote Creek tributary into south San Francisco Bay		May be extinct	Endangered: may be extinct				

Table II.F.6-1 (Cont'd)

Species	Distribution	Breeding Season	Estimated California Population	Status Trend	Migratory	Age at Maturity	Nest or Breeding Data	Number of Nesting or Breeding Sites in California
El Segundo Blue Butterfly (*Shijimiaeoides battoides allyni*) (1)(A)[a]	**Los Angeles** County coastal area near L.A. Airport	**June-July**	**Several** hundred	**Endangered:** decline-stable	**No**	**4-5 days**	Lay eggs in the flowers of wild buck-wheat (*Eriogonum parvifolium*)	**2**
Smith's Blue Butterfly (*S. enoptes smith*)	Monterey Co. Coastal Dunes			Endangered				
San Bruno Elfin Butterfly (*Callohrys mossil bayensis*)	San Bruno Mountain			Endangered				
Mission Blue Butterfly (*Icaricia icorioides*)	San Bruno Mountain, San Frnacisco			Endangered				

Key

A. Area from Point Conception to the Mexican border.
B. Area from Point Conception to Point Reyes.

Source: For a complete list of sources see POCS Reference Paper No. II.

The following animals are proposed for listing as Threatened or Endangered Species under the Endangered Species Act of 1975: bonded dune snail (*Heminthoglypta walkeriuna*); Golbose Dune Beetle (*Coelus globosus*).

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18. Rice, D.W. and A.A. Walman, 1971. The Life History and Ecology of the Gray Whale *(Eschrichtius robustus)*. American Society of Mammalogists Spec. Pub. No. 3.

19. Berzin A.A., 1971. The Sperm Whale. Translated from Russian Dept. of Commerce, NOAA, Washington, D.C.

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21. Kenyan, Karl W. 1969. The Sea Otter in the Eastern Pacific Ocean. U.S. Fish and Wildlife Service, North American Fauna Series, No. 68.

22. California Department of Fish and Game, 1976. At the crossroads, A Report on California's Endangered and Rare Fish and Wildlife, Sacramento, California.

[a]Refer to Source List.

b. Baja California, Mexico: The west coast of Baja California, Mexico lying between the international border and 27°N Latitude, is inhabited or visited by 16 rare or endangered animal species as listed in Table II.F.6-2. Fifteen of these species are the same as occur in the Southern California area, with the peninsular pronghorn antelope being the only new addition.

c. Point Conception to Point Reyes: The general trend in coastal topography and habitat tends to change as one travels north of Point Conception. The long expanses of wide sandy beaches tend to give way to a more rocky and precipitous coastline. This change in topography and general cooling of both air and water temperature lend way to the occurrence of different biota. Within the area, there is a possibility of encountering about 22 rare, threatened or endangered species of animals (Table II.F.6-1).

<u>Table II.F.6-2</u>

RARE OR ENDANGERED SPECIES OF BAJA, MEXICO

Species	Distribution in Baja	Breeding Season	Estimated Population in Baja	Status: Trend	Migratory	Age at Maturity	Nest or Breeding Data	Number of Nesting or Breeding Sites in Baja down to 27°N Latitude
California Condor *(Gymnogyps californianus)*	Reported Sightings in northern 300 miles of Baja. (Unconfirmed)	Oct-May	Less Than 5	Endangered: decline	Yes for non-breeders	6 yrs.	No known nests in Baja (solitary)	0
American Peregrine Falcon *(Falco peregrinus anatum)*	Known to occur on Gulf side; possible on Pacific side		6+	Endangered: decline	Yes	2 yrs.	Scrape on ledge high on cliffs (solitary)	
Southern Bald Eagle *(Haliaeetus l. leucocephalus)*	Along coast and inland.		6+	Endangered: decline			Twig nest high in tree or on ledge. (solitary)	Two active nests in vicinity of Magdalena Bay.
California Brown Pelican *(Pelecanus occidentalis californicus)*	Offshore islands and along the coast south to	Jan-July	2000±	Endangered: increase since 1970	Yes, north after nesting season		Twig nest on ground (colonial)	
California Least Tern *(Sterna albifrons browni)*	Known from areas around Ensenada San Quintin Bay, Scammons Lagoon and Magdalena Bay	Apr-Sept.		Endangered: Stable	Yes-south in winter Oct-May	5 yrs.±	Mud flat, bare sand-gravel areas (colonial)	

Table II.F.6-2 (Cont.)

Species	Distribution in Baja	Breeding Season	Estimated Population in Baja	Status: Trend	Migratory	Age at Maturity	Nest or Breeding Data	Number of Nesting or Breeding Sites in Baja down to 27°N Latitude
Light-footed clapper rail (*Rallus longirostris levipes*)	Marshes along the coast south of Ensenada and around San Quintin Bay.	Feb-April		Endangered:	No	2 yrs.±	Nests in clumps of *Salicornia* (solitary)	
California Black Rail (*Laterallus jamaicensis coturniculus*)	Salt marshes: San Quintin Bay	Apr-May		Rare (State of Calif.)	Some are summer and fall	2 yrs.±	Cupped nest in reeds on ground or above high tide line.	
California Gray Whale (*Eschrichtuis gibbosus*)	Along Pacific coast south to the Scammons and Magdalena Bays.	Nov-Dec		Endangered: stable	Yes-north in summer and south in winter	5-11 yrs.	Breed in Scrammons and other lagoons of Baja (Nov-Dec)	
Blue Whale (*Balaenoptera musculus*)	Offshore West Coast	Winter	1,700 (N. Pacific)	Endangered: decline	Yes-north (summer) south (winter)	10 yrs.		0
Fin Whale (*Balaenoptera physalus*)	Offshore West Coast	Winter	17,000 (N. Pacific)	Endangered: decline	Yes-north (summer) south (winter)	6-12 yrs.		0

Table II.F.6-2 (Cont.)

Species	Distribution in Baja	Breeding Season	Estimated Population in Baja	Status: Trend	Migratory	Age at Maturity	Nest or Breeding Data	Number of Nesting or Breeding Sites in Baja down to 27°N Latitude
Gray Whale *(Eschrichtius gibbosus)*	Offshore West Coast	Nov-Dec.	11,000	Endangered: stable	Yes- north (summer) south (winter)	5-11 yrs.	Southern Baja, Mexico (Nov-Dec)	0
Humpback Whale *(Megaptera novaeanglinae)*	Offshore West Coast	Oct-Mar	2,500 (ocean-wide)	Endangered: stable	Yes- north (summer) south (winter)	6-12 yrs.	Oct-Mar	0
Pacific Right Whale *(Eubalena glacialis japonica)*	Offshore West Coast		220 (N. Pacific)	Endangered: stable	Yes- north (summer) south (winter)			0
Sei Whale *(Balaenoptera borealis)*	Offshore West Coast	Winter	9,000 (N. Pacific)	Endangered: stable-decline	Yes- north (summer) south (winter)	6-12 yrs.		0
Sperm Whale *(Physeter catadon)*	Offshore West Coast	Spring-summer	699,000 (ocean-wide)	Endangered: stable	Yes- north (summer) south (winter)	♀ 8-11 yrs. ♂ 10 yrs.		0

Table II.F.6-2 (Cont.)

Species	Distribution in Baja	Breeding Season	Estimated Population in Baja	Status: Trend	Migratory	Age at Maturity	Nest or Breeding Data	Number of Nesting or Breeding Sites in Baja down to 27°N Latitude
Guadalupe Fur Seal *(Arctocephalus townsenoli)*	Offshore islands of Pacific Coast of Baja	Pupping (May-July	1,200±	Rare (state of California	Some (move north in summer)	5-7 yrs.	Guadalupe Is.	
Penisular Pronghorn Antelope *(Antilocapra americana penisularis)*	Desert area east of Scammons Lagoon and gulfside of Baja	Sep-Oct	very few	Endangered: Decline	Yes-change altitudes in winter and summer	2 yrs.±		

G. Man's Use of the Environment

1. Land and Water Use

a. Regional Land Use: Land use along the Southern California coastal zone is generally classified as urban in nature, less so north of Point Conception. Because of the topographic features of the region, the urban growth areas are separated by ranges of low mountains, marshes, or other physical characteristics, and are confined to geographic areas suited to intensive development. The transportation systems are situated within the region because of the geographical and physical characteristics and therefore, reinforce the pattern of urban growth. The major California coastal population centers are in the San Francisco, Santa Cruz-Monterey, Santa Barbara and Oxnard-Ventura areas, as well as the Los Angeles, Long Beach, and San Diego metropolitan areas.

Land use by category for each county is shown in Table II.G.1.a-1. The reporting categories are broad in scope, but present the development form and structures of the urban and non-urban uses. The category "other" includes non-urban areas, many of them mountainous. For example, vacant, undeveloped, rural recreation and livestock areas are found in each county, but are not necessarily important to the study area.

The spatial distribution of the urban uses and the major agricultural uses is shown in Figure II.G.1.a-1 and Visual No. 2. The urban enclaves near the coast are designated by crosshatches. The major concentration is in the southern portion of Los Angeles County with extensions overlapping into San Bernardino, Riverside, and Orange Counties. The next largest concentration is found in the San Diego urban area which extends from the coast to eastern valleys. Other large urban groupings are found in the Oxnard, Ventura, and Santa Barbara areas.

Major agricultural areas are shown within the dotted areas. The major groupings are located within Ventura, San Bernardino, and Riverside Counties, with other large areas located in the remaining counties.

A further breakdown of "residential" use is tabulated in Table II.G.1.a-2 to show housing inventory and vacancy rates for the five southernmost coastal counties.

Shoreline Use and Ownership. The State of California owns the submerged land off the coast and around each of the Channel Islands for a distance of three geographical miles seaward from the high tide line. The area of ownership follows the sinuosity of the coastline and the shoreline properties are intermixed private and publicly owned parcels.

Table II.G.1.a-1

LAND USE BY COUNTY
BY ACRES
1970

	San Diego	Orange	Los Angeles	Santa Barbara	Ventura
Residential	68,448	100,763	417,764	17,590	21,790
Commercial	7,104	12,301	41,648	2,070	2,890
Industrial	6,899	12,552	79,305	1,910	540
Other urban[a]	429,075	45,179	263,195	4,680	4,530
Agriculture	209,311	53,210	98,956	94,957	120,120
Other[b]	2,028,805	287,045	1,798,255	1,506,443	1,030,100

(Includes those portions of the county, as reported by county agencies, to be within the area of leasing influence.)

Sources: State of California Department of Water Resources
Southern California Association of Government
Los Angeles County Planning Department
Orange County Planning Department
San Diego County Planning Department
San Diego Comprehensive Planning Organization

[a]Contains urban uses not elsewhere classified, such as public, semi-public, recreation, military, communications, transportation, utilities etc.

[b]Contains all non urban uses such as vacant, undeveloped, livestock areas, rural recreation, etc.

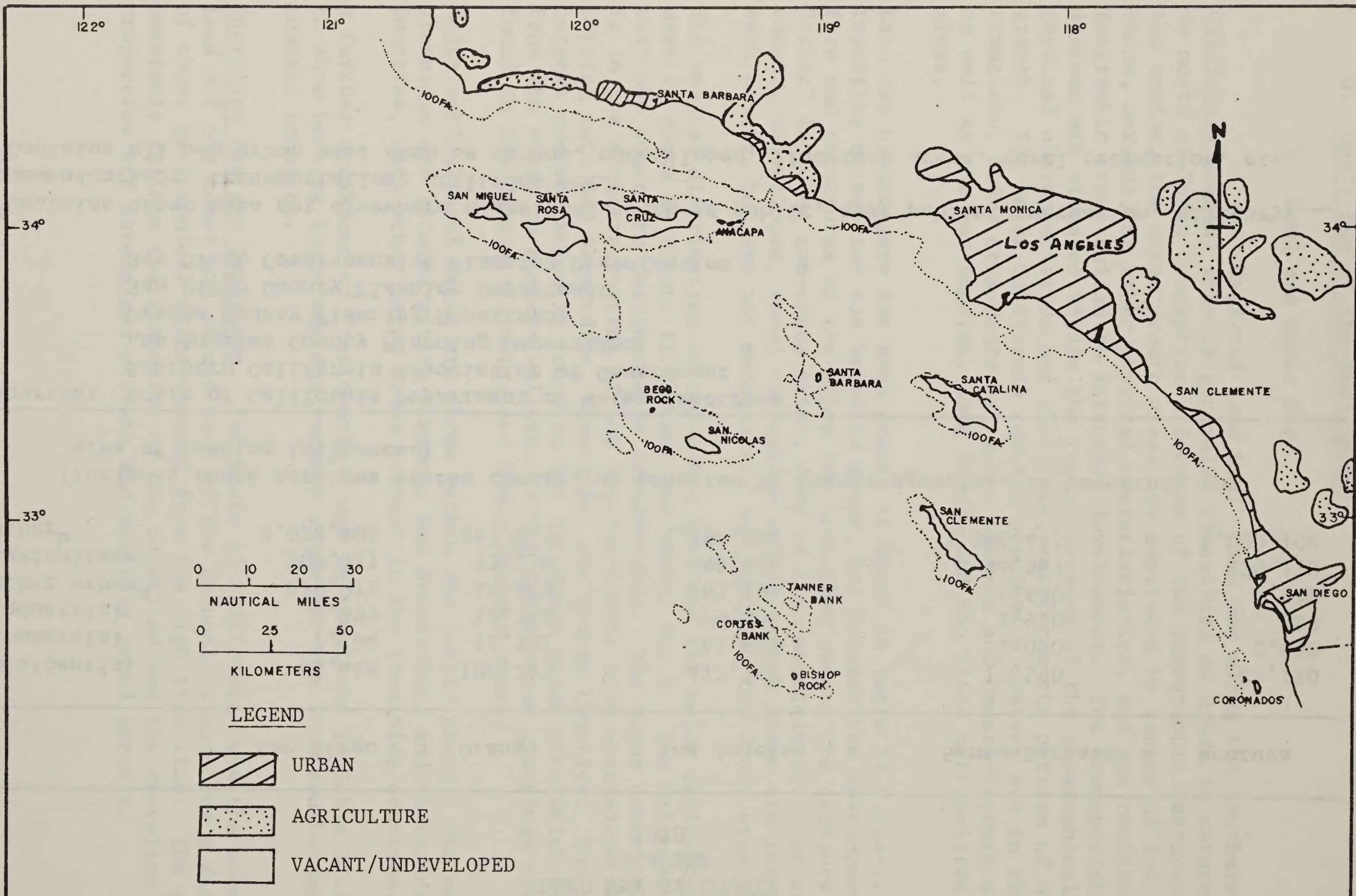


Figure II.G.1.a-1 Land Use

Table II.G.1.a-2

SOUTHERN CALIFORNIA DWELLING UNITS, 1975

County	Total Dwelling Units (Est. 1975)	% Vacancy (1975)
Santa Barbara	103,051	3.1
Ventura	144,468	4.9
Los Angeles	2,695,401	3.9
Orange	607,630	2.3
San Diego (1977)	601,899	5.1

Source: Residential Research Report (Third Qtr., 1975), Residential Research Committee of Southern California.

The National Shoreline Study (U.S. Army Corps Engineers, 1971) divides the study area into county segments for describing shoreline use and ownership, indicates the total coastal miles for each county, establishes reference stations at ten mile intervals, and maps the total 1,051.8 km (654 mile length) of the coastline (Table II.G.1.a-3).

Table II.G.1.a-3

SOUTHERN AND CENTRAL CALIFORNIA COASTLINE

County	Coastline (in miles)	(in kilometers)
San Francisco	8.3	13.4
San Mateo	56.0	90.1
Santa Cruz	42.0	67.6
Monterey	111.3	179.1
San Luis Obispo	93.0	149.7
Santa Barbara	110.0	177.0
Ventura	41.0	66.0
Los Angeles	74.0	119.1
Orange	42.0	67.6
San Diego	76.0	122.3
Total	653.6	1,051.9

A description of the regional coastal land uses from Point Reyes to the U.S.-Mexican border with emphasis upon the area south of Point Conception where the majority of the proposed actions would occur may be found in POCS Reference Paper No. II.

b. Regional Transportation: Regional transportation includes the following three major transportation systems: ports and shipping, pipeline and general systems.

i. Ports and Shipping: This section on ports and shipping describes commercial ports and marine terminals. In the region between Point Conception and the Mexican border, there are numerous ports for handling container, bulk, general and liquid cargoes. These ports extend north from San Diego to Santa Barbara and accommodate both domestic and foreign ships. The U.S. Coast Guard, in an inquiry, has indicated that ships have three routes to enter the Los Angeles and Long Beach Harbors which account for approximately 90 percent of shipping traffic into the Southern California ports. Ships from the north and from the Orient enter the Point Conception to Point Fermin area by U.S. Coast Guard established traffic lanes. Ships from Honolulu and Australia enter San Pedro Bay from the west, sailing between Santa Cruz and Santa Catalina Islands. Ships from the Panama Canal and South America sail north into the Gulf of Santa Catalina via U.S. Coast Guard established traffic lanes. Figure II.G.1.b-1 illustrates the above ports and marine terminals.

Ship arrivals and departures for the seven ports during calendar year 1976 are indicated in Table II.G.1.b-1. These figures include passengers and freight vessels and exclude domestic fishing, military ships, pleasure boats and through traffic. Total freight traffic through the ports for calendar year 1976 are shown in Table II.G.1.b-2. Total freight includes military cargoes.

Fourteen conventional types of petroleum marine terminals (five to seven buoys) are located inside State waters along the coast of Southern California. These marine terminals have submarine pipelines from the terminals to onshore facilities to load and unload tankers with crude oil and unload tankers with fuel oil. Crude oil is supplied from local onshore and offshore wells and is imported from foreign countries. Fuel oil is supplied to Southern California Edison and San Diego Gas and Electric power plants.

In the region between the Mexican border and Scammon's Lagoon, there is limited available information. Figure II.G.1.b-2 illustrates some of the transportation systems in Baja California. In Ensenada, freighters with restricted passenger accommodation occasionally make port calls while enroute for La Paz and other west coast ports. A fuel oil marine terminal is located approximately 1,600 m (5,250 feet) offshore from the Rosarito beach. A 20-inch diameter submarine pipeline connects the marine terminal to the onshore PEMEX Storage tanks. Tankers unload fuel oil about 2 to 3 times per month with 20,000 to 120,000 tanks for each shipment.

In the region between Point Conception and Point Reyes, there are eight commercial harbors and five marine terminals. Table II.G.1.b-3 tabulates the waterborne commerce for calendar year 1976 for these eight harbors.

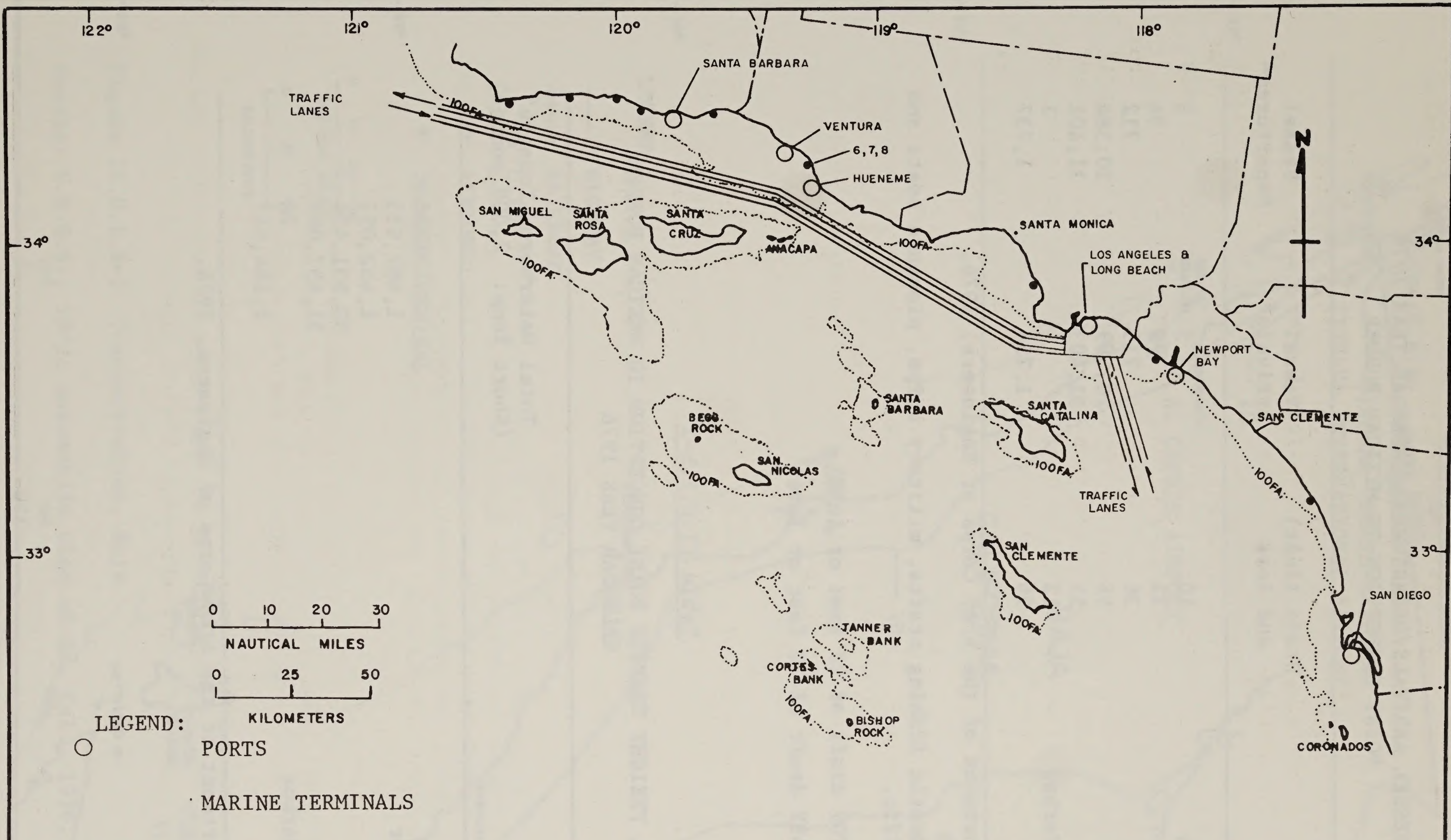


Figure II.G.1.b-1 Point Conception-Mexican Border Ports and Marine Terminals.

Table II.G.1.b-1

VESSEL ARRIVALS/DEPARTURES, CALENDAR YEAR 1976
POINT CONCEPTION TO MEXICAN BORDER

Ports	Draft (feet) and less	Vessel Arrivals[a]	Vessel Departures[a]
Santa Barbara	10	5	5
Ventura Harbor	35	73	74
Port Hueneme	36	715	712
Los Angeles	55	20,389[b]	20,384
Long Beach	55	31,403[c]	31,401
Newport Bay Harbor	12	1	1
San Diego	36	1,738	1,737

Source: Department of the Army Corps of Engineers, 1976.

[a]Excludes domestic fishing crafts, military ships, pleasure boats and through traffic.

[b]20,389 (18,707 draft of 22 feet or less)

[c]31,403 (29,492 draft of 18 feet or less)

Table II.G.1.b-2

TOTAL FREIGHT TRAFFIC POINT CONCEPTION TO MEXICAN BORDER
CALENDAR YEAR 1976

Ports	Total Waterborne Tonnage[a] (Short Tons: 2,000 pounds)
Santa Barbara	3,388
Ventura Harbor	1,487,933
Port Hueneme	1,452,057
Los Angeles	30,931,489
Long Beach	31,457,099
Newport Bay Harbor	72
San Diego	2,184,617

Source: Department of the Army Corps of Engineers, 1976.

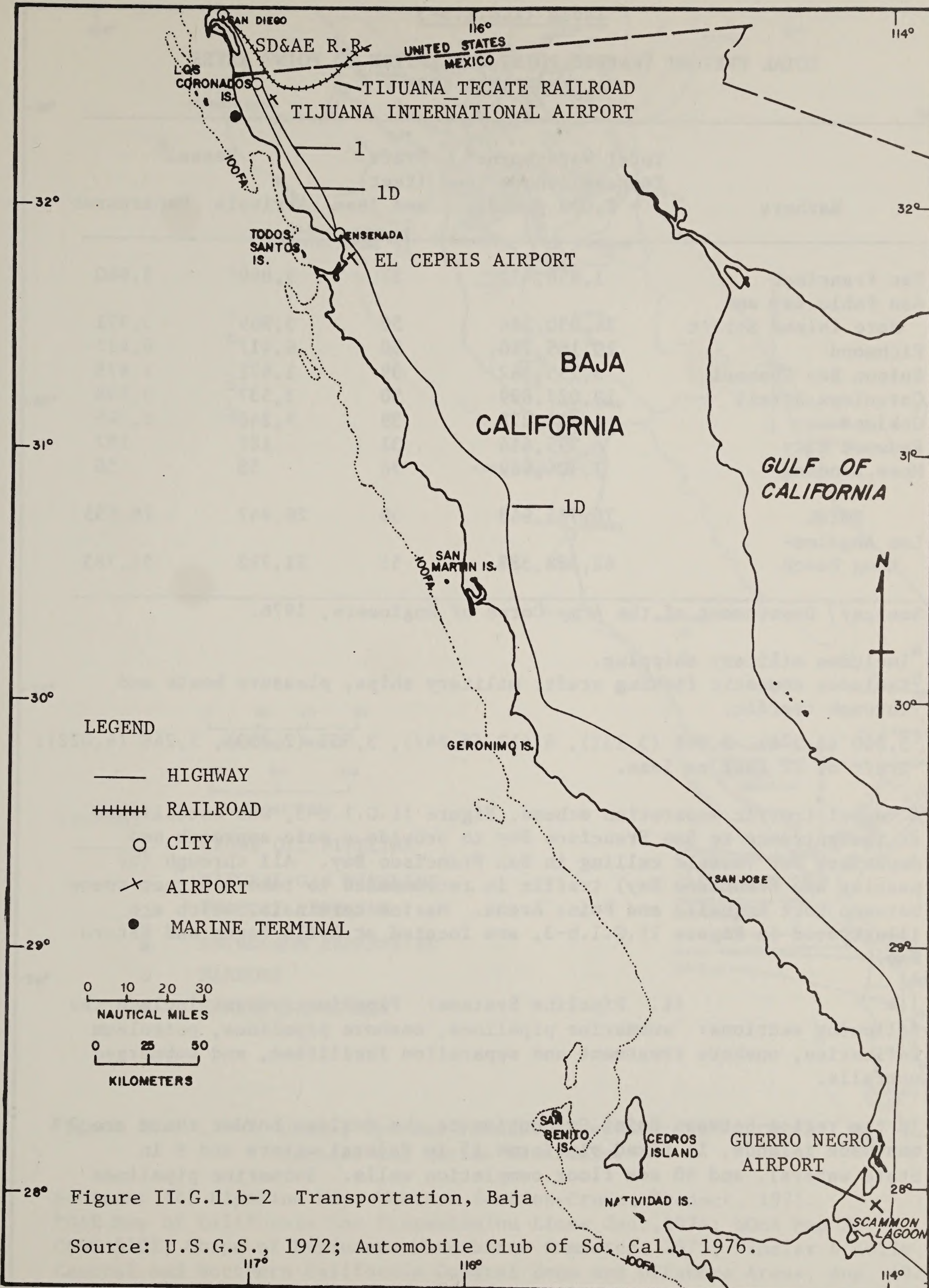


Figure II.G.1.b-2 Transportation, Baja

Source: U.S.G.S., 1972; Automobile Club of So. Cal., 1976.

Table II.G.1.b-3

TOTAL FREIGHT TRAFFIC POINT CONCEPTION TO POINT REYES
CALENDAR YEAR 1976

Harbors	Total Waterborne[a] Tonnage (short ton = 2,000 pounds	Draft (feet) and less	Vessel[b] Arrivals	Vessel[b] Departures
San Francisco	1,956,437	37	5,860[c]	5,860
San Pablo Bay and Mare Island Strait	24,030,384	50	3,969[c]	3,971
Richmond	20,165,240	50	6,417[c]	6,417
Suisun Bay Channel	3,235,162	39	1,671	1,675
Carquinez Strait	19,027,899	50	3,537[c]	3,538
Oakland	6,634,278	39	5,248[c]	5,249
Redwood City	395,614	31	187	187
Moss Landing	1,306,929	36	58	58
TOTAL	76,751,943	50	26,947	26,955
Los Angeles-Long Beach	62,388,588	55	51,792	51,785

Source: Department of the Army Corps of Engineers, 1976.

[a]Includes military shipping.
[b]Excludes domestic fishing craft, military ships, pleasure boats and through traffic.

[c]5,860 (5,378), 3,969 (3,131), 6,417 (5,847), 3,537 (2,793), 5,248 (4,022): Draft of 22 feet or less.

A vessel traffic separation scheme, Figure II.G.1.b-3, was established at the entrance to San Francisco Bay to provide a safe approach and departure for vessels calling in San Francisco Bay. All through (by passing San Francisco Bay) traffic is recommended to take a direct route between Port Arguello and Point Arena. Marine terminals, which are illustrated in Figure II.G.1.b-3, are located at Avila Beach and Estero Bay.

ii. Pipeline Systems: Pipeline systems include the following sections: submarine pipelines, onshore pipelines, petroleum refineries, onshore treatment and separation facilities, and submerged outfalls.

In the region between Point Conception to the Mexican border there are 7 man-made islands, 14 fixed platforms (5 in Federal waters and 9 in State waters), and 40 sea floor completion wells. Submarine pipelines

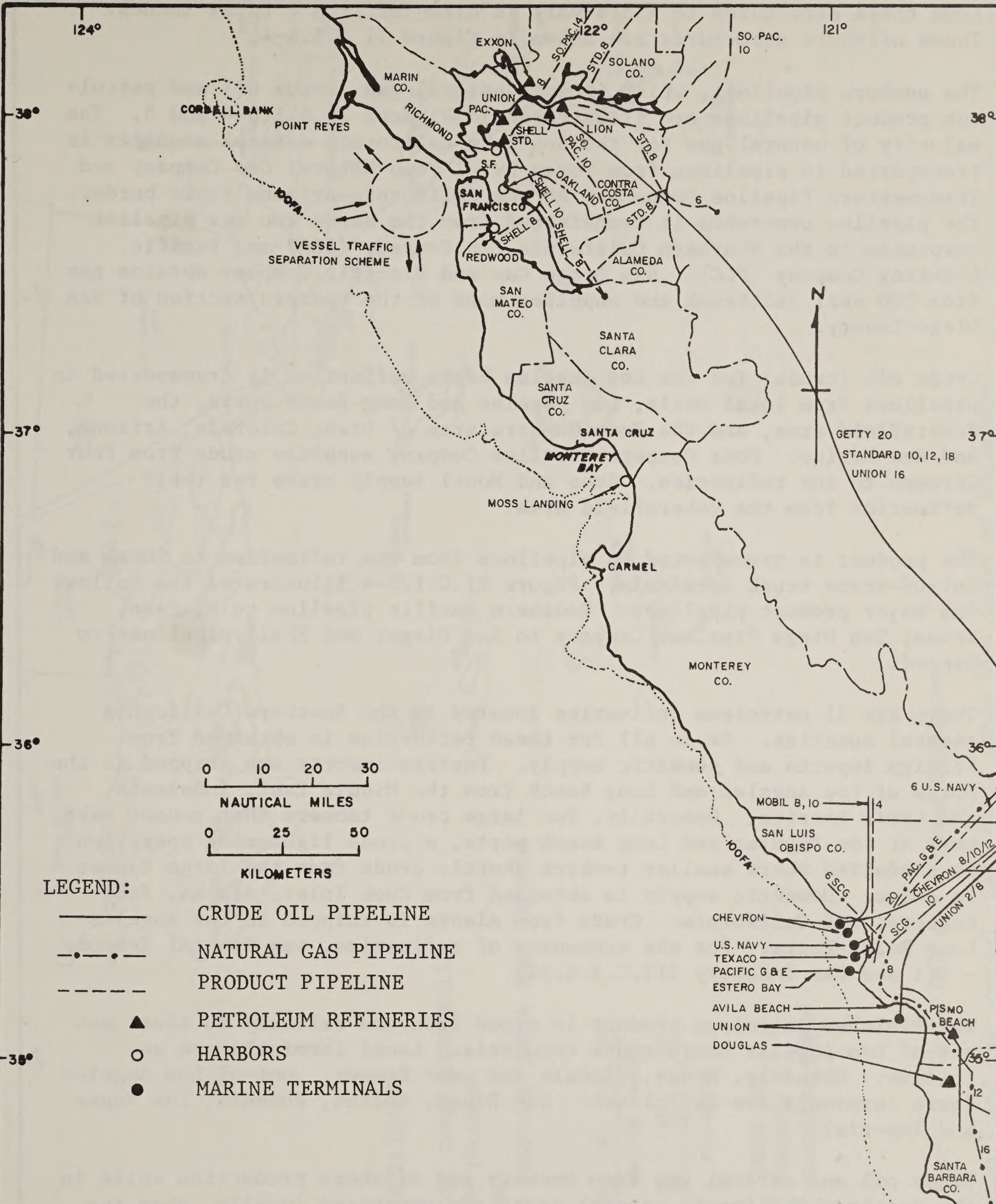


Figure II.G.1.b-3 Crude, Gas and Product Pipelines; Refineries, Harbors and Marine Terminals.

Sources: API Pipeline Maps-Western Section-Crude, Product, 1975. PG&E Map of California Gas Transmission Lines Jan.,1974; NOAA Map No. C&GS 5302; Corps of Engineers Waterborne Commerce, 1975; Winzler & Kelly Central and Northern California Coastal Zone and Offshore Areas, Aug. 1977 from these structures to shore vary in diameter from 2 to 14 inches. These offshore structures are shown in Figure II.G.1.b-4.

The onshore pipelines, which include natural gas, crude oil and petroleum product pipelines are illustrated in Figures II.G.1.b-4 and 5. The majority of natural gas for the Southern California coastal counties is transported in pipelines from Texas by El Paso Natural Gas Company and Transwestern Pipeline Company. At the California-Arizona State border, the pipeline ownership is transferred from the above two gas pipeline companies to the Southern California Gas Company (SCG) and Pacific Lighting Company (PLC). San Diego Gas and Electric Company obtains gas from SCG near Fallbrook and supplies most of the western section of San Diego County.

Crude oil (crude) for the Los Angeles basin refineries is transported in pipelines from local wells, Los Angeles and Long Beach Ports, the Bakersfield area, and the Four Corners area of Utah, Colorado, Arizona, and New Mexico. Four Corners Pipeline Company supplies crude from Four Corners to the refineries. Arco and Mobil supply crude for their refineries from the Bakersfield area.

The product is transported in pipelines from the refineries to local and out-of-state truck terminals. Figure II.G.1.b-4 illustrates the following major product pipelines: Southern Pacific pipeline to El Paso, Texas; San Diego Pipeline Company to San Diego; and Shell pipelines to Oxnard.

There are 21 petroleum refineries located in the Southern California coastal counties. Crude oil for these refineries is obtained from foreign imports and domestic supply. Foreign imports are shipped to the Ports of Los Angeles and Long Beach from the Middle East, Indonesia and Latin America. Generally, for large crude tankers that cannot make port at Los Angeles and Long Beach ports, a crude lightering operation is conducted where smaller tankers shuttle crude from the large tanker to shore. Domestic supply is obtained from Cook Inlet, Alaska, Four Corners, and California. Crude from Alaska is shipped to Los Angeles-Long Beach Ports. For the economics of refineries, see Coastal Economy - Oil and Gas Industry (II.G.2.d.ii).

The finished petroleum product is piped from the refinery to local and out-of Los Angeles Basin truck terminals. Local terminals are as follows: Glendale, Hynes, Vindale and near Downey. Out-of Los Angeles Basin terminals are as follows: San Diego, Colton, Phoenix, Las Vegas and Imperial.

Crude oil and natural gas from onshore and offshore production wells in the Southern California coastal areas are processed locally, when required, in crude oil and natural gas treatment and separation facilities.

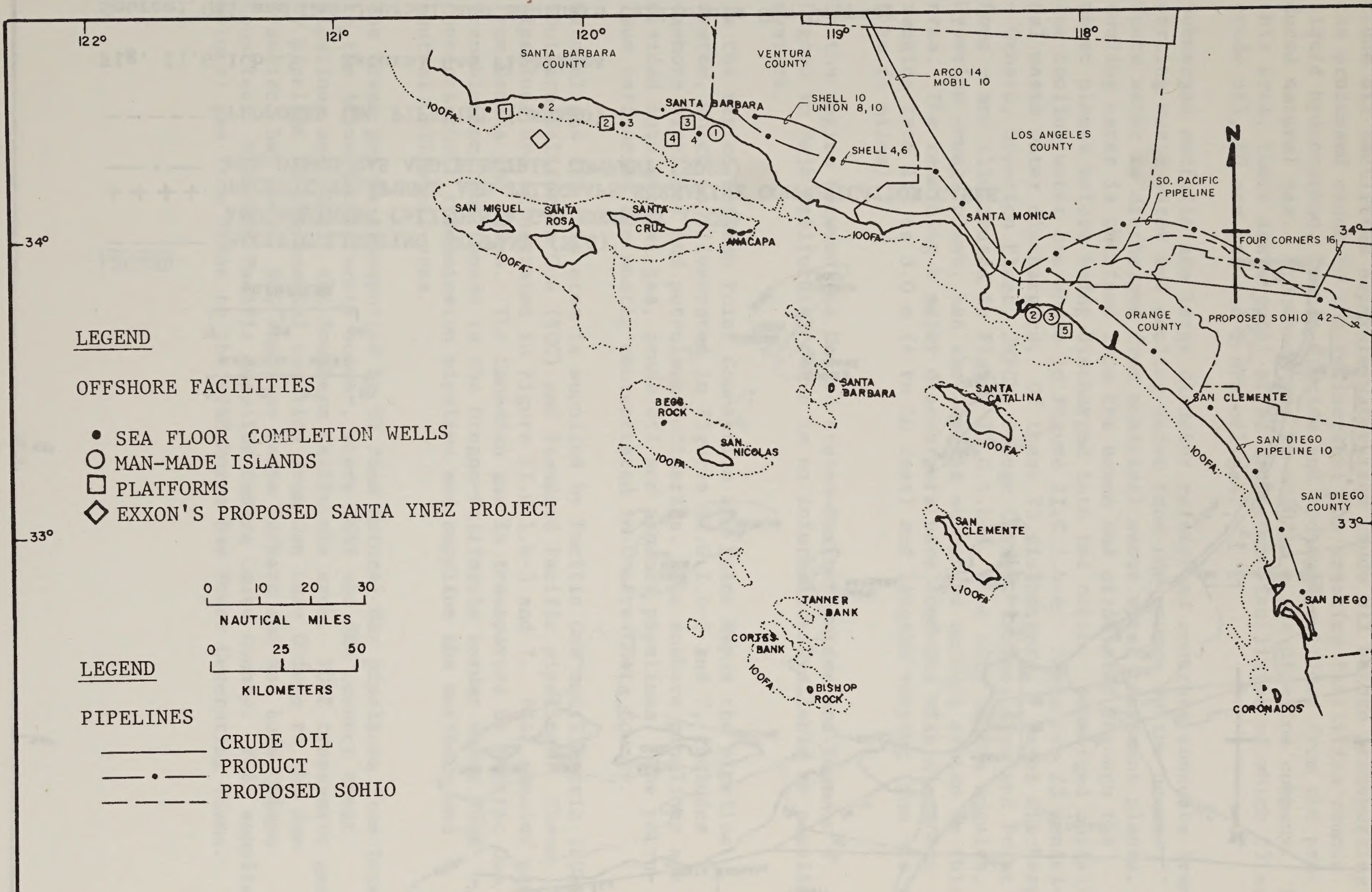
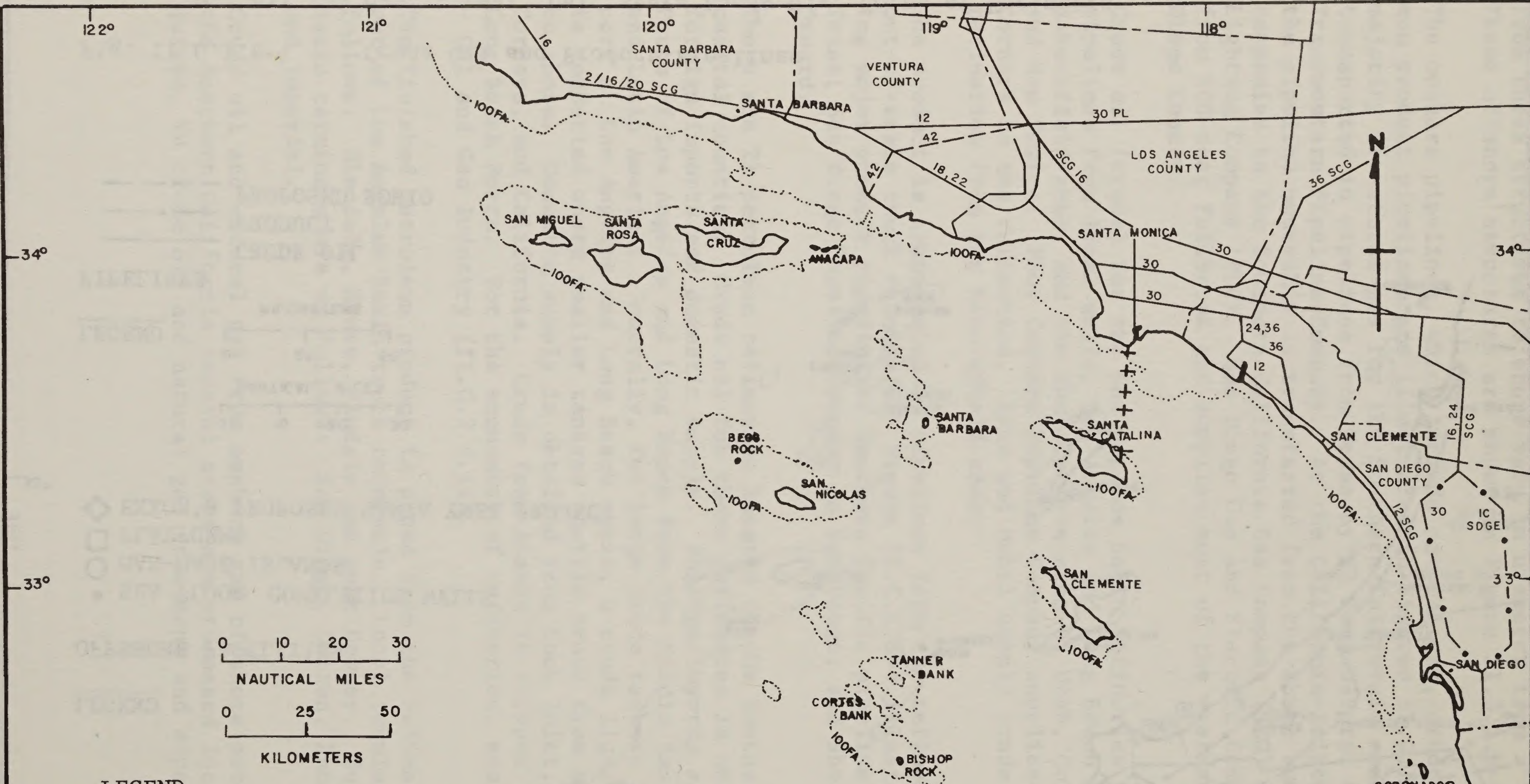


Fig. II.G.1.b-4 Crude Oil and Product Pipelines

Source: Map-Oil and Gas Journal, Cal. State Lands Div.,Corps of Engineers



LEGEND

—— PACIFIC LIGHTING COMPANY (PLC) AND SOUTHERN CALIFORNIA GAS COMPANY (SCG)

++++ PACIFIC TELEPHONE AND TELEGRAPH SUBMARINE COMMUNICATION CABLE

—•— SAN DIEGO GAS AND ELECTRIC COMPANY (SDGE)

----- PROPOSED LNG PIPELINE (OXNARD)

Fig. II.G.1.b -5 Natural Gas Pipelines

Source: Oil and Gas Journal and Southern California Gas Company

Crude oil facilities separate water from crude oil before transporting the processed crude to the refineries; gas treating facilities remove liquid hydrocarbon, carbon dioxide and hydrogen sulfides from the produced natural gas. Processed gas is sold to a gas pipeline company. In this area, there are a total of 42 separation facilities of which 23 are crude oil, 10 are gas and 9 are oil/gas.

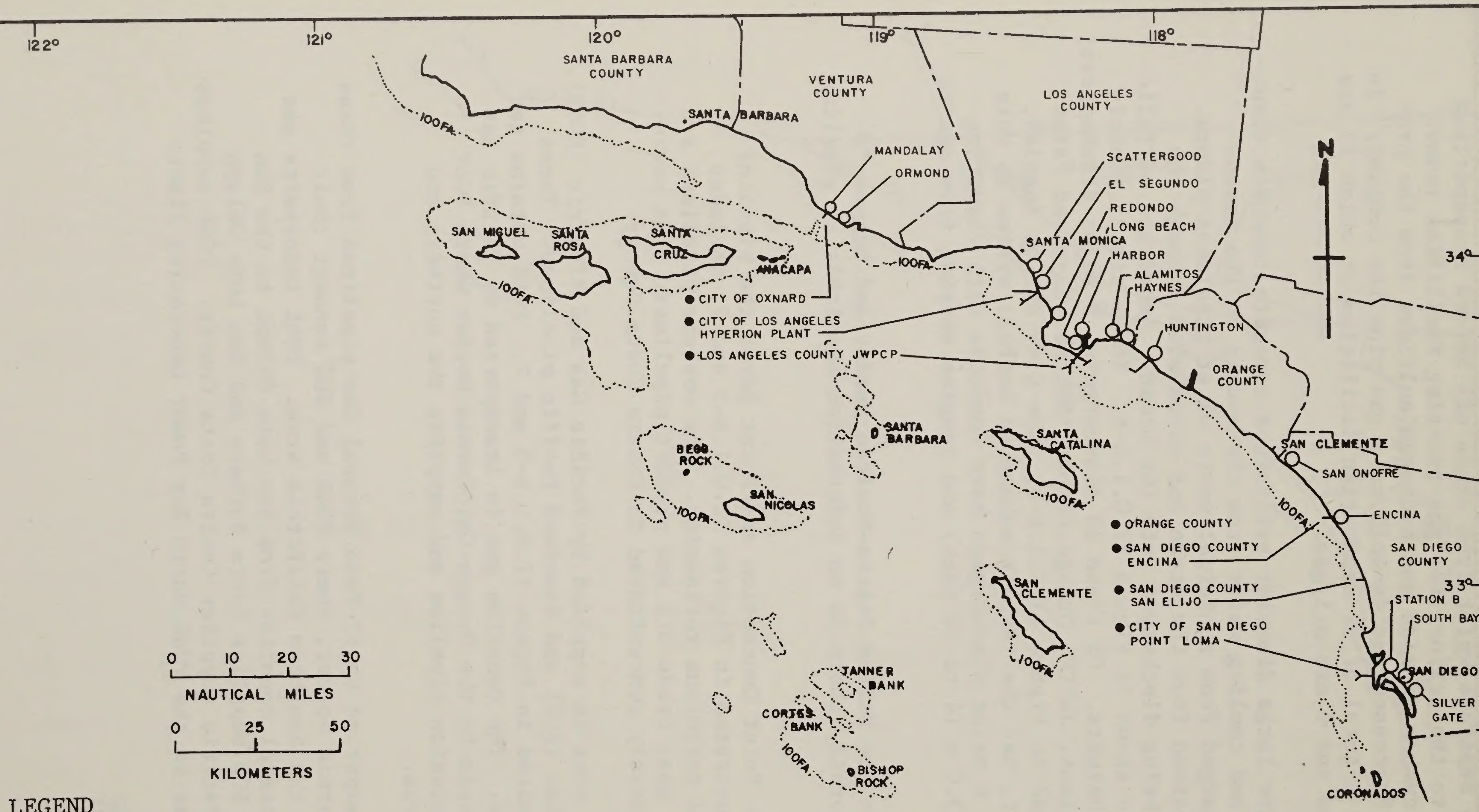
Submerged outfalls are large diameter reinforced concrete conduits transporting waste water and cooling water from the source to the ocean. Waste water is discharged from municipal waste water treatment plants. Cooling water is obtained from the ocean and circulated through the power plants before being discharged into the ocean. Submerged outfalls for cooling water are shown in Figure II.G.1.b-6. There are 23 municipal waste water dischargers. Of these 23 dischargers, 7 major dischargers - Oxnard, Hyperion Plant, JWPCP, Orange County, Encino, Elyo and Point Loma - are illustrated in Figure II.G.1.b-6. The City of Los Angeles, Hyperion sewage plant, has the largest submerged outfall system in this area. The remaining 6 major dischargers have conduits with diameters ranging from 1.2 to 3.0 m (4 to 10 feet) and lengths varying from one to 8 km (5 miles).

In the region between the United States-Mexican border and Scammon's Lagoon in Baja California, there is no information available on pipeline systems.

In the region between Point Conception and Point Reyes the pipeline system, which is illustrated in Figures II.G.1.b-3 and 7, includes onshore pipelines and petroleum refineries. The onshore pipelines are divided into natural gas, crude oil and product pipelines. The petroleum refineries are mostly concentrated in Contra Costa County.

Natural gas for this area is supplied by Pacific Gas and Electric (PG&E), Southern California Gas (SCG) and Standard Pacific pipelines. These pipelines are illustrated in Figure II.G.1.b-3 and 7. PG&E obtains gas from Canada and Texas. The Canadian gas is transported by Pacific Gas Transmission from Canada to the Oregon-California border where PG&E connects their transmission pipeline and supplies the northern and central California area.

The Texas gas is transported by El Paso Natural Gas pipelines from Texas to the Arizona-California border, where PG&E and SCG connect their pipelines and supply the Southern California area. PG&E transports gas by pipeline to the coastal counties from San Luis Obispo to the San Francisco Bay area. SCG supplies Santa Barbara and San Luis Obispo Counties. Standard Pacific supplies Contra Costa County. PG&E supplies natural gas from Texas to the PG&E Morro Bay Power Cenerating Plant.



LEGEND

- ○ POWER PLANT (THERMAL DISCHARGE)
- • MUNICIPAL WASTE WATER OCEAN OUTFALL

Fig. II.G.1.b-6 Location of Discharge and Waste Water Outfalls

Source: SCCWRP TR 104, March 1973. Information from Local Governments and Private Industries

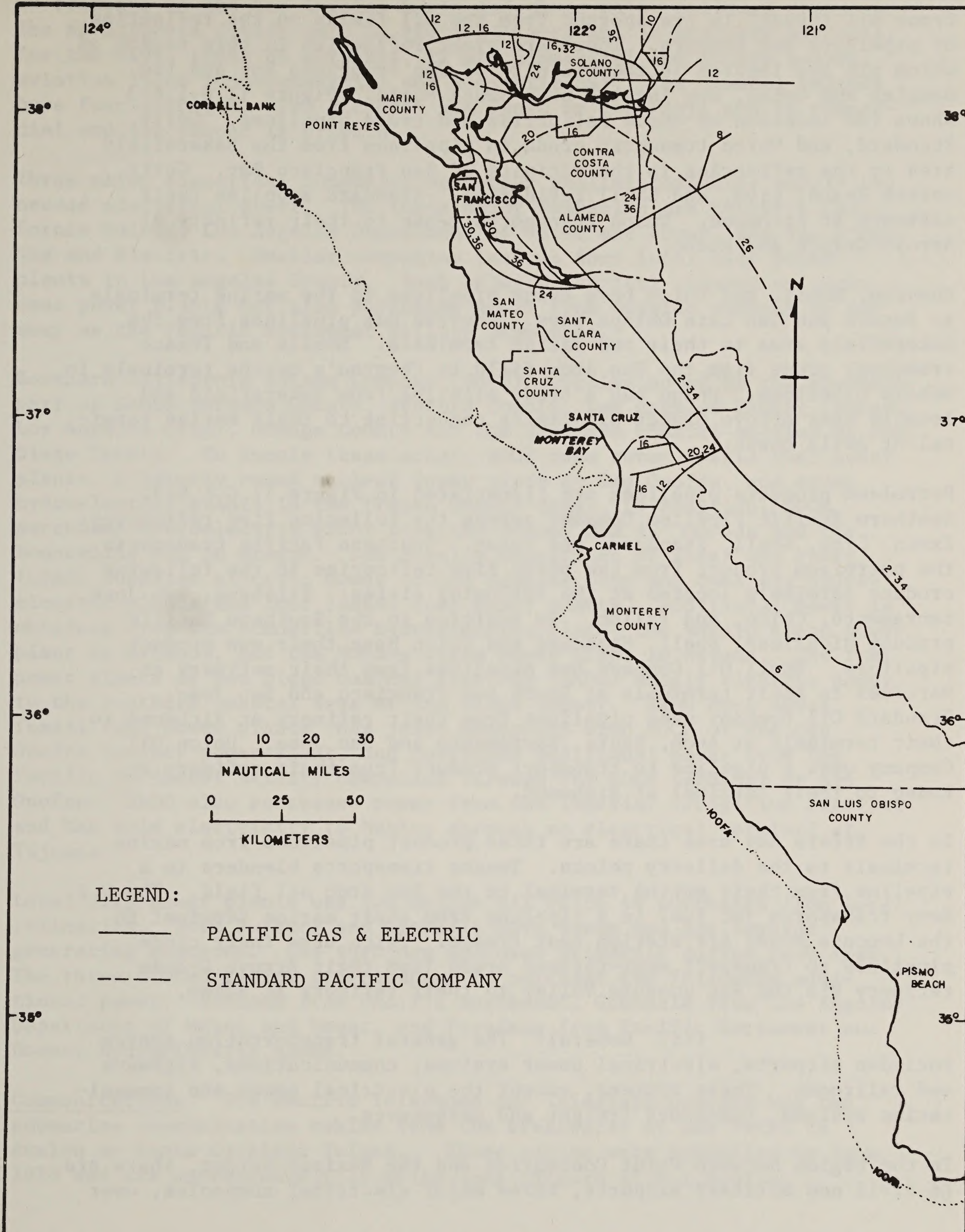


Figure II.G.1.b-7 Natural Gas Pipelines, Monterey-Point Reyes.

Sources: Oil and Gas Journal, Major Natural Gas Pipelines, Jan. 1974.

Crude oil (crude) is transported from the oil fields to the refineries by pipelines and tankers. There are eight refineries in this region of which six are located in the vicinity of San Francisco Bay and two, Douglas and Union, are located near Santa Maria. Figure II.G.1.b-3 shows the location of these refineries and crude pipelines. Getty, Standard, and Union transport crude in pipelines from the Bakersfield area to the refineries in the vicinity of San Francisco Bay. Getty serves Exxon, Lion, and Shell refineries. Standard supplies their refinery at Richmond. Union transports crude to their refinery at Arroyo Grande and Rodeo.

Chevron, Mobil, and Union have crude pipelines to the marine terminals at Estero and San Luis Obispo bays. Chevron has pipelines from the Bakersfield area to their two marine terminals. Mobile and Texaco transport crude from the San Ardo field to Chevron's marine terminals in Mobile pipelines. Union has a crude pipeline from Bakersfield and locally near Arroyo Grande oil fields connecting to their marine terminal at Avila Beach.

Petroleum products pipelines are illustrated in Figure II.G.1.b-3. Southern Pacific Pipeline Company serves the following five refineries: Exxon, Lion, Shell, Standard, and Union. Southern Pacific transports the petroleum product from the above five refineries to the following product terminals located at the following cities: Brisbane, San Jose, Sacramento, Chico, and Fallon. In addition to the Southern Pacific product pipelines, Shell, Standard and Union have their own product pipelines. Shell Oil Company has pipelines from their refinery at Martinez to their terminals at South San Francisco and San Jose. Standard Oil Company uses pipelines from their refinery at Richmond to their terminals at Avon, Banta, Sacramento and San Jose. Union Oil Company uses a pipeline to transport product from their refinery at Rodeo to their terminal at Richmond.

In the Estero Bay area there are three product pipelines from marine terminals to the delivery points. Texaco transports blenders in a pipeline from their marine terminal to the San Ardo oil field. The U.S. Navy transports jet fuel in a pipeline from their marine terminal to the Lemoore Naval Air station near Fresno. Union uses their crude pipelines to transport semi-refined crude from their Arroyo Grande refinery via the San Joaquin Valley to their refinery at Rodeo.

iii. General: The general transportation system includes airports, electrical power systems, communications, highways and railroads. These systems, except the electrical power and communication systems, transport freight and passengers.

In the region between Point Conception and the Mexican border, there are 66 civil and military airports, three major electrical companies, over

20 freeways in the Los Angeles basin and three major railroad companies. The 66 airports divide into 54 civil airports and 12 military airports. For the civil types of airports, 12 are commercial and 42 are general aviation types (non-commercial and non-military). The Channel Islands have four airports. Two airports are owned by the Navy; one is commercial and the second is private.

Three major electrical companies and other smaller companies supply the needed electrical power. The three major companies are Southern California Edison, Los Angeles Department of Water and Power, and San Diego Gas and Electric. Smaller companies include four local city power plants in Los Angeles County. Each major electrical company not only owns power plants but also purchases power from outside sources as far away as the Pacific Northwest utility companies.

Southern California Edison Company (SOCE) supplies power to the southern part of Santa Barbara County, Ventura County, Los Angeles County (except Los Angeles City), Orange County and the northern coastal section of San Diego County. To supply these areas, SOCE owns seven fossil fuel power plants, a jointly owned nuclear power plant at San Onofre, and seven hydroelectric plants in the Fresno County area. In addition, SOCE purchases hydroelectric power from the Hoover Dam in Nevada and the Bonneville Dam in Oregon. Los Angeles Department of Water and Power (LOAN) supplies electric power to Los Angeles City and owns six hydroelectric plants and four fossil fuel power plants. Additional power is obtained from the Bonneville hydroelectric plant, the Navajo steam power plant in Arizona, and the Mohave steam power plant in Nevada. The fuel power plants of San Diego Gas and Electric (SADG) supply electric power to the southern coastal area of San Diego County. SADG owns seven fossil fuel power plants, has joint ownership with SOCE of the San Onofre nuclear power plant, and purchases additional power from the Pacific Northeast utility companies through the SOCE terminal at San Onofre. SADG also purchases power from the Imperial Irrigation District and has sold electricity to Mexico through an electrical terminal at Tijuana.

Local city power plants use low sulfur oil which is purchased from local refineries. Both Burbank and Glendale have steam and gas turbine generating stations. Gas turbines are used primarily during peak load. The three listed cities are planning to purchase the following additional power: Burbank from Pacific Northwest, Glendale from Los Angeles Department of Water and Power, and Pasadena from Pacific Northwest and Hoover hydroelectric plant.

Communications. The Pacific Telephone and Telegraph Company has two submarine communication cables from the breakwater at San Pedro to Avalon on Santa Catalina Island. These cables were installed in June, 1925 and are approximately 26 miles long (Figure II.G.1.b-5).

Highways. The main coastal highways between Point Conception and the Mexican Border are Interstate 5, U.S. 1, and State 1. Interstate 5 starts at the Mexican Border and follows the coastline to Dana Point and turns inland through Santa Ana and Newhall. State 1 follows the coastline from Dana Point to east of Point Conception. U.S. 1 is the main highway connecting downtown Los Angeles with the coastal cities along the Santa Barbara Channel. Interstates 9 and 10 are the main highways traveling eastward from San Diego and Los Angeles, respectively. Today, although the freeway system is not yet completed, Los Angeles is served by over 20 freeways. Eight freeways diverge from the downtown freeway loop. Other freeways provide outlying by-pass, feeder, and suburb-to-suburb connection.

Railroads. Three major railroad companies own and maintain six main railroad tracks. Southern Pacific operates the three major railroads which run from Los Angeles (LA) through Santa Barbara, LA through Bakersfield, and LA through El Paso. Santa Fe operates the railroads from LA to San Diego and LA through San Bernardino. Union Pacific operates the railroads from LA through Las Vegas.

These three companies operate all railroad freights and limited mail and express services. Union Pacific has a main freight terminal in the City of Commerce, Los Angeles County. Santa Fe has a main freight terminal in Vernon, Los Angeles County. Santa Fe has several freight terminals scattered throughout Los Angeles County. The National Railroad Passenger Corporation (AMTRAK) is a privately owned, for profit, railroad corporation which receives subsidies from the government. Each fiscal year the U.S. Congress has to approve the subsidies.

In the region between the Mexican border and Scammon's Lagoon, there is limited information on airports, communications, highways, and railroads. No information was available on the electrical power systems. Figure II.G.1.b-2 illustrates some of the transportation system in Baja California.

In the region described above for Baja California, there are three airports of which two have major airline services. Aeromexico Airline Company services Tijuana International and Guerreso Negro Airports. El Cipres airport, which is located 8 km (5 miles) south of Esenada on Highway 1, has no major airline services. Aeromexico operates from Los Angeles to Tijuana, Guerrero Negro, Mulege, Loreto and La Paz.

The available communication services are telegraph and telephone lines from the United States to Tijuana and a government owned telephone line from Tijuana to El Rosarito.

Mexico's Federal highways, and 1D, Benito Juarez Transpeninsular highway, are the main roadways from the Tijuana border to lower Baja

California along the Pacific Ocean. U.S. Interstate 5 connects the Mexican highways at Tijuana. From these Mexican highways, there are several access roads which vary from dirt to paved roadways.

San Diego and Arizona Eastern railroad (SD&AE) connects Tijuana and Tecate railroad at the Tijuana border. Southern Pacific has filed for the abandonment of SD&AE railroad. The Tijuana-Tecate railroad originates at Tijuana and runs east through Tecate.

In the region between Point Conception and Point Reyes there are 43 civil and military airports, 13 electrical generating power plants, 2 submarine communication cables to Hawaii, 2 main north-south highways and 5 railroad companies.

Airports are illustrated in Figure II.G.1.b-8. There are a total of 43 airports of which 30 are civil and 13 are military. The civil divides into 11 regularly scheduled commercial and 19 general aviation types.

The electrical system is shown in Figure II.G.1.b-9. There are a total of 13 power plants of which one is nuclear, 9 are steam and 3 are combustion turbine. Pacific Gas and Electric (PG&E) owns and operates all but one of the 13 power plants. One not owned by PG&E is Dow Chemical's combustion turbine power plants at Pittsburg.

American Telephone and Telegraph Company (AT&T) on May 27, 1964, laid the first submarine communication cable from the Pacific Coast, near Estero Bay, to Hawaii. The second cable from Estero to Hawaii was laid in September, 1974. AT&T is planning to lay two more cables from northern California to Hawaii. Figure II.G.1.b-9 shows the location of the cables near Estero Bay.

The highways are shown in Figure II.G.1.b-8. State 1 and U.S. 101 which connect Los Angeles and San Francisco, are the only main north-south highways between Point Conception and Point Reyes. State Highway 1 is a paved scenic roadway and generally follows the coastline. The U.S. 101 highway, which is heavily travelled by passenger cars and trucks, consists of freeway and divided highway sections.

There are several State, U.S. and Interstate highways running east-west. State Highways 41, 46, and 58 connect U.S. 101 in San Luis Obispo County to Interstate 5 in the San Joaquin Valley. Also, State Highway 166 ties State 1 and U.S. 101 in Santa Barbara County to Interstate 5. In the San Francisco Bay area, there are several State and Interstate highways. Interstate 80 connects San Francisco-Oakland to Sacramento and Interstate 580 ties Oakland to Interstate 5.

Railroads are illustrated in Figure II.G.1.b-9. Passengers and freight are the main railroad traffic. The National Railroad Passengers Corporation (AMTRAK), services the passengers.

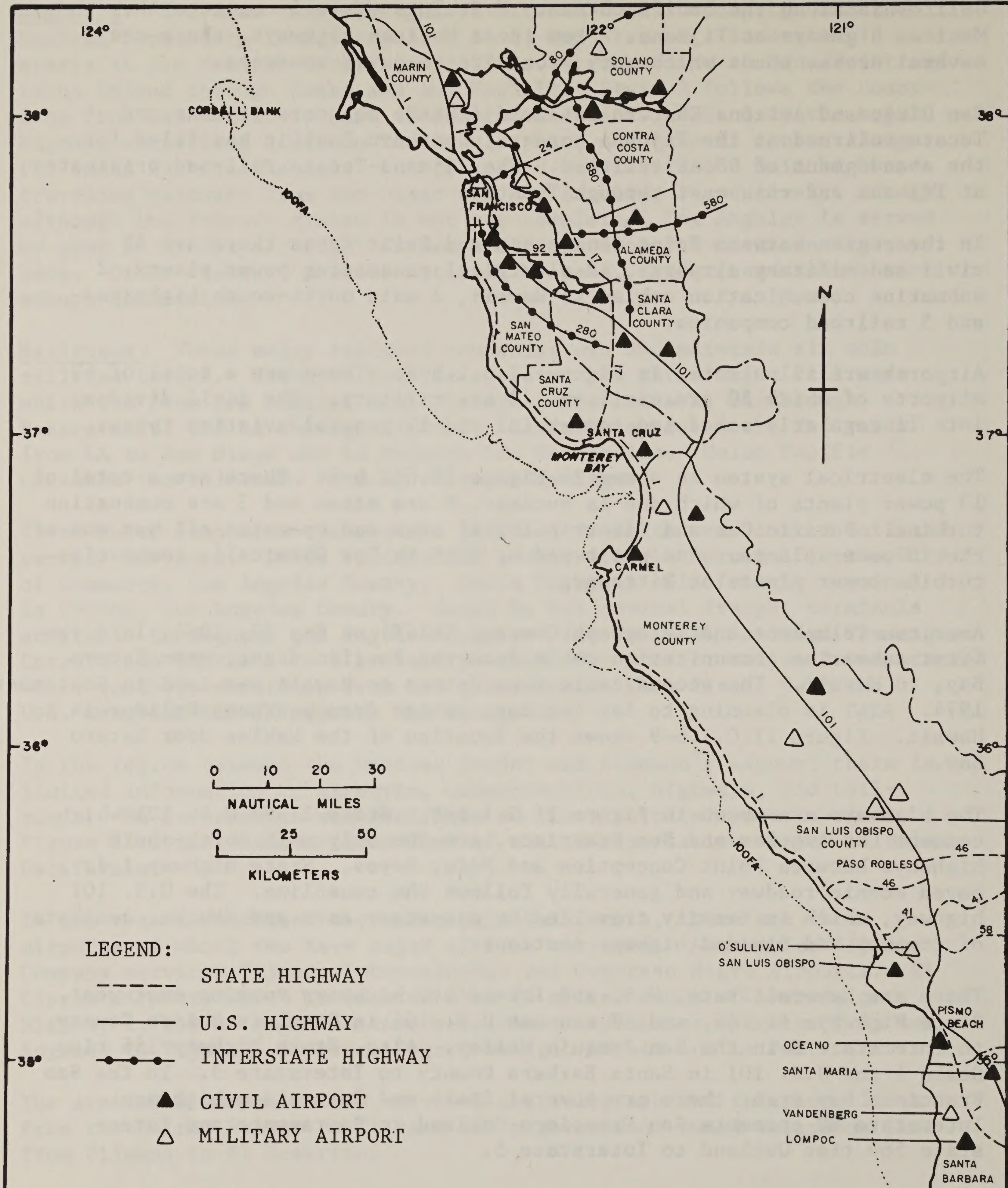


Figure II.G.1.b-8 Airports and Highways, Pt. Conception-Pt. Reyes.

Sources: Map-Auto Club of So. California, 2-76; San Luis Obispo Regional Transportation Plan, June 5, 1976; Santa Barbara County Regional Transportation Plan 1975-95, Draft March 20, 1975; Winzler and Kelly, Central and Northern California Coastal Zone and Offshore Areas, August 1977.

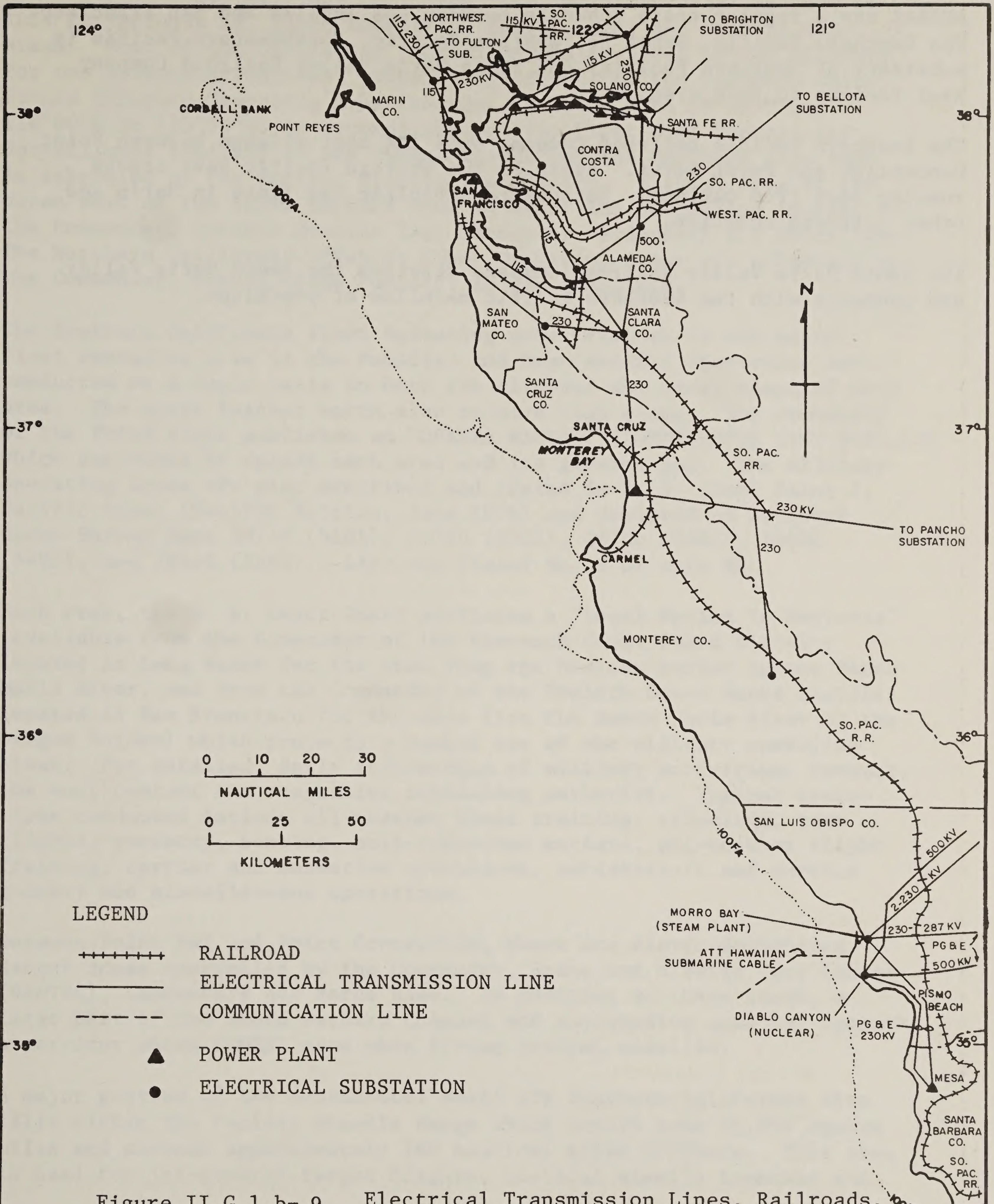


Figure II.G.1.b- 9 Electrical Transmission Lines, Railroads, Communication Lines, Power Plants and Electrical Substations; Point Conception-Point Reyes.

Source: Santa Barbara County Regional Transportation Plan, 1975.
Source: Federal Power Commission, 1977; Rand McNalley, 1974; San Luis Obispo Regional Transportation Plan, 1975.

AMTRAK has a regular train schedule between Los Angeles and San Francisco. The Southern Pacific, Santa Fe, Western Pacific, Northwestern Pacific (a subsidary of Southern Pacific) and Santa Maria Valley Railroad Company haul freight in this area.

The Southern Pacific Railroad Company owns the most mileage between Point Conception and Point Reyes. Santa Fe and Western Pacific have tracks running east from Oakland. Northwestern Pacific has lines in Marin and other northern counties.

The Santa Maria Valley Railroad Company services the Santa Maria Valley and connects with the Southern Pacific mainline at Guadalupe.

c. Military Use: The term "military area" as used in this ES includes all fleet operating, target, test and special use areas. Most of the California coastal waters are used by the military for one purpose or another. Scheduling control of the Southern California Offshore Operating Area (bounded by 27°00'N to 36°59'N and 116°00'W to 125°59'W) is accomplished by the Fleet Area Control and Surveillance Facility in San Diego, except for the northern area that is scheduled by the Pacific Missile Test Center. A large area of the ocean west of the Santa Barbara area is under the scheduling control of the Commander, Pacific Missile Test Center or Vandenberg Air Force Base. The Northern California Offshore Fleet Operating Areas are scheduled by the Commander, Patrol Wings Pacific, in San Francisco.

The Southern California Fleet Operating Area Offshore is the major fleet operating area in the Pacific, and high density operations are conducted on a daily basis in both the airspace and water space of this area. The areas farther north also receive high usage. The Commander of the Third Fleet publishes an "OPAREA MANUAL" (COMTHIRDFLT INST 3120.1J) which describes in detail each area and its general use. The military operating areas are also described and listed in U. S. Coast Pilot 7, Pacific Coast (Twelfth Edition, June 1976) and depicted on National Ocean Survey Maps 18740 (5101), 18720 (5202), 18700 (5302), 18680 (5402), and 18640 (5502). Also see Visual No. 3 of this ES.

Each week, the U. S. Coast Guard publishes a "Local Notice To Mariners" (available from the Commander of the Eleventh Coast Guard District located in Long Beach for the area from the Mexican border to the Santa Maria River, and from the Commander of the Twelfth Coast Guard District located in San Francisco for the area from the Santa Maria River to the Oregon Border) which projects a weekly use of the military operating areas. For detailed, daily information of military activities, however, one must contact the respective scheduling authority. Typical operations conducted include all-weather fleet training, refueling, test flights, rocketry, bombing, anti-submarine warfare, all-weather flight training, carrier and submarine operations, antiaircraft and surface gunnery and miscellaneous operations.

Between Point Sal and Point Conception, there are eleven designated danger zones controlled by the Commander, Space and Missile Test Center (SAMTEC), Vandenberg Air Force Base. In addition to these zones, a large part of the Santa Barbara Channel and surrounding area lay beneath a corridor which SAMTEC uses when firing orbital missiles.

A major portion of the continental shelf off Southern California also falls within the Pacific Missile Range which covers some 35,000 square miles and extends approximately 160 nautical miles offshore. This area is used for jet-powered target flights, tactical missile launches and flights, manned aircraft flights, bomb drops, anti-submarine warfare weapons, and general gun firings.

In addition to the surface operations described above, leaving the Port of San Diego, going through several of the areas and extending through the Pacific Missile Range, are submarine transit lanes such as: Sierra Venus, Sierra Mars, Sierra Apollo, Sierra Pluto and Sierra Zeus. (Refer to Visual No. 3.)

d. Ocean Dumping Areas: The Environmental Protection Agency (EPA) published its final revision of regulations and criteria for ocean dumping in the Federal Register January 11, 1977, Part VI. The pertinent regulations revise 40 CFR Chapter I, Sub-chapter H, parts 220-229 which implement sections of the Marine Protection, Research and Sanctuaries Act of 1972 and the Federal Water Pollution Control Act. These new regulations prohibit ocean dumping except by permit in the territorial seas of the United States and in the zone contiguous to the territorial sea out to 22 km (12 nautical miles) from shore. Ocean dumping permits are issued by the Regional Administrator, EPA, except for permits for dredged material disposal, which are issued by the District Engineer, U.S. Army Corps of Engineers. Excluded from this prohibition are fish wastes, fisheries resources, routine discharges from vessel propulsion and the construction of fixed structures, and emergency situations to safeguard life at sea.

The regulations provide for several types of permits, including General, Special, Interim, Emergency, Research and Dredged Material permits. The dumping of materials into the ocean will be permitted only at sites selected to minimize the interference of disposal activities with other marine activities. In particular, areas of existing fisheries and heavy commercial and recreational navigation will be avoided. The interim dumping sites have been approved for dumping the indicated materials on a temporary basis pending completion of environmental assessment surveys, and a determination for continuance or termination of use.

The Navy has been granted a general permit under the regulations to sink vessels in ocean waters while testing ordnance. All such vessel sinkings shall be conducted in water at least 1,800 m (1,000 fathoms) deep and at least 80 km (50 nautical miles) from shore. A general permit has also been granted for all persons for the disposal of vessels at sea. Disposal of these vessels shall take place no closer than 22 km (12 nautical miles) from shore and in water no less than 90 m (50 fathoms) deep. Consult the regulations for further conditions on such disposal (Dornhelm, 1977).

i. Southern California Bight: Past dumping activity in the Southern California Bight was summarized by Brown (1971) and is listed in Table II.G.1.d-1 as site numbers nine to nineteen. Material dumped included industrial chemicals, aerospace industry wastes, petroleum refinery wastes, obsolete or unserviceable military munitions, toxic chemicals, ammunition, nuclear industry and laboratory radioactive waste materials. The site locations are displayed on Visual No. 3. The sites are located in water depths over 400 m (1,320 feet) except for Site 18 which is 117 m (386 feet) and 19 which is 360 m (1,188 feet). As a result of the Marine Protection, Research and Sanctuaries Act of 1972, EPA suspended activity at all of the areas except for seven interim sites (Federal Register, 1973). Activity at these seven sites from 1973 to 1977 has been minimal, and future activity will be handled on a case-by-case basis by permit from EPA.

The new regulations establish five interim dredge material disposal sites for the Southern California Bight. These sites are listed in Table II.G.1.d-2 and are also depicted on Visual No. 3. Depths of these sites range from 81 to 360 m (267 to 1,320 feet). Other active disposal areas in the Bight are the two U.S. Navy emergency aircraft ordnance jettison areas displayed as Site Nos. 20 and 21 on Visual No. 3. These two areas are located east of the northern tip of San Clemente Island in approximately 900 m (2,970 feet) of water. Their locations are given as: primary jettison area (#21) 33°N, 117° 48'W and secondary jettison area (#20) 33°N, 118° 15'W (Commander Third Fleet, 1973). In addition, a consortium of oil companies has a permit application pending with EPA for disposing drill cuttings and muds into the San Nicolas Basin from proposed drilling activities on Tanner Banks.

ii. Central California: At present, the only approved interim dumping sites for offshore central California and San Francisco Bay are the dredged material sites listed in Table II.G.1.d-3. Past sites used for ocean dumping are given in POCS Reference Paper No. II in Table II.G.1.d-4 for military sites, and Table II.G.1.d-5 for all other documented wastes.

A summary of wastes dumped offshore San Francisco is listed in Table II.G.1.d-4 for the period 1931 to 1972. The locations of the dumpsites for the listed categories are only approximately known in many of these cases. With the exception of the dredge spoil disposal activities, alternative methods of disposal have been determined to be more cost effective than ocean dumping.

According to Dornhelm (1977), Interstate Electronics Corporation (1974 and 1975) conducted a detailed survey of the radioactive waste disposal activities in the vicinity of the Farallon Islands. The center of this radioactive waste disposal site is located about 26 km (16 miles)

Table II.G.1.d-1

SUMMARY OF OCEAN DUMPING IN THE CALIFORNIA BIGHT, 1931-1971

City	Type of Wastes	Disposal Operator	Waste Source(s)	Dumping History	Estimated Total Amount Dumped	Frequency of Dumping	Description of Dumping Grounds	Site Number on Graphic
Los Angeles	Containerized Wastes Industrial chemicals, solvents, laboratory (medical, industrial, academic), military and other unidentified wastes	California Salvage	Aircraft-aerospace, heat-treating, plating, film processing, chemical manufacturing & processing electronic instrument firms industrial medical and academic laboratories, military & other unidentified sources	1947 to present	No data prior to 1965. 1965 to March[a] 1971. 11,574 drums &[b] barrels (636,570 gals.) (2,648 tons) 1,331 containers 108,555 gallons 452 tons[c] 1,245 boxes, cartons, cases, etc. 10 cylinders 112 bottles 30 filters 1,251 carboys (6,255 gals.)[d] 26 tons 20 pallets 1 refrigerator 1 freezer Undisclosed amounts of miscellaneous wastes	weekly	33°37'N 118°40'W cited in 1961 apparently never used	9
							33°32'N 118°27'W cited in 1961	11
							33°34'30"N 118°27'30"W cited in 1968 11.5 nautical miles SW of Pt. Fermin in 485 fathoms (873 m)	10

Table II.G.1.d-1 (Cont'd)

City	Type of Wastes	Disposal Operator	Waste Source(s)	Dumping History	Estimated Total Amount Dumped	Frequency of Dumping	Description of Dumping Grounds		Site Number on Graphic
Los Angeles (continued)	Industrial chemicals, etc. Misc. airplane parts, spoiled food & confiscated materials	H-10 Water Taxi Co. Ltd.	Same as above	1947 to present	6,250 tons[e]	on demand	33°17'N 118°10'W	7.5 N.M. E of S. Santa Catalina Island Ca. 25.5 N.M. S. of San Pedro Light. 400 fathoms. (720 m)	13
	Bulk Wastes Petroleum refinery wastes (spent causics, acid sludges, etc.)	California Salvage Co.	Oil refineries	1946-61	3,000,000[b] barrels (42-gal) (126,000,000 gals)[g]	monthly	33°32'N 118°27'W	San Pedro Channel 485 fathoms (873 m)	11
				1961-present	524,160 tons	quarterly			
	Oil drilling muds & cuttings	THUMS	Oil wells	1966-1970 (discontinued)	12,264,500[h] bbls (42-gal.) (3,265,685 tons)[i]	daily	33°34'30"N 118°27'30"W	11.5 mi. SW of Pt. Fermin, 485 fathoms (873 m)	10
	Vessel refuse and garbage	H-10 Water Taxi Co., Ltd.	U.S. & foreign commercial vessels	1931 to present	52,000 tons[j]	weekly	33°17'N 118°10'W	7.5 N.M. E of S. tip of Santa Catalina Is., Ca. 25.5 N.M. S. of San Pedro Light, 400 fm (720 m). Proposed alternate site:	13
								32°33'30"N 119°05'48"W about 37 miles SW (seaward) of San Clemente Island at 200 fathoms (360 m)	19

Table II.G.1.d-1 (Cont'd)

City	Type of Wastes	Disposal Operator	Waste Source(s)	Dumping History	Estimated Total Amount Dumped	Frequency of Dumping	Description of Dumping Grounds	Site Number on Graphic
		U.S. Navy	U.S. Naval & Coast Guard	1944-1970 (discon-	8100 tons[h]	weekly	20 N.M. SE of Santa Catalina Island (position doubtful) (900 m)	14
San Diego	Industrial chemicals (sodium cyanide)	Omar Rendering	Unidentified Industrial firms	1960-67 (discontinued)	700 barrels	every 2 years	Explosives dumping ground 19 mi. W. of Pt. Loma Light, 630 fathoms. (1134 m)	16, 17
	Filter cake (perlite cellulose)	Kelco Co.	Kelco Co.	1969-70 (discontinued)	346,480 tons[k]	every 2 days	32°37'N 117°24'W 1000 yards off a point 8 N.M. W. of second entrance buoy to San Diego Bay. 65 fathoms. (117 m)	18
	Vessel refuse and garbage	U.S. Navy	U.S. Naval vessels	1947-68 (discontinued)	98,700 tons[h]	twice weekly	Vicinity of Coronado Islands	Not on graphic
Various military ammunition depots and other facilities	Unserviceable or obsolete munitions & toxic chemical ammunition	U.S. Navy U.S. Army U.S. Air Force	Military operations	1945-1970 (moratorium issued by Naval Dept. in 1971)	unknown	on demand	33°00'N 118°56'W 17 N.M. W of San Clemente Island, 100 square N.M. area, 5400 feet. (1636 m) Explosive dumping	15
							32°45' N 117°37'W 20 N.M. W of Pt. La Jolla. 100 square N.M. area, 3600 feet. (1091 m) Explosive dumping.	17

Table II.G.1.d-1 (Cont'd)

City	Type of Wastes	Disposal Operator	Waste Source(s)	Dumping History	Estimated Total Amount Dumped	Frequency of Dumping	Description of Dumping Grounds		Site Number on Graphic
							32°45'N 117°37'W	20 N.M. W of Pt. Loma, 100 square N.M. area, 3600 feet. (1091 m) Explosive dumping (inactive)	16
							33°17'N 118°50'W	15 N.M. SW of Santa Catalina Island, 100 square. N.M. area. 3000 feet. (909 m) Explosives dumping (inactive).	12
Southern California	Radioactive	AEC	Nuclear industry, laboratories, etc.	1946-68	3114 containers 107.88 curies	on demand	33°40'N 119°33'W	21 N.M. S of Santa Cruz Island, 80 square N.M. area, 6300 feet. (1909 m) Chemical dumping (radioactive)	8
					not given		31°40'N 118°33'W	95 N.M. SW of Pt. Loma, 90 N.M. off Mexican coast, 6,000 feet. (1818 m) Chemical dumping (radioactive)	Not on graphic
					not given		34°40'N 121°50'W	56 N.M. W of Pt. Arguello, 1125 square N.M. area, 12,000 feet. (3636 m) Explosives and toxic chemical ammunition (radioactive).	Not on graphic

Table II.G.1.d-1 (Cont'd)

City	Type of Wastes	Disposal Operator	Waste Source(s)	Dumping History	Estimated Total Amount Dumped	Frequency of Dumping	Description of Dumping Grounds		Site Number on Graphic
					4415 containers 33.6		32°00'N 121°30'W	225 N.M. West of San Diego, 7200 feet. (2182 m) Chemical dumping (radioactive). Not shown on available charts	Not on graphic

Source: Brown, 1971

[a]See Table 2 in Brown (1971) for complete breakdown of wastes for 1965–1971 period.
[b]Tonnage on wet weight (8.32 lbs./gal.) basis for assumed 55-gallon capacity drums and barrels.
[c]Tonnage on wet weight (8.32 lbs./gal.) basis.
[d]Tonnage on wet weight (8.32 lbs./gal.) basis for assumed 5-gallon capacity carboy.
[e]Based on reported disposal rate of 250 tons/year.
[f]Three million-barrel estimate based on correspondence in Los Angeles Regional Water Quality Control Board files.
[g]Tonnage on wet weight (8.32 lbs./gal.) for assumed 42-gallon barrel capacity.
[h]Based on data provided in 1969 to the Bureau of Solid Waste Management Ocean Dumping Study.
[i]Based on conversion factors provided by THUMS in 1969.
[j]Tonnage based on reported disposal rate of 1200 tons/year.
[k]Based on average reported wet weight tonnage of 1220-ton/trip x 284 total trips.

Table II.G.1.d- 2

DREDGE MATERIAL DISPOSAL SITES FOR THE SOUTHERN CALIFORNIA BIGHT

Site	Location	Distance from Shore	Depth	Approximate Disposal Activity	Site Number on Graphic
Port Hueneme (LA1)	34° 05' 00" N 119° 14' 00" W 1000 yd. radius (900 m)	3.8 nautical miles (NM) (7.0 km)	200 fathoms (360 m)	None recently	1
Los Angeles (LA2)	33° 37' 06" N 118° 17' 24" W 1000 yd radius (900 m)	5.2 NM (9.6 km) (5.8 NM from mouth of L.A. harbor)	100 fathoms (180 m)	100,000 yds^3/yr (76,000 m^3/yr)	2
Newport Beach (LA3)	33° 31' 42" N 117° 54' 48" W 1000 yd radius (900 m)	4.1 NM from harbor mouth (7.5 km)	250 fathoms (450 m)	2,000 yds^3/yr 1520 m^3/yr	3
San Diego - Pt. Loma (LA4)	32° 35' 00" N 117° 17' 30" W 1000 yd. radius (900 m)	5.4 NM from Pt. Loma (9.9 km)	45 fathoms (81 m)	20,000 yds^3/yr (15,200 m^3/yr)	4
San Diego (LA5)	32° 36' 50" N 117° 20' 40" W 1000 yd radius (900 m)	6 NM (11.0 km)	100 fathoms (180 m)	2,000,000 yds^3/yr (1,520,000 m^3/yr)	5

Source: Federal Register, 1977

southwest of the Farallon Islands. The "site" actually consists of three subsites, varying in depth from 90 to 1,800 m (50 to 1,000 fathoms). The radiation level of the contents of the containers dumped at this "site" is not known, except that they are considered low level. The containers photographed during the survey at the 900 m (500 fathom) subsite appeared to be intact.

Table II.G.1.d- 3

APPROVED INTERIM DREDGED MATERIAL SITES
OFFSHORE CENTRAL CALIFORNIA AND SAN FRANCISCO BAY

Location	Lat-N	Long-W	Depth	Dimension
Farallon Islands	37°31'45"	122°59'00"		1000 yd. radius
San Francisco Channel Bar	37°45'06"	122°35'45"		5000 x 1000 yds.
Moss Landing	36°37'53"	121°49'04"	100 fathoms	500 yds.
Carquinez Straits	38°03'50"	122°15'55"	7 fathoms	1000 x 2000 ft.
San Pablo Bay	38°00'28"	122°24'55"	7	1500 x 3000 ft.
Alcatraz Island	37°49'17"	122°25'23"	22	1000 ft. radius
Suisun Bay	38°03'05"	122°05'35"	6	500 x 12,000 ft.

Source: Dornhelm (1977).

Table II.G.1.d- 4

SUMMARY OF WASTES DUMPED INTO THE OCEAN OFFSHORE SAN FRANCISCO

Category	Period	Estimated Total
Refinery Waste	1966-72	315 M gal.[a]
Acid Wastes	1948-71	240 M gal.[a]
Cannery Wastes	1960-72	246 K tons[a]
Radioactive Wastes	1946-68	44,563 containers
Munitions	1968-69	746 tons
Dredge Spoil	1935-72	1 M yds.[a]

Source: Dornhelm (1977).

e. Solid Waste Disposal: The tabulation in Table II.G.1.e-1 shows available County operated solid waste disposal areas within Southern California coastal areas adjacent to the proposed Sale No. 48 tract areas. Shown also is the size of each identified landfill and the estimated life of each site (sites marked "P" are planned).

The per capita solid waste tonnage per year has been computed for each county and represents all forms of solid wastes (excluding agricultural) disposed of in land fills.

Table II.G.1.e-1

COUNTY-OPERATED SOLID WASTE DISPOSAL SITES IN THE SOUTHERN CALIFORNIA COASTAL COUNTIES

Site	size (In Acres)	Est. Life (Years)	Per Capita Tonnage/Year
Santa Barbara County			1.000 (EST)
Tajuigua	412	20-25	
Ventura County			1.0446
Toland Road	120	NA	
Santa Clara	93	2(+8)	
Simi	230	6	
Los Angeles County			1.7248
Palos Verdes	207	2	
Spadra	163	20+	
Mission Canyon	499(+1200)	20	
Scholl Canyon	444	20	
Calabasas	416	30	
Puente Hills	1214	30+	
Orange County			0.9100
Olinda	235	5	
Coyote Canyon	593	5	
Santiago Canyon	160	9	
Prima Deschecha	945	23+	
San Diego County			1.1000
Oceanside	39	16-25	
Bonsall	122	5	
Santee	493	23+	
Otay	501	23+	
West Miramar[P]	870	16	
San Marcos[P]	203	5-20	

Source: Southern California County Sanitation Departments and Regional Planning Departments.

f. Recreation and Allied Resources

i. Recreation

Southern California. Recreation is an important component of Southern California's environment and economy. An abundance of opportunity combined with a large, highly mobile population, creates a situation unparalleled elsewhere in the country. This section discusses the existing population, usage and resources of Southern California.

Population. Population has a large effect on recreation demand and ability to meet such demands. Population density and distribution patterns are important factors. See Section II.G.2.a for detailed information. Rural populations exert a much lower demand for recreation resources than do urban areas. Rural people have open space and outdoor recreation opportunities near at hand. They are also not subjected to the pressures of urban existence and are not as compelled to seek relief and self-renewal in the natural environment.

Most of California's population lives within the coastal strip and predominantly in its southern portion. This results in great pressure upon large portions of the coast for both recreation and other land uses. This pattern of population distribution will continue for the forseeable future.

Tourism. Tourism is the third largest industry in Southern California and supports approximately a million jobs according to the Southern California Visitors Council. In 1976 an estimated 9.5 million out-of-state U.S. visitors spent almost $2.7 billion in Southern California. In addition to out-of-state tourists, Southern California attracts a considerable number of visitors from the rest of California. Tourist expenditure is important in that it adds to economic well-being by contributing directly and indirectly to almost every sector of regional economic activity. Direct economic impact is discernible through expenditures and from the number of service industry employees and their dependents supported by tourism.

Also of economic significance is that dollars spent by tourists represents "new money" -- money earned elsewhere and spent here in a service industry typified by rapid dollar turn-over and a high multiplier effect within the local economy. It has been estimated that the overall effect of tourist expenditures on the regional economy is close to 2 times the dollar amount of these expenditures as a result of the multiplier effect or dollar turnover. Thus the total impact of tourist spending would not be the direct expenditure of almost $2.7 billion but closer to $5.4 billion.

Another important benefit derived from tourism is in the form of taxes paid by visitors. In 1973 and 1975, out-of-state tourists paid an estimated $119 and $153 million respectively in taxes while making relatively small demands on such services as police, fire protection, etc. These taxes represent a significant contribution to the Southern California economy. The principal taxes paid by tourists are the retail sales tax and the gasoline tax. A portion of the retail sales tax is rebated to the local communities. The gasoline tax collected in Southern California also benefits the region through a better system of freeways and through rebates to the counties and cities for local road improvement.

In 1976 the major recipients of tourist expenditures were establishments engaged in the sale of food and beverages (24.2 percent) and hotels and motels (24.9 percent). Visitors allocated 14.1 percent of their expenditures to theatres, sports, and other recreational activities. Purchases of gasoline and automobile products or services accounted for 10.5 percent. Clothing establishments were another beneficiary receiving 10.3 percent.

It must be remembered that travel and most recreation is based on the mobility of people coming into the State and/or moving around in it by means of fuel-dependent vehicles--automobiles, aircraft, trains and buses. In the event of another fuel shortage, the major impact would probably be a continued shift to common carriers and away from private autos. There would of course be some loss in trade which would be expected to increase indirectly in relation to the increased severity of the fuel shortage.

In connection with this, in 1973, the Visitors Council conducted a survey by sending questionnaires to people who had written for information. Of those who requested information but did not visit Southern California, 11 percent listed the reason as the energy shortage. This was fourth on a list headed by illness in the family, not enough money, or not enough time to make the trip.

The 1960's, a decade of economic expansion, saw steady increases in the number of visitors to Southern California. An economic slowdown caused tourist arrivals to level off in 1970 and decline somewhat in 1971. Since 1971, the number of visitors has continued to expand.

Historically, the trend in tourist expenditures has paralleled that of tourist arrivals. However, a significant increase in the inflation rate in 1973 (led by increases in food and fuel costs) resulted in expenditures expanding at a significantly faster rate than the number of visitors (See Table II.G1.f-1).

Table II.G.1.f-1

SOUTHERN CALIFORNIA TOURIST ARRIVALS
AND EXPENDITURES, 1968 - 1976

	1968	1969-1971 Average	1972-1974 Average	1975	1976
Number of Tourists Arriving in Southern California (in thousands)	7,882	8,011	8,311	8,480	9,500
Percent change compared to 1968 (Base year)	--	1.6	5.4	7.6	20.5
Tourist Expenditures in Southern California (in millions of $)	1,242	1,351	1,887	$2,430	$2,682
Percent change compared to 1968 (Base Year)	--	8.8	51.9	95.6	115

Source: Adapted from Southern California Visitors Council.

Table II.G.1.f-2

SOUTHERN CALIFORNIA TOURIST ARRIVALS
AND EXPENDITURES BY MONTH, 1973

	Tourist Arrivals	Tourist Expenditures	Expenditures Per Tourist
January	562,000	$ 173,000,000	$308
February	533,000	168,000,000	315
March	606,000	193,000,000	318
April	686,000	134,000,000	195
May	655,000	140,000,000	213
June	848,000	183,000,000	216
July	943,000	153,000,000	162
August	959,000	160,000,000	167
September	814,000	140,000,000	172
October	655,000	177,000,000	270
November	602,000	168,000,000	279
December	583,000	177,000,000	304
Total	8,446,000	$1,966,000,000	$233[a]

Source: Southern California Visitors Council.

[a]Weighted average.

The seasonal characteristics of tourism in Southern California have changed considerably since the early 1900's. The tourist season was once almost exclusively the winter months, as wealthy and more affluent people vacationed to escape eastern winters.

At present, tourism is a year-round business, with the greatest number of visitors arriving during the summer months when families can take advantage of school vacations. In spite of this shift, Southern California has not lost its appeal to winter vacationers and per capita tourist expenditures still are highest during the winter months (see Table II.G.1.f-2).

In the survey conducted by the Visitors Council, 37 percent of the 1976 out-of-state visitors were residents of eastern states. The greatest concentration of visitors came from the mid-western states, accounting for 44 percent. The remaining 19 percent came from the Mountain-Pacific states. The attractions which Southern California has to offer the tourist are many and varied. Those who like outdoor recreation have the mountains, desert and excellent beaches to choose from while others may be attracted to the cultural activities found in the larger cities. As important, however, are a number of commercial attractions, most famous of which is Disneyland. Others include Knotts Berry Farm, Marineland, Lion Country and Magic Mountain, all located in the Los Angeles-Orange County area, and Sea World located in San Diego. There are outstanding zoos in Los Angeles and San Diego. The area also offers a temperate climate which can be enjoyed the year round.

Physical Resources and Usage. Regional recreation facilities include opportunities ranging from ocean activities such as surfing and fishing, to mountain activities like hiking and skiing. This wide variety of choices has caused many people to come to the area.

Recreation options exist although most opportunities are fully exploited, thus there is no surplus of any particular facility. Dislocation in one recreation type cannot be readily absorbed elsewhere as a result.

For purposes of this analysis, those recreation sites within the immediate coastal area and seaward are to be directly considered.

Santa Barbara County South. Santa Barbara County has 177 km (110 miles) of coastline of which this section considers the 98 km (61 miles) extending from Point Conception. Of this total, 24 km (15 miles) are publicly owned and 74 km (46 miles) are private. Public recreational use occurs on 21 km (13 miles) with private recreational use on 16.1 km (10 miles). Non-recreational development occurs on 10 km (6 miles) and 52 km (32 miles) remain undeveloped. Ninety kilometers (56 miles) or 92 percent is classified as sandy beach.

Between Point Conception and Gaviota, the coast is privately owned and largely inaccessible except by boat. Uplands are generally not developed. Gaviota State Park is the only developed recreation site in this reach. This park is located where U.S. Highway 101 turns inland. From Gaviota State Park to Coal Oil Point, the shoreline is mostly privately owned and largely undeveloped. Recreation areas include: Refugio and El Capitan State Beaches, and Ellwood Pier. Oil derricks and tank farms occupy the eastern portion of the area. Between Coal Oil Point and Santa Barbara Harbor, approximately half of the shoreline is privately owned and the remainder is mostly State land. Much of the upland is developed to some degree.

State Park System

Gaviota State Park. Gaviota State Park has scenic, historic, scientific and recreational values. This park includes 8.7 km (5.4 miles) of coastline and extends inland for about 4.8 km in a 2.4 km (3 miles in a 1½ mile) wide strip which encloses a total of approximately 1,133 hectares (2,800 acres). Upland portions of the park contain many typical ecological communities consisting of coastal sage, chaparral, oaks and sycamores. These communities are to be preserved and upland development will thus be restricted. Limited beach area restricts the availability of recreation opportunity to about 500 people at one time. Behind the beach there are parking, camp and picnic units providing a potential daily beach visitation* of 817 (California, 1972).

In 1972, the full potential beach visitation was being reached on busy weekends and overflow was accommodated at the fishing pier and at isolated portions of the beach downcoast (California, 1972). The visitation in 1969-70 F.Y. totalled 112,512 (California, 1969-70) rising to 194,103 in 1974-75 F.Y. (California, 1974-75).

Scenic values are rated as high for the most part. Ocean vistas, including the offshore islands are important features. Identified unesthetic elements include the railroad right-of-way and oil company facilities (California, 1972).

Recreation activities in the park include surf fishing. Sportsmen fish from the pier at the mouth of Gaviota Creek and embark from there on deep sea party boat fishing trips. Swimming, sunbathing, surfing, picnicking,

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*Visitation is the instantaneous capacity of an area multiplied by a turn-over factor.

beachcombing and sightseeing constitute the beach activities. Inland activities are primarily hiking and horseback riding. Sightseeing and natural history study are the corollaries to hiking experiences in this park.

Expansion of Gaviota State Park in all directions with beach acquisition sufficient to connect this park with Refugio State Beach to the east would be desirable, according to the State of California.

Refugio and El Capitan State Beaches. Eastward 9.7 to 16.1 km (6 to 10 miles) of Gaviota, are Refugio and El Capitan State Beaches which lie between the ocean and the Southern Pacific railroad. The beach is relatively narrow and small portions of it are totally inundated at high tide. While lacking individually spectacular features, these parks offer relative solitude and serve to maintain public access to a scenic coast. Both units have overnight and day use facilities.

Visitor attendance at El Capitan rose from 209,378 in F.Y. 1969-70 to 275,125 in 1974-75. (California, 1969-70, 1974-75). Attendance at Refugio was 131,033 in F.Y. 1969-70, rising to 172,160 in 1974-75.

The remaining State unit is Carpinteria State Beach at Carpinteria. Attendance was 337,372 in 1972-73, rising to 458,392 in 1974-75.

State-owned sites are made available for operation by Federal or local agencies in some cases. Goleta S.B. is operated by the Santa Barbara County Park Department. Total pertinent figures for State-owned and operated units within the studied portion of the Santa Barbara County Coastal area indicate park acreage at 1,235 hectares (3,051 acres) with over 16,768 m (55,000 feet) of oceanfront. Family units within the parks total 722. Of this, 490 are for camping and 232 are for picnicking. Estimated visitation for 1974-75 was approximately 1,157,000.

Santa Barbara County Park Department. The department operates several facilities along the south coast. These are Goleta State Beach (State-owned), and Arroyo Burro Beach, with a 1969 visitation of 475,988; and Montecito, Lookout, Carpinteria Beach West and Rincon Beach.

Local, Private and Miscellaneous. A varied assortment of recreational facilities such as fishing piers, boat facilities, wildlife refuges and locally operated beaches exists primarily in the City of Santa Barbara area. Just west of Coal Oil Point, at Ellwood, are Ellwood Pier and Devereux Slough which has public beach access. The University of California at Santa Barbara occupies Goleta Point with a beach area provided. Continuing easterly, there is the airport wildlife preserve located near the Santa Barbara Airport, Hope Ranch private beach park and More Mesa private beach.

In the Santa Barbara municipal area beachfront are the following sites: Shoreline, Leadbetter, Pershing, La Mesa and Palm Parks; East, West, Cabrillo and Miramar Beaches; Andre Clark Bird Refuge and Child's Estate. Private parks are the Santa Barbara Shores Beach Club and El Descandero Park. The Sandyland Wildlife Preserve is at Carpinteria.

Federal Parks. Channel Islands National Monument includes three islands collectively called Anacapa Island, in Ventura County and Santa Barbara Island in Santa Barbara County. This national monument was established in 1938 primarily foı its unusual geological features and unique plant and animal life. Recreational use has grown in recent years to the point where management to protect the ecological values has become imperative.

Recreational facilities exist at both Anacapa and Santa Barbara Islands. At Anacapa there are unimproved anchorages, primitive camping and day use facilities.

Santa Barbara Island is 68 km (42 miles) from the mainland coast and is roughly 260 hectares (650 acres) in area. There is an anchorage at the landing cove on the northeast side of the island. This anchorage, like those at Anacapa, is uncertain. Camping is primitive, and is restricted to a limited area. Recreational attractions include the isolated island environment, hiking, unique ecosystems, spectacular scenery, diving and fishing in the magnificently lucid surrounding waters and boating near the islands. Archeological values exist on these islands but neither salvage nor interpretation has been undertaken. Visitation has risen from 31,010 in 1968, to 105,982 in 1977. The rise has been due in part to better counting, but mostly to increased visitation.

These figures probably underestimate the number of people using the surrounding waters without going ashore. The monument includes those waters within one nautical mile of shore.

Proposed Addition. Several proposals have been made to include all of the northern Channel Islands into a sea-dominated national park. None of these proposals has yet come to fruition. Incorporation of the following three islands with the two islands of the National Monument into a new National Park would radically alter recreation opportunities available in the Bight region. Use is now restricted to the small islands of the National Monument and to the waters surrounding the larger islands. If a five island National Park is established, 1980 use is predicted to reach 400,000 to 600,000 recreation days (BOR Memo, 1973).

San Miguel Island. San Miguel is under the control and jurisdiction of the U.S. Navy, but is administered by the Department of the Interior through the National Park Service. The island comprises 5,666 hectares (14,000 acres), most of it 122-152 meters (440-500 feet) in elevation, reaching a peak of 253 meters (831 feet). It has 38.6 km (24 miles) of coastline, most of which is bold rocky bluffs. Short stretches of sandy beaches and pocket beaches total about 10 km (6 miles). Several landings and anchorages are available although the Navy ordinarily prohibits landings. Surrounding waters are popular for diving. There are abundant archeological and paleontological values as well as, rookeries of sea birds and pinnipeds. The sea elephant colony is one of the largest known. Wildflower displays are prominent in spite of grazing and erosion. San Miguel is more valuable for its natural history resources than for its recreational values.

Santa Rosa. Santa Rosa is privately owned, about 16 km (10 miles) wide by 24 km (15 miles) long and comprises 22,258 hectares (55,000) acres. The shoreline extends 70 km (44 miles) and varies in character from high rocky bluffs to low sand spits. Sand dunes occur near the western end of the island. Sandy shores occur over about 19 km (12 miles) of the coast. The interior is mountainous extending to elevations of 484 m (1,589 feet). Most of the vegetation is grassland accented occasionally by shrubs and a few trees. The island is used for grazing with a small area in cultivation. Abundant archeological resources are present. Potential recreational uses are numerous. A few are boating, fishing, diving, picnicking, hiking, camping and exploring. Unique ecological assemblages exist which lend themselves to interpretive opportunities for both the casual and serious ecologist.

Santa Cruz. Santa Cruz is the largest of the islands and is privately owned. Public landings are prohibited without the owners' permission. Dr. Stanton recently sold much of his holdings to the Nature Conservancy which is now in the process of planning for the operation of a natural preserve. Limited visitation is being accommodated in the meantime, under the Conservancy's auspices. Ninety-seven kilometers (60 miles) of shoreline enclose the 25,091 hectares (62,000 acres) of this island which is roughly 8 km (5 miles) wide and 34 km (21 miles) long. The shore is steep and rugged, gashed with numerous points and indentations and punctuated by sea coves. There are plentiful anchorages, harbors and landings and approximately 10 km (6 miles) of sandy shorelines exist in pocket beaches and harbors. Numerous peaks occur on the island, with the highest reaching 732 m (2,400 feet) and several extending above 518 m (1,700 feet). Topography is varied and interesting as is the vegetation. This island is the most densely wooded of the northern islands, presenting a park-like atmosphere of wooded groves interspersed with open grass and brushlands. Unique plant and animal communities exist. Marine life abounds with good representation of invertebrates, fishes, marine grasses, kelp and other algae. This island, like the others, possesses abundant archeological values. Recreation attractions include the spectacular scenery, sea coves, fishing, diving, swimming, hiking, camping, and natural history study. The Pacific Missile Test Center maintains instrumentation and communication installations on leased areas of the island.

Boating Facilities and Use. Boating comprises a major portion of the Santa Barbara area's recreation mix. Both sail and powered craft are used as well as small skiff types. Sport fishing utilizing both private and party boats is common and covered in greater detail in Section II.G.1.f.iv. Launching facilities are available at Gaviota and both rental and launching are available at Goleta. Major facilities are in Santa Barbara Harbor including a large marina and slips along with launching and rentals. Party and private craft land sport fish catches in this harbor. There are presently 1,008 slips available in the harbor of which approximately 225 are utilized by commercial fishing vessels. Waiting lists for slips currently entail a 3-4 year delay. Twelve vistor slips are maintained with stays limited to 14 days. The destination of the majority of the permanent boaters is the waters surrounding Santa Cruz Island.

Recreational use comprises an important part of the Santa Barbara environment. While much of the recreational use comes from the local population, Santa Barbara's south coastal recreational sites are within one to four hours of Los Angeles Metropolitan Population Center. Consequently, weekend pressure comes from the Los Angeles area. The BOR (1973) estimates a total visitation of over two million people for state, county and city ocean-front parks in Santa Barbara County.

Ventura County: Ventura County, by its location, is transitional between Santa Barbara County and populous Los Angeles County. Santa Barbara County is cooler, more pastoral, and is growing more slowly. Ventura County is growing rapidly and sustains far greater impact from the Los Angeles area on its resources than does Santa Barbara County. Although still largely rural, urbanization is moving from the San Fernando Valley to Ventura County. Much of the County's coastline is readily accessible both to local residents, as well as to the Los Angeles Metropolitan area. The total length of the shoreline is 66 km (41 miles) most of which is sandy beach. Steep bluffy terrain is found on the county's northern coast and some cliffy terrain is found on the southern coast. Much of the backshore has some development.

From Rincon Point 25 km (16 miles) to the City of San Buenaventura (Ventura), public recreational use occurs on 11 km (7 miles) while private recreational use occupies less than 1 km (0.5 mile) with 1.7 km (1 mile) remaining undeveloped. The beaches are narrow and mostly sandy and some are covered at high tide. Highway 101 closely parallels the ocean in most of this reach. The northern portion of this shoreline has several offshore and onshore petroleum installations. All of the publicly owned land is either owned by recreational agencies or by the State Department of Transportation.

Living and non-living resources of this coastal reach are: tide pools, kelp beds, shoreline biotic communities, scenic vistas and archeological sites. Recreational activities include surfing, fishing, camping, beach strolling, picnicking and scenic driving. The Ventura County Coastal Study (Ventura County, 1974) policies for this region include that of preserving the character of the North Coast through the protection of designated environmental and cultural resources.

Extending from Ventura to Point Mugu are 29 km (18 miles) of sandy beach. Public ownership involves 26 km (16 miles) of shoreline including 11 km (7 miles) within the Point Mugu and Port Hueneme Naval Reservations, and 3 km (2 miles) used for private recreation. Eleven km (7 miles) remain undeveloped. Backshores consist of the Oxnard Plain which is a lowland, sand dunes, wetlands and some development. Urban development exists at the northern end of this reach within Ventura, at the south at Oxnard, and the unincorporated communities of Hollywood by the Sea and Silver Strand. Lagoons exist at the mouth of the Santa Clara River and Mugu Lagoon at Point Mugu. Planning efforts for this reach are mostly within city jurisdictions.

From Point Mugu to the Los Angeles County line at Leo Carrillo State Park covers 12 km (7.5 miles) of which 5 km (3 miles) are publicly owned. Public recreational use occurs on 5 km (3 miles) with private recreational use occurring on 0.5 km (0.3 miles) and 6 km (3.7 miles) remains undeveloped. Almost all of this reach is sandy, ranging in width from 30 m (110 feet) to 90 m (300 feet) and backed by low bluffs and containing occasional small rocky protrusions. Backshores contain the Coast Highway, scattered groups of residential development and the western end of the Santa Monica Mountains.

A summary of Ventura County shoreline use is shown in Table II.G.1.f-3.

<u>State Parks</u>. There are four State Park Units within the Ventura County coastal area which are as follows:

<u>Emma Wood State Beach</u>. Emma Wood State Beach lies just west of the City of Ventura between the Southern Pacific tracks and the ocean. This narrow beach has 116 acres of land with 440 m (14,440 feet) of ocean frontage. Major recreational activities available are camping, picnicking, swimming, surfing, and fishing. Bird life is abundant and there is a small freshwater marsh which attracts wildlife. Gray whales can be seen from the beach when they are migrating. Visitor attendance was 84,761 for the 1972-73 F.Y., increasing in 1974-75 to 112,952.

San Buenaventura State Beach. Providing ocean oriented recreation opportunity within the City of Ventura, this beach offers picnicking, swimming, surfing, fishing, and birdwatching. A total space of 47 hectares (116 acres) is available which includes an ocean frontage of 355 m (11,630 feet). A 518 m (1,700 feet) fishing pier offers opportunity to take bonita, surf perch, shark, bass and corbina. Grunion hunters indulge themselves at this beach when the runs occur in March, June, July, and August. There is day use but no overnite facilities.

Table II.G.1.f-3

SUMMARY OF VENTURA COUNTY SHORELINE USE

Category	Km	(Miles)
Public Recreational	29	18.2
Private Recreational	4	2.7
Non-Recreational Development	14	8.8
Undeveloped	19	11.5
Ownership		
Public	46	28.5
Private	20	12.7
Total Shoreline	66 Km	(41 miles)

Many upland and shorebirds add to the enjoyment of visitors who reached 756,757 in 1974-75 F.Y. down from a high of 909,761 in 1969-70 F.Y.

McGrath State Beach. Located at the western city limits of Oxnard, this 119 hectares (295 acre) park provides 318 m (10,445 feet) of ocean frontage. Facilities include 174 campsites. Sunbathing and fishing for bass, corbina and perch are some of the activities available at the park. Although lifeguards are on duty during the summer, swimming is not recommended because of strong currents and riptides. The park includes the wetlands of the Santa Clara River's mouth and a small body of water, McGrath Lake. Numerous small mammals and reptiles are found in the wetlands and surrounding uplands area. McGrath Lake attracts in excess two hundred bird species, including some that are rare. Visitation was 109,176 in the 1974-75 F.Y. down from a high of 114,287 reached in the 1969-70 F.Y.

Point Mugu State Park. With over 5,261 hectares (13,000 acres) of beach and upland Santa Monica Mountain area, Pt. Mugu State Park offers a wide variety of vegetation and environmental variety. Camping and picnicking are available. Swimming, sunbathing, fishing and surfing take place from the 24 hectares (60 acres) of beach which is fronted by 5,861 m (19,224 feet) of the Pacific. Pt. Mugu State Park is included in landscape preservation projects along with McGrath Lake. Visitation was 310,713 in the 1974-75 F.Y. up from 264,554 in the 1971-72 F.Y.

Beach attendance for the four State Beaches in Ventura County has averaged 1,179,557 over the years 1972 through 1975. High attendance of 1,289,598 occurred in the 1974-75 F.Y. and the low was reached in the 1973-74 F.Y. at 1,119,365.

County Parks. There are no State-owned, county-operated parks in the county. Hobson, 0.7 hectares (1.8 acres), and Faria, 0.6 hectares (1.5 acres), parks are two small sites located on the coast north of the City of Ventura. Neither park contains beach oriented recreation. Visitation for Faria Park was 90,775 and 135,940 for Hobson Park in 1971 (BOR Memo, 1973). Within the City of Ventura, the County Fairgrounds and associated beach park offer ocean recreation opportunities.

Hollywood and Silver Strand Beaches total 17 hectares (41 acres) and lie in the Oxnard area, receiving heavy use from that metropolitan area. Visitation in 1969 was 685,850 for both beaches, falling to 663,700 in 1971 for both parks. Parking problems exist at both beaches, hindering effective use.

Local, Private and Miscellaneous. Ventura marine beaches are operated by the City of Ventura. Oxnard owns the Oxnard Shores Park and operates the beach within county-owned Channel Islands Marina. It also has plans to develop Osmond Beach in the future.

The City of Port Hueneme operates the Port Hueneme City Beach Park, a 20 hectares (50 acre) site containing a public fishing pier and other major recreational facilities. This is the largest park in the city and attracts people from the regional area as well as from the City of Port Hueneme. There are 12 hectares (30 acres) of beach for swimming and sunbathing. Picnic facilities and children's play equipment are available. Visitation was 500,000 in 1969 and 350,000 in 1971.

In addition to the developed sites within the county, there are many miles of public and private beach areas which are used by the public. Loss of these unofficial resources through such actions as closure of private lands used for beach access will have damaging effects on regional recreation opportunities. For example, since 1941, undeveloped county shoreline has decreased from over 48 km (30 miles) to less than

12.9 km (8 miles). As the available undeveloped shoreline continues to decrease, competition between public and private interests will intensify, adding to the existing pressures and conflicts, (Ventura County, 1974).

Boating Facilities and Use. Ventura Marina, located in the City of Ventura, is owned by the Ventura Port District. Within the marina, are 850 slips with an additional 500 slated for fall, 1978 completion. Channel Islands Harbor, located in Oxnard, is owned by the Ventura County Department of Airports and Harbors. Included are public beaches, boat launching and repair, restaurants and parking. Approximately 600 slips are built with potential for an additional 1200-1800. About 25 are used commercially. Charter trips to Channel Islands National Monument are available from the Harbor. The destination of most private boaters from both harbors is the Channel Islands. There is a small craft harbor within the commercial harbor of Port Hueneme.

Los Angeles County. Los Angeles County is pivotal in any discussion of recreation in Southern California. Overwhelmingly first in population of the counties studied, and second only to San Diego County in physical size, L.A. County has a profound impact on the region's recreation. Many of the County's recreation needs are satisfied within its boundaries which enclose a diversity of values ranging from San Clemente Island some 88 km (55 miles) offshore from L.A. Harbor, to portions of the Mojave Desert. In between lie the forested ranges of the San Gabriel Mountains in the Angeles National Forest. Although generously endowed with recreation resources, the population is so large that the available resources are largely inadequate. Demand for day use facilities is particularly acute. Typical one day recreation use occurs within 2 hours travel time of the urban area. Weekday, holiday and most of the weekend demand is concentrated within 1 hour's travel. Nearly 41 percent of total recreation participation occurs within the 1-hour travel zone with nearly 55 percent of the total recreation participation occurring within the 2-hour travel zone (CORRP, 1972). Two hours travel places the entire coastline from San Diego to Santa Barbara within reach of the L.A. Metro Area. The most intense use is concentrated at the beaches on the Santa Monica Bay shoreline between the City of Santa Monica and the City of Redondo Beach. Heavy Sunday attendance there on a hot Sunday in July 1974 was estimated to be 500,000 persons. Total Los Angeles and Orange County beach attendance on that same day was estimated at 1,261,000 persons.

The Corps of Engineers, in the *National Shoreline Study*, (1971) credited mainland Los Angeles County with a shoreline length of 119 km (74 miles), exclusive of the Harbor. Public recreational use occurs on 46 km (35 miles) of shoreline while private recreational use utilizes 34 km (21 miles). A total of 83 percent of the Los Angeles shoreline is thus used for recreational purposes.

Table II.G.1.f-4 shows the ownership, use and characteristics of the county's shorelines. Non-recreational development ties up only a small segment of the shoreline and a limited amount of undeveloped shoreline remains.

Table II.G.f-4

LOS ANGELES COUNTY SHORELINE
OWNERSHIP - USE - SANDY BEACH

Area	Ownership Public	Ownership Private	Use Public Rec.	Use Pvt. Rec.	Use Non-Rec. Develop.	Use Un-Develop	Sandy Beach
Los Angeles County	37.8 mi (61 km)	30.1 mi (48 km)	34.9 mi (56 km)	21.2 mi (34 km)	0.3 mi (0.2km)	11.5 mi (18 km)	50.3 mi (81 km)
L.A. Harbor	29.1 mi (32 km)	9.9 mi (16 km)	--	--	30.0 mi	--	0.5 mi
Catalina Island	--	50.0 mi (80 km)	1.6 mi (3 km)	1.3 mi (2 km)	0.2 mi (0.3km)	46.9 mi (76 km)	5.5 mi (9 km)
San Clemente Island	50.0 mi (80 km)	--	--	--	--	50.0 mi (80 km)	2.0 mi (3 km)

From the L.A.-Ventura county line at Sequit Point, to Point Dume, the shoreline is sandy beach backed by low cliffs. About 50 percent of the backshore is developed, largely with residential structures. Approximately 73 percent of the shoreline is privately owned. Public recreation land lies within Leo Carrillo and Point Dume (Westward Beach) State Beaches and Zuma County Beach. Nicholas and Trancas are private beaches.

Leo Carrillo State Beach is 639 hectares (1,578 acres) in size and with 2,011 m (6,597 ft) of ocean frontage. There are parking, overnite, and picnic facilities. Much of the park is upland area containing representative flora and fauna of the Santa Monica Mountains. Activities include swimming, surfing, skindiving, and hiking. Numerous species of sea birds and marine mammals are seen. Attendance was 310,777 in F.Y. 1974-75, down from a high of 556,185 reached in 1971-72 F.Y.

Point Dume State Beach is operated by the L.A. County Department of Beaches. It contains 12 hectares (30 acres) of State owned land and 1,356 m (4,448 feet) of ocean frontage. Activities include swimming, surfing, and diving.

The segment from Point Dume to Santa Monica Pier consists of sandy beaches, narrower at the western portion and becoming wider to the east. The backshore is mostly developed with residences. The coastal strip is narrow and the Coast Highway is close to the ocean because the steep slopes of the Santa Monica Mountains crowd the shore in this stretch, falling back only near the City of Santa Monica. Seventy percent of this coastal reach is privately owned. All of the publicly owned land is utilized for public recreational purposes. Topanga Beach is the only State-owned and operated beach within this segment and is located near the foot of Topanga Canyon Blvd.

Will Rogers State Historic Park is less than 2.9 km (1.8 miles) from the beach. This park preserves the home of the famous humorist and provides riding and hiking trails, as well as a polo field. Abutting Will Rogers SHP is the 1,677 hectares (4,145 acres) Santa Monica Mountains State Park. This park consists of 989 hectares (2,445 acres) of State- owned land and 688 hectares (1,700 acres) of lease or permit land. Values in this park include representative Santa Monica Mountain ecosystems and vistas including some ocean views.

There are four State Beach units of the State Park System, in this stretch, which are operated by L.A. County and two cities. These are Malibu-Surfriders, Las Tunas, Will Rogers, and Santa Monica State Beaches. Malibu-Surfrider (Malibu Lagoon SB) is located at Malibu Point and has 900 m (2,950 feet) of ocean frontage. Las Tunas State Beach has 476 m (1,560 feet) of ocean shore. Both are operated by Los Angeles County.

Will Rogers State Beach is located in several discontinuous segments between the western city limit of Los Angeles and Santa Monica. It is operated by the Los Angeles City Department of Recreation and Parks, and has 2,962 m (9,715 feet) of ocean frontage. Santa Monica State Beach is located on the Santa Monica City waterfront and is operated by that city. It has 3,071 m (10,073 feet) of ocean shore. Attendance for 1973-74 was 10,520,950. Two other parks are Palisades park, just inland of the Coast Highway in Santa Monica and Corral-Solstice Beach located midway between Point Dume and Malibu Point.

In addition to the public beaches, there are beaches in the intervening areas which are privately used. Although the beach itself is public property, access is precluded by blocked-up private ownership of the backshore and private use of the beach results. For this analysis, this entire coastal reach can be considered recreationally used.

Beginning at Point Dume, the following beaches are primarily privately used:

Paradise Cove	Malibu Beach
Escondido Beach	Carbon Beach
Puerco Beach	La Costa Beach
Amarillo Beach	Big Rock Beach

The next segment encompasses the southern shore of Santa Monica Bay extending from the Santa Monica Pier to the beginning of the Palos Verdes Penninsula. Beaches are wide sandy and heavily used, being the most readily reached sites from the inland metro region. The backshore is almost totally developed and is primarily residential. One small segment at El Segundo is developed with a refinery, power and wastewater plants. Nearly all of the beaches are devoted to recreation. Twenty-five km (16 miles) of this reach are publicly owned and devoted to recreational uses while the remaining 0.8 km (0.5 mile) is privately owned and likewise devoted to recreational uses. Beach erósion has created some problems in this segment.

There are no State operated units of the State Park System in this section. County and local jursidictions operate several State Beaches. Los Angeles County operates Manhattan and Redondo State Beaches, with 17,980 m (5,481 feet) and Clifton and Torrance beaches. Visitor attendance at Clifton in 1974-75 was 1,672,004.

Local or city operated beaches complete the recreation picture in this segment. Beginning at Santa Monica Municipal Pier, these are: Santa Monica and Dockweiler State Beaches, Venice, El Porto, Hermosa, Redondo and King Harbor - Dominguez beaches.

Visitation for 1974 at Venice and Dockweiler was 6,030,000.

The next segment considered extends from the northern Palos Verdes Peninsula at Malaga Cove to the San Pedro Breakwater. This 27 km (16.8 mile) reach includes rocky cliffs and headlands with pocket beaches of sand or cobbles. The backshore is a series of prominent marine terraces. Development is residential for the most part, and clustered with a great deal of interspersed open space. Non-residential developments include the Point Vicente and Point Fermin Lighthouses, Fort MacArthur Military Reservation and Marineland commercial aquarium.

Fifty-nine percent of the shore is privately owned of which 10 percent is used for recreational purposes. A total of 11 km (6.9 miles) is publicly owned with 7 km (4.3 miles) being used for recreational purposes. Undeveloped shoreline exists for 19 km (11.5 miles) of the segment.

County parks include a fishing access at Point Vicente and Palos Verdes Shoreline Park. Both parks provide a panorama of Catalina Island and the Palos Verdes Peninsula shoreline.

Royal Palms State Beach, Point Fermin Park, and Cabrillo Bend Park are under Los Angeles City administration. The first two offer a panorama of Catalina Island and the Palos Verdes Peninsula shoreline. Los Angeles Harbor comprises the next segment of shoreline. The Harbor contains 32 km (20 miles) of publicly owned shoreline and 16 km (10 miles) of private ownership. The bulk of the shoreline's 48 km (30 miles) is developed for non-recreational purposes. Only 0.8 km (0.5 mile) of shoreline is considered as sandy beach. Although a commercial harbor facility, recreational use does come from the various marinas and embarkation facilities for water and aircraft to points such as Avalon on Catalina Island.

The last reach of county shoreline stretches from the north bank of the Los Angeles River to the Orange County Line, a distance of approximately 9 km (5.5 miles). All of this shore is owned by local governments and used for public recreation with the exception of a Navy landing. Sandy beaches exist on 7 km (4.5 miles) of this beach.

Bluff Park lies on the Long Beach waterfront and includes 10 acres of shoreline property. Alamitos Bay has been converted to a large recreation complex containing the Long Beach Marina, residential areas and the Marine Stadium complex. Visitation in 1969 was 1,870,200. The Long Beach beachfront area has a total of 229 acres of swimming beach which had a visitation of 16,000,000 in 1969.

Santa Catalina Island lies approximately 29 km (18 miles) southwest of Los Angeles Harbor. The island is mountainous with rocky shores and numerous pocket beaches. It is entirely privately owned and utilized primarily as a ranch. World-famed as a resort, Catalina is the destination of multitudes of boaters and tourists. Primary destinations are the City of Avalon and Isthmus Cove. Many coves with pocket beaches on the north side of the island are maintained by yacht clubs as private anchorages and recreation sites. Public landings are available by permit at other portions of the shoreline. The City of Avalon has 24 hectares (6 acres) of public beach. In addition to heavy boating use of its waters, Catalina is a magnet for skin and scuba divers from all over the country who savor its clean waters and abundant fish. The island's waters are used as a training area for novice divers.

San Clemente Island is a U.S. Naval Reservation used for aerial gunnery, bombing and aircraft landing operations and is about 29 km (18 miles) South of Catalina Island. It has a spectacular, precipitous eastern shoreline with a gentle western shore. Its 80 km (50 miles) of coast is largely rocky but has a few pocket beaches. Divers and party boats use the surrounding waters but no public landings are permitted.

While much of the Los Angeles County coastline has been devoted to both public and private recreational purposes, it is still grossly deficient in meeting the demand. Future demand is expected to continue increasing. According to the Bureau of Outdoor Recreation (1973), the total recreation use at California State Parks on the Los Angeles County Coast which were operated by the California Department of Parks and Recreation was 497,083 recreation days in 1969. By 1980, that figure is expected to increase to 665,700 recreation days. While these amounts represent less than one percent of the total recreation use along coastal Los Angeles County, it would probably not be unreasonable to expect a similar proportionate increase countywide.

Boating Facilities. Recreational boating comprises a significant portion of the County's recreation activity. Boating activities include fishing, sailing, overnight camping, swimming and racing.

The *Los Angeles County Regional Recreation Areas Plan*, 1965 (See Table II.G.1.f-5), studied all existing and potentially developable boating facility sites in Los Angeles County including Santa Catalina Island as based on studies and recommendations of Small Craft Harbors and County Engineers. The total capability as reported in the plan therefore represents the ultimate capability of the Los Angeles County shoreline plus the known capability of existing and future inland bodies of water. This plan recognized an ultimate capacity for daily launch and recoveries of approximately 6,500 small craft, berthing capability of approximately 20,000 and mooring capability of approximately 600. Coastal Commission policies make it unlikely that much expansion of berthing capacity will occur.

Orange County. While growth in Los Angeles County has slowed, Orange County has undergone an explosive expansion of population and urbanization. This 2,205 square km (782 square miles) county is faced with mounting recreation demands and difficult land use decisions. The county has 68 km (42 miles) of highly regarded coast, most of which is broad, sandy beach. The Planning Department notes that the County's 42 mile coastline is considered by many to be its most highly treasured natural resource. By the Department's estimate, some 20 million people annually utilize the county's coastline for fishing, surfing, swimming and sunbathing. Besides its beaches, Orange County's physiographic features include the rapidly developing alluvial plain of the Santa Ana River, the Santa Ana Mountains in the east and the coastal hills and bluffs of its southern portions.

Table II.G.1.f-5

LOS ANGELES COUNTY
SMALL CRAFT HARBORS AND LAUNCH FACILITIES

Name and Location	Operating	Type and Estimated Capacity
AVALON HARBOR Santa Catalina Island	City of Avalon	Protected anchorage-mooring for 300 boats inside, 50-60 boats outside.
CATALINA HARBOR Santa Catalina Island	Private	Marina- 150 moorings (est.) Potential berthing for 800 boats
EMERALD BAY Santa Catalina Island	Private	Marina- 10-20 moorings. Potential berthing for 400 boats.
CAMP FOX	Private	Marina- 25-30 moorings
WHITES LANDING	Private	Marina- 100-150 moorings
CHERRY VALLEY	Private	Marina- 25 (est.)
CABRILLO BEACH	Los Angeles Rec & Parks Dept.	Launch facility- 200 boats per day
GOLDEN AVENUE RAMPS Southern terminus of Golden Ave. Long Beach	City of Long Beach	Launch facility- 200 boats per day
KING SMALL CRAFT HARBOR Redondo Beach	City of Redondo Beach and Private lessees	Marina- 1,538 boats. Launching capability estimated to be 600 boats per day
LONG BEACH HARBOR Long Beach	Long Beach Marine Dept & Private lessees	Marina- berthing for approximately 2380 boats. Launching capability estimated to be 675 boats per day
Long Beach Marina Alamitos Bay Long Beach	Long Beach Marine Department	Marina- berthing for 1800 boats. Preliminary planning shows ultimate capacity of 2,900 berthing spaces. Launching capability estimated to be 425 boats per day

Table II.G.1.f-5 (Cont.)

Name and Location	Operating	Type and Estimated Capacity
LOS ANGELES HARBOR San Pedro (LA)	Los Angeles Harbor Dept & private lessees	Marina - berthing for approximately 3,200 boats. Launching capability estimated to be 425 boats per day.
MALIBU LAGOON BEACH STATE PARK (Pvt) Malibu Pt.	County Dept of Small Craft Harbors	Launch facility - potential capability of 550 launchings per day. Proposed facility in regional park.
MARINA DEL REY Marina Del Rey	County Dept of Small Craft Harbors and private lessees	Marina - Currently 6,000 boats. Ultimate launching capability estimated to be 1,490 boats per day.
PARADISE COVE (Pvt) East of Point Dume Malibu area	County Dept of Small Craft Harbors	Marina - potential berthing for approximately 1,535, and mooring for approximately 115 boats. Potential launching capability estimated at 500 boats per day. Existing private facility estimated to be capable of launching 100 boats per day.
PORTUGUESE BEND (Pvt) Palos Verdes Peninsula	County Dept of Small Craft Harbors	Marina - potential berthing for approximately 900 boats.
SANTA MONICA HARBOR Santa Monica	Santa Monica Harbor Dept.	Marina - mooring for approximately 32 boats.
SEQUIT POINT (Pvt)	County Dept of Small Craft Harbors	Protected anchorage - potential berthing for 200 boats, mooring for 200 boats, and launching capability for 400 boats per day. Part of Carillo Beach State Park acreage.
TOPANGA CANYON (Pvt) Mouth of Topanga Canyon Malibu area	County Dept of Small Craft Harbors	Launching facility - potential capability of 400 boats per day.

Source: Los Angeles County Regional Recreation Areas Plan, 1965 with updating where data was available.

There are at least seven Party Boat Landings and 17 launching facilities in the county.

Orange County's shoreline ownership and characteristics are shown in Table II.G.1.f-6.

Table II.G.1.f-6

ORANGE COUNTY SHORELINE
OWNERSHIP - USE - SANDY BEACH

	Ownership		Use				
	Public	Private	Public Rec	Private Rec.	Non-Rec. Develop.	Unde- velop.	Sandy Beach
Orange County	25.8 mi (44 km)	16.2 mi (26 km)	25.5 mi (41 km)	13.6 mi (22 km)	1.8 mi (3 km)	1.1 mi (2 km)	33.4 mi (54 km)

Source: National Shoreline Study, USCOE, 1971.

Beginning at the mouth of the San Gabriel River, the Los Angeles-Orange County Line, the coastline stretches 29 km (18 miles) to Newport Beach. All of this reach is sandy beach with interruptions only at the harbor entrances and river mouth jetties. Approximately 87 percent of this shore is publicly owned, mostly by local entities and used for public recreation. The 13 percent which is privately owned is used for recreational purposes. The backshore is developed at Seal Beach through Sunset Beach, where it becomes largely undeveloped in the Bolsa Bay area, extending within the City of Huntington Beach. It is developed in Huntington Beach and Newport Beach with little development in the intervening strip.

State beaches in this segment are Bolsa Chica and Huntington State Beaches with 11,737 m (38,507 feet) of ocean frontage and visitor attendance of 3,024,994 in 1974-75. Activities include swimming, fishing, surfing and picnicking. County facilities include Sunset Beach, 11th Street Beach, Santa Ana River Beach, Newport Harbor, Newport Dunes Aquatic Park, and Upper Newport Bay. Sunset Beach had a 1969 visitation of 773,376. Upper Newport Bay is primarily a boating installation with land support suitable for picnicking. Newport Harbor is an extensive boating installation with 49 hectares (120 acres) of swimming beach included in the complex. Attendance in 1969 was nearly 2 million people. Newport Dunes Aquatic Park, also within Newport Bay, had an attendance for 1969 of 259,328. Local facilities include Seal Beach, Huntington Beach, Newport Beach, and Corona del Mar State Beach.

Seal, Huntington, and Newport City Beaches, and Corona del Mar State Beach accounted for 18,278,000 visitor days of use in 1971.

The next segment extends from Corona del Mar to Dana Point, for 24 km (14.6 miles). This shoreline is rocky, accented by numerous points and freestanding offshore rocks and punctuated with numerous small pocket beaches. The backshore consists of bluffs ranging in height from 9 to 40 m (30-130 feet). The shoreline is developed at Corona del Mar but undeveloped south to Laguna Beach except for the small settlement at Crystal Cove. Development extends from Laguna Beach through South Laguna where it is undeveloped southerly to Dana Point. Seventy-two percent of this coastal reach is privately owned and 15 km (9 miles) of the 17 km (10.5 miles) is used for private recreational purposes with the remaining 2 km (1.5 miles) available to the public.

There are no State Park units within this segment. County facilities include Sunset Aquatic Park, Aliso Creek, South Laguna, 3 Arch Bay and Niguel Beaches. Sunset Aquatic Park has picnic and marina facilities. Aliso Creek Beach visitation was 235,200 in 1974-75. South Laguna Beaches include the Heisler Park Marine Life Refuge and South Laguna Beach Marine Life Refuge. Niguel Beach attendance was 200,000 in 1974-75.

The final county segment extends 15 km (9.3 miles) from Dana Point to the San Diego County Line at San Mateo Point. This area comprises the landward side of the Capistrano Bight. The shoreline consists of sandy beaches backed by 30 m (100 feet) bluffs. Development occurs on approximately 50 percent of the backshore. Sixty-three percent of the shore is publicly owned and nearly all of this is available for public recreation. Two-thirds of the private shoreline is devoted to recreational use.

State recreation units in this segment include Doheney and San Clemente State Beaches. Doheny State Beach is located on the City of Capistrano Beach waterfront. It has use and camping facilities and total ocean frontage of 2,002 m (6,567 feet).

Activities include fishing, swimming, and surfing. There are 119 camping units installed with plans to expand these to accommodate more of the reported 50,000 turnaways from the campground. Total visitation was 525,342 in 1974-75.

San Clemente State Beach is located at the City of San Clemente and has day-use and camping. Activities include swimming, fishing, surfing, and diving for abalone and spiny lobster. The 1,829 m (6,000 feet) of ocean frontage attracted a total of 293,226 visitors during F.Y. 1974-75. Local facilities include beaches at Dana Cove and the San Clemente City beach with an attendance of 2,165,100 in 1974-75.

Boating Facilities. Like Los Angeles County, Orange County has a large contingent of boaters. Marina facilities are shown in Table II.G.1.f-7.

Table II.G.1.f-7

ORANGE COUNTY MARINA BOATING FACILITIES CAPACITY

Name	Number of Boats
Huntington Harbor	2,500
Sunset Aquatic Park	575
Newport Bay (Lower and Upper)	8,632
Dana Point	1,400

Including the above, there are at least ten launching facilities and six party boat landings. The most common destinations of Orange County boaters are the nearshore waters and Catalina Island.

San Diego County. The following excerpts from the county's 1972 Open Space Study best sum up its attributes and self-perception.

> San Diego County embraces 11,030 square km (4,255 square miles) situated at the southwesterly corner of the continental United States. The county contains three sharply contrasting geographic sub-regions of roughly equal size: the coastal strand and foothills, the central mountains, and the eastern desert. Most of the population is concentrated in the western third of the county where moderate climate, ocean and bay frontage, and developable terrain have invited human settlement. Flat mesas interspersed with canyons and river valleys gradually give way to rolling foothills as one proceeds east from the coast. The central mountains extend almost to the Mexican border.
>
> Over half the land in the county (2,685 square miles) is in public ownership, but much of this is in military reservations or in mountain and desert areas far from urban centers.

Over the past three decades the county's population has grown by over 400 percent - a rate considerably faster than the growth of the State as a whole. In 1940 the population was less than 300,000 but it almost doubled in the next decade. This high growth rate continued, with the county's population exceeding 1 million in 1960. The latest census counted 1.36 million persons.

The results of adding almost three quarters of a million people to the county's population in 20 years have drastically changed the character of the coastal sub-region. Once relatively small, self-contained communities have become engulfed in urban sprawl and have nearly lost their identity. The City of San Diego and its neighbors (La Mesa, El Cajon, National City, Chula Vista, and Imperial Beach) have grown together to form an almost unbroken urban mass. Landforms have been altered and other natural features have been destroyed to make way for development. In many areas open space has become a scarce commodity.

Because open space and climate are the most important elements of the San Diego life style, it can fairly be said that as the county has grown, the quality of life has diminished. Although an enormous amount of open space remains available for public use in the mountain and desert sub-regions, there is a pressing shortage of recreation areas within and in close proximity to urban centers. Currently San Diegans are beginning to take stock of the results of three decades of relatively uncontrolled growth. Based on apparent environmental and financial consequences, some are questioning the advantages of rapid urbanization. Comparisons are being made with the Los Angeles-Orange County metropolitan monster that lies to the north. Few believe that the San Diego area should emulate its neighbors. There is general agreement that the most precious assets that would be lost are clean air, open space, freedom from congestion and access to open space.

Paradoxically, the root cause of most of San Diego's growth in the past decade was environmental amenity. Particularly in the late 1960's when the pace of state-wide growth had significantly declined many businesses selected San Diego County as the prime remaining unspoiled Southern California coastal location. The population growth these new industries and offices generated required construction. Pro-growth public policy generally imposed minimum constraints on the location of new development. As a consequence the coastal sub-region lost much of its precious open space-open space that was a prime element of its scenic setting and recreational resources.

Provision of access by the Coast Highway (now Interstate 5), without reservation of significant amounts of open space for public use, determined that the coastal strand will be predominantly urban, even where natural conditions dictate otherwise. Construction of Interstate 8 Freeway spurred development of the La Mesa-El Cajon area; and improvement of Route 395 (now Interstate 15) eased commuting from the north to Central San Diego, as well as generating current pressure for development of North City. As these and other public projects have made ever greater amounts of land potentially subject to urbanization, increasingly important open spaces have been lost.

In the light of the fact that much of the needless loss of open space in San Diego County occurred after the grim consequences of Los Angeles and Orange County's growth signalled warnings in the 1950's and early '60's, it would appear that there is only limited cause for optimism regarding future prospects. However, in recent years the public has become increasingly aware of the need to check the more devastating aspects of uncontrolled urbanization. Concern has arisen not only over environmental consequences, but also over the costs of new development to the taxpayers at large. Recent events demonstrate that public officials are reacting to anti-development pressures and heeding warnings of their staff members that formerly were frequently ignored. These portents suggest that growth at-any-cost policies are being abandoned by local governments (San Diego County, CPO, 1972).

Of the County's 122 km (76 miles) shoreline, 73 percent is publicly owned. Forty-four percent of the coast is available for public recreation use. Most of the beach is sandy except in the Pt. Loma Peninsula area where some rocky points and cobble beaches occur.

The first shoreline segment extends 28 km (17.7 miles) from San Mateo Point to the San Luis Rey River north of Oceanside. This entire reach is within the Camp Pendleton Marine Base. The northern 5 km (3 miles) or so is moderately wide sandy beaches which turn into narrow beaches backed by cliffs varying from 18 m to 46 m (60-150 feet) in height through the central sector. The southerly 5 km (3 miles) are wide beaches backed by the Santa Margarita Lagoon. There is little development in this reach with the exception of San Onofre State Beach and the

San Onofre Nuclear Generating Plant in the northerly portion. There are some Marine Corps installations at the southerly end. Limited surf fishing is allowed by permit when landing maneuvers have not been scheduled.

San Onofre State Beach is located on 1,192 hectares (2,945 acres) of land under a 50-year lease to the State from the Department of Defense. This beach is undeveloped and the intention is to keep it that way. Activities on the 7,585 m (24,880 feet) of ocean front include swimming, fishing, surfing, and sunning. Camping is permitted on an abandoned stretch of highway on the bluffs. Visitation was 302,864 in 1974-75 F.Y.

The next segment extends from the San Luis Rey River to the Soledad River south of Del Mar, a distance of 34 km (21.3 miles). Beaches are generally wide and sandy backed in scattered portions by low cliffs and marine terraces. Local governments own 65 percent of the shore, nearly all of which is available for public recreational purposes. The majority of the backshore is developed and largely urban in character.

There are six State Beaches in this shoreline segment. Table II.G.1.f-8 gives information pertaining to resources, facilities and visitation.

Table II.G.1.f-8

CALIFORNIA STATE BEACHES IN THE SEGMENT

State Beaches	Size (acres-hectares)	Camping Units	Ocean Frontage (Meters - Feet)	Visitation (FY 1974-75)
Carlsbad	14 - 5.7		1,655 - 5,429	782,696
South Carlsbad	78 - 31.6	226	3,668 - 12,032	316,755
Leucadia	11 - 4.4		1,640 - 5,380	284,818
Moonlight	14 - 5.7		555 - 1,820	274,737
San Elijo	39 - 15.8	171	2,784 - 9,130	491,904
Cardiff	11 - 4.4		1,164 - 3,819	166,027

Activities at these beaches include surfing, swimming, diving (skin and scuba), sunbathing, fishing, sightseeing, camping and picnicking. Camping is limited to a 7-day stay because of the beaches' popularity. County Parks and Beaches include those in Table II.G.1.f-9.

Table II.G.1.f-9

SAN DIEGO COUNTY PARKS IN SEGMENT

Park	Size (acres-hectares)	Visitation
Encinitas	2 - 0.8	N/A
Seaside Gardens	9 - 3.6	105,500
Sea Cliff	1 - 0.5	101,000
Tide Beach	1 - 0.5	50,000
Leucadia Roadside County Park	N/A	N/A
Solano Beach Park	8 - 3.2	305,500

The next segment begins at Torrey Pines State Park and extends south 22 km (13.7 miles) to the entrance of Mission Bay Park. Fifty-seven percent of this reach is publicly owned and all is available for public recreation. The privately owned land is considered to be in recreational use. The northern portion is in a State recreation area and is very lightly developed but the southern portion is highly urbanized through the communities of La Jolla and Pacific Beach. Most of the shore is sandy beach with approximately 5 km (3 miles) of rocky areas along the La Jolla Peninsula.

Torrey Pines State Reserve and Beach are the only units of the State Park System in this reach. These contiguous areas total nearly 364 hectares (900 acres) with 24 hectares (60 acres) and 7,200 m (23,613 feet) of ocean frontage. This park was established to preserve one of the world's rarest trees, the pines that give the park its name. An ice age relic, the tree is known only at the Reserve and on Santa Rosa Island. At the north end of the Reserve, the Los Penasquitos Lagoon has been designated as a Natural Preserve because it is in a nearly natural condition. Attendance at the Reserve is limited to 500 people at one time to protect the delicate ecosystems.

Table II.G.1.f-10 lists San Diego City Parks, the majority of which fall within this segment.

Table II.G.1.f-10

SAN DIEGO CITY PARKS

Parks	
Scripps Park	Palisades Park
La Jolla Cove	North and South Pacific Beach
La Jolla Shores	Mission Beach
Neptune Park - Wind n' Sea	Tourmaline Surfing Park
Coast Blvd. Park	Children's Pool
Nicholson's Pt. Park	Kellogg Park
La Jolla Strand	Palisades Park South
Hermosa Terrace Park	Ocean Beach Park
La Jolla Hermosa Park	Sunset Cliffs Beach
	Santa Clara Point

Mission Bay Park, a recreational development of some 1,740 hectares (4,300 acres) lies inside the strand at Mission Beach. This facility has marinas, parks and beaches, golf courses and commercial facilities. It is heavily utilized by boaters. A wildlife sanctuary occupies the eastern portion.

The next segment begins at Mission Bay's entrance and extends south the length of Point Loma to the San Diego Bay entrance. This 14 km (9 miles) stretch is mostly rocky except for approximately 0.8 km (0.5 miles) of sandy beach (Ocean Beach Park) just south of the mouth of the San Diego River. The beach is about 122 m (400 feet) wide near the river, narrowing to cliffs to the south. A municipal pier extends from the southern end of the beach area. The remaining portion of the shoreline is wave-cut benches, pocket beaches and sea caves. The backshore is urbanized in the northern portion, south to Sunset Cliffs. The remainder is in the Fort Rosecrans Military Reservation and is largely undeveloped. Cabrillo National Monument occupies a position near the southern end of Point Loma. Public recreation is available only at Ocean Beach Park.

San Diego Bay is a large complex containing numerous Naval facilities, commercial docks and recreational boating installations.

The final segment extends 23 km (14.3 miles) from the San Diego Bay entrance to the Mexican border. Nearly all of this is sandy beach but much of it is owned or leased by the Department of Defense. Public recreation is available at Silver Strand State Beach and at Borderfield with 9,006 m (29,540 feet) of ocean frontage and a 1974-75 F.Y. visitation of 430,149. The City of Coronado occupies the peninsula and provides recreation at Glorietta Bay and Central Beach.

Shoreline recreation areas in San Diego County seem to have a bright future. State Park attendance, which amounted to 2,054,907 recreation days in 1969, is expected to climb to 2,830,600 recreation days by 1980. Also by 1980, San Onofre State Beach will add 250 camp units and Silver Strand State Beach will add 315 camp units. Proposed landscape preservation projects include Torrey Pines State Park, a 3,887 hectares (9,605 acre) expansion of Torrey Pines State Reserve, and Tijuana River State Park which would total 3,017 hectares (7,455 acres).

The County of San Diego has developed plans to implement a system that will eventually total 39 regional parks. Of that total, seven are on the coast and are either existing or are among the highest priority for development. The following are among those regional parks not previously listed and their estimated acreage by 1990. They include Buena Vista Lagoon, 90 hectares (222 acres), Agua Hedionda, 569 hectares (1,407 acres), Batiquitos Lagoon, 573 hectares (1,416 acres), and San Elijo Lagoon with 248 hectares (614 acres). The regional park system of San Diego County will provide a variety of recreation experiences along the coast from high density intensive use at beach areas to quiet observation in ecological preserves. Attendance at City of San Diego beach areas is also expected to increase, by 1980, to 7,100,000 compared with a 1968 (F.Y.) attendance of 5,577,008. The City of Oceanside is currently developing a major addition to its facilities in the form of La Salinas Park.

Tourism in San Diego is a major factor in the local economy, ranking third in importance. Annual tourist expenditures were $845 million dollars last year. The]9.3 million visitors spend an average of $20 dollars per day. San Diego's reputation for an amenable climate, invigorating water front and several widely known attractions like the zoo and Sea World, do much to attract not only tourists but also industries seeking environmental amenities which will attract and hold highly qualified employees. Seventy six percent of all visitors to San Diego reportedly participated in water related activities, with 24 percent engaging in beach visits (San Diego GPO,]978). One study done in conjunction with the nude beach controversy in San Diego, indicates that out-of-town beach visitors may spend as much as $25 per day, based on a survey of Labor Day weekend visitors.

Boating Facilities. Boating activities are very prominent in San Diego County as they are in its two northern neighbors. Harbors include Oceanside Small Craft Harbor, Mission Bay and San Diego Bay.

Oceanside Small Craft Harbor has 760 boats berthed. Mission Bay Park has 2400 boats, Coronado Yacht Club (Glorietta Bay), 82 slips and 108 boats, Del Coronado Boathouse, 36 slips and Shelter Island (Yacht Harbor and Commercial Basin) 2,300. The total for San Diego Bay is approximately 3,530 boats. Much of the boating takes place within the large bays of Mission Bay and San Diego Bay. Destinations outside of the harbors include the Baja California Peninsula, Orange County harbors and Catalina Island.

Summary of Southern California Recreation. The preceding county by county compilation lists the majority of the recreation sites along the immediate coast and others which are close enough to be a part of the coastal environment. Undoubtedly, numerous other sites exist at varying distances inland which occupy vantage points commanding ocean vistas. The ocean is thus a part of the environment of these areas as well. Proposed and existing recreation sites are shown in Visual No. 4. Reference to this visual aid will demonstrate the dominance of recreation use of the Southern California Coastline. In addition to the public facilities shown on Visual No. 4, many of the intervening private lands can be considered recreational in nature. Some are open to the public while others are utilized by their owners for active recreation such as swimming, surfing and so on. Passive recreation plays an important part in the use of private residential shoreline. Peaceful enjoyment of the ocean environment provides, for many people, the "re-creation" so important to every individual.

Use figures have been included where available, and while they are by no means all inclusive, they do serve to indicate the magnitude of visitation to coastal parks. These figures do not indicate latent demand, that demand which is unindicated and unsatisfied because of crowding. This demand is evident in turn-away figures plus unknown numbers of people who have failed to present themselves at the entrance gate, knowing in advance that the facilities were likely to be at capacity already.

Table II.G.1.f-11 gives the regional recreation use for the affected California coastal area.

Recreational boating has been growing by leaps and bounds ever since 1886, when the San Diego Yacht Club was established. In 1973 there were over 179,000 boats in Southern California. More than one in four recreational boats in California were owned by Los Angeles County residents. Although large increases in boat registrations occurred through the 1960's, the future picture is not clear. The U.S. Corps of Engineers estimates by the year 2000, if no new harbors are built, Southern California will have a projected deficit of 88,000 berths for recreational crafts (U.S. COE, 1975). Increased concern for maintaining the integrity of the few remaining coastal wetlands, makes it unlikely that any large scale expansion of marina facilities will occur. Thus, without major expansion at existing marinas, boat storage will have to be increased by means of dry type storage. It would appear that boating growth will be leveling off, at least for the near term.

Table II.G.1.f-11

1969 RECREATION USE IN VISITOR DAYS
CALIFORNIA COASTAL STRIP LANDSCAPE PROVINCE

	Golden Gate to Pt. Conception	Pt. Conception to Mexico	Total Coastline
State Parks	12,033,602	7,400,479	22,934,162
Other Public	11,390,158	85,540,729	98,286,261
Private	226,255	403,264	805,079
	23,650,015	93,344,472	122,025,052

Source: Hanshew, Ron, Calif. Coastline Rec. Tip No. 2, Sept. 1970, State of Calif. Dept. of Parks and Recreation, May 1974.

Central California

Santa Barbara County North. There are 80 km (50 miles) in this segment of which 39 km (24 miles) are publicly owned and 41 km (25 miles) are private. Public recreation occurs on 1.8 km (1 mile) with private recreational use on 7 km (4 miles). Non-recreational development occurs on 0.8 km (0.5 mile) while 70 km (44 miles) remain undeveloped. Approximately 49 km (30 miles), or 61 percent, is classified as sandy beach.

Most of the shoreline is characterized by rocky headlands separating stretches of sandy beach backed by cliffs or sand dunes. Although there are suitable areas for recreation along this stretch of coast, much of the land is privately owned with no provisions for public recreation. Jalama and Ocean Beach Parks, operated by Santa Barbara County, are the only developed recreation areas open to the public. The coastal segment from the Santa Barbara county line past Guadalupe Dunes to Point Sal, is a sandy beach backed by sand dunes and cliffs. This stretch is suitable for recreation, however, it is privately owned and has no provisions for public recreation. Sandy beaches with stretches of rocky beach extend from Point Conception to Point Sal. The backshore in this segment predominantly consists of cliffs with a segment of dunes from Purisma Point to just south of Point Sal State Beach.

Along with Jalama beach, the only non-private lands in this segment are the Coast Guard Reservation at Point Conception, Vandenberg Air Force Base and Point Sal State Beach. Vandenberg and Point Sal are available for recreation but they are restricted to military personnel only.

Due to limited access and military restrictions, recreational use along this stretch of the coast is of low intensity and, as pointed out by the California Coastal Zone Commission, it offers an unprecedented opportunity for preservation of natural coastline.

San Luis Obispo County. In the decade 1960-70, San Luis Obispo County population increased by approximately 30 percent from 81,900 to 106,700. (California County Fact Book, 1975) The County as a whole is considered rural and the coastal area contains well over 50 percent of the population.

Recreation activities are concentrated along the 149 km (93 mile) coastline. Some of the more popular recreation opportunities offered are fishing, boating, surfing, swimming, diving, clam digging, horseback riding, camping or simply relief from summer heat.

The coastline is predominantly rocky with occasional pocket beaches of sand or gravel, from the northern county boundary down to Morro Bay. Sandy beach extends from Morro Bay to just north of Point Buchon where rocky shores begin and continue around the headland. Sandy beaches pick up again at Point San Luis and continue down to the southern county boundary.

Shoreline ownership and characteristics for San Luis Obispo County are shown in Table II.G.1.f-12.

Table II.G.1.f-12

SAN LUIS OBISPO COUNTY SHORELINE
OWNERSHIP - USE - SANDY BEACH

San Luis Obispo County

Ownership		Use				
Public	Private	Public Rec.	Private Rec.	Non-Rec. Develop.	Unde-velop.	Sandy Beach
20.2 Mi 33 km	72.9 mi 117 km	17.2 mi 28 km	16.5 mi 27 km	1.9 mi 3 km	57.5 mi 93 km	33 mi 53 km

Source: National Shoreline Study, USCOE, 1971.

Beginning at the San Luis Obispo-Monterey County line, rocky coastline stretches for 27 km (17 miles) down to San Simeon Point. In the northern portion, the coastline is very high, bold and rugged to about Ragged Point. From Ragged Point the coastline is mostly low bluffs and rolling hills. With the exception of the Coast Guard Reservation and lighthouse near Piedras Blancas, this segment of the coastline is privately owned.

The next segment from San Simeon Bay to Cambria consists of pocket beaches of sand or gravel in between small rocky headlands backed by low bluffs and rolling hills. Most of the coastline is privately owned. State beaches in this segment are San Simeon State Beach and William R. Hearst Memorial State Beach with 4,213 m (13,819 feet) of ocean frontage and visitation in 1974-75 of 301, 376. Activities include beach walking, swimming, diving, fishing, picnicking, and camping.

The 24 km (15-mile) segment from Cambria to Cayucos is rocky, backed by high bluffs in the north and gradually decreasing further south. All of the coastline is privately owned and undeveloped. Although there are a few pocket beaches suitable for recreation, the high bluffs create an access problem. Sandy beaches begin at about Cayucos and extend south to Point Buchon. In the northern section, the beach is backed by cliffs giving way to sand dunes, around Morro Bay. Approximately 60 percent of the shoreline is publicly owned and available for recreation. State-owned and operated facilities in this segment are, Cayucos, Atascadero and Morro Strand State Beach and Morro Bay State Park.

Total ocean frontage and visitation (1974-75) are 17,688 m (57,951 feet) and 4,040,045. Cayucos State Beach is State-owned but county operated and is a major county park offering such activities as picnicking, fishing, swimming, and walking. Activities at the other three sites include picnicking, camping, walking, diving, fishing, shellfishing, golf, swimming and nature study.

Morro Rock Natural Preserve encompasses a rock 137 m (450 feet) high standing at the entrance of Morro Bay. Before this "Gibraltar of the Pacific" became a part of the State Park system, tons of volcanic rock were quarried for building materials and rock necessary for building breakwaters. The park extends from the rock northeast to the bay with 1,524 m (5,000 feet) of ocean frontage and visitation for 1974-75 of 403,254.

From South Morro Bay to Point San Luis the coastline is rocky, backed by 12 to 18 m (40 to 60 foot) cliffs. This coastline is privately owned with the exception of Montana de Oro, a small pocket beach, and the only recreational facility in this stretch. Montana de Oro has 5,852 m (19,200 feet) of ocean frontage and offers horseback riding, hiking, picnicking, camping, fishing, and swimming. Visitation for 1974-75 was 330,987.

The final stretch includes Point San Luis southward to the county boundary. Rocky beaches with stretches of sand beach, backed by rocky cliffs are found mainly in the northern portion down to Pismo Beach. From Pismo Beach to the county boundary, wide sandy beaches are backed by high sand dunes. Again, most of the shoreline in this stretch is privately owned. However, two of the more popular beaches (Avila State Beach and Pismo Beach State Park) are located within this segment of the coastline. They had a visitation of 3,731,594 in 1974-75. Pismo State Beach has 11,725 m (38,470 feet) of ocean frontage. Activities offered in addition to the famous clam digging are picnicking, camping, fishing nature study, and swimming.

Boating. Although coastal boating activities are not limited to any particular area along the county coastline, the two most important areas are Morro Bay Harbor and Port San Luis.

Morro Bay Harbor, located about midway between Los Angeles and San Francisco, is one of the better protected harbors along the California coast. Morro Bay serves as home port for a U.S. Coast Guard rescue vessel as well as about 350 small recreation boats and 180 commercial and sport fishing boats. During the fishing season, as many as 200 boats from other ports may land fish at Morro Bay. (U.S. COE, 1975)

Port San Luis, located about 25 miles south of Morro Bay, is primarily used as an oil landing terminal. Commercial, sportfishing, and recreation boats use the port also. The U.S. COE, 1975 estimates that about 120 commercial, recreational craft use the anchorage.

San Luis Obispo County to Point Reyes. The coastal segment from the northern San Luis Obispo County line to Point Reyes stretches for approximately 262 miles and includes the counties of Monterey, Santa Cruz, San Mateo, San Francisco and the southern portion of Marin. Shoreline ownership and characteristics are shown in Table II.G.1.f-13. This section of the California coast, especially the Monterey-Big Sur area, is considered by many to be the most scenic in California. Tourism and recreation, as in Southern California, occurs at a multitude of beaches and parks. A list of existing coastal recreation sites by county, is shown in Table II.G.1.f-14.

Recreational boating occurs at numerous marinas, harbors, piers and launching ramps scattered along the coast and includes such activities as sport fishing from party or charter boat (See Section II.G.1.f.iv for more detailed information on sport fishing), trips on tour boats and general recreational boating.

Table II.G.1.f-13

CENTRAL CALIFORNIA
COUNTY SHORELINE OWNERSHIP - USE - SANDY BEACH

	Ownership		Use				
County	Public	Private	Public Rec.	Private Rec.	Non-Rec. Develop.	Unde-veloped	Sandy Beach
Monterey	45.3 mi	66 mi	10.4 mi	12.0 mi	1.3 mi	87.6 mi	24.3 mi
	73.0 km	106 km	17.0 km	19.0 km	2.0 km	141.0 km	39.0 km
Santa Cruz	17.0 mi	25.0 mi	14.4 mi	1.3 mi		26.3 mi	19.0 mi
	27.0 km	40.0 km	23.0 km	2.0 km	2.0 km	42.0 km	31.0 km
San Mateo	16.4 mi	39.6 mi	13.3 mi	3.6 mi		39.1 mi	28.1 mi
	26.0 km	64.0 km	21.0 km	6.0 km		63.0 km	45.0 km
San Francisco	7.9 mi	0.4 mi	7.9 mi	0.4 mi			5.8 mi
	13.0 km	0.6 km	13.0 km	0.6 km			9.0 km
Marin	54.4 mi	15.8 mi	50.3 mi	4.9 mi	0.2 mi	14.8 mi	32.2 mi
	88.0 km	25.0 km	81.0 km	8.0 km	0.3 km	24.0 km	52.0 km

Source: National Shoreline Study, USCOE, 1971.

Table II.G.f-15 provides a list of existing and planned small craft harbors and launch ramps. The facilities listed for Marin, San Francisco and San Mateo Counties are generally away from the coast and concentrated mainly in and around the San Francisco Bay area. One exception is Pillar Point Harbor in San Mateo County near Half Moon Bay. Santa Cruz Harbor is the major facility for Santa Cruz County and Moss Landing Harbor, Monterey Marina and Stillwater Cove are the major ones for Monterey County. All harbors in this area are full with waiting lists from a few months to a few years.

Table II.G.1.f-14

CENTRAL CALIFORNIA[a]
EXISTING COASTAL RECREATIONAL SITES

County Park Name	Operating Agency	Size (acres) (hectares)	Recreational Attendance	3-Year Trend in Attendance	Length of Shoreline (feet) (meters)
MARIN					
Point Reyes NS	NPS	64,546 26,122	1,404,200	Up	41.5 mi 66.8 km
Stinson Beach SP	State	51 21	398,061	Down	5,810 1,771
Marin Headlands SP	State	660 267	68,394	Up	20,000 6,098
Golden Gate NRA	NPS	34,201 13,841	737,500	Up	30,000 9,146
SAN FRANCISCO					
Fort Point NHS	NPS	29 12	680,600	Up	4,000 1,220
Lincoln Park	County	204 83			9,000 2,744
Golden Gate Park	County	1,017 412			2,000 610
Ocean Beach (Gt. Highway Bch)	County				13,500 4,116
SAN MATEO					
San Mateo State Beaches	State	824 333	3,111,690	Up	46,234 14,096
Ano Nuevo SR	State	480 194	253,327	Up	20,230 6,168
SANTA CRUZ					
Big Basin Redwood SP	State	12,668 5,127	866,186	Up	3,828 1,167
Natural Bridges SB	State	54 22	328,510	Down	5,000 1,524
Twin Lake SB	State	106 43	1,117,904	Up	4,858 1,481
New Brighton SB	State	94 38	207,951	Up	5,000 1,524

Table II.G.f-14 (Cont.)

County Park Name	Operating Agency	Size (in acres)	Recreational Attendance	3-Year Trend in Attendance	Length of Shoreline
Soquel Point County Beach	County				2,600
					793
Capitola Beach	County	3			1,800
		1			549
Capitola State Beach	State				2,600
					793
Seacliff SB	State	85	816,807	Up	7,000
		34			2,134
Manresa SB	State	68	457,437	Up	9,500
		28			2,896
Sunset SB	State	318	557,558	Up	20,001
		129			6,098
Zmudowski SB	State	176	117,474	Stable	9,124
		71			2,782
MONTEREY					
Moss Landing SB	State	55	331,380	Down	4,730
		22			1,442
Salinas River SB	State	246	107,693	Up	15,500
		100			4,726
Asilomar SB	State	103			6,100
		42			1,860
Monterey SB	State	14			2,441
		6			744
Carmel River SB	State	106	212,954	Stable	8,100
		43			2,470
Point Lobos SR	State	1,276	292,050	Up	23,777
		516			7,249
Andrew Molero, SP	State	2,154	26,089	Down	14,000
		872			4,268
Pfeiffer Big Sur SP	State	822	354,236	Up	14,100
		333			4,299
Julia Pfeiffer Burns SP	State	3,404	80,529	Up	11,900
		1,378			3,628
John Little SR	State	21			2,100
		8			640
Los Padres NF	USPS		3,623,100		5,300
					1,616

Source: Winzler and Kelly, 1977.

[a]Key:

SP	= State Park	NHS	= National Historic Site
SRA	= State Recreation Area	NF	= National Forest
SB	= State Beach	SF	= State Forest
NP	= National Park	SR	= State Reserve
NM	= National Monument	SHP	= State Historic Park
NS	= National Seashore	NPS	= U.S. National Park Service

Table II.G.f-15

EXISTING AND PROPOSED SMALL CRAFT HARBORS AND LAUNCH RAMPS IN THE CENTRAL CALIFORNIA COASTAL ZONE

County/Harbor	Total Berths and/or Moorings	Existing Launching Ramp Lanes or Hoists	Charter or Party Fishing Boats	Planned Berths	Planned Launching Ramp Lanes or Hoists
Marin County (16 facilities)					
Total	2,900	23	23	550	2
San Mateo County (6 facilities)					
Total	1,526	11	8	1,680	2
San Francisco County (3 facilities)					
Total	980	5	12	400	
Santa Cruz County (1 facility)					
Total	900	2			
Monterey County (3 facilities)					
Total	850	7	11		

Source: Winzler and Kelley, 1977.

Baja. The Pacific Coast of Baja from the U.S.-Mexico border to Scammon Lagoon, unlike the overcrowded beaches and parks of Southern California, offers a nearly continuous string of delightful, lightly used beaches.

Wheelock (1974), states that:

> "About 1920 marked the beginning of tourism in Baja California. With prohibition in the United States, and the establishment of legal gambling and other sordid entertainments, Tijuana took on a tarnished glamour that is still remembered by many residents of California. After the repeal of prohibition in the United States, the closing of gambling, and the control of other more questionable activities, Baja California moved into a new area of tourist activities. Good motels, clean restaurants, simplified border regulations - all have encouraged Norte Americanos to vacation below the border. The recent advent of car campers and vans, coupled with a continuing improvement of the back roads have resulted in a happy combination of opportunities to visit the lesser known parts of La Frontera. Some of the most attractive spots are the little known, isolated Baja Beaches."

Table II.G.f-16 shows a list of recreation areas along this stretch of coastline and some of the more popular activities offered at each site.

Table II.G.1.f-16

BAJA RECREATION SITES

Name	Beach	Camping	Fishing	Diving	Park	Hotel	Scenic View	Boating	Restaurant	Gas Station
Los Coronados			x	x				x		
Rosarito	x	x		x	x	x			x	x
Popotla	x				x		x			
Medio Camino	x	x	x		x	x			x	
La Salina		x	x		x					
Ensenada	x		x		x	x		x	x	x
Bahia Todos Santos	x		x	x						
La Bufadora					x		x			
Puerto Santo Tomas	x			x			x			
San Isidro	x			x						x
San Antonio Del Mar		x	x	x	x					
Punta Colonet							x			
San Ramon	x		x							x
Isla San Martin				x				x		
San Quintin	x		x		x	x	x	x	x	x
Santa Maria	x		x					x		
El Socorro	x	x	x				x			
El Consuelo	x									
Santa Rosalillta	x		x					x		
Playa Altamira	x									
El Tomatal	x		x					x		
Laguna Manuela			x							
Puerto Venustiano Carranza			x					x	x	
Playa Malarrimo	x						x			
Isla Cedros			x					x		
Isla Natividad	x		x					x		

Source: CETENAL Tourist Information Map, 1976. Automobile Club of Southern California, 1976. Chartguide for Southern Calif. 1975-77.

ii. Esthetic Resources: The greatest input to our esthetic stimulation is visual. Visual perceptions consist of four basic elements in descending order of importance; form, line, color, and texture. Landscape form is the mass or shape of an object and is most strongly expressed in the shape of the land surface. Lines in the natural landscape usually arise from abrupt contrasts in form, texture or color. Ridges, skylines, horizon lines and structures form lines. Color consists of hue, chroma and brightness and enables one to distinguish between otherwise identical objects. Colors in the landscape are usually most prominent in vegetation, but are frequently expressed in soil, rocks, water etc. Texture is a result of the size, shape and placement of parts, their uniformity and the distance from the observer. Vegetation and erosive patterns usually produce landscape texture. The foregoing factors form an image which may be perceived to have a sense of unity and harmony, or "beauty" or it may exhibit disorder or "ugliness". Views of the natural environment usually exhibit unity and harmony. Man's effects on the visual resource are characterized as "intrusions" which may have a positive or negative impact. Intrusions which do not relate well with their surroundings because of a lack of unity among design elements or because of the interjection of incongruous elements, are "ugly" or negative. Figures II.G.F.ii-1 through 3 rate on a general or regional scale and show the visual quality of the coastline based upon the following key factors: 1) land form, 2) color, 3) water, 4) vegetation, 5) uniqueness and 6) intrusions. Intrusions either add to or depreciate the overall quality rating. Class A scenery is the highest class and is represented by spectacular views free of negative intrusions. Class B is of lesser quality than Class A because of inherent shortcomings as compared to Class A or it is otherwise Class A scenery downgraded by the presence of some inharmonious intrusions. Class C is ordinary, common for the region scenery, or affected with numerous negative intrusions.

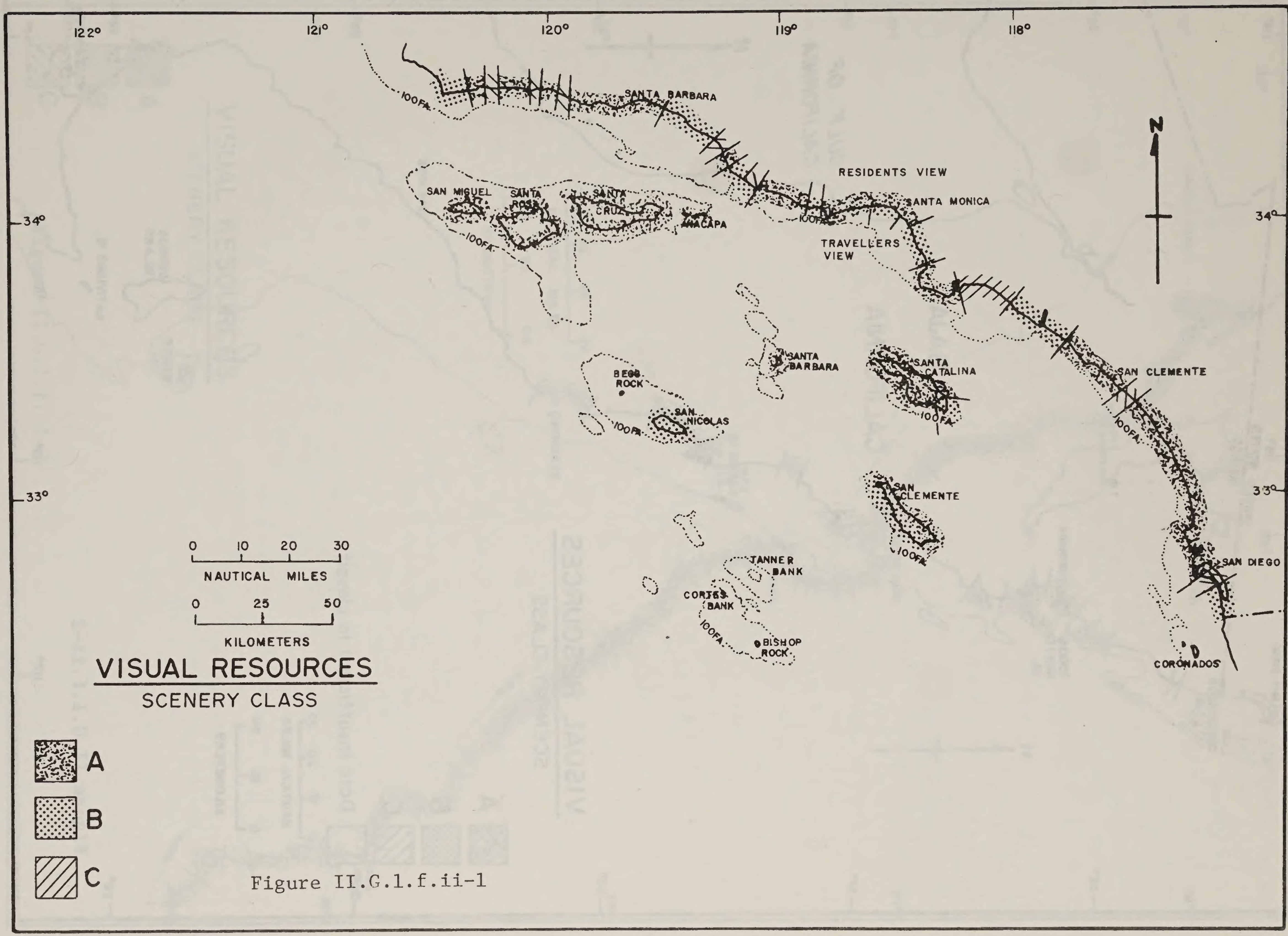


Figure II.G.1.f.ii-1

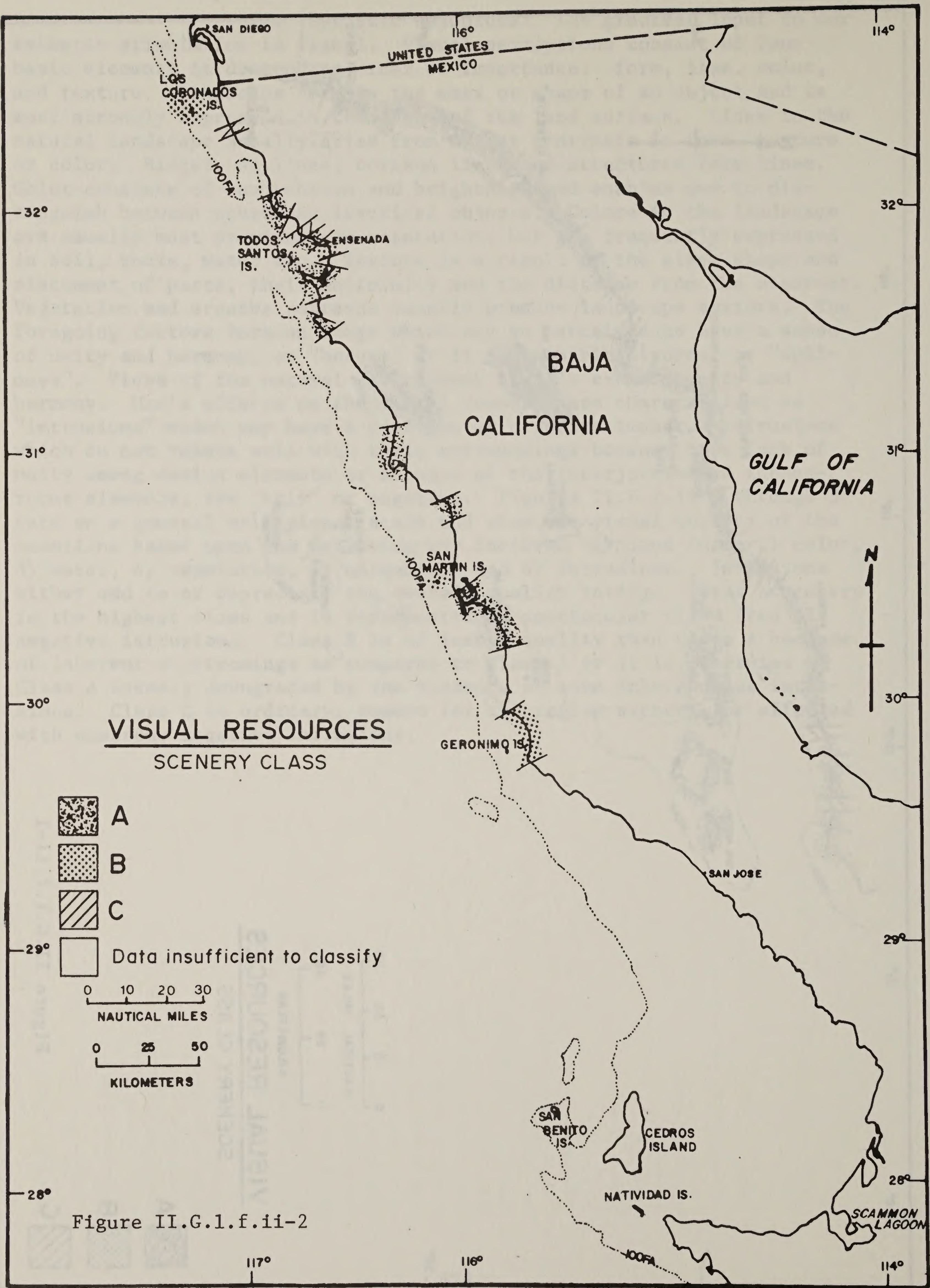


Figure II.G.1.f.ii-2

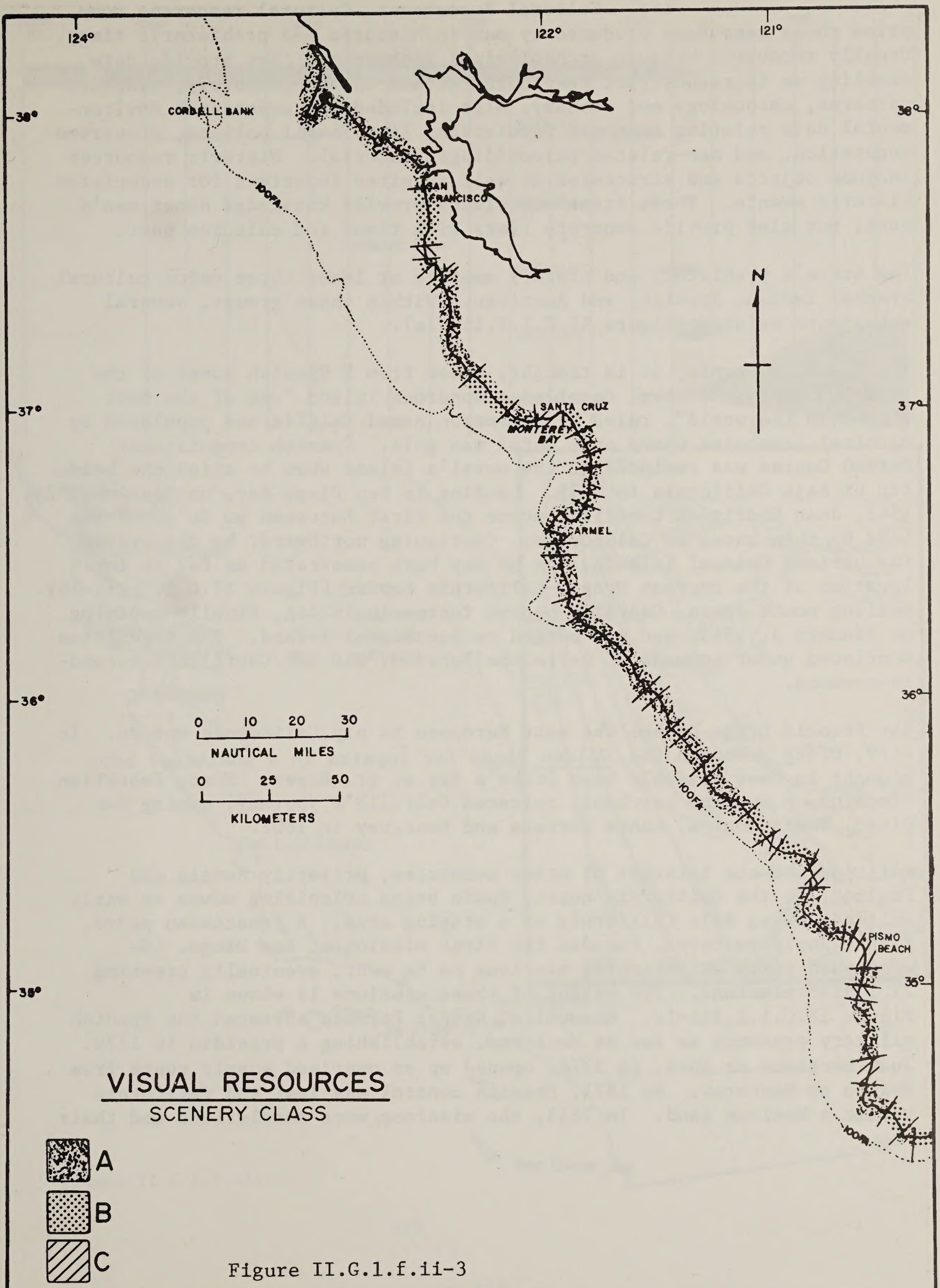


Figure II.G.1.f.ii-3

iii. Cultural Resources: Cultural resources comprise those resources produced by man in historic and prehistoric times. Usually recovered through archeological techniques, they provide data enabling us to reconstruct past cultures and their technology, adaptive patterns, chronology and economy. Also included are associated environmental data relating to these populations like fossil pollens, preserved vegetation, and man-related paleontologic material. Historic resources include objects and structures as well as sites important for associated historic events. These items and places provide knowledge about man's past, but also provide concrete links with times and cultures past.

The State's prehistory and history embrace at least three major cultural breaks; Indian, Spanish, and American. Within these groups, several sub-groups existed (Figure II.G.1.f.iii-1a).

The name California, it is thought, arose from a Spanish novel of the 16th Century. The novel detailed a wondrous island "one of the most rugged in the world", ruled by an Amazon named Calafia and populated by mythical creatures whose only metal was gold. Spanish conquistador Hernan Cortes was reminded of the novel's island when he spied the bold tip of Baja California in 1535. Landing in San Diego Bay, on September 28, 1542, Juan Rodriguez Cabrillo became the first European to do so in the land by then known as California. Continuing northward, he discovered the various Channel Islands, and he may have penetrated as far as the location of the current Oregon-California border (Figure II.G.1.f.iii-1b). Sailing south again, Cabrillo became increasingly ill, finally expiring on January 3, 1543, and was buried on San Miguel Island. The expedition continued under command of Bartolome Ferrelo, who was Cabrillo's second-in-command.

Sir Francis Drake became the next European to ply California waters. In 1579, Drake anchored the Golden Hinds for repairs in a sheltered bay thought to have possibly been Drake's Bay at Pt. Reyes. Next, Sebastian Vizcaino, a Spanish merchant, retraced Cabrillo's journey, naming San Diego, Santa Monica, Santa Barbara and Monterey in 1602.

Anticipating the interest of other countries, primarily Russia and England, in the California coast, Spain began colonizing moves as early as 1769, using Baja California as a staging area. A Franciscan padre, Father Junipero Serra, founded the first mission at San Diego. He continued north establishing missions as he went, eventually creating 21 Indian missions. The extent of these missions is shown in Figure II.G.1.f.iii-1c. Meanwhile, Gaspar Portola advanced the Spanish military presence as far as Monterey, establishing a presidio in 1770. Juan Bautista de Anza, in 1773, opened up an overland supply route from Mexico to Monterey. By 1821, Spanish control was lost and California became a Mexican land. In 1833, the missions were secularized and their

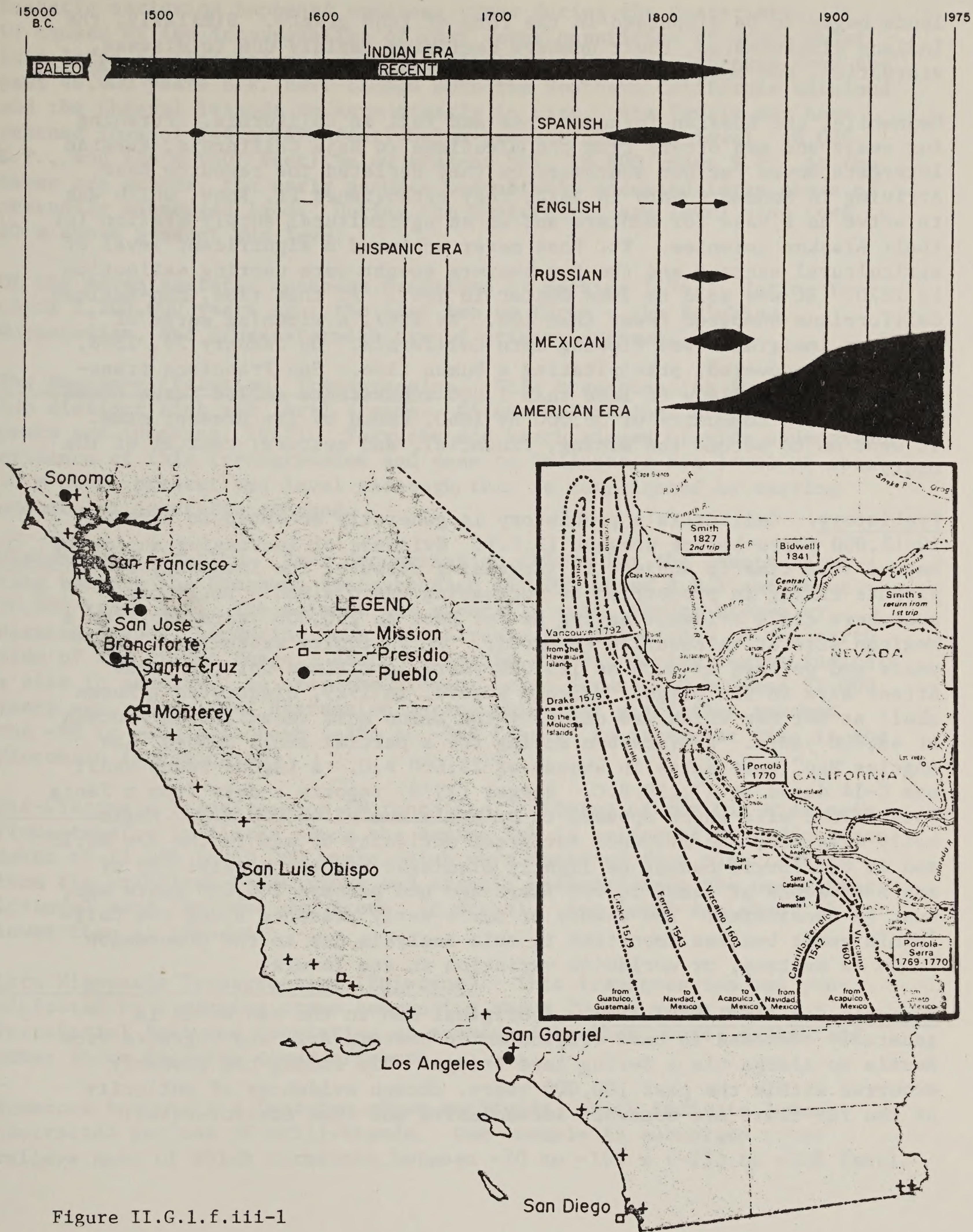


Figure II.G.1.f.iii-1

lands began to be dispersed in the form of land grants. Similarly, the Indians disseminated, their numbers declining rapidly due to disease, starvation, and murder. The period of Mexican rule terminated in 1846.

Meanwhile, the Russian fortunes rose and fell in California. Pursuing fur seals and sea otters from the Aleutians to Baja California, Russian interests moved further southward as they depleted the resource base. Arriving in Sonoma County in 1812, they established Ft. Ross, which was to serve as a base for hunters and as an agricultural supply station for their Alaskan colonies. Ft. Ross never achieved a significant level of agricultural success and the fur-bearers sought were nearing extinction by 1820. It was sold to John Sutter in 1841. At that time, non-Mexican Californians numbered fewer than 400. By 1847, a widening surge of American immigrants was flowing into California. On January 24, 1848, gold was discovered, precipitating a human tide. San Francisco transformed from a village of less than 1,000 inhabitants called Yerba Buena in 1846, to a community of 56,000 by 1860, known by its present name. It went on to become the mining, financial, and cultural capital of the West.

Prehistory. California's prehistory is generally accepted to extend 10-12,000 years before present (B.P.). Evidence of increasing antiquity beyond that time is subject to increasing dispute, the intensity of dispute rising in proportion to increasing age claimed. Early man searchers claim evidence dating as far back as 250,000 years ago from a Mexican site at Valsequillo Reservoir. An antiquity exceeding 70,000 years and perhaps as much as 125,000 years is claimed for the Texas Street site in San Diego. Malcolm Rogers, in 1929, discovered a human skull at Del Mar which was dated by the amino acid racemization process at 48,000 years. Radiocarbon dating for a partial skull dubbed "Los Angeles Man" gave dates in excess of 23,600 B.C. A Laguna Beach skull was C-14 dated at 17,150 B.C. Berger (1978) reports a date from a Santa Rosa Island site which appears to be a minimum of 40,000 B.P. While hotly disputed, the evidence for great antiquity of man in the New World and in California cannot be lightly dismissed and the possibility of man's presence at least 50,000 years ago and perhaps 100,000 years ago, must be considered. The chance of man's early presence along the California coast becomes important in this analysis due to the phenomenon known as eustacy, or worldwide variation in sea levels.

Eustatic Sea Level Variation. Aboriginal man in the New World is generally conceded to have originated in eastern Asia and migrated from Russia to Alaska via a Bering land bridge. His coming has probably occurred within the past 100,000 years, though evidences of antiquity at the far limit are somewhat inconclusive and thus controversial.

Eustatic variation happened numerous times during the Quaternary. It is caused by the incorporation of very large quantities of ocean water into large continental and mountain glaciers. Eustatic changes over the past 40,000 years B.P. have caused both the Southern California mainland and the Channel Islands to vary greatly in size. Sea levels may have reached lows of 144 m (472 feet) below present mean sea level, 40,000 B.P., and 124 m (407 feet) below present MSL, 18,600 years B.P. At the lower sea stands, the early peoples undoubtedly occupied large areas of presently submerged land. During the Quaternary, sea level also rose to 20 m above present sea level.

Of the seven eustatic episodes described by Hopkins (1967), dating to circa 2,200,000 years ago, the last two or three - the Pelukian, Woronzofian, and Krusensternian are of primary interest.

The Sangamon (Pelukian) Transgression. This transgression is marked by two distinct high sea level stands. Climax was reached about 100,000 years ago (Hopkins, 1967). Terraces and beach ridges provide widespread evidence of this transgression and seem to indicate a sea level of about 10 m above present sea level although this is complicated by varying amounts of isostatic rebound.

Wisconsin Glaciation. Poor documentation exists for the events occurring between the Sangamon transgression (70,000 years B.P.) and about 30,000 years B.P. The climate was generally cold, though broken by warming trends, producing four recognizable glacial stades on the north side of the Brooks Range. Beach ridges in the Pt. Barrow region indicate a rise in sea level to near the present level between 40,000 and 25,000 years ago. Sea level depression during this last glaciation reached the -90 to -100 m isobath (-295 to -328 feet). An irregular rise in the Wisconsin is indicated.

Mid-Wisconsin Transgression (Woronzofian). Timing of the Mid-Wisconsin Transgression in Alaska along the Bering Sea is evidenced by radiocarbon dates of 25,000 to 40,000 years which were obtained from plant fibers from the principal beach ridge and organic material from the underlying littoral sand (Sellman and Brown, in press). Sea level was about 15 m lower than at present.

Late Wisconsin Transgression (Holocene). This transgression was precipitated by a warming trend commencing about 20,000 years ago. Terrestrial features consisting of submerged beaches, bars, deltas and other shore features occur offshore.

Numerous bathymetric features occur worldwide, which indicate lower protracted periods of still-stands. One example is submerged river valleys most of which terminate between -70 to -100 m (-230 to -328 feet).

Detailed studies of the Bering Shelf reveal that it consists of three broad benches. The farthest offshore bench is located between the -80 m (226 feet) and -60 m (-197 feet) isobaths, the mid-bench between -50 m (-164 feet) and -30 m (-98 feet) isobaths and the nearshore between the -20 m (-66 feet) isobath and the tidal shoreline. The topography and morphology of these features suggest that the steeper regions along the seaward edge of each bench are ancestral submerged shorelines. The peak late Wisconsin glaciation shoreline was probably located between the -100 and -120 m (-394 feet) isobaths (Knebel, 1972).

About 10,000 years ago, the Sphanberg Strait between St. Lawrence Island and the Alaska mainland was crested at -28 m (-92 feet) by the rising sea, thus creating a break in the Bering land bridge. After minor interruption, sea level resumed rising, reaching its current level about 6,000 years ago but, perhaps, as recently as 3-4,000 years ago.

Researchers do not agree on the precise shape of late Quaternary sea level curves primarily because evidence from various geographic areas tends to give conflicting results in many circumstances. Some of the localized factors complicating the data interpretation are tectonically-related elevational changes, sediment compaction, isostatic rebound from deglaciation and subsidence due to sediment loading.

A recently published study by Atwater, et al., (1977) details the late Quaternary history of San Francisco Bay based upon studies of sediment cores. According to the study, estuarine deposits of mid-Wisconsin age are absent from the Bay indicating that sea level was not near its present height 30,000-40,000 years ago. This contrasts with data indicating sea levels were near present levels during this time frame on the U.S. Atlantic Shelf. However, others have argued (Birkeland, 1972) that the lack of post-Sangamon marine terraces in central and Southern California supports the evidence that California did not experience a high-level mid-Wisconsin sea stand.

Atwater's (1977) study determined that the lowest base level at the Golden Gate was about -70 m (-230 feet). He assumes, based upon Flint (1971), that late Wisconsin glacial maxima produced sea levels of -100 m (-328 feet). Thus, the late Wisconsin shoreline was located outside the Golden Gate on the continental shelf. The sea returned through the Golden Gate between 10,000-11,000 years ago rising about 2 cm/year (0.78 inch) until 8,000 years ago. From 8,000 to 6,000 years ago, the rate declined an order of magnitude and has averaged 0.1-0.2 cm/year (0.04-0.08 inch) from 6,000 years ago to the present. The littoral zone advanced as much as 30 m per year (98.4 feet) during the period of rapid rise. Sea level curves are presented in Figures II.G.1.f.iii-2 and 3.

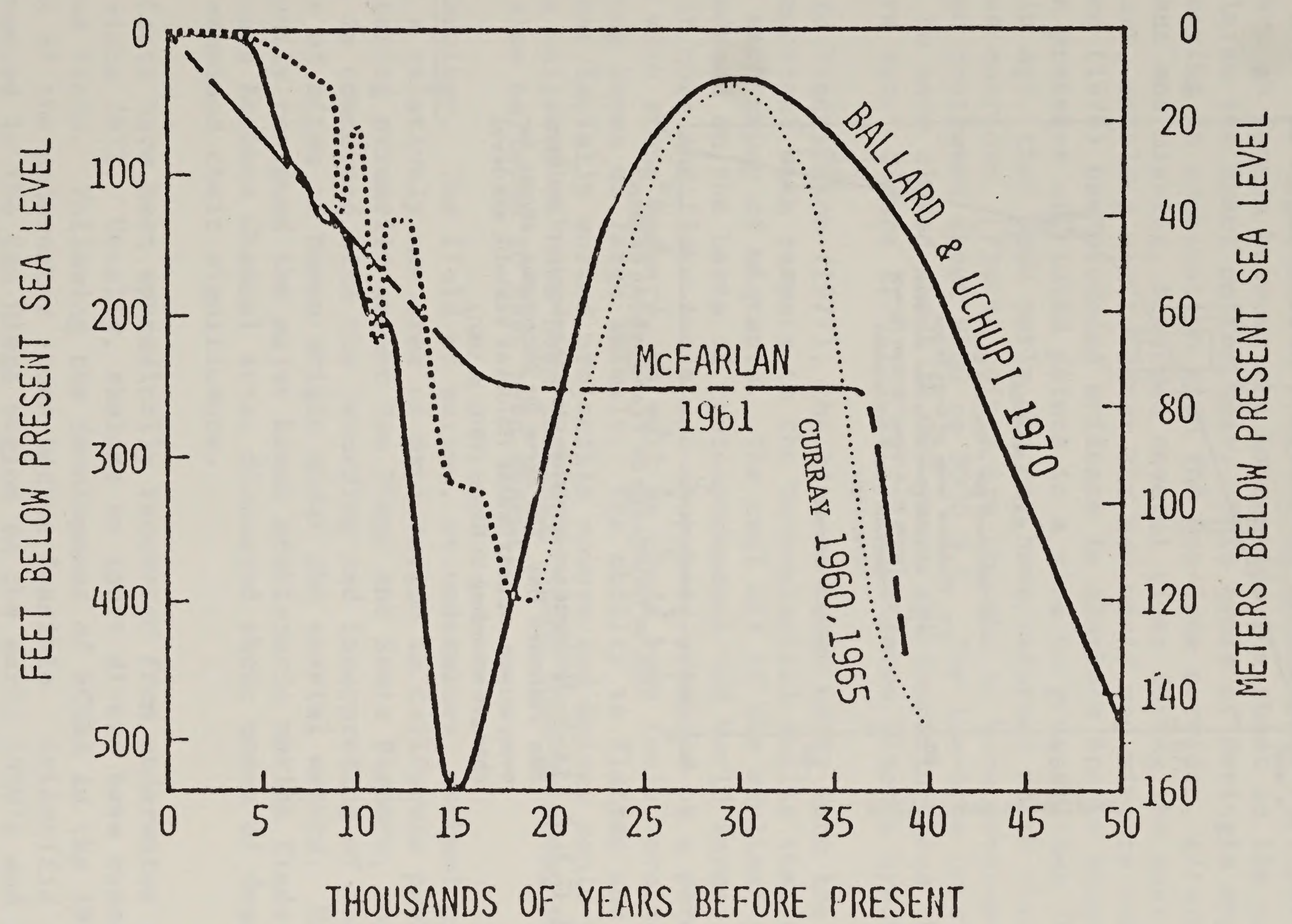


Figure II.G.1.f.iii-2 Comparison of Late Quaternary Sea Level Curves as presented by several Authors.

Source: Gagliano, 1974.

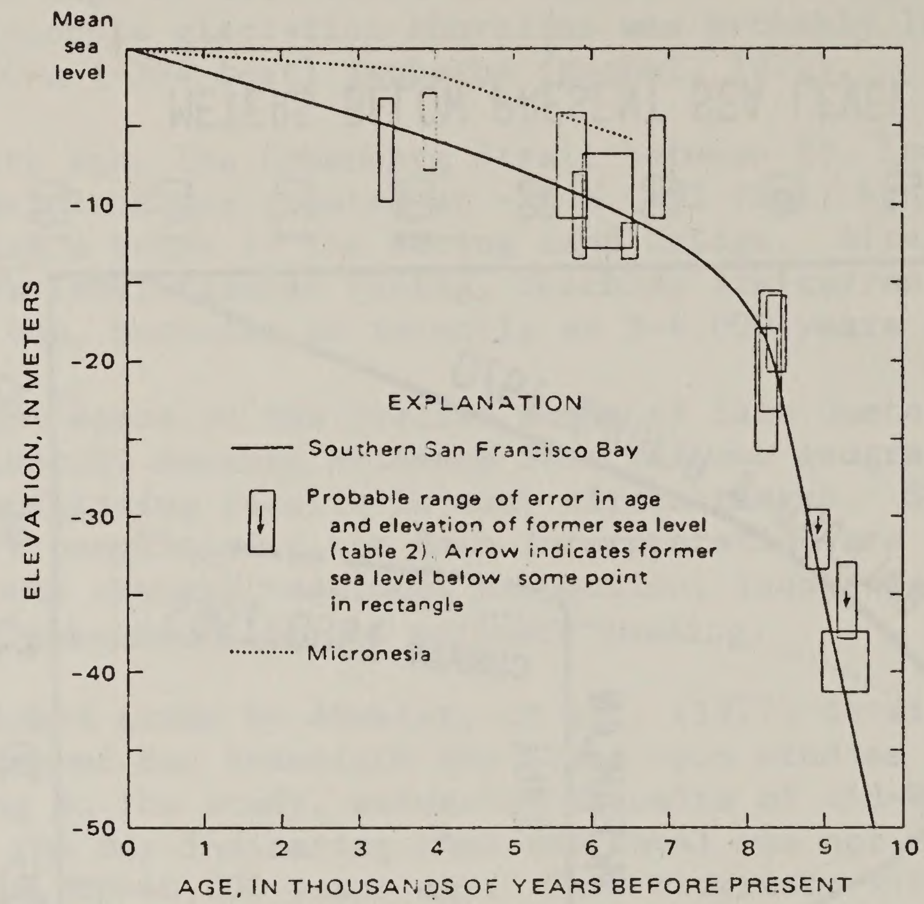


Figure II.G.1.f.iii-3– Holocene sea-level changes in the vicinity of southern San Francisco Bay. The curve for Micronesia, shown for comparison, approximates Holocene eustatic sea-level changes according to Bloom (1970, p. 1901).

Source: Atwater, Hedel, and Helley, 1977.

Eustatic depression allowed early man to occupy vast areas of land that was destined to be ocean bottom. In Alaska, the land connection with Asia was a broad grassy plain called Beringia. During the last period of emergence, from 22,000 to 10,000 or 11,000 years ago, the Beringian steppes supported a population of migratory grazers or "mammoth fauna". It is thought that hunting peoples strayed across in small groups, following the herds. Once across, their further southward progress was blocked by ice. As deglaciation progressed, an ice-free corridor appeared through Canada between the Laurentide ice sheet on the east and the Cordilleran ice sheet on the west. This cycle of Beringia appearing and disappearing in combination with the ice-free corridor, alternately being present and missing, occurred several times during the past 100,000 years, enabling man to enter the new world and migrate southward. Dixon (1976) has produced evidence in Alaska's Brooks Range, through the presence of fluted points in a site no greater than 7000-8000 B.C. in age, that some early men may have returned north through the ice-free corridor. Fluted points are thought to have developed in the American Southwest about 9500 to 8000 B.C. The ice-free corridor is thought to have closed about 18,000 years ago reopening less than 10,000 years ago. Figure II.G.1.f.iii-4 illustrates Dixon's hypothesis.

According to Fredrickson (1977), the time of human entry into the New World is important with respect to the technological skills that were brought by each group of migrants. The tool kit of the earliest peoples has been deduced on the basis of contemporaneous Old World forms to have consisted of core and flake tools and choppers, produced by a percussion technology with stone hammers, as well as crude bone tools, produced by smashing long bones of large animals. The ability to flatten and thin stone so that facially worked projectile points and knives could be produced is believed to have been lacking. Stone food-grinding implements are also believed to have been absent.

<u>Marine Archeology</u>. The field of marine, or underwater, archeology represents a relatively new area of exploration in California prehistory. Centering primarily around San Diego and Santa Barbara, marine archeology is concerned with the recording and interpreting of the occurrences of sites of human origin under the coastal waters. Hudson (1976) recently reviewed the major known prehistoric marine finds from the Santa Barbara Channel area, discussed their modes of deposition, and examined their significance.

Human artifacts have been sporadically recovered from underwater surroundings since 1871. Usually, abalone or sport divers have reported the isolated finds. Following the development of SCUBA in the 1940's, exploration of the underwater zones became feasible. Scientific explorations commenced in the San Diego region in the early 1950's and continue to be carried out more extensively. Underwater survey is hampered by

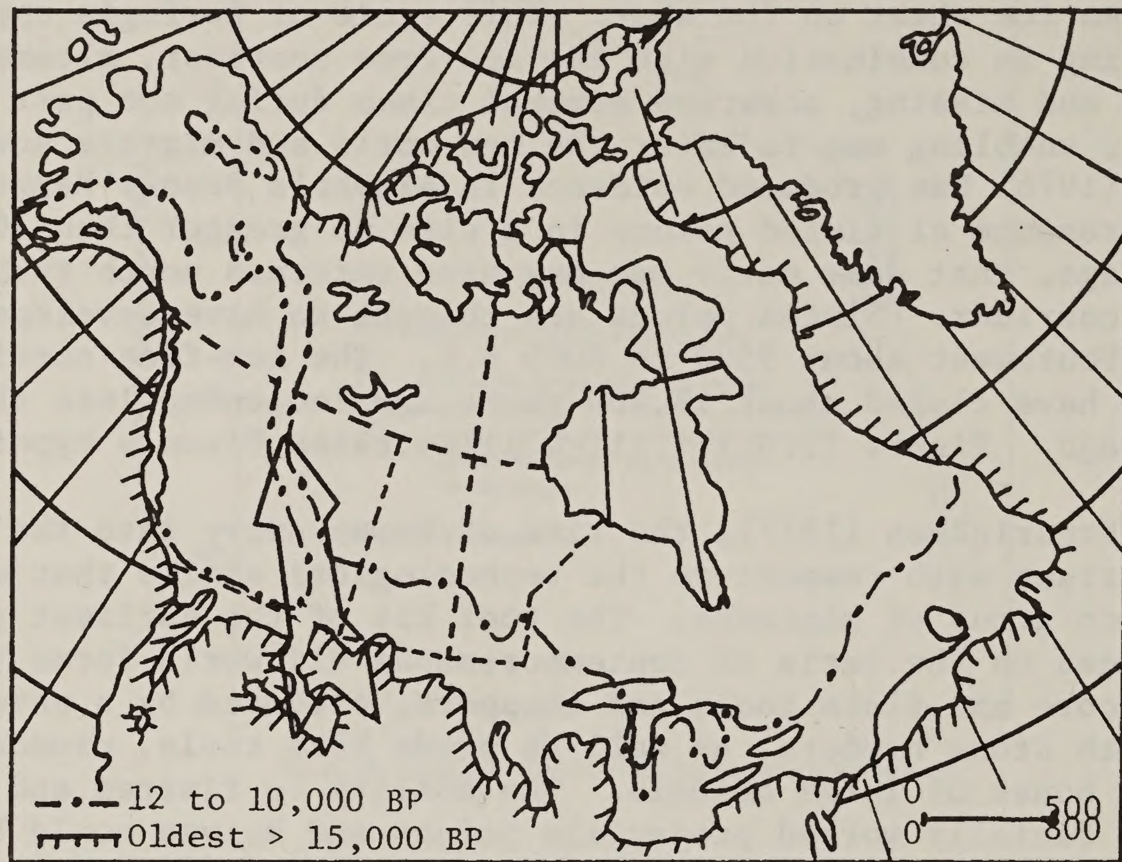


Figure II.G.1.f-4 Speculative model for the Late Wisconsin deglaciation of North America (directly from Flint, 1971:492). Arrow indicates the northward movement of the fluted point tradition, approximately 8,000 B.C.

From: Dixon, 1976

considerable handicaps, including the lack of equipment and properly trained archeologists. Primarily, however, the vastness of the ocean and poor visibility present the greatest problems. For nearshore zones, the winter months, when northerly storms drive sand deposits into deep water, have proven to be the best season for visibility since artifacts are uncovered and the water is clear.

Predominately recovered underwater artifacts are stone. This bias may result from several factors: differential preservation, visibility since stone artifacts tend to be large, recognition by unskilled divers, sea floor conditions, or cultural practices of prehistoric populations. Most of the stone tools are food processing equipment, including mortars, pestles, and metates. Stone bowls and probable net sinkers are also common.

The underwater occurrences of artifacts is believed to be the result of four causes: 1) ceremonial deposition, 2) fishing station debris, 3) erosion of archeological sites by weather or wave action, and 4) eustatic changes (Hudson, 1976).

1) The ethnographic Chumash, who occupied the Santa Barbara area at the time of initial European contact, are recorded as having thrown ceremonial stone vessels into the sea after religious rites in order to neutralize their powers. Archeological investigations have recovered ceremonial stone vessels from coastal waters off the Northern Channel Islands and the mainland. These are believed to be the results of ceremonial deposition.

2) Grooved stones, suggested as being net sinkers, have been recovered from kelp beds and intertidal zones. Ethnographic accounts of the Chumash note that extensive fishing was done in these localities.

3) Erosion of archeological sites into the sea by wave action or weathering is an observed historical fact. Recovery of artifacts close to shore suggests that the remains of these past eroded sites are now under water.

4) One of the major causes may be related to rising sea levels over the past several thousand years, as discussed above. Archeological sites situated near the mouths of rivers, coastal plains or lower elevations of coastal hills would have gradually been abandoned as the prehistoric inhabitants moved inland.

Once deposited, these materials may be moved, subaerially, by erosional and redepositional processes or they may remain undisturbed. Inundation may rework some sites as the surf zone passes through, though this depends upon the specific environment involved. For example, estuaries are low energy, depositional environments in which sites would suffer little disruption as sea levels rose. Similarly, the surf zone would pass relatively rapidly over a long gently sloping shoreline. In bluffy areas, or in areas of steep shoreline gradients the opposite is true, and prolonged surf action would occur in a limited area.

After deposition and inundation, natural factors such as turbidity currents and sedimentation could affect the sites. Man's activity such as the anchoring of vessels, dredging and trawling may affect changes in both aboriginal and historic sites. Of the three, trawling is probably the least disruptive. Trawlers operate in limited areas of the Southern California Bight and they create only shallow disturbance to the bottom. This could affect surface aboriginal sites with little depth and also shipwrecks which protrude above the mudline. Any significant source of snagging though, is quickly known to fishermen and avoided, if possible. Therefore, with the possible exception of heavily dredged areas or heavily used anchorage areas, most shallow sites should be unaffected by man's activity.

Marine archeology offers significant implications for the interpretation of the prehistory of California's coastal zones. The impact of the sea level changes and erosion upon the littoral zone implies changes in the configuration of marine resources and of land formation. These changes should be reflected in prehistoric subsistence systems, settlement systems, and socio-economic organization. The inundated sites will complement the existing archeological record of land sites and provide information on early marine adaptations and the paleoenvironment of the littoral zone. In addition, temporally diagnostic artifacts may provide aid to studies of geologic and oceanographic processes (Hudson, 1976).

Archeological finds have been made on several islands off the northern California coast. One site, believed to have had a ritual function was located on a small rocky island offshore Humboldt County, and contained more than 1,000 sea lion skulls (Heizer, 1951). In 1949, archeological investigations made on the Farallon Islands found no remains (Fredrickson, 1977). In addition to submerged aboriginal sites, the sea bottom holds numerous shipwrecks.

Southern California

Prehistory. The earliest people about which very much is known are the Hunting People and the Oak Grove People. These cultural groups had a non-maritime economy and inhabited upland portions of the mainland. A similar group called the "Highlanders" by Orr (1968) inhabited the upper regions of Santa Rosa Island.

About 4,000 years ago, drying and warming climate seemed to force a change from terrestrial sources of sustenance to a marine economy. A distinct change about 2,500 years ago produced the cultural group that the Europeans found along the coast, the Canalino, in the Santa Barbara Channel area. Further north, in San Luis Obispo County, food economies were inland oriented and consisted of acorns in the main, supplemented by hunting and littoral resources. Most known archeological values date to within 3-4,000 years before present (B.P.). Their values arise chiefly because they are much less disturbed than those farther south and thus regional inferences can be made from site types and groupings and also because these tribes were a contact zone with the highly advanced Chumash or Canalino to the south. Such contacts offer much information regarding interrelationships between differing economies and cultures.

Farther south, archeological values are widespread, as ancient peoples apparently found this area as much to their liking as does the current population. Prehistoric population concentrated along the coastal strip where they found the climate amenable and the ocean's food resources readily obtainable. The Santa Barbara and northern Channel Islands areas were inhabited by the historic Chumash and their prehistoric antecedents the Canalino, as archeologists have called them. The Los Angeles - Orange County areas were occupied by the Gabrielino and similar peoples. The most skilled Indians in California are represented by the Chumash.

From Aliso Creek south were found the Juanenos and the Luisenos. Farther south in the San Diego area, lived the Dieguenos. The Chumash were skilled tool and basket makers, fishermen and hunters. Their most notable accomplishment seems to have been the plank canoe. The craftsmanship and utility exhibited by these canoes was a marvel to the Spanish. These canoes enabled the Indians to fish very effectively and thus expand both their range and population.

Craft specialization existed with some villages being noted for specific products. Elaborate religious ceremonies had been developed, particularly by the Gabrielinos.

Among reasons for highly valuing the evidences of these people is the fact that they represent an anomalous group along the coastline. The Gabrielinos were a Shoshonean group which pressed down from the Great Basin forming a wedge between Hokan-speaking tribes which occupied the areas to the north (Chumash) and to the south (Dieguenos). Areas of such cultural interchange are most valuable.

The Channel Islands were heavily populated in times past and a thriving commerce existed between islands and with the mainland. Although some excavations and reconnaissance projects have been accomplished on the islands, there is no thorough understanding of native use of any of the Channel Islands and most data are inadequate.

The vast majority of sites is younger than 5,000 years B.P., but sites do range back to generally accepted ages of 10,000-12,000 years B.P. Evidence of man has been found on Santa Rosa Island by Dr. Phillip Orr in the form of a cut and burnt mastodon leg which dates to 29,500 B.P. This, considered with the Del Mar skull, would make the area one of North America's oldest inhabited regions and thus, one of its most valuable archeological resources.

Preservation. California has done a comparatively excellent job of preserving examples of its early history. It has identified many gaps which remain to be filled, however. Many of the original or reconstructed missions still remain. Core areas or "Old Towns" are preserved and open for public enjoyment in Santa Barbara, Los Angeles, and San Diego. Numerous churches, early wells, military installations and early pioneer homes have been designated as California Historical Landmarks and/or listed in the National Register of Historic Places. Most sites that are designated are inland.

The following sections include a brief discussion, by county, of Indian ethnohistory and historic high points. Significant or potentially significant sites have been identified by inclusion within various lists such as the National Register of Historic Places and California Historical

Landmarks. Following each county section is the total number of sites so identified which are either on or proximal to the coast. Those which may be affected by this proposal are discussed in greater detail in Section III.E.12, "Impacts on Onshore Cultural Resources".

Santa Barbara County

Indian Ethnohistory. Prior to European contact, the inhabitants of this county were Chumash Indians who spoke a Hokan language. They were divided into five groups: Barbareno, Santa Ynez, Cuyama, Puisimeno, and Island. They were among the first Indians in California to become extinct due to early contact (Kroeber, 1925).

The Santa Rosa Island Canalino band of Chumash were the first to be contacted, by Cabrillo in 1542 (Kroeber, 1925). At that time there was a population of about 20,000 on the islands of the Santa Barbara Channel (Cook, 1976). By 1850, disease, sword and gunfire had reduced them drastically (Geiger, 1970). Santa Cruz and Miguel Islands were also contacted by Cabrillo. Vizcaino landed in 1602. In 1834, Santa Rosa Island and Santa Cruz Island were granted to Carlos and Don Jose. The abusive treatment of the Canalino during this rancho period is one of the major reasons for their extinction (Geiger, 1956).

The first American settler was Colonel W. W. Hollister in 1851. Justinian Caire made Santa Cruz Island a private kingdom (Bancroft, 1886). Santa Barbara County quickly became settled after the secularization of the missions (Campbell, 1969).

The County contained the missions of Santa Barbara, La Purisima Conception, and Santa Ynez. They were settled in 1786, 1787, and 1804, respectively. The Rancherias surrounding the missions contained the majority of the Indian population (Kroeber, 1925). The repercussions of mission life on the population are best demonstrated by Mission Santa Barbara. After 13 years in the mission system, there were 864 Chumash alive, and 662 had been buried. With the end of the mission in 1834, the death rate increased. By 1923, there were just a handful of descendents left. Mission La Purisima had a similar effect on the population.

Santa Barbara has 99.28 acres of trust land at the Santa Ynez Reservation in south central county, most of which is irrigable. This is the northernmost of the mission Indian reservations and had a 1970 population of 50 (California State Advisory Commission on Indian Affairs, 1966).

Santa Barbara County (South of Pt. Conception). Total number of sites; 71 sites and 1,288 archeological sites (including National Register Sites).

National Register: 4 Sites
California Historical Landmarks: 11 Sites

Ventura County - Total number of 68 sites and 346 archeological sites (including National Register Sites).

National Register: 5 Sites
California Historical Landmarks: 5 Sites

Los Angeles County - Total number of 248 sites and 816 archeological sites (including National Register Sites).

National Register: 8 Sites
California Historical Landmarks: 20 Sites

Orange County - Total number of 100 sites and 585 archeological sites (including National Register Sites).

National Register: 3 Sites
California Historical Landmarks: 10 Sites

San Diego County - Total number of 89 sites and 2,655 archeological sites (including National Register Sites).

National Register: 20 Sites
California Historical Landmarks: 39 Sites

Baja California. The history and prehistory of Baja California is similar to that of California through the Mexican period. The region remained in Mexican hands, however, and has not undergone the explosive development of its larger northern neighbor. It is reasonable to expect that Baja's cultural resources are far less likely to have been altered and destroyed by development. Remoteness and inaccessibility have also reduced casual and intentional vandalism. The limited data available to the author indicate the existence of a considerable number of coastal sites ranging in age from European contact to about 7,000 B.P. In some cases, middens are described as semi-continuous for many miles of coastline. Historic sites range from structures still in use, to abandoned ruins, mostly from the Spanish mission period.

Northern and Central California

Archeological Overview, Northern Counties (Fredrickson, 1977): Archeological investigations in northwestern California beyond the boundaries of the North Coast Ranges and along the Oregon coast as far north as the mouth of the Columbia River have until recently revealed only late cultures, easily interpreted as being directly antecedent to the ethnographic groups (Elsasser and Heizer 1966; Heizer and Elsasser 1964; Gould 1966, 1972; Loud, 1918). Relatively late entry of the historic groups is supported by radiocarbon dates that indicate that the historic cultures had a time depth of no more than 1,000 years. A single exception has been found in the lower levels of the Point St. George site, where Gould (1972) identified a culture-type that did not appear to have the same basic adaptation as later cultures and that yielded a radiocarbon date of 310 B.C. Additional survey has been conducted in the past several years in association with historic preservation and environmental protection requirements, few new sites have been found, however, and many previously recorded ones have been found to have been destroyed (cf Hughes 1975).

It has only been recently that archeological work has been conducted in the interior of northwestern California. Most of this work has been focused upon the identification of archeological sites and attempts to place them within a chronological framework. Efforts have also been made to reconstruct the prehistoric subsistence-settlement system (e.g., Chartkoff and Chartkoff, 1975).

From southern Humboldt County into Marin County, a considerable amount of archeological work has been conducted in recent years. The first attempt to bring together the limited archeological work that had been accomplished in the North Coast Ranges was published by Meighan in 1955. Meighan defined a series of archeological assemblages that represented three cultural periods in several different areal manifestations. Chronometric dating was not possible at that time, however. Fredrickson (1973) elaborated on Meighan's synthesis, pulling together available chronometric dates that supported occupation in the region as early as 10,000 B.C.

Marin County

Indian Ethnohistory. Prior to European contact, the inhabitants of the county were the Penutian-speaking Coast Miwok Indians who probably numbered about 1,500. In 1579, Sir Francis Drake landed his ship, the Golden Hinde, probably on the shores of the bay that now bears his name. He was received kindly and traded with the Miwok (Heizer, 1947).

Portugese Captain Sebastian Cermeno landed his galleon at the north end of Drake's Bay in 1595. In 1817, Mission San Rafael was founded. In 1827 was founded the Mission at Sonoma. In 1834, Mission San Rafael became one of the secularized missions. At that time, only 20 Miwok remained at San Rafael (Merriam, 1970). The 1970 census reported an Indian population for Marin of 382, of which 10 percent resided in rural areas (State Advisory Commission on Indian Affairs, 1972). Few of these Indian residents were of Miwok descent, most being from other areas (Fredrickson, 1977).

Marin County has 30 sites and 413 archeological sites.

National Register: 1 Site
California Historical Landmarks: 3 Sites

San Francisco Bay South. The coastal area south of San Francisco Bay received early attention by collectors of Indian goods and by explorers. Archeological interest was continuous in the Santa Barbara Channel area and southward from the late 1800's to the present.

The first formal archeological sequence for the area was not devised until 1955 (Wallace, 1955). Wallace, building upon earlier efforts (e.g., Rogers, 1929), attempted to organize the masses of data from archeological investigations into a four horizon sequence. This sequence was based primarily upon technological assemblages. In 1968, the cultural sequence was revised (Warren, 1968). Warren structured a sequence for the ecologically diverse south coast following two concepts (1) cultural tradition and (2) cultural ecology. Cultural traditions were identified on the basis of cultural patterns reflected in artifact assemblages and site components. Cultural ecology was the relationship between a cultural tradition and its environment. The environment was influential upon tradition with respect to its subsistence technology, settlement patterning, and aspects of sociopolitical organization.

Warren's sequence incorporated Wallace's scheme but with considerable geographic variation allowed. Wallace's Early Man Horizon was renamed the San Dieguito Tradition. This tradition dated back to about 6000 B.C. but was poorly known on the south coast above San Diego. A major research concern for this period is the reconstruction of paleoenvironments. It has been hypothesized that early period sites may have been inundated by rising sea levels. Arguments have been put forth for the existence of early period sites beneath the waters of the Santa Barbara Channel and for sites as old as 40,000 years on Santa Rosa Island (Berger, 1977; Orr, 1968).

Wallace's Horizon II was renamed by Warren, the Encinitas Tradition and is prepresented in the Santa Barbara area by the Oak Grove Culture. This tradition reflects a seed-gathering economy marked by dominance of ground stone milling implements and rare projectile points. Its dating is tentative, probably dominating the period between 3000 to 1500 B.C., depending upon the locality.

This period was followed by the Campbell Tradition, which is best represented in the Santa Barbara region. This tradition reflects a broad environmental adaptation which included land mammal hunting, plant collecting, and shellfish gathering. On some of the Channel Islands, specialized maritime adaptations to sea mammal hunting are noted. This tradition is dated from about 3000 B.C. and may be contemporaneous with the Encinitas Tradition in some regions.

The latest period can be delineated into a series of regional traditions. In the Santa Barbara area, the regional tradition is referred to as the Canalino Culture. This culture reflected a highly developed maritime technology and considerable wealth emphasis. It is dated from about A.D. 1000 to the ethnographic period.

The interest in the relationships between the environment of an area and the archeological pattern has stimulated research into environmental analysis, midden constituent analysis, and micro-ecological studies. Interest in chronological sequences continues, with refinements of major sequences and establishment of new sequences for outlying areas (Fredrickson, 1977).

San Francisco County

Indian Ethnohistory: Prior to European contact, the county was inhabited by Costanoans who spoke a Penutian language. They were part of a culture that numbered many as 7,000 persons (for more information see Monterey County) (Kroeber, 1925).

Sir Francis Drake, in 1579, was the first white man to contact the San Francisco Indians, but created no major impact. In 1776, Juan Bautista de Anza and his party arrived on the San Francisco peninsula to choose sites for a presidio and mission. The presidio of San Francisco and Mission San Francisco De Asis (Mission Dolores) were established in 1776 and the area Indians fled across the bay from the Spanish cruelty (Stanger, 1969). The San Mateo Indians who were attached to the Mission also escaped across the bay to start rebellions during 1793 to 1795. In 1803, the first American vessel, The Eliza, sailed into San Francisco Bay (Castillo n.d.). In 1806, Count Nikolai Petrovich Rezonov aboard the Juno entered San Francisco Bay, making it the furthest southern point of Russian contact (Essig, 1933). After secularization, there were very few Indians left in San Francisco County. "Old Bruno", last of the Costanoans, died in San Francisco in 1876 (Engelhardt, 1930).

In 1964, a group of Sioux Indians citing an 1868 treaty which gave them rights to surplus Federal lands, made an abortive attempt to take hold of Alcatraz Island. It was hoped that the island could be an Indian cultural center. Subsequent to that action, the United Native Americans was organized in San Francisco, "to unite all Indians" (Forbes, 1968).

National Register: 6 Sites
California Historical Landmarks: 14 Sites

San Mateo County

Indian Ethnohistory: Prior to European contact, the County was inhabited by San Francisco and Santa Cruz bands of Costanoan Indians. They, as all Costanoans, are virtually extinct. All that remains are the shell mounds which are frequently discovered in construction of homes and streets. The Costanoan spoke a Penutian language (for more details see Monterey County) (Kroeber, 1925).

Father Juan Crespi sailed into San Francisco Bay in 1769 (Bolton, 1927). In 1776, Palov led a scouting party through San Mateo on the way to San Francisco. The Indians they encountered were noted as being gentle, friendly and generous (Castillo n.d.). After secularization of the missions there were virtually no Costanoans left (Bleeker, 1956). The 1970 census shows an Indian population of 1,340 with only 3 percent of that rural.

National Register: 2 Sites
California Historical Landmarks: 7 Sites

Santa Cruz County

Indian Ethnohistory: Prior to European contact, the inhabitants of the County were Santa Cruz and San Juan Bautista bands of Costanoan Indians who spoke a Penutian language. They were extinct by the end of the mission period (for more details see Monterey County) (Kroeber, 1925).

Cabrillo first made contact in 1542, but the true impact of contact was felt with the founding of La Exalta Lio de la Santa Cruz, 1791, one of the last of the missions. In 1796, the mission had an Indian population of 523 (Cook, 1943). The Indian population had been annihilated before American occupation (Bleeker, 1956).

National Register: 3 Sites
California Historical Landmarks: 44 Sites

Monterey County

Indian Ethnohistory: Prior to European contact, the County was inhabited by members of the Soledad, Monterey, and San Juan Bautista bands of the Costanoan and Esselen Indians. The Costanoans spoke a Penutian language and the Esselen spoke a Hokan language. The name of the Costanoan comes from the Spanish for "coast people". They ranged from San Francisco Bay to Monterey Bay. In 1910, there were only a handful of descendants of these Indians (Kroeber, 1925). Prior to contact they numbered about 7,000 in all of the counties (Cook, 1976). The Esselen were one of the least populous groups on the California coast, and extremely limited in territory (to the Lower Carmel River and the mouth of the Sur River). They were among the first to become extinct and probably only numbered about 500 at the time of contact. They may represent one of the oldest California cultures and were by necessity mountaineers (Kroeber, 1925).

The initial European contact was at Monterey Bay in 1602 by Sebastian Vizcaino (Wagner, 1929). Juan Bautista de Anza led a company of colonists overland to Monterey in 1774. By this time, the mission period had begun. Mission San Carlos was established in 1770, Mission Carmelo in 1771, and Mission De Nuestra Senora de la Soledad in 1791 (Campbell, 1969). A total of seven missions were founded within Costanoan territory and it wasn't long before all members of the tribes were associated with missions. Each band was organized into several villages or rancherias which were associated with ranchos or missions (Heizer, 1974).

The first American ship entered Monterey Bay in 1796 (Castillo, n.d.). By 1800, the area was becoming well populated by Americans due to the good port at Monterey. There were few Indians left to interact with the Americans. The whites had different concepts of property, and had laws and soldiers to enforce and reflect these concepts. This cultural difference led to the final extinction of the Indians of Monterey (Forbes, 1971).

Very soon after secularization, there were no residents on the mission rancherias (Campbell, 1969). The Indians remaining in the area participated in the Unratified Treaties of May 13, 1851; May 30, 1851; and April 29, 1851 (Heizer, 1972). The 1970 census lists an Indian population of 1,139 (State Advisory Commission on Indian Affairs, 1969).

National Register: 8 Sites
California Historical Landmarks: 28 Sites

San Luis Obispo County

Indian Ethnohistory: Prior to European contact, the county was inhabited by the Obispeno and Cuyama bands of Chumash Indians and the Playano, Migueleno, and Antoniano bands of Salinan Indians. Both groups spoke Hokan languages (Kroeber, 1925). Three missions were founded: San Miguel, in 1779; San Luis Obispo, in 1772; and San Antonio, in 1771 (Bleeker, 1956). This was the most northern section of Chumash territory. Unfortunately, their culture did not survive contact in this county, either. The Salinan people were almost entirely decimated four generations after the initial contact. Their original territory had been inland from Salinas to Soledad (Kroeber, 1925). By 1923, only 40 individuals remained and they did not speak the language of their ancestors (Cook, 1976).

Although Cabrillo did not land in San Luis Obispo County, his log mentions the fogs. Vizcaino, in 1602, saw only a few people in canoes and did not make contact either. Portola's expedition in 1769 found the Indians of San Luis Obispo to be kind and generous (Wagner, 1929). By 1800, all Indians of the county were associated with missions (Bowman, 1958). By 1812, when Rome issued a decree to record pre-mission culture, it was already too late for the Chumash and the Salinan. Little is known of their culture and like all mission Indians, their own original name is not known. The Salinan may have had a population of 1,200 to 3,000 at the time of contact (Kroeber, 1925). Mission records at San Antonio list an 1814 population of 2,000, but that included other tribes (Bowman, 1958).

The Indians surviving at the time of secularization found this period even more discouraging than the mission period. They were given appointed overseers by the Government, but these appointees did not inform them of their rights nor protect them (Campbell, 1969). The 1970 census shows an Indian population of 1,218 (State Advisory Commission on Indian Affairs, 1969).

<u>National Register</u>: 1 Site
<u>California Historical Landmarks</u>: 13 Sites

<u>Santa Barbara County (South to Point Conception)</u>

<u>National Register</u>: None
<u>California Historical Landmarks</u>: 5 Sites

<u>Shipwrecks and Aircraft</u>: Ships and boats have been wrecked on this coast and the Bight's open waters probably since the first aboriginal craft tentatively ventured from shore. The earliest recorded wrecks date from the mid-16th century Spanish explorations. There is evidence however, suggesting earlier wrecks, probably of Asian vessels. This office has compiled records in excess of 1,100 wrecks for California coastal waters. Varying degrees of accuracy and detail are available with the better locational data generally available for more recent mishaps. Following is a list of the number of shipwrecks (and aircraft), by area, which has been winnowed from the original list by including only the geographic (Southern California Bight) areas identified in the list and by excluding all vessels wrecked from 1950 to the present. Also excluded are vessels which have been refloated or salvaged completely. In some cases, the date of sinking is not available, such is often the case in wrecks which have been located by the Navy, but remain unidentified. All vessels of definite cultural resource value as well as those which cannot be proven to be of no value with available information are included. Most of the vessels, as would be expected, are located in State waters. These are analyzed in greater detail in Section III.C.6 "Impacts on Offshore Archeology".

Table II.G.1.f.iii-1

LIST OF WRECKS BY AREA
(Excludes 1950 and Later)

Area	Number of Vessels	Number Known to Be On Federal Waters
Point Conception Vicinity	21	
Gaviota Vicinity	12	
Santa Barbara Vicinity	10	
Rincon Point Vicinity	1	
Ventura Vicinity	3	
Oxnard Vicinity	7	
Point Dume Vicinity	9	1
Northern Channel Islands		
San Miguel Island	8	
Santa Rosa Island	7	
Santa Cruz Island	7	
Anacapa Island	7	
Southern Channel Islands		
Santa Barbara Island	3	
Begg Rock	1	
San Nicolas Island	6	
Bishop Rock	3	
Catalina Island	38	
San Clemente Island	14	2
Santa Monica Bay	23	2
Point Vicente	12	2
Palos Verdes Area	6	2
Point Fermin	32	
San Pedro Bay	20	2
Catalina Channel	1	1
Huntington-Newport Beach	13	
Laguna Beach - San Onofre	7	3
Oceanside - Del Mar	6	
Point La Jolla	8	1
San Diego	21	
Point Loma Area	7	
San Diego Area	5	
Offshore - San Diego	1	1
West of Catalina Island	1	1
Mexican Waters Near International Boundary	10	

iv. Sport Fisheries

Sport Fisheries of the Southern California Bight (Point Conception to U.S. Mexican Border); Pinkas, Oliphant and Haugen (1968) have divided Southern California marine sportfishing into four major types: 1) partyboats, 2) private boats, 3) shoreline, and 4) piers and jetties.

The Southern California partyboat fishery is distinct. About 75 percent of the statewide partyboat effort is expanded in Southern California while the number of boats operating in the region has, for the most part, been only slightly higher than in the rest of the State (Miller and Hardwick, 1973). A possible explanation may be that Southern California boats are larger and there are more operations of half-day boats compared with northern areas.

Rockfish, family Scorpaenidae, have gradually become the predominant species in the partyboat catch by number of fish from 1955 to 1975 (Figure II.G.1. f.iv-1). Kelp and sand bass, *Paralabrax spp.;* Pacific Bonito, *Sardo Chiliensis;* California barracuda, *Sphyraena argentea*; and halfmoon, *Medialuna californiensis* have also contributed significantly to the total catch.

The Southern California partyboat catch has fluctuated during the period from 1947 through 1976 from a low of 1.5 million fish in 1950 to a high of 4.7 million in 1968 (Figure II.G.1.f.iv-2). There is an apparent decrease in both catch and effort from 1968 through 1975. However, information is not yet available to predict whether this decrease represents longterm trends or short-term fluctuations.

Figures II.G.1.f.iv-3 and 4 are summaries of the 1973 through 1975 partyboat catch and effort data for Southern California. Both figures indicate that most sport fishes are caught and the greatest effort, in terms of numbers of anglers, occur relatively close to the mainland or the offshore islands. The areas having the largest catches during the 1973 through 1975 period were: 1) the area off the Palos Verdes Peninsula, 2) the eastern edge of Santa Catalina Island, 3) the area off San Diego between La Jolla and Point Loma, and 4) the area around Los Coronados Islands.

Information on the three other main types of sportfishing is less comprehensive and more difficult to obtain than that for the partyboat fishery. For private boats as with partyboats, kelp and sand bass, Pacific bonito and rockfish were important species. For pier and jetty fishing, white croaker, *Genyonemus lineatus,* and queenfish, *Seriphus politus*, were principal species. For open coast shoreline angling, the surfperches, family Embiotocidae, were the most important group. Pacific bonito and bass (kelp and sand) were the most frequently caught species for all types of sportfishing in Southern California during the period 1963 to 1966 (Pinkas, et al., 1968).

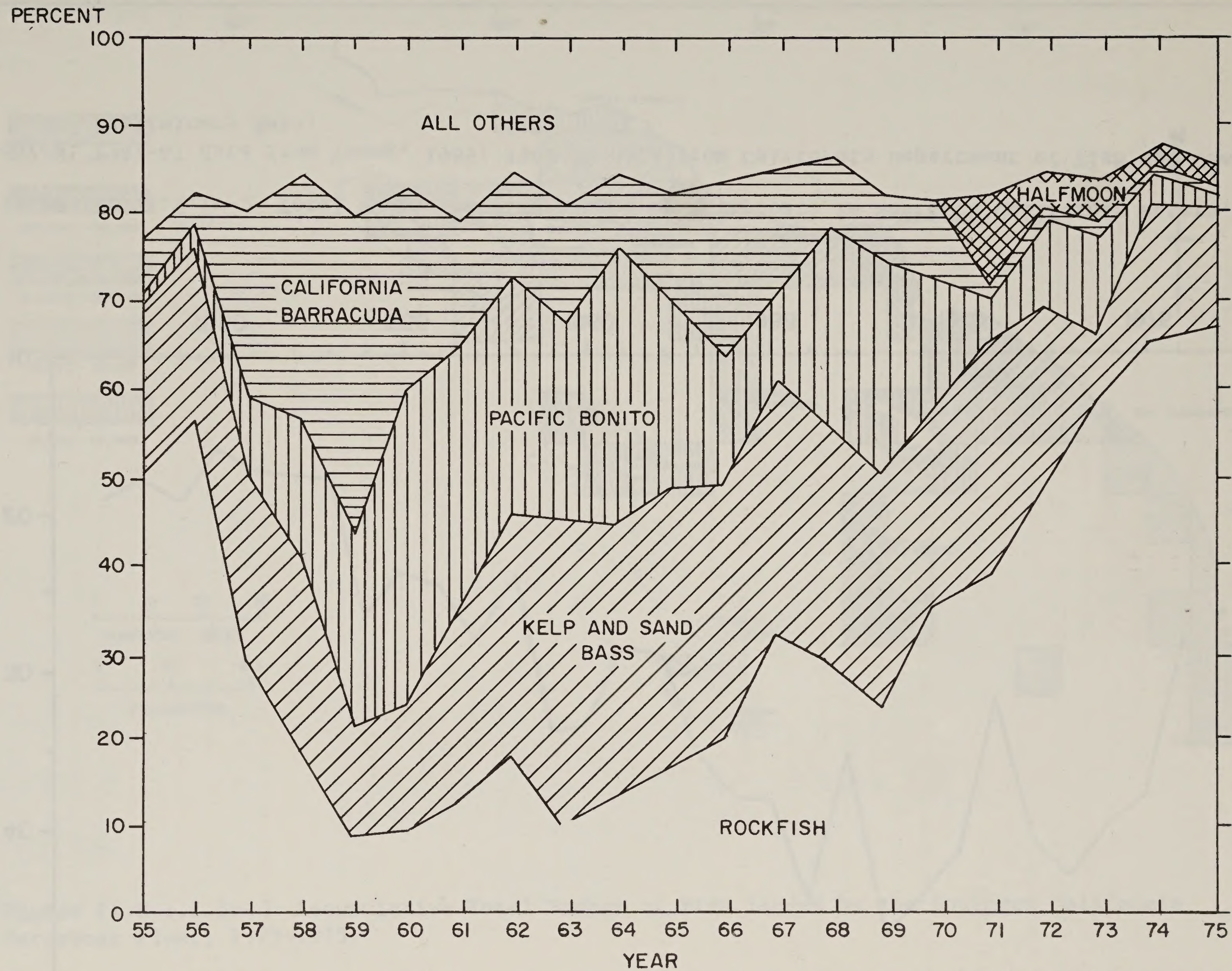


Figure II.G.1.f.iv-1 Annual percent Composition by Numbers of the Southern California Partyboat Catch, 1955-1975. Sources: Miller and Hardwick, 1973; 1972-75, California Dept. of Fish and Game, Unp. data.

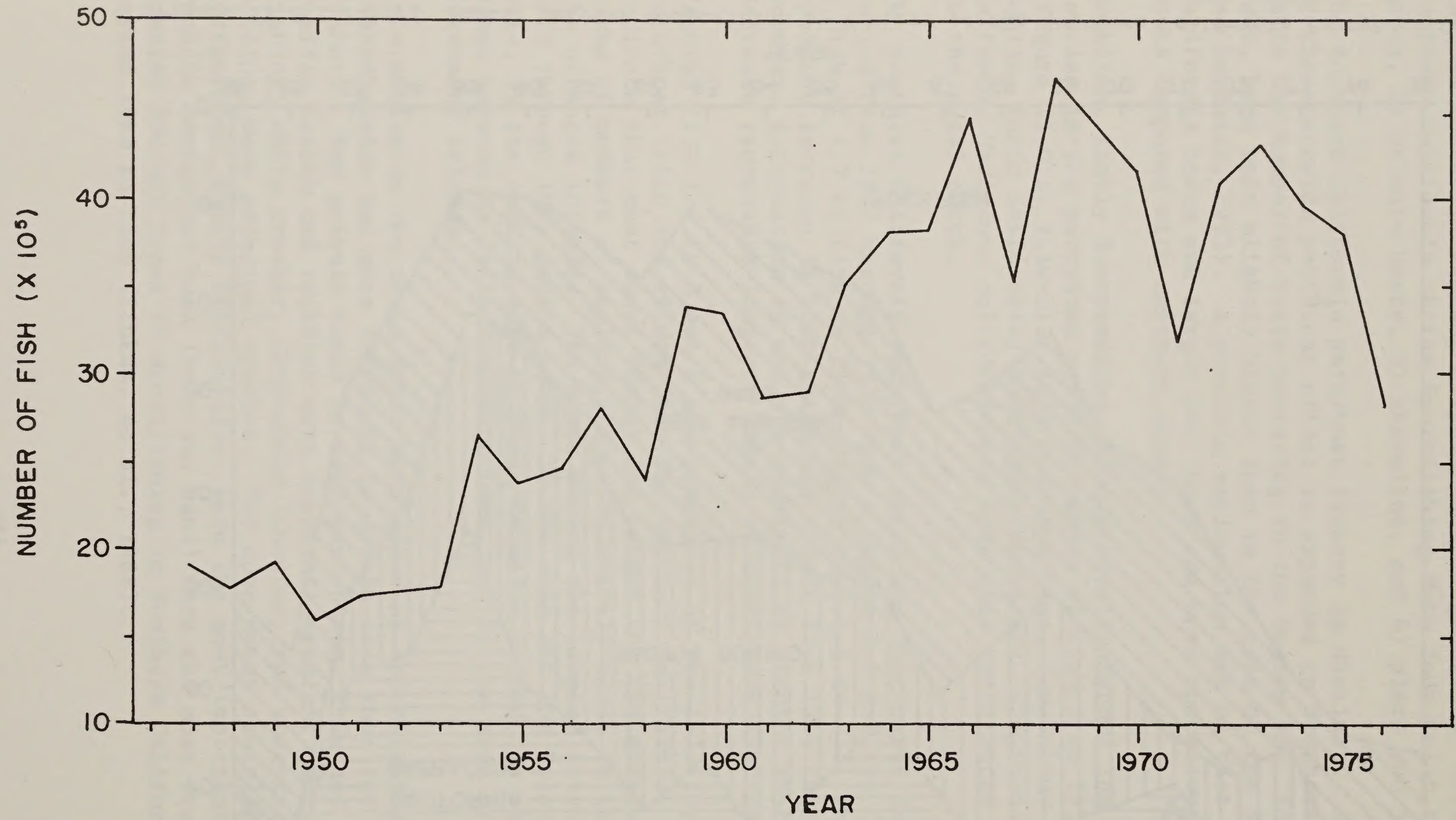


Figure II.G.1.f.iv-2 Total Number of Fish caught by Partyboats in Southern California Waters, 1947-76.

Source: 1947-67 data from Young, 1969; 1968-76 data from California Department of Fish and Game, Preliminary data.

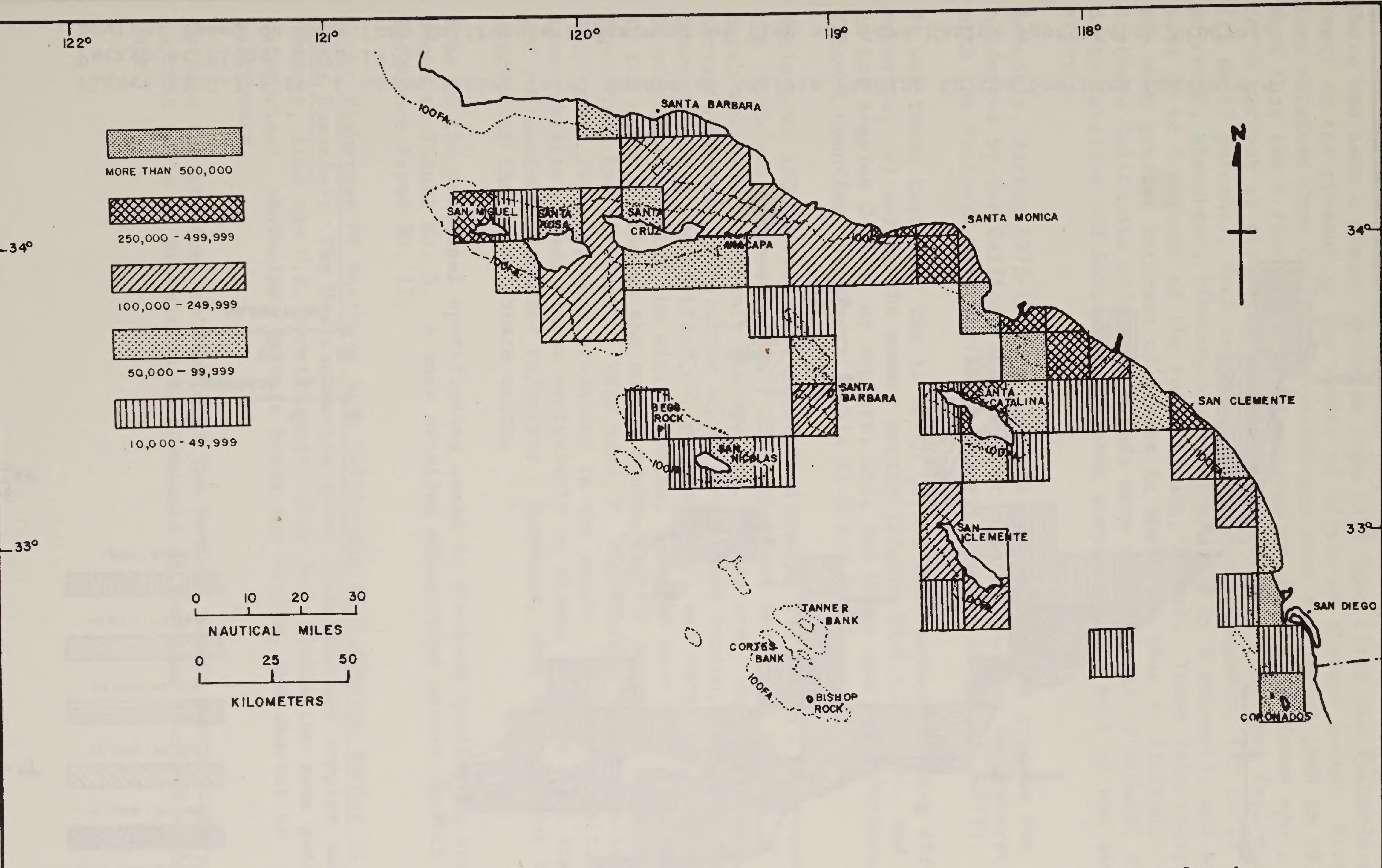


Figure II.G.1.f.iv-3 Accumulative Total Number of Fish landed by the Southern California Partyboat Fleet, 1973-1975.

Source: Based on data from California Department of Fish and Game Marine Sport Catch Studies.

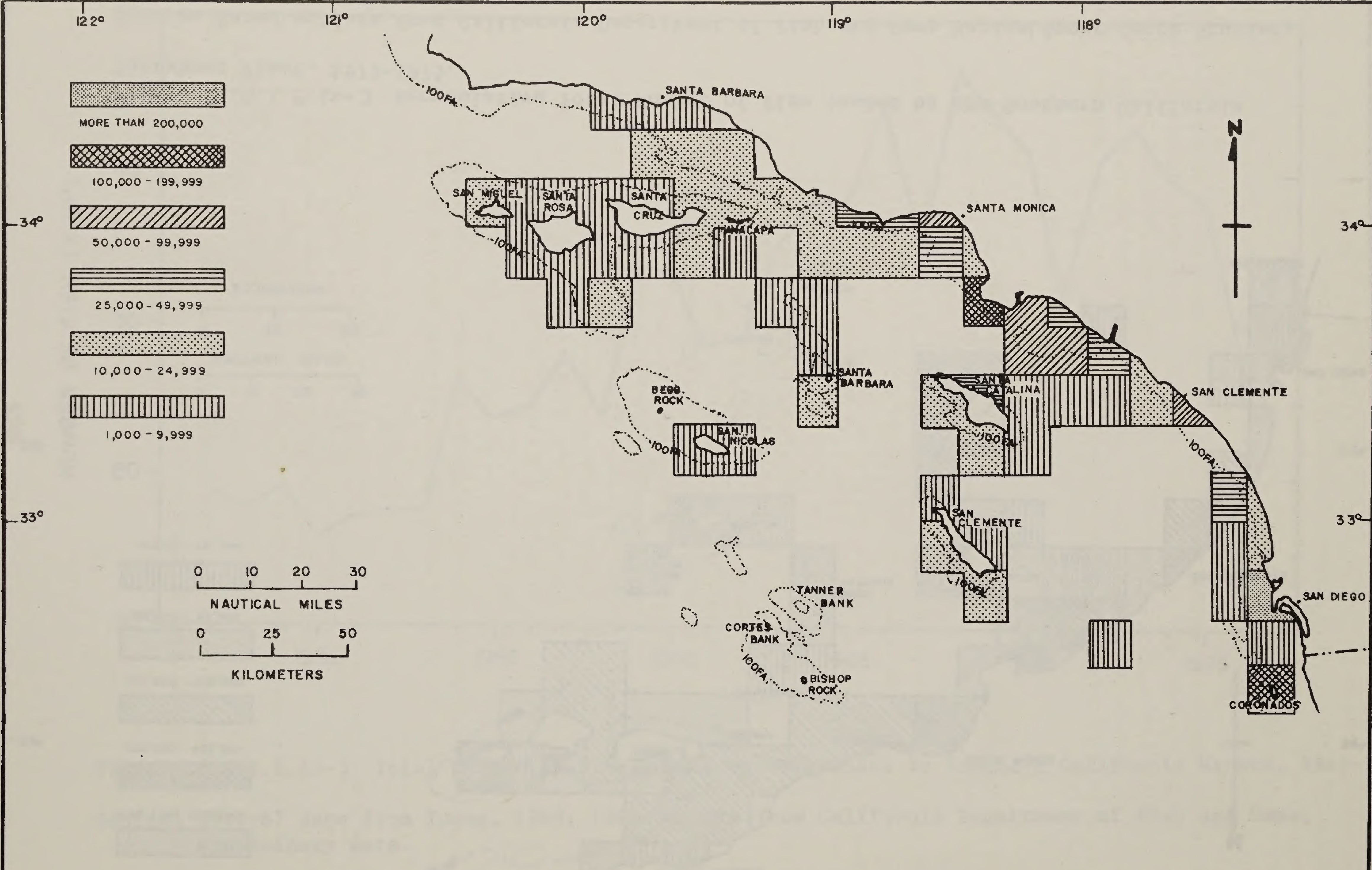


Figure II.G.1.f.iv- 4 Accumulative Total Number of Anglers Fishing in the Southern California Partyboat Fleet, 1973-1975.
Source: Based on data from California Department of Fish and Game Marine Sport Catch Studies.

Skin and SCUBA diving form a fifth and expanding type of sportfishing. There has been a steady increase from 1958 (the first year records were kept) to the present in the number of divers on charter boats. Diving logs obtained from California partyboats over the period 1965 to 1970 show that the 6 year catch was dominated by abalone, *Haliotes spp.*, (54 to 59 percent of the total catch), spiny lobster, *Panulirus interruptus*, (12 to 17 percent), rock scallop, *Hinnites multirugosus*, (10 to 15 percent), sheephead, *Pimelometopon Pulchrum* (8 to 9 percent), and kelp bass (4 to 6 percent of the total)(Young, 1973a). These data indicate the much greater interest of divers in shellfish than in finfish. Southern California offshore islands were most favored by divers, with Santa Catalina and Santa Cruz islands supporting the bulk of the diving effort.

Recently, during 1975-1976, a 12-month random sampling program was conducted by the California Department of Fish and Game in cooperation with the National Marine Fisheries Service (Wine and Hoban, 1977).

It was found that over the 12-month period the heaviest fishing effort occurred: 1) during the summer months (Figure II.G.1.f.iv-5), and 2) in Los Angeles County, by anglers, and, San Diego and Santa Barbara-Ventura Counties, by divers (Table II.G.1.f.iv-1).

While over 150 species were identified during the survey, 75 percent of the catch was composed of only 20 species and nearly 50 percent of the catch was made up of only six species. These are: white croaker, barred sand bass, *Paralabrax nebulifer;* Pacfic bonito, bocaccio, *Sebastes pancispinis*; olive rockfish, *S. serranoides;* and vermilion rockfish, *S. miniatus*. During the winter months, rockfish were most significant in the catch, while in the summer months Pacific mackerel, *Scomber japonicus*, Pacific bonito, kelp bass, *P. clathratus*, and sablefish, *Anoplopoma fimbria*, were prevalent in the catch. The most significant invertebrates, taken almost exclusively by divers were the rock scallop and red abalone, *Haliotes rufescens*. Combined, they made up over 50 percent of the invertebrate catch.

Some of the principal sportfishing areas in Southern California are shown in Visual No. 5. A more detailed description occurs in POCS Reference Paper No. II.

<u>Sport Fisheries Of Northern Baja California (U.S./Mexico Border to Punta Eugenia)</u>: The Mexican marine sport fisheries are complex and varied. However, like the U.S. sport fishery they fall within the same general categories: shoreline, private boats and skiffs, and charter or partyboats.

Perhaps the greatest attribute of the Mexican marine sport fishery is that it is an attraction to thousands of American tourists each year.

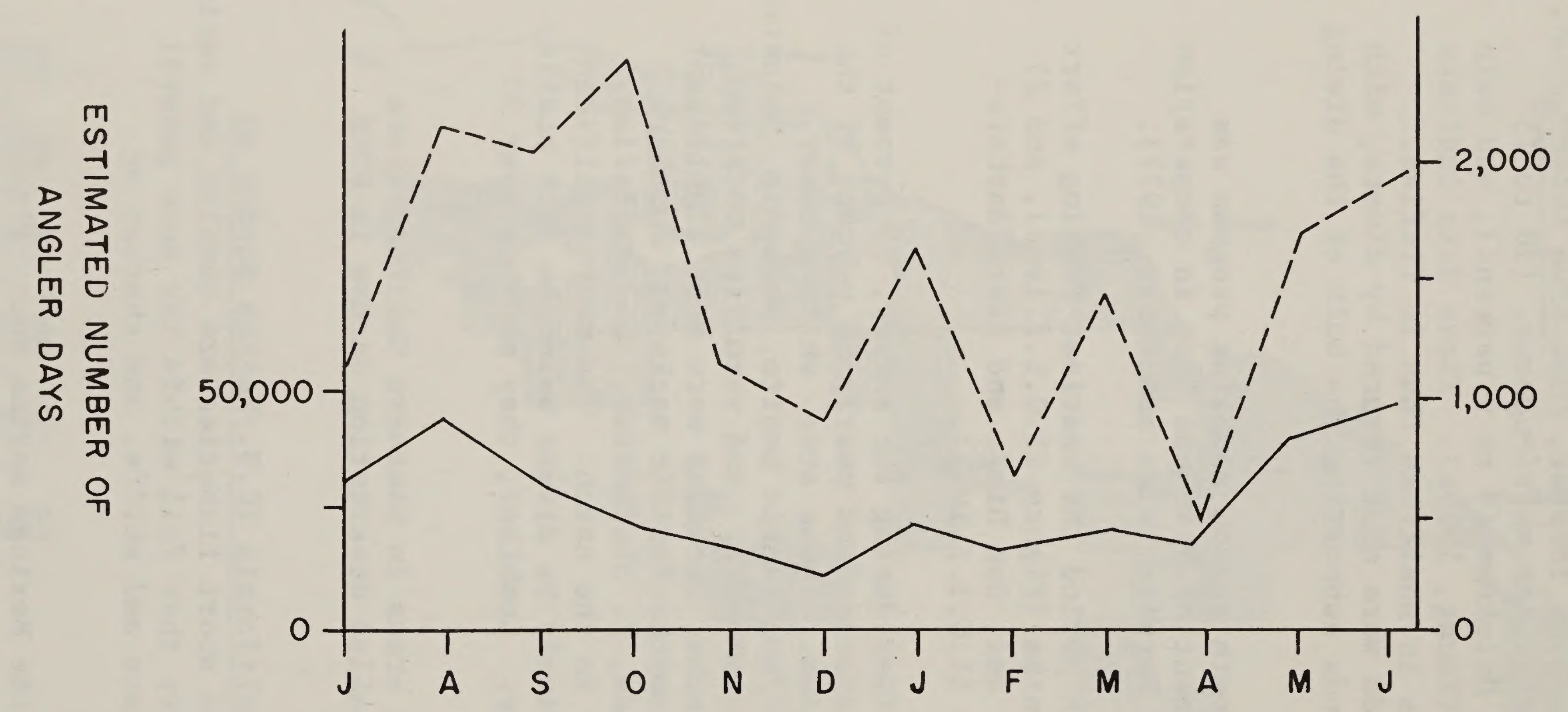


Figure II.G.1.f.iv-5 Estimated Number of Angler-days (——), and Diver-days (-----) for each Month, July 1975 through June 1976 for all Southern California Counties combined.

Source: Wine and Huban, 1976.

Table II.G.1.f.iv-1

ESTIMATED ANNUAL EFFORT LEVELS
(JULY 1975-JUNE 1976)

COUNTY	Pole Trip Hours	Diver Trip Hours	No. Angler Days	No. Diver Days
Santa Barbara-Ventura	334,776	34,836	52,152	5,260
Los Angeles	774,793	15,172	123,049	3,097
Orange	562,456	18,347	85,862	3,739
San Diego[a]	538,422	23,640	75,399	5,402

Source: Wine and Hoban, 1976.

[a]August 1975-June 1976.

Within the categories mentioned above 200,623 fishing permits were issued by the Mexican government in 1971; 11,597 of which were issued in San Diego and San Pedro, mostly to partyboat fishermen. The areas most fished were: Los Coronados Islands, Cedros and San Benitos Islands, Guadalupe Island, Socorro Island, and the coastal area near Ensenada and Cabo San Lucas (Solorzano, 1972).

It is obvious that the majority of Mexican sportfishing permits were issued outside the Republic of Mexico, primarily to fishermen on U. S. based partyboats. However, also in 1971, 89,026 permits were issued within Mexico. Of these, about 62 percent were issued from offices in Ensenada, La Paz and Guaymas (Solorzano, 1974). Undoubtedly, some of these permits were issued to Mexican sportfishermen as well as U. S. or other foreign sportfishermen.

Unfortunately, very little information is available on the Mexican based sport fishery. There is, however, a considerable amount of data available on the U. S. based partyboat fishery.

The partyboat fishery can be divided into four components: 1) long-range trips (616 days), 2) rockfish trips (3-4 days), 3) albacore trips (3-4 days), and 4) Coronado Island trips (1 day) (Gary Stauffer, NMFS Southwest Fisheries Center, personal communication). The long-range trips leave San Diego and fish such areas as Guadalupe Island, San Benitos Island, Alijos Rocks, Uncle Sam Bank, Magdalena Bay and Socorro-Clarion Islands. Some of the major species sought are: Yellowtail, *Seriola dorsalis;* Yellowfin Tuna, *Thunnus albacares;* Skipjack Tuna, *Euthynnus pelamis;* Bluefin tuna, *Thunnus thynnus;* Wahoo, *Acanthocybium solanderi;* Pacific mackerel, *Scomber jamonicus;* Pacific bonito, *Sardo chiliensis;* Dolphinfish, *Coryphaena hippurus;* California barracuda, *Sphyraena argentea;* Ocean whitefish, *Caulolatilus princeps;* and Giant sea bass, *Stereolepis gigas.*

The Los Coronados Islands sport fishery is perhaps the most popular for migrating game fish in the Southern California sport fishery and has been the mainstay of the San Diego partyboat fleet for years (Stauffer, personal communication). The major species sought are the same as those listed above for the long-range fishery with the addition of: White seabass, *Cynoscion nobilis*; kelp and sand bass, *Paralabrax spp.*, and rockfish, *Sebastes spp.*

From 1961 through 1974, 56.4 percent of the partyboat trips departing San Diego and 13.5 percent of all Southern California partyboat trips were to waters off Baja California (Stauffer, personal communication). These data support the fact that a large portion of the Southern California partyboat sport fishery, particularly those based in San Diego, occurs in Mexican waters off Baja California.

Sport Fisheries of Central California (Point Conception to Point Reyes). A survey of all sportfishing methods from Point Arguello to Oregon was conducted as part of the Central California Marine Sportfish Survey by the Department of Fish and Game from 1957-1961 (Miller and Gotshall 1965). To date, this study remains the most extensive general sport fishery survey of the area. The average annual effort in three areas between Point Conception and San Francisco during this study are illustrated in Figure II.G.1.f.iv-6.

General results of the 1957 to 1961 survey showed an average annual ocean fishing effort of around 1.5 million angler days being expended by sport fishermen. More recently, since 1970, there has been a general increase in the amount of effort expended by sportfishermen to the point that presently, the annual average effort from Oregon to Point Arguello may be as much as 4 million angler days (Jim Hardwick, California Fish and Game, personal communication). Basically, the central California sport fishery can be divided into the same major categories as that for Southern California. Although more effort may be expended in shore and pier fishing, more fish per hour are caught from boats.

Over 135 species representing 41 families have been recorded in the central California sport catch. However, only about 20 are of any significance. The species of most importance in the fishery as a whole include: blue rockfish, lingcod, striped bass, king salmon, white croaker, jacksmelt, barred surfperch, redtail surfperch, yellowtail rockfish, black rockfish, shiner perch, vermilion rockfish, and walleye surfperch.

Although several species may be taken most frequently in the intertidal areas, no species is taken solely in isolated tide pools (Miller and Gotshall, 1965). Some species taken only in shallow, rocky and kelp areas 0 to 45.7 m (0 to 150 feet) are: kelp rockfish, giant kelpfish, senorita, rainbow seaperch, grass rockfish, rubberlip perch, gopher rockfish, black-and-yellow rockfish, kelp bass, opal-eye, California sheephead, and fringeheads. Most skin diving and skiff effort and all rocky shore fishing are done in this area. Species taken only in deep reef areas 45.7 to 106.7 m (150 to 350 feet deep) are: Chilipepper, large bocaccio, squarespot rockfish, stripetail rockfish, speckled rockfish, widow rockfish, greenstriped rockfish, and greenspotted rockfish. The most frequently caught species in the shallower sandy bottom areas are striped bass, silver surfperch, retail surfperch, barred surfperch, walleye surfperch, starry flounder, sand sole, smoothhounds, and white croaker. In deeper sandy bottom areas, the more common species are rock sole, Pacific sanddabs, petrale sole, and sable fish. The more important pelagic species include king salmon, silver salmon, albacore, Pacific bonito, California barracuda, white seabass, jack mackerel, Pacific mackerel, and California yellowtail.

Figure II.G.1.f.iv-7 illustrates some of the more important sportfishing grounds of the central California area. For a more detailed description of these areas, see POCS Reference Paper No. II.

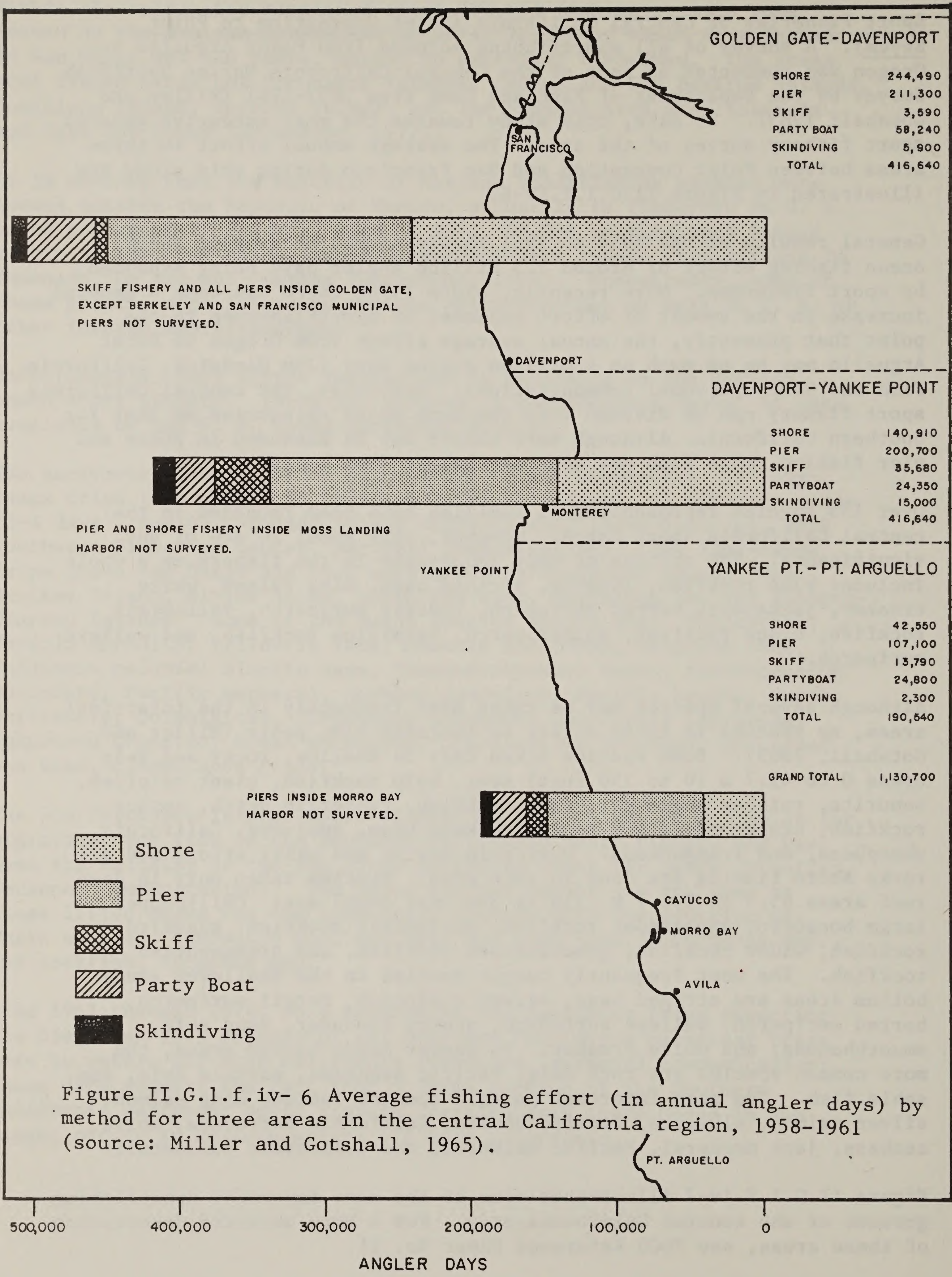


Figure II.G.1.f.iv- 6 Average fishing effort (in annual angler days) by method for three areas in the central California region, 1958-1961 (source: Miller and Gotshall, 1965).

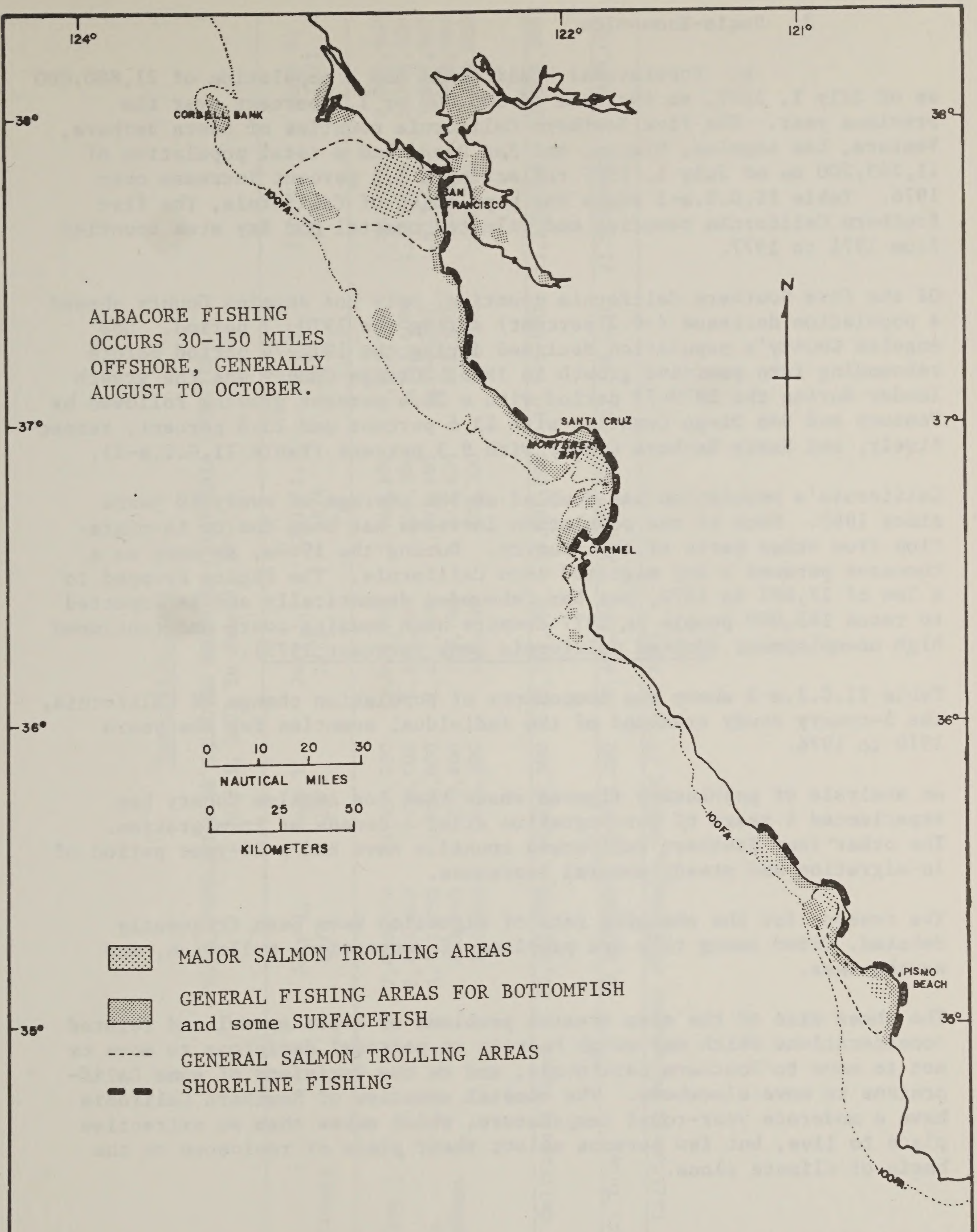


Figure II.G.1.f.iv-7 Major Sport Fishing Areas of the Central California Coast.

2. Socio-Economics

a. Population: California had a population of 21,880,000 as of July 1, 1977, an increase of 360,000 or 1.7 percent over the previous year. The five Southern California counties of Santa Barbara, Ventura, Los Angeles, Orange, and San Diego had a total population of 11,263,200 as of July 1, 1977 reflecting a 1.3 percent increase over 1976. Table II.G.2.a-1 shows the population of California, the five Southern California counties and selected coastal and Bay area counties from 1971 to 1977.

Of the five Southern California counties, only Los Angeles County showed a population decrease (-0.2 percent) during the 1970-77 period. Los Angeles County's population declined during the 1972-74 period before rebounding into positive growth in 1975. Orange County was the growth leader during the 1970-77 period with a 26.5 percent growth, followed by Ventura and San Diego Counties with 23.6 percent and 23.8 percent, respectively, and Santa Barbara County with 9.3 percent (Table II.G.2.a-2).

California's population has doubled on the average of every 20 years since 1860. Much of the population increase has been due to in-migration from other parts of the country. During the 1960s, as many as a thousand persons a day migrated into California. The figure dropped to a low of 17,651 in 1972, but has rebounded dramatically and is expected to reach 165,000 people in 1977 despite high housing costs and continued high unemployment (United California Bank Forecast 1977).

Table II.G.2.a-2 shows the components of population change of California, the 5-county study area and of the individual counties for the years 1970 to 1976.

An analysis of population figures shows that Los Angeles County has experienced 4 years of out-migration after a decade of in-migration. The other four Southern California counties have had a 14-year period of in-migration and steady natural increases.

The reasons for the changing rate of migration have been frequently debated. Cited among them are problems of congestion, pollution, and earthquakes.

The sheer size of the area creates problems of urban sprawl and related considerations which may weigh heavily on personal decisions to move or not to move to Southern California, and on the decisions of some Californians to move elsewhere. The coastal counties of Southern Califonia have a moderate year-round temperature, which makes them an attractive place to live, but few persons select their place of residence on the basis of climate alone.

Table II.G.2.a-1

TOTAL POPULATION OF SELECTED SOUTHERN CALIFORNIA COUNTIES
July 1, 1971 To July 1, 1977

County	July 1, 1971	July 1, 1972	July 1, 1973	July 1, 1974	July 1, 1975	July 1, 1976	July 1, 1977
Los Angeles	7,050,500	6,983,200	6,959,700	6,946,100	6,947,100	7,007,600	7,029,500
Orange	1,485,400	1,530,000	1,595,300	1,657,700	1,713,400	1,755,600	1,798,400
San Diego	1,381,700	1,424,600	1,474,800	1,521,100	1,594,100	1,613,300	1,677,800
Santa Barbara	269,600	270,400	273,700	277,600	281,100	286,300	288,900
Ventura	393,800	405,100	416,300	428,300	440,700	452,200	468,600
Southern California Total	10,581,000	10,613,300	10,719,800	10,831,600	10,976,400	11,115,000	11,263,200
California Total	20,287,000	20,437,000	20,665,000	20,907,000	21,198,000	21,520,000	21,880,000

Source: California Department of Finance, Report 77 E-2, 1977

Table II.G.2.a-2

COMPONENTS OF POPULATION CHANGE FOR SELECTED SOUTHERN CALIFORNIA COUNTIES
April 1, 1970 To July 1, 1977

County	Total Population April 1, 1970	Total Population July 1, 1977	Change Number	Change Per-cent	Births	Deaths	Net Migration
Los Angeles	7,041,980	7,029,500	-12,500	-0.2	820,200	439,300	-393,400
Orange	1,421,233	1,798,400	377,200	26.5	179,300	70,900	268,800
San Diego	1,357,854	1,677,800	319,900	23.6	169,500	80,300	230,700
Santa Barbara	264,324	288,900	24,600	9.3	27,400	15,000	12,200
Ventura	378,497	468,600	90,100	23.8	51,600	18,300	56,800
Southern California Total	10,463,888	11,263,200	799,300	7.6	1,248,000	623,800	175,100
California Total	19,971,069	21,880,000	1,909,300	9.6	2,339,800	1,230,800	800,300

Source: California Department of Finance, Report 77 E-2, 1977.

One prerequisite for a high rate of in-migration is a vibrant and healthy economy. Thus, the in-migration trends of the latter 1950's and early 1960's were sustained by the aerospace boom. Conversely, the major cutbacks in NASA and Department of Defense programs and in some high technology industries in the last few years have deterred new migrants and induced some Southern Californians to leave. This latter trend, moreover, coincided in part with a period of economic recession, which always has a negative impact on immigration rates, as in 1953-54, 1957-58, and 1970.

Los Angeles, Orange, and San Diego are the most populated counties in the state, respectively. Between 1960 and 1970 the population density per square mile of total population in Orange County almost doubled (Table II.G.2.a-3). Almost 77 percent of this growth was due to in-migration, which compares with 50 percent for the state as a whole. Much of this growth can be atrributed to a significant increase in new business in the county which included an influx of some Los Angeles firms. In total, almost 90 percent of the county's population lives in the lowlands in the western half of Orange County. The heavy population centers are locared adjacent to the Los Angeles County line, with the area becoming a suburb or bedroom community to Los Angeles proper. Ventura County's population increase during this same 10-year period was almost as dramatic, reflecting approximately a 90 percent increase, of which 74 percent was attributed to an influx of new residents. Much of this growth took place in the eastern portion of the county where approximately one-half of the work force commutes to Los Angeles daily. This is an extension of the trend toward urban sprawl and declining residential use of the core city.

In San Diego County, the 1960 to 1970 growth was approximately 30 percent. The components of change in this area more nearly equaled the State, compared to any other county in the study area, in that the migration and natural increase was about even. The lack of migration into this county was the major factor limiting growth during this period. Since that time the picture has changed; in-migration is up sharply and the growth closely resembles the pattern in Orange and Ventura counties. Much of this increase can be attributed to new business in the tourism and recreation industry which has more than offset losses between 1969-1972 in the manufacturing sector of the economy.

During the past decade, Santa Barbara County reflected a better than 50 percent growth, of which two-thirds resulted from persons moving into the area. The county is presently striving to control its growth and appears to have achieved some success, although 70 percent of new growth can still be attributed to in-migration.

Table II.G.2.a-3

POPULATION PER SQUARE MILE,
SOUTHERN CALIFORNIA COASTAL COUNTIES AND CALIFORNIA
FOR SELECTED YEARS

County	Land Area, Square Miles	Population Density Per Square Mile			Percentage Change[a]	
		1960	1970	1975	1960-1970	1970-1975
Santa Barbara	2,738	63	97	103	54	6
Ventura	1,851	109	205	237	88	16
Los Angeles	4,060	1,492	1,731	1,717	16	- 1
Orange	782	920	1,832	2,167	99	18
San Diego	4,255	246	319	369	30	16
TOTAL	13,686	599	764	801	28	5
State of California	156,573	101	128	135	27	5

Source: California Statistical Abstract (1975). Information from State of California, Department of Water Resources.

[a]Rounded.

Los Angeles County, with a 16.1 percent increase in population between 1960-70, recorded the smallest percentage gain in the five-county area. However, because of the size of the base, the total increase was almost one million people. Compared to the other counties the percentage increase is small, but to put it in proper perspective, it is still greater than the national increase of 13 percent for this period. Migration accounted for only 25 percent of the increase, which was the lowest for the study area. There were several factors responsible for this slow rate of growth compared to earlier periods. Among them were cutbacks in the aerospace industry, slow economic growth, and, finally, the recession and earthquake in 1970. This trend continued until 1972 when Los Angeles County showed a negative growth rate with the loss of approximately 82,000 people. During this period (July 1971-72) in-migration was exceeded by more than 100,000 out-migration. In 1973 there was almost a repeat of 1972 with the total population showing a decline attributable to a heavy out-migration. Between July 1973-74 a distinct slowing in this trend was noted. The county still showed a negative growth but it was much smaller than the previous two years. The population loss between 1973 and 1974 can be mainly attributed to a loss in military personnel, such as occurred when Fort MacArthur was closed.

In summary, Southern California coastal counties experienced exceptional population growth during the past several decades. A distinct slowing was apparent in the latter part of the 1960s. As the decade progressed, it became evident that a decline in the rate of population growth was taking place, but this trend has been reversed as noted earlier. The increases in three of the counties (Orange, San Diego and Ventura), when examined separately, are two to three times greater than the national percentage increase. However, when these areas are lumped with Los Angeles County the negative growth factor there and the sheer size of the base pulls the area increase (including Santa Barbara County) down to the level of the national population increase.

In forecasting projections of population for an area, there are two important components which must be analyzed: natural increase and migration. Population at any given time is necessarily a function of the births and deaths in the study area (natural increase), plus the difference between incoming and outgoing persons (i.e., migration). Natural increase is a much easier component to evaluate than migration. This encompasses such things as marriages, birth, mortality and fertility rates. The characteristics of a community by age group are critical when making an analysis. A concentration of young persons, such as in Ventura County, will probably have the effect of raising the fertility and birth rates and lowering the mortality rate (barring major disasters and catastrophes). The opposite would be true for Santa Barbara County where the average age is considerably higher. Migration rates are much more difficult to project. The most promising possibility for an accurate forecast in this area would be to consider variables such as trends in employment, labor force participation, wages and salaries, and factors related to intracounty and intrastrate migration. In simple terms, economic and climatic condition are the major variables. Differences may also be noted on current and historic population figures between different sources. Some of this can be accounted for by time frame (some are mid-year, others end-of-year figures). Another dependent factor is whether or not the data are preliminary or revised figures. This in itself can often be responsible for marked changes in estimates even from the same source.

It should be noted that population projections are not normally predictions, but are a set of population figures that may reasonably be expected if a certain set of conditions are met. These conditions which include migration and fertility levels are based on current as well as historic performance. Table II.G.2.a-4 projections are based on fertility levels of 2.1 as well as annual in-migration of 150,000. These levels are thought to be reasonable but do not represent possible extremes. In California, between 1971 and 1973, natural civilian increase varied between 132,000 and 184,000 while net civilian in-migration fluctuated between 46,000 and 79,000. Other factors were considered such as changes resulting from movements of military personnel, etc. It should be noted that this projection is based on a demographic model and does not include assumptions for either social, economic or political changes.

Population of Baja California, Mexico. The population of Baja California, Mexico, totals 870,421, of which 434,160 are male and 436,261 female. With a surface area of 70,113 square kilometers (km^2) (27,062.15 square miles) it averages out to 12.41 persons per km^2 or 4.79 persons per square mile. This, compares to a figure of 52.11 per km^2, 135 persons per square mile, in the State of California (Table II.G.2.a-3). The municipality of Tijuana, in the northwest corner of Baja has the largest share of Baja's population, with 39.13 percent made up of 169,317 males and 171,266 females, totaling 340,583. Tijuana is also the most densely populated municipality with 244.59 persons per km^2 or 94.41 per square mile and a surface area of 1,392.45 km^2. The municipality of Ensenada is the only other area geographically in contact with the Pacific Ocean in Baja. It stretches from the muncipality of Tijuana in the northwest to the Territory of Baja California in the south. It has a surface area of 51,952.26 km^2 (20,052.48 square miles) or 74.10 percent of Baja's total area but only 13.26 percent of the population. The population of the Ensenada municipality totals 115,423 persons of which 58,033 are male and 57,390 are female. The population per km^2 is 2.22 persons or 0.86 persons per square mile.

Table II.G.2.a-4

TOTAL POPULATION OF SELECTED SOUTHERN CALIFORNIA COUNTIES, PROJECTED, 1975-2000

County	July 1, 1975	July 1, 1980	July 1, 1985	July 1, 1990	July 1, 1995	July 1, 2000	Military July 1, 1975	Assumed Military 1980-2000
Los Angeles	6,949,300	7,144,000	7,377,900	7,627,100	7,853,700	8,041,900	15,300	15,300
Orange	1,712,600	1,935,000	2,173,400	2,398,300	2,594,100	2,755,800	12,100	11,900
San Diego	1,594,100	1,814,800	2,055,700	2,280,700	2,483,000	2,663,800	108,700	106,100
Santa Barbara	281,100	297,400	317,100	338,000	355,900	370,700	4,700	4,800
Ventura	440,700	507,200	584,100	664,000	741,500	813,800	5,900	5,300
Southern California Total	10,977,800	11,698,400	12,508,200	13,308,100	14,028,200	14,646,000	146,700	143,400
California Total	21,198,000	22,827,000	24,594,000	26,340,000	27,935,000	29,342,000	274,000	267,000

Source: California Department of Finance, Series E-150, Report 77P-1, 1977

The major Pacific Coast cities in Baja California are:

Tijuana	277,306
Ensenada	115,423
Rosarito	6,645
El Maneadero	3,658
El Sauzal	3,360

In addition, there are 26 other coastal cities with populations ranging from 2,159 for Sanchez Toboada to 3 in San Luis. Data concerning population growth rates in Baja has not become available at the writing of this statement. The population of central California coastal and Bay Area counties are shown in Tables II.G.2.a-5,-6 and 7.

Table II.G.2.a-5

TOTAL POPULATION OF CALIFORNIA SELECTED CENTRAL COUNTIES, July 1, 1971 To July 1, 1977

County	July 1, 1971	July 1, 1972	July 1, 1973	July 1, 1974	July 1, 1975	July 1, 1976	July 1, 1977
Alameda	1,086,300	1,093,800	1,088,800	1,088,900	1,091,400	1,091,400	1,100,300
Contra Costa	567,300	570,200	573,900	579,600	586,600	597,700	611,200
Marin	211,000	212,000	214,800	213,200	217,500	221,600	223,700
Monterey	252,800	255,500	260,200	263,500	267,600	271,500	277,500
Napa	81,200	83,500	85,800	88,200	90,600	91,200	91,600
San Francisco	707,400	695,100	689,900	679,000	667,400	664,000	653,900
San Luis Obispo	110,000	112,800	118,000	124,400	126,500	131,600	136,400
San Mateo	560,800	561,700	567,300	573,000	578,600	584,100	588,000
Santa Clara	1,095,000	1,114,600	1,138,100	1,160,000	1,180,300	1,196,700	1,217,700
Santa Cruz	131,000	139,200	145,400	150,800	156,100	162,900	169,200
Solano	179,000	181,700	180,500	182,400	188,000	193,900	201,100
Sonoma	214,100	223,500	233,800	242,000	247,100	253,200	262,800
California Total	20,287,000	20,437,000	20,665,000	20,907,000	21,198,000	21,520,000	21,880,000

Source: California Department of Finance, Report 77 E-2, 1977

Table II.G.2.a-6

COMPONENTS OF POPULATION CHANGE FOR SELECTED CENTRAL CALIFORNIA COUNTIES
April 1, 1970 To July 1, 1977

County	Total Population April 1, 1970	Total Population July 1, 1977	Change Number	Change Per-cent	Births	Deaths	Net Migration
Alameda	1,071,466	1,100,300	28,900	2.7	111,000	67,800	-14,300
Contra Costa	556,116	611,200	55,100	9.9	55,300	29,000	28,800
Marin	208,652	223,700	15,000	7.2	17,300	10,900	8,600
Monterey	247,450	277,500	30,100	12.1	34,900	13,000	8,200
Napa	79,140	91,600	12,500	15.7	7,500	7,000	12,000
San Francisco	715,674	653,900	-61,800	- 8.6	62,000	60,200	-63,600
San Luis Obispo	105,690	136,400	30,700	29.1	10,700	7,900	27,900
San Mateo	557,361	588,000	30,600	5.5	51,800	29,400	8,200
Santa Clara	1,065,313	1,217,700	152,400	14.3	124,900	49,100	76,600
Santa Cruz	123,790	169,200	45,400	36.7	15,400	11,600	41,600
Solano	171,989	201,100	29,100	16.9	24,200	9,200	14,100
Sonoma	204,885	262,800	57,900	28.3	24,300	17,100	50,700
California Totals	19,971,069	21,880,000	1,909,300	9.6	2,339,800	1,230,800	800,300

Source: California Department of Finance Report 77 E-2, 1977

Table II.G.2.a-7

TOTAL POPULATION OF SELECTED CENTRAL CALIFORNIA COUNTIES, PROJECTED, 1975-2000

County	July 1, 1975	July 1, 1980	July 1, 1985	July 1, 1990	Julyl, 1995	July 1, 2000	Military July 1, 1975	Assumed Military 1980-2000
Alameda	1,091,700	1,110,000	1,140,300	1,173,800	1,203,900	1,226,200	14,400	13,900
Contra Costa	586,600	633,700	681,800	730,000	773,600	809,900	2,700	3,100
Marin	217,500	228,700	242,700	258,700	273,100	284,700	2,100	2,100
Monterey	266,000	299,400	330,500	360,600	388,200	414,900	23,800	21,900
Napa	90,600	101,100	113,600	126,700	139,500	151,600	300	300
San Francisco	667,600	643,700	628,400	625,500	626,900	627,900	5,700	5,800
San Luis Obispo	126,800	148,600	167,100	185,100	202,300	218,800	200	200
San Mateo	578,700	599,600	621,300	640,400	653,800	659,500	1,300	1,300
Santa Clara	1,180,300	1,277,600	1,385,400	1,491,800	1,586,900	1,664,200	6,400	6,400
Santa Cruz	156,000	185,500	216,600	248,100	279,200	310,300	--	--
Solano	188,000	216,300	250,100	287,100	326,200	367,900	13,400	13,400
Sonoma	247,100	279,400	317,600	356,400	394,000	429,800	800	900
California Totals	21,198,000	22,827,000	24,594,000	26,340,000	27,935,000	29,342,000	274,000	267,000

Source: California Department of Finance, Series E-150, Report 77 P-I, 1977

b. Employment: This section is taken mainly from Area Manpower Review, October 1977, published by the California Employment Development Department.

The national economy rebounded strongly from the pause in activity experienced during the latter part of 1976 as real Gross National Product (GNP) increased at a 7.5 percent annual rate in the first quarter of 1977 followed by a 6.4 percent gain in the second quarter. The rate of inflation as measured by the Consumer Price Index increased at a faster rate than that experienced during 1976, advancing at about an 8 percent annual rate.

Consumer spending continued at a rapid pace during the first quarter of 1977, increasing faster than disposal personal income. Consumer expenditures moderated during the second quarter as individuals began to restore savings to more normal levels.

Business investment increased at a healthy pace during the first half of 1977, after performing sluggishly during 1976. Real capital investment increased at a 16 percent annual rate while inventory investment advanced at a rate consistent with increased sales. Residential housing starts were up nationally by about 30 percent over the comparable 1976 period.

Between July 1976 and July 1977, total civilian employment increased by 3.1 percent while the seasonally adjusted unemployment rate declined from 8.0 percent in November 1976 to 7.0 percent in April 1977. The rate was relatively constant through July.

It is expected that the rate of economic expansion will moderate into 1978. Real GNP should increase by and by somewhat less than 5 percent during the first half of 1978. Inflation should also slow to a rate below that experienced during the first half.

Investment outlays should assume a relatively more important role in this stage of the recovery, with consumer spending advancing at a healthy but slower pace than that experienced during the recovery to date. Federal purchases of goods and services and expenditures in the areas of public works and public jobs are expected to provide increased support for the recovery.

At the national level, the unemployment rate is expected to decline to about 6.5 percent by mid-1978.

The California economy during the first half of 1977, continued at the brisk pace established in 1976. Consumer spending, supported by strong growth in personal income, continued to contribute to the recovery. Personal income for the first 6 months of 1977 exceeded $82 billion, up

11.3 percent over the comparable 1976 figure, while first quarter taxable sales were 19.2 percent greater than the first quarter total of last year. Construction activity also continued its advance during the early months of 1977. Seasonally adjusted authorized housing units totaled 20,612 in May 1977, up 43 percent from the depressed totals of a year earlier.

Labor market developments reflected this strong pace of economic activity. Total civilian employment increased by about 381,000 between July 1976 and July 1977 for a year-over increase of 4.3 percent. Wage and salary employment also gained a substantial increase during this period, led by significant gains in construction, trade, and services.

Unemployment in California declined by 13.3 percent between July 1976 and July 1977. The seasonally adjusted unemployment rate dropped from 9.2 percent in October 1976 to 7.8 percent in February 1977. After reaching a 3-year low of 6.9 percent this June, the rate rose to 7.4 percent in July.

The pace of economic growth in California is expected to generally parallel that of the nation as a whole. Growth will occur at a healthy but more moderate pace into 1978. Prices, as measured by the California CPI, should also increase at a slower rate relative to the first half of the year.

Consumer demand is expected to ease somewhat in response to slightly slower growth in personal income and to moderation of the strong demand for durables experienced earlier in the year.

Total civilian employment is expected to reach about 9,560,000 by mid-1978, or 3.2 percent over July 1977 levels. Unemployment should approach 725,000 by the middle of next year for a year-over decline of 5.5 percent. The unemployment rate should decline and reach about 7.0 percent by mid-1978. Nonagricultural employment should increase by about 285,000 between July 1977 and July 1978, down from the particularly strong 381,000 year-over growth which occurred between July 1976 and July 1977. Growth in trade is expected to lead the increase both in terms of absolute and percentage growth, reflecting the continuing strength of consumer outlays. Growth in services employment should continue to reflect favorable demand in the health, business, and tourist-related service industries. Construction gains should be moderate as the rate of growth of construction activity tapers. Manufacturing expansion is expected to be modest compared to the overall employment increase, with the lumber and machinery industries showing the strongest growth within manufacturing.

A county by county discussion of Southern California, central coastal and bay area Counties follows.

Santa Barbara County Employment developments in the first 7 months of 1977 indicated a continued expansion from the 1974-1975 slowdown in business activity. The latest period of employment growth of 24 months raised total civilian employment in the Santa Barbara County in June to a record 124,400, or 4.4 percent above the previous high set in the same month last year. From January to July of 1977, employment averaged 121,100 per month, setting record employment levels for each month (Table II.G.2.b-1).

The current expansion in employment halted a rising trend in unemployment during the first 7 months of 1977. In the span since 1972, joblessness has increased annually from 5,900 to 9,000 in 1976. In 1977, the average number of persons out of work dropped under the year earlier level for the first time, averaging 8,500 per month through July, a level of unemployment nearly 6 percent lower than in the corresponding year ago months. The monthly unemployment rate also averaged 6.6 percent of the civilian labor force during the first half of 1977.

The strong employment expansion of 1975 and 1976 is expected to slacken somewhat during 1978 with total employment advancing to approximately 127,500 in July 1978. This would represent a growth rate of 3.8 percent more in line with the long-term trend for the County and should approximate the growth anticipated in the State.

However, the continuing growth in the civilian labor force will forestall any significant reduction in the level of unemployment. Although the number of unemployed in July 1978 is expected to be at the same level as in July 1977, the rate of unemployment should be down to approximately 6 percent with a seasonally adjusted unemployment rate of about 5.4 percent. The civilian labor force in Santa Barbara County grew nearly 7 percent during 1976, but the growth rate dipped to about 5 percent in the first half of 1977.

Total civilian employment in Ventura County grew at an annual rate of 5.8 percent between July 1976 and July 1977. In April 1977, employment reached 172,500, a new high for the County, and increases continued through June when an all-time employment high of 175,700 was achieved. Employment declined seasonally to 173,000 in July (Table II.G.2.b-2).

Between January and May 1977, unemployment in the country dropped from 14,000 to 11,200. In June, joblessness amoung students and new graduates increased unemployment to 12,100 and by July unemployment among seasonal farmworkers caused unemployment to climb to 14,100. During the first-half of 1977, unemployment was well below that recorded in the same period of 1976, ranging from 2,700 to 5,100 less. July unemployment, at

Table II.G.2.b-1

SANTA BARBARA COUNTY WAGE AND SALARY EMPLOYMENT
JULY 1976 - JULY 1978

	July 1976	July 1977	Forecast 1978
Agriculture - total	8.2	8.8	9.2
Agricultural production	6.5	6.6	6.8
Agricultural services	1.7	2.2	2.4
Nonagricultural - total	99.8	101.8	106.0
Mining	1.0	1.0	1.0
Construction	3.6	3.5	3.6
Manufacturing - total	13.2	14.1	14.6
Nondurable goods	3.3	3.7	3.9
Food and kindred products	1.4	1.8	2.0
Printing and publishing	1.2	1.2	1.2
Other nondurables	.7	.7	.7
Durable goods	9.9	10.4	10.7
Lumber and furniture	.2	.2	.2
Stone, clay and glass	1.0	1.0	1.0
Primary and fabricated metal	.4	.4	.4
Machinery, exc. electrical	1.3	1.3	1.3
Electrical & electronic mach.	3.9	4.2	4.5
Aircraft and parts	.1	.1	.1
Guided missiles & space veh.	1.3	1.5	1.5
Other transp. equipment	.1	.1	.1
Instruments & related prod.	1.2	1.2	1.2
Misc. manufacturing	.4	.4	.4
Transportation & public utilities	3.4	3.4	3.4
Trade	24.6	25.4	26.4
Wholesale	3.9	4.4	4.6
Retail	20.7	21.0	21.8
Finance, insurance, & real estate	4.4	4.4	4.4
Services	24.7	24.8	25.6
Government	24.9	25.2	26.0
Federal	3.8	3.9	4.0
State & local, incl. educ.	21.1	21.3	22.0
All industries total	108.0	110.6	114.2

Table II.G.2.b-2

VENTURA COUNTY ESTIMATED WAGE AND SALARY EMPLOYMENT BY INDUSTRY
(THOUSANDS)

	July 1976	July 1977	July 1978
Agriculture, forestry & fisheries	17.5	18.7	19.4
Agriculture production	11.2	12.2	12.6
Agricultural services	6.3	6.5	6.8
Nonagricultural industries	115.7	118.4	122.3
Mining	2.1	2.2	2.3
Contract construction	4.8	4.8	5.0
Manufacturing	17.5	17.7	18.1
Durable goods	11.9	11.9	12.2
Stone, clay & glass	0.2	0.2	0.2
Machinery	4.8	4.7	4.9
Transportation equip.	3.7	3.7	3.7
Other durable goods	3.2	3.3	3.4
Nondurable goods	5.6	5.8	5.9
Food and kindred	1.4	1.5	1.5
Apparel	1.2	1.2	1.3
Printing and publishing	0.9	0.9	0.9
Other nondurable goods	2.1	2.2	2.2
Transportation and public util.	4.6	4.7	5.0
Wholesale trade	5.6	5.9	6.1
Retail trade	22.5	22.9	23.5
Finance, insurance, & real estate	4.5	4.5	4.9
Services	20.3	20.7	21.0
Government	33.8	35.0	36.4
Federal	10.1	10.0	10.0
State and local	23.7	25.0	26.4
All industries total	133.2	137.1	141.7

14,100, reversed the first half trend and was 600 above July 1976 due mainly to increases in the number of unemployed farmworkers. Average unemployment for the first 7 months of 1977 was 7.0 percent of the civilian labor force as compared to 8.9 percent in the same period in 1976 and an average annual unemployment rate of 8.4 percent for the year.

The total civilian labor force residing in the county reached an all-time high in April 1977 and continued to set new records through June. In July, the number of new and reentrants into the labor force tapered off and the number of persons in the labor force declined to 187,100. Between July of 1976 and 1977, the civilian labor force rose 10,000 for a 5.7 percent increase.

The civilian labor force is expected to increase 5.3 percent to 197,100, for a growth of 10,000 by July of 1978. Employment will increase by about 5.5 percent to 182,500 and unemployment will increase slightly to 14,600. The unemployment rate is expected to drop fractionally to 7.4 percent of the labor force.

Wage and salary employment averaged 135,100 in the first 7 months of 1977, a 3.2 percent gain over the previous year. Gains occurred in both the agricultural and the nonagricultural sectors.

Employment in nonagricultural industries averaged 118,600, up 2,900, or 2.5 percent, from the first 7 months of 1976. Gains were recorded in manufacturing, transportation and public utilities, government, wholesale trade, retail trade, and services. The largest gains were in services (+800) and retail trade (+800).

Agricultural wage and salary employment was up 8.6 percent, or 1,300 during the reporting period.

<u>The Los Angeles County civilian labor force</u> grew 1 percent from 1975 to 1976 and for the first 7 months it has been expanded at a 1.2 percent rate. This was a sharp decline from the 1974 and 1975 rates of increase which were 3.1 percent and 2.3 percent, respectively. Participation rates were, therefore, up during the 1974-75 recession despite unusually high unemployment rates and, in fact, may have been partially responsible for adding to the high rates of unemployment. Further, the participation rates of women has been on the increase since the early 70's. This socio-economic change is probably due to an increased consciousness of women's rights and an increase in the number of married women choosing to work. The latter may have been a response to the double digit inflation of 1974 and 1975. In any event, there appears to have been a permanent shift in the composition of the labor force toward women with further shifts anticipated in the coming years (Table II.G.2.b-3).

Table II.G.2.b-3

LOS ANGELES COUNTY ESTIMATED WAGE AND SALARY EMPLOYMENT
JULY 1977

	July
Agriculture, forestry and fisheries	18.0
Agricultural production	10.2
Agri. services, forestry, fisheries	7.8
Nonagricultural total	3,229.7
Mining	11.5
Contract construction	106.0
Manufacturing	820.4
Nondurable goods	278.6
Food and kindred products	53.0
Textile	10.4
Apparel	75.4
Paper and allied products	17.0
Printing and publishing	45.7
Chemicals and allied products	27.2
Petroleum and coal products	11.8
Rubber and plastic proudcts	30.1
Leather and leather products	8.0
Durable goods	541.8
Lumber and wood products	11.3
Furniture and fixtures	34.1
Stone, clay, glass products	26.0
Primary metal industries	24.1
Fabricated metal products	74.0
Machinery, except electrical	74.4
Electrical and electronic machinery	110.9
Motor vehicles	25.8
Aircraft and parts	88.0
Guided missiles and space vehicles	15.0
Other transportation equipment	9.0
Instruments	27.0
Miscellaneous manufacturing	22.2
Transportation and public utilities	182.0
Wholesale trade	240.5
Retail trade	508.1
Finance, insurance, and real estate	199.4
Services	680.5
Government	481.3
Federal	67.8
State and local, incl. education	413.5
All industries total	3,247.7

Employment of Los Angeles County residents rose 1.9 percent from 1975 to 1976 and as of July 1977 has averaged 2.5 percent above that in 1976. By 1978 it is expected that employment will have increased by an average 3.4 percent.

Following a seasonal drop in January, employment should continue to make gains through 1978, leveling off at a 3.0 percent annual average rate of increase.

The unemployment picture has improved throughout the recovery period following 1974-75. After reaching an all time high of 345,300 in May 1975, the number of unemployed has steadily declined to 244,200 in July 1977. This was the lowest number of unemployed reached since January of 1975 (a span of 25 months) when 278,900 were out of work. By 1978, the annual average number of unemployed should decline by 14 percent from the 1976 average of 290,000. This would almost double the 7.9 percent drop in unemployed from 1975 to 1976. The number of unemployed is expected to continue to decline in 1978; however, the low levels of 1973 do not appear to be realistic goals for the future due to the ongoing changes in the labor force. The projected 1978 decline of 7 percent in unemployment would reflect a leveling off of the recovery experienced within the past 2 years.

Projected unemployment rates for 1978 are more optimistic than previous projections due to the rapid recovery experienced in the first half of 1977. Though the pace of decreasing unemployment and increasing employment may not continue into 1978, the directional movement of these aggregates is expected to remain the same.

Effective January 1, 1977 the U.S. Department of Labor reclassified the Los Angeles-Long Beach area from Group E (9.0 to 11.9 percent unemployed) to Group D (6.0 to 8.9 percent unemployed). However, both classifications are considered areas of substantial unemployment.

<u>The Orange County seasonally adjusted unemployment rate</u> declined with very few interruptions from an April 1975 peak of 8.3 percent to just 4.4 percent for June and July 1977. The labor market has the lowest unemployment rate of any major metropolitan area in California. Joblessness in Orange County averaged 6.9 percent in 1972 as the area recovered from the 1970-71 aerospace recession, then hovered around 5.2 percent for the following year and a half. The energy-related recession of 1975 boosted the average unemployment rate to 7.6 percent for that year. The annual average unemployment rate for 1976 was 5.9 percent, and the average for the first 7 months of 1977 was 4.7 percent (Table II.G.2.b-4).

The total labor force residing in Orange County reached an all-time high of 875,000 in June 1975, up 4.3 percent from the year before and then

Table II.G.2.b-4

ORANGE COUNTY ESTIMATE WAGE AND SALARY EMPLOYMENT BY INDUSTRY
JULY 1976 TO JULY 1978

Item	July 1977	July 1978	Change July 1977 to July 1978 Number	Percent
Agri. W & S emp.	10,900	10,000	- 900	- 8.3
Agri. products	6,600	6,100	- 500	- 7.6
Agri. serv, forest, fish	4,300	3,900	- 400	- 9.1
Nonagri. W & S emp.	644,100	680,200	+36,100	+ 5.6
Manufacturing	167,600	173,500	+ 5,900	+ 3.5
Durable goods	123,600	126,900	+ 3,300	+ 2.7
Lumber	2,800	2,900	+ 100	+ 3.6
Furniture	3,600	3,800	+ 200	+ 5.6
Stone/clay/glass	3,100	3,200	+ 100	+ 3.2
Primary metals	1,700	1,900	+ 200	+ 11.8
Fab. metals	14,000	15,100	+ 1,100	+ 7.9
Nonelec. machinery	19,700	20,200	+ 500	+ 2.5
Elec. machinery	41,500	41,300	- 200	- 0.5
Transportation equip.	19,300	19,600	+ 300	+ 1.6
Instruments	12,300	13,100	+ 800	+ 6.5
Misc. durables	5,600	5,800	+ 200	+ 3.6
(Aerospace sub-total)	(57,100)	(57,700)	(+ 600)	(+ 1.1)
Nondurable goods	44,000	46,600	+ 2,600	+ 5.9
Food	9,000	9,900	+ 900	+ 10.0
Textiles	1,900	2,000	+ 100	+ 5.2
Apparel	2,500	2,600	+ 100	+ 4.0
Paper	3,500	3,600	+ 100	+ 2.9
Printing	9,000	9,300	+ 300	+ 3.3
Chemicals	7,000	7,400	+ 400	+ 5.7
Petroleum	1,300	1,400	+ 100	+ 7.7
Rubber/plastic/leather	9,800	10,400	+ 600	+ 6.1
Nonmanufacturing	476,500	506,700	+30,200	+ 6.3
Mining	2,000	2,100	+ 100	+ 0.5
Construction	38,900	42,700	+ 3,800	+ 9.8
Transp./pub. util.	19,900	20,600	+ 700	+ 3.5
Trade	158,300	169,500	+11,200	+ 7.1
Wholesale	28,400	30,100	+ 1,700	+ 6.0
Retail	129,900	139,400	+ 9,500	+ 7.3
Fin./ins./real estate	36,200	39,200	+ 3,000	+ 8.3
Services	122,800	129,000	+ 6,200	+ 5.0
Government	98,400	103,600	+ 5,200	+ 5.3
Federal	9,800	9,800		0.0
State/local	88,600	93,800	+ 5,200	+ 5.9
Total W & S employment	655,000	690,200	+35,200	+ 5.4

declined seasonally to 868,200 in July. An estimated 39,300 of the latest figure were unemployed, and 828,900 had jobs.

By mid 1978, the resident civilian labor force is expected to expand by 4.8 percent to 910,200 -- up 42,000 from July 1977. At the present time it appears that energy problems, drought conditions, and aerospace layoffs in neighboring Los Angeles County will have little impact on the Orange County labor market, and unemployment should decline slightly to about 39,000 in July 1978.

The labor force in San Diego County increased steadily, climbing from 655,000 in January to 667,700 in June, and then declined slightly to 664,100 in July 1977. The increase was almost entirely due to a rise in employment, as the number of county residents seeking work declined quite sharply. The number of jobholders rose from 581,800 in January to an all time high of 599,700 in June, with the July figures showing a seasonal dip to 597,900. At the same time, the number of unemployed fell from 73,200 at the first of the year to 66,400 in May. The influx of students looking for work boosted unemployment to 68,000 in June and then joblessness dropped off again in July to 66,200 (Table II.G.2.b-5).

An over the year comparison shows a comparatively small gain in the civilian labor force, as an increase in employment was partially offset by the sharp decline in the number of unemployed. The number of county residents with jobs during July 1977, rose by 24,100 over the year for an advance of 4.2 percent, while the number of unemployed dropped by 13,700 during the same period for a net gain of 10,400 in the labor force.

By July 1978, the total number of employed persons living in the County should reach 627,300, for an increase of nearly 30,000 over the current July figure. Most of the new jobs anticipated during the next 12 months will be the result of the expected continued climb in the area's population and expanding opportunities in construction and manufacturing industries. The number of unemployed is expected to continue its general decline with the jobless level dropping to about 55,000. This would be a reduction of just over 11,000 from the July 1977 figure and would give the lowest level since 1974. If employment and unemployment follow these projections, the seasonally adjusted unemployment rate would be 7.8 percent in 1978, or a drop of nearly two percentage points from the July figure of 9.7 percent.

Even though the number of people looking for work is expected to decrease, the number of employed should far exceed the decline, and the civilian labor force of San Diego is expected to grow by just over 18,000 by next July.

Wage and salary employment in San Luis Obispo County expanded seasonally from 39,400 in January 1977 to 40,800 in July 1977, an increase of 3.6

Table II.G.2.b-5

SAN DIEGO COUNTY WAGE AND SALARY EMPLOYMENT
JULY 1976-JULY 1978

	July 1976	July 1977	Forecast July 1978
Agriculture and fishing	13,300	14,100	14,100
Agricultural production	9,500	10,200	10,200
Agricultural services & fishing	3,800	3,900	3,900
Total nonag. wage & salary employment	488,800	513,400	542,300
Mining	800	800	800
Construction	26,600	30,500	32,500
Manufacturing	72,700	74,800	80,000
Nondurable goods	15,800	15,600	16,500
Food and kindred	4,100	4,400	4,800
Apparel & Textiles	3,900	3,200	2,900
Printing & publishing	5,000	5,200	5,700
Chemicals	1,200	1,200	1,300
Other nondurable goods	1,600	1,600	1,800
Durable goods	56,900	59,200	63,500
Lumber, furniture, & fixtures	1,500	1,500	1,500
Stone, clay, & glass	800	800	800
Primary & fabricated metals	5,000	5,000	5,100
Nonelectrical machinery	10,100	11,100	11,800
Electrical machinery	10,400	11,700	12,900
Aircraft, missiles, space vehicles	14,000	14,200	16,200
Shipbuilding	8,700	7,800	7,300
Instruments	4,100	4,700	5,300
Other durable goods	2,300	2,400	2,600
Transportation and public utilities	23,200	24,300	25,300
Wholesale trade	18,100	19,500	20,700
Retail trade	97,000	101,000	107,400
Finance, insurance, & real estate	26,500	28,100	29,700
Services	105,800	111,500	117,000
Government	118,100	122,900	128,900
Federal	39,200	38,400	38,400
State and local	78,900	84,500	90,500
All industries employment total	502,100	527,500	556,400
Military Employment[a]	108,700	108,700	108,700

Source of Military Data: California Department of Finance.

[a]As of July 1, 1975

percent or 1,400 new jobs. The comparable year ago expansion was 4 percent or 1,500 new positions. The peak of 42,150 that occurred in June 1977 is an all-time record for total wage and salary employment within the County (Table II.G.2.b-6).

Table II.G.2.b-6

SAN LUIS OBISPO COUNTY
WAGE AN SALARY EMPLOYMENT 1976, 1977, AND 1978 FORECAST

	1976 July	1977 July	Forecast 1978 July
Agriculture, forestry and fisheries	2,350	2,400	2,500
Agricultural production	1,850	1,900	2,000
Agricultural services	500	500	500
Nonagricultural industries	36,600	38,400	40,550
Manufacturing	1,850	1,950	2,050
Durables	950	1,000	1,050
Nondurables	900	950	1,000
Food and kindred	250	300	350
Printing	450	450	450
Other nondurables	200	200	200
Nonmanufacturing	34,750	36,450	38,500
Mining	100	100	100
Construction	2,650	2,800	3,000
Transportation and utilities	2,400	2,500	2,600
Trade	10,350	10,650	11,050
Wholesale	1,400	1,300	1,300
Retail	8,950	9,350	9,750
Finance, insurance, and real estate	1,300	1,250	1,300
Services	6,850	7,400	8,000
Government	11,100	11,750	12,450
Federal	650	650	650
State and local	10,450	11,100	11,800
All industries total	38,950	40,800	43,050

Between July 1976 and July 1977 wage and salary employment increased by an estimated 4.7 percent, from 38,950 to 40,800 with job gains recorded in most industries. The expansion during the past year was paced by employment gains in government (+650), services (+550) and retail trade (+400) as business activity continued to expand. Although agricultural production was affected by the drought, farm employment is estimated to have increased slightly between July 1976 and July 1977.

Monterey County employment and labor force should show continued growth through mid-1978, but at a rate somewhat reduced from which occurred during the 12-month period ending in July 1977. Services, retail trade, and government industry divisions will generate most of the increased job opportunities, pushing employment up 4.3 percent above July 1977 levels. The number of unemployed is not expected to drop any further by July of 1978, because growth in the labor force will match the number of new jobs. When measured against the larger labor force, however, the unemployed will constitute 6.0 percent of the labor force in July 1978, down slightly from the 6.3 percent recorded in July 1977 (Table II.G.2.b-7).

Table II.G.2.b-7

MONTEREY COUNTY ESTIMATED CIVILIAN LABOR FORCE, EMPLOYMENT, AND UNEMPLOYMENT 1976-1978

	July 1976	July 1977	Forecast July 1978
Civilian Labor	114,500	121,500	126,400
Employment	106,600	114,300	119,200
Unemployment	7,900	7,200	7,200
Unemployment Rate			
Unadjusted Rate	6.9	5.9	5.7
Seasonally Adjusted Rate	7.3	6.3	6.0

The number of jobholders in Santa Cruz County will be growing modestly during the forecast period ending July 1978. The rate of growth, however, will be slower than it was during the past year. Comparison with the July 1977 figure in Table II.G.2.b-8 must be qualified because that total was affected by an expanded summer youth program. Aside from seasonal fluctuations which can be quite large, the outlook period will be characterized by a slowly falling level of unemployment. As a result, the seasonally adjusted unemployment rate will edge lower during the period, but is expected to exceed the national unemployment rate.

Table II.G.2.b-8

SANTA CRUZ COUNTY
ESTIMATED CIVILIAN LABOR FORCE, EMPLOYMENT, AND UNEMPLOYMENT 1976-1978

	July 1976	July 1977	Forecast July 1978
Civilian Labor Force	72,200	76,600	78,000
Employment	65,900	70,900	72,700
Unemployment	6,300	5,700	5,300
Unemployment Rate			
Unadjusted Rate	8.7	7.4	6.8
Seasonally Adjusted Rate	9.0	7.7	7.0

The seasonally adjusted unemployment rate in the San Francisco-Oakland labor market area dropped from 10.3 percent in July 1976 to 8.3 percent in July 1977, as unemployment declined sharply during the recent economic recovery period. Total employment in the Bay Area will rise to 1,430,200 in July 1978, keeping pace with the expanding economy. During the same period, unemployment will continue to decline and reach 125,600 in July 1978. Consequently, the seasonally adjusted unemployment rate will fall to 7.7 percent in July 1978 (Table II.G.2.b-9).

Table II.G.2.b-9

SAN FRANCISCO-OAKLAND LABOR MARKET AREA[a]
ESTIMATED CIVILIAN LABOR FORCE, EMPLOYMENT, AND UNEMPLOYMENT

	July 1976	July 1977	Forecast July 1978
Civilian Labor Force	1,538,100	1,525,000	1,555,800
Employment	1,371,000	1,392,600	1,430,200
Unemployment	167,100	132,400	125,600
Unemployment Rate			
Unadjusted Rate	10.9	8.7	8.1
Seasonally Adjusted Rate	10.3	8.3	7.7

[a]Includes Marin, Contra Costa, Alameda, San Mateo, and San Francisco Counties.

Total employment in Santa Clara County reached a record level of 553,300 in July 1977, increasing by 23,200 from July 1976. During the same period, total unemployment fell by 8,900, to 36,200. The seasonally adjusted unemployment rate dropped from the 7.8 percent recorded in July 1976, to 6.1 percent in July 1977. Strong job gains in services, manufacturing, retail trade, and government were largely responsible for this improvement (Table II.G.2.b-10).

Table II.G.2.b-10

SANTA CLARA COUNTY
ESTIMATED CIVILIAN LABOR FORCE, EMPLOYMENT, AND UNEMPLOYMENT

	July 1976	July 1977	Forecast July 1978
Civilian Labor Force	575,200	589,500	605,500
Employment	530,100	553,300	571,800
Unemployment	45,100	36,200	33,700
Unadjusted Rate	7.8	6.1	5.6
Seasonally Adjusted Rate	7.8	6.1	5.6

Recruitment in manufacturing, services, and retail trade will be an important factor in further improvement of the labor figures in the coming year. The total number of employed residents in Santa Clara County will increase by 18,500 by July 1978, reaching a level of 571,800. Meanwhile, total unemployment will decline by 2,500, to a level of 33,700. A jobless total lower than that has not been recorded since October 1974. Unemployment will decrease in 1978 at a slower rate than in 1977 because a growing population and a rising labor force participation rate make reducing joblessness increasingly difficult once a certain point is reached. The seasonally adjusted unemployment rate will fall to 5.6 percent by July 1978.

For each month between July 1976 and July 1977, unemployment in Sonoma County was consistently below the year-earlier level. This pattern paralleled recovery from the recession, the impact of which was most strongly felt in 1975. By mid 1978, further improvement in the unemployment situation should occur, although the rate of decline in the jobless totals will become less brisk. As a result, the seasonally adjusted unemployment rate will contract to 7.5 percent in July 1978 from the mid-1977's 8.3 percent. The level recorded in mid-1976 was 9.5 percent (Table II.G.2.b-11).

Table II.G.2.b-11

SONOMA COUNTY
ESTIMATED CIVILIAN LABOR FORCE, EMPLOYMENT, AND UNEMPLOYMENT

	July 1976	July 1977	Forecast July 1978
Civilian Labor Force	101,300	107,000	113,600
Employment	91,400	97,900	104,900
Unemployment	9,900	9,100	8,700
Unemployment Rate			
Unadjusted Rate	9.8	8.5	7.7
Seasonally Adjusted Rate	9.5	8.3	7.5

On the employment side of the economic scene, the number of jobholders grew by 6,500, or 7.1 percent, between July 1976 and July 1977. Thus, for the second consecutive year, an extremely vigorous rate of growth was sustained. During the forecast period, an additional 7,000 increase in employment is projected, amounting to a 7.2 percent rate of expansion. Several developments, discussed in the following pages, will contribute to this outlook. Because of unique conditions, employment in Sonoma County should experience a healthier growth rate during the coming year than occurs in the State as a whole.

Outpacing the growth rate of the State as a whole, civilian employment in Solano and Napa Counties expanded significantly between July 1976 and July 1977. However, because the labor force grew slightly faster than new jobs were created, total unemployment edged upward by 200 during this period. Yet, the seasonally adjusted unemployment rate eased downward by one-tenth of a percent between Julys; the increased number of unemployed was small compared to the sizeable employment growth (Table II.G.2.b-12).

Employment growth in Solano and Napa Counties will continue to be strong during 1978. Rising consumer demand spurred by considerable population expansion, will translate into job gains in retail trade, services, and government. Meanwhile, a generally healthy national economic climate will combine with the local area's attractiveness to new businesses, resulting in significant employment advances in manufacturing, wholesale trade, construction, and agriculture. The transportation-public utility and finance-insurance-real estate complexes will increase the size of their payrolls due to expansion of both consumer and industrial activity. At the same time, the total unemployed will decline slowly because the employment growth rate should outpace slightly the rate of labor force expansion. As a consequence, the seasonally adjusted unemployment rate will recede from 6.2 percent in July 1977 to 5.7 percent in July 1978.

Table II.G.2.b-12

NAPA AND SOLANO COUNTY
ESTIMATED CIVILIAN LABOR FORCE, EMPLOYMENT, AND UNEMPLOYMENT

	July 1976	July 1977	Forecast July 1978
Civilian Labor Force	107,100	114,000	120,700
Employment	100,100	106,800	113,700
Unemployment	7,000	7,200	7,000
Unemployment Rate			
Unadjusted Rate	6.5	6.3	5.8
Seasonally Adjusted Rate	6.3	6.2	5.7

Petroleum Industry Employment, Baseline Data for Southern California. Petroleum production and service industries are well established in California, for both onshore and offshore production. Employment statistics are generally reported under the following U.S. Department of Commerce Standard Industrial Classification Codes, (SIC Codes).

Description	SIC Code
Crude Petroleum and Natural Gas	13
Oil and gas field services	138
Drilling oil and gas wells	1381
Oil and gas field exploration	1382
Oil and gas field services	1389
Petroleum Refining and Related Industries	29
Petroleum refining	2911
Paving mixtures and blocks	2951
Asphalt felts and coatings	2952
Manufacture of Oil Field Machinery and Equipment	3533

Description	SIC Code
Pipelines	46
Water Transportation	44
Ship and Boat Building and Repair	373

Table II.G.2.b-13 summarizes current (September, 1975) and projected (1980 and, for comparison, 1975 projected) employment, according to figures obtained from the California Employment Development Department.

Table II.G.2.b-13

SOUTHERN CALIFORNIA OIL AND GAS INDUSTRY EMPLOYMENT

		Los Angeles Co.			Orange Co.			San Diego Co.			Ventura Co.			Santa Barbara Co.		
		Projected		Current	Projected		Current	Projected		Current	Projected		Current	Projected		Current
	SIC	'75	'80	Empl.	'75	'80	Empl.	'75	'80	Empl.	'75	'80	Empl.	'75	'80	Empl.
Crude Pet. and Nat. Gas	13	9.9	10.5	9500	2.1	2.5	1900	0	0	<20	1.6	1.7	1700	.6	.7	600
Petro. & Coal Prods.	29	13.5	13.4	12700	.9	.9	1000	.1	.1	0	.1	.2	32	.2	.3	150
Petroleum Refining	291	11.3	11.0	10800	.8	.8	800	0	0	0.	.1	.2	28	.2	.3	145
Misc. Pet. Coal Prods.	295-9	2.2	2.4	1900	.1	.1	200	.1	.1	0	0	0	4	0	0	5
Water Transportation	44	6.4	6.3	5800	.2	.2	100	.4	.4	100[a]	.2	.3	165	.1	.1	35
Pipelines	46	0	0	100	0	0	0	0	0	15	0	0	0	0	0	1
Constr. Machines	353	11.0	11.8	10800	1.9	2.2	500	.6	.8	450	.7	.8	650	0	0	30
Ship, Boat Bldg. Repair	373	12.6	13.2	4600	3.0	4.3	2700	7.8	8.3	7800	.3	.3	150	.1	.1	15

Projections are rounded to thousands.

[a] Fluctuates from 100 to 300 during the year.

Source of "Current employment:"

Current Employment Statistics Program
Underlined figures -- ES 202 listings 4th Quarter 1974

From: Onshore Impacts of Offshore Southern California OCS Sale No.35, OPR, 1976, page VIII-10.

c. Income Characteristics: This section discusses Gross National and Gross State Product as well as current trends of Personal Income, Per Capita Income, and Median Family Income for the State of California and the five Southern California coastal counties.

i. Gross National and Gross State Product: 1976 was a year of strong economic expansion in both the nation and California. Real gross national product rose at an estimated 6.3 percent, with notable gains in auto sales, housing investment, inventory building and net exports. The softness which affected demand during the second and third quarters of the year appears to have been a temporary respite from the heady pace of expansion which occurred earlier in the recovery. The economy is expected to continue expanding with strong activity forecast for next year.

Real GNP is projected up 4.8 percent for 1977 with a further growth of 4.9 percent in 1978. Above-average gains are expected to occur in spending for durable goods, and for investment projects. The strength in homebuilding will continue, and a pickup in plant and equipment investment will be well underway by the end of this year. It is also anticipated that the government sector will contribute more to overall growth during this year and next than in the past because of policies designed to reduce unemployment--most probably through federally supported hiring at the State and local level (See Table II.G.2.c-1).

The Federal Reserve Board is expected to accommodate expansion with moderate increases of 5 to 7 percent in the money supply. With demand for loans from commercial banks remaining somewhat lower than anticipated and rising corporate retained earnings, no significant run-up in interest rates should occur. A gradual increase in the prime rate to slightly more than 7 percent during the second and third quarters of 1977, and moderate firming in short-term rates should not lead to a renewed inflationary spiral.

Reflecting the improved economic situation, corporate profits should be up strongly during 1977, rising by more than 13 percent to $167 billion. This follows a 29 percent gain in 1976. A further advance of 8.7 percent has been forecast in pre-tax profits for 1978. In many cases this will lead to higher dividends and will also permit internal financing of many investment projects, effectively restraining demands on financial markets.

There is some disagreement on the need for new plant and equipment investment at the present time, as various surveys of industrial capacity and utilization rates yield different results. It appears likely that capacity shortages will start to develop in some industries, thus stimulating new investment. However, other industries for which demand

Table II.G.2.c-1

GROSS NATIONAL PRODUCT 1975-1978

NATIONAL DATA (Dollar amounts in billions)	1975	1976	Forecast 1977	Forecast 1978
Gross national product	$1,516.3	$1,693.1	$1,868.0	$2,063.0
Personal consumption expenditures	973.2	1,077.8	1,183.5	1,302.5
Durable goods	131.7	156.8	175.5	193.8
Nondurable goods	409.1	439.0	471.0	506.7
Services	432.4	482.0	537.0	602.0
Gross private domestic investment	183.7	242.3	282.5	325.0
Nonresidential structures	52.0	55.1	62.0	70.1
Producers' durable equipment	95.1	105.2	120.4	140.9
Residential	51.2	66.9	84.1	104.0
Change in inventories	-14.6	15.1	16.0	10.0
Net exports	20.5	7.4	5.5	3.5
Government purchases	339.0	365.6	396.5	432.0
Federal	124.4	132.7	142.0	152.2
State and local	214.5	232.9	254.5	279.8
GNP, 1972 dollars	1,191.7	1,266.4	1,326.7	1,391.2
Personal income	1,249.7	1,374,0	1,513,0	1,666.0
Less: Personal taxes and nontax payments	168.8	192.5	208.0	225.0
Disposable income	1,080.9	1,181.5	1,305.0	1,441.0
Savings	84.0	78.2	94.1	109.1
Savings rate (%)	7.8	6.6	7.2	7.6
Corporate profits before taxes	114.5	147.5	167.0	181.5
Consumer price index (1967=100)	161.2	170.7	180.0	188.8
Housing starts (thousands)	1,160	1,540	1,750	1,800
New car sales (millions)	8.6	10.2	10.8	10.8
Civilian labor force (000)	92,613	94,700	96,800	98,750
Employment	84,783	87,500	90,100	92,650
Unemployment	7,830	7,200	6,700	6,100
Unemployment rate (%)	8.5	7.6	6.9	6.2

Source: California Department of Finance, California Economic Indicators, December 1976.

does not build up rapidly will have less need for major expansion. It was estimated that plant and equipment spending would rise by 8.8 percent in real terms in 1977, with acceleration to an 11.2 percent growth in 1978.

Consumer price trends have shown gradual improvement during the past year. Increases in wholesale prices which have recently occurred are not expected to be passed along to the consumer in full. There is concern in the business community that the new Administration will push for wage and price controls. This appears to have led to a philosophy of increasing list prices beyond what could be supported by market conditions in order to establish a higher base in the event controls should be imposed. The probability of controls being reinstituted appears minor at the present time, given the noninflationary nature of the present expansion. Wholesale prices are therefore likely to be discounted in many instances, which will prevent a significant run-up in the consumer price index.

During the second half of 1975, large increases were registered in housing starts--primarily for single-family units, although improvement in apartment units was moderate. The continued availability of mortgage money, relatively stable interest rates, and a backlog of demand have laid the foundation for further gains in this sector. More than 1.5 million housing starts were registered during 1976. This was expected to increase to 1.75 million during 1977, with a further rise to 1.8 million in 1978. The greater proportion of 1977 activity was again predicted to be in single-family building. By 1978, however, the oversupply of apartment units--still existing in some parts of the country--should be largely reduced, permitting a resurgence in this area.

The current forecast does not incorporate an assumption of a national housing program which could lead to a new overbuilding situation in many areas and the onset of a construction boom-bust cycle.

It was anticipated that employment during 1977 would rise by 3 percent with a further 2.8 percent gain during the following year. Employment gains have been reflected in personal income, with significant increases in wages and salaries; dividends, interest income, and nonfarm proprietors' income have also expanded sharply. Personal income, which increased by 9.9 percent during 1976 was forecast up 10.1 percent in 1977 and 1978 providing momentum for the consumer sector. Much of the strength in purchasing was expected to be felt in autos. An estimated 10.2 million cars were sold during 1976, with strong demand for standard size cars. It is expected that total car sales in both 1977 and 1978 will amount to 10.8 million units. Demand for other remains high. Sales of furniture and fixtures, for instance, are expected to rise more rapidly both this year and next, reflecting the developing strength in residential construction. The service and nondurable sectors also will continue to post substantial gains.

Expansion in California was substantial during 1976, with a gain of 3.8 percent in wage and salary employment (representing 293,000 jobs), and a rise of 10.5 percent in personal income. Major gains were posted during the year in nonaerospace manufacturing, (up by 6%), services (+5.1%), trade (+4.9%), and the financee-insurance-real estate sector (+4.5%). Nevertheless, the State's unemployment rate remained at relatively high levels, averaging 9.6 percent for the year. However, the rate declined after midyear and appears to be on a downward trend at the present time.

The outlook for the State during the next 2 years is favorable. Major increases in employment will be achieved, with 290,000 wage and salary jobs added this year and a further gain of 270,000 jobs forecast for 1978. Concurrent with this expansion will be a gradual reduction in the State's jobless rate to an estimated 8.4 percent this year and 7.4 percent next year. This drop will occur as a result of advances in civilian employment outstripping growth in the labor force.

California's gross State product (GSP) will move ahead 13.2% in 1977, to a new landmark of $214 billion. In real terms, GSP will advance by 6.5%, on top of 1976's surprisingly strong 6.4% increase (Table II.G.2.c-2). In fact, California's economy has a resiliency that is the envy of other states and many nations. Real GSP slipped by 2.2% in 1975--fairly comparable to the 1.8% drop in real GNP. Then, the State's real growth in output spurted past the nation's in 1976 and should outpace it again in 1977. This reflects California's unique blend of agri-business, high-technology manufacturing and business services, as well as leisure-time activities.

If California were a separate nation, it would rank as the ninth largest country in the world in total output of goods and services. The State is not far behind Italy in volume of output and stands ahead of certain large countries such as Canada, Brazil, India, Australia, Mexico and Sweden.

The primary forces contributing to the continuation of the economic upswing in 1977 include: Continued population growth and nationwide advance in capital spending (which will impact very favorably on such major industries as electrical equipment, electronics and nonelectrical machinery manufacturing), business services, and construction. However, the State's economic path in 1977 will have some obstacles. The main concerns focus on the uncertainty over some defense projects, namely the B-1 program and continuing unemployment problems due to rapid growth of the labor force. This will cause budgetary and employment

Table II.G.2.c-2

CALIFORNIA GROSS STATE PRODUCT

YEAR	Gross State Product (billions current $)	Percent Change Over Prior Year: Gross Product	Percent Change Over Prior Year: California Price Index
1971	$118.0	7.1%	3.7%
1972	127.9	8.4	3.4
1973	140.6	9.9	5.8
1974	154.7	10.0	10.2
1975	167.6	8.3	10.5
1976 (est.)	$189.0	12.8	6.5%
1977 (fcst.)	$214.0	13.2%	6.7%

United California Bank, Research and Planning Division, Forecast 1977, November, 1976.

strains for already hard-pressed local governments. Environmental constraints will limit land available for new homebuilding and increase costs. The business development climate in the State, which will remain murky, will also be a formidable obstacle.

ii. Personal Income: Employment gains will contribute to the rising forecast for personal income. Income is expected to reach $169.5 billion in 1977, an increase of 10.1 percent from the 1976 level. A further gain of 9.8 percent will carry the 1978 total to $186.15 billion. Another major factor in the advance will be property income, with sharply higher dividends and interest payments. Farm proprietors' income could experience some erosion from the forecast level during the year if the drought continues (Tables II.G.2.c-3 and 4).

The employment and income gains registered in the State indicate the present strength in consumer markets. Sales in California appear to have outpaced those of the nation during 1976 with particular strength in autos, recreational vehicles, building materials, home furnishings and various specialty categories. This trend should continue both this year and next.

Table II.G.2.c-3

CALIFORNIA GROSS STATE PRODUCT 1975-1978

CALIFORNIA DATA (Dollar amounts in millions)	1975	1976	Forecast 1977	Forecast 1978
Personal income	$139,337	$154,005	$169,500	$186,150
Wages and salaries	89,348	98,850	108,400	118,700
Other labor income	5,706	6,620	7,480	8,320
Proprietors' income	9,784	10,655	11,580	12,550
Property income	20,210	22,240	25,260	28,310
Transfer payments	20,082	22,045	23,900	26,150
Less: Contributions for social insurance	5,937	6,575	7,310	8,090
Residence adjustment	145	170	190	210
Personal taxes and nontax payments	18,504	21,175	22,860	24,740
Disposable income	120,833	132,830	146,640	161,410
Civilian labor force (000)	9,380	9,510	9,660	9,800
Employment	8,455	8,595	8,845	9,070
Unemployment	925	915	815	730
Rate (%)	9.9	9.6	8.4	7.4
Nonagricultural wage and salary workers (000)	7,836	8,137	8,430	8,700
Mining	34	35	35	35
Construction	304	312	335	350
Manufacturing	1,585	1,646	1,695	1,745
Transportation-utilities	460	461	470	480
Trade	1,787	1,875	1,950	2,015
Finance-insurance-real estate	448	468	485	505
Services	1,550	1,629	1,710	1,790
Government	1,668	1,711	1,750	1,780
Consumer price index (1967=100)	158.5	168.2	178.1	186.9
Housing units authorized (000)	131	215	240	275
New car sales (000)	808	910	990	990

Source: California Department of Finance, California Economic Indicators, December, 1976.

Table II.G.2.c-4

CALIFORNIA PERSONAL INCOME
(In millions of dollars)

	1976 I	1976 II	1976 III
WAGES AND SALARIES (place of work)	94,290	97,509	100,143
Farm	1,470	1,500	1,540
Mining	598	598	614
Construction	4,735	4,590	4,760
Manufacturing	20,589	21,500	21,948
Trade	16,375	16,817	17,209
TCU	6,536	6,778	6,918
Transportation, ex railroad	3,280	3,398	3,463
Railroads	540	552	565
Communication-utilities	2,716	2,828	2,890
Finance-insurance-real estate	5,168	5,351	5,443
Services	15,646	16,228	16,401
Government	22,560	23,423	24,534
Federal civilian	4,515	4,916	5,064
Military	3,100	3,330	3,380
State and local	14,945	15,177	16,090
Other industries	623	724	776
OTHER LABOR INCOME (place of work)	6,193	6,495	6,764
PROPRIETORS' INCOME (Place of work)	10,356	10,560	10,764
Farm	2,406	2,420	2,454
Nonfarm	7,950	8,140	8,310
PROPERTY INCOME (place of residence)	21,336	21,800	22,490
TRANSFER PAYMENTS (place of residence)	21,688	21,498	22,176
LESS: CONTRIBUTIONS FOR SOCIAL INSURANCE (place of work)	6,274	6,482	6,660
PLUS: RESIDENCE ADJUSTMENT	163	168	173
TOTAL PERSONAL INCOME (place of residence)	147,752	151,548	155,850

Source: California Department of Finance, California Economic Indicators, December, 1976.

Housing activity has been a major factor in sustaining California's recovery. Approximately 215,000 housing units were authorized in the state during 1976, a rise of 63 percent from the 1975 level. While the gain is significant in both single and multiple units, multiples have rebounded from the low levels of the past few years. Demand has continued strong despite the rising costs of construction, and declining vacancy rates suggest that the market will improve further in 1977. The current forecast is for 240,000 new units this year with 275,000 new units by 1978. Nonresidential construction is also expected to improve during 1977 with strong advances in office-professional buildings and stores.

Price increases in California have remained slightly higher than the national average throughout 1976. The annual increase over 1975 is estimated at 6.1 percent for all items. Further increases in the cost of living are predicted, although these gains will be much lower than the past several years. Advances in the California CPI are forecast at 5.9 percent for 1977, dropping to 4.9 percent in 1978.

In the five county study area, Los Angeles County is by far the personal income leader with $53.12 billion in 1976 which was a 10.6 percent increase above 1975. Orange County was the growth leader with a 13.3 percent increase during the 1975-76 period while San Diego was lowest with a 11.4 percent increase. However, San Diego County's increase was still above the statewide growth rate of 11.2 percent. Personal income is again projected to increase substantially in 1977 with Orange County again leading the way with a 14.7 percent increase while Santa Barbara County is projected to show a modest 10.8 percent rise (Table II.G.2.c-5).

iii. Per Capita Personal Income: California's per capita personal income was $6,497 in 1975 and grew 10.6 percent to $7,184 in 1976. It is forecast to continue its growth in 1977 by reaching $7,905 for a 10.0 percent increase. All five Southern California counties had positive growth rates in 1975 and 1976 and are forecast to grow again in 1977. Los Angeles County was the per capita personal income growth leader in 1976 with a 11.2 personal income growth leader in 1976 with a 11.2 percent rate while San Diego County had the lowest growth rate with a 2.3 percent increase.

San Diego County has experienced rapid population growth combined with sluggish economic growth and a high unemployment rate which resulted in the lower than average per capita personal income growth rate. Table II.G.2.c-6 shows per capita personal income for the five Southern California counties and California for the years 1975, 1976 and a forecast of 1977.

Table II.G.2.c-5

PERSONAL INCOME, SOUTHERN CALIFORNIA COUNTIES AND CALIFORNIA

COUNTIES	Estimated (millions) 1975	1976	Forecast (millions) 1977	Numerical Change (millions) 75/76	76/77	Percent Change 75/76	76/77
Santa Barbara	1,785	2,000	2,215	216	215	12.1	10.8
Ventura	2,430	2.695	3,010	284	315	11.8	11.7
Los Angeles	47,800	53,120	58,900	5,105	5,780	10.6	10.9
Orange	11,635	13,205	15,150	1,555	1,945	13.3	14.7
San Diego	9,745	10,430	11,695	1,070	1,265	11.4	12.1
California	138,000	155,000	173,000	15,663	18,000	11.2	11.6

Source: United California Bank, Research and Planning Division, 1977 Forecast, November 1976.

Table II.G.2.c-6

PER CAPITA PERSONAL INCOME, SOUTHERN CALIFORNIA COUNTIES AND CALIFORNIA

	Estimated		Forecast	Numerical Change		Percent Change	
COUNTIES	1975	1976	1977	75/76	76/77	75/76	76/77
Santa Barbara	6,330	7,042	7,718	712	676	11.2	9.6
Ventura	5,472	5,884	6,404	412	520	7.5	8.8
Los Angeles	6,849	7,614	8,414	765	800	11.2	10.5
Orange	6,772	7,348	8,163	576	815	8.5	11.1
San Diego	6,110	6,253	6,780	143	527	2.3	8.4
California	6,497	7,184	7.905	687	721	10.6	10.0

Source: United California Bank, Research and Planning Division, 1976 and 1977 Forecast.

iv. Median Family Income: California median family income grew 8.8 percent in 1976 to $16,825 and is forecast to grow to $18,220 in 1977 for an 8.3 percent growth rate. Of the five Southern California counties, Orange County had the highest median family income with $17,780 while San Diego County was lowest with $14,450. Los Angeles and Orange Counties compare favorably with the Statewide average median family income while San Diego, Ventura and Santa Barbara Counties are below the Statewide norm. Orange County is projected to be the percent total growth leader in 1977 with a $1,640 increase or 9.2 percent above 1976's median family income. Table II.G.2.c-7 shows median family income for the five Southern California counties of Los Angeles, San Diego, Ventura, Santa Barbara and Orange in addition to California and the United States for the years 1970, 1974, 1975 and a forecast of 1977.

v. Central California and Bay Area Income: This section covers personal income and median family income of the central California coastal and Bay Area counties. The impact of Lease-Sale No. 48 related activities on these counties' income would not be directly related to drilling and production activities but would be impacted by secondary economic activities. The incomes of these counties is shown in Table II.G.2.c-8.

Table II.G.2.c-7

MEDIAN FAMILY INCOME, SOUTHERN CALIFORNIA AND THE NATION

COUNTIES	1970	Actual 1974	1975	Estimated 1976	Forecast 1977	Numerical Change 75/76	76/77	Percent Change 75/76	76/77
Los Angeles	11,390	15,290	15,475	17,215	18,730	1,485	1,515	9.5	8.8
San Diego	10,507	13,260	14,170	14,450	15,430	945	980	7.0	6.8
Ventura	11,423	14,395	15,110	15,055	17,105	1,160	1,050	7.8	6.5
Santa Barbara	10,931	13,895	15,090	16,820	18,120	1,525	1,300	10.0	7.7
Orange	12,620	15,310	16,560	17,780	19,420	1,435	1,640	8.8	9.2
California	11,156	14,485	15,220	16,825	18,220	1,365	1,395	8.8	8.3
United States	9,867	13,000	13,900	14,800	16,000	900	900	6.9	6.5

Source: United California Bank, Research and Planning Division, 1974, 1976, 1977 Forecast.

Table II.G.2.c-8

CENTRAL COAST AND BAY AREA COUNTIES
ESTIMATED TOTAL PERSONAL INCOME AND MEDIAN
FAMILY INCOME, 1977

County or Area	Total Personal Income (millions of dollars)	Median Family Income
San Luis Obispo	807	14,995
Monterey	2,215	17,445
Santa Cruz	1,080	14,055
San Francisco - Oakland[a]	29,745	20,565
Santa Clara	10,970	23,260
Napa-Solano	2,010	16,565
Sonoma	1,855	16,455
TOTAL	48,682	NA
California Total	171,650	18,255

[a]Includes San Francisco, San Mateo, Marin, Alameda, and Contra Costa Counties.

Source: United California Bank, 78 Forecast, 1977.

d. Coastal Economy: This section contains a discussion of the southern and central coast of California and Bay Area local government financial transactions and tax base, taxable sales, hospital facilities, and school enrollments. Subsection i discusses the coastal commercial fishing industry from Point Reyes in Marin County to Punta Eugenia in Baja California, Mexico. Subsection ii discusses the California oil and gas industries. More detailed descriptions of each of the above subjects can be found in Pacific OCS Reference Paper No. II. Financial transactions concerning counties, cities and school districts by county during the 1974-75 fiscal year are shown in Table II.G.2.d-1. The assessed value of tangible property subject to local taxation, taxes levied, average tax note, and the assessment ratio, by county for 1975-76 fiscal year is shown in Table II.G.2.d-2. A discussion of taxable sales in California taken from the State Board of Equalization's Sixteenth Annual Report follows.

Taxable Sales. The sales subject to California's sales and use tax reached $83.8 billion during 1976. The total was $10.3 billion, or 14.1 percent higher than that in 1975. Price increases averaged 6.1 percent for the year; therefore, expressed in 1975 constant value dollars, the physical volume of goods sold or used in the State increased by 8 percent. This was in sharp contrast to the decrease of 2.3 percent during 1975 in terms of constant value dollars. Taxable sales performance throughout the year and significant comparisons are presented in Table II.G.2.d-3.

Retail stores attracted $57.3 billion in taxable sales, accounting for 68.4 percent of all transactions subject to sales taxation. Early in the recession, financial savants stated that economic recovery would depend upon consumers spending more and saving less. The annual increase of $7.5 billion, or 15.1 percent for retail stores with its impact on manufacturing, construction, trade and services, indicates we were buying our way out of the recession. Expressed in constant-value dollars, the sales volume increased a solid 9 percent during the year.

Retailers featuring durables posted a gain of 20 percent for 1976, far surpassing the growth of those handling nondurables (12.1%). Nodurables have performed fairly consistently over the past three years, with average annual gains of 13 percent. Durables fluctuated widely, however, averaging only 10.5 percent a year.

The largest sales gains were reported by lumber and building materials outlets (35.2%), and mobile home, camper, and trailer dealers (38.2%). Such sales reflect the pressure in demand for both conventional housing and moblile homes. The 220,600 private housing permits authorized during the year were 67 percent above the number for 1975. The production of 25,800 mobile homes in the State during 1976 (nearly all of

Table II.G.2.d-1

FINANCIAL TRANSACTIONS CONCERNING COUNTIES, CITIES, AND SCHOOL DISTRICTS, BY COUNTY, 1974-75
(In thousands of dollars)

County	Counties			Cities			School Districts		
	Receipts	Payments	Bonded Indebtedness	Receipts	Payments	Bonded Indebtedness	Receipts	Payments	Bonded Indebtedness
Los Angeles	$2,391,918	$2,429,768	$ 36,194	$2,303,103	$2,449,562	$ 2,217,885	$2,410,803	$2,387,931	$ 751,047
Orange	289,739	281,159	4,365	330,507	348,515	78,239	645,521	627,133	343,974
San Diego	341,794	339,933	4,580	310,695	332,024	139,785	535,984	529,559	192,900
Santa Barbara	74,511	75,501	--	42,917	46,939	24,901	106,533	105,102	48,329
Ventura	105,623	104,055	--	61,384	64,208	36,026	168,461	170,421	56,572
Southern California Total	$3,103,585	$3,230,416	$ 45,139	$3,048,606	$3,241,248	$ 2,496,836	$3,867,302	$3,820,146	$ 1,392,822
Monterey	58,589	58,754	3,575	34,732	38,752	11,304	95,515	94,319	18,629
San Luis Obispo	31,080	31,191	165	15,259	17,705	7,330	36,703	35,785	8,400
Santa Cruz	43,743	42,010	3,250	22,446	23,615	19,215	48,798	48,839	17,759
Central Coast Total	$ 133,412	$ 131,955	$ 6,990	$ 72,437	$ 80,072	$ 37,849	$ 180,016	$ 178,943	$ 44,788
Alameda	306,462	284,998	--	290,502	272,140	144,134	413,106	415,257	155,513
Contra Costa	176,301	175,217	1,230	91,749	90,546	36,129	243,850	243,747	74,636
Marin	53,247	51,442	6,180	25,988	26,383	8,436	81,567	82,829	23,659
Napa	20,393	20,684	2,820	12,689	11,788	12,183	32,385	31,626	11,288
San Francisco	--	--	--	717,323	760,552	643,821	194,914	201,958	58,151
San Mateo	125,852	123,172	--	107,099	109,199	20,741	206,849	211,683	80,791
Santa Clara	277,991	286,765	57,850	275,442	281,946	163,827	503,475	500,653	229,502
Solano	40,843	41,387	6,850	33,440	35,204	44,944	64,487	63,318	30,719
Sonoma	65,744	66,308	--	39,026	37,326	19,328	80,940	79,999	35,787
Bay Area Total	$1,066,833	$1,049,973	$ 74,930	$1,593,258	$1,625,084	$ 1,093,543	$1,821,573	$ 1,831,070	$ 700,046
California Total	$5,893,742	$5,899,543	$ 141,519	$5,412,951	$5,644,597	$ 3,885,000	$7,664,811	$ 7,607,562	$ 2,728,538

Source: California Statistical Abstract, 1976. California State Board of Equalization, 1976.

Table II.G.2.d-2

ASSESSED VALUE OF TANGIBLE PROPERTY SUBJECT TO LOCAL TAXATION, TAXES, AVERAGE TAX RATE, AND ASSESSMENT RATIO, BY COUNTY, 1975-76
(Assessed value and levies in thousands of dollars)

County	Net Taxable Assessed Value	Taxes Levied in 1975-76					Average Tax Rate per $100 of Assessed Value	Assessment Ratio (in Percent)
		City	County	School	Other District	Total		
Los Angeles	$22,094,306	$405,958	$1,011,746	$1,335,987	$ 67,998	$2,821,689	12.77	25.3
Orange	6,377,135	66,593	115,087	389,625	45,030	616,335	9.66	26.5
San Diego	5,121,849	63,626	137,070	289,776	28,522	518,994	10.13	24.0
Santa Barbara	849,054	5,022	27,734	58,777	9,512	101,045	11.90	21.0
Ventura	1,448,449	9,068	42,429	85,540	23,848	160,885	11.11	24.8
Southern California Total	$35,890,793	$550,267	$1,334,066	$2,159,705	$174,910	$4,218,948	11.75	25.2
Monterey	1,068,851	7,304	26,200	57,495	6,675	97,674	9.14	25.5
San Luis Obispo	497,156	2,790	15,217	26,843	2,743	47,593	9.57	23.7
Santa Cruz	551,271	2,736	16,162	34,620	3,896	57,414	10.41	23.6
Central Coast Total	$ 2,117,278	$ 12,830	$ 57,579	$ 118,958	$ 13,314	$ 202,681	9.57	24.6
Alameda	3,643,293	65,777	115,642	239,225	58,847	479,491	13.16	24.8
Contra Costa	2,500,354	23,706	69,782	155,716	52,178	301,382	12.05	26.1
Marin	975,996	9,541	24,238	62,360	11,415	107,554	11.02	23.7
Napa	319,620	2,324	7,881	16,232	1,218	27,655	8.65	22.9
San Francisco	2,950,756	--	198,737	127,428	17,109	343,274	11.63	23.4
San Mateo	2,724,613	26,283	49,368	162,739	15,633	254,023	9.32	25.6
Santa Clara	4,383,309	50,679	116,888	316,040	19,505	503,112	11.48	24.7
Solano	521,378	8,052	16,347	26,988	3,021	54,408	10.44	24.5
Sonoma	831,422	5,760	28,614	58,051	6,243	98,668	11.87	24.7
Bay Area Total	$18,850,741	$192,122	$ 627,497	$1,164,779	$185,169	$2,169,567	11.51	24.7
California Total	$73,245,581	$864,741	$2,545,379	$4,359,707	$526,925	$8,296,752	11.33	24.7

Source: California Statistical Abstract, 1976. California State Board of Equalization, 1976.

Table II.G.2.d-3

CALIFORNIA TAXABLE TRANSACTIONS, 1976

1976	Amount	Percent of Annual Total	Percent Change From Prior Year	Percent Change In Terms of 1975 Dollar	Percent Change In CPI From 1975
1st Quarter	$18,563,820,000	22.1%	15.6	8.2	7.4
2nd Quarter	20,673,196,000	24.7	13.6	7.6	6.0
3rd Quarter	21,261,574,000	25.4	12.5	6.7	5.8
4th Quarter	23,323,430,000	27.8	14.8	9.2	5.6
Annual	$83,822,020,000	100.0%	14.1	8.0	6.1

Source: California State Board of Equalization, 1977.

which are retailed in California) were up 35 percent. Recreational vehicles made strong strides as the State's production of 54,400 motor home and camper units spurted upward 53 percent and the 33,200 travel trailers were 37 percent more than in 1975. The sales of new car dealers advanced 21.6 percent and exceeded the dollar volume of every other class of business. Registrations of 1,147,200 new cars and trucks during the year were up 14.2 percent from 1975.

Among nondurables, service stations (15.2%) made the most significant gain in dollar volume, $956 million. The distribution of 10,756,400,000 gallons of gasoline was up 5.1 percent, while approximately $6,112,400,000 was spent for this fuel at an estimated average cost of 56.8 cents per gallon (excluding sales tax). A substantial part of the increase shown for service stations is attributable to the production of fuel oil for power companies which have converted generating plants from natural gas to fuel oil. In the Board's records, a corporation which operates both refinery and service stations is treated as a unitary operation and classified with service stations. Some refining facilities have been expanded or converted to increase their production of low-sulfur fuel oil to meet the demand of the utilities.

Northern California and the mountain counties for the second consecutive year posted the largest gain in taxable sales (15.4%), maintaining a narrow margin over the San Joaquin Valley and Central Coastal counties (15.2%). Southern California (13.6%) held on to a slight edge over the San Francisco Bay Area (13.5%). (Table II.G.2.d-4.)

Table II.G.2.d-4

SOURCES OF SALES AND USE TAX REVENUES IN CALIFORNIA, 1976

State	1976
Self-assessed tax	$3,981,546,000
Board-assessed tax	43,764,000
Penalties and interest	6,003,000
Tax withheld from gas tax refunds	295,000
Total state sales tax collections	$4,031,608,000
Local	
City and county sales and use tax	$ 846,786,000
Transit district sales and use tax	52,175,000
Transportation fund	211,892,000
Total local sales tax collections	$1,110,853,000
GRAND TOTAL	$5,142,561,000

Source: California State Board of Equalization, 1977.

Table II.G.2.d-5 shows taxable sales by county for 1976 and the 1975 percentage change.

Hospital Facilities. The number of general acute care hospitals and their total bed capacities as well as the number of hospital beds per 100,000 of population of the study area counties is shown in Table II.G.2.d-6.

Public school enrollment in the five Southern California counties held almost steady from 1974 to 1975. Enrollment totaled 2,170,277 in 1975, a decrease of 828 from the 1974 lead of 2,176,105. Los Angeles County enrollment dropped 5,345 or 0.4 percent. That was almost one half of the Statewide decrease of 10,943. However, this was offset by increased enrollment of approximately 5,000 in San Diego and Orange counties. Table II.G.2.d-7 gives a breakdown of public school enrollment for the southern, central and Bay Area counties.

The central coastal counties were counter to the Statewide trend in enrollment, and showed a 1.3 percent increase in 1975. San Luis Obispo County led the way with a 3.8 percent rise.

The Bay Area counties led the Statewide trend of falling enrollments with a 1.4 percent decrease in 1975. Notably, the Bay Area enrollment decreased 13,750 which is greater than the Statewide total decrease. Increases in other counties countered this trend, however, with total Statewide enrollment dropping only by 10,943 in 1975.

Table II.G.2.d-5

TAXABLE SALES, BY COUNTY, IN 1976
(Taxable transactions in thousands of dollars)

County	Taxable Sales	Percent Change, 1975 to 1976
Los Angeles	27,415,161	11.2
Orange	6,965,894	21.1
San Diego	5,395,786	13.8
Santa Barbara	967,683	13.3
Ventura	1,318,829	15.3
Southern California Total	42,063,353	13.3
Monterey	892,841	10.1
San Luis Obispo	459,790	26.6
Santa Cruz	514,731	19.6
Central Coast Total	1,867,362	10.9
Alameda	4,061,993	10.1
Contra Costa	2,291,756	25.7
Napa	278,907	15.7
San Francisco	3,233,058	6.0
San Mateo	2,533,909	14.9
Santa Clara	4,716,474	16.1
Solano	560,248	13.0
Sonoma	884,372	17.2
Bay Area Total	18,560,717	14.0
California Total	83,185,397	13.8

Source: California State Board of Equalization, 1977.

Table II.G.2.d-6

NUMBER OF GENERAL ACUTE CARE HOSPITALS WITH BED CAPACITY OF CALIFORNIA AND SELECTED COUNTIES, 1976

Counties	Number of Hospitals	Total Bed Capacity	Number of Hospital Beds per 100,000 of Population
Los Angeles	186	39,627	565
Orange	40	9,214	527
San Diego	31	5,895	364
Santa Barbara	9	1,317	460
Ventura	11	1,544	340
Southern California Total	277	57,597	518
Monterey	6	859	311
San Luis Obispo	6	543	406
Santa Cruz	4	494	304
Central Coast Total	16	1,896	331
Alameda	26	4,989	456
Contra Costa	10	1,843	308
Marin	6	725	330
Napa	4	3,522	3,841
San Francisco	18	5,470	823
San Mateo	9	2,466	423
Santa Clara	14	4,237	354
Solano	5	522	268
Sonoma	11	3,016	1,194
Bay Area Totals	103	26,790	547
California Totals	571	107,293	499

Source: California Statistical Abstract, 1976.

Table II.G.2.d- 7

TOTAL GRADED ENROLLMENT BY COUNTIES, WITH PERCENT OF INCREASE OR DECREASE SINCE FALL, 1974

County	Graded Enrollment, Kindergarten and Grades One through Twelve, Fall, 1975			Fall 1974	Increase or Decrease Between Fall, 1974 and Fall, 1975	
	Male	Female	Total	Total	Number	Percent
Los Angeles	669,939	648,256	1,318,195	1,323,540	- 5,345	- 0.4
Orange	190,834	185,470	376,304	374,458	1,846	0.5
San Diego	158,162	153,282	311,444	308,476	2,968	1.0
Santa Barbara	28,165	27,423	55,588	56,382	- 794	- 1.4
Ventura	55,750	52,996	108,746	108,249	497	0.5
So. California Totals	1,102,850	1,067,427	2,170,277	2,171,105	- 828	0.0
Monterey	26,977	25,592	52,569	52,514	55	0.1
San Luis Obispo	11,512	10,722	22,234	21,414	820	3.8
Santa Cruz	15,149	14,578	29,727	29,300	427	1.5
Central Coast Totals	53.638	50,892	104,530	103,228	1,302	1.3
Alameda	104,866	100,897	205,763	210,252	- 4,489	- 2.1
Contra Costa	68,113	65,844	133,957	135,569	- 1,612	- 1.2
Marin	21,073	19,831	40,904	41,740	- 846	- 2.0
Napa	8,607	8,845	17,092	17,353	- 261	- 1.5
San Francisco	35,727	32,462	68,189	70,390	- 2,201	- 3.1
San Mateo	54,066	51,626	105,692	109,022	- 3,330	- 3.1
Santa Clara	139,296	134,272	273,568	275,830	- 2,262	- 0.8
Solano	20,834	20,116	40,950	40,387	563	1.4
Sonoma	26,387	25,265	51,652	50,974	678	1.3
Bay Area Totals	478,969	491,260	937,767	951,517	-13,750	- 1.4
California Total	2,182,674	2,101,797	4,284,471	4,295,414	-10,943	- 0.3

Source: Bureau of School Apportionments & Reports, State Department of Education, February, 1976

i. Commercial Fisheries, Kelp Harvesting, and Maricultures: California has historically been an important center in the United States for both commercial and sport fishing interests. In 1975, for example, the total value of its landings of fish and shellfish ($129 million) was only exceeded nationally by those from the State of Alaska (NOAA/NMFS, December 1976).

Since 1916 the California Department of Fish and Game has kept records of California fish landings. These data have shown an almost steady rise from 1916 to 1936 when a peak of 1.76 billion pounds of fish was landed, followed by a fluctuating decline into the early 1950's somewhat stabilized through about 1968. The catch subsequently rose again reaching a high of just over 1 billion pounds in 1973.

The tunas (yellowfin, skipjack, bluefin, Pacific bonito, and albacore) have dominated the California landings, although the Pacific bonito and albacore are the only two species which are caught in significant numbers from California waters. Northern anchovy and jack mackerel, both fished primarily in Southern California waters, have also been among the dominant species in recent years. Other significant species include: California spiny lobster, in Southern California; squid, fished primarily in central and Southern California waters; rockfish, fished throughout, but more significantly in northern California waters; and Dover sole, petrale sole, sablefish, salmon, albacore, Pacific herring, and abalone, all fished primarily from Morro Bay north.

The following is a summary of a more detailed discussion found in POCS Reference Paper No. II.

The Southern California Fishery (Point Conception to the Mexican Border): The Southern California Bight has followed the general trend of commercial landings for the state as a whole and, in fact, has represented the major percentage (Table II.G.2.d.i-1).

Commercial fishing in Southern California has largely consisted of pelagic wetfish (sardine, anchovy, Pacific mackerel, jack mackerel, and squid) and tunas. The anchovy is the most important species in the wetfish industry. The tuna catch, is the result of a worldwide operation, most of the fish being brought to Southern California from waters off Central and South America and West Africa.

The total landings by weight and dollar value of all fish and shellfish species for each of the three principal Southern California areas, San Diego, Los Angeles, and Santa Barbara (ports south of Point Conception only) during the ten year period from 1965-1974 show a general increase

Table II.G.2.d.i-1

A COMPARISON OF COMMERCIAL LANDINGS INTO THE SOUTHERN CALIFORNIA BIGHT WITH THOSE STATEWIDE, 1965-1974

	Total California Landings		Southern California Landings[a]			
Year	Pounds	Value	Pounds	Value	% of State Total lbs.	% of State Total $
1965	544,479,901	$ 66,208,358	72,434,240	$ 39,316,175	68	59
1966	458,440,080	$ 55,149,708	354,373,533	$ 42,721,140	77	77
1967	503,893,182	$ 50,948,900	404,323,964	$ 38,934,421	80	76
1968	445,307,390	$ 53,695,507	348,914,849	$ 40,541,726	78	76
1969	576,735,857	$ 62,516,322	493,756,449	$ 50,343,943	86	81
1970	703,215,504	$ 86,253,713	599,885,655	$ 65,695,144	85	76
1971	582,295,875	$ 86,266,200	474,899,100	$ 65,692,015	82	76
1972	638,241,215	$ 95,044,984	540,310,576	$ 77,985,049	85	82
1973	718,004,675	$104,510,026	621,021,972	$ 84,114,753	86	80
1974	672,344,243	$128,191,987	555,281,333	$104,970,290	83	82
Mean	584,295,792	78,878,570	476,520,167	61,031,466	82	77

[a]Landings into ports from Santa Barbara to San Diego.

in harvest by Southern California fishermen(Figures II.G.2.d.i-1 and 2). From 1972 to 1975, the Los Angeles (San Pedro) area has been the leading port in the United States in both weight and value of landings: San Diego has ranked ninth or tenth in poundage and fourth to eighth in value of landings (NOAA/NMFS, 1973, 1974, 1975, 1976).

Not all landings into Southern California, however, represent catches from California waters. Generally, less that 50 percent of the total landings represent fish and shellfish catches from California waters (Figure II.G.2.d.i-3). The significance of landings from California waters increases rather dramatically from south to north. Assuming the values of fish landed from California waters equals the value of fish landings from other waters, the Southern California commercial fisheries still represent a $19 to $53 million a year industry (1965-1974)

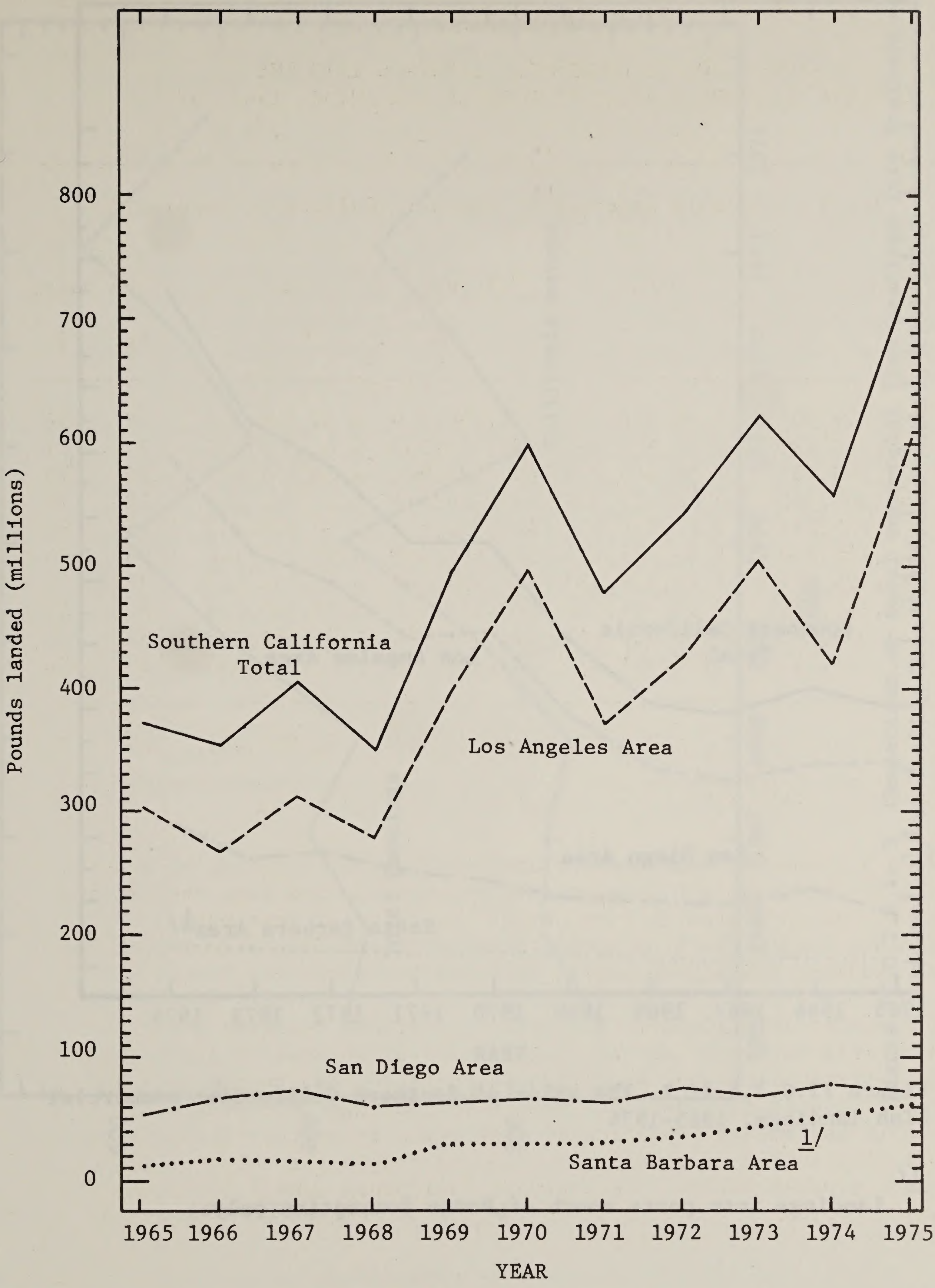


Figure II.G.2.d.i-1 Southern California commercial fish and shellfish landings, 1965-1975.

1/ Landings into ports south of Point Conception only.

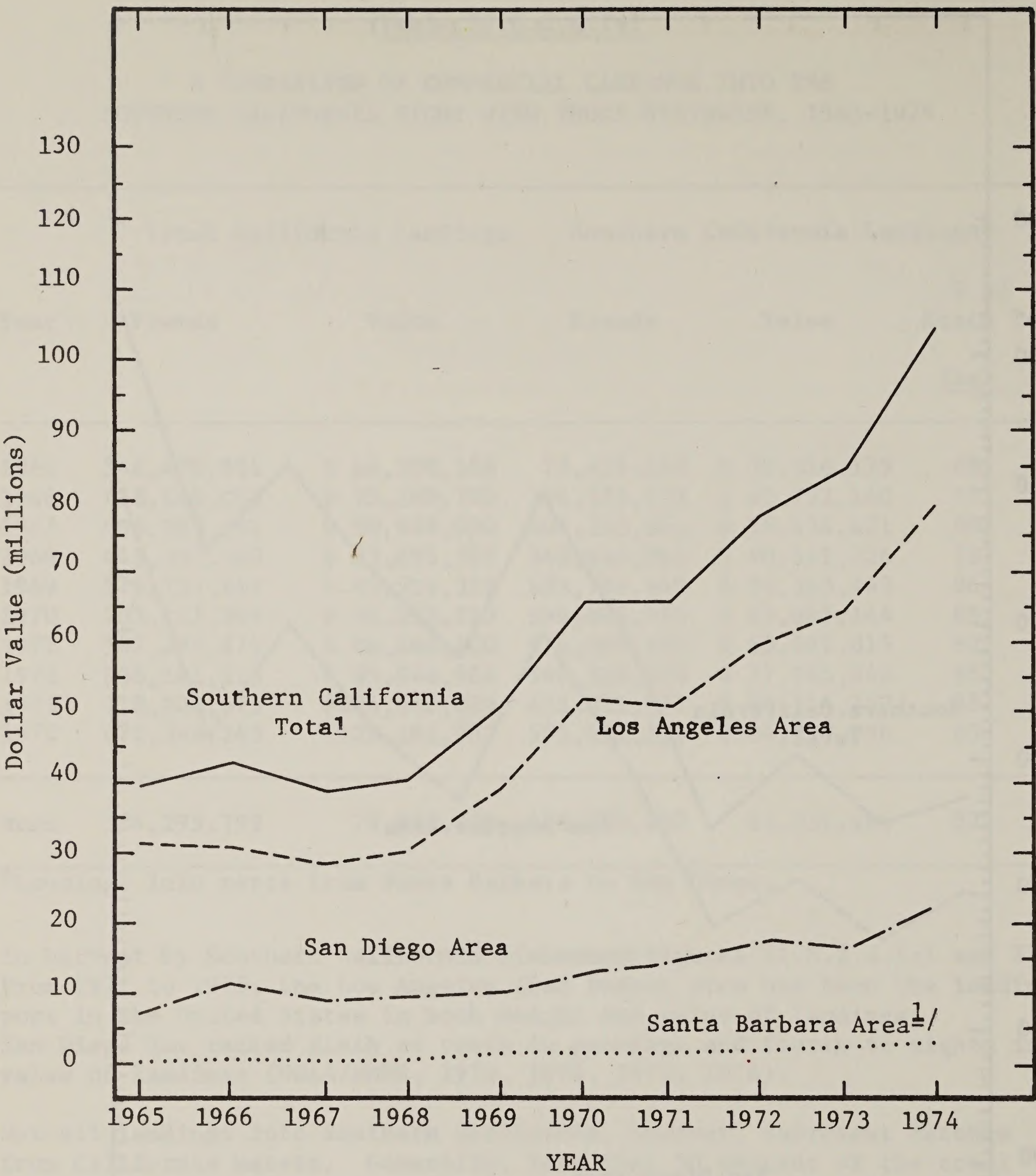


Figure II.G.2.d.i- 2 The value of Southern California commercial fish landings, 1965-1974

1/ Landings into ports south of Point Conception only.

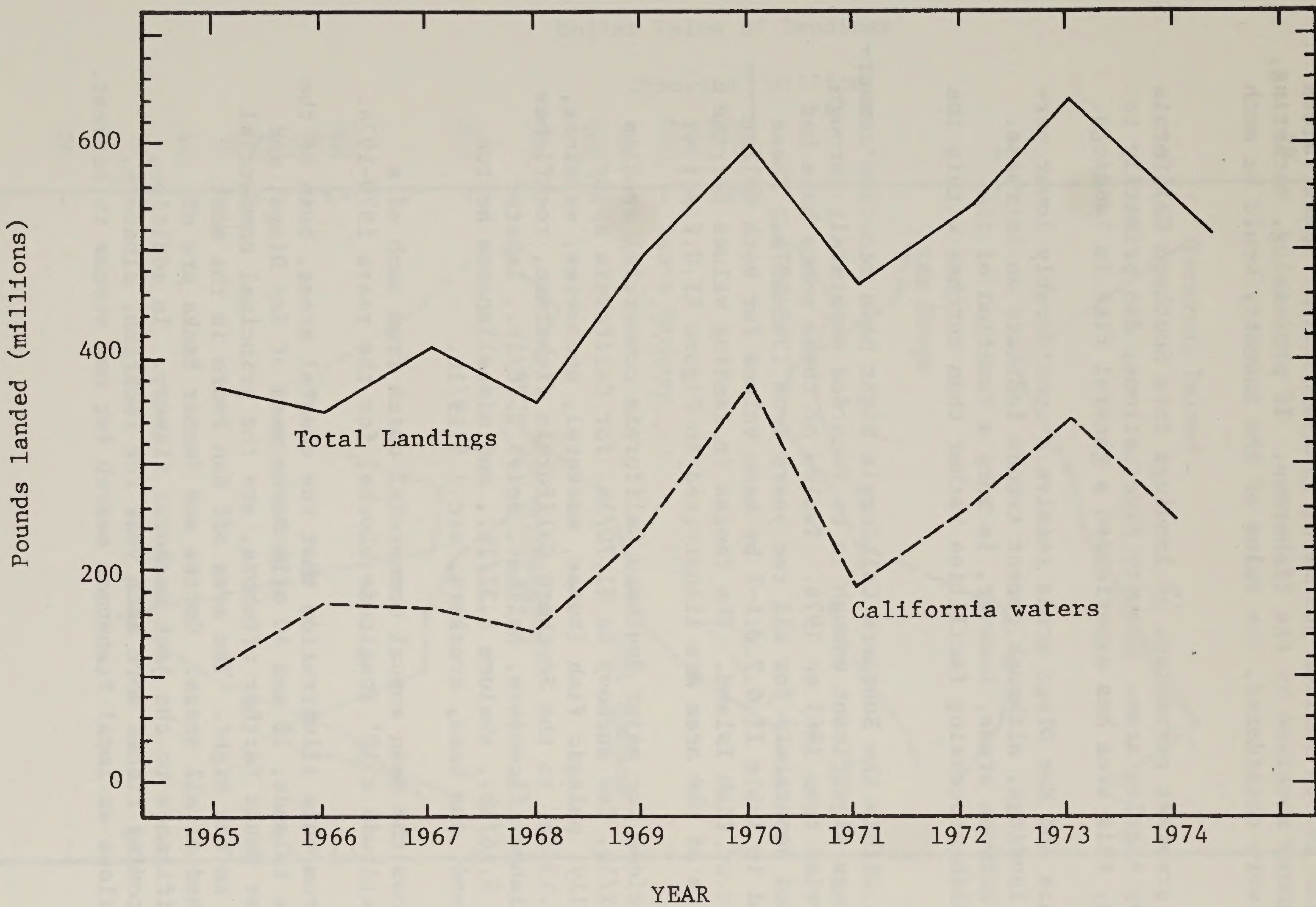


Figure II.G.2.d.i- 3 Comparison of total commercial fish landings into Southern California 1/ vs landing from California waters, 1965-1974.

1/ Landings into ports south of Point Conception.

consisting of 112 to 323 million pounds of fish annually. These values represent the money received by the fishermen. If processing, marketing, shipping, etc. were considered, the value of the industry would be much greater.

Generally, the greatest percentage of landings into Southern California occur in the Los Angeles area. Despite fluctuations, due primarily to anchovy catches, this area has experienced a general rise in landings.

The Santa Barbara and San Diego areas receive a considerably lower percentage of the landings, although recent trends indicate an increase. This disparity between areas, however, is more a function of the occurrence of fish processing facilities rather than catches within the area.

Seventeen ports within the Southern California Bight have recorded commercial fish landings significant enough to be recorded separately through the ten year period from 1965 to 1974. Twelve of these ports have had landings recorded separately for all ten years from 1965-1974. These ports are ranked in Table II.G.2.d.i-2 by mean values for both dollar value and weight of fish Island. The ranges in landing values for the seven major ports of the area are illustrated in Figure II.G.2.d.i-4.

In 1973, unit prices for major Southern California commercial species ranged from $.02/lb. for anchovy to $1.70/lb. for California spiny lobster. Generally, pelagic fish (tunas, mackerel, anchovies, sardines, etc.) brought $.13/lb. to the Southern California fishermen, rockfishes $.16/lb., flatfishes (flounders, halibut, sole) $.28/lb., lobster $1.70/lb., crab $.16/lb., abalone $.32/lb., and miscellaneous bottom roundfish (lingcod, sea bass, croakers, etc.) $.19/lb.

Visual No. 6 shows the mean annual commercial catch from each of a series of 10' latitude x 10' longitude blocks, for the years 1970-1974.

It is evident from this illustration that the coastal areas, both of the mainland and the islands, 30 and 40 mile Banks west of San Diego, and Cortes and Tanner Banks farther offshore, are the principal commercial fishing grounds in the Bight. The area off San Pedro is the most extensively fished of all areas. Cortes and Tanner Banks are of particular significance to the jack mackerel fishery. In addition, this area is becoming fished more each year for rockfish, albacore, lobster, and abalone as local fisherman search for new stocks to harvest.

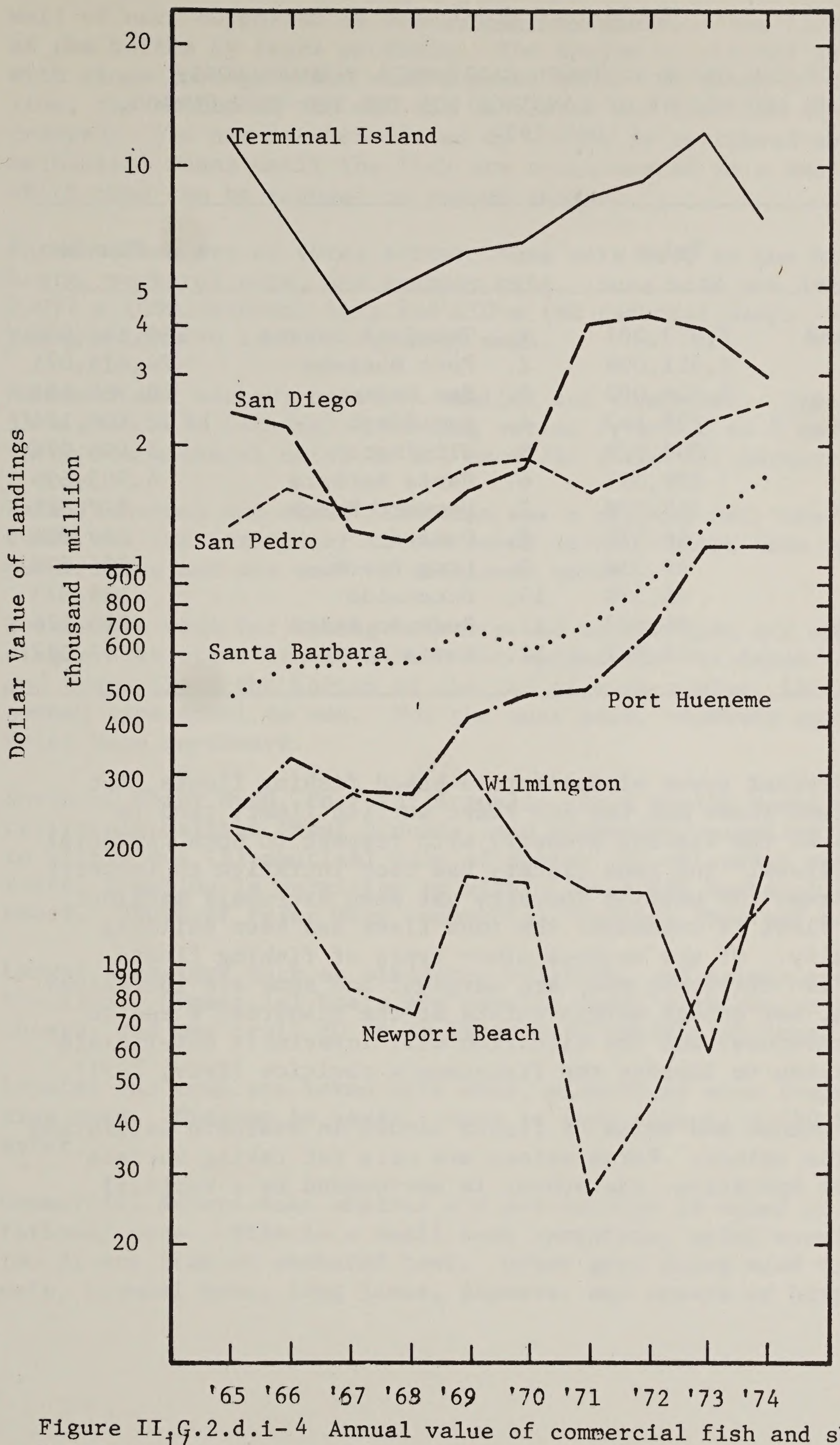


Figure II.G.2.d.i-4 Annual value of commercial fish and shellfish Landings [1] for the seven major ports of the So. Cal. Bight, 1965-1974.

1/ Exclusive of landings of yelllowfin, skipjack, black skipjack and bigeye tuna.

Table II.G.d.i-2

RANKING OF THE MAJOR SOUTHERN CALIFORNIA FISHING PORTS BY MEAN VALUE AND WEIGHT OF LANDINGS FOR THE TEN YEAR PERIOD, 1965-1974

	Value			Pounds	
1.	Terminal Island	7,823,001	1.	Terminal Island	159,185,053
2.	San Diego	2,551,099	2.	Port Hueneme	24,615,071
3.	San Pedro	1,736,002	3.	San Pedro	20,565,956
4.	Santa Barbara	798,597	4.	San Diego	12,106,174
5.	Port Hueneme	538,929	5.	Wilmington	5,498,276
6.	Wilmington	199,393	6.	Santa Barbara	4,505,699
7.	Newport Beach	118,079	7.	Newport Beach	377,821
8.	Oxnard	44,372	8.	Oxnard	259,804
9.	Oceanside	44,319	9.	Long Beach	231,808
10.	Long Beach	35,330	10.	Oceanside	143,573
11.	Redondo Beach	34,687	11.	Redondo Beach	140,125
12.	Santa Monica	15,961	12.	Santa Monica	47,027

There are many different types of California-based fishing fleets, but two of them, the tuna fleet and the San Pedro wetfish fleet, tend to represent extremes of the fishing industry with respect to both financial and physical conditions. The tuna fishery has been lucrative to industry and employees, whereas the wetfish industry has been extremely marginal. While the wetfish fleet is outmoded, the tuna fleet has been building new boats continually. Of the various other types of fishing fleets between the above two extremes, many are marginal and some are lucrative. For most fisheries, not enough margin exists at the fisherman's end to entice necessary revenues, and the situation will invariably deteriorate unless steps are taken to improve the fishermen's position (Frey, 1971).

By far, the major volume and value of fishes landed in Southern California are taken with purse seines. Purse seines are nets for taking surface schooling fish. In operation, the school is surrounded by a vertical wall of net, supported at the surface by plastic-foam floats and weighted at the bottom by leads or chain. The bottom of the net is equipped with rings through which runs a purse line. By means of the purse line, the bottom of the net can be closed and the fish school is trapped. The net is then "dried up", that is retrieved aboard by mechanical means until the fish are concentrated in a small area from which they can be scooped or pumped aboard.

Purse seines are of three sorts: tuna nets used by the high seas boats, mackerel nets, and anchovy nets. Tuna nets are large, typically 1,097 m (600 fathoms) long and 110 m (60 fathoms) deep. Webbing is a heavy nylon (4½ inch to 7½ inch) mesh.

Mackerel and anchovy nets are smaller and shallower. Typically 485 x 55 m (265 x 30 fathoms). Webbing varies from 3.8 to 5 cm (1½ to 2 inch) for mackerel nets, to 1.4 cm (9/16 inch) for anchovy nets.

Bait fishermen and squid fishermen use a simpler net, the lampara, which was the forerunner to the purse seine. These nets lack rings and purse lines and are used in shallower water.

Trawls are used for taking midwater and bottom fish and shrimp. The single boat otter trawl, a sack net spread open by doors (otter boards) and towed along the bottom at the end of wire cables, is the most common type trawl in use. For the most part, trawlers operate from Point Mugu northward.

North of Point Mugu, to Point Arguello, is a region known as the California halibut trawl grounds, and commercial trawling is permitted to within one (1) nautical mile of shore. In all other parts of the State, trawling is permitted to within three (3) nautical miles of shore. South of Point Mugu commercial trawling does not occur.

Larger predators such as albacore, billfish, and salmon are taken by trolling. Commercial boats are usually small with one or two men aboard, and may troll 10 to 15 lines with artificial lures or bait.

Lobster and crab are taken with wood, plastic or wire traps or with ring nets. Fishing is usually done in less than 91 m (50 fathoms) of water.

Commercial divers take abalone and sea urchins in water to 46 m (25 fathoms) deep. This is a small boat operation, using usually one or two divers from an anchored boat. Other gear being used include: gill nets, trammel nets, long lines, dipnets, and spears or harpoons.

In 1975 there were 15 canning and reduction plants and 15 curing and manufacturing plants operating in Southern California (Pinkas, 1976). Fishes are canned, smoked and kippered, salted and bait-cured or reduced to fish meal and fish oil. Tunas are the principal cannery fishes and most are canned in the Los Angeles area. Anchovies are the main fishes processed for meal and oil in the reduction plants. In 1975, 98 percent of the anchovy catch was reduced (Pinkas, 1976).

Kelp and Algae Resources: The giant kelp *Macrocystis* occurs in dense stands in Southern California and can be conveniently harvested by means of mechanical "mowing" ships. These vary in size and some are capable of carrying up to 300 tons of wet kelp. Kelp is cut to a maximum depth of four feet (by regulation) below the water's surface, and is transferred by a conveyor belt into the open hold of the barge. It is then transported to a processing plant where it is transformed to a marketable product. Prices for dried kelp have varied from approximately $90-125/ton based on prices quoted by C. D. Pratt, Vice President, Kelco Company. Kelp beds and attached algae are discussed further in Sections II.E.3.a and II.F.2.

Mariculture: Ebert (1973) listed 17 private companies engaged in mariculture in California. Most are working with oysters, abalone, or lobster and are in various operational stages from research and development to full production. Only one of the 17 is located in Southern California, the Limno Corporation located in San Diego Bay. This company is in the pilot production stage of cultivation of brown shrimp in a 100-acre pond receiving heated water effluent from a power plant.

The National Sea Grant Program currently provides funding to six universities in California for mariculture-oriented projects (Ebert, 1973). Four of these institutions are in Southern California. California Institute of Technology has a project to restore, propagate, and manage giant kelp. The Institute of Marine Resources at the University of California, San Diego is involved in abalone culture methodology and larval ecology. The University of California, Santa Barbara, is continuing to study seaweed resource management. San Diego State University has one project underway on the recruitment and growth of spiny lobster, and one on the investigation and development of an American fishery in California.

U.S. and Mexican Fisheries Off Northern Baja California (U.S./Mexican Border to Punte Eugenia). A significant portion of the U.S. commercial fishing effort occurs off the western coast of Baja California. For the most part these are California based vessels (particularly from San Diego and Los Angeles) which fish off Mexico to either lengthen fishing seasons or to fish for species which do not normally occur off California. The principal species which are sought off Mexico by U.S. fishermen are: yellowfin tuna, *Thunnus albacares*; skipjack tuna, *Euthynnus pelamis*; bluefin tuna, *T. thynnus*; albacore, *T. alalunga*; Pacific bonito, *Sarda chiliensis*; white seabass, *Cynoseion nobilis*; giant sea bass, *Stereolpis gigas*; grouper, *Mycteropeka spp.*; sculpin, *Scorpaena gutsuta*; and yellowtail, *Seriola dorsalis*.

Roedel and Frey (1968) have indicate major fishing areas for bluefin tuna and "market" fish off Baja California used by U.S. fishermen. These are presented in Figures II.G.2.d.i-5 and 6.

The Mexican fisheries off the west coast of Baja are in the process of developing. The Mexican fish canning industry is centered here, although much of the raw material is trucked across the peninsula from the Gulf of California. The Pacific coast also provides fresh and frozen fish, lobster and abalone and some tonnage of kelp.

At present, there are about 13 canneries in Baja. With two exceptions, all of the seafood canned in Baja is sold in Mexico. All the fish meal produced is sold in Mexico. The exceptions are canned abalone, about half of which is exported to the U.S. or Asia, and pet food made from tuna scrap, which is exported to the U.S.

The value of processed fishing products to Baja was $9,057,000 in 1965 and $10,519,000 in 1966, the two years for which data are available (Croker, 1968).

The greatest potential fishery off Baja is the anchovy. With rising prices and demand for fishmeal, it is likely that a major reduction fishery will develop shortly.

Until the reduction fishery does develop, the mainstay of the industry are canned tuna, bonito, and wetfish (sardine, anchovy, jack, and Pacific mackerel).

The Central California Fishery (Point Conception to Point Reyes): Commercial fish and shellfish landings into central California have fluctuated during the ten year period, 1965-1974, (Figure II.G.2.d.i-7).

Total landings by weight and value for each of the major ports located within the central California area are shown in Figure II.G.2.d.i-8.

Salmon become a significant part of the commercial catch from Point Conception northward. Other major commercial species include: albacore, anchovy, squid, rockfish, sablefish, lingcod, petrale sole, abalone, Dungeness crab, and sea urchin.

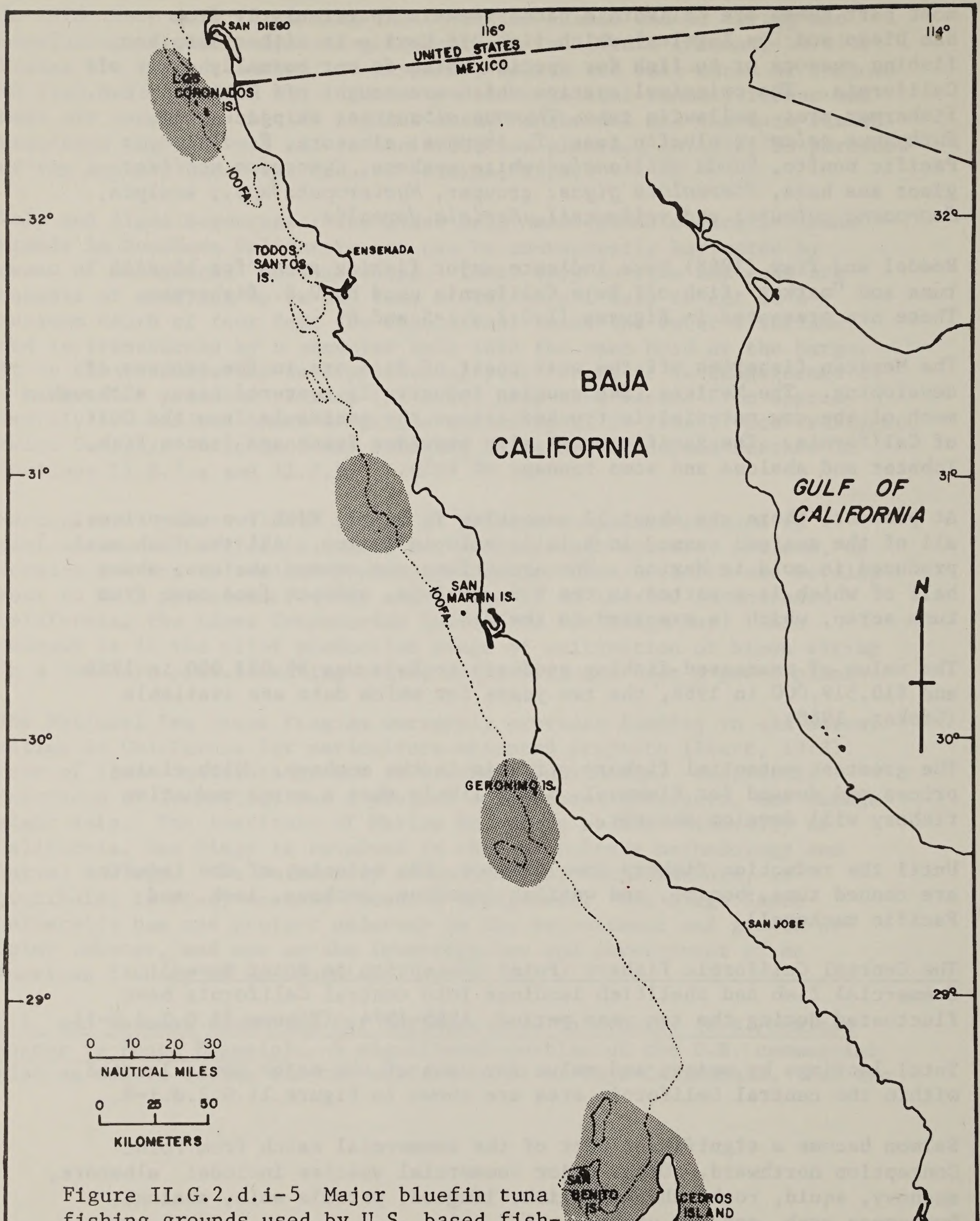


Figure II.G.2.d.i-5 Major bluefin tuna fishing grounds used by U.S. based fishermen (adapted from Roedel & Frey, 1968).

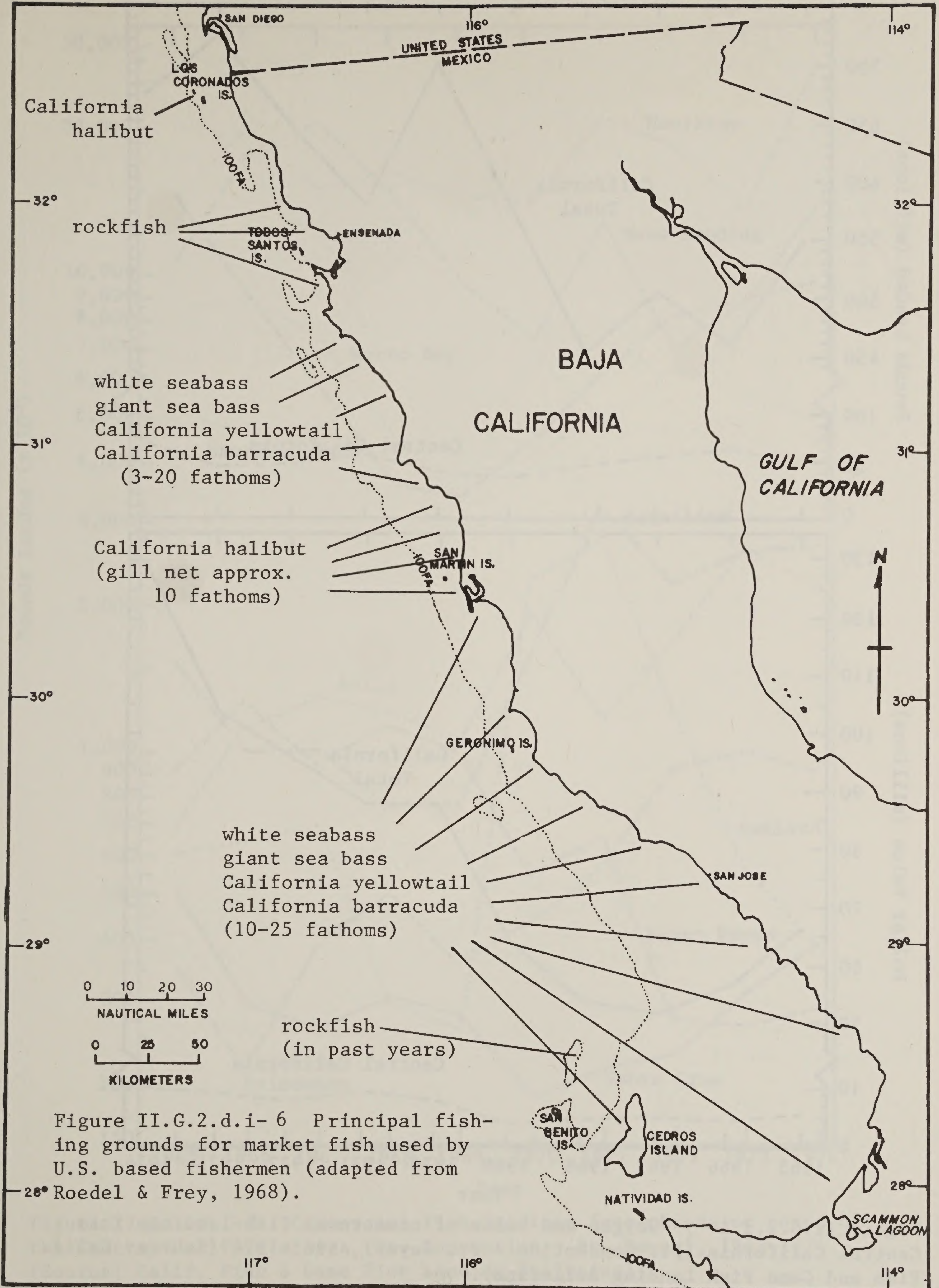


Figure II.G.2.d.i-6 Principal fishing grounds for market fish used by U.S. based fishermen (adapted from Roedel & Frey, 1968).

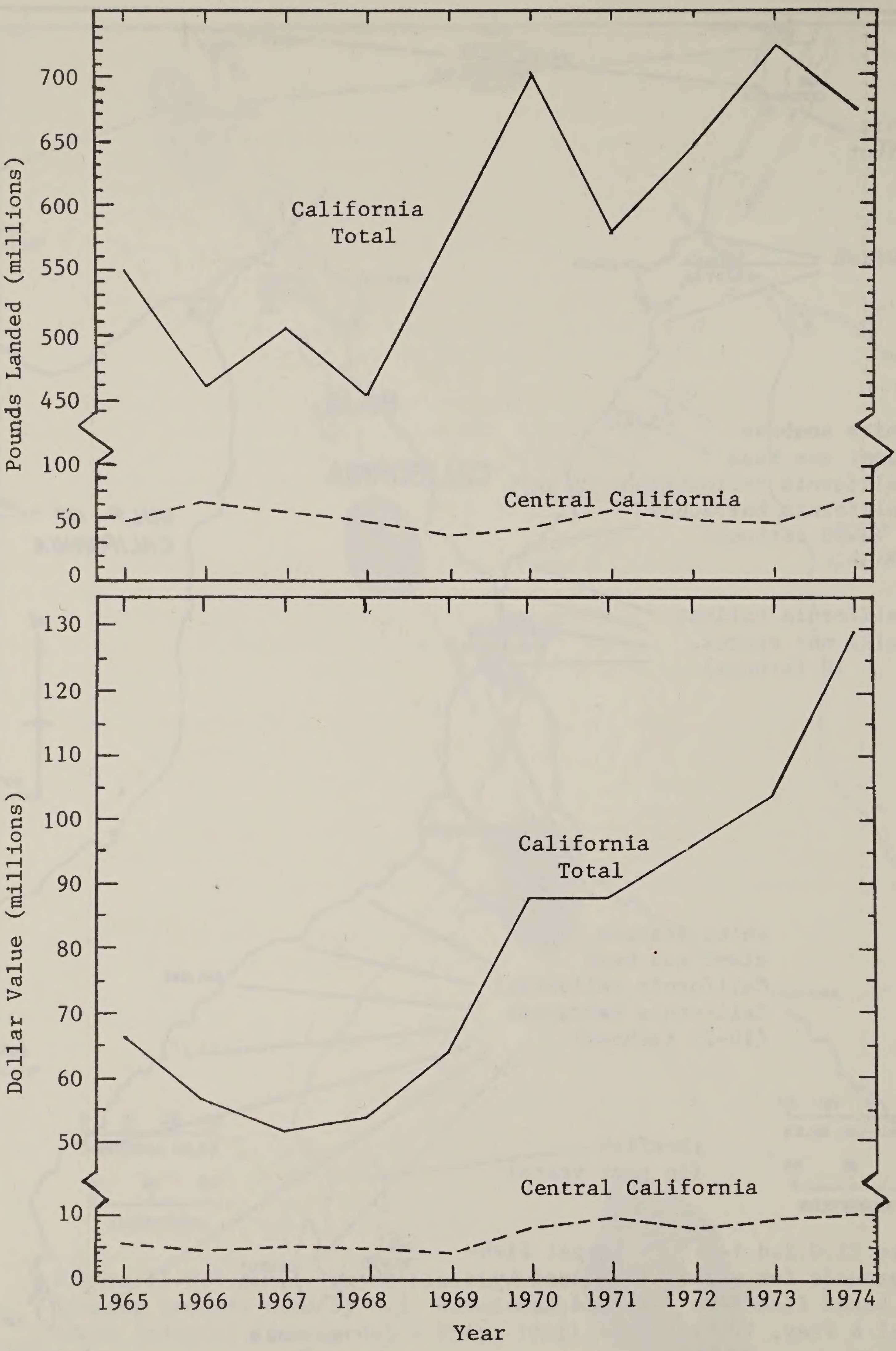


Figure II.G.2.d.i- 7 Weight and value of commercial fish landings into Central California (Pt. Conception - Pt. Reyes), 1965-1974 (Source: Calif. Fish and Game Fish Landing Bulletins).

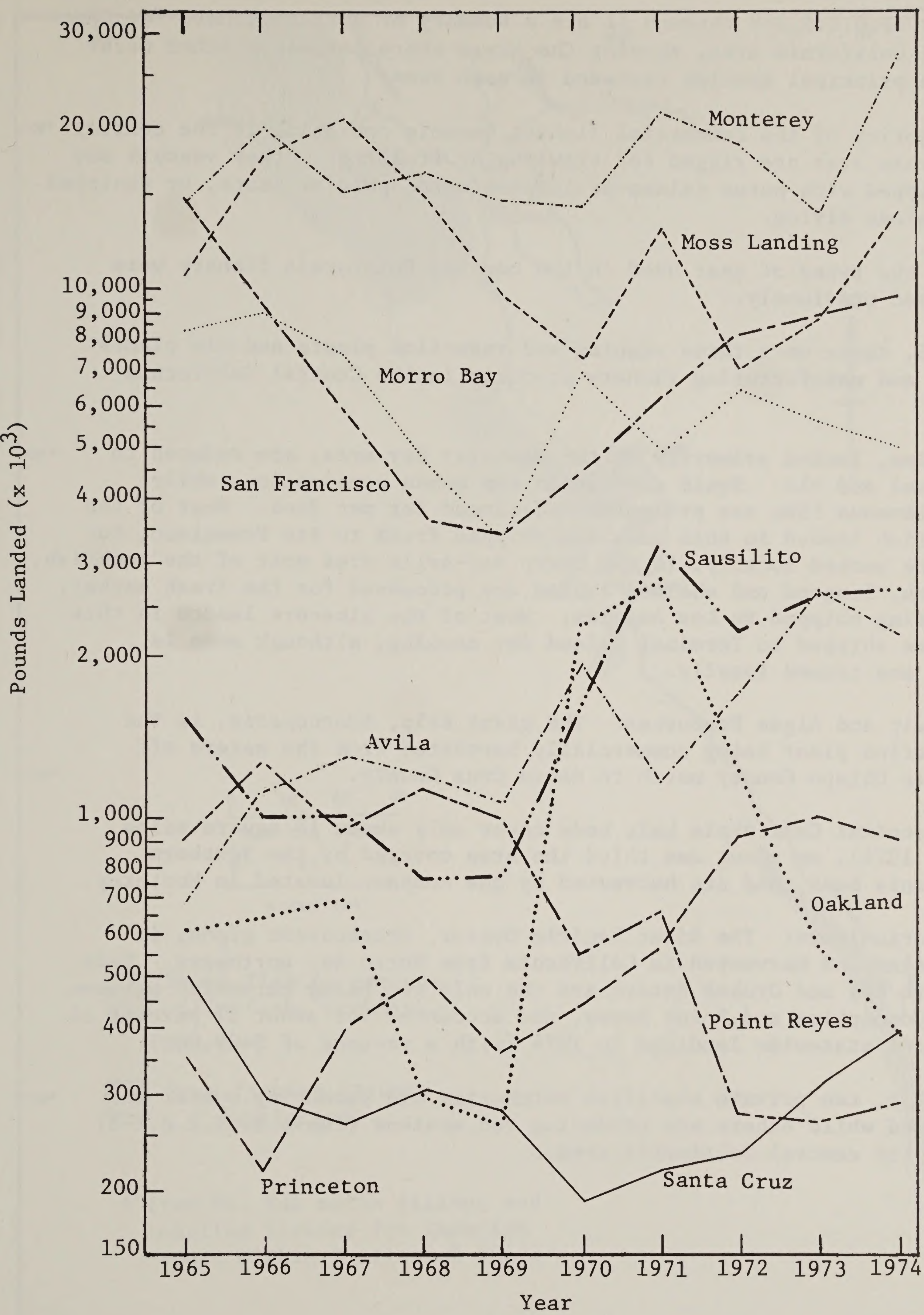


Figure II.G.2.d.i-8 Commercial fish landings into the major ports of the Central California area (Pt. Conception - Pt. Reyes), 1965-1974 (Source: Calif. Fish & Game Fish Landing Bulletins).

Figures II.G.2.d.i-9 through 11 are a summary of available data for the central California area, showing the areas where largest catches occur and the principal species captured in each area.

The majority of the commercial fishing vessels operating in the central California area are rigged for trawling or trolling. Other vessels may be equipped with purse seines or lampara nets, pots or traps, or equipped for abalone diving.

All of the types of gear used in the central California fishery were described previously.

In 1975, there were three canning and reduction plants and six plants curing and manufacturing fishery products in the Central California area.

Anchovies, landed primarily in the Monterey Bay area, are reduced to fish-meal and oil. Squid are canned for human consumption, while miscellaneous fish are processed and canned for pet food. Most of the other fish landed in this area are shipped fresh to San Francisco, but some are smoked locally. In the Morro Bay-Avila area most of the rockfish, flatfish, lingcod and abalone landed are processed for the fresh market, some being shipped to Los Angeles. Most of the albacore landed in this area are shipped to Terminal Island for canning, although some is smoked and canned locally.

Kelp and Algae Resources: The giant kelp, *Macrocystis*, is the only marine plant being commercially harvested from the waters off San Luis Obispo County north to Santa Cruz County.

These central California kelp beds cover only about 15 square miles (Frey, 1971), or about one third the area covered by the Southern California beds, and are harvested by one company located in Monterey.

Mariculture: The Giant Pacific Oyster, *Grassostera gigas*, is cultivated and harvested in California from Morro Bay northward. Beds in Morro Bay and Drakes Estero are the only two being harvested between Point Conception and Point Reyes, and accounted for about 37 percent of the total statewide landings in 1974 (with a revenue of $409,000).

Presently, two private shellfish hatcheries are producing oyster and clam seed while others are producing red abalone (Table II.G.2.d.i-3) within the central California area.

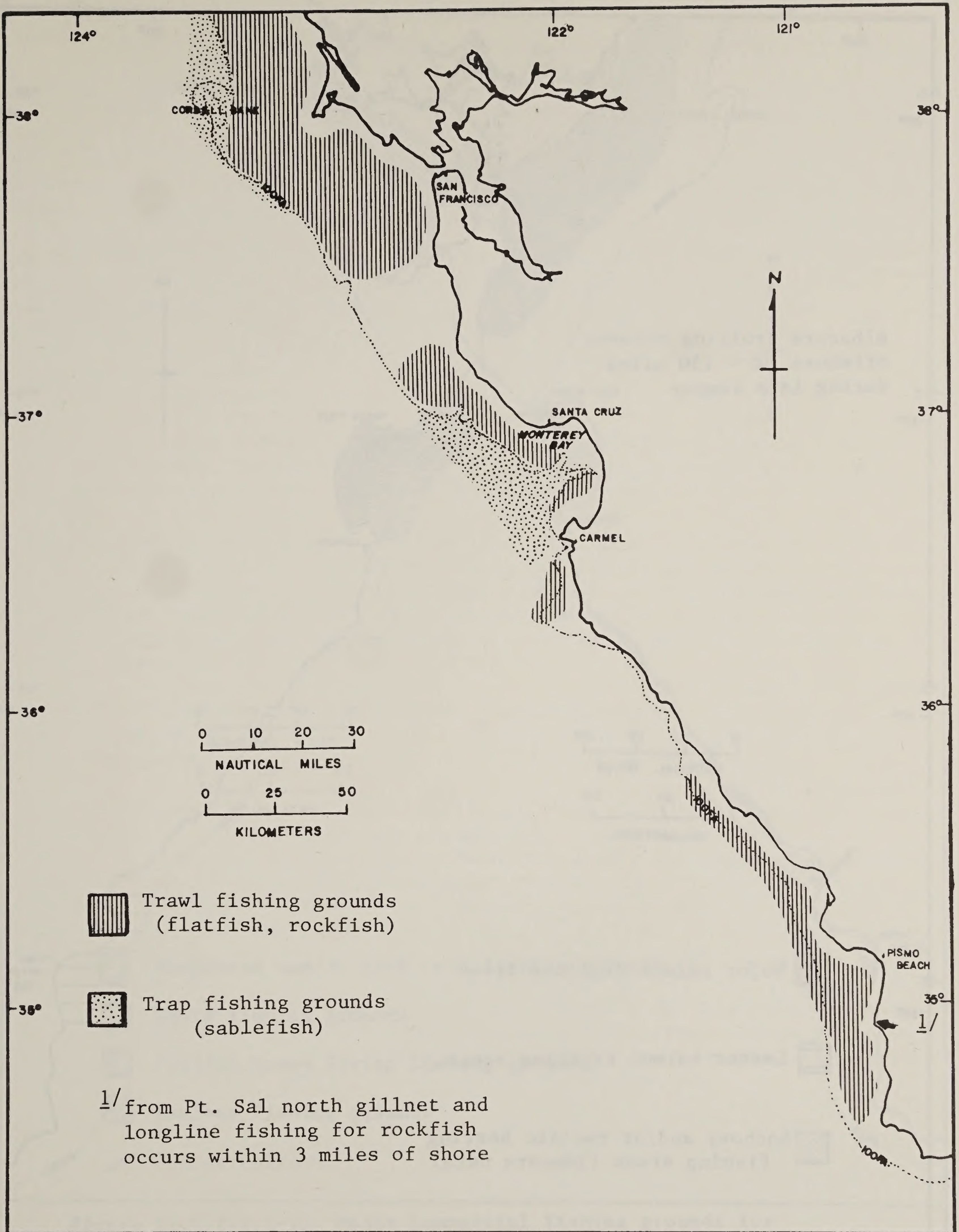


Figure II.G.2.d.i-9 Major commercial fishing grounds of the central California area for Bottomfish (i.e. rockfish, flatfish, sablefish).

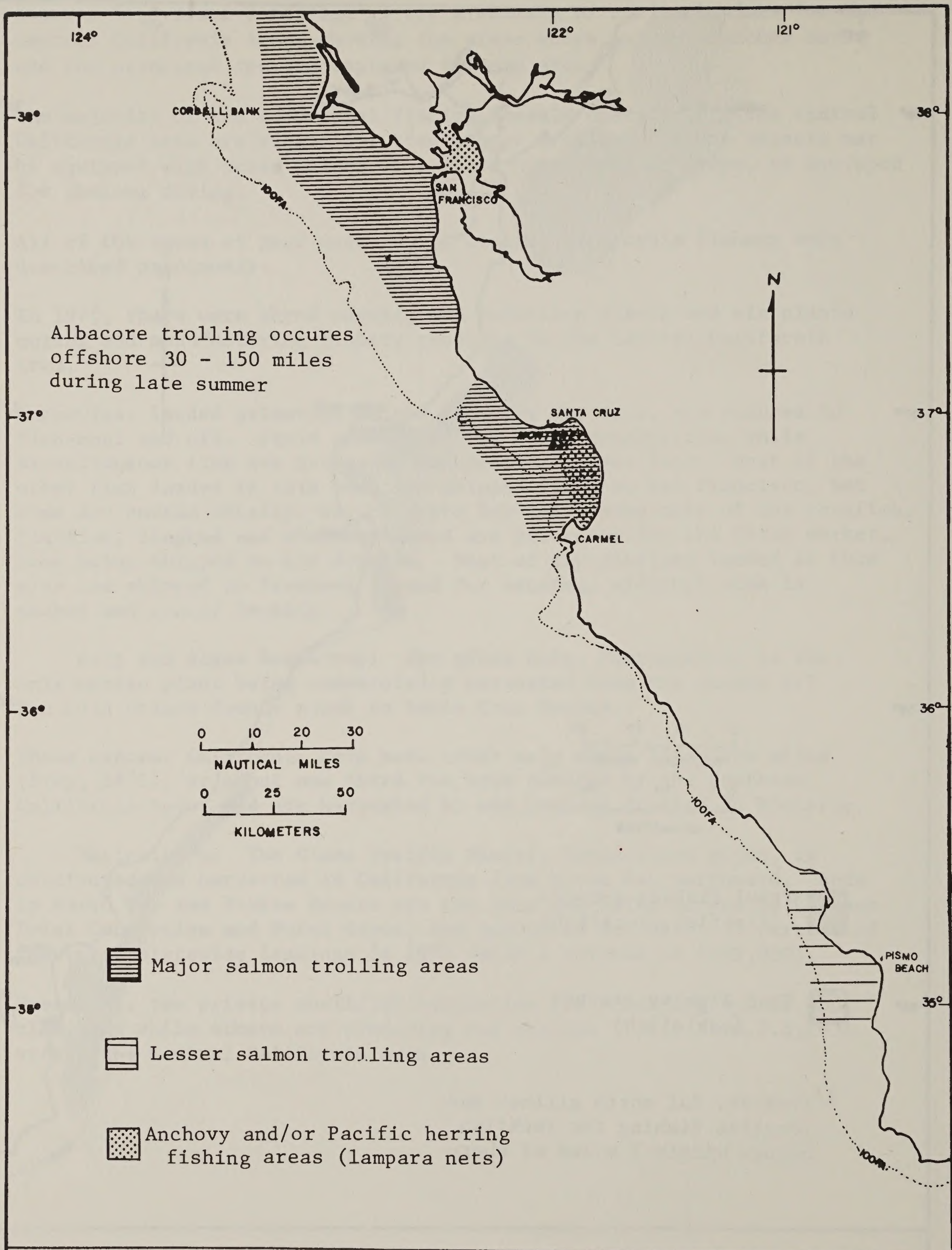


Figure II.G.2.d.i-10 Major commercial fishing areas of central California for pelagic species (i.e. salmon, albacore, anchovy, Pacific herring).

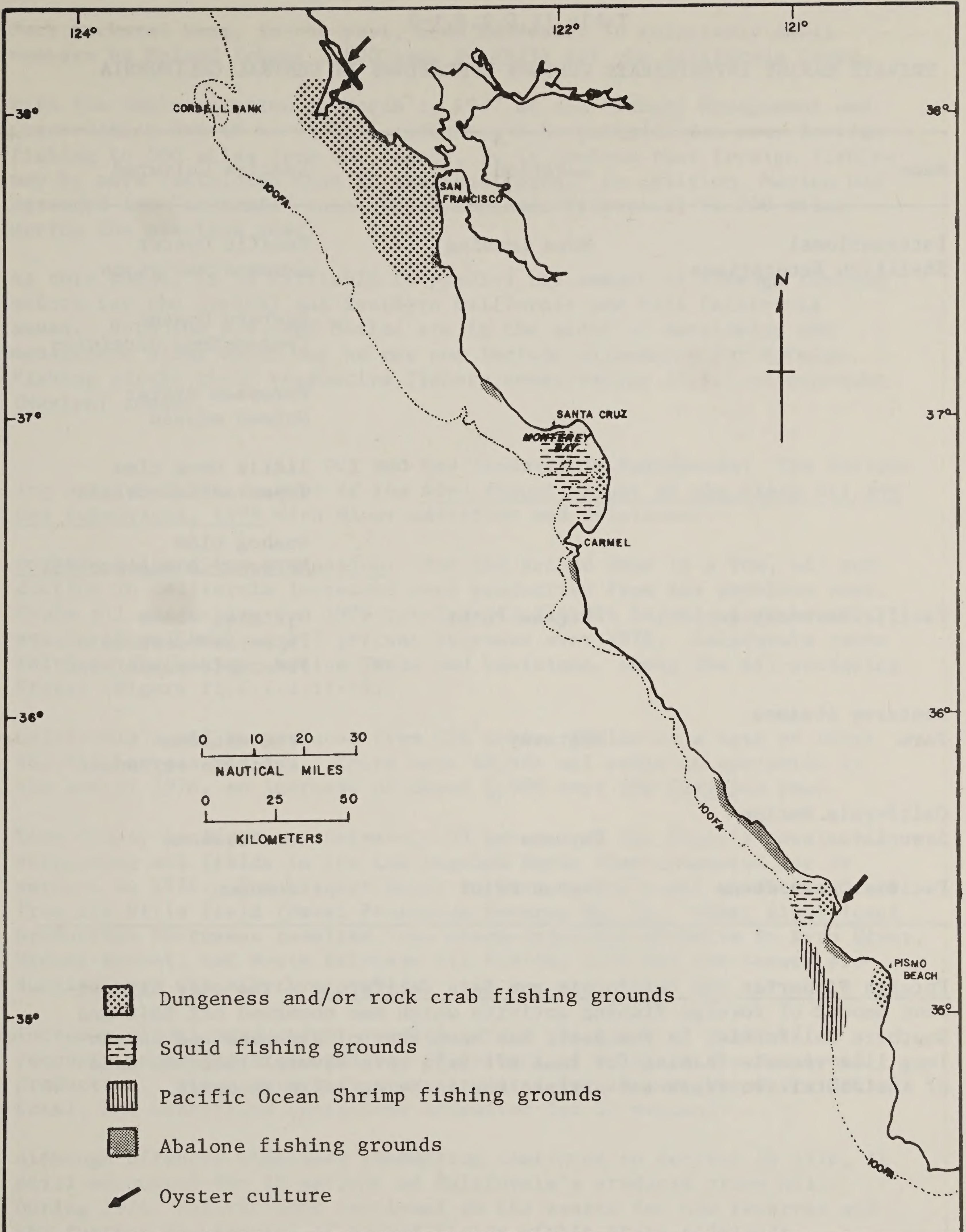


Figure II.G.2.d.i-11 Major commercial fishing grounds for invertebrates.

Table II.G.2.d.i-3

PRIVATE MARINE INVERTEBRATE CULTURE OPERATIONS IN CENTRAL CALIFORNIA

Name	Location	Species Cultured
International Shellfish Enterprises	Moss Landing	Pacific Oyster *Crassostrea gigas*
		Eastern Oyster *Crassostrea virginica*
		European Oyster *Ostrea edulis*
		little neck clam *Tapes semidecussata*
		quahog clam *Mercenaria mercenaria*
Pacific Mariculture	Pigeon Point	Oysters, clams *Tapes semidecussata* *Venerupis japonicosa*
Monterey Abalone Farm	Monterey	red abalone *Haliotis rufescens*
California Marine Associates	Cayucos	red abalone
Pacific Ocean Farms	Pigeon Point	unknown

Foreign Fisheries Off California and Baja California: The only significant amount of foreign fishing activity which has occurred off Baja and Southern California, in the past, has been that of Japanese and Korean long line vessels fishing for tuna off Baja with several thousand tons of incidental swordfish and striped marlin being taken annually.

Jack mackerel have, in the past, been harvested in relatively small numbers by Poland (about 3,600 tons in 1975) off the California Coast.

With the implementation on March 1, 1977 of the Fishery Management and Conservation Act (P.L. 94-265) extending U.S. jurisdiction over foreign fishing to 200 miles from our coasts, it is obvious that foreign fishing may be more restricted than in previous years. In addition, Mexico had extended its "economic" zone (which includes fisheries) to 200 miles during the previous year.

At this point, it is difficult to predict the amount of foreign fishing effort for the central and Southern California and Baja California areas. Both the U.S. and Mexico are in the midst of developing new management plans which may or may not include allowances for foreign fishing within their respective fishery conservation (U.S.) or economic (Mexico) zones.

ii. Oil and Gas Industry in California: The following section is an excerpt of the <u>62nd Annual Report of the State Oil and Gas Supervisor, 1976</u> with minor additions and deletions.

<u>Onshore Oil and Gas Production</u>: For the second year in a row, oil production in California increased over production from the previous year. Crude oil production for 1976 totaled 312,275,064 barrels (one barrel equals 42 gallons), a 1.7 percent increase over 1975. California ranks third in the nation, behind Texas and Louisiana, among the oil-producing States (Figure II.G.2.d.ii-1).

California's oil is produced from 236 active fields at a rate of about 855,548 barrels per day. There were 42,534 oil wells in operation at the end of 1976, an increase of about 1,500 over the previous year.

Kern County produced approximately 43 percent of the State's total oil, surpassing oil fields in the Los Angeles Basin that accounted for 36 percent in 1976. The biggest boost in Kern County's oil production came from Elk Hills field (Naval Petroleum Reserve No. 1). Other significant production increases resulted from steam-injection projects in Kern River, Midway-Sunset, and South Belridge oil fields; 1976 was the record production year for all three fields.

Incremental oil production, resulting from all types of enhanced recovery projects, accounted for 48 percent of California's total oil production. Steam stimulation was credited for 27 percent of the State's total, and waterflood operations accounted for 20 percent.

Although offshore tidelands production continued to decline in 1976, it still accounted for 18 percent of California's produced crude oil. During 1976, restrictions continued on the search for new reserves and the further development of proved fields within State tidelands.

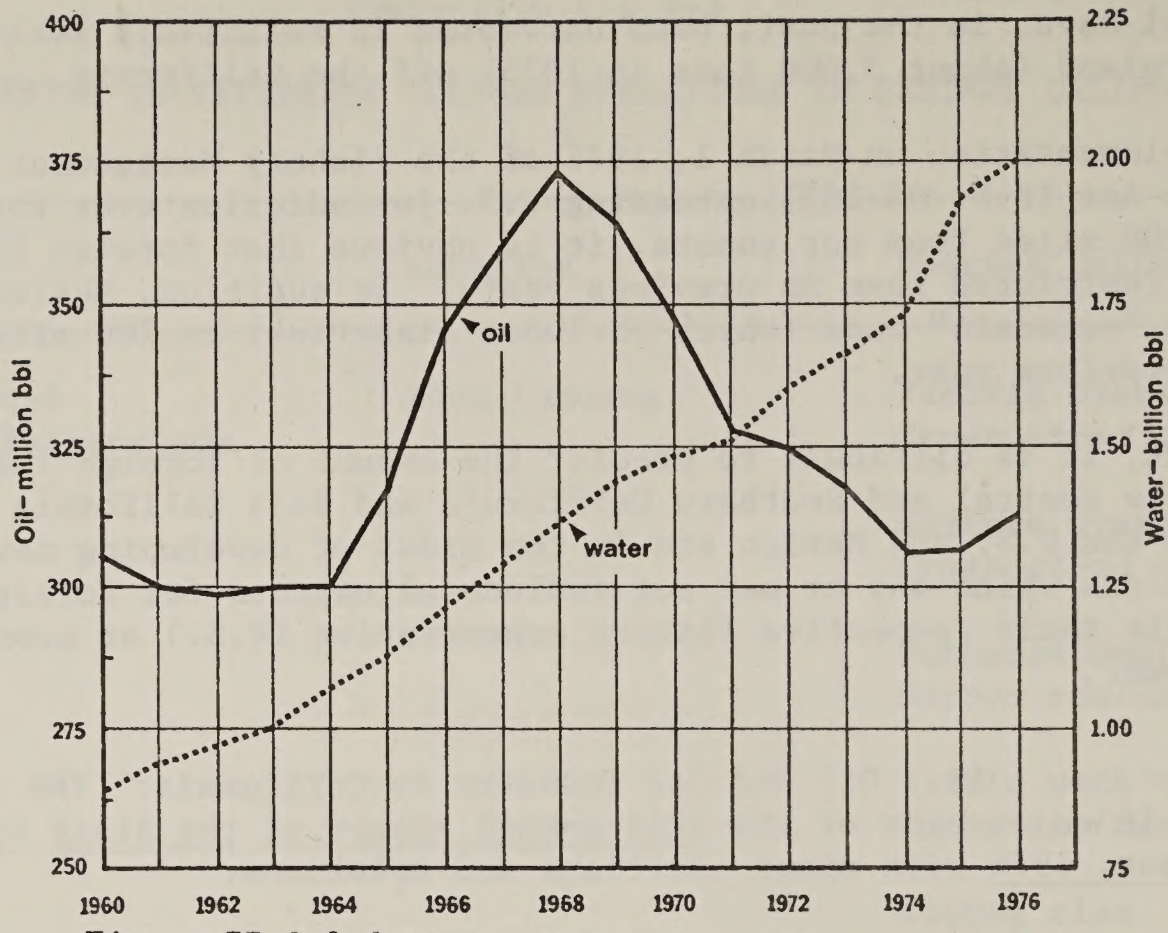


Figure II.G.2.d.ii-1 California Oil and Water Production

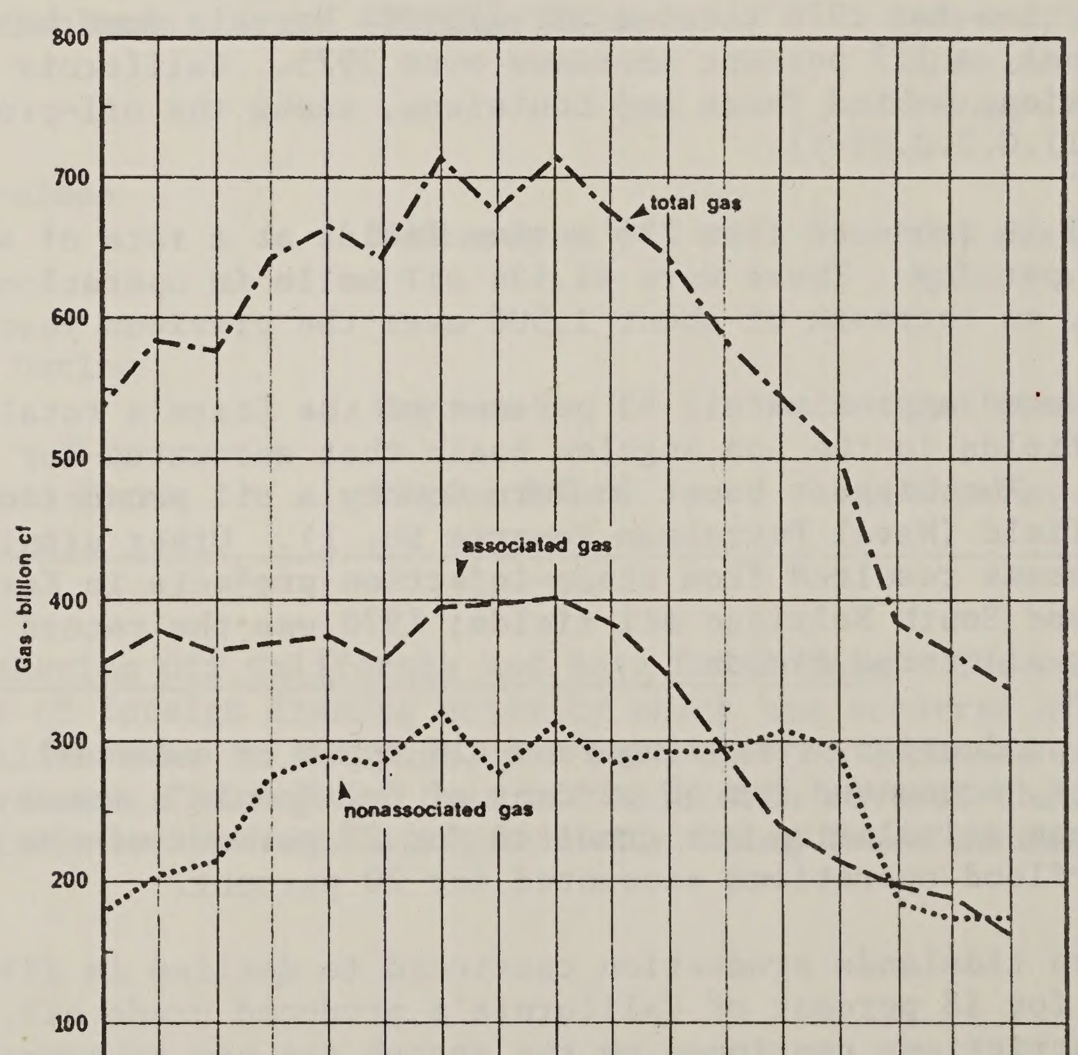


Figure II.G.2.d.ii-2 California Gas Production

California's net natural gas production declined in 1976; 335,219,260 Mcf (one Mcf equals 1,000 cubic feet) was produced, a 7.3 percent decrease from the previous year. The amount of gas produced from oil zones was 160,596,803 Mcf, a 14.7 percent decrease from 1975 totals. However, gas production from the State's 77 active gas fields and 14 active gas zones increased 0.6 percent to 174,622,457 Mcf (Figure II.G.2.d.ii-2 and Table II.G.2.d.ii-1).

California's estimated recoverable oil reserves, as of December 31, 1976, total 4.8 billion barrels. Considering both estimated reserves and State cumulative oil production as of December 31, 1976, 78 percent of California's presently recoverable oil resources have been extracted. Recoverable gas reserves, as of the same date, are estimated at 4.7 trillion cubic feet.

Table II.G.2.d.ii-1

PRODUCING WELLS AND PRODUCTION OF OIL, GAS, AND WATER BY COUNTY - 1976

County	Average number of producing wells: Oil		Maximum number of producing wells: Gas			Oil production (bbl)	Gas production (Mcf)			Water production (bbl)	Proved acreage as of Dec. 31, 1976
	Actual	Actual and potential	Actual	Standing	Shut-in		Associated (from oil zones)	Nonassociated (from gas zones)	Total		
Alameda	10	10	0	0	0	84,559	0	0	0	74,592	75
Butte	0	0	17	6	6	0	0	1,935,513	1,935,513	3,404	2,750
Colusa	0	0	97	17	7	0	0	7,316,703	7,316,703	40,781	14,495
Contra Costa	45	59	45	9	23	223,652	1,490,088	[b]4,672,984	6,163,072	2,831,159	5,970
Fresno	2,553	4,428	4	0	3	9,831,793	6,078,231	[c]496,242	6,574,473	77,217,746	30,787
Glenn	0	0	100	6	16	0	0	10,193,378	10,193,378	159,516	15,940
Humboldt	0	0	24	0	3	0	0	1,849,966	1,849,966	800	1,270
Kern	24,568	33,690	45	23	48	[a]134,108,413	54,676,437	986,625	55,663,062	807,431,585	158,425
Kings	138	357	3	1	1	347,395	5,454,730	31,342	5,486,072	1,766,417	8,824
Los Angeles	5,988	8,861	2	11	0	85,327,744	47,096,507	80,297	47,176,804	627,642,850	37,643
Madera	0	0	13	22	5	0	0	2,422,818	2,422,818	25,076	1,720
Merced	0	0	3	0	0	0	0	402,476	402,476	247	180
Monterey	953	1,306	0	0	0	12,865,126	10,599	0	10,599	104,255,796	4,710
Orange	3,185	4,481	0	1	0	29,385,773	8,795,645	0	8,795,645	205,603,232	11,706
Riverside	15	23	3	0	2	77,410	35,354	86,961	122,315	52,833	220
Sacramento	0	0	114	23	34	0	0	[d]18,880,132	18,880,132	209,179	17,587
San Benito	35	40	0	8	0	45,411	11,913	0	11,913	208,765	915
San Bernardino	42	46	0	0	0	118,958	37,245	0	37,245	97,942	280
San Joaquin	0	0	163	15	14	0	0	[e]30,269,509	30,269,509	121,976	12,780
San Luis Obispo	253	359	0	0	0	1,373,127	862,952	0	862,952	3,210,453	2,960
San Mateo	13	29	0	0	0	26,218	1,798	0	1,798	92,762	205
Santa Barbara	1,849	2,889	8	8	2	16,686,767	15,773,859	[f]2,727,858	18,501,717	119,679,303	28,345
Santa Clara	0	5	0	0	0	0	0	0	0	0	20
Solano	0	0	196	18	48	0	0	[g]48,628,247	48,628,247	477,039	18,958
Sonoma	1	1	1	8	0	500	0	1,400	1,400	0	80
Sutter	0	0	149	5	12	0	0	17,942,422	17,942,422	168,466	22,840
Tehama	0	0	32	2	16	0	0	1,812,290	1,812,290	12,654	7,120
Tulare	31	35	6	22	12	53,036	0	456,912	456,912	2,173,493	4,165
Ventura	2,613	3,605	7	0	0	21,719,182	20,271,445	1,263,498	21,534,943	55,806,551	21,365
Yolo	0	0	91	5	62	0	0	[h]22,164,884	22,164,884	172,251	11,170
STATE TOTALS	42,292	60,224	1,123	210	314	312,275,064	160,596,803	174,622,457	335,219,260	2,009,536,868	443,505

a/ Includes 351,814 barrels of plant condensate (cumulative production: 46,774,392 barrels).
b/ Also produced 3,105 barrels of condensate from gas fields (cumulative production: 237,250 barrels revised figure).
c/ Also produced 10,446 barrels of condensate from gas fields (cumulative production: 95,248 barrels).
d/ Also produced 7,157 barrels of condensate from gas fields (cumulative production: 703,063 barrels).
e/ Also produced 647 barrels of condensate from gas fields (cumulative production: 659 barrels).
f/ Also produced 27,785 barrels of condensate from gas fields (cumulative production: 4,516,447 barrels).
g/ Also produced 73,570 barrels of condensate from gas fields (cumulative production: 1,821,865 barrels).
h/ Cumulative condensate production: 935 barrels.

Total footage drilled for new wells in 1976 equalled 2,064,033 m (6,771,761 feet) and rework footage 50,479 m (165,615 feet). The average depth for new wells was 777 m (2,549 feet). Although footage increased about 4 percent in 1976, deep-well drilling declined. Only two wells were drilled deeper than 4,572 m (15,000 feet) in 1976, compared with six in 1975. However, the total number of exploratory (prospect) wells increased from 170 in 1975 to 195 in 1976. During the year, ten new fields were discovered (seven gas fields and three oil fields), nine new pools in oil fields were discovered, and the productive areas of eight fields (three gas and five oil) were extended.

Offshore Oil and Gas Production. Production from offshore areas within California's territorial boundary of 5.56 km (3 nautical miles) totaled 56 million barrels of oil and 17 million Mcf of natural gas produced in 1976. The two most prolific producing areas were the offshore areas of Wilmington and Huntington Beach oil fields; together these two areas accounted for 88 percent of the State's total offshore oil production and 49 percent of the State's total offshore natural gas production.

On the Outer Continental Shelf (OCS), production from the two Federal fields declined for the fifth consecutive year. OCS production during 1976 was 14 million barrels of oil and 5 million Mcf of natural gas, compared with 15 million barrels of oil and 6 million Mcf of natural gas in 1975.

During 1976, combined State and Federal offshore fields accounted for 23 percent of the oil and 7 percent of the natural gas produced in California. The combined offshore oil production decreased 10 percent while the combined natural gas production decreased 21 percent from 1975. Offshore oil production has declined 33 percent since 1970 and natural gas production has decreased 72 percent during the same period.

Although this decline in State and Federal offshore production continued into 1976, several key events are developing that may alter this trend in the next few years: OCS exploratory drilling in Southern California as the result of a lease sale (OCS Sale No. 35) in December 1975; development of the Santa Clara and Santa Ynez units; installation approval of Platform C for final development of the western portion of Dos Cuadras field; and the release of final environmental impact reports by the State Lands Commission on resumption of developmental drilling in Carpinteria, Huntington Beach, South Elwood, and Summerland fields.

Offshore drilling activity decreased in 1976 with 11 new wells completed to production, compared to 35 in 1975. As in the past, the offshore areas of Wilmington and Huntington Beach fields were the busiest areas. No new-field or new-zone wells were drilled during 1976.

Belmont Offshore Field and Long Beach Unit. Chevron U.S.A. Inc. finished its drilling program in the early part of 1976, and Exxon Corporation is currently redrilling wells from Belmont Island. THUMS Long Beach Company completed eight new development wells in the offshore area of Wilmington field; most of these wells were completed in the Ranger zone.

Huntington Beach Field, Offshore Area. An environmental impact report was prepared and Aminoil U.S.A., Inc., awaits State Lands Commission approval before redrilling more than 100 wells in Huntington Beach field from Platform Emmy and from onshore sites over a period of several years. Some of these wells will be used in a new waterflood project of the Upper Main zone, and some to develop the Deep (nodular shale) zone, a new zone in the field.

South Elwood Offshore Field. Atlantic Richfield Company was given approval to begin development of the Monterey Formation. The redrilling of well "Ames 3120" 7 was still in progress at the end of the year and was the first drilling operation for oil production allowed in State waters in the Santa Barbara Channel in 8 years.

At this time, nearly all of the gas from the field is unavailable for sale because gas from the Monterey Formation is sour (high hydrogen sulfide content), and sweet gas from other zones is used to eliminate hydrogen sulfide from Monterey oil. ARCO plans to upgrade its onshore facility to make this gas available when Coastal Commission and Santa Barbara County permits are issued.

Carpinteria and Summerland Offshore Fields. An environmental impact report was completed and Chevron U.S.A. Inc. received permission from the State Lands Commission to resume development drilling in Carpinteria and Summerland Offshore oil fields. As many as 14 wells in Summerland and 22 in Carpinteria are planned.

Federal OCS Exploratory Drilling Activity. New field and evaluation exploratory wells were drilled in three areas of the California OCS: the Santa Barbara Channel, San Pedro Bay, and the Santa Rosa-Cortes Ridge. Two delineation wells and a deeper pool test in the Santa Barbara Channel can be attributed to three factors, all related to Department of the Interior actions: 1) the release in early 1976 of a final Environmental Impact Statement on Santa Barbara OCS development; 2) determination by the Department that present OCS leases without discoveries will expire, forcing the companies to act expeditiously if they intend to explore their leases further; and 3) the desire to evaluate tracts in anticipation of the proposed lease sale in May 1979. Three wells were drilled on San Pedro Bay tracts acquired in OCS Sale No. 35, and four were in progress on OCS Sale No. 35 tracts in San Pedro Bay and over the Santa Rosa-Cortes Ridge at the end of the year (Figure II.G.2.d.ii-3).

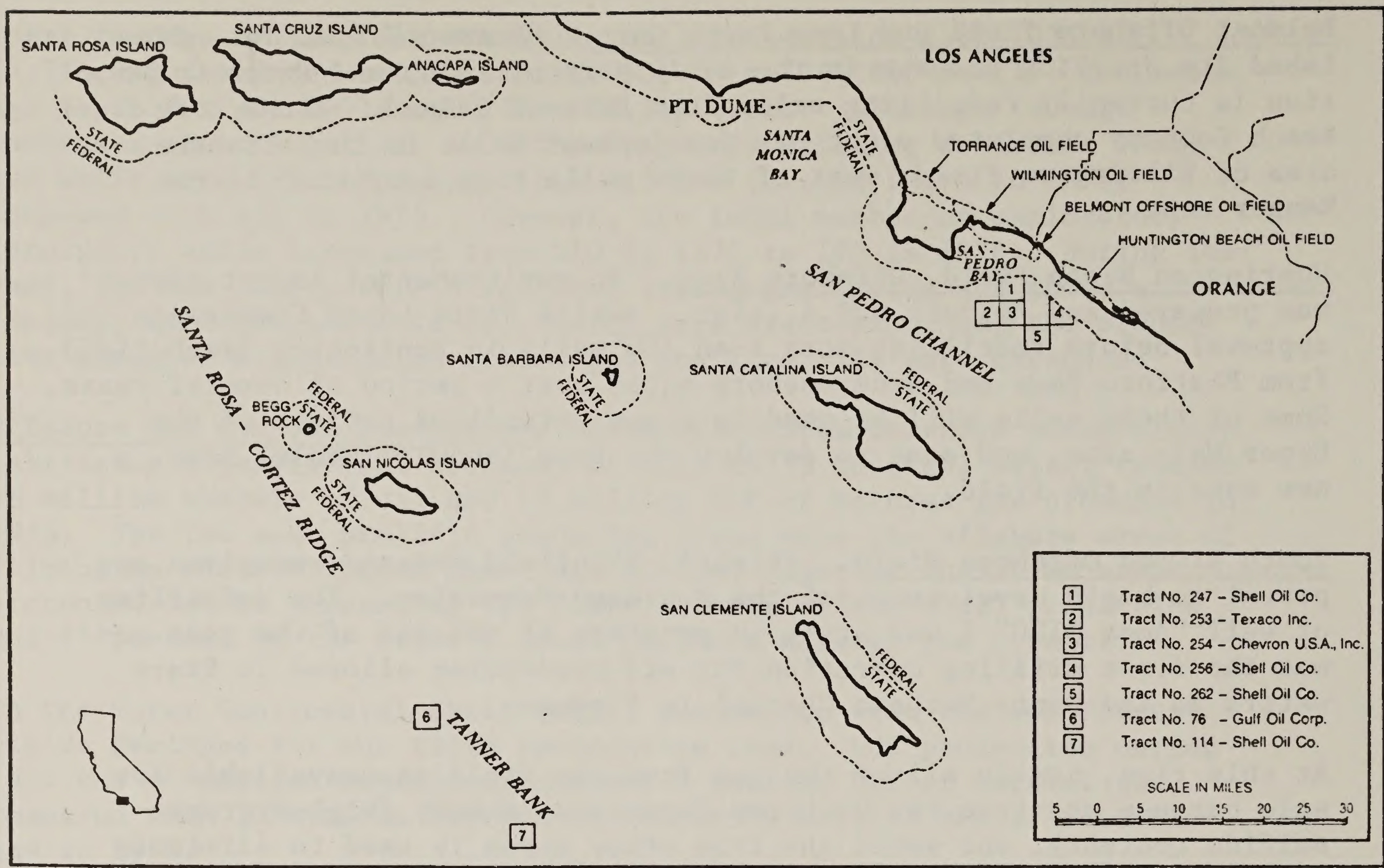


Figure II.G.2.d.ii-3. 1976 Outer Continental Shelf Exploratory drilling Southern California federal leases.

Sun Oil Company drilled well "OCS-P 0240" 9 into the western edge of the Carpinteria Offshore field structure to obtain geological information needed to determine the feasibility of installing Platform Henry. The well was drilled from the drillship "Glomar Grand Isle" to a depth of about 1,700 m (5,000 feet) and was in the process of being redrilled at the end of the year. No results of the well test have been released. Platform Henry was originally planned to be used in developing the western portion of this field, and was under construction in the San Francisco Bay shipyards when the drilling moratorium was imposed in 1969.

Texaco Inc., operator for the Pitas Point Unit, is credited with a discovery on Tract 0234 in June 1968 but, like Sun Oil Company in the Carpinteria field, was unable to follow up with further drilling after the drilling moratorium.

Texaco's well "OCS-P 0234" 3, was drilled in 1976 from the drillship "Coral Sea" to a depth of 6,241 m (18,314 feet) and a promising interval below 5,930 m (17,400 feet) was thoroughly tested. The commercial potential of this well has not been released.

Chevron U.S.A. Inc., operator for the Santa Clara Unit, completed drilling well "OCS-P 0217" 2 in Parcel P-0217, which covers a portion of the Santa Clara Offshore field. This well, drilled to 3,220 m (9,450 feet) was suspended in March 1976 after flowing 540 barrels per day of 30.5° APl gravity oil and 571 barrels per day of 21.4° APl gravity oil from two test intervals within the Monterey Formation. The well also encountered oil shows in the lower Pico Formation and flow-tested at approximately 150 barrels per day of 18° to 24° APl gravity oil from thin sand stringers.

Shell Oil Company drilled two wells and began a third on Tract No. 262 in San Pedro Bay. Drilling began in July 1976 on the first well, "OCS-P 0301" 1, credited as the discovery well of the Beta field. The well was drilled in 222 m (650 feet) of water from the semi-submersible platform "Ocean Prospector" to a total depth of 2,834 m (8,317 feet). Three of seven oil-bearing intervals were tested, but only one indicated commercial production if follow-up drilling showed the reserves to be large enough to warrant development. This zone, at a depth between 1,114 and 1,164 m (3,454 and 3,609 feet), contains 133 feet of oil sand that tested at rates of 473 barrels per day of 19.5° APl gravity oil during short interval tests.

A second well on Tract No. 262 was also drilled to a depth of 6,260 feet from the "Ocean Prospector" one-quarter mile west of the first well. Numerous sidewall samples were taken and the well logged before being abandoned on December 26, 1976. After abandonment of this well, the "Ocean Prospector" was assigned to the Santa Rosa-Cortes Ridge South area to drill a well for Shell on Tract No. 114. During the last week of 1976, Shell was preparing to begin a third well on Tract No. 262 with another newly arrived semi-submersible platform, "Diamond M. General".

On December 17, 1976, Shell Oil Company began to drill well "OCS-P 0293" 1 from the Borgsten Dolphin", a new jack-up platform. The well, located on Tract No. 247 adjacent to the 5.56 km (3-mile) line, was nearing the proposed total depth of 2,386 m (7,000 feet) by the end of 1976.

Chevron U.S.A. Inc. began drilling its first well on Tract No. 254 on July 20, 1976. This was the highest-priced ($105.2 million) tract of the Federal lease sale of December 1976. The well, "OCS-P 0296" 1, was drilled from the drillship "CUSS 1" to a depth of 3,713 m (10,895 feet). A 67 m (209-foot) oil sand interval at 994 m (3,082 feet) was tested and yielded 17.7° APl gravity oil at disappointing rate of 62 barrels per day. The sand intervals below 1,261 m (3,700 feet) failed to produce hydrocarbons and the well was abandoned November 11.

Drilling began on a second well in Tract No. 254 on November 25 and was continuing at the end of 1976. This well, "OCS-P 0296" 2, is 66 m (215 feet) north and 914 m (3,000 feet) east of the first well.

On October 10, 1976, Texaco Inc. began drilling well "OCS-P 0295" 1 in Tract No. 253 in San Pedro Bay. Tract No. 253, for which Texaco and partners paid $21.5 million, is located just west of Chevron's Tract No. 254. The well was drilled in 48 m (141-foot) water to 2,063 m (6,053 feet), plugged back and redrilled to 3,589 m (10,531 feet), and was being tested at the end of the year. There has been no information released on the well other than it is apparently in a different structure than Chevron wells to the east.

Gulf Oil Corporation drilled well "OCS-P 0258" 1 in the Tanner Bank region of the Santa Rosa-Cortes South Ridge area, approximately 145 km (90 miles) southwest of Long Beach and 177 km (110 miles) west of San Diego. The well was being drilled at the end of the year from the semi-submersible platform "Aleutian Key" and was programmed for a depth of 3,067 m (9,000 feet).

Santa Ynez Unit. In 1974, the USGS approved Exxon's plan to develop the Hondo field portion of the Santa Ynez Unit, comprised of 17 tracts sold to Exxon at the February 1968 OCS lease sale in Los Angeles. As an initial phase of development, Exxon positioned Hondo platform in 1976, the world's tallest offshore structure, 32 km (20 miles) west of Santa Barbara and 8.9 km (5.5 miles) offshore from Gaviota. The 945-foot platform, designed to support 28 wells, stands in 290 m (850 feet) of water, a depth over four times that measured at any other platform in the Santa Barbara Channel. The superstructure contains three levels, each 29 by 58 m (86 by 170 feet). The drilling deck is 32 m (95 feet) above mean water level. The substructure, also called the jacket, consists of 14 horizontal levels supported by 18 main legs interspersed with cross and diagonal bracings. The jacket is anchored to the ocean floor by eight 122 cm (48-inch) main piles penetrating about 119 m (350 feet) into the ocean floor. The jacket is 295 m (865 feet) long and weighs 9,900 metric tons (10,900 tons) in place. Drilling began in 1977 and the first production is scheduled for mid-1978.

Union Oil is currently proposing to develop the Hueneme OCS Unit. Union Oil plans to set a 15-slot platform in Federal Lease OCS P-0202 in December, 1979. Peak production rate for the field is estimated by Union to be 6,450 barrels of oil per day in September, 1980, which is proposed to be processed at a new onshore treatment plant at Mandalay Beach.

Southern California Refinery Capacity. The refinery capacity as of January 1, 1976 for the 17 Southern California refineries is shown in Table II.G.2.d.ii-2. Southern California refineries had approximately 60 percent of total California capacity. Standard Oil Company of California's El Segundo refinery is rated at 405,000 B/cd (barrels per calendar day) since its expansion of 175,000 B/cd to process high sulfur crude. California's Office of Planning and Research's draft study of Southern California refineries shows approximately 200,000 B/cd of excess capacity as of mid 1976. A breakdown of oil and gas processing plants by county follows.

Table II.G.2.d.ii-3 shows the onshore oil and gas processing and separation facilities in Ventura and Santa Barbara Counties. Even though Ventura and Santa Barbara Counties produced a combined total of 39,539,657 barrels of oil in 1975, only four small refineries are located in the two counties: the Douglas Oil Company refinery in Santa Maria with a capacity of 9,500 B/cd, the Coline gasoline plant and LPG plant in Ventura with a capacity of 8,000 B/cd, the Edgington refinery in Oxnard which produces asphalt and has a capacity of 2,500 B/cd, and the U.S.A. Petrochemical Corporation plant in Ventura with a capacity of 15,000 B/cd.

Tables II.G.2.d.ii-4 and 5 show the onshore treatment and separation facilities in Los Angeles and Orange Counties. There are no treatment and separation or refining facilities in San Diego County.

The OPR draft inventory shows excess oil treatment capacity of over 100,000 B/cd and gas treatment excess capacity of over 170,000 Mcf/cd as of mid 1976 in the five Southern California coastal counties.

The refining capacity of central California coastal and Bay Area counties totaled 852,500 B/cd in January 1976. This total includes the expansion of the Chevron refinery in Richmond from 190,000 B/cd to 365,000 B/cd. Table II.G.2.d.ii-6 shows the eight refineries in the central and Bay Area counties. Five refineries with a total capacity of 714,000 B/cd are located in Contra Costa County in the cities of Martinez, Hercules and Richmond. The remaining Bay area refinery is located in Benecia, Solano County. The two other refineries are located in Arroyo Grande, San Luis Obispo County and Santa Maria, northern Santa Barbara County.

Table II.G.2.d.ii-2

REFINERY CAPACITY AS OF JANUARY 1, 1976 SOUTHERN CALIFORNIA

Company	Location	Crude Capacity B/cd
Atlantic Richfield Co.	Carson	185,000[a]
Coline Gasoline Corp.	Ventura	8,000[a]
Champlin Petroleum Co.	Wilmington	31,500[a]
Douglas Oil Co.	Paramount	46,500
Edgington Oil Co.	Long Beach	29,500
Edgington Oxnard Refinery	Oxnard	2,500[a]
Fletcher Oil & Refining Co.	Carson	20,000[a]
Golden Eagle Refining Co.	Carson	16,000[a]
Gulf Oil Co.	Santa Fe Springs	51,500
Lunday-Thagard Oil Co.	South Gate	12,000[a]
MacMillan Ring-Free Oil Co.	Signal Hill	12,200[a]
Mobil Oil Corp.	Torrance	123,500
Newhall Refining Co., Inc.	Newhall	11,500
Powerline Oil Co.	Santa Fe Springs	44,120
Shell Oil Co.	Wilmington	90,000
Standard Oil Co. of California	El Segundo	405,000
Texaco Inc.	Wilmington	75,000
Union Oil Co. of California	Wilmington	108,000
USA Petrochemical Corp.	Ventura	15,000[ab]
Total Southern California		1,286,820
Total California Refining Capacity		2,297,385
Southern California Refining Capacity as a percent of the State total		56%

Source: Oil and Gas Journal, March 1977.
[a]Capacity totals verified by telephone 5-16-77 by BLM.
[b]Currently expanding the capacity of the refinery to 30,000 barrels of oil per day with the addition of a desulfurization unit (1911-1978).

Table II.G.2.d.ii-3

ONSHORE OIL AND GAS PROCESSING AND SEPARATION FACILITIES IN VENTURA AND SANTA BARBARA COUNTIES

Co.	Facility	Operator	Design Gross	Design Net	Existing Gross	Existing Net	Surplus	Age	Expansion Potential	Remarks
S.B.	Pt. Concep.	Union Oil	5 MB/D		3 MB/D		2 MB/D	5 yrs.	Possible	2 acre site
S.B.	Ellwood P.F. (5 mi. N of Gol.)	Aminoil	7000 BWPD	1000 BOPD 2000 MCFPD	4000 BWPD	100 BOPD 600 MCFPD	3000 BWPD 900 BOPD	30 yrs.	Yes	
S.B.	Ellwood M.T. (Coal Oil Pt.)	Aminoil		20,000 BOPD		4000 BOPD	16,000 BOPD	40 yrs.	No	Could relocate at Dos Pueblos
S.B.	Dos Pueblos Marine Term.	Aminoil		40,000 BOPD		0			Yes	In planning stage
S.B.	Ellwood	Arco		9600 BOPD 10,000 MCF		4000 BOPD 0 MCF	5600 BOPD 10,000 MCF	9 yrs.	Yes	
S.B.	St. 2793 (Gaviota)	Arco		1000 BOPD 900 MCF		150 BOPD 300 MCF	850 BOPD 600 MCF	13 yrs.	No	
S.B.	St. 308-309 (Goleta)	Arco		1000 BOPD 2500 MCF		40 BOPD 130 MCF	960 BOPD 2370 MCF	14 yrs.	No	
V.	Rincon Island (Punta Gorda)	Arco		5000 BOPD 5000 MCF		700 BOPD 100 MCF	4300 BOPD 4900 MCF	17 yrs.	No	
V.	La Conchita[a] Near S.B. Co. Line So. of Carp.	Phillips		27,000 MCFD		4900 MCFD	22,100 BOPD	7 yrs.	Possible	16 acre site
S.B.	Tajiguas Shore N. of S.B.	Phillips		36,000 MCFD 1000 BNGB		4000 MCFD 65 BNGD	26,000 MCFD 935 BNGD	11 yrs.	No	5 acre site

Table II.G.2.d.ii-3 (Cont.)

Co.	Facility	Operator	Design Gross	Design Net	Existing Gross	Existing Net	Surplus	Age	Expansion Potential	Remarks
S.B.	Molino (Gaviota)	Shell	34 MCFD		2 MCFD		32 MCFD gross	40 yrs.	No	
V.	Ventura	Shell	60 MCFD		6 MCFD		54 MCFD gross	50 yrs.	No	
S.B.	Capitan	Shell							No	Insignificant
S.B.	Las Flores	Mobil	8000	800	2950	215	585 B/D	36 yrs.	Feasible	1-250 B, 2-2000 B, 1-3000 B, 1-3500 B
V.	Barnard	Mobil	3000 BD	500	800	160	340 B/D	43 yrs.	No	1-200 BBL, 2-2000, 1-3000 BBL
V.	Ferguson	Mobil	3000	750	750	295	455 B/D	45 yrs.	No	7-3000 BBL[a] 1-4000 BBL
V.	Notten	Mobil	1500	100	20	15	85 B/D	43 yrs.	No	Using Barnard
V.	Padre	Mobil	2500	750	1000	515	185 B/D	41 yrs.	No	2-2000 BBL, 2-3000 BBL, 1-8000 BBL
V.	Rincon[a]	Mobil	120,000	95,000 B/D	50,000 B/D	36,000 B/D	59,000 B/D	7 yrs.	Yes	
S.B.	Gaviota Plan	Std. Oil Cal.		30,000 MCFD		1100 MCFD	28,900 MCFD	11 yrs.	No (recycle?)	Abandoning or remove poss.
S.B.	Carpinteria	Std. Oil		23,000 MCFD		11,900 MCFD	11,100 MCFD	13 yrs.	Yes	Could increase throughput
V.	West Montalvo	Std. Oil						20 yrs.		Not suitable for OCS oil
S.B.	Santa Maria	Union Oil		35,000 MCFD			10,700 MCF			

Source: FED Oil and Gas Development in the Santa Barbara Channel, USGS, P. I-176

[a]These two onshore facilities handle the total existing Santa Barbara Channel OCS Production.

Table II.G.2.d.ii-4

ONSHORE TREATMENT AND SEPARATION FACILITIES - LOS ANGELES

Facility & Location	Operator	Feed Source	Process	Design Gross	Design Net	Current Thruput Gross	Current Thruput Net	Surplus Capacity	Crude Storage Capacity	Site Acres
Venice	Damson Oil Corp. New York		oil							
Inglewood	Socal	Packard & San Vicente Urban Sites and Inglewood Oil-field	gas		45,000 MCFD		16,600 MCFD	28,400 MCFD		None (leased)
Gas Plant 20 (Inglewood)	Burmah	W.L.A. Oilfield	gas		25,000 MCFD		5,000 MCFD	20,000 MCFD		
Torrance	Socal	Torrance Oilfield	gas		3,000 MCFD		1,300 MCFD	1,700 MCFD		None (leased)
South Torrance	Mobil	South Torrance Unit	oil	10,000	2,000	1,700	715	1,285	none	
Wilmington	Exxon	Wilmington Field	oil		20,000 BOPD		9,000 BOPD	11,000 BOPD		
Isco	Mobil	3-well lease in L.A. Harbor	oil	2,500	300 BOPD	2,050	215	85 BOPD	none	
Terminal	Mobil	3-well lease in L.A. Harbor	oil	6,000	1,200	3,600	935	265		
Long Beach Unit (THUMS)	City of Long Beach	Islands Chaffee brisom White and Freeman	oil gas				100,000 BOPD 20,000 MCFD		174,000 EBL N/A	
San Gabriel	Socal	Torrance Pipeline	oil	2,500 BFPD	500 BOPD	1,200 BFPD	200 BOPD	300	500	None (leased)

Table II.G.2.d.ii-5

ONSHORE TREATMENT AND SEPARATION FACILITIES - ORANGE COUNTY

Facility & Location	Operator	Feed Source	Process	Design Gross	Design Net	Current Thruput Gross	Current Thruput Net	Surplus Capacity	Crude Storage Capacity
Seal Beach	Exxon	Belmont Offshore	oil		3,000 BOPD		2,600 BOPD	None	12,000 BBL
Seal Beach	Socal	Offshore State land leasee	oil	26,000 BFPD	11,000 BOPD	9,700 BFPD	4,700 BOPD	5,300 BBL	9,000 BBL
Heil St. H.B.	Union		oil						
Gas Plant	Burmah	Aminoil field and some Socal field in H.B.	gas		20,000 MCFD		10,000 MCFD	10,000	
Huntington Beach	Socal	Huntington Beach area	gas		3,000 MCFD		(Fore-casted) 3,000 MCFD		
Huntington Beach	Socal	Socal oil in Huntington Beach area	oil	61,000 BFPD	5,000 BOPD	61,000 BFPD	5,000 BOPD		25,000 BBL
Huntington Beach	Aminoil	Huntington Beach oilfield	oil gas	450,000 BWPD	80,000 BOPD	375,000 BWPD	35,000 BOPD	30,000 BWPD 45,000 BOPD	87,000 BBL

Table II.G.2.d.ii-6

CAPACITY OF PETROLEUM REFINERIES IN CENTRAL CALIFORNIA COASTAL AND BAY AREA COUNTIES JANUARY 1, 1976
(BARRELS PER CALENDAR DAY)

Company	Location City	Location County	Crude Oil Distillation Operating
Exxon Company U.S.A.	Benecia	Solano	88,000
Lion Oil Company	Martinez	Contra Costa	126,000
Pacific Refining Company	Hercules	Contra Costa	53,000
Shell Oil Company	Martinez	Contra Costa	100,000
Standard Oil Company of California	Richmond	Contra Costa	365,000
Union Oil Company of California	Arroyo Grande	San Luis Obispo	41,000
Union Oil Company of California	Rodeo	Contra Costa	70,000
Douglas Oil Company	Santa Maria	Santa Barbara	9,500
Totals			852,500

Platform Fabrication. The following is from Onshore Impact of Southern California OCS Sale No. 35, OPR, 1976, Section VIII.

> Offshore oil and gas production is usually accomplished from fixed platforms attached to the ocean floor.
>
> Different types of platforms are used depending on the water depth, function, and adversity of the ocean environment. Self-contained platforms (template type) have been used in the Gulf of Mexico and off the west coast.
>
> Conventional platforms are generally considered to be suitable for use in water depths to a maximum of 1,000 to 1,200 feet. Exxon's Platform Hondo, a 950 foot structure designed for installation in water 850 feet deep, is the deepest conventional production platform in California waters. Shell's Cognac Platform in the Gulf of Mexico was installed in 1025 feet of water in 1978. Deep Oil Technology, Inc. has conducted tests on a prototype of a tension leg platform for deep-water use. This concept relies on tensioned anchor cables in order to hold the buoyant platform in place.
>
> Drilling and production platforms are usually fabricated in steel tubulars with steel pipe pile foundations. To conserve expensive offshore installation time, the "jacket" or tower portion is fabricated as a single unit and the other major components-deck and equipment packages-are built separately in the largest possible module sizes that can be reasonably transported and installed offshore. General requirements for fabrication yards include a large level work yard and loading dock with clear access to the sea.
>
> Once completed, jacket structures are transported from fabrication yards to offshore locations by flat-deck cargo barges.
>
> In the process of installation, the structure is either lifted from the barge (depending on the crane capacity) or launched and positioned by a combination of flooding and lifting with a floating crane. Other platforms have been transported by flotation. Structures of this type are launched on slip ways at the fabrication yards and then towed to the site and installed by controlled flooding.

Shipyard Potential for Construction - Southern California. The Maritime Administration has identified the following west coast shipyards as being capable of building oil rigs:

Bethlehem Steel - San Francisco
Kaiser Steel - Oakland
Lockheed - Seattle
National Steel - San Diego
Tacoma Boatbuilding - Tacoma
Todd Shipbuilding - San Pedro
Todd Shipbuilding - Seattle

Of these potential sites, the most likely, according to the Maritime Administration, are:

Bethlehem Steel - San Francisco
Kaiser Steel - Oakland
Tacoma Boatbuilding - Tacoma

These shipyards have been involved in previous offshore construction and meet the physical space and equipment requirements for additional construction on a large scale; they all have launching facilities, on-site cranes capable of rig and platform work, and access to the sea.

Several other non-California firms which have been active in offshore work and could be called on to produce rigs or components for use on the west coast, have also been identified, including:

Ameron - Vancouver, Washington and Portland, Oregon
Brown & Root - Houston
Raymond International - Houston
J. Ray McDermott & Co. - Houston
Boeing - Seattle
La Tourneau Corporation - Brownsville
Bethlehem Steel - Beaumont
Avondale - Houston

The eventual selection of contractors for future OCS work will, as in the past, be based on competitive-cost, delivery, and schedule bids; and the jobs must be performed wherever the contractor can do so economically.

California steel mills will be affected. Fabrication of platforms will, in most cases, be accomplished in west coast harbors (the majority in the San Francisco Bay area and Tacoma-Puget Sound area with some, possibly, in Los Angeles). Judging from research and inquiries, west coast shipyards could produce a maximum of eight platforms annually, once the shipyards are in full gear. Deck sections and super-structures would be fabricated and assembled in the west coast or Gulf Coast while drilling and production equipment could come from the Gulf area or the Midwest. Actual installation of platforms can be handled adequately by establishing west coast contractors working out of support harbors in Southern California and other parts of the Pacific region.

In addition to capacity and other limitations of Southern California shipyards capable of platform construction, the capabilities and competitive record of Kaiser Steel's Northern California operations must also be considered in evaluating the likelihood of Southern California's capturing a large share of the platform construction market.

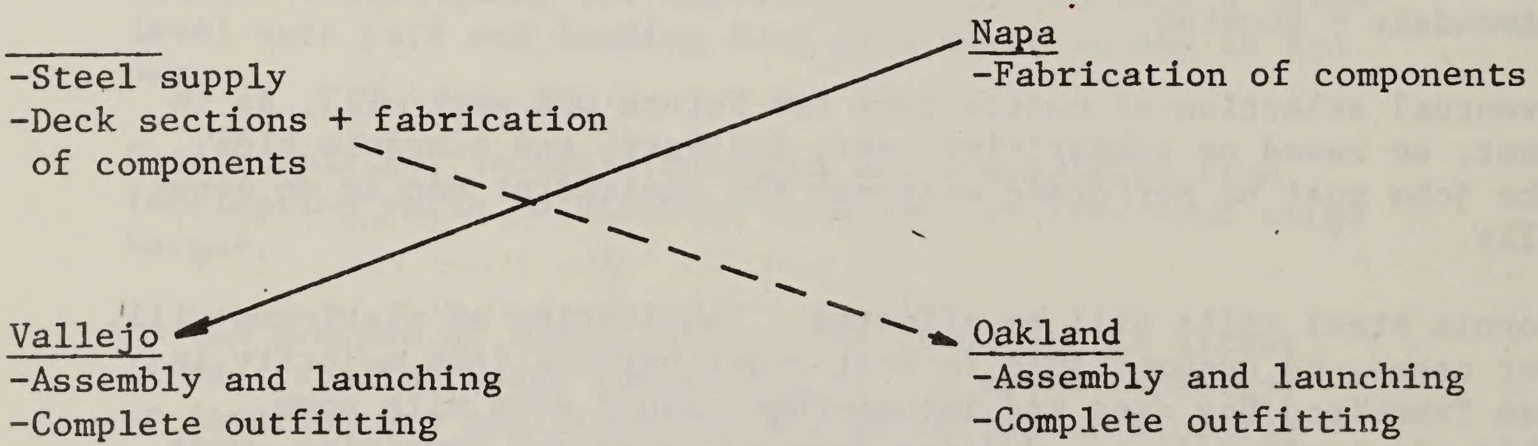
Soon after the first major Federal California Offshore Lease Sale was held in 1968, Kaiser won contracts for three platforms. Other contracts soon followed, and by the time of the 1969 oil spill in Santa Barbara, Kaiser had been responsible for constructing, fabricating or outfitting seven of the existing fifteen offshore platforms in both Federal and State waters.

Kaiser Steel currently operates four facilities in California where phases of platform construction, fabrication, and assembly are performed.

Unlike most other fabricators or platform constructors, Kaiser has a large productive steel mill in Fontana, San Bernardino County. Fontana also has one heavy plate shop, a structural shop and four fabricating shops.

Kaiser's Northern California fabricating site is in Napa, California near the San Francisco Bay area. This site contains a pipe mill, a heavy plate fabricating shop, four graving docks and some limited storage area.

Two assembly and outfitting yards are operated by Kaiser in the Bay area, one at Oakland and one at Vallejo. Only minor fabrication occurs at either of these facilities, which are used for assembly of fabricated structural elements, outfitting and launching. A schematic illustration of the relationships among the Kaiser facilities is given below:



(Arrows indicate common shipping routes).

Kaiser (Napa) fabricated the tubular elements for the jacket for the new deepwater platform "Hondo" for Exxon which was installed in the Santa Ynez Unit Area in the Santa Barbara Channel.

All of Kaiser's facilities (especially those in the Bay area) would probably be involved in additional offshore construction for OCS development.

If fabrication were to occur in Southern California shipyards, modifications would be necessary in these yards before work could begin.

H. Existing Environmental Problems

1. Air Quality: This section presents a discussion of air basins, regulatory agencies, a characterization of the onshore air quality during the base year, and a discussion of pollution trends.

a. Air Basins: An air basin is defined as an area over which local and regional air flow is relatively unimpeded by major topographic barriers. Such substantial barriers generally define the boundaries of air basins and limit flow into or out of the air basins. Three basins, as determined by the California Air Resources Board (ARB Bulletin, August 1976), lie wholly or partially within the study area and are shown in Figure II.H.1-1. The boundaries of these basins, however, are a compromise between actual physical limits to pollutant transport and politically defined limits.

The study area referred to in this section is the area which has potential air quality impacts from the proposed development. The landward boundaries of the study area are defined by geographic and meteorological factors, such as physical obstructions, of sufficient scale to significantly impede transport of airflow. These boundaries are illustrated in Figure II.H.1-1.

The study area thus includes part of the South Central Coast Air Basin (the southern coastal sector from the Los Osos Valley near San Luis Obispo to the Los Angeles County boundary), part of the South Coast Air Basin (the Los Angeles basin including the coastal plain, the San Fernando, San Gabriel, and Pomona-Walnut Valleys, and the San Bernardino-Riverside area), and part of the San Diego Air Basin.

b. Regulatory Agencies: Ambient Air Quality Standards (AAQS) for the study area have been established by the U.S. Environmental Protection Agency (EPA) and the California Air Resources Board (ARB). In addition, Santa Barbara County Air Pollution Control District has also promulgated a standard for hydrogen sulfide. These standards are presented in Table II.H.1-1. Federal standards for gaseous pollutants are given in $\mu g/m^3$ or mg/m^3, while California standards are in ppm. For ease of discussion, all data are presented in ppm in this section. The standard for H_2S prescribed by the Santa Barbara County APCD applies only to Santa Barbara County.

Control of mobile source emissions (excluding ships) in the study area is the responsibility of the California Air Resources Board and the EPA. Control of emissions from stationary sources and ships is the responsibility of the local air pollution control or Air Quality Management District (AQMD). That part of the study area from the northwestern boundary to the Santa Barbara County line is under the jurisdiction of

FIGURE II.H.1-1 California air basins with study area hatched.

<u>Table II.H.1-1</u>

AMBIENT AIR QUALITY STANDARDS

Pollutant	Averaging Time	California Standards[a] Concentration	National Standards[a] Primary	National Standards[a] Secondary
Oxidant (Ozone)	1 hour	0.10 ppm ($200 \mu g/m^3$)	$160 \mu g/m^3$ (0.08 ppm)	Same as Primary Stds.
Carbon Monoxide	12 hour	10 ppm ($11 mg/m^3$)		Same as Primary Stds.
	8 hour		$10 mg/m^3$ (9 ppm)	
	1 hour	40 ppm ($46 mg/m^3$)	$40 mg/m^3$ (35 ppm)	
Nitrogen Dioxide	Annual Average		$100 \mu g/m^3$ (0.05 ppm)	Same as Primary Stds.
	1 hour	0.25 ppm ($470 \mu g/m^3$)		
Sulfur Dioxide	Annual Average		$80 \mu g/m^3$ (0.03 ppm)	
	24 hour	0.05[c] ppm ($131 \mu g/m^3$)	$365 \mu g/m^3$ (0.14 ppm)	
	3 hour			$1,300 \mu g/m^3$ (0.5 ppm)
	1 hour	0.5 ppm ($1,310 \mu g/m^3$)		
Visibility	1 Observation	In sufficient amount to reduce the prevailing visibility to less than 10 ml. when rel. humidity is less than 70%.		

Table II.H.1-1 (Cont.)

Pollutant	Averaging Time	California Standards[a] Concentration	National Standards[a] Primary	National Standards[a] Secondary
Suspended Particulate Matter	Annual Geometric Mean	60 $\mu g/m^3$	75 $\mu g/m^3$	60 $\mu g/m^3$
	24 hour	100 $\mu g/m^3$	260 $\mu g/m^3$	150 $\mu g/m^3$
Sulfates	24 hour	25 $\mu g/m^3$		
Lead	30 day average	1.5 $\mu g/m^3$		
Hydrogen Sulfide[d]	1 hour	0.03 ppm (42 $\mu g/m^3$)		
Hydrocarbons (Corrected for Methane)	3 hour (6-9 a.m.)		160 $\mu g/m^3$ (0.24 ppm)	Same as Primary Stds.
Ethylene	8 hour	0.1 ppm		
	1 hour	0.5 ppm		

[a]California standards are values that are not to be equalled or exceeded.
[b]National standards, other than those based on annual averages or annual geometric means, are not to be exceeded more than once per year.
[c]At locations where the State standards for oxidant and/or suspended particulate matter are violated. Federal standards apply elsewhere.
[d]Santa Barbara County has an H^2S regulation limiting ambient levels to 0.06 ppm for 3 minutes.

the San Luis Obispo Air Pollution Control District. The Santa Barbara County Air Pollution Control District and the Ventura County Air Pollution Control District have jurisdiction over the portions of the study area in Santa Barbara and Ventura Counties. The South Coast Air Quality Management District has jurisdiction over the portion of the study area in Los Angeles, Riverside, San Bernardino, and Orange Counties. That portion of San Diego County in the study area is under the jurisdiction of the San Diego County Air Pollution Control District.

The offshore islands fall under the jurisdiction of the APCD or AQMD in the county to which they belong (i.e., Santa Catalina Island is in Los Angeles County and is, therefore, under the jurisdiction of the South Coast Air Quality Management District).

c. Area Classification: Certain portions of the 1977 Clean Air Act Amendments require that all areas of the country be categorized according to their attainment status and Prevention of Significant Deterioration (PSD) classification. Such is also the case for the study area. The following discussion addresses both of these categories.

Attainment Status. Section 107 of the Clean Air Act (CAA) requires that all Air Quality Control Regions (AQCR), or portions thereof, must be designated as either attaining or not attaining the applicable AAQS for each criteria pollutant. If there was not adequate data to make such a determination for a certain area, the responsible regulatory agency could deem it as unclassified.

The designation of each AQCR (or portions thereof) was originally published by the EPA in March, 1978. The original attainment status for California still applies even though the California ARB has proposed a number of revisions to the EPA for their approval. Table II.H.1-1A presents the March 1978 designation for each portion of the study area. Figures II.H.1-1A through II.H.1-1E incorporates both the original classification for each pollutant plus the ARB-proposed changes.

New facilities wishing to construct in any nonattainment area before July 1, 1979, requiring new source review, must adhere to the Interpretative Ruling, as promulgated by the EPA (Section 129, CAA). This rule places a number of requirements on the source, including emission offsets and Lowest Achievable Emission Rate standards. After July 1, 1979, new sources in nonattainment areas will theoretically be regulated by the State under an approved Implementation Plan.

Prevention of Significant Deterioration. Section 162 of the 1977 Clean Air Act initially places all attainment or unclassified areas of the country, as described above, into either a Class I or Class II area. Class I is designed to accommodate almost no industrial growth and is used for pristine areas such as national parks and wilderness areas.

TABLE II.H.1-1A

Attainment Status of Study Area
3 March 1978

Air Basin				TSP		SO_2	
County Subarea	O_x	CO	NO_2	Prim.	Sec.	Prim.	Sec.
<u>South Central Coast</u>							
San Luis Obispo Salinas Valley	N	A	A		N	U	
San Luis Obispo Non-Salinas Valley	N	A	A	U		U	
Santa Barbara AQMA	N	N	A		N	U	
Santa Barbara Non-AQMA (West)	N	A	U	N		U	
Santa Barbara Non-AQMA (East)	N	A	U	U		U	
Ventura - North of Los Padres Nat'l Forest	N	A	A	U		A	
Ventura - South of Los Padres Nat'l Forest	N	A	A	N		A	
Channel Islands	U	U	U	U		U	
<u>South Coast</u>	N	N	N	N			
Los Angeles (South Coast Basin Portion)	N	N	N	N		N	
Orange	N	N	N	N		A	
Riverside (South Coast Basin Portion)	N	N	N	N		A	

Air Basin				TSP		SO_2	
County Subarea	O_x	CO	NO_2	Prim.	Sec.	Prim.	Sec.
South Coast (cont'd.)							
San Bernardino (South Coast Basin Portion)	N	N	N	N		A	
San Diego County							
West San Diego County	N	N	N	N		A	
East San Diego County	N	U	U	U		A	

N = Nonattainment
U = Unclassified
A = Attainment

Source: "Air Quality Designations for California," California ARB, October 1978.

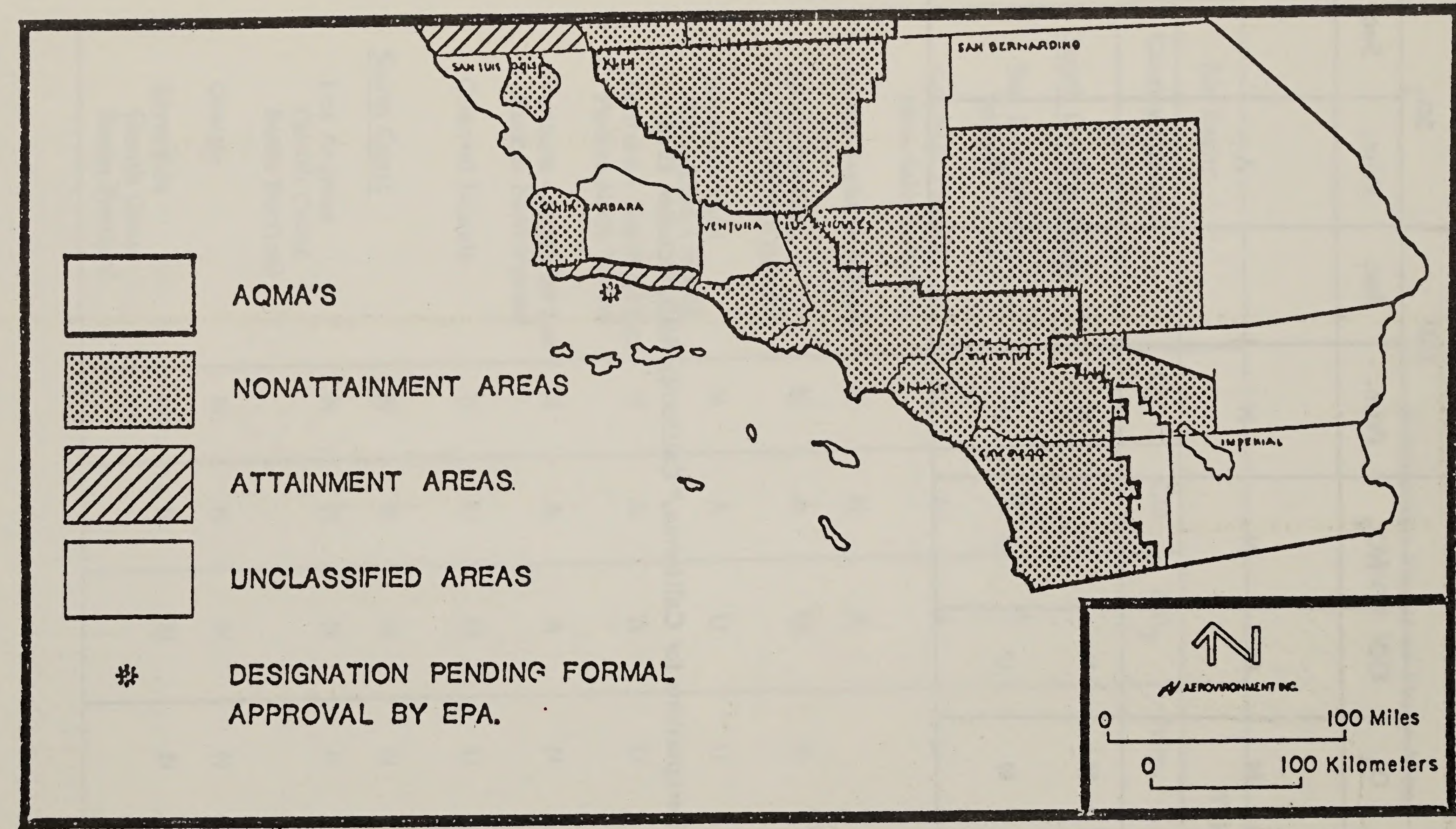


FIGURE II.H.1-1A. Existing and proposed nonattainment areas for particulate matter.

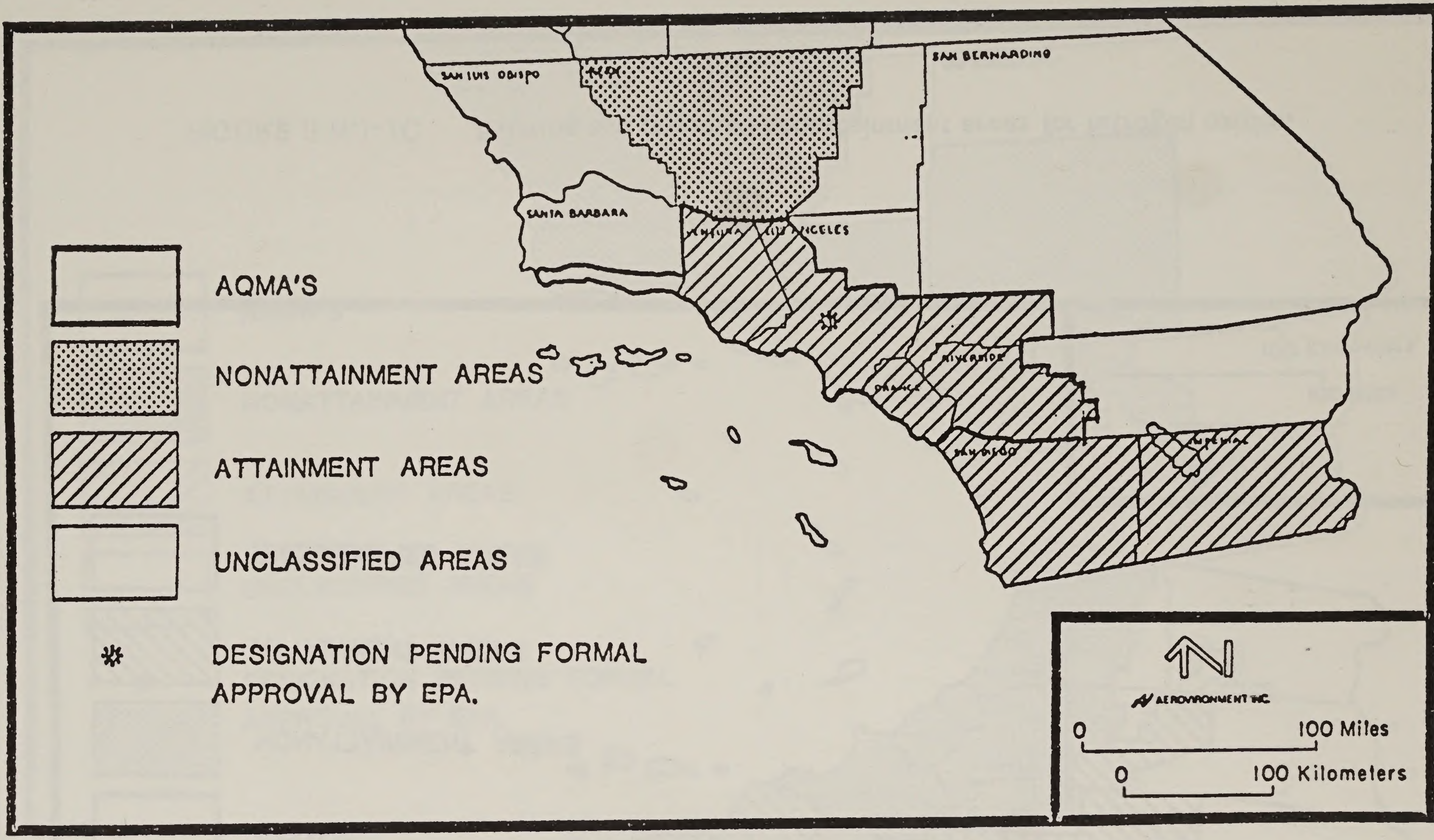


FIGURE II.H.1-1B Existing and proposed nonattainment areas for sulfur dioxide.

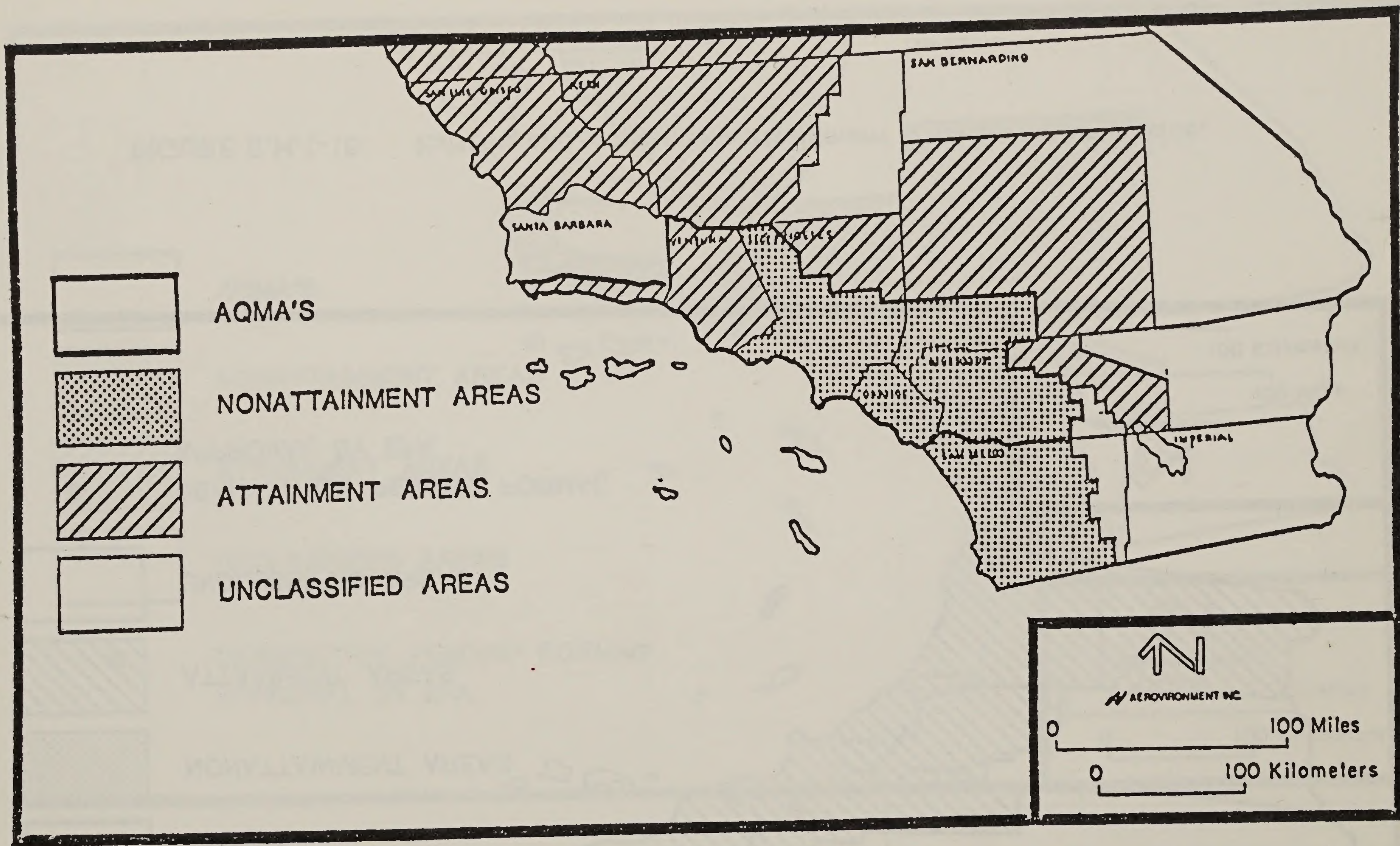


FIGURE II.H.1-1C Existing and proposed nonattainment areas for nitrogen oxides.

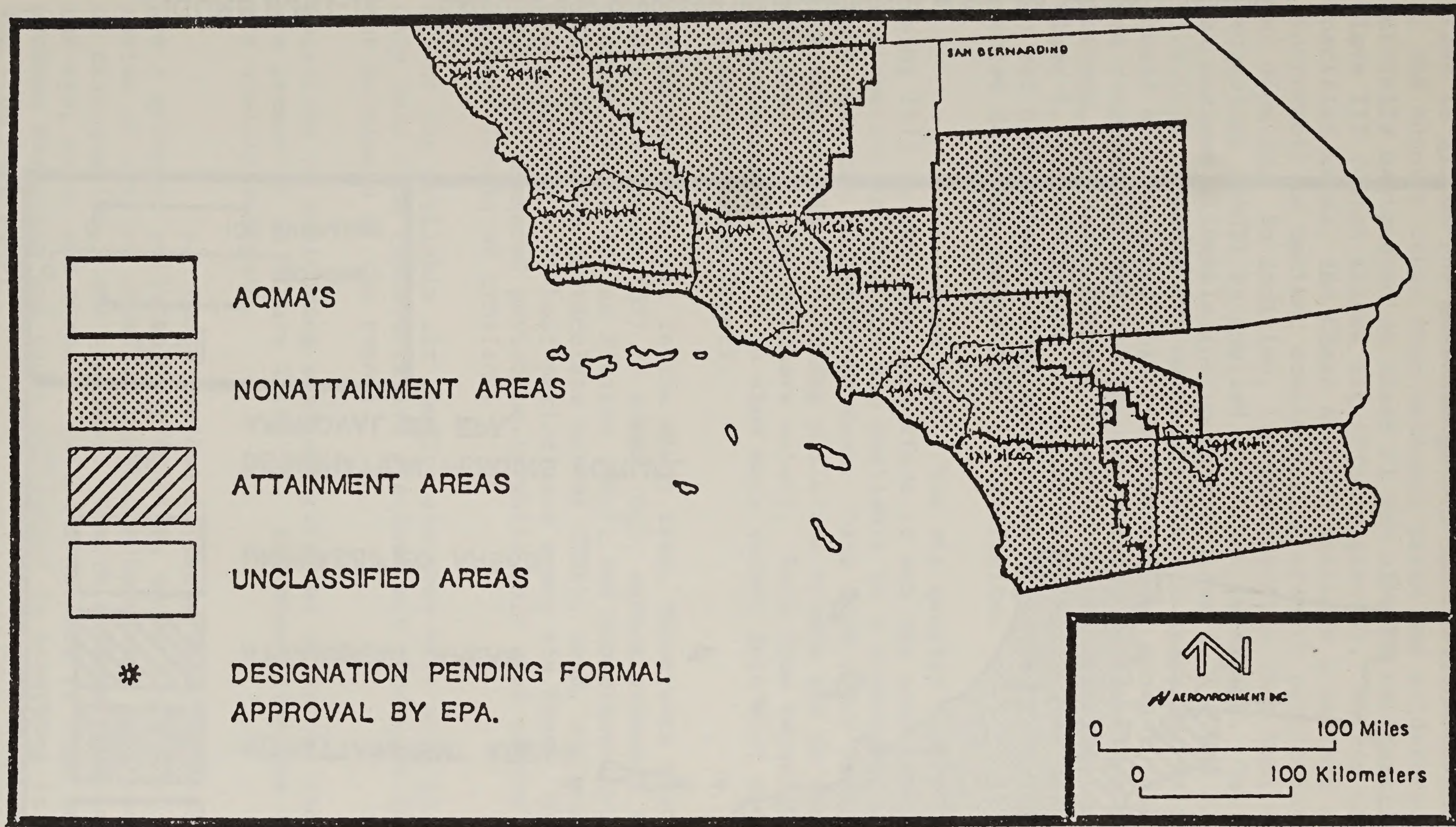


FIGURE II.H.1-1D Existing and proposed nonattainment areas for photochemical oxidants.

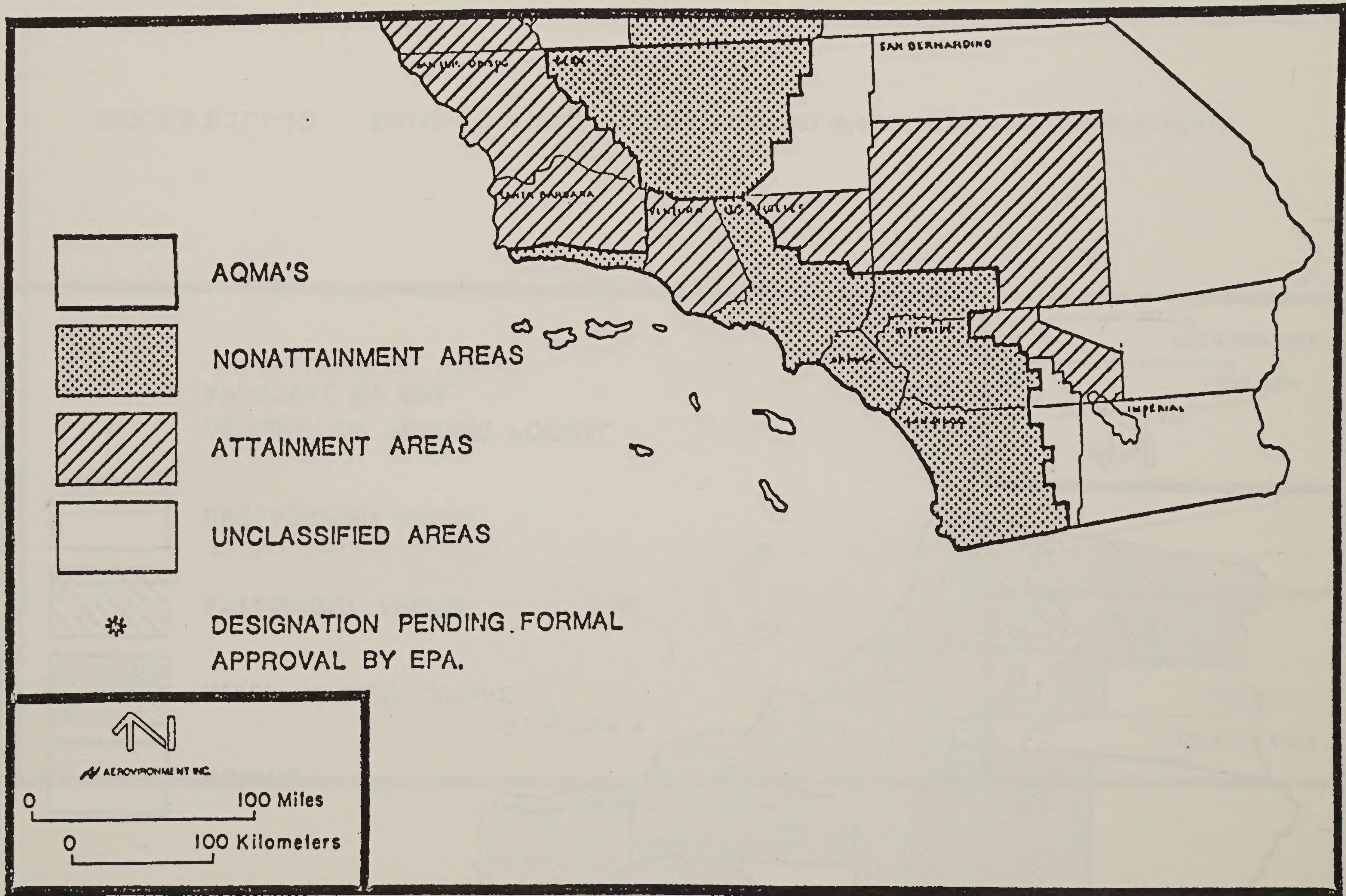


FIGURE II.H.1-1E Existing and proposed nonattainment areas for carbon monoxide.

Class II allows for moderate growth and is used for all other portions of the country other than national parks and wilderness areas. Any area initially designated as Class II may also be reclassified to Class I or Class III (which allows significant growth). Within each of the above specified areas, the Clean Air Act mandates a maximum allowable increase (increment) in ambient concentration of both particulate matter and sulfur dioxide. In addition, it also requires that Best Available Control Technology (BACT) be applied to reduce emissions. Table II.H.1-1B gives the maximum allowable increment for Class I, II, and III areas. Figure II.H.1-1F presents the mandatory Class I areas for California. It should also be noted that the Federal land manager (National Park Service) has recommended that the Channel Islands National Monument (San Miguel, Anacapa, and Santa Barbara Islands) be reclassified from Class II to Class I, also indicated in Figure II.H.1-1F. This recommendation has not as yet been acted upon by either the Congress or the State, and the projected date for such action is indefinite.

d. Base Year: The air quality impact analysis was done using 1975 as the base year since it was the most recent year for which air quality information was available in a reasonably complete and useful form when the analysis was done. Data from other years will be used, however, to aid in defining pollutant trends and in characterizing the air quality of the offshore waters. Data from representative stations is presented for 1976 to show more recent data that was not available for the AeroVironment Report.

During the base year in the study area, there were continuous measurements of oxidants (OX) or ozone (O_3), carbon monoxide (CO), nitrogen dioxide (NO_2), sulfur dioxide (SO_2), and nonmethane hydrocarbons (NMHC). Total suspended particulate matter (TSP), lead, and sulfates were measured over a 24-hour period once every six days. Hydrogen sulfide (H_2S) was measured periodically while only spot checks were made of ambient levels of ethylene.

All of the available air quality stations were used in the analysis. Only data from representative stations are presented in the tables to cut bulkiness of the report.

Locations of monitoring stations referred to in the ensuing discussion are presented in Figure II.H.1-2. All these stations were used in the air quality analysis.

e. Photochemical Oxidants (OX): Photochemical oxidants are a group of pollutants, primarily, ozone (O_3), that result from a series of complex chemical reactions involving hydrocarbons (HC), oxides of nitrogen (NO_x) and sunlight. Health effects include irritation of the eye, nose, and throat. Extended periods of high levels of oxidants produce headaches and cause difficulty in breathing in patients suffering from emphysema.

TABLE II.H.1-1B

Allowable Increments for PSD Class I, II, and III Areas

Pollutant	Averaging Time	Class I Area	Class II Area	Class III Area
Particulate Matter	Annual Geometric	5 $\mu g/m^3$	19 $\mu g/m^3$	37 $\mu g/m^3$
	24-hour Maximum	10 $\mu g/m^3$	37 $\mu g/m^3$	75 $\mu g/m^3$
Sulfur Dioxide	Annual Arithmetic	2 $\mu g/m^3$	20 $\mu g/m^3$	40 $\mu g/m^3$
	24-hour Maximum	5 $\mu g/m^3$	91 $\mu g/m^3$	182 $\mu g/m^3$
	3-hour Maximum	25 $\mu g/m^3$	512 $\mu g/m^3$	700 $\mu g/m^3$

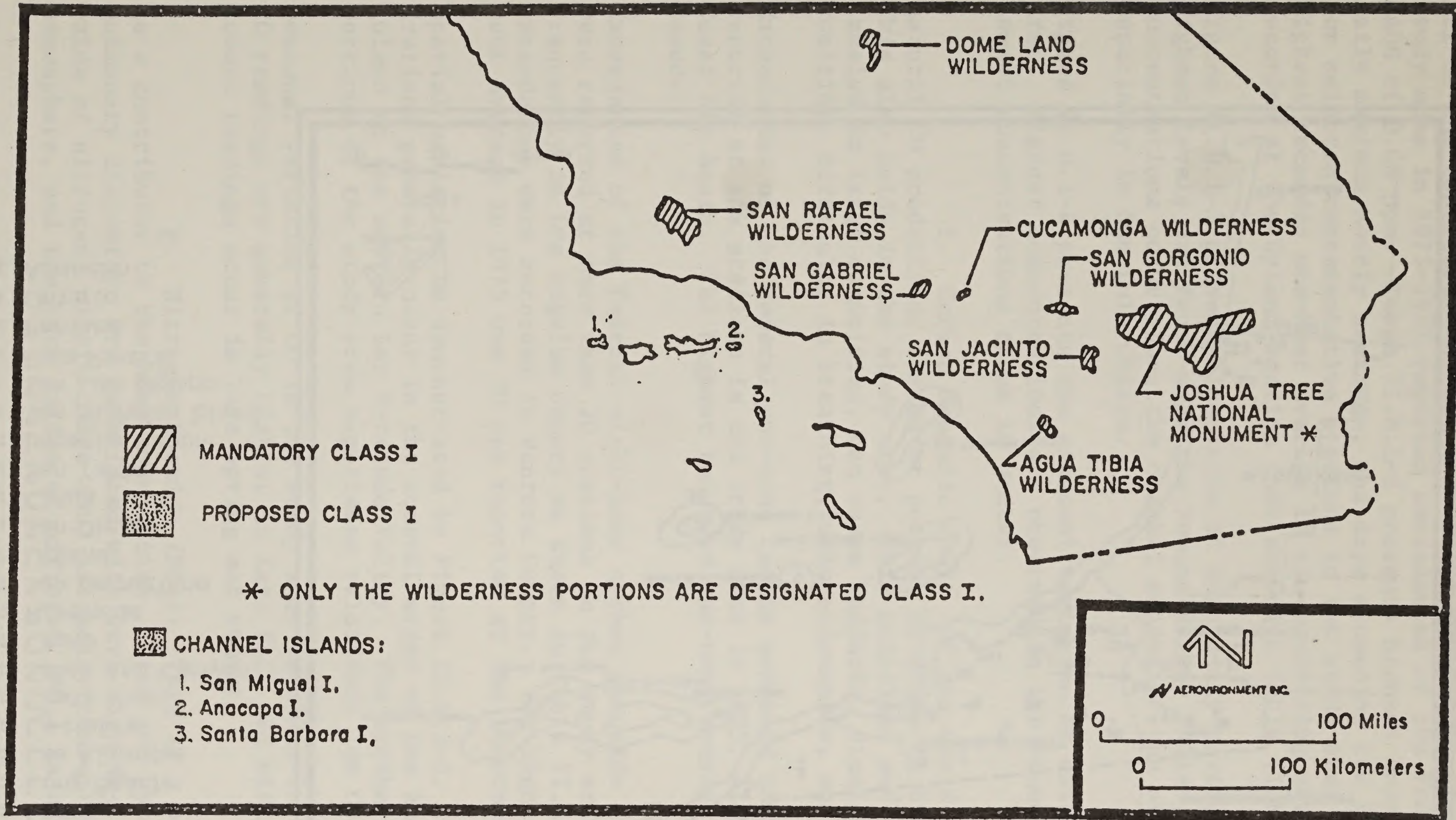


FIGURE II.H.1-1F Mandatory and proposed Class I areas under 1977 Clean Air Act Amendments.

KEY

1: Santa Barbara
2: Ventura
3: Camarillo
4: Reseda
5: Burbank
6: Pasadena
7: Azusa
8: West Los Angeles
9: Los Angeles
10: Lennox
11: Long Beach
12: Los Alamitos
13: La Habra
14: Costa Mesa
15: Santa Ana Canyon
16: Chino
17: Riverside
18: San Bernardino
19: Upland
20: San Diego
21: Chula Vista
22: San Ysidro
23: Imperial Beach
24: San Nicholas Island
25: San Luis Obispo
26: Pico Rivera
27: Fontana
28: Ontario
29: Anaheim

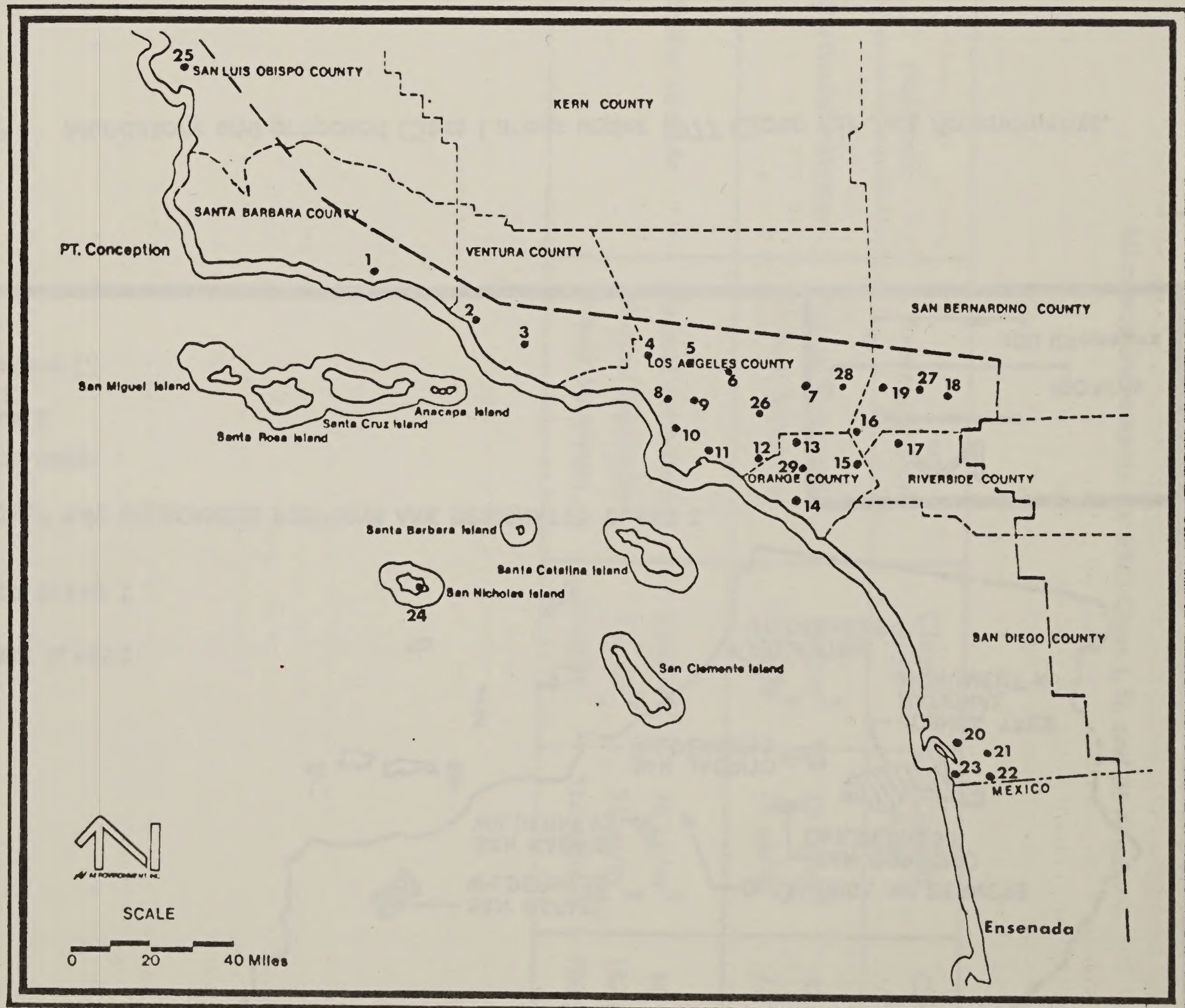


FIGURE II.H.1-2 Locations and names of monitoring sites.

All of the continuous oxidant (or ozone) monitoring stations in the study area in 1975-1977 reported exceedances of the Federal one-hour AAQS of 0.08 ppm. Table II.H.1-2 presents highest hourly averages, mean daily maximum hourly averages, and days exceeding the Federal Standard for selected representative stations in the study area in 1975-1977. The highest recorded one-hour average in the monitoring network was 0.39 ppm recorded at the Upland station (not shown in Table II.H.1-2).

Figure II.H.1-3 presents isopleths of mean daily maximum hourly averages. Highest levels are found near the Pomona-Walnut Valley, while lowest concentrations occur along the coastal sector of the study area, especially in San Luis Obispo.

Figure II.H.1-4 presents the seasonal variation of oxidant in the study area. Highest concentrations are observed in the summertime, while lowest concentrations occur in winter.

f. Carbon Monoxide (CO): Of the world's total non-natural CO production, the major portion is produced by automobiles. This also holds in the study area. This colorless and odorless gas, when inhaled in large quantities, can cause headache, dizziness, nausea, vomiting, difficulty in breathing, unconsciousness, and finally death.

Exceedances of the Federal one-hour carbon monoxide AAQS of 35 ppm were reported at six stations in the study area in 1975, all in the South Coast Air Basin. The highest recorded one-hour average was 53 ppm in Reseda.

Exceedances of the Federal eight-hour carbon monoxide AAQS of 9 ppm were reported at more than 20 stations in the study area in 1975, most frequently in Los Angeles County as shown in Table II.H.1-3. No 8-hour exceedances were recorded in Ventura County. The highest recorded 8-hour average in 1975 was 30 ppm reported at the Lennox station.

Spatial variation is demonstrated by Figure II.H.1-5. Highest concentrations generally occur in the coastal areas of Los Angeles County and inland to the eastern San Fernando Valley. The southern and northern portions of the study area experience relatively low CO levels.

Seasonal variation of CO in the study area is shown in Figure II.H.1-6. CO readings are generally highest in late fall and wintertime, and lowest readings occur in late spring and summer.

g. Nitrogen Dioxide (NO_2): This is a pungent gas which is a contributor to the haze over cities. Nose and eye irritation and pulmonary discomfort are associated with very high NO_2 levels. Another oxide of nitrogen, nitric oxide (NO) is easily converted to NO_2 in the atmosphere, and the term oxides of nitrogen (NO_x) is often used to

Table II.H.1-2

OZONE DATA (PPM) FOR SELECTED REPRESENTATIVE STATIONS IN THE STUDY AREA

Station	Air Basin[a]	County Name	Maximum Hourly Average			Mean Daily Maximum Average			Days Exceeding Federal Standard		
			1975	1976	1977	1975	1976	1977	1975	1976	1977
San Luis Obispo	SCC	San Luis Obispo	0.09	0.11	0.10	0.037	0.043	--	2	3	1
Santa Barbara - State St.	SCC	Santa Barbara	0.19	0.17	0.04	0.037	0.048	--	5	21	16
Camarillo-Elm St.	SCC	Ventura	0.22	0.17	0.25	0.056	0.050	0.070	41	33	76
Ventura - Telegraph Hill	SCC	Ventura	0.16	0.19	0.25	0.050	0.053	0.060	24	35	41
Long Beach	SC	Los Angeles	0.14	0.16	0.15	0.033	0.033	0.037	9	11	16
Pasadena - Walnut	SC	Los Angeles	0.32	0.34	0.32	0.105	0.109	0.109	183	193	195
West Los Angeles	SC	Los Angeles	0.19	0.28	0.18	0.059	0.066	0.062	65	91	54
Riverside - Rubidoux	SC	Riverside	0.35	0.36	0.35	0.099	0.105	0.116	196	88	212
San Bernardino[b]	SC	San Bernardino	0.32	0.32	0.34	0.102	0.072	0.114	174	169	120
Santa Ana Canyon	SC	Orange	0.33	0.33	0.30	0.082	0.078	0.070	135	135	115
Costa Mesa[c]	SC	Orange	0.18	0.16	0.19	0.043	0.037	0.045	19	18	38
San Diego - Overland Ave.	SD	San Diego	0.22	0.19	0.18	0.058	0.056	---	55	79	64

[a]SCC: South Central Coast; SC: South Coast; SD: San Diego

[b]Data for July, August, and September, 1976 missing.

[c]Data for August, 1975 missing.

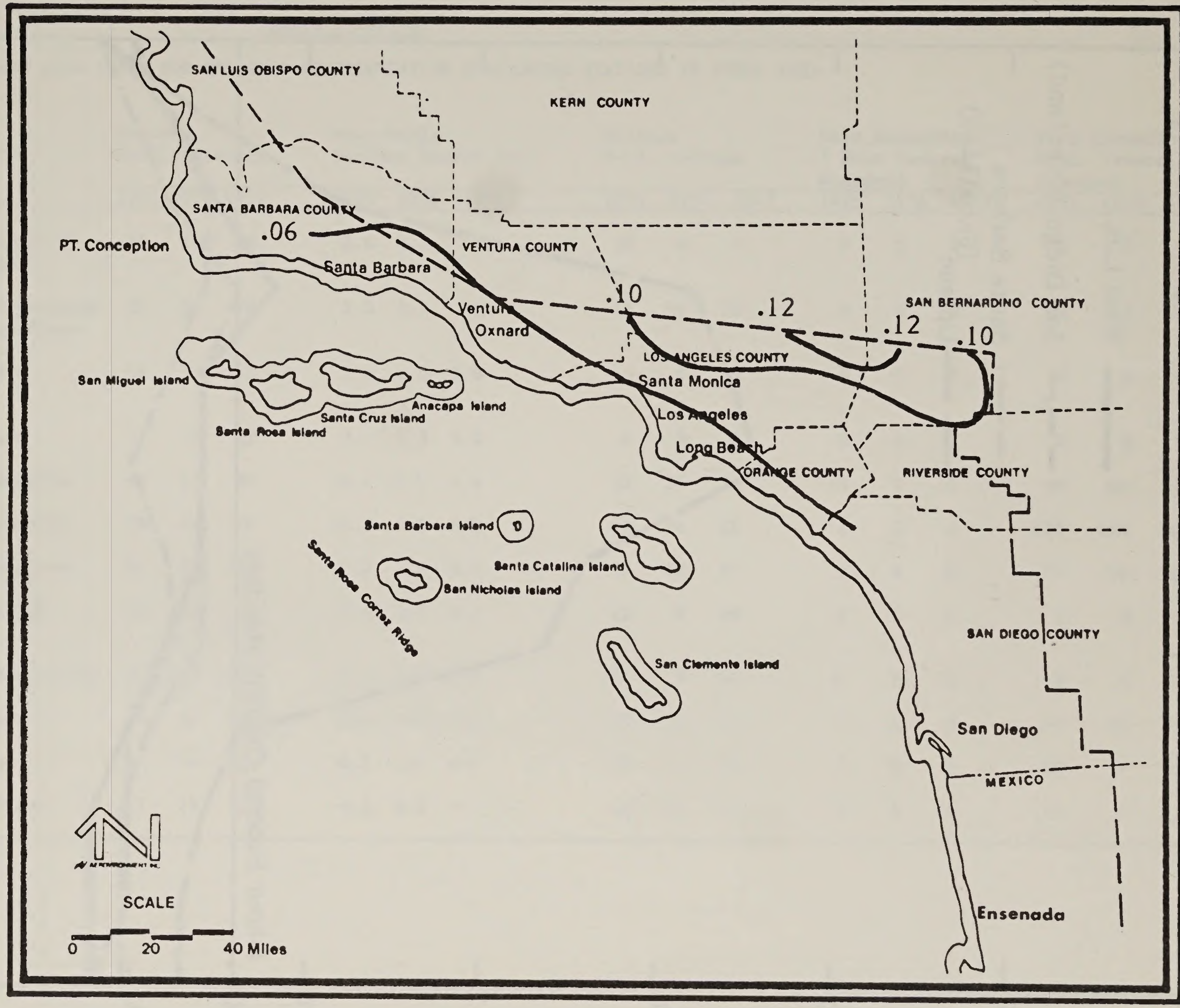


FIGURE II.H-1-3 Isopleths of mean daily maximum hourly average ozone concentrations (ppm) in 1975. Federal 1-hour oxidant standard is 0.08 ppm.

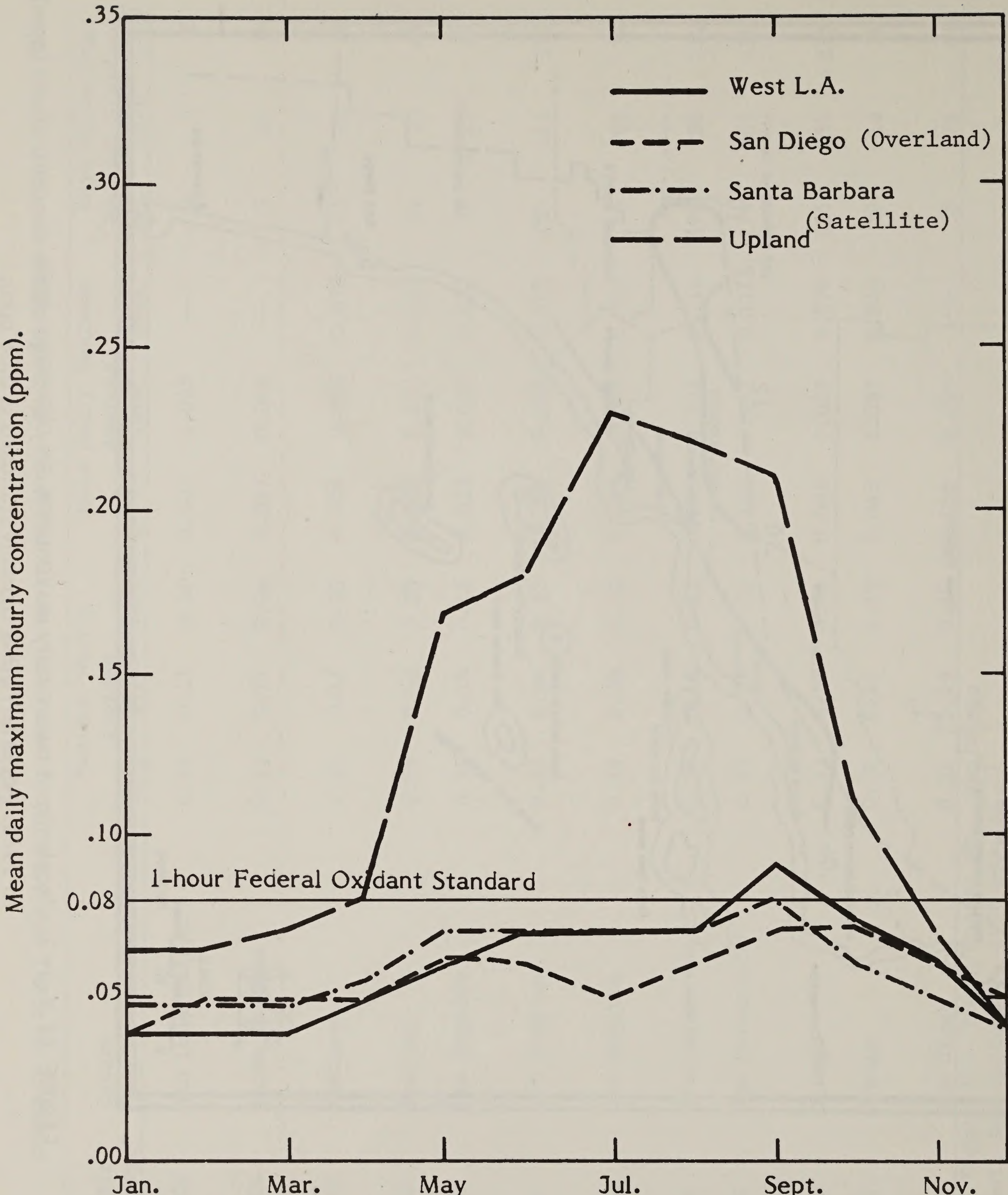


FIGURE II.H.1-4 Seasonal variation of oxidant. Mean daily maximum hourly concentration at selected stations in 1975.

Table II.H.1-3

CARBON MONOXIDE DATA (PPM) FOR SELECTED REPERSENTATIVE MONITORING STATIONS IN STUDY AREA

Station	Air Basin[a]	County Name	Maximum Hourly Average			Mean Daily Maximum Hourly Avg.			Maximum 8-hr. Average			Days Exceeding 1 Hour Federal Standard			Days Exceeding 8-hr. Federal Standard		
			1975	1976	1977	1975	1976	1977	1975	1976	1977	1975	1976	1977	1975	1976	1977
San Luis Obispo	SCC	San Luis Obispo	14	16	16	2.8	3.5	--	10	8	7	0	0	0	1	0	0
Santa Barbara-State Street	SCC	Santa Barbara-State Street	22	22	19	5.2	5.2	--	14	12	10	0	0	0	14	13	4
Camarillo-Elm Street	SCC	Ventura	14	9	12	3.0	2.6	3.0	--	4	5	0	0	0	0	0	0
Ventura	SCC	Ventura	17	18	13	3.3	3.3	3.0	6	8	6	0	0	0	0	0	0
Lennox	SC	Los Angeles	40	43	30	10.4	10.7	8.4	30	25	20	3	2	0	96	90	70
Burbank	SC	Los Angeles	36	30	28	10.7	9.3	8.2	27	26	22	1	0	0	125	106	82
Long Beach	SC	Los Angeles	21	19	20	7.2	7.6	6.9	17	15	17	0	0	0	57	58	43
Riverside-Rubidoux	SC	Riverside	14	10	11	4.4	4.2	4.7	13	9	10	0	0	0	5	0	2
San Bernardino	SC	San Bernardino	20	12	15	4.6	4.2	4.5	12	9	12	0	0	0	8	0	2
Costa Mesa	SC	Orange	--	27	18	11.4	7.3	5.5	23	21	12	--	0	0	40	66	22
La Habra	SC	Orange	--	--	23	8.1	--	6.9	17	--	13	1	0	0	23	--	15
San Diego-Island Ave.	SD	San Diego	17	17	17	4.4	4.4	--	13	11	11	0	0	0	14	7	3

SCC: South Central Coast
SC: South Coast
SD: San Diego

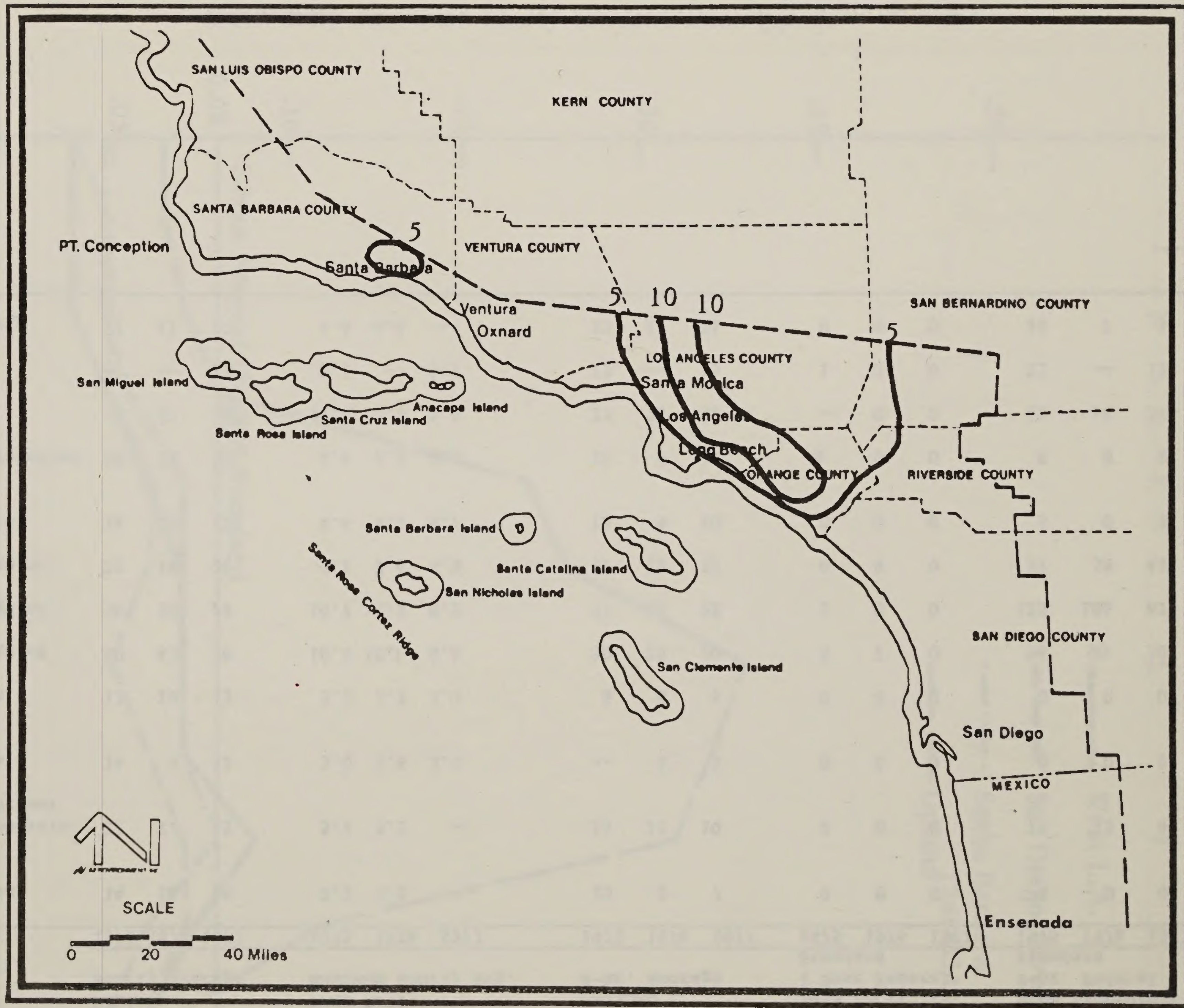


FIGURE II.H.1-5 Isopleths of mean daily maximum hourly average CO concentration (ppm) in 1975.

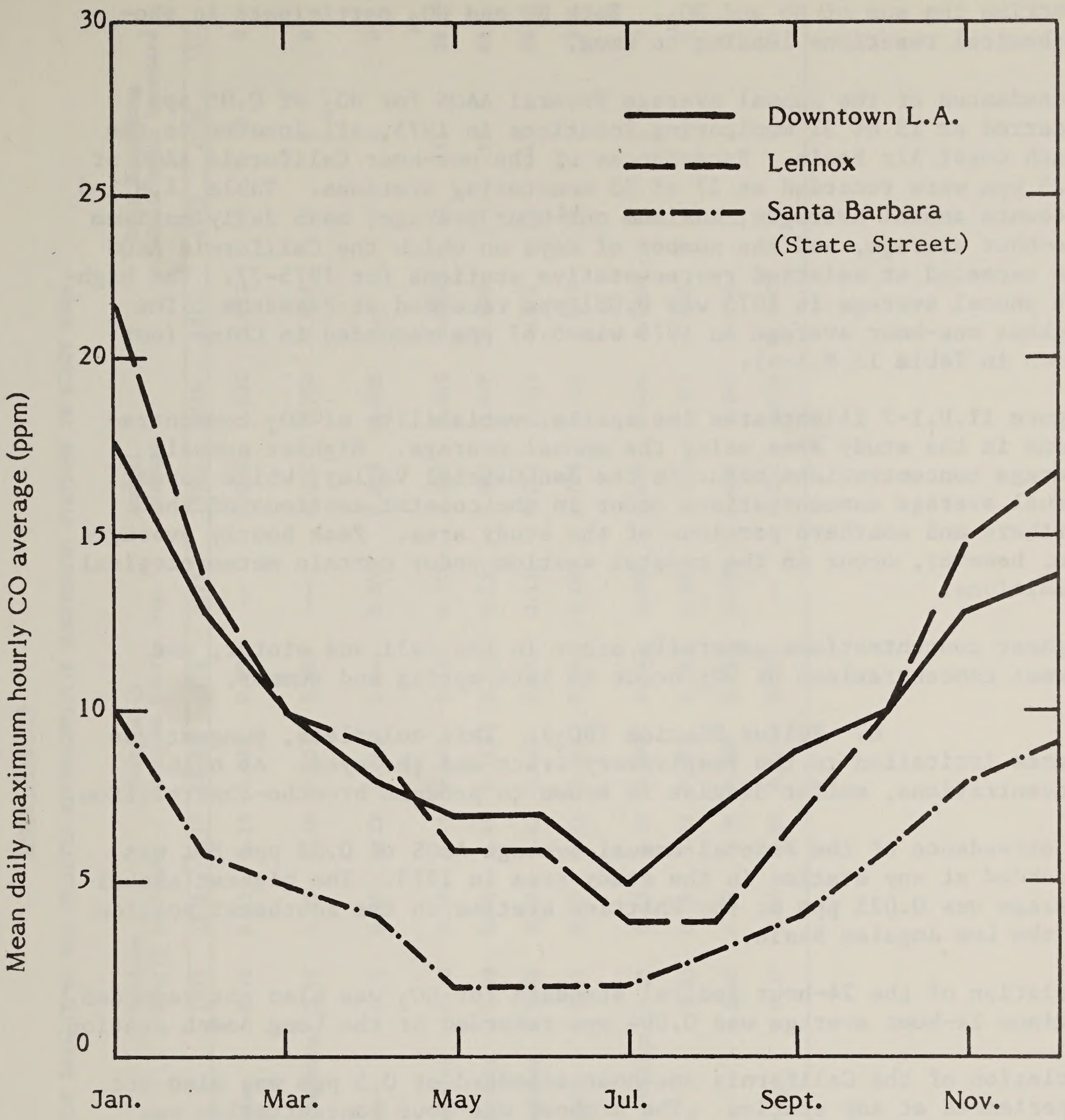


FIGURE II.H.1-6 Seasonal variation of CO. Mean daily maximum hourly average at selected stations in 1975.

describe the sum of NO and NO_2. Both NO and NO_2 participate in photochemical reactions leading to smog.

Exceedances of the annual average Federal AAQS for NO_2 of 0.05 ppm occurred at 13 of 31 monitoring locations in 1975, all located in the South Coast Air Basin. Exceedances of the one-hour California AAQS of 0.25 ppm were recorded at 27 of 33 monitoring stations. Table II.H.1-4 presents annual averages, maximum one-hour average, mean daily maximum one-hour average, and the number of days on which the California AAQS was exceeded at selected representative stations for 1975-77. The highest annual average in 1975 was 0.081 ppm recorded at Pasadena. The highest one-hour average in 1975 was 0.67 ppm recorded in Chino (not shown in Table II.H.1-4).

Figure II.H.1-7 illustrates the spatial variability of NO_2 concentrations in the study area using the annual average. Highest annual average concentrations occur in the San Gabriel Valley, while lowest annual average concentrations occur in the coastal sections of the northern and southern portions of the study area. Peak hourly averages can, however, occur in the coastal section under certain meteorological conditions.

Highest concentrations generally occur in the fall and winter, and lowest concentrations of NO_2 occur in late spring and summer.

h. Sulfur Dioxide (SO_2): This colorless, pungent gas causes irritation to the respiratory tract and the eyes. At high concentrations, sulfur dioxide is known to produce broncho-constriction.

No exceedance of the Federal annual average AAQS of 0.03 ppm SO_2 was recorded at any station in the study area in 1975. The highest annual average was 0.025 ppm at the Whittier station in the southeast portion of the Los Angeles Basin.

Violation of the 24-hour Federal standard for SO_2 was also not recorded. Maximum 24-hour average was 0.064 ppm recorded at the Long Beach station.

Violation of the California one-hour standard of 0.5 ppm was also not experienced at any station. The highest one-hour concentration was 0.26 ppm recorded at the Whittier station.

Table II.H.1-5 presents annual averages and maximum 24- and one-hour averages for selected representative monitoring sites for 1975-77. Federal standards will not be violated at any of the sale areas; therefore, exceedances were not tabulated.

Spatial variability of SO_2 is presented in Figure II.H.1-8, using the annual mean concentration. Highest concentrations occur in the southeast portion of Los Angeles County. Lowest concentrations occur

Table II.H.1-4

NITROGEN DIOXIDE DATA (PPM) FOR SELECTED REPERSENTATIVE MONITORING STATIONS IN STUDY AREA

Station	Air Basin[a]	County Name	Maximum Hourly Average			Mean Daily Maximum Hourly Avg.			Annual Average			Days Exceeding California Standard		
			1975	1976	1977	1975	1976	1977	1975	1976	1977	1975	1976	1977
San Luis Obispo	OCC	San Luis Obispo	0.10	0.15	0.13	0.035	0.036	--	0.020	0.030	0.022	0	0	0
Santa Barbara State Street	SCC	Santa Barbara	0.21	0.19	0.18	0.053	0.065	--	0.032	0.034	0.038	0	0	0
Camarillo-Elm Street	SCC	Ventura	0.18	0.17	0.23	0.043	0.044	0.050	0.022	0.025	--	0	0	0
Lennox	SC	Los Angeles	0.40	0.39	0.43	0.101	0.125	0.109	0.056	0.073	0.069	10	21	29
Pasadena	SC	Los Angeles	0.49	0.38	0.48	0.141	0.133	0.151	0.081	0.078	0.089	35	23	42
Long Beach	SC	Los Angeles	0.45	0.43	0.43	0.110	0.131	0.136	0.062	0.074	0.072	26	43	28
Riverside-Rubidoux	SC	Riverside	0.21	0.23	0.27	0.061	0.061	0.087	0.030	0.036	0.047	0	1	3
San Bernardino	SC	San Berardino	0.25	0.13	0.19	0.080	0.048	0.054	0.040	0.024	0.030	1	0	0
Costa Mesa	SC	Orange	0.35	0.34	0.23	0.065	0.063	0.061	0.030	0.027	0.028	3	8	0
La Habra	SC	Orange	0.46	0.28	0.39	0.109	0.087	0.090	0.064	0.048	0.093	16	4	6
San Diego-Island Ave.	SD	San Diego	0.37	0.24	0.30	0.074	0.068	--	0.031	0.034	0.040	2	0	3

a SCC: South Central Coast
SC: South Coast
SD: San Diego

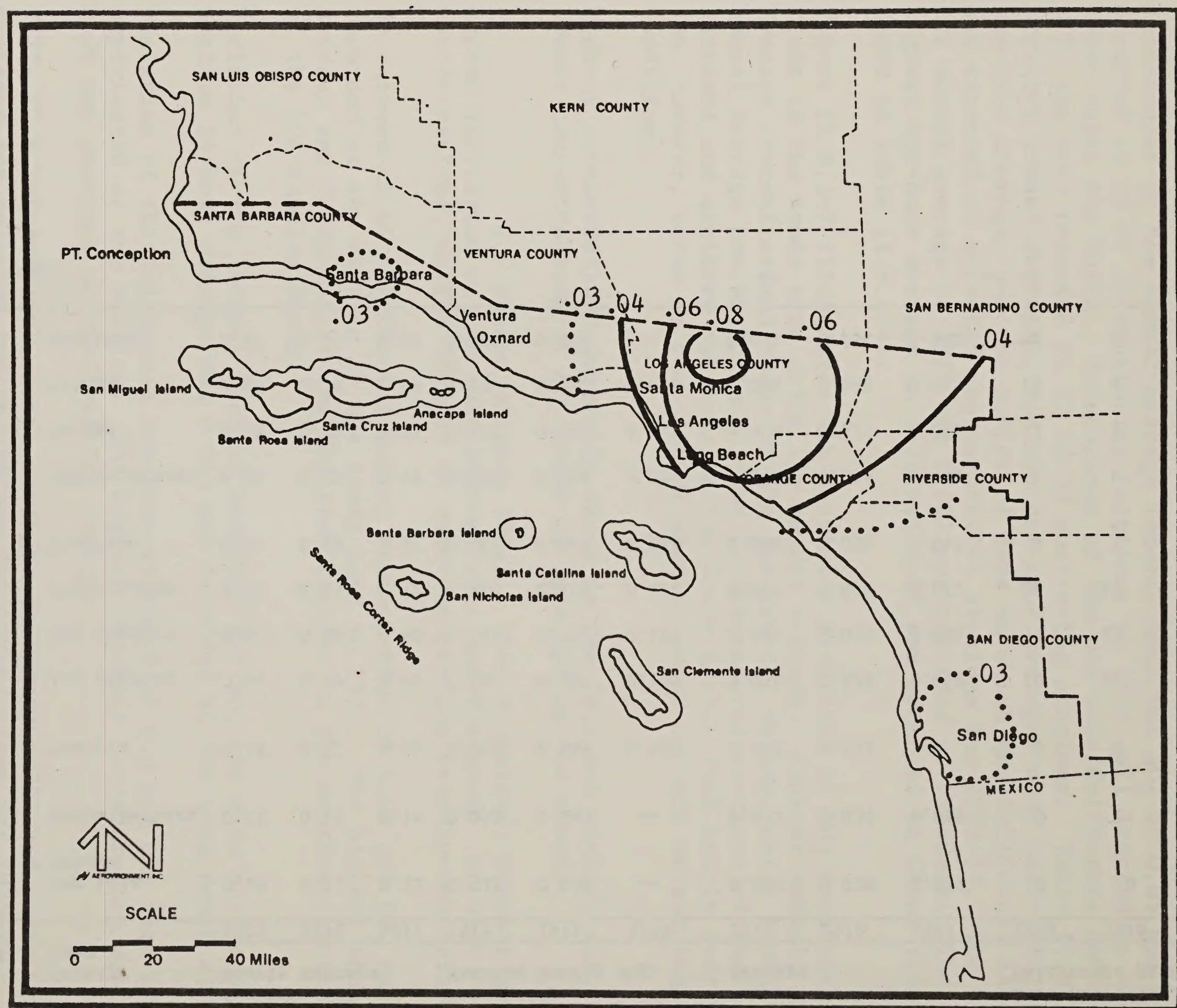


FIGURE II.H.1-7 Isopleths of annual average NO_2 (ppm) in 1975. Federal Standard is 0.05ppm.

Table II.H.1-5

SO_2 ANNUAL AVERAGES AND MAXIMUM 24 HOUR AVERAGES (PPM) FOR SELECTED REPRESENTATIVE STATIONS IN THE STUDY AREA

Station Name	Air Basin[a]	County	Annual Average			Max. 24 Hr. Average			Max. 1 Hr. Average			Days > Fed. 24 Hr. Std.			Days > Calif 1 Hr. Std.			Days > Calif. 24 Hr. Std.[b]		
			1975	1976	1977	1975	1976	1977	1975	1976	1977	1975	1976	1977	1975	1976	1977	1975	1976	1977
Camarillo-Elm Drive	SCC	Ventura	0.000	0.000	--	0.016	0.001	--	0.04	0.01	--	0	0	--	0	--	--	0	0	--
Lennox	SC	Los Angeles	0.020	0.017	0.018	0.055	0.043	0.052	0.14	0.18	0.30	0	0	0	0	0	0	9	2	0
Los Angeles Downtown	SC	Los Angeles	0.020	0.019	0.020	0.061	0.072	0.063	0.12	0.12	0.09	0	0	0	0	0	0	19	12	0
Long Beach	SC	Los Angeles	0.021	0.015	0.014	0.064	0.049	0.051	0.23	0.13	0.13	0	0	0	0	0	0	22	7	0
Riverside-Rubidoux	SC	Riverside	0.008	0.007	0.010	0.030	0.041	0.030	0.06	0.08	0.12	0	0	0	0	0	0	0	1	0
San Bernardino	SC	San Bernardino	0.010	0.008	0.015	0.040	0.029	0.067	0.10	0.07	0.35	0	0	0	0	0	0	2	0	2
Costa Mesa	SC	Orange	0.009	0.006	0.006	0.030	0.024	0.034	0.13	0.13	0.10	0	0	0	0	0	0	0	0	0
Los Alamitos	SC	Orange	0.014	0.010	0.009	0.040	0.043	0.034	0.21	0.24	0.14	0	0	0	0	0	0	8	1	0
San Diego-Island Ave.	SC	San Diego	0.004	0.007	0.004	0.020	0.025	0.023	0.05	0.09	0.05	0	0	0	0	0	0	0	0	0

[a] SCC: South Central Coast
SC: South Coast
SD: San Diego

[b] The California 24 hour standard change from 0.04 in 1975 to 0.05 in the presence of oxidant and/or particulates violating applicable State standards after 1976.

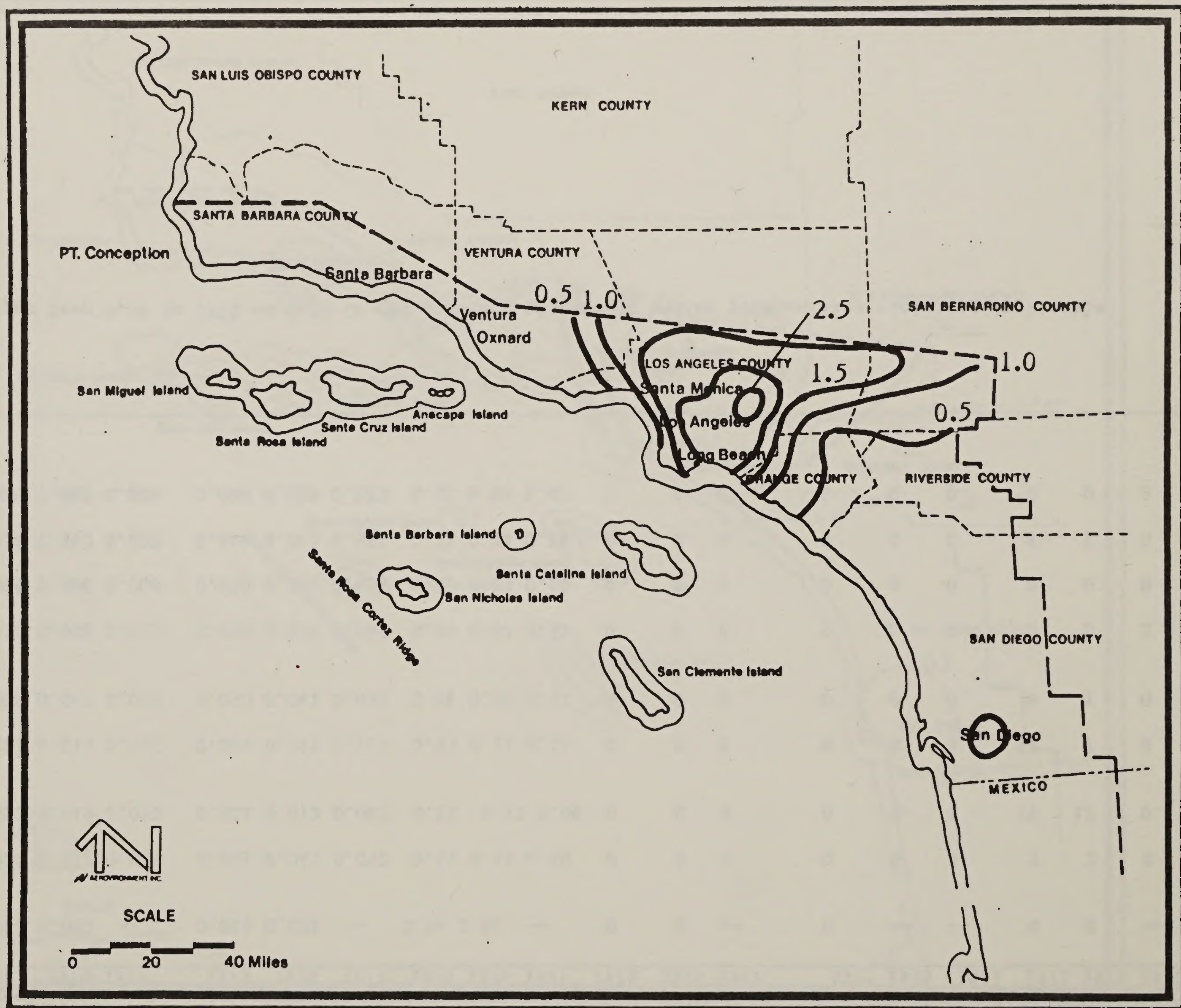


FIGURE II.H.1-8 Isopleths of annual average SO_2 concentration (pphm) in 1975. Federal Standard is 0.03 ppm.

outside the Los Angeles basin. Wintertime is the severe season for SO_2, while summertime concentrations are relatively low.

i. Suspended Particulate Matter: Particles cause irritation to the respiratory tract. Sorption of gases on small particulates increase the effect, particularly if the particles penetrate to deeper portions of the lungs.

Exceedances of all California and Federal AAQS for total suspended particulate (TSP) were reported in the study area in 1975-77, as shown in Table II.H.1-6. The highest annual geometric mean (AGM) was 167.7 $\mu g/m^3$ for 6 months at the San Ysidro monitoring site (not shown in Table II.H.1-6), near the Mexican border. The highest 24-hour average was reported at the Riverside (Rubidoux) monitoring site in Riverside County. This site also reported the greatest number of exceedances of the Federal 24-hour AAQS of 260 $\mu g/m^3$.

Figure II.H.1-9 indicates the spatial variability of TSP concentrations, using the annual geometric mean. Lowest concentrations are generally found in coastal sections, while higher concentrations occur downwind of industrialized areas.

Maximum TSP concentrations tend to be found in wintertime, although seasonal variability is not well-defined in some locations.

j. Other Pollutants: Non-Methane hydrocarbons, lead, sulfate, hydrogen sulfide, ethylene and visibility are discussed here.

Non-Methane Hydrocarbons (NMHC): This category includes all hydrocarbons except methane, which is excluded because it does not participate significantly in photochemical reactions. The three-hour 6:00-to-9:00 a.m. Federal Standard for NMHC was established to reduce the formation of photochemical pollutants (OX) through reactions with NO_x, and not as a health standard, per se.

In the study area, the standard was exceeded at all 19 stations for which data was available in 1975, most frequently (306 days) at the San Diego (Island Avenue) station. For the San Diego area only 1 hour maximum averages were available. Maximum 3 hour averages were available for 1975 in the South Coast Air Basin and are presented in Table II.H.1-7. Spatial variability of NMHC in the Los Angeles Basin is given in Figure II.H.1-10.

Other stations report total hydrocarbon data (THC, methane included). Highest hourly averages ranged from 5.0 ppm at Chula Vista in San Diego County to 21 ppm at San Bernardino.

Table II. H. 1-6

TOTAL SUSPENDED PARTICULATE ANNUAL GEOMETRIC MEAN, MAXIMUM 24-HR. AVERAGE (MglM3), & EXCEEDANCES OF AAQS FOR SELECTED SECTIONS IN STUDY AREA

Name	Air Basin	County Name	Annual Geometric Mean			Maximum 24 Hour Average			b Exceedance Days			c Exceedance Days			d Exceedance Days		
			1975	1976	1977	1975	1976	1977	1975	1976	1977	1975	1976	1977	1975	1976	1977
San Luis Obispo	SCC	San Luis Obispo	45.6	48.0	48.5	90	122	111	0	0	0	0	0	0	0	1	2
Santa Barbara State Street	SCC	Santa Barbara	62.6	66.6	68.4	125	171	158	0	0	0	0	1	1	5	11	10
Ventura Telegraph Road	SCC	Ventura	67.0	63.1	56.0	146	125	106	0	0	0	0	0	0	7	7	2
Lennox	SC	Los Angeles	92.6	94.1	96.4	227	230	227	0	0	0	8	5	10	24	31	26
Azua	SC	Los Angeles	116.2	109.4	132.7	213	226	430	0	0	3	16	19	29	43	36	44
West Los Angeles	SC	Los Angeles	78.0	64.1	64.7	156	152	172	0	0	0	2	1	1	17	7	0
Riverside Rubidour	SC	Riverside	149.0	131.2	142.5	467	276	508	10	1	9	37	26	29	42	41	45
Bernardino	SC	San Bernardino	103.3	102.3	102.3	264	242	414	2	0	2	20	12	16	34	32	33
Costa Mesa	SC	Orange	74.4	72.7	68.0	177	179	202	0	0	0	3	2	3	20	17	13
La Habra	SC	Orange	110.0	107.4	107.3	220	253	284	0	0	1	15	16	10	39	40	37
San Diego Island Avenue	SD	San Diego	74.4	69.4	66.8	153	170	240	0	0	0	1	3	4	12	18	19

SCC: South Central Coast
SC: South Coast
SD: San Diego

b. Exceedances of Federal primary 24 Hour standard of 260 MglM3
c. " " " secondary 24 Hour standard of 150 MglM3
d. " " California 24 Hour standard of 100 MglM3

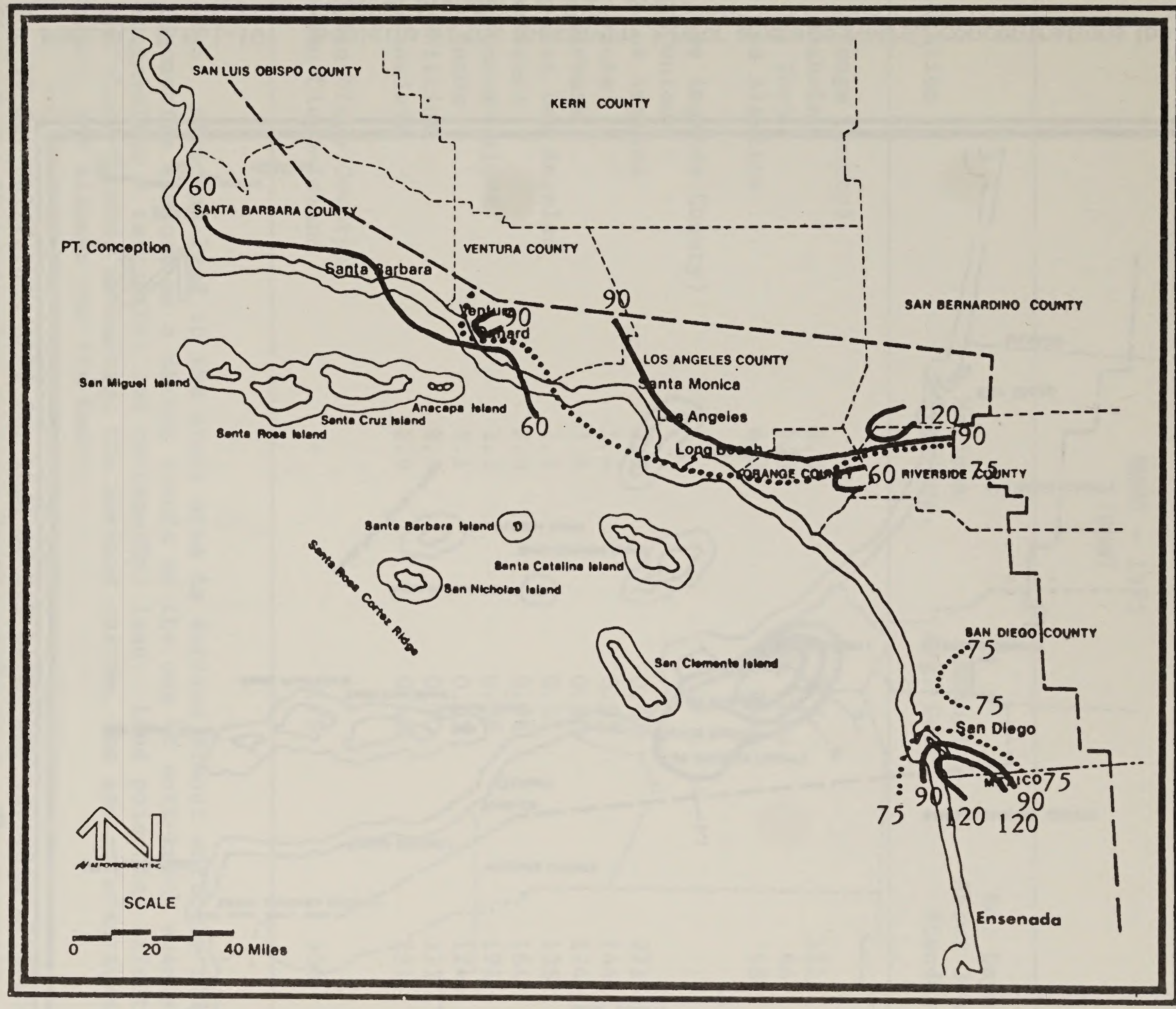


FIGURE II.H.1-9 Isopleths of total suspended particulate annual geometric mean ($\mu g/m^3$). Isopleths terminate where data is scarce or non-existent.

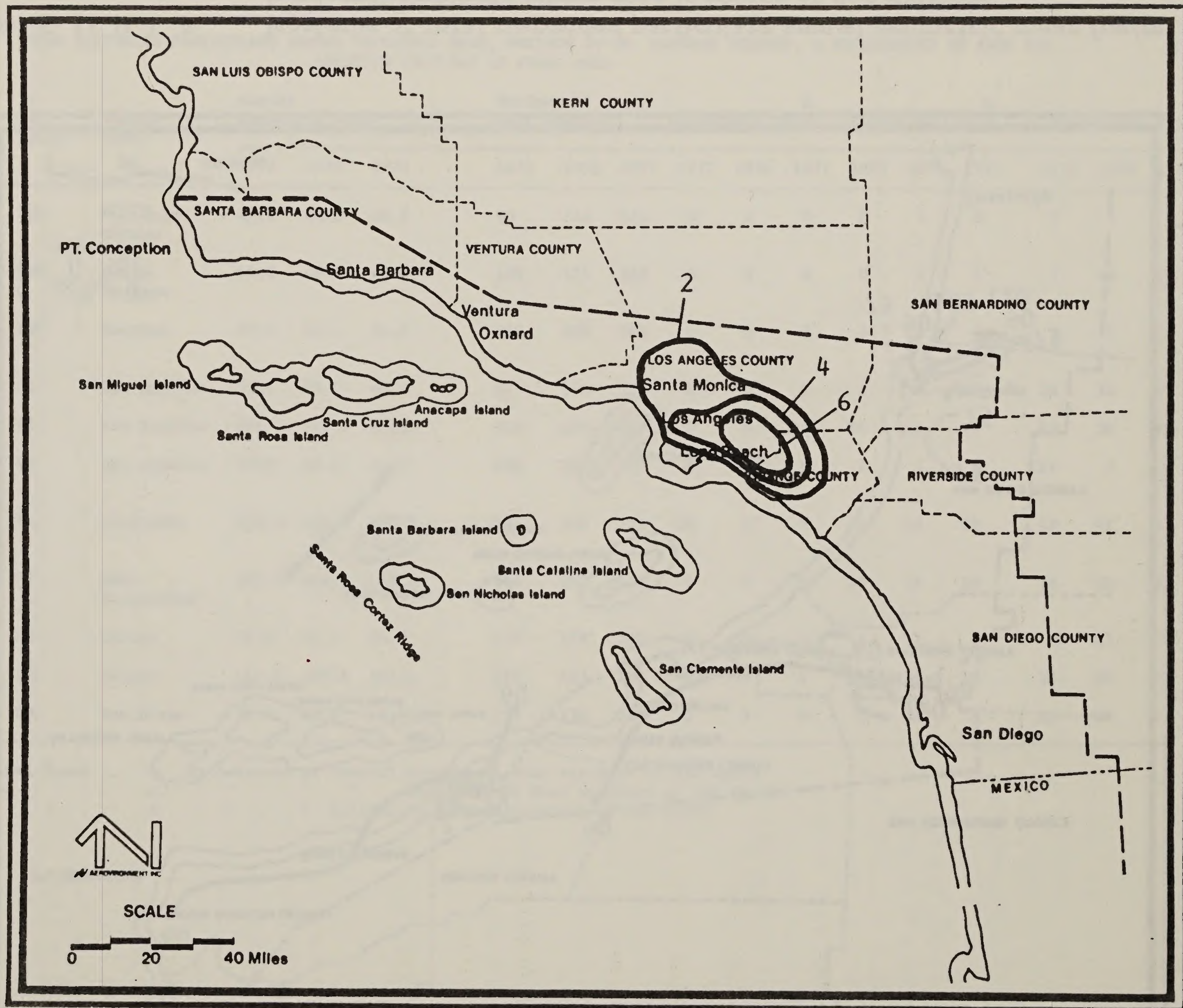


FIGURE II.H.1-10 Isopleths of the maximum 3-hour average NMHC concentrations (ppm). Federal Standard is 0.24 ppm.

Table II.H.1-7

NMHC - 1975
(ppm)

Station	Maximum 3-hrs. Avg.	Annual Avg. Conc.	No. Days Above 3-hrs. Standard
(Orange County)			
Anaheim	6.0	2.9	111
El Toro	2.0	No Data	66
Los Alamitos	6.0	No Data	98
(Los Angeles County)			
Downtown Los Angeles	2.6	0.41	271
Azusa	1.4	0.25	144
Burbank	3.6	0.66	274
West Los Angeles	3.5	0.57	138
Reseda	2.0	0.26	164
Pomona-Walnut	1.2	0.28	191
Lennox	5.1	0.52	124
Whittier	6.4	0.70	272
Pasadena	1.9	0.46	251
(San Diego County)			
San Diego-Island	-	1.70	306

Lead: Airborne lead in the study area is derived almost entirely from automobile exhaust as a direct result of the use of anti-knock agents in gasoline - tetraethyl and tetramethyl lead. Lead poisoning affects the blood-forming mechanism, the nervous system, the gastrointestional tract, the kidneys and the heart.

The 30-day California AAQS for lead of 1.5 μg/m^3 was exceeded at twenty-five of the 30 monitoring stations in the study area. The recently promulgated national standard is 1.5 μg/m^3 quarterly average. The highest monthly average of 9.39 μg/m^3 was recorded at the Lennox station in December. Table II.H.1-8 presents lead concentrations at selected representative stations in the study.

In winter, the measured concentrations of lead tend to be higher than in summer, although exceedances were recorded during every month in 1975.

Table II.H.1-8

LEAD CONCENTRATIONS ($\mu g/m^3$) AT SELECTED STATIONS IN THE STUDY AREA

Station Name	Air Basin	County	Maximum 30 Day Average			Annual Average		
			1975	1976	1977	1975	1976	1977
Santa Barbara State Street	SCC	Santa Barbara	3.28	4.43	3.21	1.47	1.63	1.36
Camarillo[b]	SCC	Ventura	1.66	1.16	1.00	0.77	0.69	0.70
West Los Angeles	SC	Los Angeles	3.75	2.98	2.63	1.52	1.45	1.45
Los Angeles Downtown	SC	Los Angeles	6.84	4.90	5.06	2.44	2.68	2.80
Lennox	SC	Los Angeles	9.39	10.04	6.77	2.84	4.05	3.49
San Bernardino	SC	San Bernardino	3.19	2.40	1.83	1.38	1.44	1.34
Riverside Rubidoux	SC	Riverside	2.86	2.94	2.45	1.13	1.42	1.47
Costa Mesa Harbor	SC	Orange	3.99	4.16	3.63	1.08	1.67	0.99
Los Alamitos Orangewood	SC	Orange	5.85	6.38	4.68	1.52	2.45	1.98
San Diego Island Ave.	SD	San Diego	3.56	4.10	3.42	1.35	1.57	1.56

[a] SCC: South Central Coast
SC: South Coast
SD: San Diego

[b] 6-Months Data Available for 1977.

Sulfate: Sulfates are formed from gaseous sulfur dioxide. The acidic nature of sulfate aerosols makes them potential irritants.

The 24-hour California AAQS for sulfate of 25 $\mu g/m^3$ was exceeded at most of the monitoring stations in the study area. The highest 24-hour average during the base year 1975 was 109.1 $\mu g/m^3$ recorded at the Chino station. Sulfate concentrations and exceedances for 1975-77 are summarized in Table II.H.1-9.

Hydrogen Sulfide: Although a State AAQS for H_2S, a poisonous gas characterized by a "rotten egg" odor, has been promulgated, monitoring has been performed only periodically. Results of such monitoring by the South Coast Air Quality Management District indicate that the State standard of 0.03 ppm for one hour was not exceeded.

According to recent data, the only station operated in Monterey County monitoring for hydrogen sulfide is at San Ardo. This station operates only infrequently and on a sporatic schedule. In addition, this particular site is located generally downwind of the San Ardo oilfield and is thus extremely source-oriented. For the monitoring conducted to date for the year 1978, there are some 2,814 1-hour values recorded, and of those, only 0.07 percent currently exceed the applicable CARB for AAQS H_2S. For 1977 there are 3,677 1-hour values recorded, and of those, 18.8 percent exceed the applicable standard. It can be concluded, therefore, that the AAQS for H_2S is being exceeded on occasion at the San Ardo site, but the data is biased.

Ethylene: The California standards were promulgated, not for human health reasons, but to protect sensitive plants. Only spot checks of ethylene concentration were made in 1975 in the study area. In January, the average value of spot checks was 0.292 ppm and the average value of spot checks in May was 0.150 ppm.

Visibility: The California AAQS for visibility reducing particles was established primarily for aesthetic reasons.

Frequent exceedances of this standard were recorded in 1975, especially in the South Coast Air Basin. All seven of the South Coast AQMD monitoring stations exceeded the standard on over 100 days, while five exceeded on over 200 days, most of these being inland monitoring stations.

k. Air Quality Offshore and in Baja California: There is a distinct lack of air quality data for the offshore portions of the study area. The California Air Resources Board has done a year of ozone monitoring on San Nicolas Island during 1976.

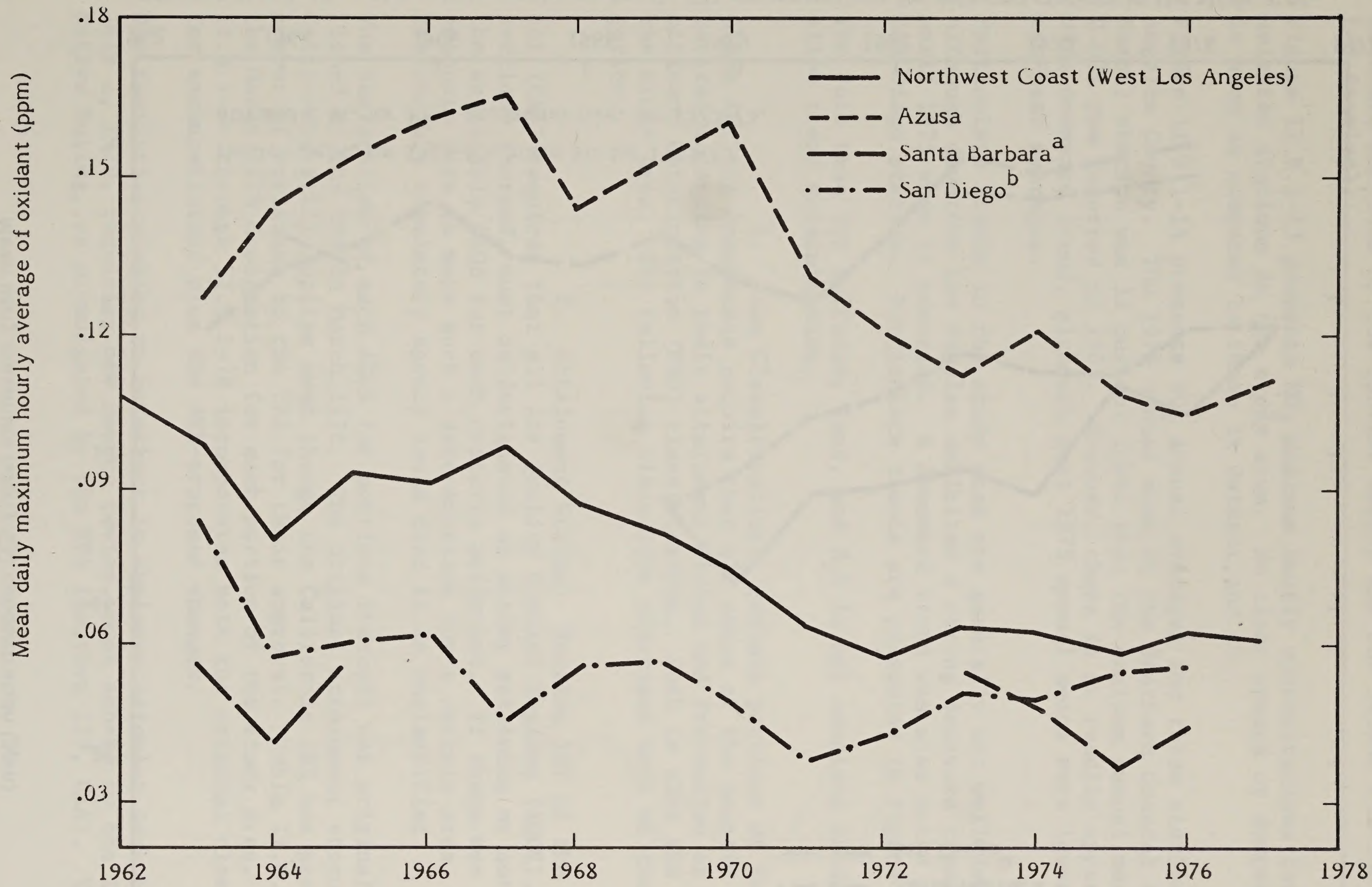
The data from San Nicolas Island indicates that the highest hourly averages occur in the fall (October and November) probably under the influence of mild Santa Ana conditions (offshore flow). These highest values exceeded 0.20 ppm. Lowest values occurred during July, August, and February, with maximum hourly averages of only about 0.05 ppm.

Total suspended particulate is the only pollutant monitored at Baja California. It is measured in Tijuana and Mexicali by the Mexican government. The recorded TSP levels are much lower than the levels reported across the border at San Ysidro, but the accuracy of the Mexican data is highly suspect at this point in the development of their monitoring system. Analysis of San Ysidro data indicates that Tijuana is the source of the high particulate readings observed there (AGM = 167.7 $\mu g/m^3$), based on a strong correlation between high TSP readings and air flow from Tijuana.

Since gaseous pollutants are not monitored in Baja California, the air quality of the area cannot be accurately assessed. Some inferences can be made from monitoring done near the Mexican border at San Ysidro and Imperial Beach. Ozone levels probably exceed 0.10 ppm, especially directly downwind of San Diego and Tijuana, since Imperial Beach reported 0.19 ppm in 1975. CO levels may remain below 35 ppm for one hour and 9 ppm for 8 hours based on border data. However, sources are not well-controlled in Baja California, so there is a high potential for exceedance. Nitrogen dioxide levels remained below 0.25 ppm for one hour and below 0.055 ppm for the annual average along the border. SO_2 levels were also well below standards. The highest hourly average of SO_2 was 0.04 ppm at San Ysidro.

1. Pollutant Trends: Oxidant levels have generally been decreasing throughout the study area in recent years. The beginning of the downward trend varies from station to station and is sometimes difficult to pinpoint since yearly variability is greater than the magnitude of this downward trend. Figure II.H.1-11 presents the trend of mean daily maximum hourly average concentrations for four locations in the study area, three in the coastal sector and one (Azusa) inland in the Los Angeles Basin. All stations exhibit the general downward trend, although the lack of data at Santa Barbara makes trends difficult to recognize. Also, the San Diego station appears to have experienced a slight upward trend in the last five years.

A downward trend in CO levels is also apparent. The annual averages of daily one-hour CO maxima (Figure II.H.1-12) illustrate this trend. Four stations have been selected: one each for the northern, central, and



[a] Health Department, 1963-1966; State Street for 1973-1975.
[b] 8th and E Street for 1963-1972; Island Avenue for 1973-1977.

FIGURE II.H.1-11 Oxidant trends. Mean daily maximum hourly average for selected stations (1962-1977).

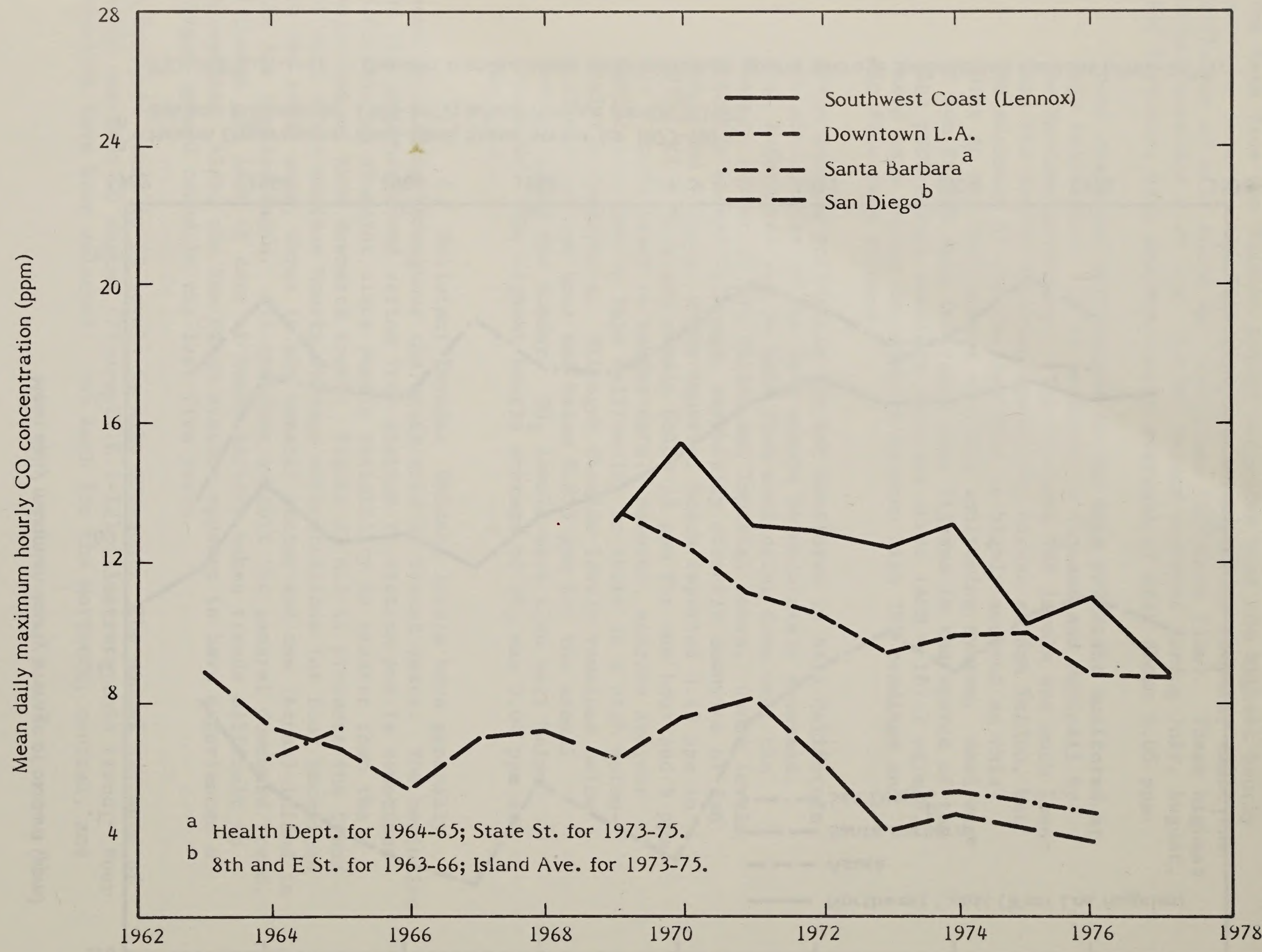


FIGURE II.H.1-12 Mean daily maximum hourly CO concentrations for selected stations in the study area.

southern portions of the coastal sector and one inland station (downtown Los Angeles).

Figure II.H.1-13 presents NO_2 maximum hourly concentrations for four selected stations in the study area. No clear upward or downward trend is seen as compared to those in Oxidant and CO.

Figure II.H.1-14 presents SO_2 annual averages for three stations in Los Angeles County. The 1975 annual mean at the Southern Coastal (Long Beach) station was 32 percent lower than the maximum annual mean of 0.031 ppm reported in 1968. However, there is no readily apparent area-wide downward trend, although most 1975 annual means were lower than the ten-year averages.

Particulate trends in the study area are generally not well-defined, although downtown Los Angeles exhibited a strong downward trend from 1971 until 1975 when it reversed. A downward trend was also noted at the San Diego station. Particulate trends are presented in Figure II.H.1-15.

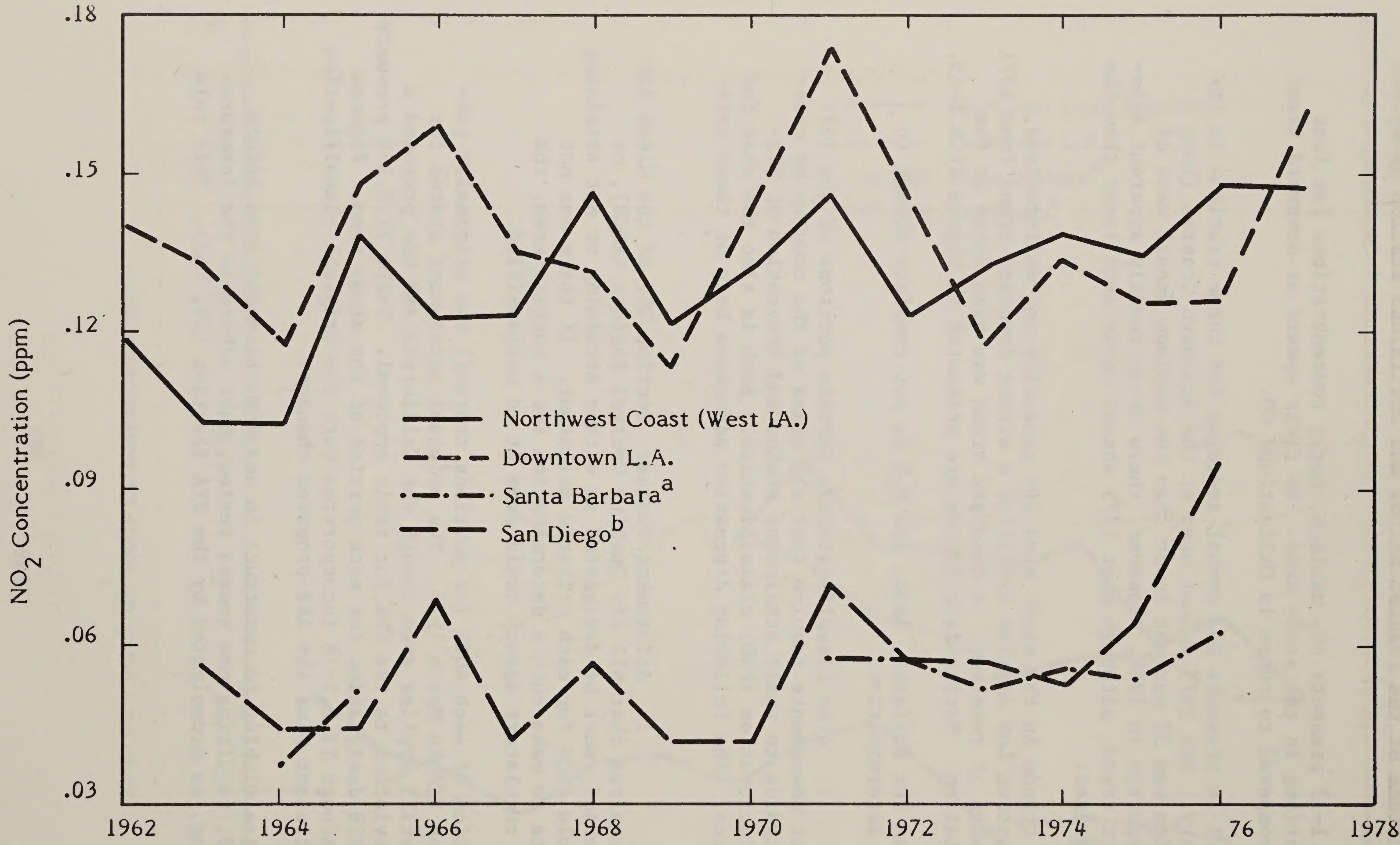
The data base for sulfates, lead, and H_2S is not complete enough to allow trend determination.

1. Area Classification: Certain portions of the 1977 Clean Air Act Amendments require that all areas of the country be categorized according to their attainment status and Prevention of Significant Deterioration (PSD) classification. Such is also the case for the study area. The following discussion addresses both of these categories.

i. Attainment Status: Section 107 of the Clean Air Act (CAA) requires that all Air Quality Control Regions (AQCR), or portions thereof, must be designated as either attaining or not attaining the applicable AAQS for each criteria pollutant. If there was not adequate data to make such a determination for a certain area, the responsible regulatory agency could deem it as unclassified.

The designation of each AQCR (or portions thereof) was originally published by the EPA in March 1978. The original attainment status for California still applies even though the California ARB has proposed a number of revisions to the EPA for their approval. Table II.H.1-8 presents the March 1978 designation for each portion of the study area. Figures II.H.1-14 through II.H.1-18 incorporates both the original classification for each pollutant plus the ARB-proposed changes.

New facilities wishing to construct in any nonattainment area before July 1, 1979, requiring new source review, must adhere to the Interpretative Ruling, as promulgated by the EPA (Section 129, CAA). This rule



[a] Health Dept. for 1964-65; State St. for 1971-75.
[b] 8th and E St. for 1963-72; Island Ave. for 1973-75.

FIGURE II.H.1-13 Mean daily maximum hourly NO_2 concentrations (ppm) for selected stations in the study area. California Standard for 1 hour is 0.25 ppm.

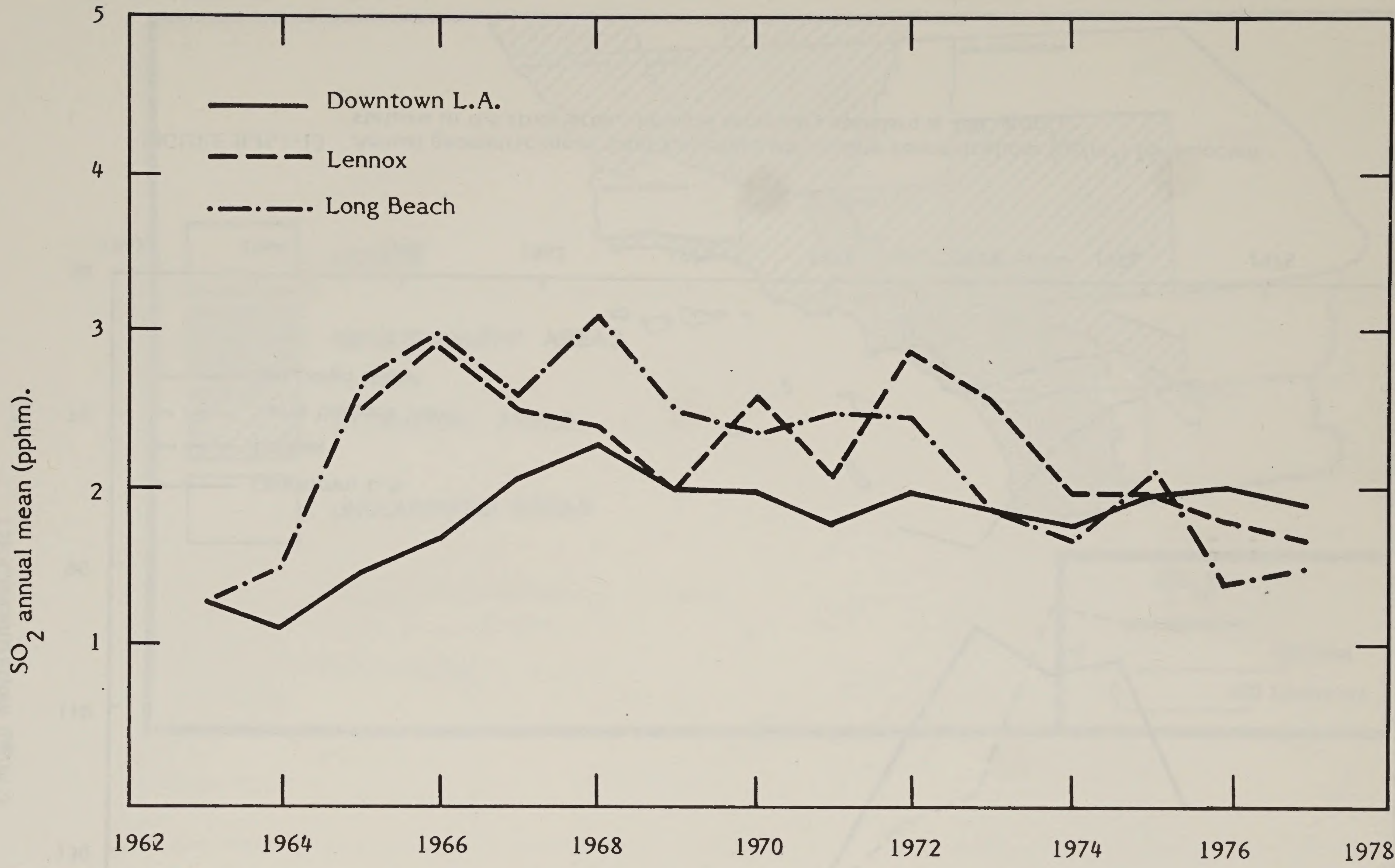


FIGURE II.H.1-14 SO_2 annual mean trend for 3 selected stations.

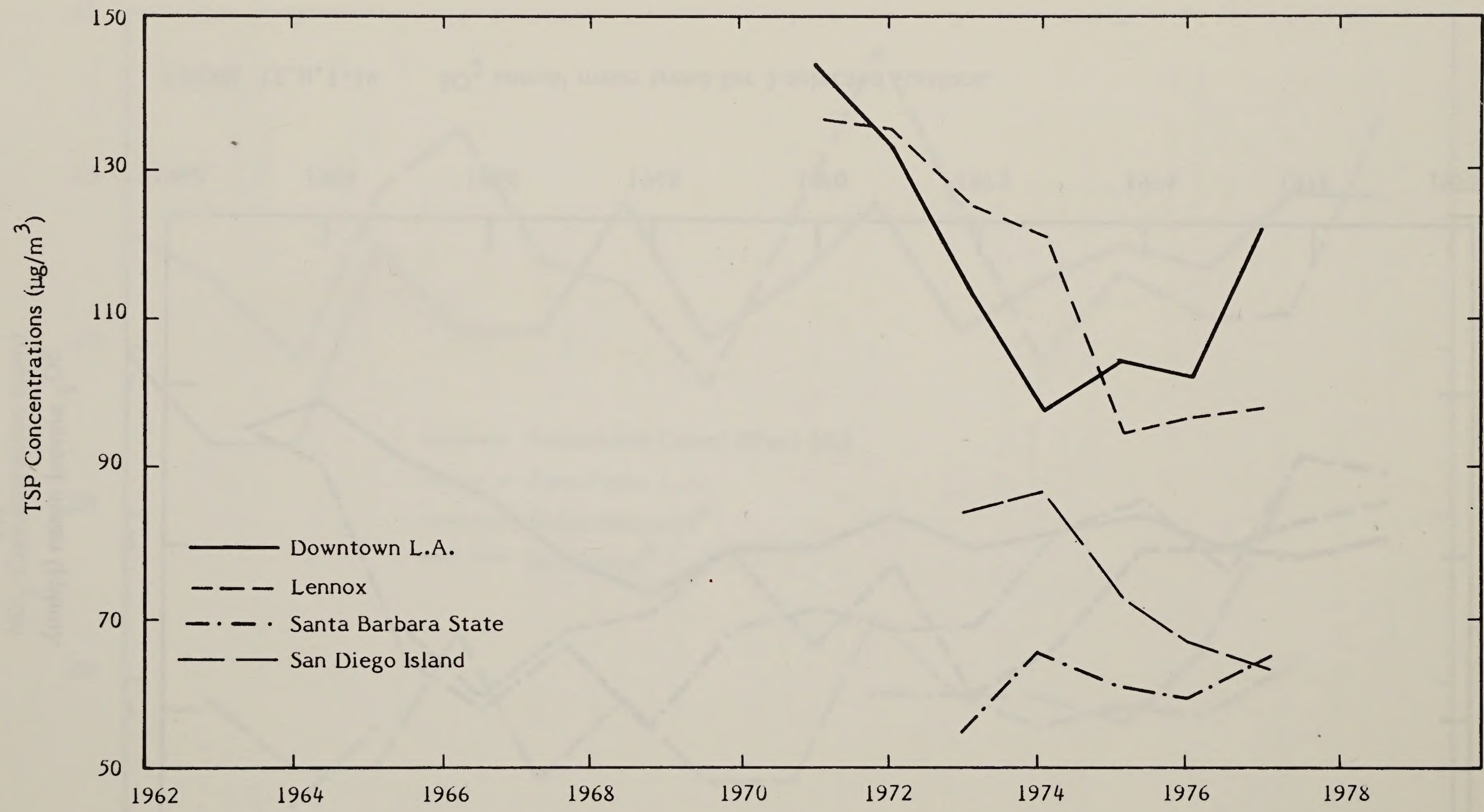


FIGURE II.H.1-15 Annual geometric mean total suspended particulate concentrations ($\mu g/m^3$) for selected stations in the study area. Federal secondary standard is 150 $\mu g/m^3$.

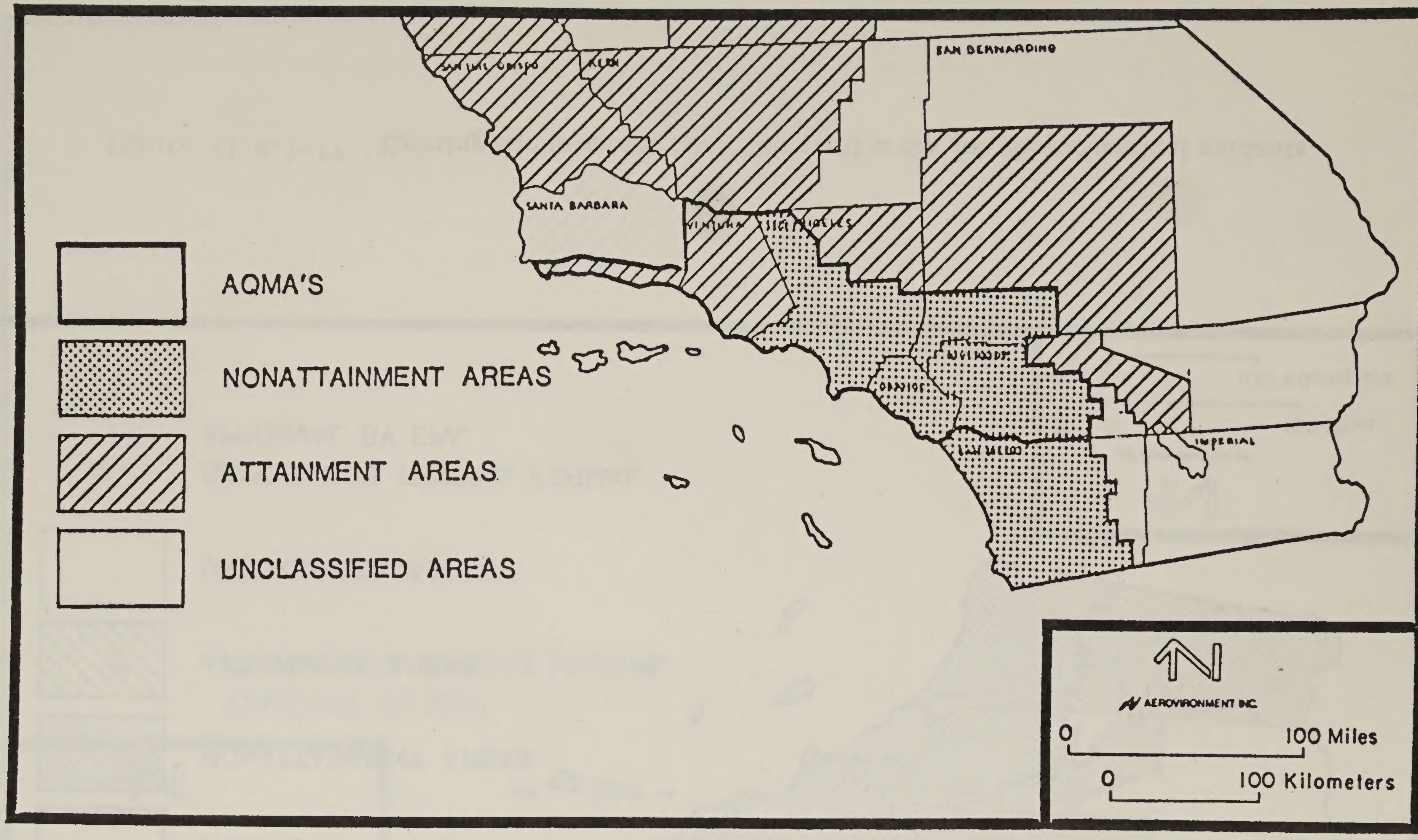


Figure II.H.1-16 Existing and proposed nonattainment areas for nitrogen oxides.

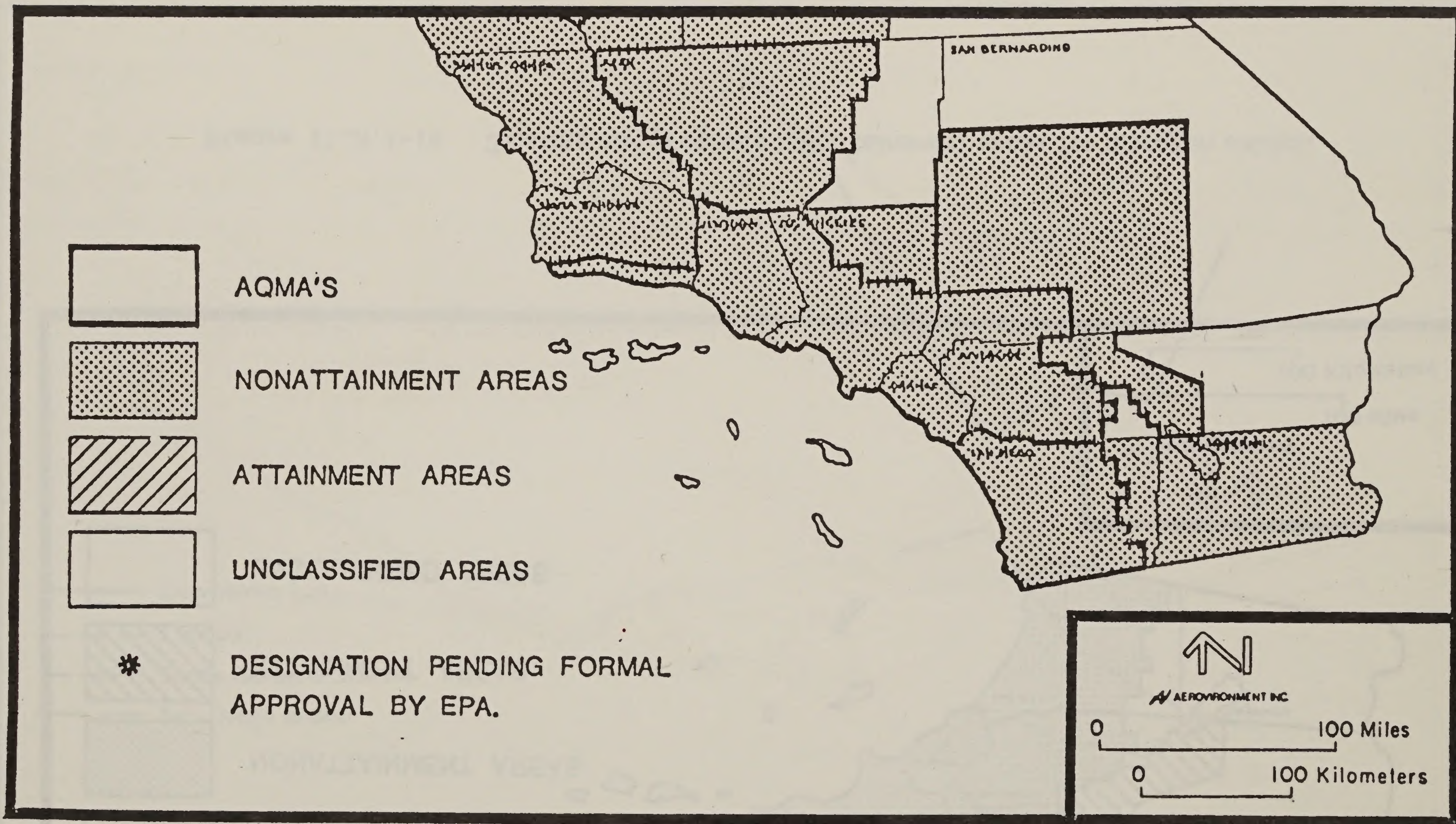


Figure II.H.1-17 Existing and proposed nonattainment areas for photochemical oxidants.

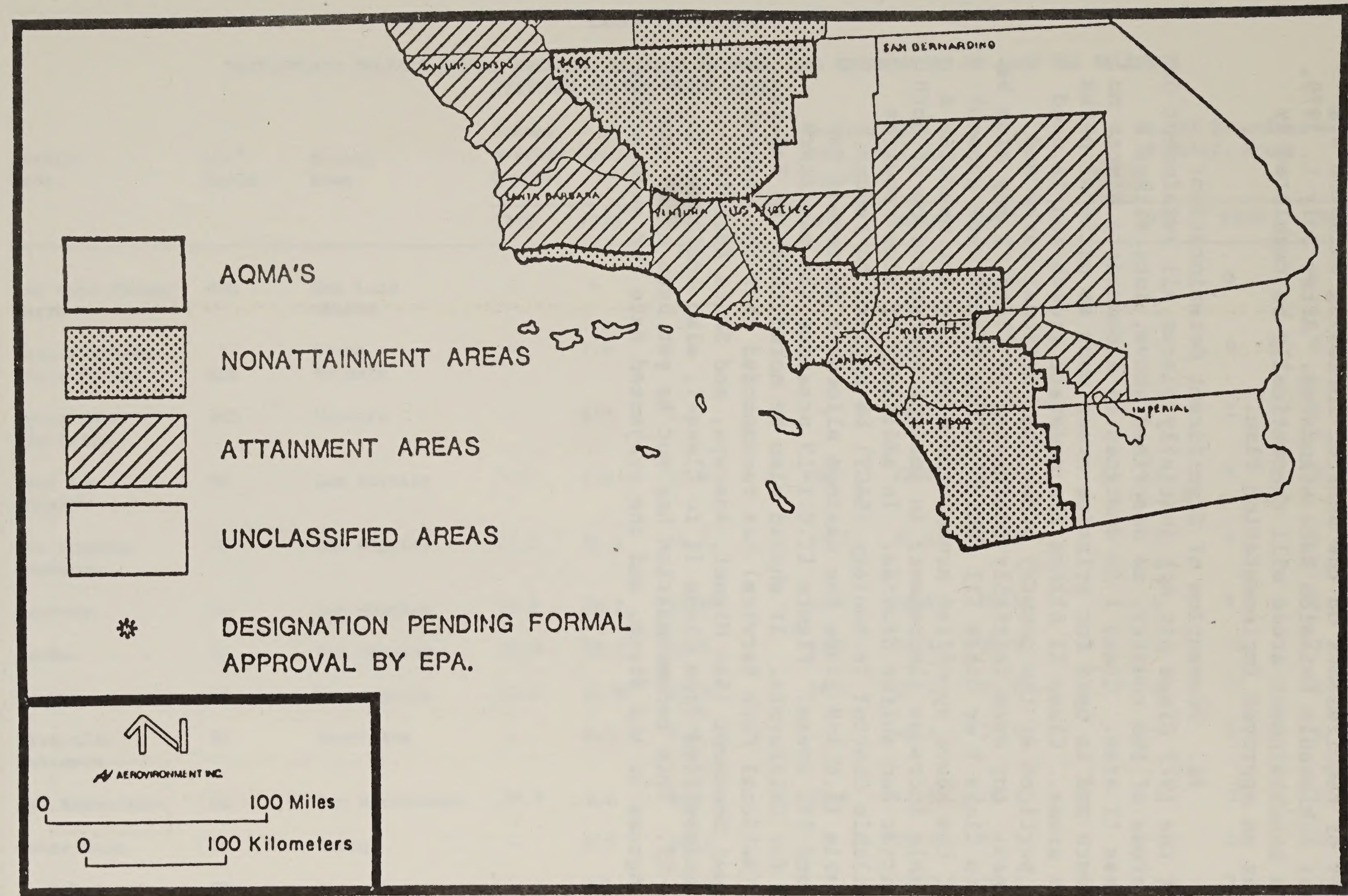


Figure II.H.1-18 Existing and proposed nonattainment areas for carbon monoxide.

places a number of requirements on the source, including emission offsets and Lowest Achievable Emission Rate standards. After July 1, 1979, new sources in nonattainment areas will theoretically be regulated by the State under an approved Implementation Plan.

ii. Prevention of Significant Deterioration: Section 162 of the 1977 Clean Air Act initially places all attainment or unclassified areas of the country, as described above, into either a Class I or Class II area. Class I is designed to accommodate almost no industrial growth and is used for pristine areas such as national parks and wilderness areas. Class II allows for moderate growth and is used for all other portions of the country other than national parks and wilderness areas. Any area initially designated as Class II may also be reclassified to Class I or Class III (which allows significant growth). Within each of the above specified areas, the Clean Air Act mandates a maximum allowable increase (increment) in ambient concentration of both particulate matter and sulfer dioxide. In addition, it also requires that Best Available Control Technology (BACT) be applied to reduce emissions. Table II.H.1-9 gives the maximum allowable increment for Class I, II, and III areas. Figure II.H.1-19 presents the mandatory Class I areas for California. It should also be noted that the Federal land manager (National Park Service) has recommended that the Channel Islands National Monument (San Miguel, Anacapa, and Santa Barbara Islands) be reclassified from Class II to Class I, also indicated in Figure II.H.1-19. This recommendation has not as yet been acted upon by either the Congress or the State, and the projected date for such action is indefinite.

Table II. H. 1-9

PARTICULATE SULFATE ANNUAL AVERAGE, MAXIMUM 24 HOUR, AND EXCEEDANCES OF AAQS FOR SELECTED STATIONS IN THE STUDY AREA

Station Name	Air[a] Basin	County Name	Annual Average Conc. (μg/m³)			Maximum 24[c] Hour Conc. (μg/m³)			No. of Exceedances[b] of Calif. Study		
			1975	1976	1977	1975	1976	1977	1975	1976	1977
San Luis Obispo Marsh	SCC	San Luis Obispo	-	-	5.5	-	-	11.5	-	0	0
Santa Barbara State Street	SCC	Santa Barbara	-	7.6	7.8	-	6.5	23.3	-	0	0
Carmarillo Elm Drive	SCC	Ventura	-	8.7	7.5	-	25.3	25.5	-	1	1
West Los Angeles	SC	Los Angeles	9.3	7.9	10.0	32.7	22.6	28.7	2	0	1
Los Angeles Downtown	SC	Los Angeles	12.3	12.1	15.0	36.3	34.4	47.2	5	4	7
Pasadena	SC	Los Angeles	10.9	10.7	12.8	34.0	33.8	38.2	4	5	8
Azusa	SC	Los Angeles	11.0	10.3	13.5	32.6	29.8	38.3	2	3	7
Lennox	SC	Los Angeles	12.5	13.8	15.9	34.5	37.2	43.6	6	7	8
Riverside Rubidoux	SC	Riverside	-	8.7	9.8	-	44.3	33.4	-	2	1
San Bernardino	SC	San Bernardino	10.9	9.0	8.5	29.4	27.5	28.5	6	2	1
Costa Mesa	SC	Orange	-	8.5	10.3	-	28.2	37.8	-	1	3
La Habra	SC	Orange	-	9.4	11.2	-	26.0	34.5	-	1	3
San Diego Island Ave.	SD	San Diego	8.0	9.0	9.2	-	23.2	37.9	0	0	2

Table II. H. 1-9 (Con't)

PARTICULATE SULFATE ANNUAL AVERAGE, MAXIMUM 24 HOUR, AND EXCEEDANCES OF AAQS FOR SELECTED STATIONS IN THE STUDY AREA

Station Name	Air[a] Basin	County Name	Annual Average Conc. ($\mu g/m^3$)			Maximum 24[c] Hour Conc. ($\mu g/m^3$)			No. of Exceedances of Calif. Study[b]		
			1975	1976	1977	1975	1976	1977	1975	1976	1977
Chino	SC	San Bernardino	11.4	10.0	11.2	109.1	29.9	35.9	7	2	3
Fontana	SC	San Bernardino	12.2	9.2	10.2	41.5	32.7	30.2	7	2	1
Ontario	SC	San Bernardino	15.2	13.4	8.4	-	35.1	29.4	2	5	1
Upland	SC	San Bernardino	-	8.6	9.5	41.0	34.0	64.7	-	3	1
Anaheim	SC	Orange	12.9	9.7	11.2	-	29.3	37.7	4	3	3

[a] SCC: South Central Coast
SC: South Coast
SD: San Diego

[b] Measurements taken every 6 days. California Standard is $25 \mu g/m^3$ for a 24-hour average.

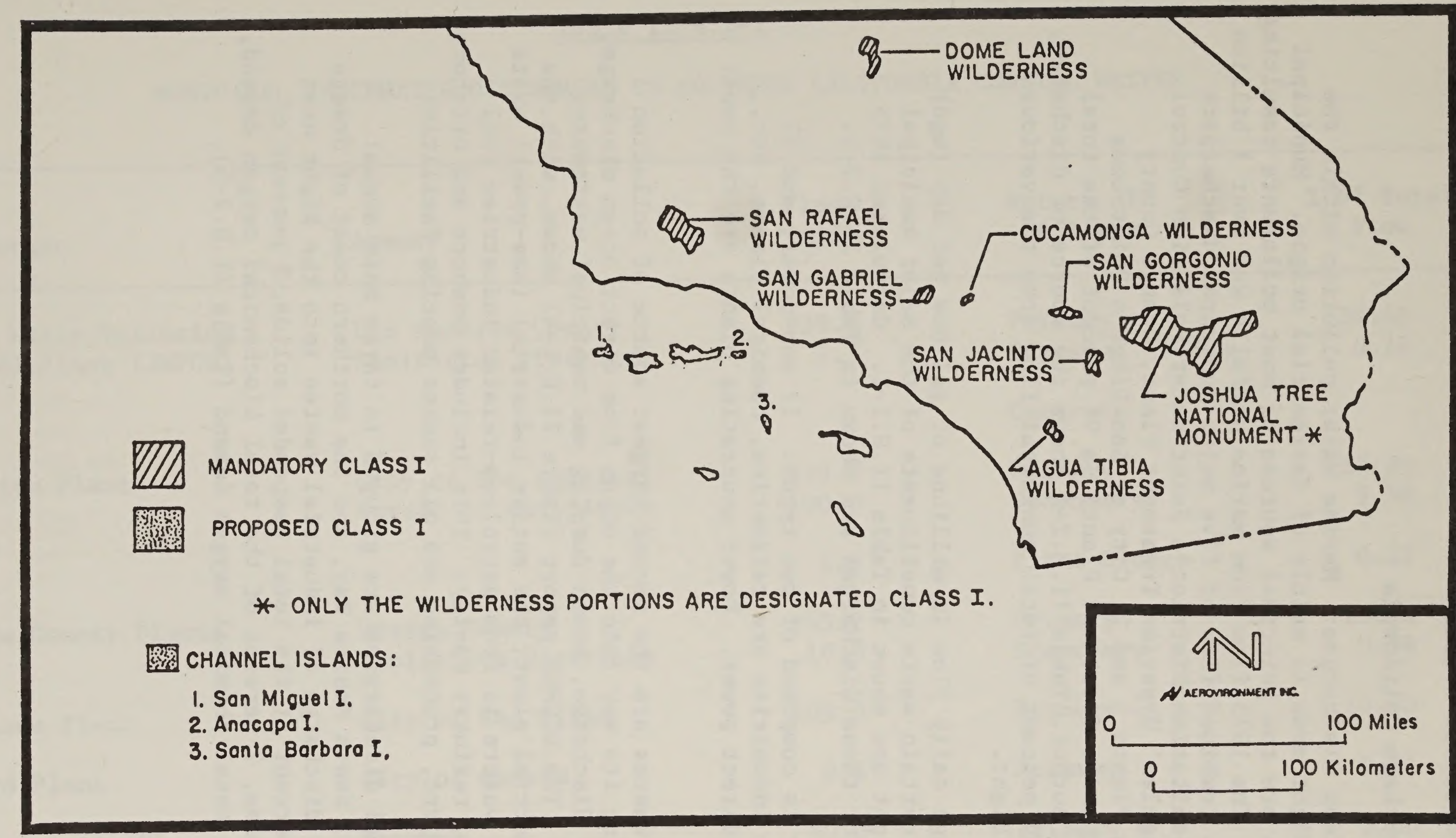


Figure II.H.1-19 Mandatory and proposed Class I areas under 1977 Clean Air Act Amendments.

2. Water Pollution Sources

a. Southern California

i. Ocean Discharges: Marine water pollution within the Southern California Bight area is mainly of terrestrial origin. Municipal wastewater discharges are the principal sources of most pollutants resulting from human activity. The 1975 flow from marine outfalls was over 1 billion gallons per day. The combined flow of five major municipal dischargers (Los Angeles County Sanitation District's Joint Water Pollution Control Plant, City of Los Angeles' Hyperion Treatment Plant, Orange County Sanitation District's Plants 1 and 2, City of San Diego's Point Loma Plant, and City of Oxnard's Treatment Plant) is 94 percent of the total municipal waste water output. Table II.H.2-1 shows the source of discharge, nature of effluent and percent of total municipal flow from the various dischargers into the Bight.

The 1975 annual average daily flow in millions of gallons per day (mgd) and concentration of certain waste constituents of the major municipal dischargers in the Bight are shown in Table II.H.2-2. Calculated 1975 mass emission rates for these discharges are shown in Table II.H.2-3.

Industrial wastewater is composed of two types: 1) non-power, and 2) power. The non-power industries are refineries, chemical plants, etc., which do not produce direct power. Power generating plants are the power industries.

Non-power industrial wastes are the second largest source of pollution (SCCWRP, 1975), finding its way into the ocean from direct ocean discharge, estuary and tributary discharge, ocean dumping and municipal wastewater treatment facilities. The SCCWRP report (Table II.H.2-4) shows, with the exception of one industrial plant, the entire industrial (non-power) waste discharge into marine waters is from petroleum-related industries (oil brine, tanker ballast, refinery waste). This includes onshore and offshore oil production, transport, processing and oil tanker mooring facilities.

Direct ocean industrial dischargers are grouped in three main areas: Santa Barbara Channel, Santa Monica Bay, and the northern coast of Orange County. Direct ocean discharge of industrial wastes into the Bight area contributes about 6 percent of the total suspended solids, 3 percent of the total oil and grease, 2 percent of the total biochemical oxygen demand, and 10 percent of the total chemical oxygen demand (Table II.H.2-5).

Table II.H.2-1

MUNICIPAL WASTEWATER DISCHARGED TO SOUTHERN CALIFORNIA COASTAL WATERS

Discharger	Agency	Flow (mgd)	Nature of Effluent	% of Total Flow
Joint Water Pollution Control Plant (JWPCP)	Los Angeles County Sanitation Districts	339.0	Primary	32.40
		1.7	Digested Sludge	0.16
			Centrate	
Hyperion Plant	City of Los Angeles Bureau of Sanitation	249.0	Primary	23.80
		100.0	Secondary	9.56
		2.3	Plant Sludge	0.22
Orange County Plants	Orange County Sanitation Districts	165.2	Primary	15.80
		10.0	Secondary	0.96
Pt. Loma Plant	City of San Diego	109.0	Primary	10.40
Oxnard Plant	City of Oxnard	9.5	Primary	0.91
Other (about 20)	Various	40.0	Primary	3.80
		20.0	Secondary	1.90
Total		1,045.7		100.0

Source: Southern California Coastal Water Research Project (SCCWRP) 1976

Table II.H.2-2

AVERAGE CONCENTRATIONS OF GENERAL CONSTITUENTS, TRACE METALS AND CHLORINATED HYDROCARBONS IN THE FINAL EFFLUENT OF MUNICIPAL WASTE DISCHARGERS, 1975

	JWCP	Hyperion 5 mile	Hyperion 7 mile	Orange County	Point Loma	Oxnard
Flow (mgd)	341.	345.	4.3	175.2	109.	9.51
General Constituents (mg/liter)						
Total Suspended Solids	278.	85.	10,300.	138.	125.	166.
5-day B.O.D.	209.	125.	a	193.	191.	305.
Oil and Grease	61.4	20.	970.	34.	26.7	37.
Ammonia Nitrogen	37.6	13.9		33.3	25.7	28.9
Total Phosphate	13.2	9.	80.			
Detergent (MBAS)	7.1	3.9			6.16	1.84
Cyanide (CN)	0.33	0.14	0.67	0.10	0.001	<0.001
Phenols	4.13	0.04	0.29	0.43	0.272	0.469
Trace metals (mg/liter)						
Silver	0.013	0.02	0.8	0.012	0.0143	0.013
Arsenic	<0.011	0.01	0.29		<0.001	0.0068
Cadmium	0.036	0.02	1.17	0.04	0.0515	0.017
Chromium	0.8	0.13	11.7	0.19	0.167	0.044
Copper	0.42	0.19	16.8	0.41	0.149	0.073
Mercury	0.0011	0.002	0.108		0.0007	0.0015
Nickel	0.28	0.15	3.1	0.15	0.16	0.226
Lead	0.25	0.03	2.05	0.16	0.1	0.07
Selenium	<0.013	0.02	0.27			
Zinc	1.45	0.23	23.1	0.65	0.315	0.209

Table II.H.2-2 (Cont'd)

	Hyperion			Orange	Point	
	JWCP	5 mile	7 mile	County	Loma	Oxnard
Chlorinated Hydrocarbons (ug/liter)						
Discharger Values						
Total DDT	2.33	1.63	6.49	0.31		
Total PCB	3.03	3.92	17.3	10.8		
Project Values[b]						
Total DDT	2.3	0.07	3.	0.04	0.89	0.1
Total PCB	1.38	0.34	22.	7.31	1.63	0.29

Source: SCCWRP, 1976

[a]Not Reported
[b]Analyses of two 1-week composite samples of each effluent.

Source: SCCWRP, 1976.

Table II.H.2-3

MASS EMISSION RATES OF GENERAL CONSTITUENTS, TRACE METALS AND CHLORINATED HYDROCARBONS IN FINAL EFFLUENT OF MUNICIPAL WASTE DISCHARGERS, 1975

	JWCP	Hyperion 5 mile	Hyperion 7 mile	Orange County	Point Loma	Oxnard
General Constituents (metric tons/year)						
Flow mgd	341	345	4.3	175.2	109	9.5
Total Suspended Solids	130,966	40,460	69,720	33,396	18,725	2,181
5-day B.O.D.	98,460	59,575	a	46,706	28,612	4,002
Oil and Grease	28,926	9,532	6,566	8,228	4,000	485
Ammonia Nitrogen	17,713	6,625		8,059	3,850	379
Total Phosphate	6,912	4,289	541			
Detergent (MBAS)	3,345	1,859		24.2	923	24.1
Cyanide (CN)	155	66.7	4.5		0.15	0.013
Phenols	1,945	19.1	2	104.1	40.7	6.15
Trace metals (metric tons/year)						
Silver	6.12	9.5	5.4	2.90	2.14	0.17
Arsenic	5.18	4.8	2		0.15	0.09
Cadmium	17	9.5	7.9	9.68	7.71	0.22
Chromium	317	62	79.2	46	25	0.58
Copper	198	91	113.7	99.2	22.3	0.96
Nickel	132	71	21	36.3	24	2.97
Lead	118	14.2	13.9	38.7	15	0.92
Selenium	6.1	9.53	1.83			
Zinc	683	110	156	157.3	47.2	2.74
Mercury	0.52	0.95	0.73		0.114	0.02
Chlorinated Hydrocarbons (kg/year)						
Discharger Values						
Total DDT	<1,098	777	43.9	75		
Total PCB	<1,427	1,868	117.1	2,613		

Table II.H.2-3 (Cont.)

	JWCP	Hyperion 5 mile	Hyperion 7 mile	Orange County	Point Loma	Oxnard
Project Values[b]						
Total DDT	1,080	32.4	18	8.7	134	1.2
Total PCB	649	162	239	1,777	247	3.5

Source: SCCWRP, 1976

[a]Not Reported
[b]Based on analyses of two 1-week composite samples of each effluent

Table II.H.2-4

DISCRETE INDUSTRIAL WASTE DISCHARGERS ON THE SOUTHERN CALIFORNIA COAST

Area		Discharger	Type of Waste	Flow (mgd)	Pipe Length (m)	Pipe Depth (m)	Reference to Tab 3-9 & 3-10
I	11	Phillips Petroleum-Point Conception	Oil brine Tanker ballast	0.2			T1, E1
	12	Texaco, Inc.-San Augustin	Oil brine	0.2			E2, E3
	13	Getty Oil-Gaviota	Oil brine Tanker ballast	0.16			T2
	14	Shell Oil-El Capitan	Oil brine Tanker ballast	0.2			T3
	15	Signal Oil & Gas-Ellwood	Oil brine	0.2			T4
	16	Atlantic Richfield-Coal Oil Point	Oil brine	0.29			E9, E10
	17	Standard Oil-Summerland	Oil brine	0.4		32	E11
	18	Standard Oil-Carpinteria	Oil brine Tanker ballast	0.4	120	3	T5
	19	Atlantic Richfield-Rincon	Oil brine	0.01	76	6	
	110	Atlantic Richfield-Rincon Island	Oil brine	0.04	800	18	E15
	111	Western Oil & Dev.-Rincon	Oil brine	0.36		3	
	112	Petrol Industries-Rincon	Oil brine	0.01			
	113	Continental Oil-Rincon	Oil brine	0.49	150	4	
	114	Norris Oil Co.-Rincon	Oil brine	0.05	670	3	
	115	Phillips Petroleum-La Conchita	Oil brine	0.36	270	6	
	116	Phillips Petroleum-Punta Garda	Oil brine	0.4	150	6	
	117	Mobil Oil-Sea Cliff	Oil brine Tanker ballast	0.18	950	9	
II	118	Continental Oil-Pitas Point	Oil brine	0.27	150	4	
	119	Continental Oil-Grubb Lease	Oil brine	0.75	150	2	
	120	Getty Oil-Ventura	Oil brine	0.06		3	T7
	121	Standard Oil-McGrath Beach	Oil brine	0.14		1	
III	122	McDonnell Douglas Corp.-Venice	Cooling tower bleedoff	0.65			
	123	Standard Oil-El Segundo	Cooling water Refinery Waste	72.0	170	5	T9
V	124	Standard Oil-Island Esther	Oil brine	1.0			E18
	125	Union Oil-Platform Eva	Oil brine	0.02			E19
	126	Signal oil and Gas-Platform Emmy	Oil brine	0.08			E20
	127	Signal Oil and Gas-Huntington Beach	Oil brine	0.6	300	3	
	128	Signal Oil-Huntington Beach	Oil brine	0.8	310	4	
	129	Gulf Oil-Huntington Beach	Oil line ballast	0.01	300		T10

Source: SCCWRP, 1973

Table II.H.2-5

SUMMARY OF GENERAL CONSTITUENT MASS EMISSION RATES (Metric tons/yr) FROM DISCRETE SOURCES, 1971-1972

Area		Flow[a] (10^6cu m/yr)	Silt	Total Suspended Solids	Volatile Suspended Solids	5-day Biol. Oxy. Demand	Chemical Oxygen Demand	Oil and Grease	Dissolved Silica (SiO_2)	Nitrate Nitrogen
I.	Muni. wastewaters	22		2,000	1,500	3,000	7,000	1,000	1,000	4
	Surface runoff	3.7	200				1,000	100	100	24
	Indust. waste	5.2		300			12,000	100		
II.	Muni. wastewaters	28		2,000	1,500	3,000	8,000	1,000	1,000	38
	Surface runoff	44	200,000				6,000	100	700	166
	Indust. waste	1.7		100			5,000	100		
III.	Muni. wastewaters	470		61,000	37,000	59,000	154,000	14,000	12,000	290
	Surface runoff	50	12,000				8,000	1,400	800	210
	Indust. waste	100		2,800			18,000	1,300		
IV.	Muni. wastewaters	510		169,000	106,000	160,000	311,000	35,000	9,000	112
V.	Muni. wastewaters	196		28,000	21,000	36,000	113,000	7,400	5,500	48
	Surface runoff	131	45,000				14,000	2,400	900	400
	Indust. waste	144		12,800		6,000	43,000	800		9,500
VI.	Muni. wastewaters	24		2,000	1,000	2,000	5,000	800	1,000	4
	Surface runoff	13	17,000				1,000	500	300	180
VII.	Muni. wastewaters	132		14,000	11,000	28,000	77,000	5,800	3,500	33
All Area										
	Muni. wastewaters	1,380		278,000	179,000	291,000	675,000	65,000	33,000	530
	Surface runoff	242	274,000				29,000	4,400	2,800	980
	Indust. waste	251		16,000		6,000	78,000	2,200		

Table II.H.2-5 (Cont.)

	Area	Ammonia Nitrogen	Organic Nitrogen	Total Nitrogen	Phosphate Phosphorus	Detergent (MBAS)	Cyanide (CN)	Phenols	Heat[a] (10^9 kwh/yr)
I.	Muni wastewaters	400	150	560	183	97	2	2	
	Surface runoff	34	15	73	14	0.5	0.1	0.1	
	Indust. waste								
II.	Muni. wastewaters	550	190	780	350	69	2	2	
	Surface runoff	166	200	530	132	5	2	1	
	Indust. waste								17
III.	Muni. wastewaters	8,100	6,400	14,800	3,200	2,200	117	46	
	Surface runoff	102	260	570	64	17	5	3	
	Indust. waste								23
IV.	Muni. wastewaters	41,000	13,700	55,000	7,300	3,500	58	1,620	
V.	Muni. wastewaters	5,900	2,600	8,600	1,180	970	16	39	
	Surface runoff	100	560	1,070	165	40	4	265	
	Indust. waste	9,500		10,000				43	38
VI.	Muni. wastewaters	350	123	590	240	95	2	3	
	Surface runoff	37	52	270	35	3	0.1	0.1	9
VII.	Muni. wastewaters	3,100	1,700	5,100	810	690	13	16	7
All Area									
	Muni. wastewaters	59,400	24,800	84,500	13,300	7,600	210	1,730	
	Surface runoff	440	1,090	2,510	410	66	11	269	
	Indust. waste	9,500		10,000				43	94

Table II.H.2-5 (Cont.)

	Area	Flow (10^6 cu m/yr)	Trace Metals: Silver	Cad-mium	Cobalt	Chro-mium	Copper	Mer-cury	Nickel	Lead	Zinc	Iron	Mang-anese	Chlorinated Hydrocarbons: Total DDT	Total PCB	Dieldrin	Total CHC
I.	Muni. wastewaters	22															
	Surface runoff	3.7	0.02	0.04	0.3	0.9	0.6		0.8	0.6	2	970	9	0.001	0.001	0.0001	0.002
II.	Muni. wastewaters	28		0.3		1	1		1		4	8	2	0.002	0.003		0.005
	Surface runoff	44	0.02	0.5	3.4	11	8		10	7	22	11,600	105	0.007	0.010	0.0007	0.018
III.	Muni. wastewaters	470	1.1	25	3	148	190	2.1	147	31	330	660	16	0.008	0.57		0.86
	Surface runoff	50	0.4	0.2	0.4	5	3		1	22	21	1,190	15	0.021	0.018	0.0098	0.049
IV.	Muni. wastewaters	510	10.2	15.4		440	290	0.5	123	128	1,220	5,100	67	19	6		25
V.	Muni. wastewaters	196	3.6	10.9		41	66	0.2	34	40	101	230	17	0.075	3		3.1
	Surface runoff	131	0.5	0.4	0.9	7.3	6.0	0.05	4	57	52	11,900	39	0.088	0.214	0.02	0.322
VI.	Muni. wastewaters	24															
	Surface runoff	13	0.02	0.1	0.3	0.8	0.9	0.01	0.7	3	4	700	15	0.002	0.003	0.007	0.006
VII.	Muni. wastewaters	132		2.5		19	20	0.1	8	12	22			0.022	0.11		0.14
TOTAL																	
	Muni. wastewaters	1,380	15	54	3.0	649	567	2.9	313	211	1,689	6,000	102	19.2	9.7		29
	Surface runoff	242	1.1	1.2	5.3	25	18	0.06	17	90	101	26,000	183	0.119	0.246	0.031	0.396

Source: SCCWRP TR104, March 1973

[a]Cooling water flow not included in industrial waste flow rate.

The SCCWRP (1973) report points out that the total suspended solids, oil and grease, and chemical oxygen demand from industrial sources are significantly lower than those of similar types of waste discharged into the ocean from municipal sources. It should be noted, however, that not all industrial waste is discharged directly from their originating source, but is often discharged into the ocean via municipal waste systems.

Inputs of petroleum from terrestrial sources are mainly from municipal wastewaters, industrial wastewaters and surface runoff. A comparison of the estimated mass emission rates from these sources is given in Table II.H.2-6.

Table II.H.2-6

SOURCES OF OIL AND GREASE/PETROLEUM DISCHARGED INTO THE SOUTHERN CALIFORNIA MARINE ENVIRONMENT

SOURCE	Mass Emission Rates (metric tons/yr) Oil and Grease	Petroleum
Municipal wastewaters	65,000	32,000
Industrial wastewaters	2,200	2,200
Runoff	4,400	?

Source: Storrs, 1973.

Storrs, (1973) found that the petroleum refining capacity in Southern California is about 10 percent of the United States capacity. Table II.H.2-7 shows the results of a recent survey of oil discharged to the Southern California coastal waters from the petroleum industry (SCCWRP, 1973).

Of the 2,200 metric tons of oil and grease in industrial wastewater discharged yearly to the nearshore waters, approximately 80 percent is due to oil in refinery wastewaters. The remaining 20 percent is due to operations of both the onshore and offshore production facilities. In the Southern California area, the offshore production capacity is about 9.7 million bbls/yr.

Fifteen power generating plants located along the Southern California coast constitute the power industries. These industries use approximately 39 x 10^6 cubic meters (10.2 billion gallons) of ocean water for cooling purposes daily. The cooling water is raised an average of 10.50°C (Table II.H.2-8), contributing the only single large-scale source of thermal pollution to the ocean waters of the Bight.

Table II.H.2-7

OIL DISCHARGES FROM THE PETROLEUM INDUSTRY TO SOUTHERN CALIFORNIA COASTAL WATERS

WASTEWATER TYPE	Wastewater Flow (cu m/s)	Mass Emission Rate (metric tons/yr)
Oil field brines	1.75	380
Tanker and line ballast	0.35	65
Refinery wastewaters	4.72	1,740
Cooling tower bleedoff	0.03	10
TOTAL		2,200

Source: Storrs, 1973.

ii. Diffuse Pollution Sources: Diffuse sources of pollution are those pollutants which enter the marine environment through non-discrete sources such as runoff, oil seeps, re-mobilization of pollutants through re-suspension, advection by ocean currents and aerial fallout.

There are 200 to 300 major rivers, streams and storm drains (SCCWRP, 1973) which yearly introduce a wide spectrum of solids, trace metals, chemicals, organic nutrients and hydrocarbons into the marine environment (Table II.H.2-9). Surface runoff is seasonal, being the greatest during winter months. The oil in runoff waters is from urban storm drainage, runoff from rural areas and natural stream drainage. The percentage of petroleum in these waters is unknown.

Table II.H.2-10 compares the various pollutant factors of municipal waste water, surface runoffs, and industrial water, using several different parameters (total suspended solids, oil and grease, trace metals, 5-day BOD). With the exception of silt and the trace metals, iron and manganese, municipal waste waters are the largest single contributors of pollutants.

Another source of oil is natural oil seeps. Young (1975) indicates that estimates of petroleum losses to the water column from 50-60 known natural oil seeps between Point Conception and Huntington Beach are uncertain, although four seep sites at Coal Oil Point are reported to have lost the equivalent of 4000 metric tons/year during October, 1969. However, such seepage rates are reported to be quite variable.

Table II.H.2-8

THERMAL DISCHARGES AT POWER GENERATING STATIONS
IN THE SOUTHERN CALIFORNIA COASTAL AREA AS OF 1970-71[a]

Fuel STATION- Location	Plant Operation 1 Capacity MW_e (mw)	2 Load Factor, F (%)	3 Overall Efficiency, E (%)	Estimated Waste Heat to Cooling Water[d] 4 Waste Heat per unit of Electrical Output, Q	5 Waste Heat to Cooling Water per Unit Output, Q_w	6 Plant Waste Heat H 6A Maximum, H_{max} (10^6 kw)	6B Average, H_{avg} (10^6kw)	Estimated Cooling Water Flow[d] 7 Normal Average Temp Rise T (C°)	8 Cooling Water Flow, R 8A Maximum R_{max} (10^6 cu m/day)	8B Annual R_{avg} (10^8 cu m/year)
FOSSIL-FUEL TYPE										
L.A. Dept. of Water and Power										
P1 Harbor, Wilmington	445	14	25	3.00	2.55	1.1	0.2	11	2.1	1.1
P2 Haynes, Seal Beach	1,625	60	36	1.78	1.51	2.5	1.5	10.5	4.8	10.5
P3 Scattergood, Playa del Rey	350	59	34	1.65	1.65	0.5	0.3	10	1.2	2.5
Subtotal	2,420					4.1	2.0		8.1	14.1
Southern California Edison Co.										
P4 Alamitos, Seal Beach	1,950	58	36	1.78	1.51	2.9	1.7	11	5.5	11.6
P5 El Segundo, El Segundo	1,020	50	35	1.86	1.58	1.6	0.8	12	2.7	5.0
P6 Huntington, Huntington Beach	990	65	35	1.86	1.58	1.6	1.0	12	2.8	6.5
P7 Long Beach, Long Beach[b]	210	20	25	3.00	2.55	0.5	0.1	10.5	1.0	0.8
P8 Mandalay, Oxnard	430	73	36	1.78	1.51	0.6	0.5	11	1.2	3.2
P9 Redondo, Redondo Beach	1,600	52	31	2.03	1.72	2.8	1.4	11	5.1	9.8
P10 Ormond, Ormond Beach	1,580	55	34	1.94	1.65	2.6	1.4	10.5	5.1	10.2
Subtotal	7,780					12.6	6.9		23.4	47.1

Table II.H.2-8 (Cont.)

Fuel STATION- Location	Plant Operation 1 Capacity MW_e (mw)	2 Load Factor, F (%)	3 Overall Efficiency, E (%)	Estimated Waste Heat to Cooling Water[d] 4 Waste Heat per unit of Electrical Output, Q	5 Waste Heat to Cooling Water per Unit Output, Q_w	6 Plant Waste Heat H 6A Maximum, H_{max} (10^6 kw)	6B Average, H_{avg} (10^6kw)	Estimated Cooling Water Flow[d] 7 Normal Average Temp Rise T (C°)	8 Cooling Water Flow, R 8A Maximum R_{max} (10^6 cu m/day)	8B Annual R_{avg} (10^8 cu m/year)
FOSSIL-FUEL TYPE										
San Diego Gas and Electric Co.[b]										
P11 Encino, Carlsbad	345	55	34	1.94	1.55	0.5	0.3	10.5	1.1	2.2
P12 Silver Gate, San Diego Bay	235	55	34	1.94	1.65	0.4	0.2	7	1.1	2.2
P13 South Bay, San Diego Bay	530	55	34	1.94	1.65	0.9	0.5	7	2.5	5.0
P14 Station "B", San Diego Bay	95	55	34	1.94	1.65	0.2	0.1	7	0.5	0.9
Subtotal	1,205					2.0	1.1		5.2	10.3
Total, Fossil-Fuel Type	11,405					18.7	10.0			7.5
Weighted Mean[c]		55	34	1.94	1.65			10.5		
NUCLEAR										
P15 San Onofre, San Clemente	450	80	32	2.12	2.02	0.9	0.7	10	1.9	5.5
TOTAL	11,855					19.6	10.7		38.6	77.0

Source: SCCWRP Report TR 104 March, 1973

Table II.H.2-8 (Cont.)

[a]Station operating data provided by power companies, except as noted in Note b below.
[b]Estimated values for the year 1971.
[c]All mean values are weighed by plant capacity.
[d]Calculations:

(i) Column (4): $Q = (1 - E)/E$

(ii) Column (5): Assume 15% of heat wastage lost through stack for fossil-fuel-type plant: 5% for nuclear power plant.

(iii) Column (6A): $H_{max} = (MW_e) \times (Q_w) \times 10^8$

(iv) Column (6B): $H_{avg} + (H_{max}) \times F$

(v) Column (8A): $R_{max} = (H_{max}) \times 20.7/(T)$

(vi) Column (8B): $R_{avg} = (R_{max}) \times (1) \times 10^6$

Table II.H.2-9

SUMMARY OF STORM WATER AND DRY WEATHER FLOW SAMPLING EFFORT, 1971-72

		Storm Flow			Dry Weather Flow		
			Estimated Flow (1,000 cu m/yr)				
Area	Stream	Sample Designation	Sampled	Not Sampled	Sample Designation	Date Collected (1972)	Estimated Flow (1,000 cu m/yr)
I	Santa Barbara Group			2,500			1,200
II	Ventura River			3,000	R11	6 Apr	11,700
	Santa Clara River	R1	26,000		R12	2 May	a
	Calleguas Creek			700	R13	29 Mar	2,700
III	Malibu Creek			3,400			
	Pico Drain			1,200	R14	11 Apr	3,600
	Ballona Creek	R2	26,000		R15	28 Mar	15,700
V	Dominguez Channel			5,300	R16	28 Mar	5,400
	Los Angeles River	R3	48,000		R17	28 Mar	20,000
	San Gabriel River			10,300	R18	28 Mar	300
	Coyote Creek			27,000	R19	2 May	4,000
	Santa Ana River	R4	1,800	8,600			
VI	San Diego River			2,500	R20	2 May	8,000
	San Juan Creek			200	R21	2 May	2,100
	APPROX. TOTAL		102,000	65,000			75,000

Source: SCCWRP Report March, 1973

[a]Dry weather flow diverted by percolation.

Table II.H.2-10

CONSTITUENT MASS EMISSION RATES (M TONS/YR) FROM SURFACE RUNOFF IN SOUTHERN CALIFORNIA, 1971-72

Stream	Flow (10^6 cu m/yr)	Silt	Total Organic Carbon[a]	Chemical Oxygen Demand	Oil and Grease	Dissolved Silica (SiO_2)	Nitrate Nitrogen[a]	Ammonia Nitrogen	Organic Nitrogen	Total Nitrogen	Phosphate Phos-phorus[a]	Detergent (MBAS)	Cyanide (CN)	Phenole
Santa Barbara Cr.														
Storm	2.5	200	200	100	<50	50	16	23	10	49	9	0.4	<0.1	0.1
Dry Weather	1.2	100	100	100	<50	50	8	11	5	24	4	0.2	<0.1	0.1
Ventura R.														
Storm	3	200	200	100	<50	50	20	27	12	59	11	0.4	<0.1	0.1
Dry Weather	11.7	700	900	500	<50	200	75	107	46	230	43	1.6	0.1	0.1
Santa Clara R.														
Storm	26	199,000	2,800	4,800	50	300	63	11	132	206	64	2.6	2.4	0.8
Callequas Cr.														
Storm	0.7	100	<100	<100	50	<50	2	4	2	8	3	0.1	<0.1	<0.1
Dry Weather	2.7	100	100	300	50	80	7	17	9	33	11	0.2	0.1	<0.1
Malibu Cr.														
Storm	3.4	1,000	300	400	50	<50	15	4	17	36	5	1.0	0.1	0.3
Pico Drain														
Storm	1.2	500	100	300	<50	<50	7	2	8	17	2	0.5	0.2	0.1
Dry Weather	3.6	200	100	200	180	100	9	1	9	19	7	1.2	<0.1	<0.1
Ballona Cr.														
Storm	26	10,000	2,800	6,600	600	250	151	42	180	370	36	10.3	4.1	2.3
Dry Weather	15.7	800	200	500	530	420	30	55	49	134	14	4.1	0.1	<0.1
Dominguez Ch.														
Storm	5.3	100	100	1,000	180	50	1	<1	13	14	2	3.8	<0.1	127
Dry Weather	5.4	100	100	1,000	190	50	1	<1	13	14	2	3.9	<0.1	130

Table II.H.2-10 (Cont.)

Stream	Flow (10^6 cu m/yr)	Silt	Total Organic Carbon[a]	Chemical Oxygen Demand	Oil and Grease	Dissolved Silica (SiO_2)	Nitrate Nitrogen[a]	Ammonia Nitrogen	Organic Nitrogen	Total Nitrogen	Phosphate Phos-phorus[a]	Detergent (MBAS)	Cyanide (CN)	Phenole
Los Angeles R.														
Storm	48	14,000	3,600	5,700	590	50	204	53	242	500	72	14.5	1.9	4
Dry Weather	20	1,200	200	700	790	36	14	<1	67	81	13	3.2	0.2	<0.1
San Gabriel R.														
Storm	10.3	3,000	800	1,300	130	110	44	11	52	107	16	3.1	0.4	1
Dry Weather	0.3	<100	<100	100	<50	50	1	3	1	5	3	0.1	0.1	0.1
Coyote Cr.														
Storm	27	8,000	2,000	3,200	330	290	110	30	140	280	40	8.1	1.1	2
Dry Weather	4	100	100	200	140	50	12	<1	11	23	1	3.0	<0.1	<0.1
Santa Ana R.														
Storm	10.4	18,000	600	600	70	50	15	2	27	44	16	0.6	0.3	1
San Diego Cr.														
Storm	2.5	4,000	100	100	90	50	42	9	12	63	8	0.7	<0.1	<0.1
Dry Weather	8	13,000	400	900	290	170	133	28	37	198	27	2.2	<0.1	<0.1
San Juan Cr.														
Storm	0.2	<100	<100	<100	<50	<50	1	<1	1	1	<1	<0.1	<0.1	<0.1
Dry Weather	2.1	<100	<100	<100	60	50	5	1	3	8	<1	0.3	0.1	<0.1
Total														
Storm	167	258,200	13,800	24,400	2,340	1,450	691	220	848	1,754	<285	46	10.4	139
Dry Weather	75	16,500	2,400	4,600	2,380	1,256	295	226	250	769	126	20	1.2	130
TOTAL	241	274,100	16,200	29,000	4,720	2,706	986	446	1,098	2,523	411	66	12.3	269

Source: Adapted SCCWRP March, 1973.

[a]Combined mass emission rates of soluble and suspended silt fractions

In comparison, estimates for the 1969 Santa Barbara oil spill range from 3,000 to 106,000 (Foster, et al., 1971) metric tons, with an intermediate value of about 11,000 tons. Visual No. 9 shows the location of documented seeps along the Southern California coast.

Over the decades, tons of man's pollutant discharge into the environment have accumulated on the shelf and basins adjacent to the Southern California mainland. These materials are, or may be occasionally resuspended due to bottom surge, dredging activities, or mass down slope movement. The quantity (mass) of chemical constituents, which could possibly be remobilized during this type of turbulence, is unknown.

Another potentially significant but largely unknown mode of pollutant transport into the Bight is advection, via the California Current, which transports waters past the western United States (see Physical Oceanography, Section II.C. for details). Young (1971) found that the net rate mercury removed from the water column and deposited in the underlying sediments is estimated to be in the order of 11,000 kg (24,250 pounds). No other chemical constituents, net deposition rate, have been found to be calculated for the Bight.

b. Baja California, Mexico: No information pertaining to ocean pollution waste loads and flow rates is available for this area.

c. Central California

i. Ocean Discharges: Within the central California coastal area, between Point Conception and Point Reyes (excluding San Francisco Bay), there are a number of small ocean outfalls. These municipal and industrial outfalls are principally located in the areas of San Luis Obispo (SLO), Monterey Bay and San Francisco. The respective daily municipal and industrial flow rate for each of these areas is shown in Table II.H.2-11.

Included within this table are the flow rates for industrial and municipal discharge into San Francisco Bay.

Although the municipal wastewater treatment plants are principally designed to treat domestic wastes, in virtually all cases, a certain amount of industrial wastes from dischargers become municipal influent.

In comparing the municipal waste loads discharged from Point Conception to San Francisco (Winzler and Kelly, 1977) with those of Southern California, it is found that the waste load and flow rate within central California are only a few percent of the waste load and flow rate found within the Bight.

In central California the largest non-power industrial waste volumes are from food processing plants. Fruit and vegetable canning and freezing, poultry dressing, and dairy food processing operations generate large seasonal volumes of waste, generally with a high content of organic material.

Table II.H.2-11

OCEAN DISCHARGE FLOW RATE, mgd[a]

AREA	Industrial: Power (Cooling Water)	Industrial: Non-Power	Municipal
Point Conception to Simeon (SLO)	2 sites/1.9 mgd	2/.74	4/1.9
Big Sur and Monterey	1/1,450	3/40	14/30
San Francisco (Ocean discharge)			6/15
San Francisco Bay	1/993	9/232	386

Source: Adapted from Winzler and Kelly, 1977.

[a]Million gallons per day.

Within San Francisco Bay, municipal sewage treatment plants contribute the largest point-source pollutant loads. Table II.H.2-12 lists the constituent waste loads. San Francisco Bay municipal waste loads and flow rates are approximately 25 percent of those for the Bight.

Six major categories of industrial operations discharge wastewaters either directly into San Francisco Bay or into municipal collection systems. These include food and kindred products, pulp and paper products, petroleum refining, organic and inorganic chemical manufacturing, primary metals, and fabricated metals. Waste loads and flows generated by heavy industries vary widely depending on the type and volume of the product.

Oil and chemical spills are a major problem in the San Francisco Bay system. Spills occur most frequently during fuel transfer operations at dock facilities, but the most damaging incident occurred in January, 1971, when two tankers collided in the Bay and released 840,000 gallons of fuel. The incident was not related to fuel oil transfer operations.

ii. Diffuse Pollution Sources: Precipitation on urban and non-urban areas results in runoff which contains inorganic pesticides, herbicides, etc. Irrigated agriculture is a major land use along the Central Coast, requiring a large portion of the total water used. Surface runoff from agricultural land can occur when rainfall or irrigation rates exceed evapotranspiration rates. Runoff characteristics vary considerably with land use practices, soil characteristics, rainfall intensity, and amount of applied irrigation water.

Table II.H.2- 12

MUNICIPAL POINT SOURCE WASTE LOADS TO SAN FRANCISCO BAY[a]

Constituent	Waste Load (lb/day) South Bay[b]	Lower Bay[c]	Central Bay[d]	San Pablo Bay[e]	Suisan Bay[f]
Biochemical Oxygen Demand	56,500	183,000	56,200	14,500	31,900
Suspended Solids	51,300	96,000	32,200	16,300	23,300
Oil and Grease	7,700	31,400	16,400	5,500	12,100
Total Nitrogen	27,200	41,200	16,200	8,300	8,600
Total Phosphate	26,300	16,500	6,900	3,500	6,200
Arsenic	3.1	10.4	9.6	3.7	0.7
Cadmium	6.5	17.1	7.0	3.9	2.7
Total Chromium	90	220	13	16	8.6
Copper	340	450	36	24	19
Lead	31	110	60	35	10
Mercury	39	1.6	0.7	0.4	0.2
Nickel	91	80	27	17	3.9
Zinc	200	580	100	29	35
Cyanide	11	130	26	5.5	0.8
Phenolic Compounds	31	490.	30	11	11
Total Identified Hydro-carbons	0.4	1.5	0.8	0.03	0.3
Flows (mgd)	170	150	81	36	41

Source: Winzler and Kelly, 1977

[a]From San Francisco Regional Water Quality Control Board, personal comm.
[b]South Bay - South of the mouth of Alameda Creek.
[c]From the San Francisco - Oakland Bay Bridge to the mouth of Alameda Creek.
[d]From the Richmond - San Rafael Bridge to the San Francisco - Oakland Bay Bridge
[e]From the Carqincz Bridge to the Richmond - San Rafael Bridge.
[f]From the Carquinez Bridge to the mouth of the Sacramento River.

3. Oil and Gas Technology: This section describes the oil and gas technology that could be utilized in developing the Sale No. 48 tracts. Technical activities are the geophysical and geological explorations, exploratory drilling, development drilling and production. The description for this section is presented as follows.

a. Exploratory Drilling: Drilling is the only presently known technique available to determine the presence of a hydrocarbon reservoir and to delineate its boundaries and characteristics. Drilling can be divided into two broad categories, i.e., (1) Exploratory drilling to discover a reservoir, to delineate its boundaries, and to determine its characteristics; (2) Development drilling to most economically realize the potential of the reservoir.

Offshore exploratory drilling today is generally conducted from a floating vessel or from a mobile "jack-up" platform. The latter type platforms are of many configurations, but can most generally be compared to a barge on which all drilling equipment, as well as auxiliary facilities such as living quarters, helicopter deck, etc., are mounted. The platform may or may not be self-propelled. The platform is equipped with three or more legs suspended in "jacks" which serve to raise or lower the legs in a vertical direction. When moving the platform, the legs are elevated. On arrival at the drilling location, the legs are lowered to the bottom and the platform is elevated on the legs to a position above the water surface. The platform is then essentially a fixed platform and drilling is conducted in the same manner as from a fixed platform.

For these reasons, only floating vessel drilling will be discussed in this section. General features of a floating vessel drilling system are illustrated in Figure II.H.3.a-1.

Subsea completions discussed later in this section would also probably utilize floating vessel drilling.

i. Features of Floating Vessel Drilling: Whether drilling is conducted on land, a platform, or from a floating vessel, most of the requirements are similar. Drilling from a floating vessel, however, requires certain modifications in procedures and, in some cases, equipment modifications. Five areas of major differences in procedures can be identified for floating vessel drilling. They are:

<u>Movement of the Vessels from One Location to Another</u>. Drillships move from one location to another under their own power. The older semi-submersible drilling vessels were moved by towing vessels. Most modern semi-submersibles have their own propulsion system, but may require assistance from towing vessels, especially on long moves, in order to save time.

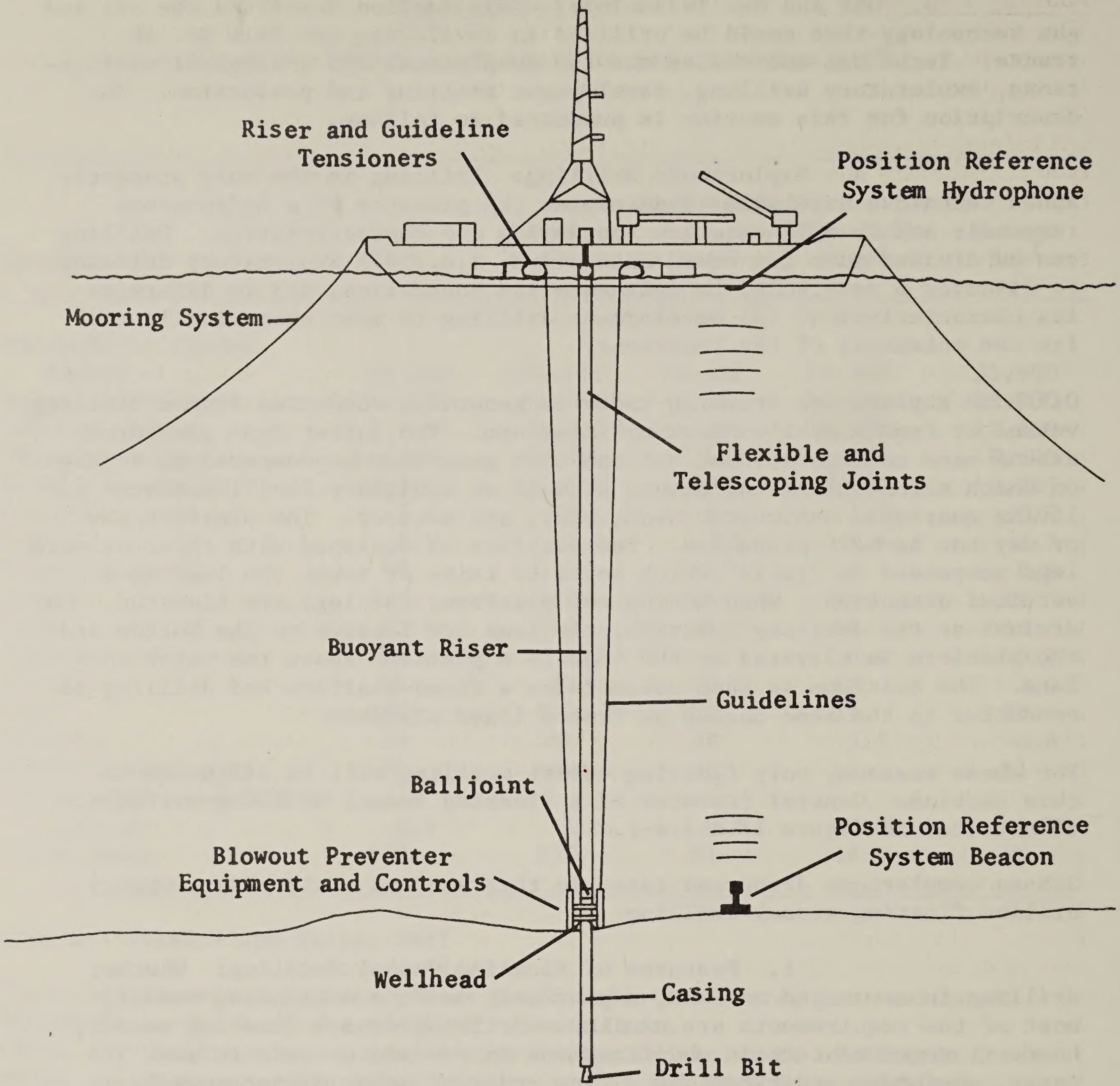


Figure II.H.3.a-1 Components of a Deepwater Exploratory Drilling System

Mooring the Vessel. The mooring system is that system designed to hold the vessel on location against the forces of wind, waves, and current. Component parts include the mooring line winches, the mooring line, the anchor chain, the anchors, the pendants, the buoys, and all connecting links throughout the system. Mooring systems must not only provide satisfactory restoring force, but must also limit horizontal displacement. Moorings should be designed to limit vessel horizontal displacement to 10 percent of water depth.

Mooring systems normally consist of a combination wireline-chain system or a chain system. Wirelines are normally sized so that expected mooring loads never exceed one-third of the wireline breaking strength.

In practice, chain-only mooring systems are used in water depths to about 1,000 feet. Combination cable and chain systems can be used to depths of about 2,000 feet. At depths over about 1,000 feet, it is generally considered prudent to employ dynamic positioning in conjunction with a mooring system and at depths greater than 2,000 feet dynamic positioning is the only practical method of maintaining position. This positioning method is discussed below.

Reliable information on the relative position of the drilling vessel and the subsea wellhead is an important key to controlling horizontal displacement. Three types of monitoring devices are in use today. One type of vessel-position indicating system is based on acoustics. Vessel position is continuously monitored by triangulation methods using acoustic signals fed into shipboard computers; this position is visually displayed on a console which shows the location of the drilling vessel related to distance and direction of departure from the wellhead. The second type is the taut-line system. This system consists of a taut steel line stretched from the vessel to an anchoring point on the ocean floor and a dual-axis inclinometer to measure the slope of the line. The taut-line slope indicates vessel displacement in the horizontal plane. Both taut-line and acoustic position reference systems have been employed on drilling vessels in the Santa Barbara Channel. The third type of monitoring system is a riser angle sensor that will indicate the departure of the riser from vertical and, therefore, the horizontal displacement of the vessel from the wellhead location. The output from these monitoring systems is fed to a shipboard computer system and the output from the computer controls the tension in mooring system lines to maintain the vessel in position.

The more modern drilling vessels, both drillships and semi-submersibles, have in addition to the main fore and aft propulsion system, a "thruster" propulsion system. This system makes possible lateral, or sideways, movement of the vessel through screws or jets perpendicular to the fore and aft axis of the vessel. The combination of fore and aft, and lateral propulsion systems permits accurate positioning of the vessel in relation to a fixed point.

In practice, on location, the output of the thrusters and main propulsion system is computer controlled. The input to the computer is from the position monitoring system described above, the output from the computer controls the thrusters and main propulsion systems to maintain the vessel on position. In water depths from about 1,000 to 2,000 feet this dynamic positioning system is generally used in conjunction with a conventional mooring system. In depths over 2,000 feet, the system can be used alone to maintain position.

Core holes were successfully drilled, and re-entered, by the Glomar Challenger in water depths up to 20,000 feet. Conventional cased wells have been successfully drilled and re-entered using this method, without the aid of divers, in waters up to 1,500 feet deep off southeast Asia.

Generally, there are at least two positioning systems for redundance and, of course, the vessel can also be manually controlled to maintain position in case of failure of computer systems.

Vessel Motion Compensation. Because of the flexibility of the drill string and due to the ball joints incorporated in the riser system, horizontal motion of the drilling vessel in relation to the ocean floor wellhead can be accepted up to at least 10 percent of the water depth.

One of the requirements for successful rotary drilling is to maintain a constant weight on the bit. Drilling from a floating vessel which moves up and down in relation to the ocean floor requires special methods to maintain a constant weight on the bit. The riser system is equipped with telescoping joints to permit vertical motion of the vessel. The bottom hole assembly of the drill string is also equipped with telescoping joints, called bumper subs, for the same purpose. Hydraulic or pneumatic vertical motion compensators have also been developed and are in use on many vessels. In one system the compensator is placed in the drill string below the traveling block. In another, the compensator is a part of the crown block, which is normally fixed in place at the top of the derrick, but in this system the crown block moves to compensate for vertical motion of the drilling vessel. Both systems maintain a constant drill string weight on the bit. Thus, as the vessel moves up and down, the drill string automatically maintains its position relative to the bottom. These compensators have been designed with as much as a 400,000-lb. capacity and a 14-foot stroke. Figure II.H.3.a.i-1 shows a typical hydraulic vertical motion compensator.

Remote Location of Well Control Equipment. In floating vessel drilling, the wellhead and the blowout preventer (BOP) stack are located on the ocean floor. Therefore, all of the functions normally carried out just below the drilling floor on land and platform drilled wells must be conducted by remote control.

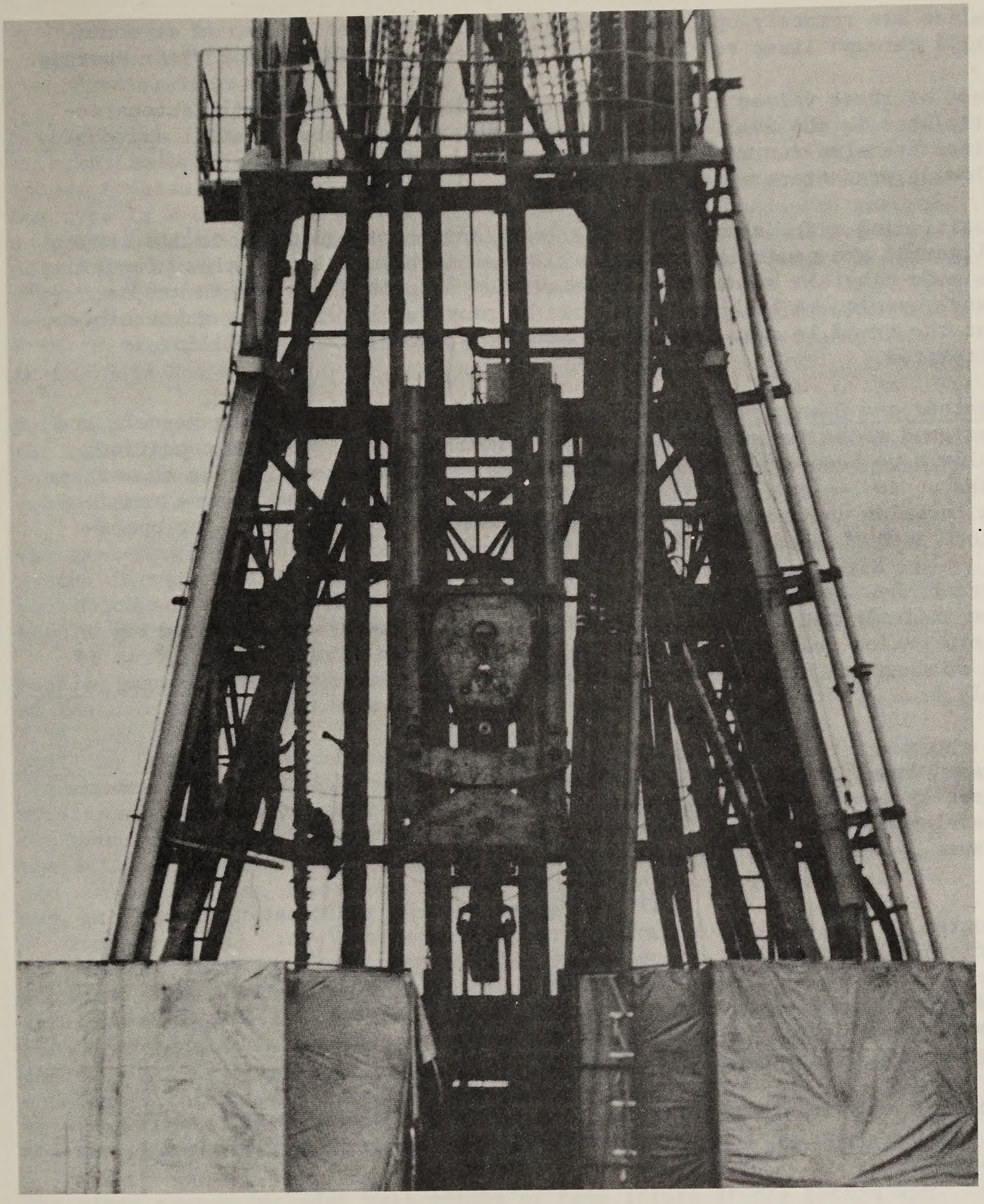


Figure II.H.3.a.i-1 Vertical Motion Compensator

Source: VETCO Offshore, Inc.

Valves are remotely operated (hydraulically, pneumatically, or electrically) through lines run in conjunction with the guidance and riser systems.

Most of these valves are of the fail-to-close type which will automatically shut in the well should loss of control power occur. Kill and choke lines are also run with these systems to permit circulation in case the blowout preventers are closed.

Positioning systems to permit the installation of equipment in its proper alignment are generally mechanical. Visual observation of these functions is made possible by underwater television systems which are in use on many vessels. A back-up system can be provided by divers or submersibles, but the trend is away from these methods as deeper water drilling is attempted.

Weather and Oceanographic Influences on Operations. Drilling vessels are designed to be functional in all but the most severe weather conditions. Wells have been drilled in the North Sea, with no down-time due to weather, when up to 14-foot significant waves were running. Vessels have remained on location under much more severe conditions, although drilling operations were suspended.

Recent observations from a modern semi-submersible drilling in the North Sea indicate the stability of these vessels in rough weather. During a storm period reaching 9 on the Beaufort Scale, with wave heights from 16 to 45 feet and 8 to 12 second wave periods, the vessel's heave ranged only from 1.5 to 7 feet.

In the event that conditions were severe enough to require that the vessel leave the location, the blowout preventers would be closed and the riser system retrieved by the vessel. When conditions permitted, the vessel would resume its location as before, re-run the riser system, and resume operations.

ii. Drilling Equipment: In implementing a drilling program, a lease operator should focus on two objectives: (1) to conduct efficient drilling operations using advanced technology; and (2) to conduct operations in a safe manner, with emphasis on maintaining well control and protecting the environment against accidental spills. The following discusses how floating drilling equipment components are selected, designed, and utilized to meet these objectives.

Floating drilling operations can be more easily described and understood by first separating the components into five categories, or systems, as follows:

Drill Vessel
Mooring System

Drilling System
Marine Well Control System
Special Operating Techniques

Drill Vessel. The term "drill vessel" is used here to refer to the vessel or hull from which drilling operations are conducted. There are two types of vessels utilized for the preponderance of deepwater drilling. One type is a conventional drillship where drilling is conducted through a vertical water-tight shaft (moon pool) built through the hull of the ship. The other type is a semi-submersible drilling platform with a structural configuration in which the main buoyancy members are located below wave action. Each of the types would be considered acceptable for drilling exploratory and submerged production system devèlopment wells in the Sale No. 48 area.

Both hull types have exhibited favorable operating characteristics in the relatively mild environmental conditions of the Sale No. 48 area. Overall weather downtime averaged only about 2 percent while one operator conducted floating drilling operations in the Santa Barbara Channel.

The semi-submersibles are large, advanced-design rigs that have better motion characteristics in rough seas than do ship types. The units can work in water depths to 1,000 feet and beyond. Vessels are being developed which have the capability to drill in over 3,000 feet of water.

Mooring System. The mooring system was discussed in Section II.H.3.a.i on Features of Floating Vessel Drilling.

Drilling System. Components included in the drilling system are generally the same components found on most rotary rigs and are associated with all drilling operations whether on land or offshore. Those include the equipment for hoisting the pipe, rotating the drill string, circulating the drilling fluid and the associated auxiliary facilities. Since these are common drilling components and not unique to floating vessel drilling, no description will be included here.

(a) Drilling Riser and Well Control Conduits: One part of the floating vessel drilling system that is unique to floating vessel drilling is the riser system. The riser itself is a large diameter pipe connected to the top of the blowout preventer stack by a hydraulic connector. All drilling operations after the conductor pipe is set are carried on through the riser and the primary function of the riser are to permit circulation of drilling mud and cuttings from the bottom of the hole to the drilling vessel, and to serve as a drill pipe guide.

The riser system includes ball joints or flex joints at the bottom and near the top to reduce bending moments caused by vessel movement in the horizontal plane. Horizontal movement is permissible to at least 10 percent of the water depth. In addition, the system includes telescoping or slip joints to permit vertical movement of the vessel. Figure II.H.3.a.ii-1 shows a typical riser system and its relationship to other components of the drilling system.

The riser system is connected to the drilling vessel by riser tensioner lines designed to maintain proper tensioning of the riser. This is necessary to avoid overstress and buckling of the riser. In the later vessels proper tensioning of each line is controlled through a computer system.

In deeper water, in order to diminish stress on the tensioner lines, buoyant riser joints or external float attachments are included in the riser string. It is possible to drill in water depths to about 1,500 feet without help, but in waters over 1,500 feet deep a buoyant riser system is a necessity.

Riser length has been one of the limiting factors in deepwater drilling, from the standpoint of strain on the tensioning system and on storage and handling facilities on the drilling vessel. However, Shell Oil Company is currently drilling a well in 2,150 feet of water off Gabon in western Africa.

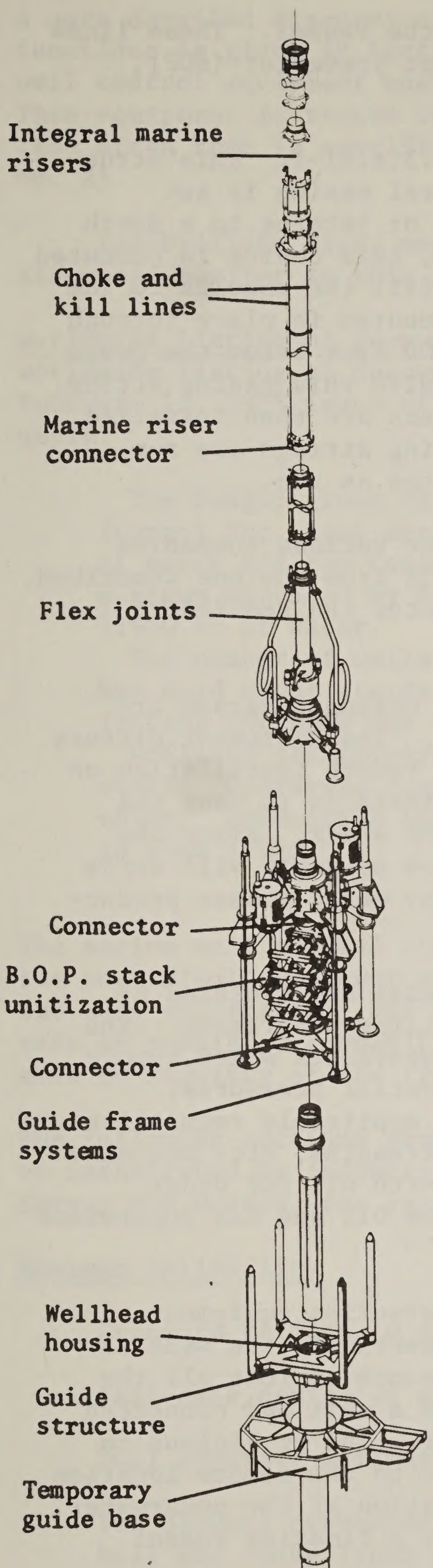
Kill and choke lines are integral within the riser system to minimize running and pulling time. Connections of these lines to the BOP and manifolding are such that the lines can be operated as either kill or choke lines. Well control conduits are also run simultaneously with the riser system.

(b) Vertical Motion Compensation: The second part of the drilling system unique to floating drilling is the vertical motion compensation system. This was discussed in Section II.H.3.a.i.

Marine Well Control System. The well control system is the composite of those components that provide for utilization and control of, and communication with, the subsea well during drilling operations. Major components of the system are:

- Guidance System
- Wellhead
- Well Casing
- Blowout Preventer Stack and Controls
- Drilling Riser

(a) Guidance System: A guidance system is one of the first ties made between the ocean floor and the drilling vessel. This consists of two or more wirelines attached to a fixed ocean floor structure and



MARINE RISER SYSTEM

The Marine Riser System functions to carry drilling fluid returns back to the drilling vessel. The Riser System incorporates a flexible joint at its lower extremity to isolate the blowout preventer and the wellhead from bending loads should the vessel move off location. A telescopic joint, located near the top, accommodates the vertical reciprocating motion of the vessel.

BLOWOUT PREVENTER STACK

Comprised of large diameter, high pressure valves, the Blowout Preventer provides the ability to securely control variation in well bore pressures during the drilling operation. Duplicate hydraulic control systems assure reliability of preventer operation at all times.

WELLHEAD ASSEMBLY

The wellhead assembly functions as a pressure vessel to which the casing strings are securely sealed as they are installed in the wellbore. The outer profile of the wellhead provides the means of attaching the blowout preventer stack.

GUIDANCE SYSTEM

The permanent guide base run with the conductor casing. The temporary guide base run on drill pipe. The guide bases incorporated in the assembly function as an anchor for guidelines extending from the drill vessel and provide initial support for the installation of the wellhead assembly.

Source: VETCO OFFSHORE , INC.

Figure II.H.3.a.ii-1 Marine Well Control System tensioned by hydraulic and/or pneumatic units on the vessel. These lines serve as guides for running the drill pipe, blowout preventer (BOP), riser system, and television camera if used.

A typical guide structure is shown in Figure II.H.3.a.ii-1. This structure is run and set on the drill string. Structural casing is set through the guide structure by drilling, driving, or jetting to a depth of about 100 feet. If drilled or jetted in place, this casing is cemented in place with a quantity of cement sufficient to fill the annulus to the ocean floor. Conductor casing is then set and cemented in place through the structural casing to a depth of from 300 to 500 feet below the ocean floor. The wellhead casing hanger system is run with this casing string. The blowout preventer assembly and the riser systems are then installed and the actual drilling proceeds. Subsequent casing strings are run through the wellhead casing hanger system and seated as run.

The guidance system described above is typical, but various companies have adopted different methods that vary in details from the one described. Some systems make use of acoustic beacons to re-enter the sea floor assembly.

(b) Wellhead: Subsea wellhead equipment and casing programs are similar in most respects to the land counterparts. The equipment differs principally in that it incorporates provision for remote installation on the ocean floor. The primary function of the wellhead is to hang the casing strings and to serve as the base for the BOP stack. After the well is drilled, tested, and completed the wellhead assembly will serve as the base for the christmas tree assembly and any other subsea production equipment that may be installed.

(c) Well Casing: Formation pressures and fluids are isolated by setting and cementing steel casing strings as drilling progresses. The USGS approves casing programs submitted by lease operators which incorporate appropriate safety factors for maximum potential pressures. Casing setting depths comply with, or exceed, all applicable regulations. Pipe quality, dimensions, weights, grade, yield strengths, etc. are also regulated by the USGS. The Operator must comply with all OCS order casing requirements plus any other requirements the Oil and Gas Supervisor deems necessary.

(d) Blowout Preventer Stack: The blowout prevention equipment (BOPE) used in floating drilling operations is essentially the same as that used for land drilling. The principal difference is that all the valves comprising the stack are run at one time as a unit and connected to the conductor casing with a hydraulic connector. The provisions to control the preventers are also more elaborate due to the remote location of the stack. Figure II.H.3.a.ii-1 shows the relation of the underwater blowout preventer (BOP) stack to other elements of a floating vessel drilling system.

A more detailed discussion of the blowout prevention equipment and functions is given in Section II.H.3.a.iv. Blowout preventers and other well control equipment must meet the Geological Survey requirements. This equipment is tested on a schedule set by prudent practice, but not less often than is specified in Geological Survey regulations (OCS Order No. 2).

(e) Drilling Riser and Well Control Conduits: The riser system was discussed earlier in this section.

Worldwide Listing of Deepwater Wells. Table II.H.3.a.ii-1 provides a worldwide listing of deepwater wells. In addition, page 23 of the February 13, 1978 issue of the Oil and Gas Journal makes the following quote:

> The Seagap group operated by Getty Oil International (Congo) Inc. last week was on location in a record 4,348 ft of water off the Congo. And across the Atlantic off Surinam, a group operated by Esso Exploration Inc. was drilling in 3,950 ft of water.
>
> The number of wells spudded in waters deeper than 1,000 ft has held about steady the past 2 years. Operators are projecting the same for this year.
>
> Drilling technology has advanced significantly in recent years. Operators say they can drill in 5,000-8,000 ft of water. Production capability extends to 2,000 ft of water in some areas.

iii. Safety Features of Marine Well Control System: The marine well control system of wellhead, BOP, controls and riser is the most vital component of the floating drilling system. It is also the most vulnerable. For this reason, the system must be designed as safe as possible, compatible with the applicable safety features available to industry at the time and pursuant to Survey regulations.

The following sections enumerate common operating procedures developed or established by industry organizations, OCS Operators or Geological Survey OCS Orders, for various components of well control systems:

Maximum Reliability

Pressure ratings in excess of those which may be encountered.

Fail-safe design of all critical functions.

Dual separate fail-safe valving on critical lines and outlets.

Two blowout preventer (BOP) side outlets and manifolding such that kill and choke lines can be operated as either kill or choke lines.

Table II.H.3.a.ii-1

WORLDWIDE LISTING OF DEEPWATER WELLS

Operator	Well location	Rig name	Water depth (in feet)
Future			
Chevron Overseas	Gulf of Valencia, Montanazo D-1, Spain		1,519
Chevron Overseas	West Greenland, Ikermiut 1		1,492
Gulf Energy & Minerals—U.S.	Southern California, OCS 0310 #1		1,260
Gulf Energy & Minerals—U.S.	Southern California, OCS 0302 #1		1,080
Gulf Energy & Minerals—U.S.	Southern California, OCS 0230 or 0231 #1		637
Gulf Energy & Minerals—U.S.	Gulf of Alaska, Y-0059 #1	Aleutian Key	615
1978			
Atlantic Richfield	Tannoil Bank 82-1, California		1,200+
Atlantic Richfield	West Greenland, Hellefisk #31-A		650+
Atlantic Richfield	North Sea, U.K. 211/11-3		600+
1977			
Esso Exploration	Red Sea, RSO L'95-1	Discoverer 534	2,506
Hipco of New Zealand	South Island, New Zealand	Penrod 74	2,250
Hipco of New Zealand	South Island, New Zealand	Penrod 74	2,247
Wepco	Egypt, Quseir well	Discoverer Seven Seas	2,000+
Getty Oil	Congo	Discoverer Seven Seas	2,000
Hipco of New Zealand	South Island, New Zealand	Penrod 74	2,100
Tenneco	New Orleans area NO42 E163		1,950
Placid	Louisiana	Penrod 72	1,900
Esso Libya	Libya, B1-NC35A	Discoverer II	1,512
Amoco	Valencia coast off Spain, Mediterranean	Discoverer 511	1,460
Exxon USA	Louisiana	Zapata Lexington	1,372
Mobil	Texas, East Breaks Area	Zapata Concord	1,220
Gulf Energy & Minerals	Tanner Banks OCS 6261 #1, California	Aleutian Key	1,080
Placid	North Sea	Penrod 71	889
Exxon USA	Santa Barbara Channel	Glomar Coral Sea	719
Japan Petroleum Corp.	Nigeria		680
Atlantic Richfield	West Greenland, Hellefisk #31-D	Sedco 445	600+
British Petroleum	North Sea	Sedco 703	600+
British Petroleum	North Sea	Sea Conquest	600+
British Petroleum	Unknown	Sedco 471	600+

Operator	Well location	Rig name	Water depth (in feet)
1976			
Esso Exploration	Thailand, W9-E1	Discoverer 534	3,461
Esso Exploration	Thailand, W9-C1	Discoverer 534	2,959
Esso Exploration	Red Sea, RSO T'95-1	Discoverer 534	2,737
Esso Exploration	Thailand, W9-DI	Discoverer 534	2,652
Esso Exploration	Thailand, W9-B1	Discoverer 534	2,632
Union Oil of Thailand	West Thailand	Sedco 445	2,039
Union Oil of Thailand	West Thailand	Sedco 445	2,028
Union Oil of Thailand	West Thailand	Sedco 445	2,017
Placid	Louisiana	Penrod 72	1,796
Placid	Louisiana	Penrod 72	1,763
Union of California et al	Thailand	Sedco 445	1,689
Union Oil of Thailand	West Thailand	Sedco 445	1,646
Esso Exploration	Red Sea, RSO B'95-1	Discoverer II	1,512
Hipco of New Zealand	New Zealand	Penrod 74	1,500
Amoco Espana	Spanish Mediterranean	Discoverer 511	1,460
Union Oil of Thailand	West Thailand	Sedco 445	1,308
American Petrofina	Louisiana	Blue Water No. 4	1,270
Exxon USA	Louisiana	Zapata Lexington	1,130
American Petrofina	Louisiana	Blue Water No. 4	1,150
Mobil	Texas, Bay City area	Zapata Concord	1,129
Shell	Mobile South OCS 2639#1	Western Pacesetter II	1,122
American Petrofina	Louisiana	Blue Water No. 4	1,121
Mobil	Texas, Bay City Area	Zapata Concord	1,109
Shell	Mobile South OCS 2638#2	Western Pacesetter II	1,106
Exxon USA	Louisiana	Western Pacesetter II	1,065
Exxon USA	Louisiana	Zapata Lexington	1,069
Exxon USA	Louisiana	Zapata Lexington	1,018
Exxon USA	Louisiana	Zapata Lexington	1,018
Exxon USA	Louisiana	Western Pacesetter II	1,015
Mobil	Texas, Bay City Area	Zapata Concord	988
Mobil	Texas, Bay City Area	Zapata Concord	971
Chevron Overseas	Gulf of Valencia, Casablanca #5, Spain	Bideford Dolphin	955
Mobil	Texas, Bay City area	Zapata Concord	943
Mobil	Texas, Bay City Area	Zapata Concord	933
Shell Expro	North Sea	Sedco 700	933
Shell	Mobil South OCS 2643#4	Ocean Queen	927
Exxon USA	Santa Barbara Channel	Glomar Coral Sea	925
Shell	Mobile South OCS 2642#5	Ocean Queen	881
Total Hispania	Spain, Marina Well	Pelican	872
Mobil	North Sea, Norwegian sector	Deep Sea Saga	869
Esso Libya	Libya, A1-NC35A	Discoverer II	856
Exxon USA	Texas	Western Pacesetter II	815
Gulf Energy & Minerals—U.S.	Mobile South #2 OCS 2636#3	Zapata Concord	782
Chevron Overseas	Spanish Mediterranean	Bideford Dolphin	775
Esso Exploration	North Shetlands, UK 210/5-1	Dixilyn Venture One	773
Aquitaine S.W.A.	South Africa, AA1	Sedco K	772
Gulf Energy & Minerals—U.S.	Okinawa	Wodeco VIII	704
Atlantic Richfield	Louisiana	Glomar Java Sea	697
Atlantic Richfield	Louisiana	Glomar Java Sea	696
Shell	Garden Banks OCS 2957#1	Ocean Queen	696
Gulf Energy & Minerals—U.S.	Tanner Banks OCS 0258#1	Aleutian Key	686
Exxon USA	Santa Barbara Channel		670
Shell	San Pedro 262 OCS 0301#1	Ocean Prospector	656
British Petroleum—Canada	Labrador, Indian Harbor M-52	Sedco J	649
Shell	San Pedro 262 OCS 0301#2	Ocean Prospector	633
Challenger Oil & Gas	South Portugal	Glomar Sirte	619
British Petroleum	North Sea, U.K. 211/12-5	Sedco 702	612
Oceanic Exploration Co.	Greece	Wodeco V	600+

Table II.H.3.a.ii-1 (Cont.)

Operator	Well location	Rig name	Water depth (in feet)
1975			
Shell	Gabon	Sedco 445	2,292
Esso Exploration	Thailand, W9-A1	Discoverer 534	1,914
Esso Exploration	Egypt, NDO-B1	Glomar Coral Sea	1,354
Esso Exploration	Egypt, NDO-A1	Glomar Coral Sea	1,340
*Esso Exploration	Australia, Morum #1	Regional Endeavour	1,260
Chevron Overseas	Portugese Atlantic	Bideford Dolphin	1,216
Esso Exploration	Egypt	Glomar Coral Sea	1,200
*Eastcan Exploration	Labrador, Cartier well	Pelican	1,017
*Esso Exploration	Australia, Hapuku #1	Regional Endeavour	938
Shell Oil	Louisiana (7 wells)	Ocean Queen and Western Pacesetter II	936-1,093
Exxon	Santa Barbara Channel	Glomar Coral Sea	907
Shell Development (Australia)	Australia	Regional Endeavour	829
Burmah	Morocco	Havdrill	823
Amoco Espana	Spanish Mediterranean	Sedco I	804
Shell Expro	North Sea	Sedco 700	765
Saga Petroleum	North Sea	Deep Sea Saga	741
Arco	Louisiana	Santa Fe Mariner II	697
Wapet	West Australia	Dalmahoy	696
*Gulf Energy & Minerals—U.S.	Garden Banks OCS 2809#2	New Era	689
British Petroleum	North Sea	Sedco 703	670
Mobil	Canadian Grand Banks	Sedco J	664
Arco	Louisiana	Glomar Java Sea	650
British Petroleum	Labrador	Havdrill	649
Chevron Overseas	Spanish Mediterranean	Bideford Dolphin	634
Sun	Texas	Century	602
1974			
Shell	Gabon	Sedco 445	2,097
Shell	Mauritania	Sedco 445	1,929
Shell	Morocco	Sedco 445	1,721
British Petroleum	Newfoundland	Havdrill	1,087
Eastcan Exploration	Labrador, Guidrid well	Pelican	982
British Petroleum	North Sea	Sedco 703	709
Union Oil of Canada et al	Canadian Atlantic	Sedco H	635
British Petroleum	North Sea	Sedco 703	620
Shell Expro	North Sea	Sedco 700	619
Arco	North Sea	Waage Drill II	612
1973			
Shell	Brunei	Sedco 445	1,356
Shell	Australia	Sedco 445	1,272
Shell	Australia	Sedco 445	776
Shell/AGIP	Adriatic	Scarabeo 2	636
Nishi-Nihon	Japan	Ocean Prospector	630
Phillips	North Sea	Ocean Rover	616
1972			
Shell	Brunei	Sedco 445	1,349
Shell	South Java	Sedco 445	1,223
Shell	South Java	Sedco 445	1,155
Exxon USA	Santa Barbara Channel	Wodeco IV	1,070
Socal-Exxon	Santa Barbara Channel	Wodeco IV	768
Shell Korea	South Korea	Ocean Prospector	646

Table II.H.3.a.ii-1 (Cont.)

Operator	Well location	Rig name	Water depth (in feet)
Esso Exploration	Ivory Coast	Glomar Grand Isle	635
Esso Exploration	Norway	Glomar Grand Isle	635
Exxon USA	Santa Barbara Channel	Wodeco IV	612
1971			
Exxon USA	Santa Barbara Channel	Wodeco IV	1,437
Exxon USA	Santa Barbara Channel	Wodeco IV	1,395
Exxon USA	Santa Barbara Channel	Wodeco IV	1,212
Exxon USA	Santa Barbara Channel	Blue Water No. 2	1,032
Exxon USA	Santa Barbara Channel	Blue Water No. 2	1,008
Exxon USA	Santa Barbara Channel	Wodeco IV	873
Exxon USA	Santa Barbara Channel	Blue Water No. 2	849
Exxon USA	Santa Barbara Channel	Blue Water No. 2	839
Exxon USA	Santa Barbara Channel	Blue Water No. 2	830
Exxon USA	Santa Barbara Channel	Wodeco IV	812
1970			
Exxon USA	Santa Barbara Channel	Wodeco IV	1,497
Exxon USA	Santa Barbara Channel	Blue Water No. 2	1,049
Shell Oil	Santa Barbara Channel	Blue Water No. 2	913
Exxon USA	Santa Barbara Channel	Wodeco IV	764
Exxon USA	Santa Barbara Channel	Blue Water No. 2	762
Exxon USA	Santa Barbara Channel	Wodeco IV	756
Socal-Exxon	Santa Barbara Channel	Wodeco IV	719
1969			
Exxon USA	Santa Barbara Channel	Wodeco IV	1,299
Exxon USA	Santa Barbara Channel	Wodeco IV	1,245
Exxon USA	Santa Barbara Channel	Wodeco IV	1,046
Exxon USA	Santa Barbara Channel	Blue Water No. 2	1,055
Exxon USA	Santa Barbara Channel	Blue Water No. 2	941
Shell Oil	Offshore California	Blue Water No. 2	913
Exxon USA	Santa Barbara Channel	Blue Water No. 2	730
1968			
Exxon USA	Santa Barbara Channel	Wodeco I	944
Exxon USA	Santa Barbara Channel	Blue Water No. 2	669
Exxon USA	Santa Barbara Channel	Blue Water No. 2	641
Exxon USA	Santa Barbara Channel	Blue Water No. 2	629
1965			
Humble Oil	Southern California	Cuss I	632

* 1977 Additions

Source: Offshore, June 5, 1977, p. 42-45.

Adequate ocean floor storage of hydraulic power for cycling all critical functions in case of loss of surface connected power hose.

Fast closure of blowout preventers (BOP) provided by ocean floor hydraulic power supply.

Redundant control systems and pilot valves which can be retrieved individually and repaired without pulling BOP stack.

Established operating practice to alternate use of control systems weekly to insure both are functional.

Established practice to suspend operations when either control system is not functional, while conducting repairs.

High level preventative maintenance such as sandblasting and magnafluxing riser joints, then repainting. Also, inspection for wear and testing functional capability of each piece prior to installation.

Assembling, activating, and pressure testing each function of BOP on board vessel prior to installation.

Functional testing of BOP daily and pressure testing weekly, or when changes are made.

Well Closure in the Event of an Emergency

Optimum ram closure around drill pipe to allow circulation of drilling fluid in the event of a well kick.

BOP facilities to sustain emergency well control conditions over prolonged periods.

Provision for hanging drill pipe on rams and moving drilling vessel off location.

Capability to re-establish vessel on location, monitor and circulate well prior to reconnecting drill pipe.

Provisions for alternate procedures should any of the foregoing fail.

Drill with a float valve in the drill string to prevent reverse flow.

Automatic locks on all ram-type preventers.

All marine connectors through top of BOP stack designed to adequately handle full-well pressure.

Annular preventer equipped with automatic closure or acoustically operated closure device in case of loss of control hoses.

Completely Diverless Operation

Provision for remote operation and remote recovery.

Appropriate redundancy in all valves and controls.

Provisions for latching and re-establishing guidelines.

Simplified Installation

Integration of choke and kill lines into marine riser to simplify simultaneous installation of riser and control lines.

Run well control systems simultaneously with riser.

Before landing BOP stack, install upper components (ball joint, telescoping joint and riser tensioning). This allows easy precision control in lowering last few feet with tensioning system.

iv. Well Control: In Section II.H.3.a.ii, the mechanical well control systems were discussed. However, well control is actually maintained through a variety of interrelated systems. The primary means of well control is the weighted column of drilling fluid (mud) in the hole. The weight of this column serves to control subsurface formation pressures and to prevent formation fluids from entering the well bore. The well casing is the secondary means of well control since, when casing is run and cemented through a formation, that formation is isolated from the well bore and from other formations. The blowout preventer system is the third means of well control and is designed to be used if the primary system fails.

Drilling Fluid. During drilling, the well bore is kept filled by circulating the drilling fluid (mud) through the drillstring, out the bit, and up to the surface through the annulus. The weight per volume of the drilling fluid (mud) can be controlled by the addition of weight material (barite) through a very wide range to give the desired hydrostatic pressure on bottom. This pressure is designed to be in excess of any natural formation pressure that may be encountered.

The pressure exerted by the mud column is a function of the mud weight and the height of the column. Should the formation pressure be allowed to exceed the pressure exerted by the column of drilling fluid, the column of mud would be forced up and out of the well and an uncontrolled flow of gas, oil, or water could ensue if proper control measures were not taken.

There are two ways in which the formation pressure may exceed the hydrostatic pressure of the mud column. The first, of course, is when the weight per volume of the mud is insufficient. The second is when the height of the column is allowed to decrease to the point where the hydrostatic pressure of the mud column is less than the formation pressure. Some formations contain highly permeable zones which will accept large quantities of the drilling fluid and result in "lost circulation". As the drilling fluid is lost to the formation, the height of the column will fall and a point may be reached where another formation will release formation fluid to the well bore.

When gas, or any formation fluid that is lighter than the drilling fluid, is allowed to enter the well bore, the weight per volume of the drilling fluid is decreased. The effect is cumulative; as formation fluid enters the well bore, the weight of the drilling fluid decreases, thus allowing a continually increasing rate of formation fluid entry. Figure II.H.3.a.iv-1 illustrates this process.

If formation fluid enters the well bore and a surface indication of some influx of formation fluid is observed, such an occurrence is called a kick. When even a slight kick occurs, the operator uses the precautionary measure of circulating out through the choke with the blowout preventers closed.

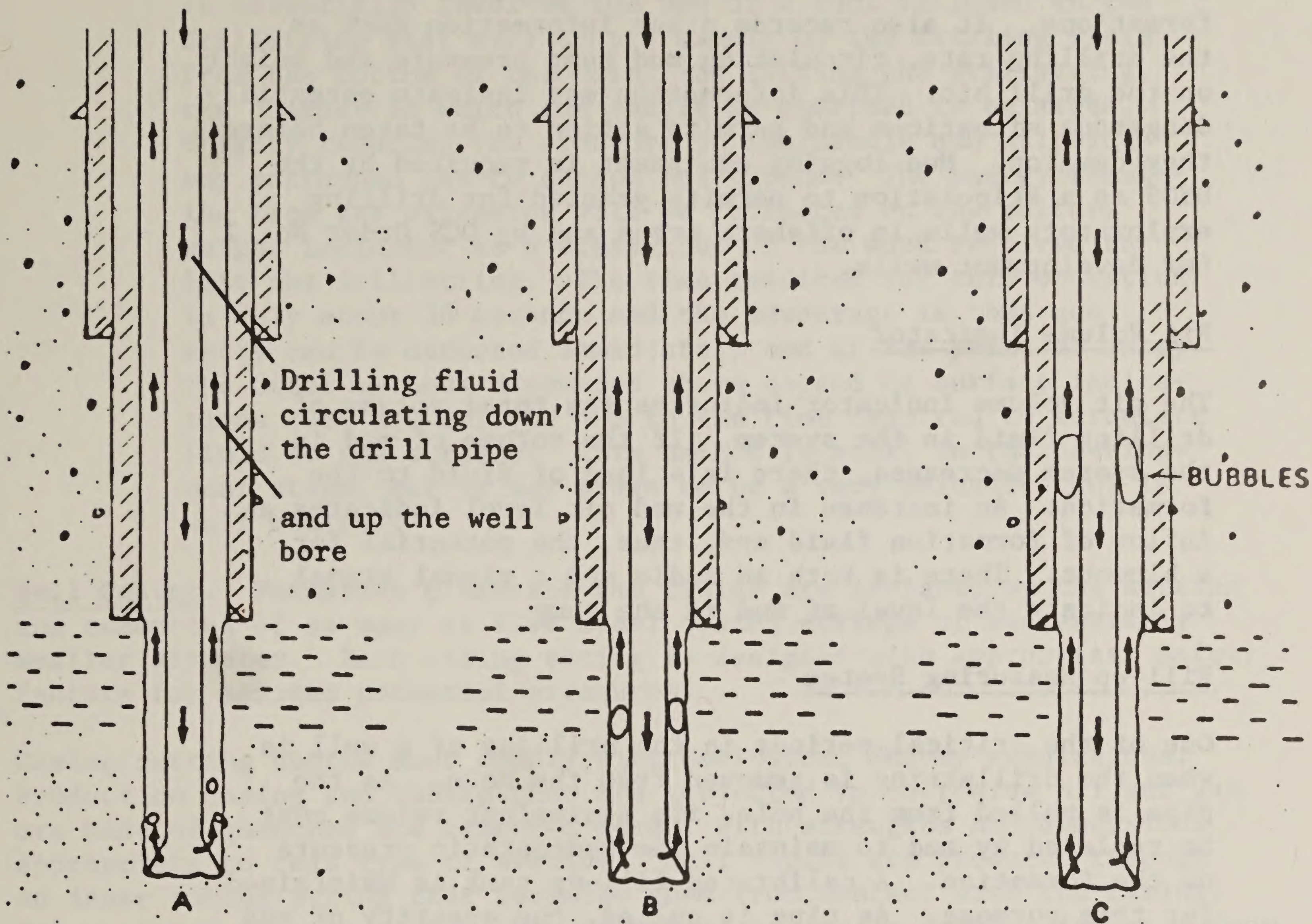
Several methods are employed to ensure that the weight of the drilling fluid column is sufficient to control formation pressures and yet not so high as to risk lost circulation:

(a) Mud Program: The mud program is a very important part of the drilling program and is based on all available information on the area to be drilled. Mud weights are specified at the various depths to be drilled and changeover points are indicated where high pressure or loss-of-circulation zones can be expected. Naturally, in development drilling this program can be very detailed and based on known information. In exploratory drilling, the program must be based on general knowledge, inference, and experience. As an exploratory well is drilled, the mud program is adjusted to fit conditions as they are encountered. Mud programs are reviewed and approved by the USGS.

(b) Mud Monitoring and Control

<u>The Mud Engineer</u>

The drilling fluid (mud) engineer makes periodic mud property tests and prescribes the treatment required to obtain or maintain the desired properties.



A "kick" is a gas or liquid influx that reduces the hydrostatic head in the annulus. Here, the kick is a gas bubble (A). As it rises (B and C), it expands.

(Adopted from Panel on Operational Safety in Offshore Resource Development, "Outer Continental Shelf Resource Development Safety", Marine Board of National Academy of Engineering, December, 1972).

Figure II.H.3.a.iv-1 Gas Influx

Mud Logging Equipment

This equipment continuously monitors the mud system, recording mud properties, the presence of oil or gas in the mud system, and the lithologic properties of the formations. It also records other information such as the drilling rate, circulating mud pump pressure and weight on the drill bit. This information may indicate potentialy dangerous situations and permits action to be taken before they develop. Mud logging equipment is required by the USGS as a stipulation to permits granted for drilling exploratory wells in offshore areas and by OCS Order No. 2 for development wells.

Pit Volume Indicator

The pit volume indicator indicates the total volume of drilling fluid in the system. If the volume of mud in the system decreases, there is a loss of fluid to the formation. An increase in the mud pit level indicates an inflow of formation fluid and, thus, the potential for a blowout. There is both an audio and a visual signal to indicate the level of mud in the sump.

Fill-up Measuring System

One of the critical periods in the drilling of a well is when the drillstring is removed from the hole. As the pipe is pulled from the hole, its equivalent volume must be replaced by mud to maintain the hydrostatic pressure on the formation. A calibrated fill-up tank is maintained for this purpose. As pipe is pulled, the quantity of mud required to replace its volume is metered. Any difference between pipe volume and replacement mud volume will indicate a potential hazardous situation.

Mud Degasser

Gas may enter the mud system as discussed above, or merely from from the gas contained in the pores of the formation being crushed by the bit. The mud viscosity may prevent the release of small gas bubbles and thus there is a possibility of a continuing decrease in the mud weight per volume. A mud degasser is included in the mud system to remove any entrained gas from the mud before it returns to the mud pit. This prevents continued lightening of the mud and also prevents any hazardous gas buildup at the mud pit.

Down-Hole Gas Influx Indicator

A new method of indicating gas entry into the well-bore during drilling presently is being developed and tested. It essentially involves the use of a tool included in the drillstring that will trap a sample of the drilling fluid from the bottom of the hole. By lifting the drillstring, the chamber in which the sample is confined is enlarged, thereby reducing the pressure on the sample and allowing any entrapped gas to escape and expand. The energy resulting from gas expansion will be reflected on the surface weight indicator as a diminution of the work required to lift the drillstring. The time required for this operation is only about 30 seconds and the advantage is that gas entry can be detected immediately and at the point of entry. The other methods discussed above depend on surface indications that are delayed due to the time required to circulate fluid to the surface. This method is still in the development stage, but it may prove to be a very valuable tool in well control.

Well Casing. Formation pressures and fluids are isolated by the setting and cementing of as many as five steel casing strings of successively smaller diameter. Each casing string is designed with appropriate safety factors for maximum potential pressures.

Casing setting depths must comply with Geological Survey regulations. Production casing and tubing that are subjected to corrosive oil and gas are made of quenched and tempered steel, with strengths and dimensions appropriate to this type of service. Well fluids are produced through an inner tubing string that isolates them from contact with the casing. In completed flowing wells, the production casing is further isolated from wellbore fluids and pressures by an annulus packer.

Blowout Preventer Equipment. The blowout preventer installation is an emergency tool designed to be used in the event the primary means of well control, the drilling fluid, fails to control the well. It can be described as a large valve assembly attached to the top of the casing. In the event of an uncontrolled blow from the well, these valves can be closed to contain the blow. All drilling functions are conducted through the blowout preventers and the series of valves contained in the blowout assembly are designed to close in the well regardless of the operations being conducted.

Some of the valves are full closing, that is, they will shut in the well completely. Others will seal around any pipe in the hole and thereby close in the annular well space. One valve, called a shear blind ram, is designed so that it will shear through any pipe in the hole and close in the well.

The upper valve in the stack, an annular type, is designed to allow stripping operations. That is, pipe can be run or pulled through the valve while it is under pressure. In this way, circulation can be regained through the use of the pipe in the hole and the kill and choke lines.

The present USGS regulations require a minimum of four remotely controlled, hydraulically operated blowout preventers including at least one equipped with pipe rams, one with blind rams, and one bag (annular) type. In practice, subsea BOP's generally exceed this minimum and may consist of at least four ram types and one or two annular types.

The valves in the blowout preventer assembly are hydraulically operated and can be controlled from two or more locations and by alternate control systems. At least one of the component valves, usually the lower annular type preventer, is designed to close automatically if control pressure is lost.

The control fluid accumulator, or reservoir, is usually installed near the blowout preventer assembly, or stack, to provide minimum reaction time. In the case of offshore drilling from a floating vessel, the accumulator may be underwater or it may be on the surface vessel. Side outlets are provided in the blowout preventer body to permit circulation in case it is necessary to shut the preventers.

USGS regulations specify the minimum frequency of testing blowout prevention equipment as well as the testing range. These regulations also require crew training in the operation of this equipment.

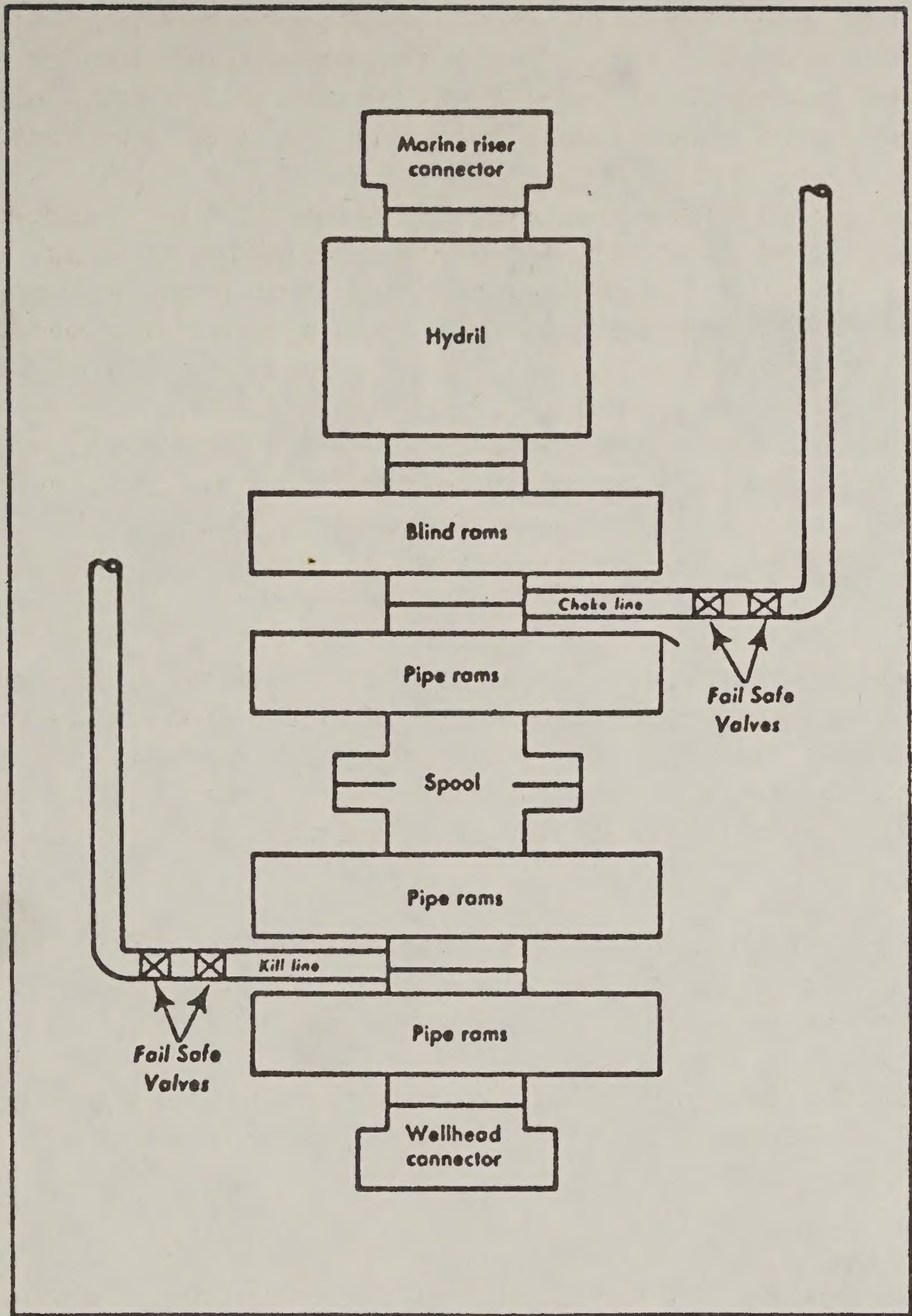
Figure II.H.3.a.iv-2 is a stylized version of a typical subsea BOP stack while Figure II.H.3.a.iv-3 shows one of the largest and heaviest assemblies in use at present.

Additional Control Methods. Drill pipe safety devices are maintained in the drill string and on the derrick floor in conformance with USGS regulations.

(a) Full-Opening Drill String Safety Valve: This is maintained in the open position on the derrick floor for installation on the drill pipe to contain any unexpected flow from the well.

(b) Socket Type, Sealed Coupling with Full-Opening Safety Valve: This is also maintained on the derrick floor for situations where the well status prevents the use of a safety valve screwed on the drill pipe threads. The socket type, sealed coupling is capable of being dropped over exposed drill pipe and sealed.

(c) Back-Pressure Valve: A back pressure valve is maintained on the derrick floor for installation after the safety valve is installed. This



L. M. Harris, *An Introduction to Deepwater Floating Drilling Operations* (Tulsa: Petroleum Publishing Co., 1972, p. 99. Used by permission.)

Figure II.H.3.a.iv-2 Stylized Subsea BOP Stack

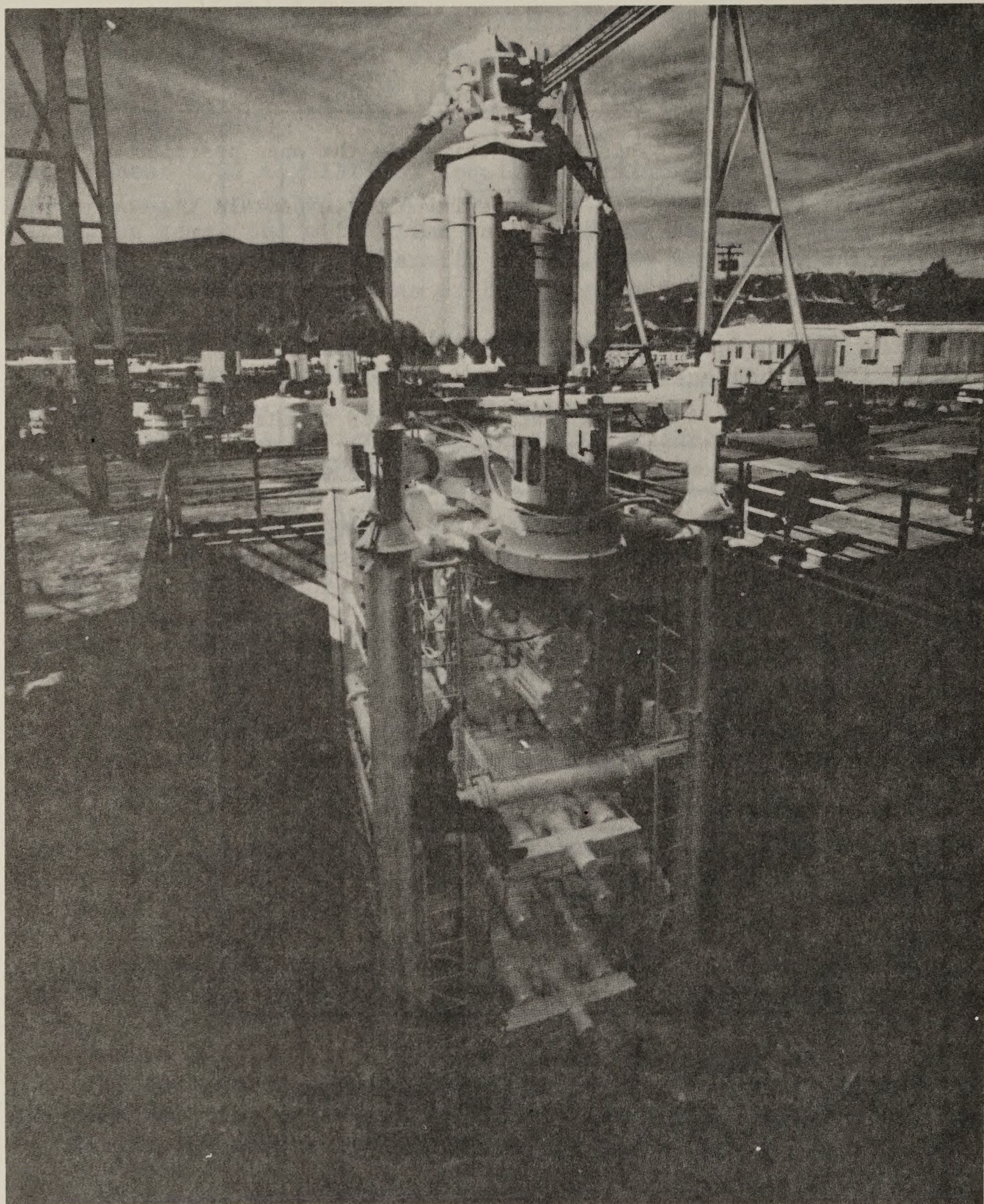


Figure II.H.3.a.iv-3 Subsea BOP Stack
Assembly consists of, from the bottom:

(1) Wellhead Connector
(2) Triple Ram Preventer Unit
(3) Double Ram Preventer Unit
(4) Bag Type Preventer Unit
(5) Ball Flex Joint
(6) Marine Riser Connector

Source: VETCO Offshore, Inc.

valve prevents well bore fluids from flowing up the drill pipe, but will permit fluids to be pumped down the pipe.

(d) Kelly Cocks: Valves are installed at the top and bottom of the kelly to permit shutting off flow from the drill string while the kelly is in use. The two valves allow access regardless of the position of the kelly in regard to the rotary table. The kelly is a long steel forging which makes connection with the top joint of drill pipe in the drill string. The rotary table turns the kelly which turns the drill pipe and bit.

b. Development Drilling: Offshore development drilling has normally been conducted from fixed bottom-founded, water surface-piercing platforms similar to those depicted in Figures II.H.3.b-1 through II.H.3.b-4. If exploratory efforts are successful in proving a commercial hydrocarbon reserve, production operations are initiated by installing a platform to serve as a base for drilling development wells if water depth is less than 1,200 feet. For water depths greater than 1,200 feet, different techniques would appear more feasible. A number of wells may be directionally drilled to develop a large area from a single platform. Platforms in the Santa Barbara Channel area may contain as many as 60 wells. The five existing Santa Barbara Channel OCS platforms are designed for 50 to 60 wells. Presently, 30 to 50 wells have been drilled from each platform.

Platforms have been installed in the Gulf of Mexico in water depths to 373 feet, and Shell Oil Company has let contracts to build two jacket-type platforms for installation in 1,000-foot waters in the Gulf of Mexico. Industry experts state that the technical capability presently exists to extend platform operations to about 1,200 feet. Platforms are now being fabricated for installation in the North Sea in water depths to 505 feet and a platform has been installed in 850 feet of water in the Santa Ynez Unit in the Santa Barbara Channel.

Development drilling could also be conducted from floating vessels or from mobile jack-up barges with wells completed on the ocean floor as discussed in Section II.H.3.a.

i. Platform Fabrication and Installation: In shallow waters, platforms are usually constructed by driving piling (wood, steel, or concrete) to resistance in the ocean floor. The platform proper is then constructed on the piling, or prefabricated on shore and installed on the piling.

In deeper waters the platform is prefabricated on shore, floated or barged to the location and sunk in place. Platforms may be constructed of steel or concrete. Several different basic designs have been developed, some are fastened to the sea floor by piling driven through templates on the platform proper (Figure II.H.3.b-2), or through the legs (Figure II.H.3.b-3),

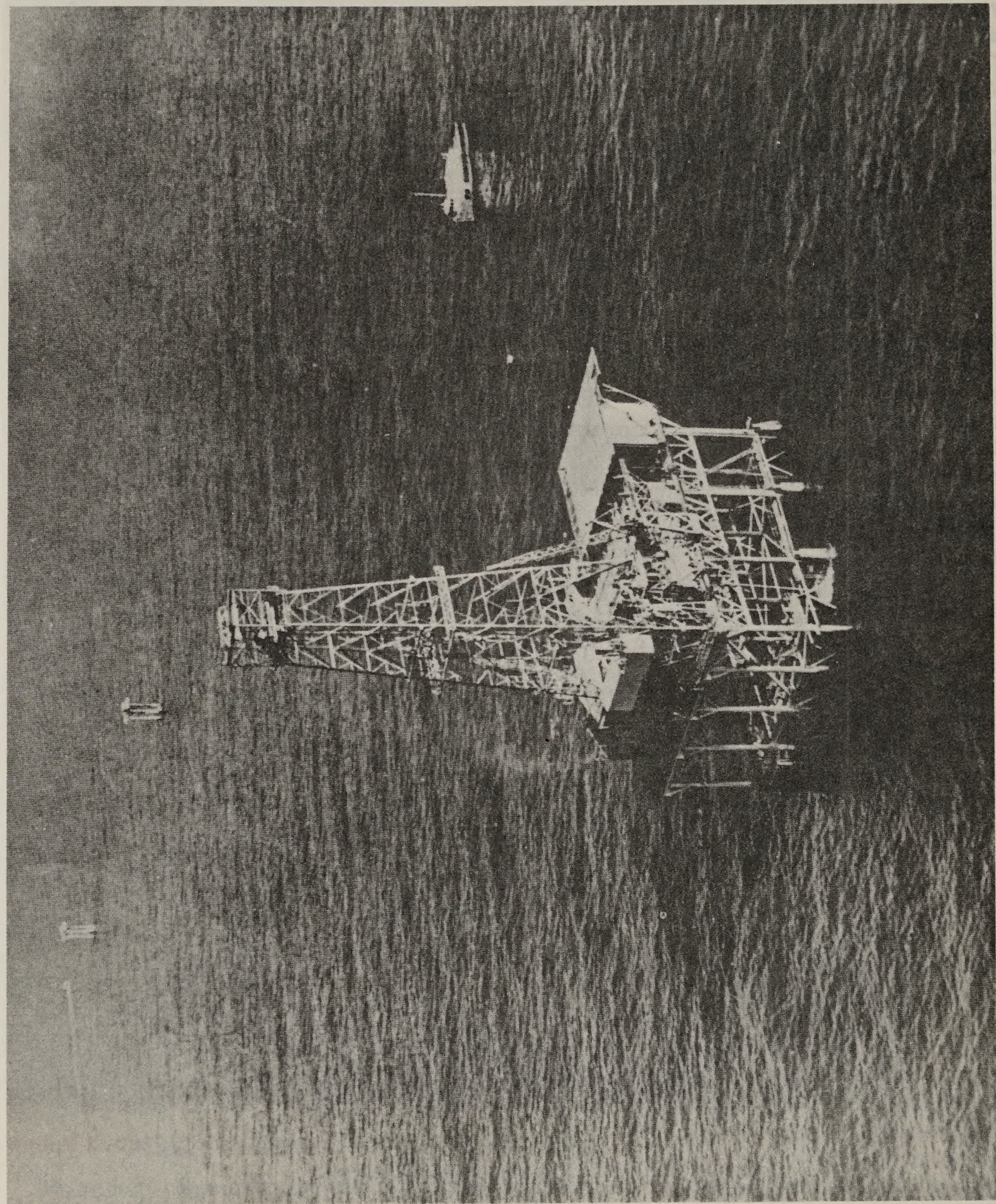


Figure II.H.3.b-1 Self-Contained Fixed Platform

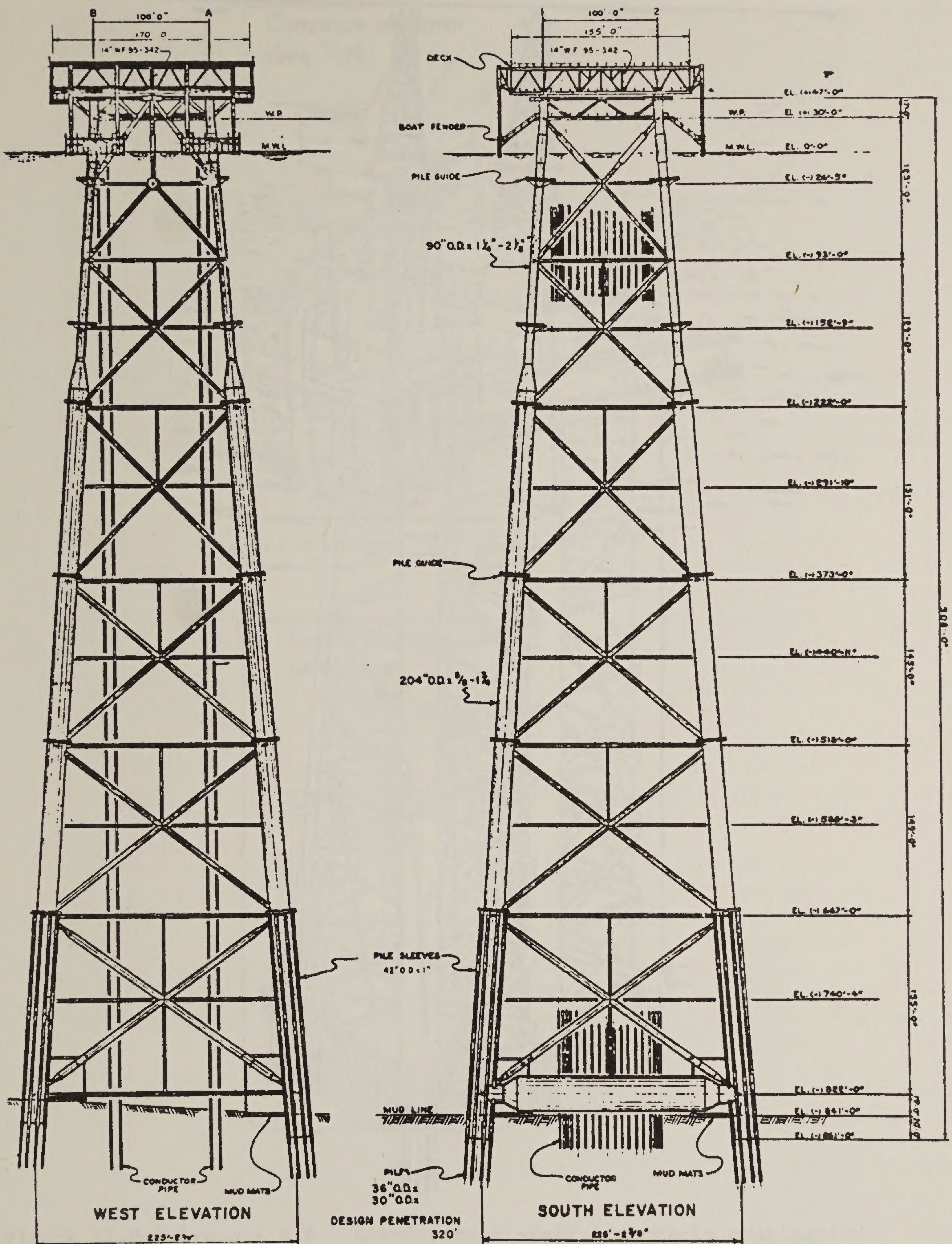


Figure II.H.3.b-2 Template Platform

Source: Exxon Company, U.S.A., 1971 Supplemental Plan of Operations, Santa Ynez Unit

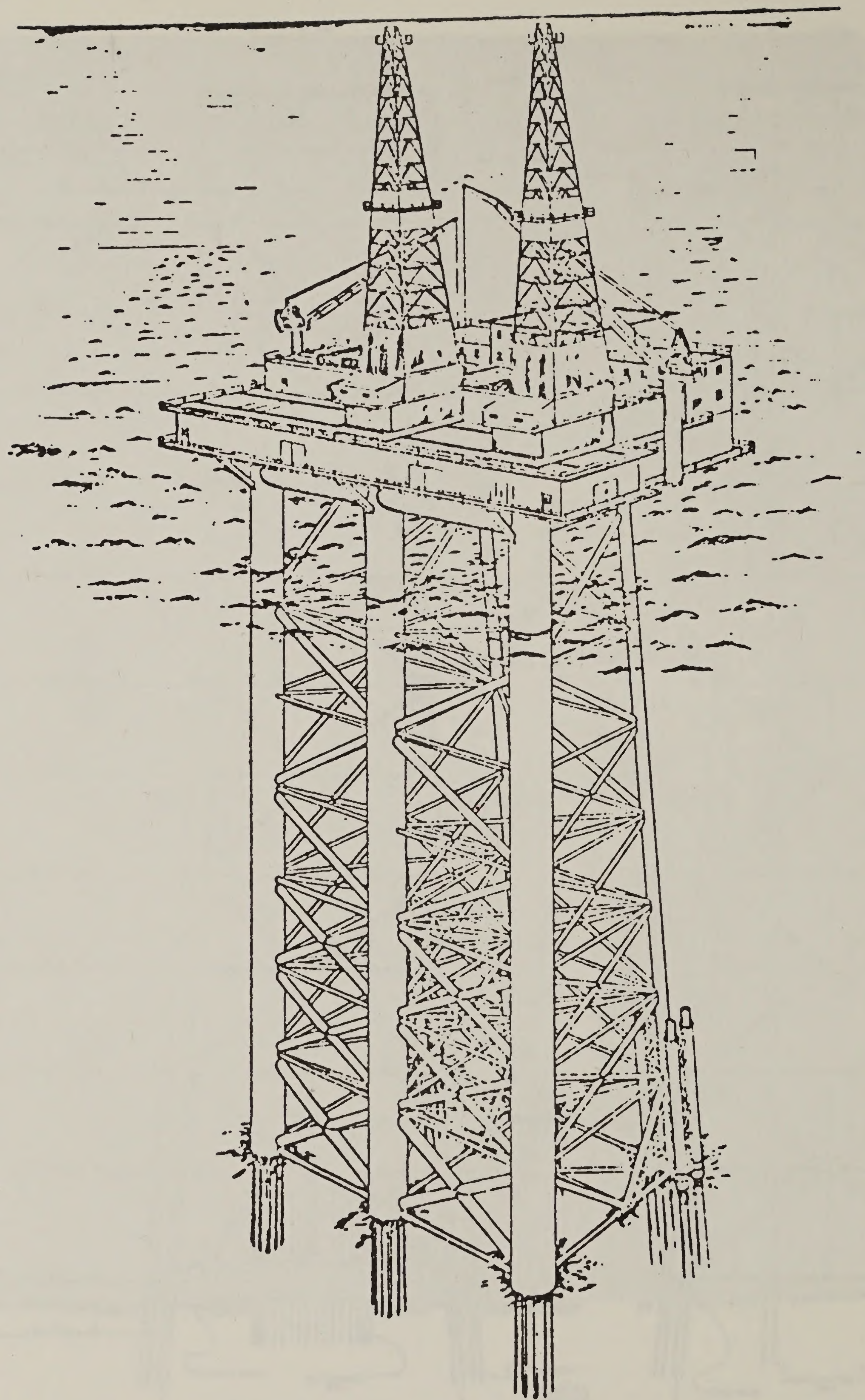
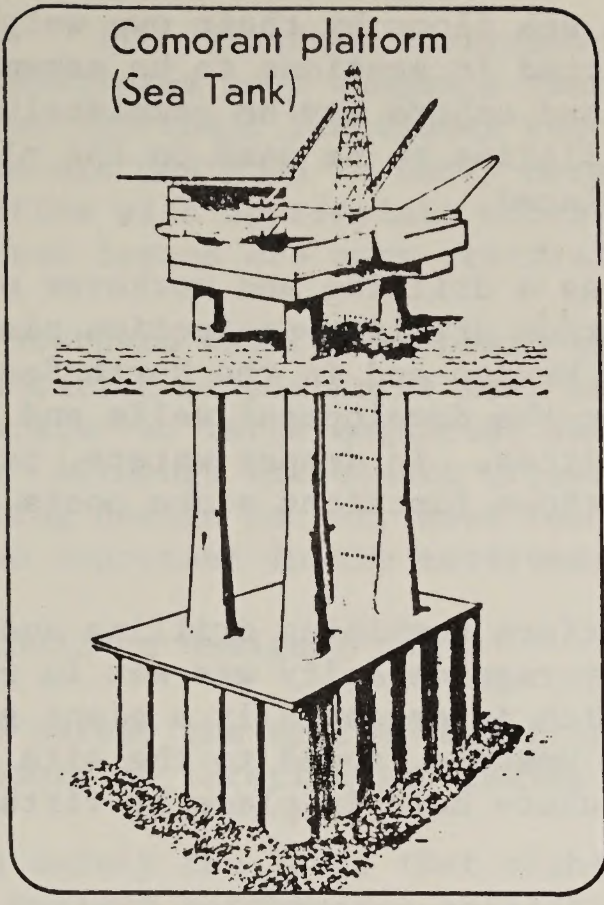
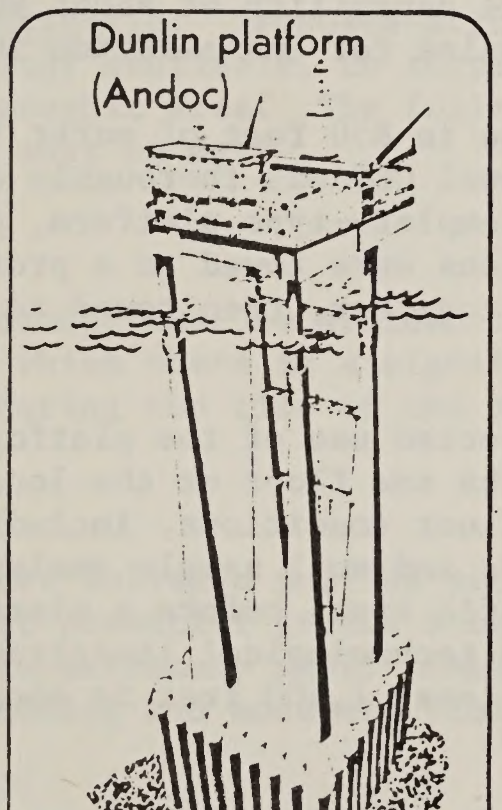


Figure II.H.3.b-3 Tower/Template Platform



A



B

Figure II.H.3.b-4 A & B - Gravity type steel & concrete combination drilling, production & storage platforms in construction for the North Sea.
From: Oil & Gas Journal, May 27, 1974, Vol. 72, No. 21, p. 34.

while others are supported on the sea floor by their own weight (Figure II.H.3.b-4). Some may be transported in sections to be assembled at the location before sinking in place and others may be completely prefabricated onshore. Equipment and facilities to be used on the platform are installed after the platform is placed.

Platforms may be designed purely as a drilling and workover platform or they may be designed as a combination drilling-production platform. Many of the fields in the Gulf of Mexico and in the North Sea are developed using a drilling platform for the development wells and a satellite platform for the production facilities. In deeper waters, particularly, the trend is toward combining platform functions since costs increase greatly with depth.

Recently, in the North Sea, a platform combining drilling and production functions with a 900,000 barrel storage capacity was set in place in the Ekofisk field. This platform, which is essentially a giant group of concrete tanks, was prefabricated onshore, towed to the site and sunk in place. It is a gravity-type structure held in place by virtue of its geometry and weight.

The platforms shown in Figure II.H.3.b-4 are also gravity-type structures and are being constructed for installation in the North Sea in waters about 500 feet deep. Each platform is similar in size and construction methods and each will have a storage capability of about 900,000 barrels of oil in the base. They are scheduled for installation in 1976.

The Exxon platform, designed for use in 850 feet of water in the Santa Ynez Unit in the Santa Barbara Channel OCS was thoroughly discussed in the Santa Ynez Unit EIS. It is a template-type platform, prefabricated onshore in two sections. The sections were towed to a protected area near the installation site, joined together, then towed to the site and sunk in place.

Platform design depends on the projected use of the platform, the water depth, and the characteristics of the sea floor at the location. A thorough investigation of the sea floor conditions, including resolution, shallow penetration acoustic surveys and soil sample analyses, is required by the Oil and Gas Supervisor, Pacific Area, before a platform site and design is approved by the USGS. No technological limitation in platform installation in water depths to at least 1,200 feet is apparent at this time, according to industry experts.

Platform construction and installation would probably require from six to eighteen months, depending on the design. A probable prefabrication site for platforms in the Santa Barbara Channel would be in the Los Angeles Harbor area, a center of heavy industrial activity.

ii. Platform Environmental Design Criteria: To insure that OCS platforms have adequate resistance to environmental forces and can fulfill their functional requirements, the structures and their foundations are designed to carry normal gravity and operating loads in conjunction with appropriate storm or earthquake induced forces. The latter forces are more critical in the Sale No. 48 area.

Inasmuch as the Southern California basin is a seismically active area, the design and location of platforms must take into account the probability that moderate- to large-magnitude shocks may occur during the life of the platform. Although earthquake criteria are the most important and the controlling design factor, wave load and severe storm design criteria are also important in the environmental design criteria.

The structure should be designed to:

- Withstand safely the most severe loads that might occur during the transport to location and during installation,

- Withstand safely the loads that might be caused by severe storm waves or maximum earthquakes anticipated in the area, and

- Perform the functions of a drilling and/or production facility.

Earthquake Design Criteria. Proposed structures must be designed, based on the best technology available, to accommodate the seismic conditions within a given geographic area. The following general design requirements and criteria must be met:

- Criterion 1

  Structural damage must be avoided in the event of ground shaking for which there is a significant probability of occurrence during the life of the structure.

- Criterion 2

  Safety against collapse must be provided in the event of the strongest potential ground shaking (or ground shaking having an extremely small probability of occurrence); plastic straining and moderate yielding are permitted.

- Criterion 3

  The structure must have sufficient ductility to undergo plastic straining without loss of structural integrity. (This condition insures ductile behavior well into the yielding range).

Geological Survey regulations are presently being revised and will contain more specific design criteria guidelines and requirements.

Existing and presently proposed platforms on Federal leases in the Sale No. 48 area have all been designed in accordance with the best technology for seismic design and structural analysis available, at the time of their initiation. In view of the continuing developments in the fields of earthquake seismology and seismic design, and the need to establish platform criteria in other areas of concern, the USGS is concluding negotiations and arrangements for the first step in establishing a system of third-party certification of platform design and for the development of various design criteria for OCS platforms. In essence, the system is to be patterned after the present British system now employed for the North Sea.

In addition to the design criteria, the location site is carefully investigated to ensure that potentially hazardous areas (areas with recently active faults, potential slide zones, incompetent bottom soil conditions, etc.) are avoided.

Storm Design Criteria. Structural member stresses must remain within American Institute of Steel Construction (AISC) allowables for severe storms that have significant probability of occurrence during the life of the structure. For this criterion, AISC allowables are derived from Specifications for the Design, Fabrication and Erection of Structural Steel for Buildings, Seventh Editon, 1970.

Repetitive stresses arising from all storms occurring in the life of the structure must be sufficiently small as to preclude undesirable effects on the structure.

(a) Severe Storm: Standard engineering practices have led to platform designs for severe storms that have a probability of occurrence of one percent per year (a 100-year storm). This criterion was used for five existing OCS platforms in the Santa Barbara Channel and is presently acceptable storm design criteria. However, for the Santa Ynez Unit platform, a severe storm crest elevation having a probability of exceedance of one-fourth of one percent per year (400-year storm) was used for analysis purposes. In designing this 850-foot water depth platform to meet desired earthquake criteria, it coincidentally met essentially all requirements for the 400-year storm.

The severe analysis crest elevation (400-year event) is derived from oceanographic analyses of historical meteorological data and statical treatment of these data. The resulting severe analysis conditions are as follows:

- Crest elevation above storm mean water level 28 ft. (wave height, crest to trough, 44 ft.)

- Storm tide, eight feet

- Storm wind velocity, 100 mph.

Oceanographic studies of meteorological data were performed by Oceanographic Services, Inc. (OSI). A copy of this report "Storm Wave Study, Santa Barbara Channel", is contained in the Santa Ynez Unit Operator's Supplemental Plan of Operations which was submitted to the Geological Survey for approval. This study includes a hindcast of the ten storms generating the most severe sea state at each of five locations in the Santa Barbara Channel for a historical period covering the years 1899 to 1968. Standard procedures are employed to derive the extreme crest elevation.

(b) High-Cycle Repetitive Storm Stresses: Calculation of repetitive stresses from all storms to which a platform may be exposed during its lifetime requires integration of storm effects continuously with time. To make this integration practical, all sea states expected at a platform location, either frequently or as an extremely rare event, are classified into eight conditions of sea amplitude and dominant period.

Other Design Conditions. During the 27-year history of oil operations in the Gulf of Mexico, industry has gained a good understanding of the physical forces acting on offshore platforms. Therefore, platform design is a matter of selecting the optimum geometry and sizing structure members with appropriate safety factors to withstand maximum anticipated natural forces and operational loads. Appropriate design procedures are outlined in American Petroleum Institute (API) Recommended Practice RP 2A and various API specifications. Those guidelines were prepared to cover engineering design and operation of offshore structures and related equipment.

(a) Gravity Loads: Gravity loads for design must include all deck loads developed by the drilling and producing operations conducted on the platform as well as the dead weight of the platform itself.

(b) Piling Design and Soil Conditions: Foundation borings and detailed geological-geophysical studies will be made in order to assure that the selection of a location where sediments in which the piling is founded will be stable under the largest eqrthquake ground shaking expected in the Santa Barbara Channel during the lifetime of the structure and to provide data for design of adequate piling for the platform.

(c) Transportation and Installation: Platforms are designed to withstand the most severe loads that might occur during transportation and installation, and to have adequate stability. The design requirements insure structural integrity under dynamic wave loads that might occur during transportation, and under impact loads that might occur during either transportation or installation. Stability requirements insure safety under tow and during installation.

(d) Corrosion Control: Platforms are protected from corrosion by coatings above mean water level and by cathodic protection below mean water level.

(i) Protective Coating: The protective coating system used is an established concept and employs only standard materials used in accordance with conventional corrosion protection practices. It has been used successfully for over ten years in the Gulf of Mexico. Examples of protective coatings are used.

Galvanizing - applied to all hardware, fencing, handrails, and grating.

Sheathing - synthetic rubber and monel sheathing is applied to all members in the wave zone between ELEV (-) 8'-0" and ELEV (+) 16'-0".

Painting - a 5-coat, 14-mil epoxy or vinyl system is applied to all surface areas above mean water level not protected by galvanizing or sheathing.

(ii) Cathodic Protection: The cathodic protection system employs standard materials used in accordance with conventional engineering practices. The system is a galvanic anode system that will provide 10 ma/sq. ft. of current density for surfaces in the water zone and 4 ma/sq. ft. current density for surfaces in the mud zone for approximately 20 years. Provision can be made to switch to an impressed current system for the remainder of platform life after depletion of the galvanic system.

(e) Specifications: In accepted engineering practice, various well-established specifications, codes and standards are incorporated into platform specifications in whole or in part, as applicable. Some examples of these specifications are listed below.

American Institute of Steel Construction (AISC): Code of Standard Practice for Steel Building and Bridges. Specification for the Design, Fabrication, and Erection of Structural Steel for Buildings.

American Society for Testing and Materials (ASTM).

American Welding Society (AWS).

American Petroleum Institute (API).

Steel Structures Painting Council (SSPC).

U.S. Standards Institute (USSI).

(f) Platform Removal: Platform structures are designed to be removed at the end of their useful life. The platform wells would be plugged and abandoned, well conductors would be cut below the mudline and removed, and deck units and production equipment would be dismantled and removed. The platform pilings would then be cut below the mudline and the jacket refloated and removed.

(g) Beautification: Beautification studies have shown that under some conditions structures may be screened by the use of painted pattern designs that change their silhouette or by water spray techniques that reduce their visibility. However, the U.S. Coast Guard has expressed concern that camouflage techniques could increase the hazards to navigation. Since this is a prime consideration in platform location and design any such proposals would require very careful consideration.

c. Production Facilities: Generally, production facilities are considered to mean the equipment used to bring production to the surface, deliver it to a separation facility, and to separate the production into its component parts (oil, gas, and water).

i. Producing to the Surface

Natural Flow Wells. Most wells in their initial completion stage will flow naturally to the surface. The reservoir pressure is sufficiently high to support the column of reservoir fluid in the production tubing and deliver it to the surface.

Gas Lift Wells. When reservoir pressures are insufficient to life production to the surface, gas may be injected under pressure down the casing. A series of valves is located down the tubing string with each valve designed to open at a different pressure. As the gas enters the tubing string through a valve, the column of fluid in the tubing is lightened and the reservoir pressure is enabled to bring the fluid to the surface. Gas lift is not practical in all wells and is generally a temporary stage, being practical only so long as reservoir pressure remains relatively high.

Artificial Lift Wells. Almost all wells, at some stage in their productive lives, require artificial lift to bring production to the surface. The most common pumping method is a piston type pump run in or on the tubing and connected to the rod string run inside the tubing. The rod string is connected to the walking beam above the wellhead. Through a series of gears and levers power from a motor or engine is translated to up and down vertical motion of the walking beam. These pumping units are a common sight in most oil fields located on shore, but are not generally used for offshore production due to space limitations. Either submersible or hydraulic pumps are usually used in offshore applications. The submersible or hydraulic pump is an electrically operated rotary pump generally run on tubing, but some models can be suspended in the casing. The hydraulic pump is a piston type pump operated by hydraulic fluid pumped down the tubing or through a separate line run alongside the tubing. Either method requires little surface space and can be used in platform operations. Some models of the hydraulic pump can be placed or retrieved from the tubing string by pumping down or up the tubing and are praticularly suitable for subsea applications.

ii. Flow Lines: Flow lines are the pipelines used to deliver production from the individual wells to a separation facility. In the case of wells drilled from a common platform, flow lines are practically non-existent. Production from each well is directed to a manifold consisting of a series of valves by which the production from all wells connected to the manifold can be commingled and sent to the production separation facility, or individual well production can be separately directed to a test separation facility.

For subsea completions the flow line could run from each well on the ocean floor to a production platform, and then up a riser to the separation and test manifold. The flow lines could also run to a subsea manifold for delivery in a common line to a separation facility or the wells could be directionally drilled from a common location to produce to a subsea manifold.

iii. Separation Facilities: After production is brought to the surface, it must be separated into its component parts of oil, gas and water. The production is introduced to a pressure vessel where the pressure is reduced and gas is liberated from the crude oil. These vessels are called separators and, where wellhead pressures are sufficiently high, there may be more than one separator connected in series to permit gas separation at decreasing pressures for increased efficiency. Generally, a production station will have a production separator, or series of separators, where the production from all wells connected to the station is handled. In addition to the production separator, a test separator is available. Flow lines from all the wells connected to the station are connected to a manifold, a series of valves that allows the flow from each well to be connected to a common production line or to the test separator line. The test separator is used to gauge the production from each well periodically and determine its status.

Some separators are called three-phase separators and in addition to separating gas, also separate free water from the oil. In other cases, an additional pressure vessel called a free-water knockout is included in the flow pattern. These vessels have a series of chambers through which the crude oil-water mixture is directed with sufficient dwell time to permit water separation.

Often, water associated with crude oil forms an emulsion which is difficult to break down. Various methods including chemical, electrolytic, and the application of heat are used to break the emulsion and separate the water. As a rule, these separation methods are not used on offshore installations due to space limitations, and after primary separation the mixture is pumped ashore for treatment.

After separation, the gas is introduced to the gas pipeline for disposal, perhaps through compressors if necessary. Crude oil flows from the separators to a holding tank and from there is pumped to storage. The transfer pumps may be motor driven, but when gas pressures are sufficiently high they are commonly actuated by gas pressure. The gas, after use, is returned to the gas system.

Free water, if separated at the station, is treated to reduce the oil content to less than 50 ppm and sent to the water disposal line. It may be re-injected to the formation, disposed of in the sea, or piped to shore for disposal.

Present treating facilities in the Sale No. 48 area reduce the oil and grease concentration to from 5 to 25 ppm. The variation in the oil and grease concentration reported by different operators for treated produced waste water is not completely due to the treatability of the waste water or the treatment method; it is partly due to the variation in analytical sample testing methods and sample preparation procedures. The Environmental Protection Agency and the Geological Survey recognize this problem and, in the future, one analytical method and sample preparation procedure will be used by all OCS operators.

With the increasingly stringent regulations concerning waste-water disposal, in the near future, a major portion of produced water may be returned to the formation rather than discharged to the ocean. In addition to the disposal of the water, this method would also aid in maintaining reservoir pressure and, therefore, in increasing ultimate production.

As previously mentioned, production facilities may be included on the drilling platform or they may be installed on a separate, satellite platform. In either case, platform design, construction, and safety and pollution control features would be similar to those discussed under Section II.H.3.b, Development Drilling.

iv. Special Production System Safety Features: Produced fluids are controlled at the wellhead by control and safety devices including: dual master valves, a check valve, a fail-closed wing valve and a wellhead choke valve on flowing wells. Wellhead equipment is specifically designed for hydrogen sulfide service and maximum wellhead pressure. All components of the wellheads are designed to appropriate API specifications.

Tubing strings on flowing wells contain a subsurface safety valve. This valve is located at least 100 feet below the ocean floor and is designed to prevent flow from the well in the event of damage to the wellhead. These valves are surface-controlled, fail-closed safety valves that are hydraulically operated from a pressure system at the surface. A drop in hydraulic pressure, either intentional or accidental, will cause the valve to close, thereby shutting in the well.

Future subsurface safety valves will be selected on the basis of proven performances and reliability. The Geological Survey, National Academy of Engineers Marine Board, American Petroleum Institute (API) and private industry have formed various committees to improve oil and gas OCS operations.

In the report "Energy Under the Ocean: A Technology Assessment of Outer Continental Shelf Oil and Gas Operations," (University of Oklahoma Press, September 1973) the velocity-actuated subsurface valve was identified as a technological weakness. That report suggests that the replacement of these with the newer-type surface-actuated valves would resolve this problem. The following excerpt is from that report:

> Downhole Safety Devices. Although reliability data for velocity actuated downhole safety devices are limited, there are numerous indications of their inadequacy. For example, in recent major accidents in the Gulf of Mexico, 25 to 40 percent of them failed. The U.S. Geological Survey (USGS) now requires new wells to be equipped with a surface, rather than a velocity actuated, downhole safety device. However, this new requirement does not apply to wells presently producing until tubing has to be pulled for some other purpose, such as a workover, for example. This may not occur for several years, if ever. Until there is a reliable replacement for "storm chokes" that can be installed in most producing wells without pulling tubing, the "storm choke" will continue to be a problem. Therefore, the "storm choke" must be made more reliable.

It is recognized that certain Gulf Coast incidents reflect a poor subsurface safety valve performance record. However, most of these were velocity actuated valves and were in an area known for excessive sand production problems. Severe excessive sand production, as experienced in some Gulf of Mexico areas, has not been experienced in existing Southern California OCS wells. There have been some instances of sand problems in the Santa Barbara Channel, but the results have not been as severe as in the Gulf due to the difference in producing characteristics--the Channel wells generally exhibit lower volumes and pressures and, therefore, much lower velocities.

A few velocity actuated subsurface valves that were in the Santa Barbara Channel were replaced with surface controlled valves several years ago. All future Southern California OCS subsurface safety valves will be the surface controlled type as required by the Pacific Area OCS Orders of June 1, 1971. (See "OCS Order No. 5", for further discussion on subsurface valve types.)

For these reasons, increased reliance can be placed on future Southern California OCS subsurface safety valves.

Sand monitoring devices can be installed in the flow lines near the wellhead on wells that may produce sand to indicate excessive sand production and thus alert operating personnel before damage to valves, connections, etc. can occur. These devices are a thin-walled, hollow steel tube inserted into the flow line perpendicular to the direction of flow. The production of sand will cut out the thin steel wall of the probe and expose the inside of the device to the flow line pressures. The probe may be used only as a monitoring device or it can be connected to a pilot valve that will actuate a safety valve to shut the well in until corrective measures can be taken.

All connections and equipment from wellhead to the separators are designed for maximum anticipated wellhead pressures. Separators and other pressure vessels are equipped with high and low level automatic shutdown devices in case of oil surges to the gas system or gas flows to receiving tanks. All relief valves from pressure vessels are piped to a main vent scrubber and liquid from the scrubber is pumped to the receiving tanks. The receiving tanks are equipped with level control systems and vapors from these atmospheric pressure tanks is vented to a vapor recovery system to be returned to the gas system.

All well completion and production facilities must be designed pursuant to current regulations. The platform production facilities must be approved by the USGS before commencing operations. Equipment that would be used on future platforms in the Southern California area would be similar to that being used safely in current operations, and would be installed and operated in accordance with safe practices accumulated from industry experience. This experience forms the basis of USGS requirements, which give the safe practices a regulatory mandate. Requirements specify multiple, redundant controls and safety devices including safety shut-in valves, high-low pressure pilots, high-low level controls, high-temperature shutdowns, gas detectors, shielded ignitions, fire prevention and detection equipment, and pressure relief systems. Drain and sump systems are also designed to collect any spillage that might occur on the platform.

d. Subsea Production Systems: As with all wells, the production from wells completed on the ocean floor must be collected, sent to a production facility, and at some point reach the surface in order that it may be utilized.

To date, the production facilities for subsea wells are generally located on a nearby platform. In this case, the production facility, itself, and separators, etc., would be as described in Section II.H.3.c.

Since there are so many possibilities regarding subsea production systems, it is perhaps best to proceed logically from the well to the final disposition of the production.

i. Well Location: Wells can be drilled vertically from conforming to the spacing pattern of the subsea field. In this case, flow lines are required from each well to a common point. This common point may be either a surface production facility, an ocean floor production and test manifold, or, possibly, a subsea production facility.

There are two principle drawbacks in developing a field in this manner:

- There is a practical limit to the length of flow line that can effectively be considered. Depending on the production characteristics, wellhead pressure and fluid viscosity in particular, there will be a pressure drop per unit length of line. In some cases, this pressure drop could be such as to prevent production from reaching the central collecting point and certainly, as the reservoir pressure declines during the life of the field, problems will develop. With wells on artificial lift, the flow line length could be critical.

  Depending on the type of well completion, the production tree in particular, flow line lengths are critical. If the well is to be maintained by divers and/or surface vessels, the flow line length may not be too important, but where maintenance is to be carried out by pump down, through flow line (TFL) tools, the length of flow line would be important. Also, if the well is to be remotely controlled, hydraulic lines and/or electric cables may be required to actuate well controls. These would normally parallel the flow line.

  Normally, subsea wells are drilled within three miles of the central collecting point, but perhaps two miles is a more realistic limit.

- If conventionally moored vessels are used in field development, and later in field maintenance, the presence of a number of lines on the sea floor may hinder the use of anchors and increase the hazard of rupturing the lines.

Wells can be drilled directionally from a common site on the sea floor to bottom in widely-spaced locations to meet the needs of optimum field spacing. Generally, some type of base plate or template is employed to space wellheads. These templates may be elaborate and combine functions other than wellhead spacing as described in Section II.H.3.d.iv., or the templates can be simple and merely replace the temporary guide base described in Section II.H.3.a.ii.

This system is called the cluster concept for subsea completions, and the wells can be conveniently connected to a common subsea test and production manifold. In this case, only two lines carrying production are required, one to carry the total production from the cluster, and the second to carry an individual well's production to a test facility. Depending on the field development plan, additional lines to handle well and manifold control functions may also parallel the flow lines.

ii. Well Completion: Down hole completion procedures for subsea wells are carried on through the riser pipe and the blowout preventor stack. After tubing is hung and plugged, the BOP stack is removed and the wellhead is set and connected in place.

Wellhead equipment for subsea wells is functionally similar to the equipment described for platform wells and inculdes all the safety devices previously described. The control equipment is necessarily modified in accordance with the type of basic control design - that is, diver operated, remote control from the surface, control at atmospheric pressure in encapsulated wellheads, etc.

<u>Diver Manipulated Production Tree</u>. In the simplest form, the subsea production tree can be the same as those used on land. The tree is installed by divers and manipulation of well controls would also require divers.

Figure II.H.3.d.ii-1 shows a somewhat more sophisticated tree designed for subsea use. The tree is installed by divers who must also make up the flow line connections. The tree valves are controlled hydraulically from a remote point through hydraulic control lines. Four trees of this type were installed by Phillips Petroleum Company in the El Molino Field in the Santa Barbara Channel in 1963 in 200 feet of water.

<u>Diver Depth Capability</u>. The problem with diver operated subsea systems is the diver depth capability. As of June, 1974, working dives were routinely carried out in water depths to 600 feet and they had been

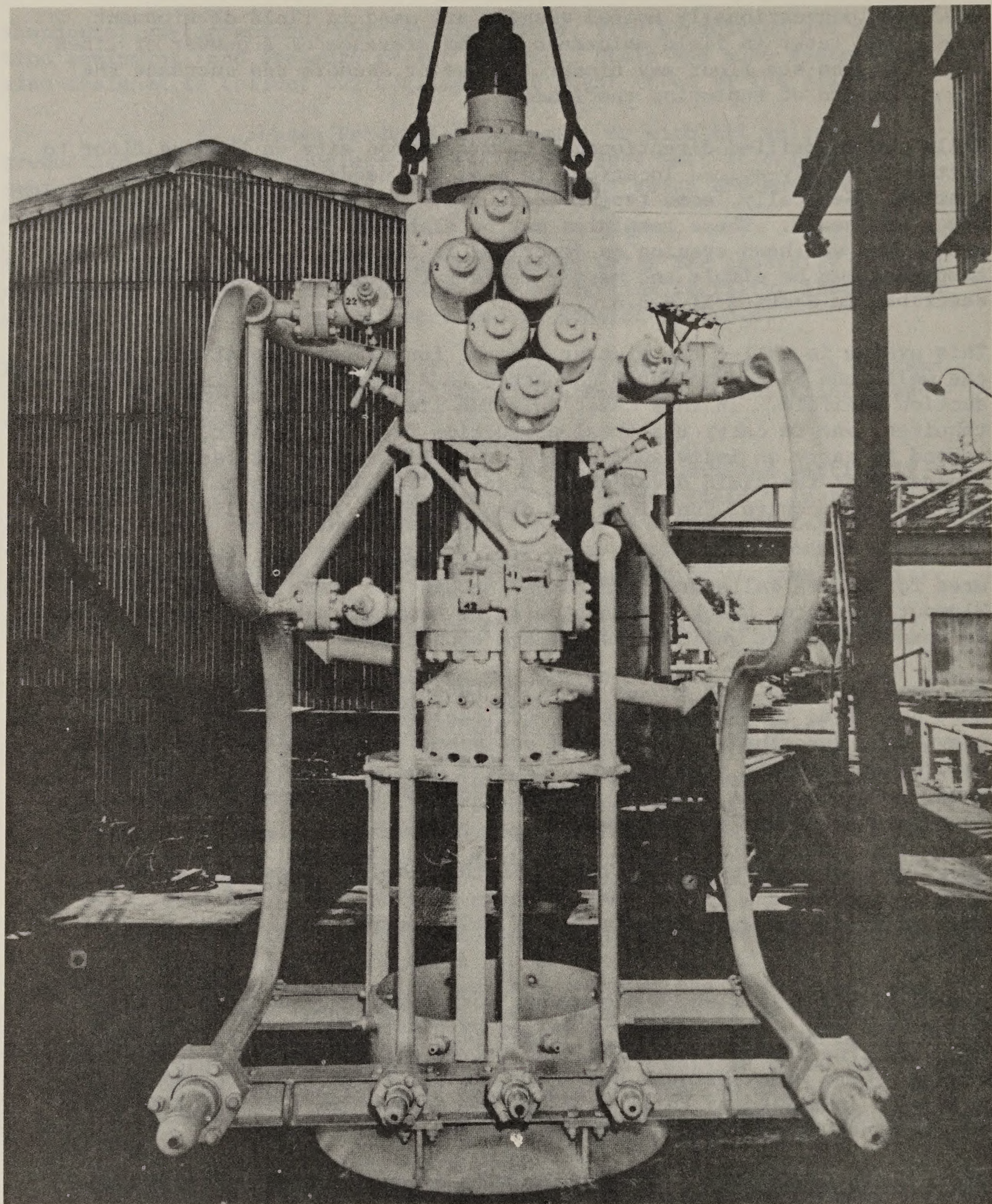


Figure II.G.3.d.ii-1 Diver Installed and Operated Subsea Tree

Source: Vetco Offshore, Inc.

carried out in depths of 840 feet.[a] The U.S. Navy has, however, conducted working dives on an experimental basis to depths of 1,010 feet off San Clemente Island, California, and experimental saturation chamber dives have been conducted to a simulated depth of 2,000 feet. The diving industry's depth capabilities have advanced rapidly over the past decade with the advent of saturation diving and through government and industry research and experimentation in the areas of breathing mixtures and diving physiology. Industry experts stated that working dives were feasible to 1,000 feet, at state-of-the-art in June, 1974.

To reflect the rapid advancement of deep water diving technology, two deep dives in June, 1975, pushed the frontiers of diving beyond the 1,000-foot mark and have proven the technology exists for man to perform useful work in such water depths. The first dive was conducted by Comex, France, off Canada and the second series of dives was conducted by a joint project of the U.S. and Royal British Navies off Florida. The two dives are described in the following excerpts from Offshore Magazine (August, 1975, Vol. 35, No. 9).

- Comex Dive. Comex carried out the world's deepest commercial saturation dive early in June, 1975, working from the drilling vessel, HANDRILL, Offshore Labrador, Canada for a consortium headed by British Petroleum Canada. The dive, to a water depth of 1,069 feet, was for the purpose of recovering a blowout preventer stack and a control assembly that were left on the ocean floor by the HANDRILL during the previous season. Six divers (two teams of three divers each) were pressurized over a period of 24-hours to their living depth of 1,004 feet. Three of the divers descended to the stack in 1,069 feet of water and surveyed it by closed circuit TV both inside and outside of the diving bell. The diving bell was on the bottom for a total of four hours, during which two of the divers each spent an hour working out of the bell. Their work included the removal of debris from the control assembly, disconnection of broken hydraulic hoses, reconnection of new hydraulic hoses, pressuring up of the control assembly and mechanical locking of the indicator pins.

The following morning, the other three divers went back down to the stack with slings which were attached to the control assembly and was then successfully recovered to the surface. The water temperature was 0° centigrade and the sea conditions were calm. The divers worked easily and were relaxed with respiration rates in the water between 10 and 15 per minute. The recovery operation was carried out in less than the scheduled time and clients, BP Canada, Chevron and Columbia Oil & Gas, were pleased with the operation. More time could have been spent working at this depth, but there was nothing left for the divers to do. The divers underwent

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[a]See the discussion immediately following this paragraph for a recent extension of diver depth capabilities.

139.5 hours of decompression after the dive. Comex uses a basic rule of 1 day decompression per 150 feet of dive. The company indicates that this operation represents a milestone in the history of commercial diving. It has pushed the frontiers beyond the 1,000 foot mark and has proven that the technology exists and that men are capable of doing useful, hard work deeper than 1,000 feet of water. Comex says it seems certain that in the near future men will be successfully working commercially in the sea at 1,500 feet of water. Comex also says that it is going to conduct an experimental dive before the end of the year to 1,450 feet. That dive will be conducted in one of the fjords offshore Norway.

- U.S. Navy and British Navy Dive. Also in June, in the Gulf of Mexico, a team of U.S. Navy and British Navy divers completed a dive to 1,148 feet. The dive took place about 80 miles southwest of Panama City, Florida, in the open sea.

Operating out of the Mark I Deep Diving System installed on board the diving tender YDT-16, the dive was conducted on June 3-6. Significant was the fact that three divers eclipsed the previous depth record of 1,010 feet on the same day, proving that man is capable of working at great ocean depth. In the deep dive system for 15 days, the divers spent close to 11 days in decompression. The divers began their deep saturation dive leaving the surface by way of the deck chambers to carry on multilevel dives to the 1,000 foot level. The personnel transfer capsule (PTC) was launched from the YDT to carry out open sea dives to 1,000 feet. A diver swam out of the PTC diving bell at a depth of 1,030 feet, thus passing the previous deepest U.S. Navy open sea dive of 1,010 feet. The same day, the PTC hatches were closed and the PTC recovered. Again that day, the PTC entered the water. On reaching 1,000 feet, the PTC was pressurized and lowered to 1,130 feet. Pressure between the hatches was equalized and hatch seals broken. A diver entered the water and reported that in the glare of the 200-watt light he could see bottom about 20 feet below him. Another diver entered the water and checked his breathing rig with topside control and descended to the bottom. Depth was checked on the pressure gauge and a reading of 1,148 feet was logged, representing the deepest dive yet. The previous depth record was bettered three times by the three divers on this mission, on the same day.

Remote Controlled, Hydraulically Manipulated Tree. Figure II.H.3.d.ii-2 shows a later tree than that discussed in Section II.H.3.d.ii. This tree is installed without diver assistance using the same techniques as those used to make up blowout preventer and riser pipe connections during drilling. All valves are controlled hydraulically, or electro-hydraulically where distance attenuates hydraulic response time, from a remote control point. All valves are also of the fail-to-close type, which means they will automatically shut in the well should loss of hydraulic pressure occur. Flow line connections can also be made from the surface. Four of these trees are installed in 230 feet of water in the Ekofisk field in the North Sea operated by Phillips Petroleum Company.

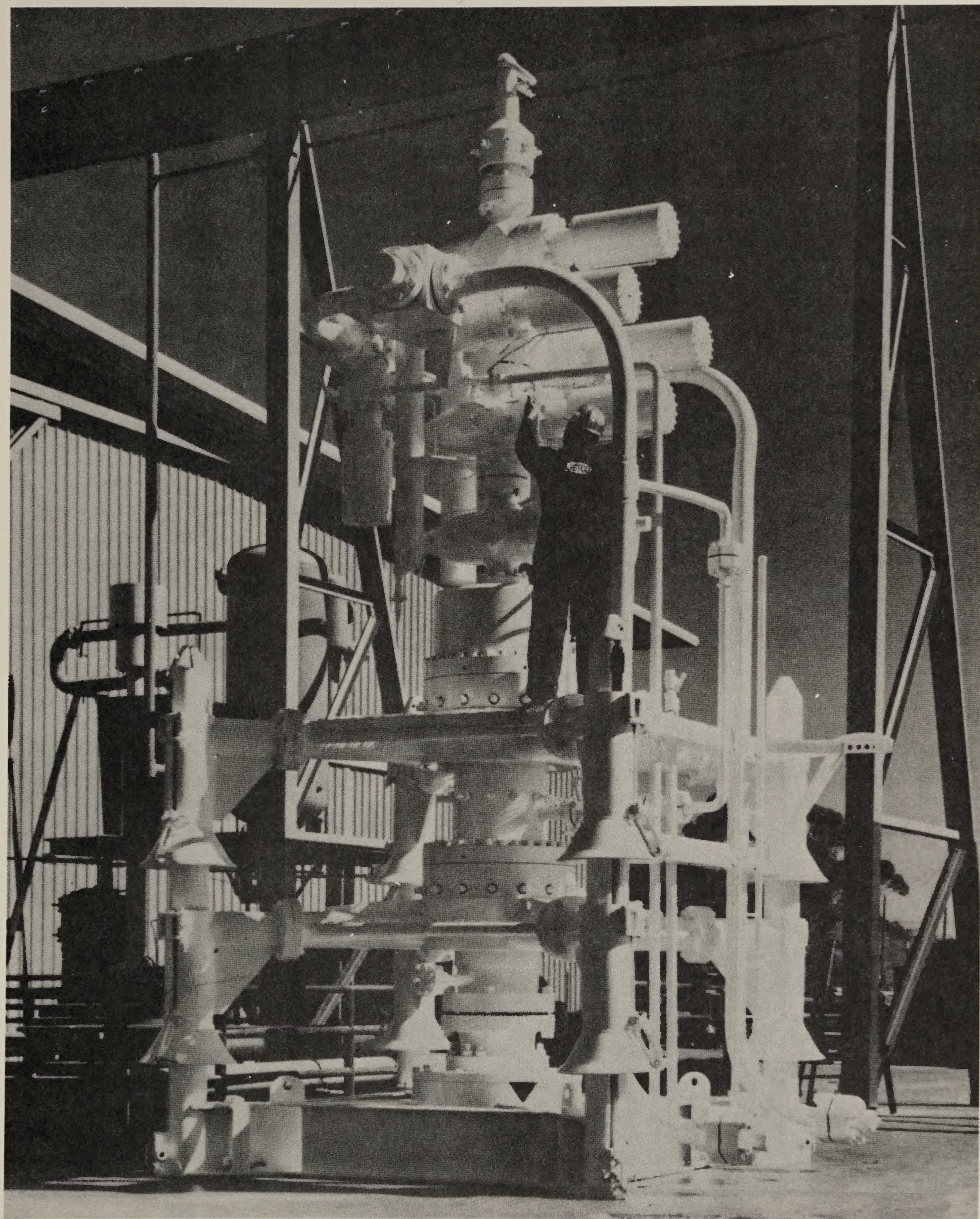


Figure II.H.3.d.ii-2 Tree designed for use in Ekofisk field (North Sea) by Phillips Petroleum Company. All valves are remotely controlled.

Source: VETCO Offshore, Inc.

The particular trees depicted in Figures II.H.3.d.ii-1 and II.H.3.d.ii-2 do not include facilities for through flow line (TFL) tools, but this is incorporated in the tree shown in Figure II.H.3.d.ii-3.

Encapsulated Trees. An encapsulated tree is a conventional tree installed in a chamber that is maintained at atmospheric pressure and includes a means of access from a personnel vehicle. The personnel vehicle can be considered a diving bell with means of connection to the subsea chamber over the wellhead. In this manner, non-diving technical personnel have access to the wellhead controls and can perform all of the functions possible on a land well, including wire-line work.

Several systems have been developed, and they are discussed more fully in Section II.H.3.d. One of these, the Lockheed system, was installed by Shell Oil Company in the Gulf of Mexico in September, 1972 in 375 feet of water. In 1975 the well was successfully re-entered for routine maintenance.

This concept can be expanded to include a complete production system as discussed in Section II.H.3.d. The advantage, of course, is that well work can be performed at surface conditions (atmospheric pressure) and that the work can be done using conventional oil field tools and techniques with no reliance on sophisticated remote control techniques. These systems are presently viable to at least 1,500 feet and even greater depths can be anticipated in the future.

iii. Subsea Manifold: A subsea manifold would perform the same function as a manifold on a surface production installation. The purpose of this series of valves is to collect the production from several wells and combine it to a single stream for delivery to a separation facility. There must also be a means of segregating individual well production for metering and testing. This is accomplished by the series of valves included in the manifold.

The manifold, which can be operated hydraulically or electro-hydraulically from a remote control point can be "wet" or it can be encapsulated. These systems are described in Section II.H.3.d. The value of such a system is to permit a cluster of subsea wells and avoid the number of flow lines required if wells were widely spaced.

iv. Subsea Production Facilities: The ideal, from an aesthetic point of view, would be for an offshore oil field to have all production facilities located on the sea floor. This is within the realm of possibility and several systems have been designed and are being tested.

Zakum Field. A subsea production system was installed in the Zakum field of Abu Dhabi Marine Areas Ltd. in the Arabian Gulf in 1970. The field is operated by British Petroleum and Cie. Francaise du Petroles. The system

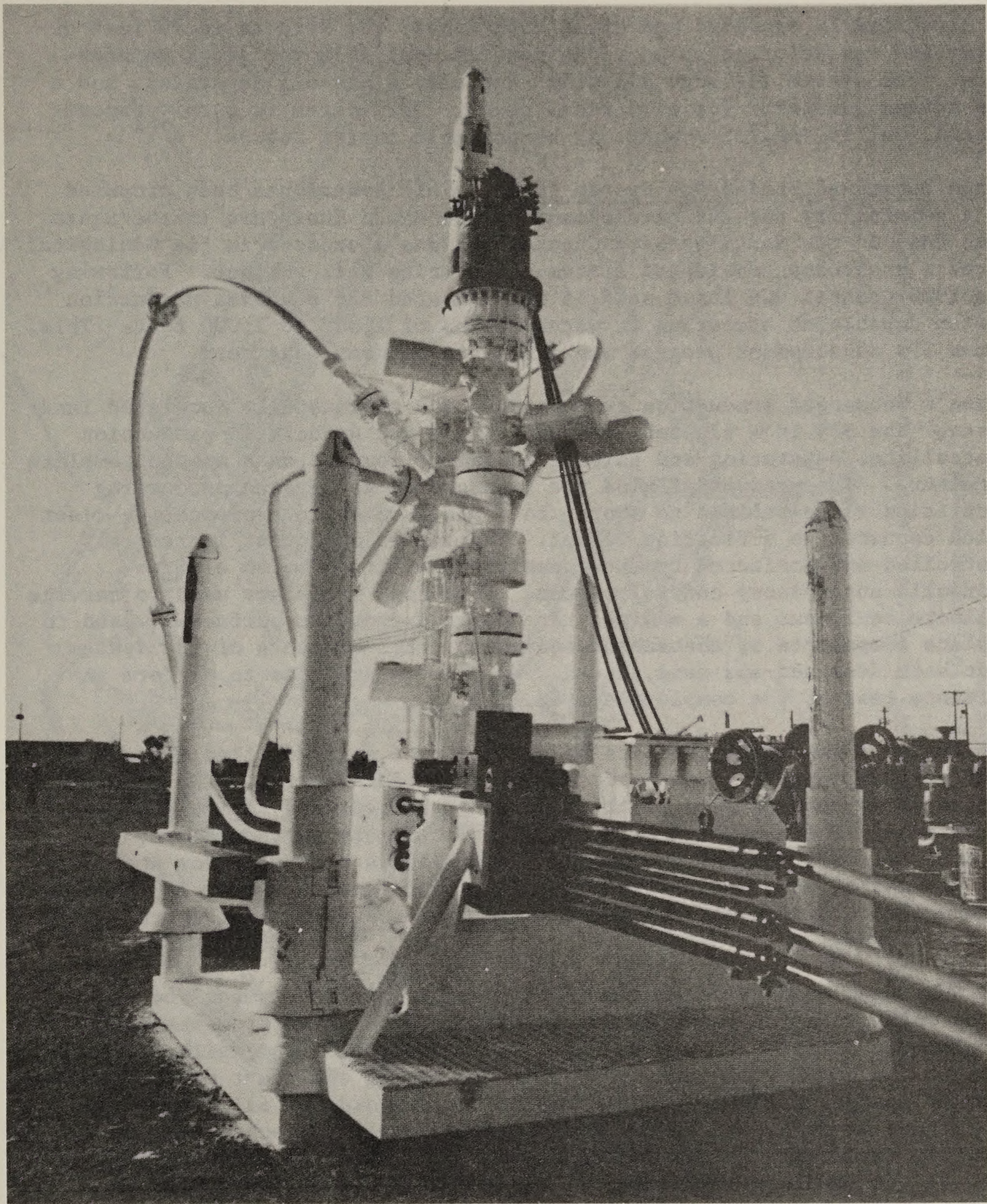


Figure II.H.3.d.ii-3 Tree designed for use by Shell Oil Company in the Gulf of Mexico. Designed for installation without diver assistance and remote control of all functions possible on a surface installation.

Source: VETCO Offshore, Inc.

is electrically operated and diver maintained; the site is in 70 feet of water and was selected so as to be readily available for diver maintenance. The system includes all well controls, a gas-oil separator, and a gas driven generator for electrical power. The system is purely experimental, but it indicates what may be possible in the future.

Exxon Submerged Production System (SPS). This system has been proposed as a possibility for the development of the Santa Ynez Unit in the Santa Ynez Unit in the Santa Barbara Channel and was discussed in the Geological Suvey's environmental impact statement covering this subject. Following the 1968 Channel OCS lease sale, a need existed for a subsea production system capable of operating in water depths of 1,500 to 2,000 feet. This Exxon SPS development program was initiated to meet that need.

Exxon's submerged production system (SPS) has successfully completed land tests. The SPS is a cluster of subsea wells and associated production controlling, separating and pumping equipment mounted on a subsea template structure. The produced fluids are transported to surface processing facilities via pipelines to shore, to a platform or to a production riser which connects to a floating vessel. The subsea equipment is remotely controlled and monitored from the surface facilities by an electro-hydraulic supervisory control system. Pump-down tools are used to service wellbore equipment and a manipulator operated from the surface is used to replace components of the subsea equipment. All elements of the system have been designed and land tested. Work is in progress to perform an offshore test of the complete system.

The system essentially consists of a cluster of wells drilled through a seafloor template and connected through a manifold system. The manifold system is surrounded by a track on which a wellhead and manifold manipulator runs. The manipulator is controlled from the surface and can control all well control functions. Provision is also made for access to the annulus of each well. The manipulator maintenance system is shown in Figure II.H.3.d.iv-1 and the manifold schematic is given in Figure II.H.3.d.iv-2.

The submerged production system (SPS) provides both equipment and procedures which span the production requirements of a filed from the time development drilling starts to filed abandonment and from wellbore equipment at the completion interval to the processing equipment at the common carrier custody transfer point. The SPS is composed of eight functional subsystems as follows: 1) the drilling and completion subsystem, 2) the manifold subsystem, 3) the remote control subsystem, 4) the pump/separator, 5) the template subsystem, 6) the pipeline connection subsystem, 7) the production riser and floating facility subsystem, and 8) the maintenance manipulator.

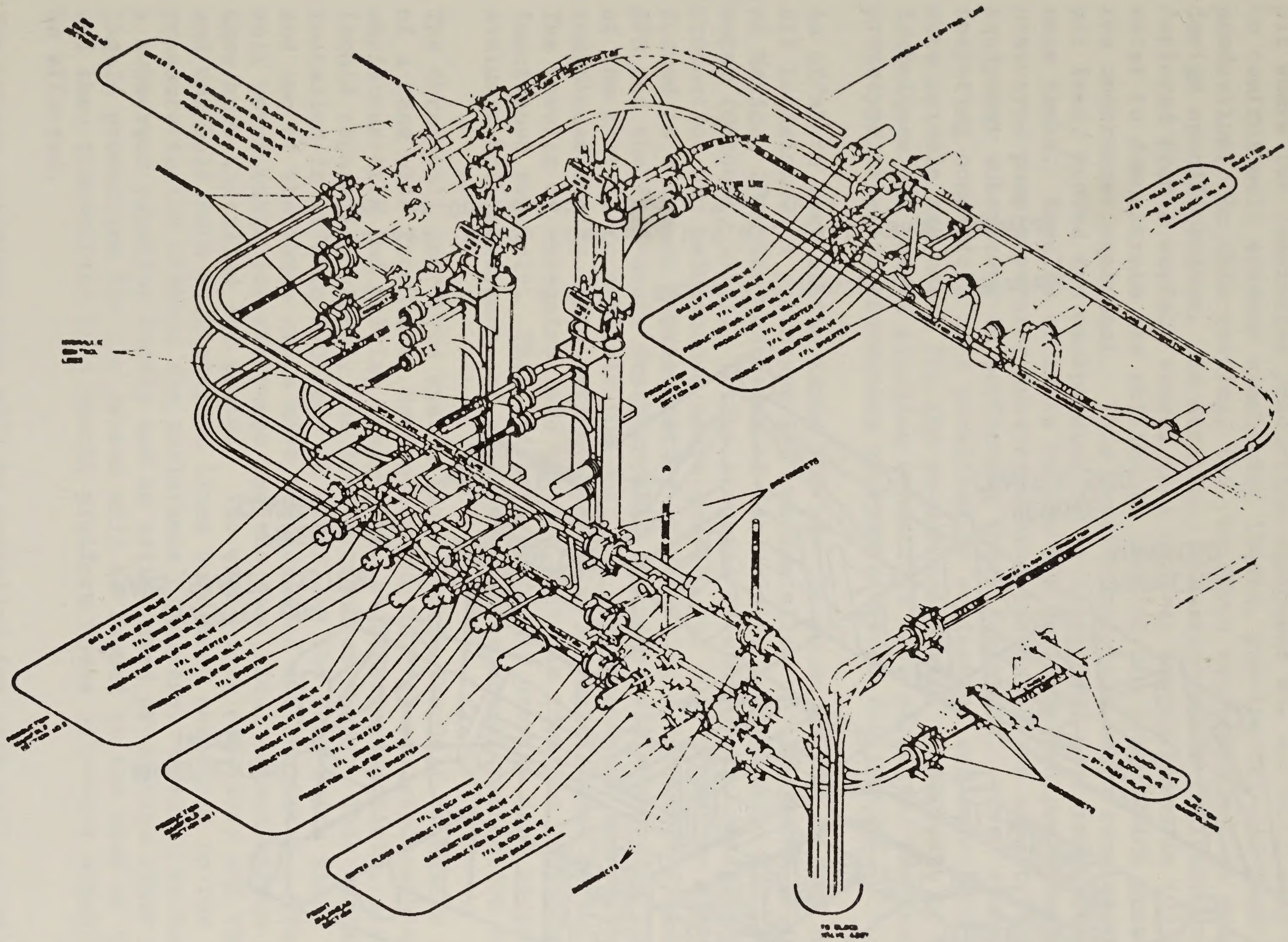


Figure II.H.3.d.iv-2 Exxon SPS Production and Maintenance System

Source: Exxon Company, U.S.A., 1971, Supplemental
Plan of Operations, Santa Ynez Unit.

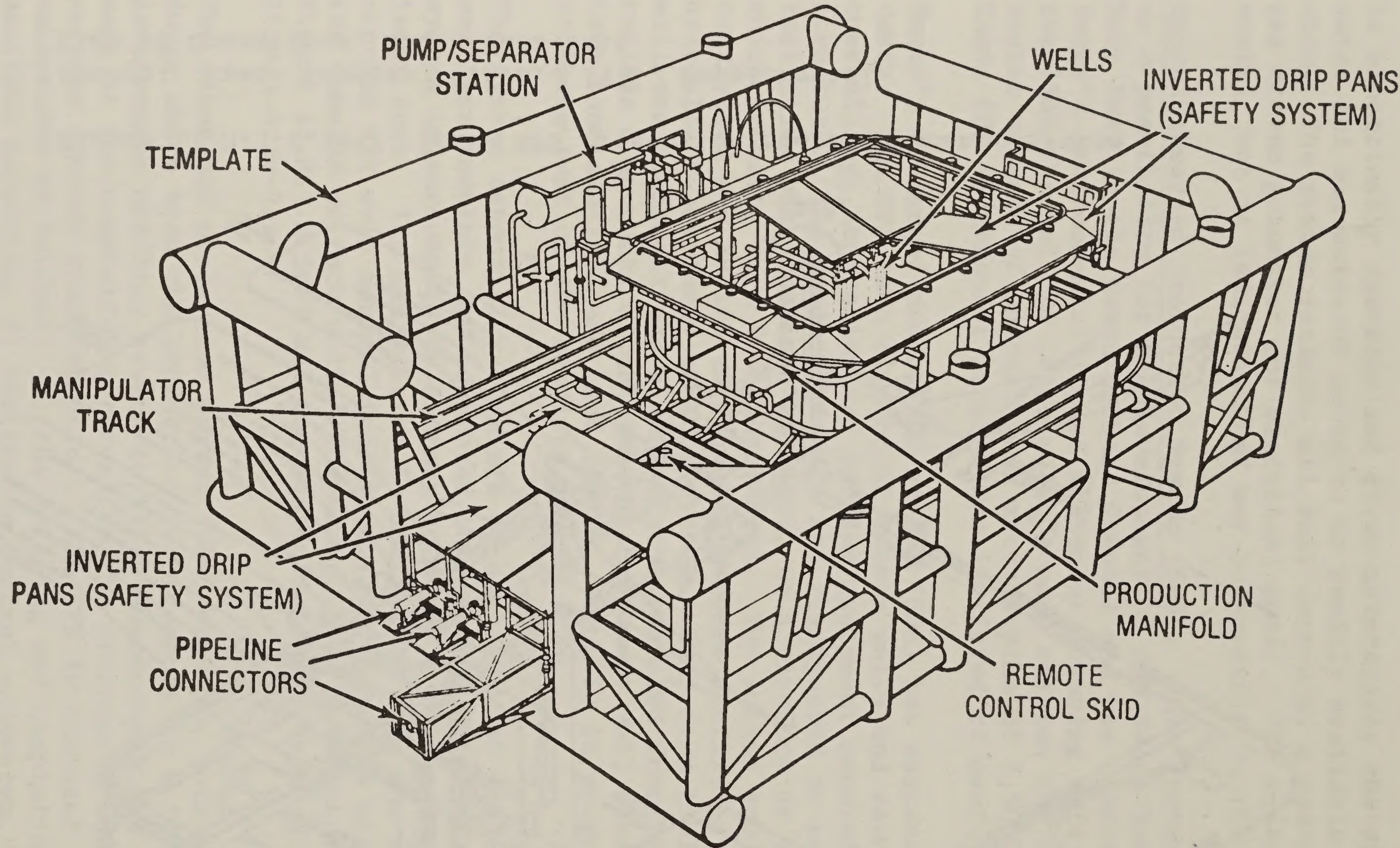


Figure II.H.3.d.iv-1 Exxon SPA Manipulator System

Source: Exxon Company, U.S.A., 1971, Supplemental Plan of Operations, Santa Ynez Unit.

The final suite of land tests on a prototype, 3-well, subsea production manifold and a maintenance manipulator were performed in a water-filled pit where the underwater production equipment was automatically operated to control well streams simulating liquid, gas-liquid, and sand laden production. In this testing, the prototype equipment met or exceeded design specifications. In addition, the maintenance manipulator was deployed from a surface vessel to a mock-up installation in 425 feet of water to demonstrate its ability to land on its track which surrounds the underwater equipment. This development test, when coupled with the pit test, proved the manipulator to be capable of performing the maintenance tasks. Results of tests on the SPS wellbore equipment and on a pre-prototype pump/separator subsystem have indicated the utility of these equipment subsystems in performing their functions. Tests simulating operating conditions have permitted an evaluation and selection of pressure swivels and hoses for the production riser. Land tests of line-up techniques and remote pipeline connectors have permitted the design of prototype pipeline connecting equipment needed for the SPS.

An offshore test of the Exxon SPS has commenced in the Gulf of Mexico off Louisiana. A prototype SPS was installed on the bottom of the Gulf of Mexico, 27 miles southeast of Grand Isle, Louisiana in 170 feet of water (October, 1974). In the proposed offshore test, installation, production and maintenance operations in the Gulf of Mexico will be performed in a manner representative of producing a deepwater field with an SPS and the full-scale depth-capable equipment will be used. The purpose of the test is to evaluate the cost and performance of the equipment and techniques during installation, operation and maintenance activities. The results of extensive land testing indicate that the equipment functioned properly. This offshore test will provide data necessary to evaluate both equipment and procedures under actual production conditions.

The three-well prototype system installed in the Gulf of Mexico consists of a base skid (template) secured to the Gulf floor, replaceable subsea christmas-tree and valving assemblies, a gathering manifold, a subsea liquid separation vessel, and liquid transfer pumps. This assembly was installed in 1974 in 170 feet of water, in the West Delta Block 73 Field and two of the three wells have been drilled and completed. The 35,000-volt power cable for the pumps and the electrical communication cables have been installed and tested. Two eight-inch pipelines and three four and one-half inch multipurpose lines have been connected to the unit and pressure tested without the assistance of divers. Also to be tested is a submerged pipeline bundle and an articulated production riser assembly. Liquid production for the system will be looped to the head of the riser and then transmitted to a nearby platform where oil-water separation will be effected.

The subsea christmas tree will be installed for each well at an upper elevation on the template. Each christmas tree is designed to accommodate the production of the wall, fluid injection, pump-down tools, hydraulic control lines and reentry for conventional workover. Replacement of remote control pods or well control valves can be accomplished by use of a manipulator unit which is lowered from the surface to a curved track which encircles the unit. Once on the track, the manipulator can be remotely positioned with the aid of television cameras. Portions of the system undergoing replacement are isolated by manual isolation valves which are opened and closed by the manipulator.

Lockheed Subsea Completion and Production System. Shell Oil Company and Lockheed Petroleum Services joined efforts to develop and field test an ocean-floor system for completing and producing wells. The system is based on the concept of housing more-or-less standard equipment in one-atmosphere chambers. The chambers can then be linked together with subsea pipelines to form a complete producing system. Servicing the equipment inside the chambers can be performed by experienced oilfield workers, transported to and from the chambers in a dry, one-atmosphere diving capsule.

The current joint program consists of three phases. Phase I, the subsea wellhead chamber, was successfully placed in operation in October, 1972, on a Shell producing well in 375 feet of water. Phase II, the subsea manifold center, was scheduled for field trials in about 240 feet of water in the latter part of 1975. The third phase consisted of a subsea pumping station which was scheduled for startup in early 1976. It is anticipated that data from these tests will provide the sound basis necessary to project design and cost criteria for application in up to 3,000 feet of water.

Shell and Lockheed have completed the first phase of their program with the completion of the first encapsulated (dry) subsea well, whereby men work in a normal pressure air environment to assemble christman-tree and control components in a wellhead chamber on the ocean floor. The system is designed for 1,200-foot water depth and the first well was completed in 375 feet of water and has been producing since October, 1972. The well is located in the Gulf of Mexico on lease OCS-G 1666, Main Pass Block 290 Field. Using the atmospheric diving system of Lockheed, Shell successfully reentered and performed maintenance in the atmospheric chamber of this well in September, 1973.

The main purposes for the reentry were to locate and repair a leak in the hydraulic control, system, observe condition of chamber and christmas-tree components after one year of operation, and provide diving experience for Shell personnel. Nine dives lasting a total of 67 hours were made. Nine Shell personnel and two USGS technicians made dives in addition to Lockheed crew members. Each dive carried four persons.

In the first year, the well produced 263,000 barrels of oil and 83 million cubic feet of gas and was producing at a rate of 1,350 barrels per day and 450 thousand cubic feet per day from two oil zones. Maintenance and remedial experience has included three TFL (through-the-flowline) operations, where tools are pumped through the tubing, to service subsurface controls and acidize the lower zone, and the reentry into the WHC (wellhead Chamber) described above.

Shell Oil Company installed in 1975 a Subsea Manifold Center (SMC) and drill, and completed two subsea wells in 240 feet of water in Eugene Island Block 331. The SMC is the second phase of the comprehensive program that Shell and Lockheed Petroleum Services, Ltd. have been working on since 1971.

The two subsea wells will be drilled and completed using techniques employed by Shell for previous subsea wells in the Gulf of Mexico. Production from these wells and one platform well will be routed to the SMC where the wells will be tested and production commingled prior to delivery through a common line to a nearby production platform.

The SMC is 12 feet in diameter and 30 feet long. It is a pressurized vessel built to provide a dry noraml one-atmosphere environment.

Two examples of the Lockheed system for wellhead equipment are shown in Figure II.H.3.d.iv-3. The chambers shown are those permanently installed on the wellhead and the upper hatch indicates where the service capsule is attached. After the capsule is connected, the chamber below the capsule and above the entry hatch to the work chamber, is pumped dry and the atmoshpere is tested prior to opening the hatches.

SEAL Subsea Completion and Production System. Subsea Equipment Associates Limited (SEAL) has been principally funded by British Petroleum, Mobil Oil Company, Compagnie Francaise des Petroles, Westinghouse Electric Corporation, and Groupe Deep, the latter a consortium of Eugopean Contractors. Associate members of the group include Conoco, Sunoco, Phillips, ELF/ERAP, and Petrobras.

SEAL currently has under development three subsea oil and gas production systems. Two of the systems undergoing tests are designed for use in foreign fields where high production rates are prevalent. SEAL is also testing a subsea oil production system in the Gulf of Mexico which is designed primarily for utilization with large numbers of domestic low-production wells of less than 1,000 barrels per day which, in turn, generally require significant maintenance. Sun Oil Company is participating in the test project in the Gulf.

Essentially, the SEAL system is similar to the Shell-Lockheed system where working areas are enclosed in atmospheric chambers and access is available

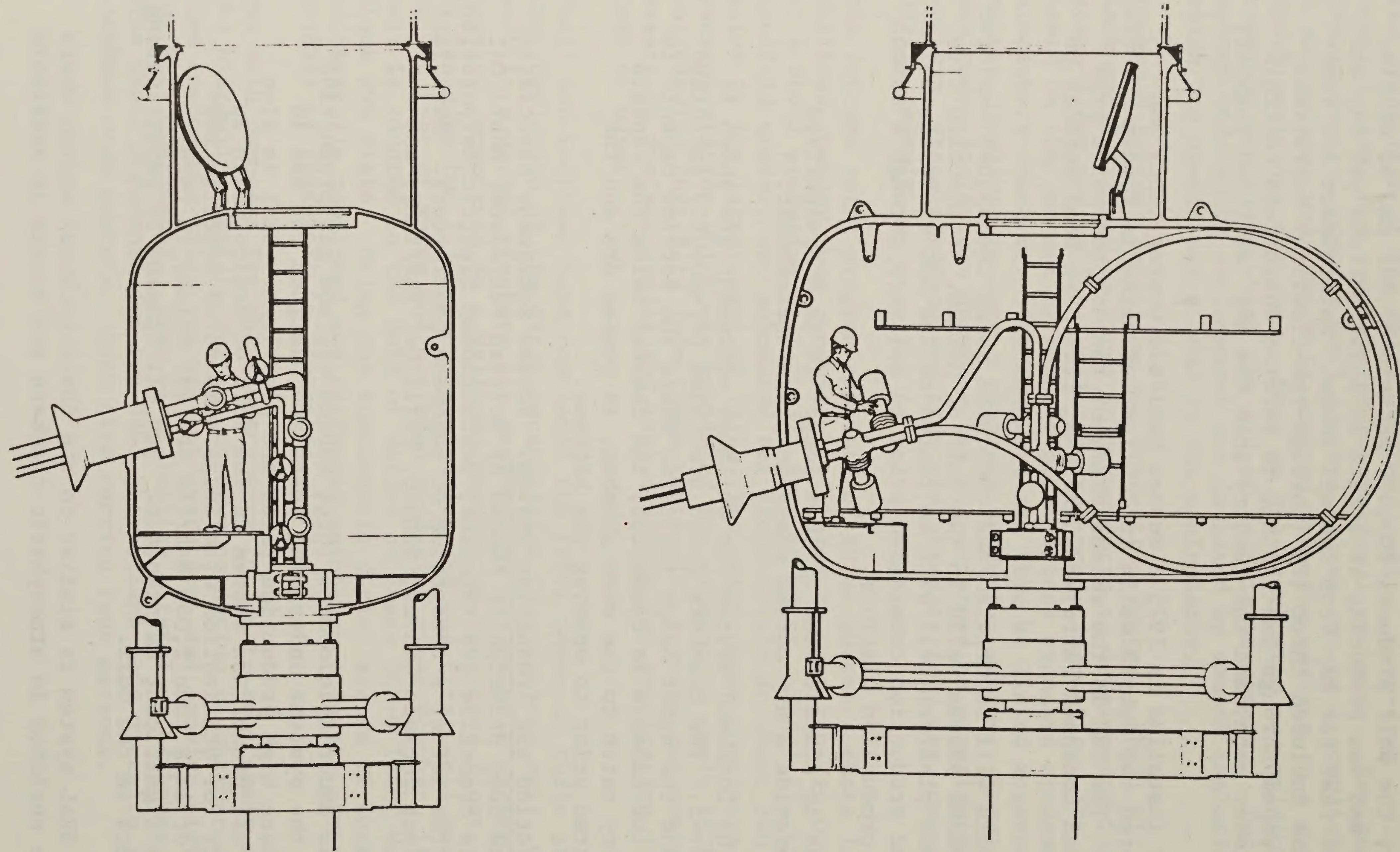


Figure II.H.3.d.iv-3 Lockheed One-Atmosphere Subsea Completion System

a. For wellhead installation where TFL tools are not required.
b. A wellhead collar designed to enclose the TFL tubing loop.

Source: Lockheed Petroleum Services, Ltd. (Also presented at the Sixth Annual Offshore Technology Conference, Houston, Texas, May 6-8, 1974.)

through personnel transfer capsules lowered from a surface vessel. Systems have been designed for individual well completions, cluster type well completions, a production manifold station, a subsea separation facility and a subsea pumping station.

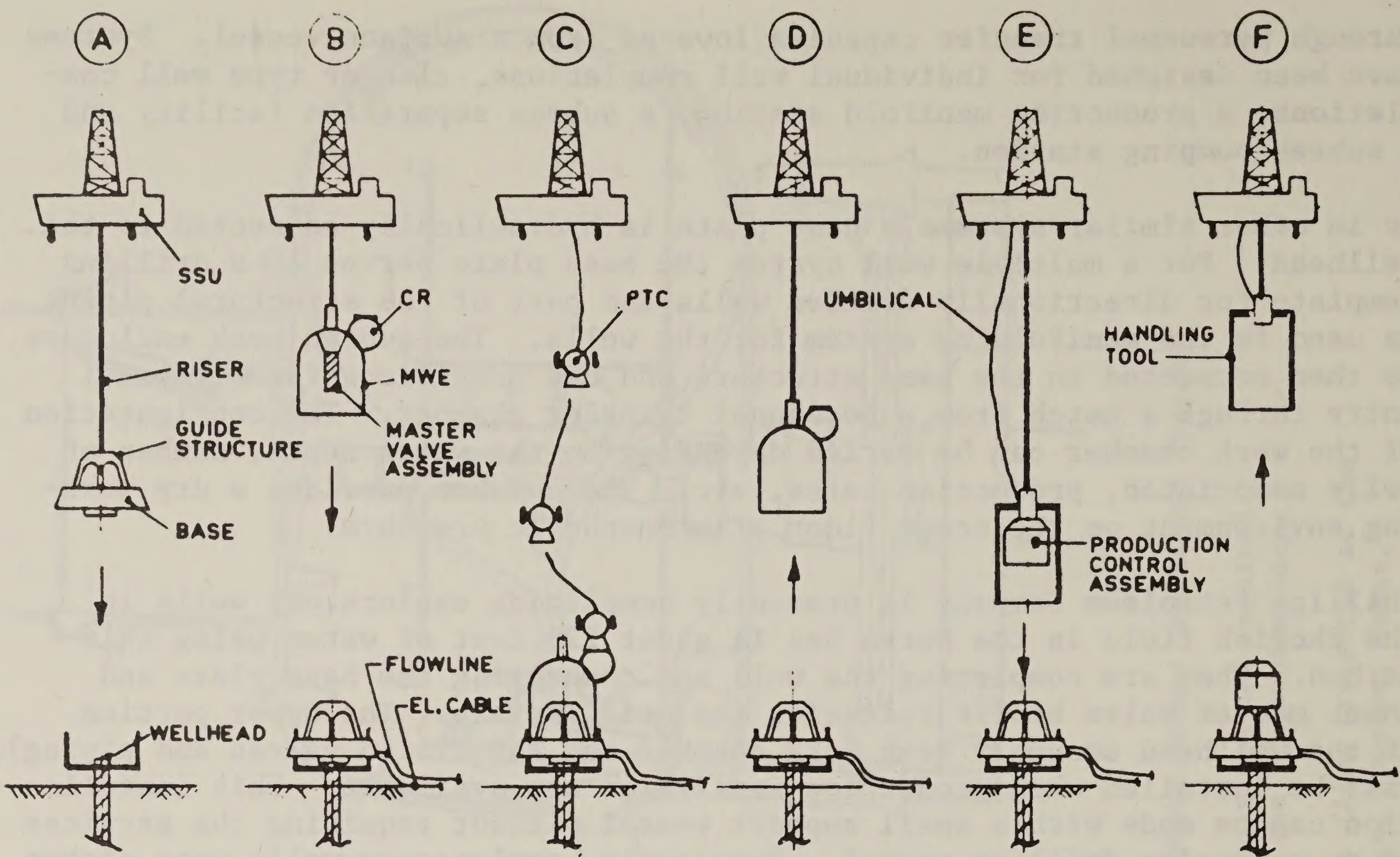
As in other similar systems a base plate is hydraulically connected to the wellhead. For a multiple well system the base plate serves as a drilling template for directionally drilled wells and part of the structural piping is used in the manifolding system for the wells. The subsea work enclosure is then connected to the base structure and has provisions for personnel entry through a hatch from a personnel transfer chamber. The configuration of the work chamber can be varied depending on the water depth, number of wells associated, production rates, etc. The chamber provides a dry working environment on the ocean floor at atmospheric pressure.

Phillips Petroleum Company is presently completing exploratory wells in the Ekofisk field in the North Sea in about 220 feet of water using this method. They are completing the well and connecting the base plate and lower master valve beofre releasing the drilling rig. The upper portion of the wellhead assembly (the work chamber and associated valves and piping), will be installed when production facilities are available. This installation can be made with a small support vessel without requiring the services of an expensive drilling vessel. Previously, exploratory wells were either abandoned, or temporarily abandoned. Abandonment represents a loss of considerable investment and if temporarily abandoned, a drilling vessel would be required to re-enter and complete the well.

In October of 1973, a series of tests involving the SEAL well completion system were started in the Gulf of Gabes, Tunisia. The first tests were in approximately 200 feet of water and the next step will be to test the system in about 575 feet of water in the same area. The system is designed to be used in waters over 1,500 feet in depth.

The vessel used in the Gulf of Gabes test was dynamically positioned using the "taut wire" system. The base plate was lowered on pipe and hydraulically connected to the wellhead, the master valve assembly was then lowered inside a manned work enclosure and manually connected by personnel within the MWE. The MWE was retrieved and remotely controlled production assembly (tree) was hydraulically connected to the master valve assembly. Since the MWE was lowered on drill pipe, wire line operations and well circulation could be conducted from the surface vessel. Figure II.H.3.d.iv-4 shows the sequence of operations followed in these tests.

These tests are described in a paper, "Handling the SEAL Intermediate System for Subsea Wellhead Completions from the Support Vessel 'Tarabel'", by Mercier, Higler, Vine, and Darnborough of Subsea Equipment Associates, Ltd. The paper was presented at the 1974 Offshore Technical Conference in Houston, Texas. The paper is numbered OTC 1941.



A - Lower the seal base from the surface support unit (SSU) with internal guide structure attached to it onto wellhead.

B - Lower the master valve assembly inside the manned work enclosure (MWE). Attach flowline and electric cable to base.

C - Personnel transfer to MWE to attach master valve assembly to wellhead and connect flowline and electric cable to master valve assembly. (Atmospheric conditions inside MWE)

D - Raise the MWE leaving behind the master valve assembly.

E - Lower the production control assembly inside its handling tool and latch it to the master valve assembly.

F - Operate the master valves with the handling tool. Operate the production control assembly from the support vessel (SSU). Raise the handling tool.

Figure II.H.3.d.iv-4 Installation Sequence of Seal Intermediate Subsea Wellhead Completion System

Source: Subsea Equipment Associates, Ltd. (Also presented at the Sixth Annual Offshore Technology Conference, Houston, Texas, May 6-8, 1974.)

Another test of the SEAL system is underway in the Gulf of Mexico. This involves a multi-well system and it is described in a paper titled "Subsea Manifold System" by Chatas and Richardson, Seal Petroleum Company. It is numbered OTC 1967 and was presented at the 1974 Offshore Technical Conference in Dallas, Texas.

Testing started by simulating field production on dry land in 1971 in Long Beach, California where the prototype was constructed. In 1972, the unit was transported to the Gulf of Mexico and installed in 247 feet of water near a Sun Oil Company production platform at Main Pass 293A. First tests were conducted by diverting production from wells on the platform through the manifold system. After processing, the production was returned to the platform; additional drilling operations were started in December, 1973. Entrance into the production satellite is via a diving well designed to permit entry into the "shirt-sleeve" environment maintained in the chamber.

During the commissioning and check-out phase of the test, 56 entries by personnel were made into the subsea work enclosure (SWE). Most of these personnel were not divers, but regular oil company personnel and Geological Survey engineers and inspectors. Over 90 automatic operations of pump-down tools were performed, principally to remove paraffin deposits in the wells. These tools were pumped through the flow line network, to the platform, down the well and teturned. The personnel transfer bell used in these tests is capable of transporting five men into the subsea structure.

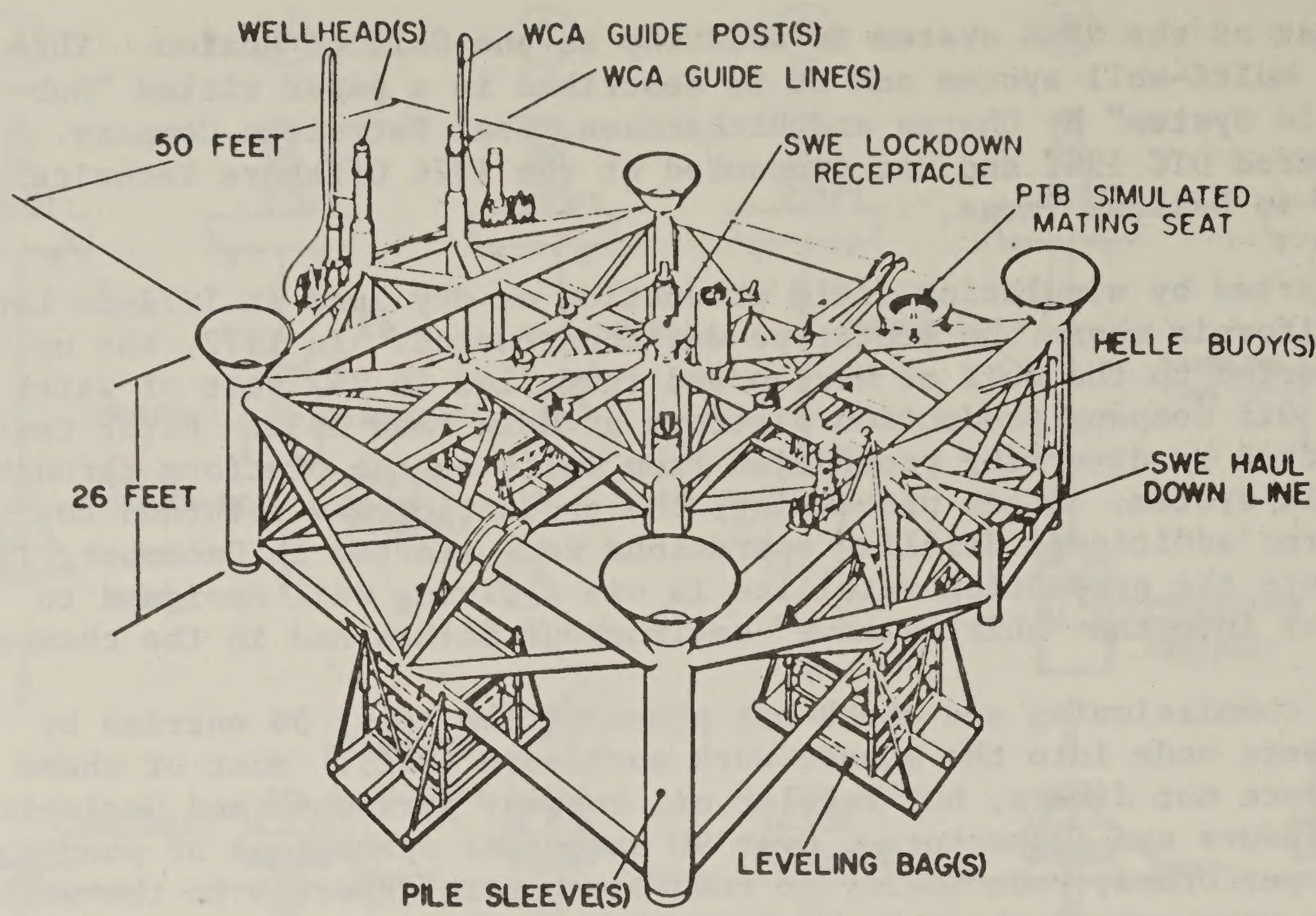
The base of the SEAL Atmospheric System (SAS) and the subsea work enclosure (SWE) used in the Gulf of Mexico test are shown on Figure II.H.3.d.iv-5.

The SEAL Atmospheric System (SAS), which is being tested in the Gulf of Mexico, is based on the use of a large habitat type structure permanently installed on the sea floor to house oil field equipment. The SAS system incorporates a subsea manifold system in which various oil field production equipment can be installed depending on the application.

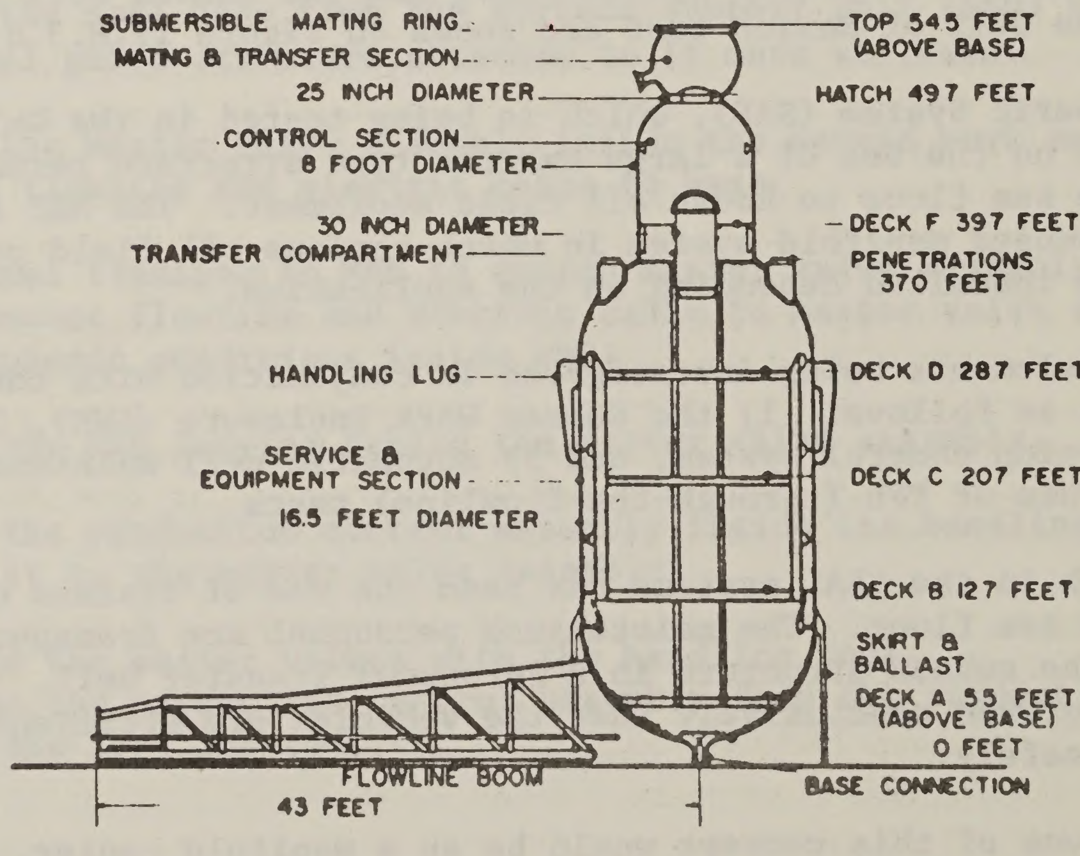
The three major elements being investigated in conjunction with the SAS Test Program are as follows: 1) the Subsea Work Enclosure (SWE), 2) the automatic production control system, and 3) automatic well maintenance system based on use of TFL (through-the-flowline) tests.

A common approach in the SEAL systems has been the use of trained oil field personnel on the sea floor. The maintenance personnel are transported from the surface to the subsea structure in a Personnel Transfer Bell. Test operations have proven conclusively that the vehicles are efficient and can be operated safely.

Future applications of this concept would be as a manifold center, a test separator center or a complete oil production system. In a similar manner to other systems, men are transported to and from the Subsea Work Enclosure



a. Base & wellhead connector assembly



b. Subsea work enclosure

Figure II.H.3.d.iv-5 Seal Subsea Manifold System

Source: Subsea Equipment Associates, Ltd. (Also presented at the Sixth Annual Offshore Technology Conference, Houston, Texas, May 6-8, 1974.)

(SWE) through the use of a Personnel Transfer Bell. The men perform their duties at atmospheric pressure.

Other Submerged Production Systems. Other submerged production systems are in the design or test stage. Deep Oil Technology, Inc., Transworld Drilling Company (a subsidiary of Kerr-McGee Corporation), and Standard Oil of California all have systems that have not yet been fully developed. The Transworld system is similar to the Lockheed and SEAL systems where an underwater work chamber at atmospheric pressure is utilized. The main difference is that wellheads would be maintained in a wet atmosphere except when work was actually in progress with the underwater work chamber in place. Construction is in progress on prototype models and the system is designed to be operable in water depths to at least 1,500 feet.

Floating Production System. A possible production system where production from subsea wells is directed to a surface vessel containing separation equipment is more likely to be used in deep water where platform costs become prohibitive. A moored vessel could be connected to an underwater well manifold by a production riser. The vessel could be simply a separation facility and direct oil to a floating storage facility or the two functions could be combined. The vessel could be either a conventional ship type or a version of the semisubmersible type hulls used in exploratory drilling. An adaptation of the semisubmersible type hull was tested off the coast of Scotland for a period of nearly two years from 1963 to 1965. This vessel was moored using the tension leg technique whereby anchor points were established by drilling in and cementing piles in the sea floor. The vessel was then connected to the anchor points by wire cables and by alternately taking in on the cables and flooding the buoyancy chambers, the vessel reached its predetermined buoyancy point with the buoyancy chamber about 80 feet below the surface. The water was then expelled from the buoyancy chamber, leaving the wire cable "legs" in tension. Even in severe weather, the movement of the vessel was negligible since the only resistance offered to the sea was by the legs connecting the work platform to the buoyancy chamber which is itself below the depth affected by wave action. This test is described in OTC paper 2104, "The Design and Field Testing of the "Triton" Tension-Leg Fixed Platform and its Future Application for Petroleum Production and Processing in Deep Water," by R. David McDonald. This paper was presented at the 1974 Offshore Technical Conference in Dallas, Texas.

Industry Assessment of the Current Status of Technology in Subsea Well Completion Techniques and Subsea Production Systems. By Notice in the Federal Register of January 27, 1975, the Department of the Interior requested from interested parties, comments on the current status of subsea well completion techniques and subsea production systems. Comments were also requested as to the impacts from requiring subsea completion as a condition to granting some OCS leases.

As stated in the Notice, comments were to address all aspects of subsea operations, including the following:

- Water depth capabilities, depths at which subsea systems are economical (versus bottom-founded platforms).
- Cost of drilling, completing, and maintaining subsea wells.
- Flowline connections and servicing.
- Navigation for well location and reentry.
- Well maintenance and repairs.
- Subsea separation and storage.
- Diving limitations.

Comments were received during the months of February and March, 1975 from twenty separate parties, including major oil companies, companies which market subsea systems equipment and/or components, and one United States governmental agency. The respondents did not agree in their assessments of the state-of-the-art in any of the seven specific aspects to which previous reference was made. These comments with attachments are available for reference in the Geological Survey Library, National Center, Reston, Virginia. Following is a brief summary of the information submitted by the companies as to the above aspects of subsea operations.

- <u>Water Depth Capabilities</u>

Technology is now available for installation and operation of "wet" subsea completions to a depth of 400 feet with diver assistance. However, platforms are necessary to provide support facilities. It is anticipated that this depth capability will be increased to 600 feet in the very near future.

The limiting factor in this operation at present is the capability for making flowline connections.

The use of manned diving capsules to perform this operation in encapsulated subsea completions at the present time has a water depth capability of 600 feet. Design and procedures have been developed to extend this capability to a depth of 1,200 feet, but practical experience is lacking.

It is anticipated that the use of encapsulated wellheads and manned diving chambers will further extend depth capability to 2,000 feet in a time-frame of from 5 to 8 years.

In the case of subsea production systems, additional research and development and more field testing or critical subsea production components for water depths between 1,000 and 2,000 feet should be completed within the next 5 years. However, subsea systems independent of fixed platforms or other nearby surface facilities are not likely to become a reality until some type of subsea station capable of inputting energy into well streams can be perfected. There is no definite indication at this time as to when a reliable working station of this nature may be fully developed and implemented.

- Economic Feasibility of Subsea Systems

It is the consensus of the respondents that in water depths of up to 1,000 feet platform systems are more economical than subsea systems.

It is indicated that subsea systems such as those using manned diving capsules and encapsulated trees may be competitive economically with fixed platforms in water depths of 200 to 700 feet, but in depths greater than 600 feet comparative economics would necessarily be employed on an individual basis.

In water depths ranging from 600 to 1,200 feet it is suggested that different types of structures, such as the tension-leg platform, may replace conventional platforms more economically than subsea systems.

- Cost of Drilling, Completing and Maintaining Subsea Wells

Under existing conditions, platforms are required for production equipment support. These same platforms can be used for drilling most of the wells at a fraction of the cost of subsea completions.

The first major use of subsea completions will probably be to drain areas beyond the reach of directionally-drilled wells. In water depths to at least 500 feet, and possibly to 1,000 feet depending on individual circumstances, subsea completions are economically justified only as peripheral or outpost wells to an established platform. As development moves into greater depths, the economics of subsea completions as compared to platform wells will shift in favor of underwater completions.

When platform depth limits are exceeded, the subsea completion may be the only alternative, even if they are connected to and controlled from some type of floating platform or vessel.

Under usual conditions, the cost of drilling, completing and maintaining a subsea well will be 2 to 3, or possibly more, times greater than that of a well drilled from a conventional platform. This is due primarily to higher costs of mobile rigs and the added cost of a flowline bundle between the subsea well and its surface facility.

The economic feasibility of drilling subsea wells cannot be determined by drilling and maintenance costs alone; the factor of reserves is very important. The cost of subsea completions may cause loss of reserves by early abandonment or prevent development of marginal properties.

- Flowline Connections and Servicing

The greatest depth at which a flowline has been connected to subsea well equipment is about 450 feet. Most connections have been made with diver assistance, but maintenance has been accomplished by the use of through flowline (TFL) tools.

Flowline connection and servicing appears to present the single most difficult barrier to subsea completions beyond diver depth. The mechanical complexity involved in remotely aligning, coupling, and high-pressure sealing of multiple pipe runs presents a significant problem in providing an economic and reliable system. It is anticipated that a period of 5 years will be needed to achieve this reliability.

Remote flowline connection capability has not been satisfactorily demonstrated, but several prototype systems are available and show potential for satisfying this requirement in water depths to 1,500 feet. The "dry" system offers a promising approach by replacing the complexity of remote, "wet" mechanical functions with personnel within a subsea chamber to carry out the connections following a relatively simple pipe "pull-in" operation. However, the sole means of repairing these complex cable and pipe bundles under the current state-of-the-art technique is by removal and replacement of the malfunctioning equipment.

- Navigation for Well Location and Reentry

The consensus of the respondents is that this operation does not present a problem for subsea systems. Precise positioning and navigation of mobile drilling rigs, construction barges, and maintenance vessels have been proven for any water depth or offshore location in an environment such as the Gulf of Mexico.

There is some indication that positioning and reentry procedures can be time-consuming and costly, especially in greater depths, which would warrant additional development and improvement of techniques and associated tool units.

- Well Maintenance and Repairs

Divers can be successful in reparing and maintaining wellheads in depths up to 400 feet.

Through flowline (TFL) techniques have been successful in performing "in-tubing" maintenance in the Gulf of Mexico. Minor repairs to "wet" trees and control systems have been carried out by divers or remote manipulators.

Industry is developing refinements in the remote control of tool retrieval and manipulation techniques. Many wellhead components now require service with a diver or manned one-atmosphere chamber; therefore, depth capabilities are limited by either diver or vessel capability.

Subsea systems planned for depths beyond diver capability will require a backup remotely-controlled manipulator or robot system.

Work requiring removal of tubing strings requires a drilling rig since flowlines must be disconnected and the wellhead completely removed.

For subsea wells requiring major repairs, economics may dictate early abandonment in some instances.

- Subsea Separation and Storage

Production from all current subsea completions is processed through facilities located either on fixed platforms or onshore.

Work done to date on subsea separation and production systems has primarily been in the area of developing concepts and prototype equipment. At present, the operating water depth of these systems is about 375 feet. This depth should be extended to about 1,500 feet in 10 years.

Current state-of-the-art subsea separation is limited to experimental and developmental gas/liquid separation of relatively small volumes of fluids. Large volume separators have not been installed and tested and their application in subsea installations involves major problems requiring further research and development.

- Diving Limitations[a]

Diver-assisted subsea well installations are now practical in the water depth range of 250 to 300 feet. Between 300 and 400 feet, conventional diving techniques being to become ineffective as on-bottom time is limited to 1/2 hour or less.

[a]The diving depth limitations assessment and discussion under this heading is a summary of the situation as indicated in the February-March 1975 Company comments. A working dive to recover a blowout preventer stack was performed at a water depth of 1,069 feet.

Current limitations on diving are to depths of less than 1,000 feet, with actual working dives on oil field projects to 840 feet. The diving industry has conducted experimental working dives to depths of 1,000 to 1,300 feet. At these depths, the divers' work efficiency drops to 25-40 percent. Consequently, diving at these depths is now limited to observation service. Depths greater than 850 feet necessitate access by means of a manned or emote-controlled vehicle.

- Impact of Requirement for Subsea Completions as a Condition for Granting of Certain OCS Leases

It is unanimous among the respondents to the Department's Federal Register Notice request that a requirement of subsea completions as a condition for granting certain OCS leases would have adverse effects.

The most-repeated reason is additional costs resulting in delayed development of properties.

The second most-repeated reason is the adverse effects of regulation of technical decisions in determining the method of developing a property. It is indicated that the technology for deep water platforms is advancing as rapidly as subsea technology.

Summary-Subsea Production Systems. The Shell-Lockheed, the SEAL, and the Exxon SPS Systems are undergoing operational tests as just described in the Gulf of Mexico at this time. The three systems have the capability for remote safety inspections as well as visual inspection in the underwater chambers. All submerged production systems must be approved for installation by the Geological Survey and must conform to regulations. As of January, 1976, no applications for other than test installation of any such system have been received by the Geological Survey.

Servicing and maintenance for the Shell-Lockheed and SEAL Systems are designed for operation in a similar manner, with experienced oil field workers being transported to the encapsulated wellhead chamber at the sea bottom. Diving capability may be required for special type maintenance outside the chambers.

Maintenance and service is to be performed on the Exxon System mechanically by remotely activating a manipulator, but diver capability may still be required.

It is likely that for the near future most subsea completions will be for single well completions similar to those on State leases in the Santa Barbara Channel, and possibly some cluster type completions with a subsea manifold in locations which cannot be reached by drilling from a platform. Production from such completions would be directed to surface separation Perhaps in a few years a complete subsea production facility will be feasible, but it is not likely that their use will be widespread very soon.

Significant problems have been encountered and resolved during the evolution of subsea production systems and, prior to installation in water depths greater than 700 feet, further testing is required to improve and demonstrate the reliability of such systems. As early as 1962, subsea production systems were installed in more than 250 feet of water; however, investigation revealed that early deep-water installations were made prematurely when certain components were little beyond prototype state. The recent trend has been to install such subsea system components in shallow water for field testing until dependability can be ensured for use at greater depths (Ocean Industry, Subsea Production Systems - 1974). An example of this trend is the Exxon Submerged Production System installed in the Gulf of Mexico in 170 feet of water for several years of field testing prior to being considered for installation at greater depths such as in the Santa Barbara Channel, Santa Ynez Unit.

Prior to acting on a specific request to install a subsea production system in the Southern California OCS area, the Geological Survey would take into consideration the results of all testing, including several years of offshore subsea field operations and also diver depth capabilities. Since such systems are still largely experimental, a specific proposal would be carefully studies before granting approval and the need for additional environmental statements would be determined by an environmental analysis of each proposal.

e. General Information for Proposed OCS Sale No. 48: Proposed OCS Sale No. 48 tracts are located between Point Conception and the Mexican Border and are located in an approximate water depth that varies between 30 to 1,350 m (100 to 4,430 feet). From these tracts to the shore, there are possible pipeline routes that vary from 250 to 950 m (820 to 3,120 feet) in water depth. These tracts are illustrated in Figure I.A-1 and shown in Table II.H.3.e-1.

Table II.H.3.e-1

PROPOSED SALE NO. 48 TRACTS ESTIMATED MAXIMUM WATER DEPTH

TRACTS	Estimated Tract Max. Water Depth Ranges		Estimated Pipeline Max. Water Depth Ranges	
	Meters	Feet	Meters	Feet
Santa Barbara Channel	30 - 762	100 - 2,500	500	1,640
Santa Rosa Island	101 - 750	330 - 2,460	250	820
Santa Barbara Island	131 - 500	430 - 1,640	899-951	2,950 - 3,120
Tanner-Cortes	79 - 1,350	260 - 4,430	451-826	1,480 - 2,710
San Pedro Bay	30 - 799	100 - 2,620	524	1,720
Dana Point - San Diego	101-1,180	330 - 3,870	351-750	1,150 - 2,460

Table II.H.3.e-2 1 shows the platforms, submerged pipelines, subsea completion systems, and exploratory wells that are currently in operation and located mostly in the Santa Barbara Channel. There are 17 fixed leg steel platforms of which seven are in Federal waters. These five platforms are located in water depths that range from 46 to 61 m (150 to 200 feet). In addition, Exxon's platform Hondo, which is located in the Santa Barbara Channel and did start development testing on September 15, 1977, is a fixed leg steel platform in 259 m (850 feet) of water.

The submerged pipelines that connect the five platforms to shore are 25 to 30 cm (10 and 12 inches) in diameter and in 40 to 70 m (130 to 230 feet) of water. A proposed 30 to 41 cm (12 and 16-inch) pipeline connects the platform Hondo to shore in maximum water depth of 259 m (850 feet).

There are 40 "wet tree" subsea completion systems in operation in the Santa Barbara Channel. These "wet trees" are located in State waters. Of these 40 "wet trees", 15 are gas, and 25 are oil.

As of November, 1977, there were 100 exploratory wells drilled in the Southern California Federal water with a maximum water depth of 448 m (1,471 feet) in Lease OCS-P 0181, Santa Barbara Channel. This well was spudded on November 13, 1971 with a drill barge WODECO IV.

Table II.H.3.e-3 summarizes the previously described technical deep water limitations for exploratory drilling, platforms, subsea completion systems, submerged pipelines, pipeline burial, and mooring systems.

Table II.H.3.e-1 summarizes the estimated maximum water depth ranges for proposed Sale No. 48 tracts and for the estimated pipeline routing from the tracts to shore. The regional tracts in Table II.H.3.e-1 are located in Figure I.A.-1. These estimated maximum water depths are given only as an indicator.

In conclusion, it is apparent that the current deepwater technology will meet technical needs for nearly all tracts. Advanced technology may be required for tracts in greater than 3,000 feet of water.

Table II.H.3.e-2

ESTIMATED WATER DEPTH OF EXISTING PETROLEUM OPERATIONS
IN SOUTHERN CALIFORNIA

Existing Petroleum Operations	Estimated Maximum Water Depth: Meters (Except as Noted) Centimeters (cm)	Estimated Maximum Water Depth: Feet (Except as Noted)
A. Platforms		
1. 17 Foxed steel Platforms		
a. 7 in Federal water	46-259	150-850
b. 10 in State water		
B. Submerged Pipeline		
1. Federal water	25 and 30 cm	10 and 12 inch in
From the 5 platforms to shore	40-70	130-230
2. Proposed from platform Hondo to	30 and 41 cm	12 and 16 inch in
shore	259	850
C. Subsea Completion System		
40 "wet tree" - 15 gas, 25 oil all in State water in the Santa Barbara Channel	76	250
D. Exploratory Drilling		
100 Exploratory wells	450	1,478

Table II.H.3.e-3

TECHNICAL LIMITATION FOR DEEP WATER OPERATION

Existing Petroleum Operations	Estimated Maximum Water Depth: Meters (Except as Noted) Centimeters (cm)	Estimated Maximum Water Depth: Feet (Except as Noted)
1. Exploratory Drilling		
a. Jack-up rig	114	377
b. Drill ship	1,829	6,000
c. Semisubmersible	1,829	6,000
d. Dynamically positioned drill ship	914	3,000
e. In the near future	1,829	6,000
2. Production		
a. Platforms		
1. Jack-up rig	144	377
2. Fixed leg concrete	183	600
3. Fixed leg steel	457	1,500
4. Experimental - capability		
a. Guyed tower	549	1,800
b. Tension Leg Platform (TLP)	762	2,500
c. Dynamical Positioned floating vessel	914	3,000
b. Subsea Completion		
1. "Wet tree"		
a. Current	610	2,000
b. In the near future	914	3,000
2. "Dry tree"		
a. Current	366	1,200
b. In the near future	914	3,000

Table II.H.3.e-3 (Contd.)

Existing Petroleum Operations	Estimated Maximum Water Depth Meters (Except as Noted) Centimeters (cm)	Feet (Except as Noted)
c. Submerged Pipeline		
1. Lay-vessel general	91 cm in 183	36-inch in 600
2. Reel barge		
a. Experimentally	25 cm in 305	10-inch in 1,000
b. Capability for 1978	41 cm in 610	16-inch in 2,000
	914	Smaller dia. in 3,000
3. Lay barge		
a. Mooring system	366	1,200
b. Combined mooring - thruster capability for 1977	41 cm in 610	16-inch in 2,000
4. Future	914	3,000
d. Pipeline Burial		
1. Available trencher	183	600
2. Experimental remotely controlled	488	1,600
e. Mooring Systems		
1. Conventional Mooring Buoy	91	300
2. Single anchor leg mooring	162	530
3. Future	305	1,000

4. Previous History of Major Oil Spills: This section on the history of major oil spills is based on available offshore oil spill records. The majority of recorded oil spill incidents have taken place in San Pedro Bay and San Francisco Bay. There is little available information on oil spill incidents in the region between the Mexican Border and Scammon's Lagoon. Information on oil spills was obtained from the U.S. Coast Guard, U.S. Geological Survey (USGS), State of California, Department of Fish and Game (CDF&G) and published data. This section describes only the oil spills caused by offshore production and petroleum transportation. The remaining seven sources of petroleum pollution are described in Section II.H.2, Water Pollution Sources.

Oil spills from OCS activities for the Southern California offshore from 1971-1975 are: none reported for oil spills of more than 50 barrels; and no summarized data available for oil spills of less than 50 barrels. According to the national OCS blowout records, which date back to 1956, the only drilling related blowout in the Southern California offshore occurred in the Santa Barbara Channel in 1969 when the Platform A blowout discharged at least 25,000 barrels of crude oil.

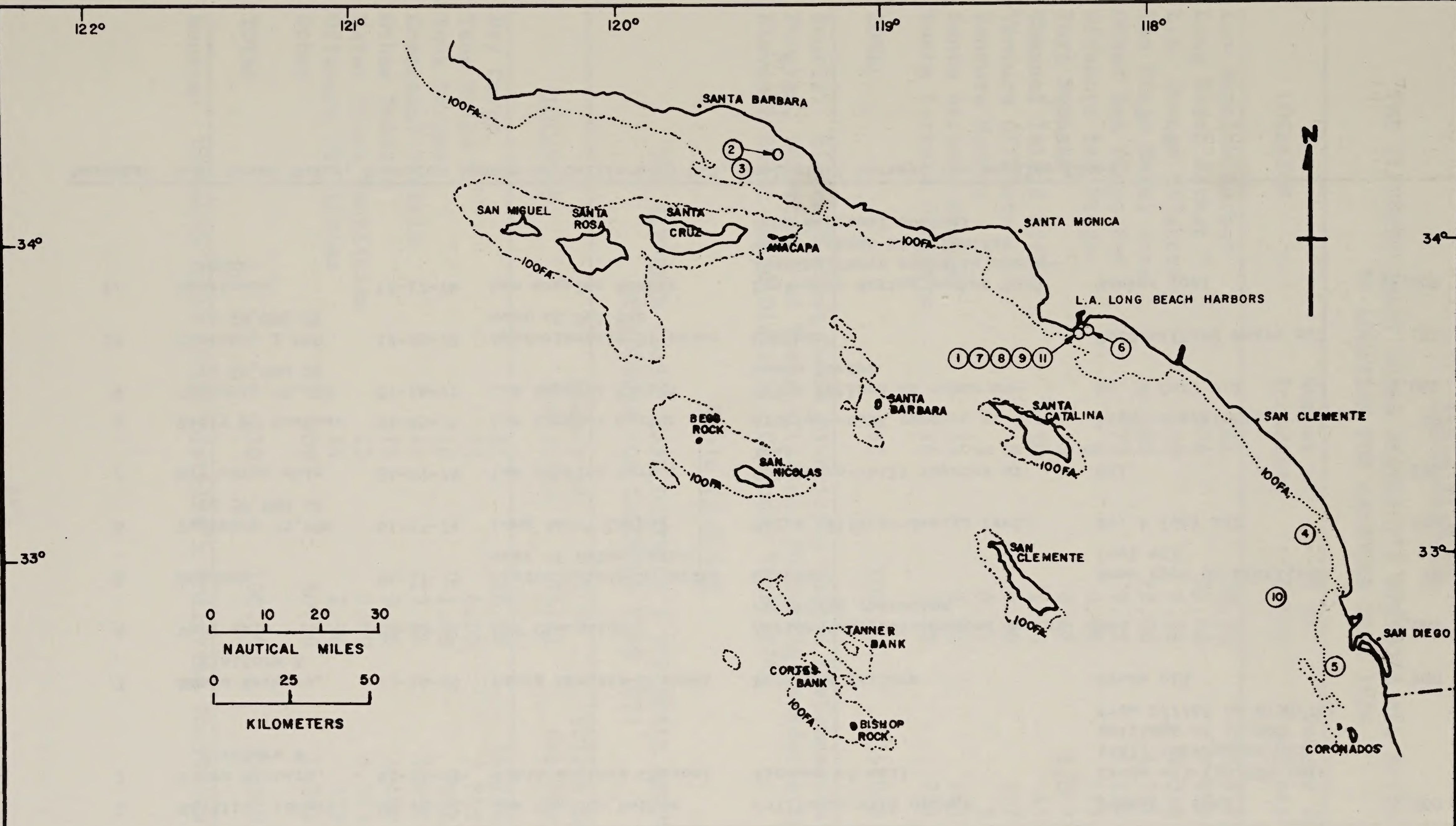
a. Offshore Oil Spill Incidents Between Point Conception and the Mexican Border: For oil spills of 2,000 gallons or more, the Eleventh Coast Guard District's incidents of calendar year 1974, CDF&G's report on vessel spills in San Pedro Bay, and USGS's record on incidents for the OCS show eleven oil spill incidents. There are eleven oil spill incidents of 2,000 gallons or more which are shown in Figure II.H.4-1 and Table II.H.4-1.

Coast Guard: The Eleventh Coast Guard District documents all reported offshore oil spill incidents that occur between Point Conception and the Mexican Border. It maintains a record from 1973 which is published in the Water Pollution Violation Report. In addition, the Eleventh Coast Guard has a summarized oil spill record for calendar year 1974. The offshore oil spill incident record for 1974 is tabulated by locations in Table II.H.4-2 and by sources in Table II.H.4-3.

State of California Department of Fish and Game: The oil summary for the Navy and merchant ships is listed in Tables II.H.4-4 and 5. Between 1962 and 1969, there were a total of 833 oil spill investigations resulting from 13,042 barrels of oil spilled from Navy and merchant ships.

The oil spill summary for dry cargo vessels and tankships in San Pedro Bay for 1976 is indicated in Table II.H.4-6.

b. Offshore Oil Spill Incidents Between the U.S.-Mexican Border and Scammons Lagoon, Baja California, Mexico: Three oil spill



Note:
○ See Table II.H.4-1 for oil spill information.

Figure II.H.4-1 Recorded Oil Spills Between Point Conception and Mexican Border, 2,000 Gallons or Greater

Source: U.S. Coast Guard, Geological Survey, Resource Agency of California and Los Angeles Times.

Table II.H.4-1

OIL SPILLS 2,000 GALLONS (48 BARRELS) OR GREATER, BETWEEN POINT CONCEPTION AND THE MEXICAN BORDER

MAP KEY FIGURE II.H.4-1	Identification	Date	Location	Cause of Spill	Material	Volume (Barrels)
1	Martita, tanker	09-20-62	Los Angeles Harbor	Collision with dredge	Bunker C fuel	4,000
2	Santa Barbara. Platform A	01-28-69	Santa Barbara Channel	Blowout of well	Crude oil (10,000 initial, subsequent oil spillage of 15,800 from 2/7/69 to 6/30/76)	
3	Santa Barbara, Platform A	12-16-69	Santa Barbara Channel	Pipeline failure	Crude oil	900
4	Navy ship	08-26-71	Off Oceanside	Accidentally discharged during refueling operation	Oil	5,000
5	Unknown	04-17-73	Approximately 10 miles west of Point Lorna	Unknown	Some type of distilled fuel oil	48
6	Tankship 35,000 to 50,000 GT	01-27-74	Long Beach Harbor	Valve failure--design fault	No. 4 fuel oil	400
7	Dry cargo ship	04-09-74	Los Angeles Harbor	Collision--hull rupture or leak	Oil	250
8	Sally H, towboat	04-15-75	Los Angeles Harbor	Sinking--hull rupture or leak	Light diesel oil	75
9	Tankship 35,000 to 50,000 GT	07-16-75	Los Angeles Harbor	Valve failure or other unknown factor	No. 6 fuel oil	2,000
10	Tankship 1,000 to 10,000 GT	12-30-75	Approximately 27 miles west of Del Mar	Unknown	Unidentified heavy oil	150
11	Sansinena, tanker	12-17-76	Los Angeles Harbor	Explosion during bunker fuel loading (most probable cause--vapor inside tank ignited from external source)	Bunker fuel	26,000

Sources: U.S. Coast Guard, Resource Agency of California; U.S. Geological Survey; Los Angeles Times.

Table II.H.4-2

THE ELEVENTH COAST GUARD DISTRICT'S OFFSHORE OIL SPILL RECORD BY LOCATION FOR CALENDAR YEAR 1974

LOCATION	Number of Incidents	% of Total	Volume in Gallons	% of Total
Los Angeles Harbor	241	29.74	14,917	42.62
Long Beach Harbor	174	21.48	7,909	22.60
L.A. Orange Offshore	59	7.28	4,010	11.46
San Diego Naval Area	186	22.96	4,785	13.67
Other San Diego Bay	77	9.51	1,134	3.24
Offshore San Diego	8	0.99	127	0.36
Port Hueneme	5	0.62	1,067	3.05
Channel Island Harbor	10	1.23	45	0.13
Ventura Offshore	8	0.99	107	0.31
Ventura Marina	3	0.37	3	0.01
Santa Barbara Harbor	13	1.61	163	0.47
Santa Barbara Offshore	26	3.22	733	2.08
TOTAL	810	100.00	35,000	100.00

Source: Eleventh Coast Guard District's Marine Environmental Protection Program, Department of Transportation, Polluting Incidents in the Eleventh Coast Guard District, Calendar Year 1974.

Table II.H.4-3

THE ELEVENTH COAST GUARD DISTRICT'S OIL SPILL RECORD BY SOURCES FOR CALENDAR YEAR 1974

LOCATION	Number of Incidents	% of Total	Volume in Gallons	% of Total
Dry Cargo	81	10.00	15,226	43.50
Tank Ships	49	6.05	7,563	21.61
Tank Barges	16	1.98	192	0.55
Combatant Vessels	143	17.64	4,452	12.72
Other Vessels	75	9.26	1,440	4.11
Water Trans Facilities	13	1.60	4,553	13.01
Offshore Facilities	24	2.96	533	1.52
Other	409	50.50	1,041	2.98
TOTAL	810	100.00	35,000	100.00

Source: Eleventh Coast Guard District's Polluting Incidents for 1974.

Table II.H.4-4

TOTAL OIL SPILL INVESTIGATIONS FROM SHIPS
IN SAN PEDRO BAY 1962-1976

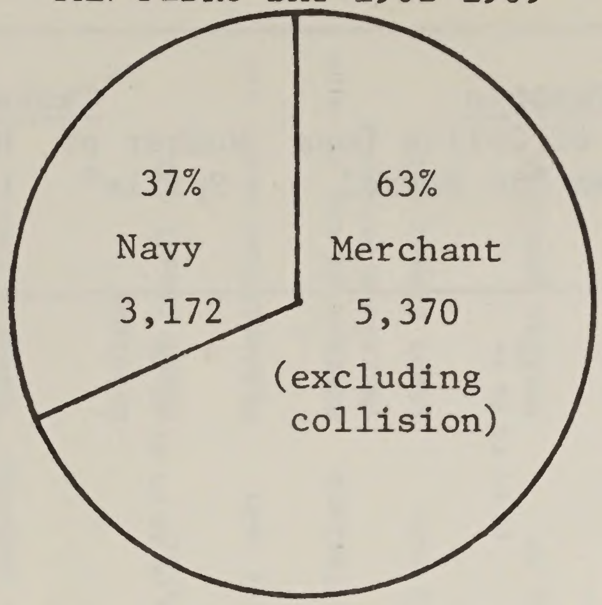
Year	Merchant	Navy
1962	32	28
1963	41	48
1964	51	36
1965	48	23
1966	52	71
1967	84	91
1968	79	57
1969	51	36
1970	98	a
1971	124	a
1972	107	a
1973	85	a
1974	81	a
1975	59	a
1976	64	a

Source: The Resources Agency, California Dept. of Fish and Game; Captain W. H. Putman.

[a]Information not available.

Table II.H.4-5

TOTAL BARRELS OF OIL SPILLED FROM SHIPS IN SAN PEDRO BAY 1962-1969



Merchant Size Spill	Merchant No. Spills	Navy Size Spill	Navy No. Spills
-1 to 1	179	-1 to 1	173
2	60	2	66
3	28	3	32
4	4	4	16
5	61	5	36
6	1	6	2
7	1	7	1
8	1	8	1
10	30	10	13
15	10	15	3
20	14	20	7
25	7	25	5
30	6	30	4
50	5	40	1
60	1	45	1
100	2	50	4
150	2	60	1
200	1	65	1
300	3	75	1
350	1	100	1
1,300	1	150	1
4,500 (collision)	1	200	1
		250	1
		300	1
		350	1

Total Number Barrels - 9,870 Total Number Barrels - 3,172

Source: The Resources Agency, California Dept. of Fish and Game; Captain W. H. Putman.

Table II.H.4-6

OIL SPILLS BY MERCHANT SHIPS IN SAN PEDRO BAY, 1976

Evolution	Dry Cargo Vessels: Number of Spills[a]	Dry Cargo Vessels: No. of Spills Less Than One Barrel	Tankships: Number of Spills[a]	Tankships: No. of Spills Less Than One Barrel
Bunkering	22	11	5	2
Fuel Transfer	6	5	2	2
Load Cargo	3	3	2	2
Ballasting	1	1	3	2
Deballasting	3	2	0	0
Leaks			3	2
Discharge Cargo			2	0
Other	7	6	5	3
TOTAL	42	28	22	13

Source: The Resources Agency, California Department of Fish and Game, Captain W.H. Putman.

[a]Excludes small oil spill (sheen) and undetermined oily bilge spill.

incidents, offshore Baja California, were indicated in a technical paper by Unidad de Ciencias Marinas (Marine Sciences Unit). These oil spills are: Tanker, Plan de Ayala, on April 15-16, 1971 spilled 60,000 barrels of heavy oil close to Rosarito; Department of the Navy vessel, in January, 1972, sank at Punta San Miguel, B.C.; and Marine Terminal at Rosarito Beach, in 1963, had minor leaks during unloading of fuel oil. Petroleos Mexicanos, the decentralized Mexican government agency which handles all matters which refer to oil, reports that no oil spills were registered in 1976 (Edmundo Flores, Director General, Consejo Nacional de Ciencia y Techologia, September 2, 1977).

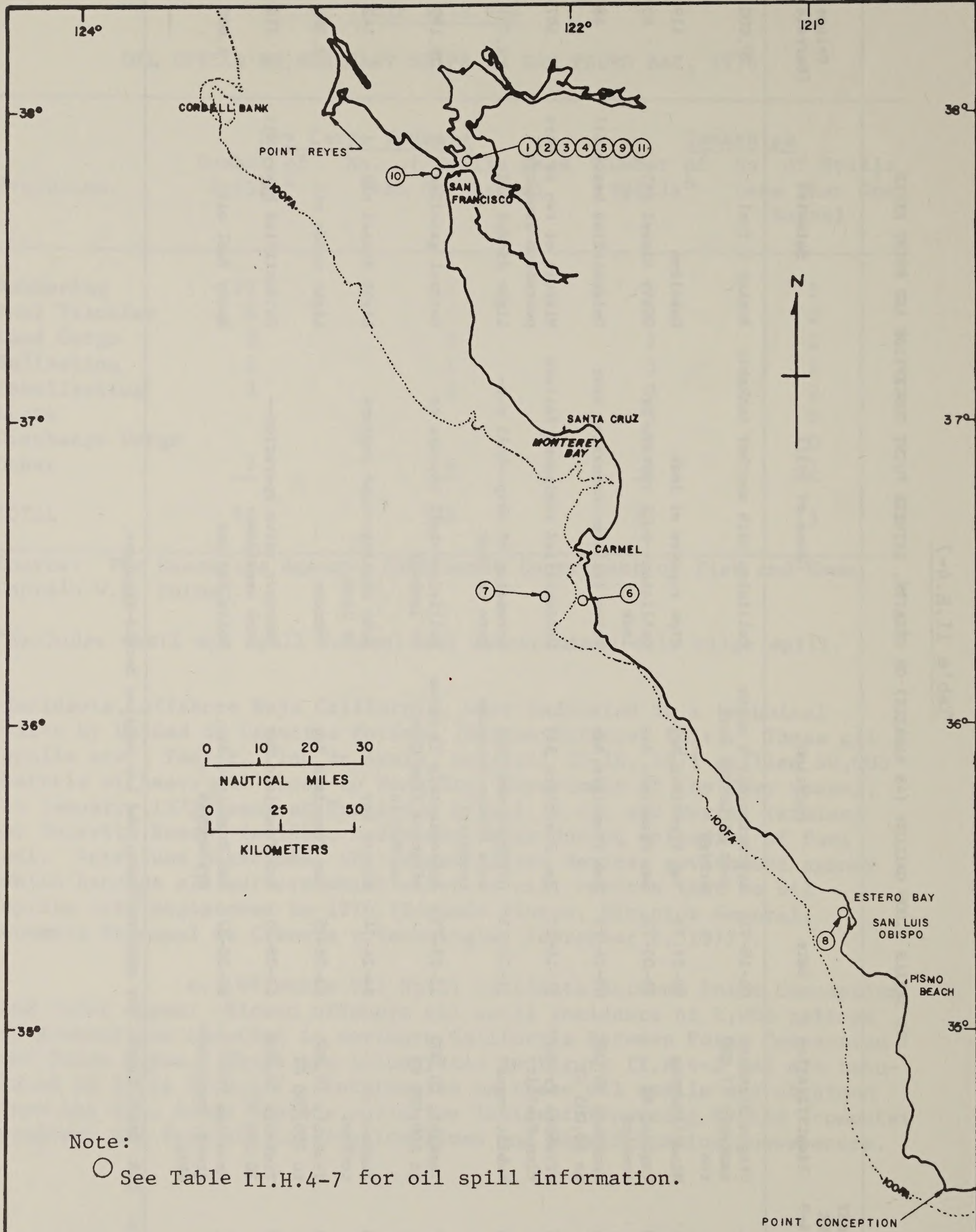
c. Offshore Oil Spill Incidents Between Point Conception and Point Reyes: Eleven offshore oil spill incidents of 2,000 gallons or greater are recorded in northern California Between Point Conception and Point Reyes. These are illustrated in Figure II.H.4-2 and are tabulated in Table II.H.4-7. Information on these oil spills was obtained from the U.S. Coast Guard's pollution incident reporting system (computer program) and from the Los Angeles Times and Herald-Examiner newspapers.

Table II.H.4-7

OIL SPILLS 2,000 GALLONS (48 BARRELS) OR GREATER, BETWEEN POINT CONCEPTION AND POINT REYES

MAP KEY FIGURE II.H.4-9	Identification	Date	Location	Cause of Spill	Material	Volume (Barrels)
1	Oregon Standard tankship 17,000 ton	01-18-71	Approximately ¼ miles west of Golden Gate Bridge	Collision with another tankship	Bunker C fuel	20,000
2	Miscellaneous	02-27-73	San Francisco Bay	Pipe rupture or leak	Gasoline	119
3	Tugboat or towboat	09-05-73	San Francisco Bay	Collision--hull rupture or leak	Heavy diesel oil	83
4	Tankship 10,000 to 20,000 GT	09-26-73	San Francisco Bay	Valve failure--excessive wear	Unidentified heavy oil	48
5	Offshore Production Facility	11-16-73	San Francisco Bay	Unidentified equipment failure	Mixture of two or more petroleum products	107
6	Public vessel	12-29-73	Offshore near San Luis Obispo-Monterey boundary	Grounding of ship--hull rupture or leak	Light diesel oil	2,200
7	Tankship 50,000 to 100,000 GT	12-29-73	Approximately 12 miles offshore from Cape San Martin	Collision--hull rupture or or leakage	Natural gasoline	26,190
8	Tugboat or towboat	04-24-74	Estero Bay	Boat sinking--tank rupture or leak	Light diesel oil	143
9	Tankship 50,000 to 100,000 GT	03-28-75	San Francisco Bay	Unknown	Light crude oil	2,381
10	Tankship 10,000 20,000 GT	12-08-75	San Francisco Bay	Improper valve operation--tank overflow	Unidentified heavy oil	714
11	Hawaiian Progress, container ship	02-10-77	San Francisco Bay, dry docked	Valve failure	Heavy fuel oil	6,000

Source: U.S. Coast Guard; Los Angeles Times; and Los Angeles Herald-Examiner.



Note:
○ See Table II.H.4-7 for oil spill information.

Figure II.H.4-2 Recorded Oil Spills Between Point Conception and Point Reyes, 2,000 Gallons or Greater.

Source: U.S. Coast Guard, Los Angeles Times, Los Angeles Herald Examiner.

5. Oil Spill Contingency Plans

a. Area of Consideration: Oil spills can occur as a result of natural disasters, equipment failure, or human error. According to a California Cooperative Oćeanic Fisheries Investigations Report (Atlas Number 16, dated June, 1972) an analysis of drift bottle recovery records from 1955 through 1971 show that under worst-case conditions a drift bottle released in the general area of the tracts being studied was recovered in the area of Point Reyes 38 days later and another was recovered in the vicinity of Scammons Lagoon 29 days later. While unlikely that an oil spill from the Southern California Bight (the detailed oil spill trajectory modeling will be discussed in Section II.A.4) will get much outside the area, the contingency study area extends from Point Reyes to Punta Eugenia.

b. Federal Laws and Regulations: The "Federal Water Pollution Control Act of 1972" (Public Law 92-500, 92nd Congress, S.2770, October 18, 1972) was amended by the Clean Water Act of 1977 (Public Law 95-217, December 27, 1977). The "Federal Water Pollution Control Act" (70 Stat. 498; 84 Stat. 91. 33 USC 1151), Section 311.(a)(1) defines oil: "'oil' means oil of any kind or in any form--". Section 311.(b)(1) goes on to say, "The Congress hereby declares that it is the policy of the United States that there should be no discharges of oil or hazardous substances into or upon the navigable waters of the United States, adjoining shorelines, or into or upon the waters of the contiguous zone or in connection with activities under the Outer Continental Shelf Lands Act or the Deepwater Port Act of 1974, or which may affect natural resources belonging to, appertaining to, or under the exclusive management authority of the United States (including resources under the Fishery Conservation and Management Act of 1976)." Section 311.(c)(2) goes on to say, "Within sixty days after the effective date of this section, the President shall prepare and publish a National Contingency Plan for removal of oil and hazardous substances, pursuant to this subsection."

i. Region Nine Multi-Agency Oil and Hazardous Materials Pollution Contingency Plan: In California, the law has been implemented by the U.S. Coast Guard Region Nine Contingency Plan.

The Region Nine Contingency Plan, prepared by the Coast Guard, is effective for coastal waters within the Standard Federal Administrative Region Nine, which is the area of California, Hawaii, Guam, American Samoa and U.S. Trust Territory of the Pacific Islands. The Region Nine Contingency Plan was issued by the Commander, Twelfth Coast Guard District, December, 1970 and revised May, 1977. Locally, copies can be obtained from: Commander, Eleventh Coast Guard District, Union Bank Building, 400 Oceangate, Long Beach, California 90822.

This plan provides for a pattern of coordinated and integrated response by departments and agencies of the Federal Government to protect the environment from damaging effects of spills. It also promotes the coordination and direction of Federal, State, and local response systems and encourages the development of local government and private capabilities to handle spills. The Region Nine Contingency Plan provides for and describes the functions of a Regional Response Team (RRT) and an On-Scene Coordinator (OSC).

The roles of the RRT and OSC as related to spills resulting from oil and gas operations will be further discussed later in this section.

Region Nine is divided into sub-regions and zones for pollution planning purposes. Therefore, the Region Nine Contingency Plan contains five apppendices, one for each sub-region. The California Sub-region is divided into two zones, Southern California (includes the Santa Barbara Channel) and Northern California. The Appendix for California is divided into two sections. The five appendices, one for each State and Territory are listed below:

Appendix I - California (Sub-region one)
Zone One Section - Southern California
Zone Two Section - Northern Califonia
Appendix II - Hawaii (Sub-region Two)
Appendix III - American Samoa (Sub-region Three)
Appendix IV - Territory of Guam (Sub-region Four)
Appendix V - The Trust Territories of the Pacific Islands (Sub-region Five)

There are three Coast Guard districts within Region Nine: the Eleventh headquarters in Long Beach which is responsible for Appendix I, zone one; the Twelfth headquarters in San Francisco which is responsible for Appendix I, zone two; and the Fourteenth Coast Guard District, Honolulu, which is responsible for Appendixes II, III, IV, and V.

For Sub-region one, zone one (Southern California) the Commander of the Eleventh Coast Guard District has been designated as Chairman of the Regional Response Team. In order to more effectively coordinate cleanup activities and to expeditiously establish and maintain liaison with local communities, the Commander, Eleventh Coast Guard District has delegated the responsibility of On-Scene Coordinator (OSC) as follows:

- Captain of the Port, San Diego - for waters adjacent to San Diego County.
- Captain of the Port, Los Angeles/Long Beach - for waters adjacent to Los Angeles and Orange Counties.
- Commanding Officer, Port Safety Detachment, Santa Barbara - adjacent to Santa Barbara and Ventura Counties (the Santa Barbara Channel area).

The Eleventh Coast Guard District, with the help of State and Federal agencies such as the California Department of Fish and Game and the U.S. Fish and Wildlife Service, has compiled hundreds of pages of data for the Southern California area to aid the OSC in advising and making decisions during an oil spill emergency. These data consist of such information as: coastline characteristics (shore and shoreline, accesses, outfall and inlets, beach usage, property owners controlling beach access, etc.), critical water uses, marine biological factors, meteorological and climatological factors, oceanographic factors (i.e. current patterns, water characteristics). A portion of these data are physically incorporated into the Regional Contingency Plan; the remainder are on file and readily available. These data would be used to predict the movement of an oil spill and to determine the order of priority for protection and cleanup of certain areas.

Regional Response Team and On-Scene Coordinator Functions. In the event of a spill originating from an oil and gas operation, the lessee or responsible party must take the initiative in combating the oil spill. The Coast Guard OSC is to determine pertinent facts about the particular spill and give advice and assistance. If the discharger is unknown, cannot be contacted, or after legal notification fails to take proper or adequate measures for removal, all response phases are conducted by the OSC. Resources for cleanup are contracted by the OSC, and resource utilization in the cleanup effort is directed by the OSC. District Comptroller and legal staff will attempt to recover funds on the cleanup from the discharger after cleanup is complete.

The Commanders of the Coast Guard Districts are responsible for chairing the regular RRT meetings and activating the RRT in the event of a spill situation meriting such action. The RRT consists of regional representatives of the primary and selected advising agencies, as appropriate. Appropriate private organizations are frequently invited to attend the regular RRT meetings. The Coast Guard and Navy are government members of the RRT with capability to supply oil-spill-combating equipment, and will do so for spills originating from oil and gas operations if the situation justifies such action.

The RRT advises the OSC during time of emergency and performs review and advisory functions relative to the regional plan. Additionally, the RRT helps to determine if and when the On-Scene Coordinator should take over a spill-combating operation. The OSC is to fully inform and coordinate closely with the RRT to ensure the maximum effectiveness of the Federal effort to protect the natural resources and the environment from pollution damage.

U.S. Geological Survey and U.S. Coast Guard Responsibilities. A memorandum of understanding between the Departments of the Interior and Transportation outlines the respective responsibilities of the Geological

Survey and the Coast Guard as to spills originating from oil and gas operations. It spells out that the Geological Survey is responsible for the coordination and direction of measures to abate the source of pollution. The Coast Guard is responsible for containment and removal operations.

ii. U.S. Geological Survey: To provide uniform cleanup regulations and standards for all oil and gas operations on Federal tracts, adherence to the U.S. Geological Survey OCS Operating Order No. 7 is required as a condition of sale. A copy of this order may be obtained from: U.S. Geological Survey, 7744 Federal Building, 300 North Los Angeles Street, Los Angeles, California 90012.

OCS Order No. 7 sets forth a reporting procedure for notifying appropriate persons and agencies and requires that immediate corrective action be taken. Additionally, it requires that all OCS operators have an approved spill contingency plan which includes a listing of spill cleanup and containment equipment. This pollution control equipment may be maintained on the particular facility or, at the discretion of the Area Supervisor, may be land-based.

iii. Stipulations: During the course of environmental analysis, if any potential problems appear relating to possible oil or gas spills that would not be covered by the above regulations, then special stipulations are also required as a condition of the lease terms. The special stipulations are published at the same time as the announcement of the sale.

iv. Funding: When an oil spill occurs and immediate funds are not available to combat it, or the party responsible for the spill cannot be immediately identified, there is an Oil Pollution Revolving Fund administered by the U.S. Coast Guard that can immediately be brought into use if the spill is in or threatens the contiguous zone.

c. State Laws and Regulations: The State of California has developed the California Oil Spill Contingency Plan. This State Plan is similar to the National and Regional Contingency Plans but has been written from the standpoint of the State of California and the State agencies. It was framed in such a way as to serve as an extension of the Federal Plans. It provides also for the State's response organizations to act, whether or not Federal forces are activated. The State Contingency plan provides for a State Operating Authority (SOA), and the SOA is charged with the responsibility and delegated authority for planning and directing the coordinated overall operations for all State and local government agencies engaged in combating a spill. The SOA coordinates these operations with Federal agencies and private organizations and regularly participates in the Regional Response Team meetings.

The SOA, in cooperation with the Federal On-Scene Coordinator, directs the State and local government agency oil spill response operations. The State Oil Spill Contingency Plan was revised in May, 1977.

The California Department of Fish and Game has also issued an "Oil and Hazardous Materials Contingency Plan" which was revised in July, 1974. This plan further clarifies and implements the State plan. Copies of these plans may be obtained from California Department of Fish and Game, 350 Golden Shore, Long Beach, California 90802.

d. Local and Private Plans: Local Federal, Cooperative, private and other groups also have detailed contingency plans. These include groups such as the Navy Construction Battallion Base at Fort Hueneme, Long Beach Naval Shipyard, San Diego Naval Shipyard, Clean Seas Inc., Clean Coastal Waters, etc. Local contingency plans are quite detailed, listing equipment, plan, numbers, etc., and therefore, are subject to frequent up-dating. Applicable groups, their address and pertinent equipment will be listed in the following pages.

e. U.S.-Mexico: Oil Spill Contingency Contacts: It was agreed at a U.S.-Mexico Health and Environmental discussion in Mexico City on August 12, 1977, that the U.S. Government will provide the following point of contact through the U.S. Coast Guard for notification in the event of an oil spill which might affect either country: Captain of the port, U.S.C.G., Marine Safety Office, 2710 Harbor Drive, San Diego, California 92101.

f. Oil Spill Cleanup Capability and Equipment: Government, industry, and universities have pursued multimillion dollar research programs since the 1969 Platform A, Santa Barbara Channel oil spill to improve procedures and equipment to effectively deal with offshore oil spills. To date, no system or equipment has been developed which is 100 percent effective in controlling and removing pollution under all weather and sea conditions. Heavy emphasis continues to be placed on preventing oil spills; however, in Southern California there are more and better equipped oil spill groups than anywhere else in the world.

The following list represents some of the key groups with offshore expertise and equipment. The many groups that respond to oil spills on shore and whose equipment is limited to shores, inland and harbors are not listed. For those that are listed, only a representative offshore type is noted. The lists of equipment for these groups changes frequently, so an address is provided should anyone desire an accurate and up-to-date list (Many of the contingency plans and associated equipment lists are quite large and a small cost is required of anyone who is not one of the member companies or a regulatory agency). It should also be remembered that this equipment is in addition to the equipment that is to be maintained at each site.

i. Southern California (Mexican Border to Point Conception):

United States Coast Guard
Pacific Team, National Strike Force
Hangar No. 2
Hamilton Air Force Base, California 94934

Although located in San Francisco, the Strike Force will have four men and their equipment on the way within 2 hours of notification. The remainder of their team will be on the way within 12 hours (total team is 18 persons).

Key Offshore Equipment
- 3 ADAPS submersible pumps
- 7 containers of ADC - High Sea Barrier boom (Each container has 612 feet of 48" boom)
- 500 feet of 36 inch Coastal Barrier boom
- 1 - 051-125 Advancing Weir Skimmer
- 1 Lockheed Open Water Oil Recovery System
- 1 Marco Class I skimmer
- 1 Acme skimmer
- 1 Slurp skimmer
- 1 Mobile command post and communications equipment.

Clean Seas Incorporated
18 Marine Center Building - Breakwater
Santa Barbara, California 93109

An oil spill cooperative consisting of 15 member companies

Key offshore equipment (Does not include 6 vans now deployed at key positions along the coast).

- 2,000 feet of 12 foot bottom - tension boom
- 2 Vikoma seapacks with 1,600 feet of boom each
- 4,000 feet of Kepner Sea Curtain boom
- 1,200 feet of Goodyear Sea Sentry boom
- 10,700 feet of Expandi boom
- 1 CSI Skimmer System
- 1 Sea Dragon skimmer
- 2 Mark - II skimmers
- 1 Komara miniskimmer
- 3 Exxon Floating weir skimmers
- 1 Acme 39 T Weir skimmer
- 5 Acme 51 T Weir skimmers
- 1 641 ton tank barge

2 5,000 gallon floating storage bags
6 1,200 gallon floating storage bags
1 Cyclonet 050 skimmer
Large quantity of sorbents and chemicals

Southern California - Petroleum Contingency Organization
Suite 2302 - International Tower
666 East Ocean Blvd.
Long Beach, California 90802

An oil spill cooperative consisting of 12 member companies

Key offshore equipment based on Catalina Island
1 Vikoma Sea Pack
1 Seavac Oil Recovery System
1 Komara Mini skimmer
2,000 feet expandi and compacts boom
1 Kepner Sea bag
1 Dunlop Dra cone
8 drums dispersant

Key offshore equipment based in Long Beach
2 Mark-II skimmers
1 Vikoma Sea Pack
3,100 feet of 36" Goodyear boom
3,000 feet of Compacti boom
1 Seavac oil recovery system
2 Kepner Sea bags
1 050 Cyclonet skimmer
1 150 Cyclonet skimmer
2 Dunlap Dracones
2 Acme skimmers

Clean Coastal Waters
Suite 1401 - International Tower
666 East Ocean Blvd.
Long Beach, California 90802

An oil spill cooperative consisting of 14 member companies

Key equipment based in Long Beach
1 Marco Class II skimmer
10,000 feet of Kepner Sea curtain boom

Department of the Navy
Naval Construction Battalion Center
Port Hueneme, California 93043

Key equipment
1,500 feet - Type I Class II boom
1 Lightweight portable skimmer
1 LCM-6 converted and rigged for skimming
1 AVR with holding tanks

Chevron U.S.A. Inc.
El Segundo Refinery
324 West El Segundo Blvd.
El Segundo, California 90245

Key equipment
7 Seavac skimmer
4 1,200 gallon oil recovery bags
10,000 feet of boom
1 Mark II skimmer

San Diego Gas and Electric
Encina Power Plant
4,600 Carlsbad Blvd.
Carlsbad, California 92008

Key equipment
1 skimmer
1,500 feet of boom

Commanding Officer
Naval Air Station
North Island, Attention: Code 315
San Diego, California 92135

Key equipment
1 DIP-3001 skimmer
3,000 feet of Sea curtain boom

Commanding Officer
Naval Supply Center
Attention: Code 701
San Diego, California 92132

Key equipment
1 LCM-6 converted and rigged for skimming
1 DIP-1001 skimmer
3,000 feet of Kepner sea curtain boom

Commanding Officer
Naval Station
San Diego, California 92136

1 LCM-6 converted and rigged for skimming
1 DIP-3001 skimmer
1 floating skimmer
5,000 feet of type 3 boom
500 feet of type 1 boom

Kepner Plastics
3131 Lomita Blvd.
Torrance, California 90505

As a major oil spill boom manufacturer, they normally have over 10,000 feet in stock that could be used in case of emergency.

Whittaker Corporation
5159 Baltimore Drive
La Mesa, California 92041

As a major oil spill boom manufacturer, they normally have over 10,000 feet in stock that could be used in case of emergency.

ii. Mexico (California border to Punta Eugenia): There is no known containment or recovery capability in this area, however if a spill from the Southern California Bight area should threaten Mexico, any of the equipment listed above could quickly be brought into use.

iii. Central California (Point Conception to Point Reyes): In addition to the equipment listed above, the resources of Clean Bay can be brought to into use.

Clean Bay, Inc.
Room 220,
2280 Diamond Blvd.
Concord, California 94520

An oil spill cooperative consisting of 14 member companies.

Key Offshore equipment
1 9,000 661 cargo tanker
17,000 feet of various sizes and types of boom
2 Marco Class III skimmers
1 Marco Class I skimmer
2 Floating Weir skimmers
5 Mark II Weir skimmers

I. Future Environment Without Proposal

Making meaningful predictions about the future environment is very difficult. However, some broad generalizations can be made, (note, relevant, current and future projects are discussed in detail in Section I.E).

The Southern California coastal zone is highly urbanized. Some governmental planning efforts are being directed towards controlled population growth and immigration has declined markedly since the high levels that characterized the 1940's, '50's and '60's. Nevertheless, growth will continue. The coastal zone will become increasingly more congested as the number of people wanting to live in and use this zone increases.

Open space for recreational and agricultural use will become more scarce, while the need for both will increase. Total direct land requirements resulting from proposed Sale No. 48 would only be 24.3 ha (60 acres). It is unlikely that this acreage, with its probable location, will have a significant impact on the total open space picture in Southern California.

Continued population growth will subject living marine resources to increased harvesting pressure. Domestic effluents, shipping and industrial effluents will also increase and will reduce water quality in the Bight. The combination of these factors will reduce marine biological productivity and the catch per unit effort for many marine fisheries will continue to diminish. The rate of decline in biological productivity will be less without the sale. However, unless a moderate oil spill occurred, this increased rate of decline would probably be undetectable, except in a few very pristine, highly productive (biologically) areas like Tanner and Cortes Banks, where high rates of oil development could occur.

Public awareness towards the environment will increase. As a result, greater efforts will be directed towards the protection of the ocean and all its species. In light of this trend, industry use and activities will receive greater scrutiny than at present. Any negative impacts will result in greater public protest.

State tidelands (offshore) oil production has declined from 89,061,000 barrels (bbl) in 1969 to 57,000,000 bbl in 1976 (62nd Annual Report of the State Oil and Gas Supervisor, most recent available figures). Note, however, that total State production has increased 1.7 percent over 1975. Although State offshore production continued to decline in 1974 through 1976, production from Federal waters offshore California can now be expected to increase as a result of higher crude prices and discoveries made from Sale No. 35. The increased production from State and Federal waters coupled with increased imports from Alaska (SOHIO project) and possibly foreign crude, will place significant stresses upon the marine and coastal environment of Southern California. For example, the SOHIO project, alone, will initially transport 700,000 bbl of oil per day to Long Beach from Valdez, Alaska. Approximately one tanker (80,000 to 165,000 dead weight tons (dwt) will arrive daily. This increase in tanker traffic would increase the volume of crude being transported and subsequently could significantly increase the potential for a large oil spill in the Bight area. Considerable land will be taken for tank farms, docks, and pipelines to handle this Alaskan crude. This places the remaining open space at greater premium.

The Port of Long Beach plans to expand its pier facilities to accommodate large crude carriers. This expansion project will require approximately 1.1 million metric tons (1.25 million short tons) of rock from Santa Catalina Island quarriers, 180,000 metric tons (200,000 short tons) of armor rock and 535,000 cubic meters (700,000 cubic yards) of spoil material from harbor dredging (DES Crude Oil Transportation System: Valdez, Alaska to Midland, Texas, 1976). The new pier would primarily handle Standard Oil of Ohio (SOHIO) tankers carrying crude from Valdez, Alaska. Initially, (1978) 700,000 bbl/day (bbl/d) would be off loaded at this pier with over 1,200,000 bbl/d arriving in the 1980's. According to the DES, these imports will create a west coast surplus of 300,000 to 600,000 bbl/d. Of course, there will still be a deficit nationwide.

Increased ship traffic will also result from the Space Transportation System (STS) at Vandenberg Air Force Base. Transportation and recovery of certain components of this system will involve increased ship and barge activity in the Bight (see Section I.C.5).

LNG (Liquefied Natural Gas) imports via tankers could result in 190 trips per year into the Southern California area (Dames and Moore, 1974; U. S. F.P.C., 1976; Arthur D. Little, 1978). Pacific Alaska LNG Company would contribute approximately 70 trips while the Pacific Indonesia LNG Company would add about 120 trips. The LNG would be delivered to one location. There is one onshore site proposed at Point Conception and six offshore sites proposed (see Section I.C.5).

Other projects under consideration include nuclear power plants and possible tankering of Elk Hills oil production from Port Hueneme. The San Onofre nuclear power plant is currently being expanded.

The conditions and projects described above will contribute toward the reduction of open space, water, and air quality and will increase congestion both onshore and offshore. The extent of most of these impacts is undetermined. However, computer air quality model studies performed for the SOHIO Project (DES Crude Oil Transportation System: Valdez, Alaska to Midland, Texas) showed increased hydrocarbon emissions from storage tanks and tankers (in Long Beach). The increases ranged from 1 percent from storage tanks to 89.9 percent from three 63,000 dwt, metric tons, (70,000 dwt short ton) tankers (ballasting simultaneously).

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project) and possibly foreign crude, would place significant [illegible] upon the marine and coastal environment of Southern California. For example, the SOHIO project alone, with potential throughput [illegible] of oil per day to Long Beach from Valdez [illegible] tanker (80,000 to 165,000 dead weight tons) traffic [illegible] daily. This increase in tanker traffic would increase the volume of crude being transported and subsequently could significantly increase the potential for a large oil spill in the Bight area. [illegible] taken for such hazards, [illegible] planned [illegible] This [illegible].

The Port of Long Beach [illegible] plan facilities [illegible] accommodate large [illegible] carriers. This [illegible] approximately 1.1 million metric tons (1.2 million short tons) of [illegible] from Santa Catalina Island quarries, 180,000 metric tons (200,000 short tons) of [illegible] and [illegible] cubic meters [illegible] cubic yards) of [illegible] material from harbor dredging [illegible] Transportation System [illegible] This plan would [illegible] carrying crude from [illegible] (1979) [illegible] would be off loaded at this pier with [illegible] arriving in the 1980's. According to the DEIR, these imports will create a [illegible] there will [illegible].

Increased [illegible] would also [illegible] from the Trans-Alaska Pipeline System (TAPS) [illegible] of [illegible] large [illegible] in the Bight [illegible].

LNG (Liquefied Natural Gas) [illegible] trips [illegible] Southern California [illegible] 1976; [illegible] Archer D. [illegible] 1978). Pacific Alaska LNG Company would contribute approximately 70 trips while the Pacific Indonesia LNG Company [illegible] Point Conception [illegible].

Other projects under consideration include [illegible] possible [illegible] of Elk Hills oil production from Port Hueneme. [illegible]

The cumulative [illegible] would [illegible] reduction of [illegible] Valdez, Alaska [illegible] from storage tanks and [illegible] from 1 percent from storage tanks to 88.9 percent from three 63,000 dwt. metric tons, 170,000 dwt short ton) tankers (ballasting simultaneously).