# California Marine Waters
# Areas of Special Biological Significance
# Reconnaissance Survey Report


CALIFORNIA STATE WATER RESOURCES CONTROL BOARD

SURVEILLANCE AND MONITORING SECTION

October 1980

WATER QUALITY MONITORING REPORT NO. 80–3

**STATE OF CALIFORNIA**
*Edmund G. Brown Jr., Governor*

**STATE WATER RESOURCES CONTROL BOARD**

*Carla M. Bard, Chairwoman*
*William J. Miller, Vice Chairman*
*L. L. Mitchell, Member*
*Jill B. Dunlap, Member*
*F. K. Aljibury, Member*

•

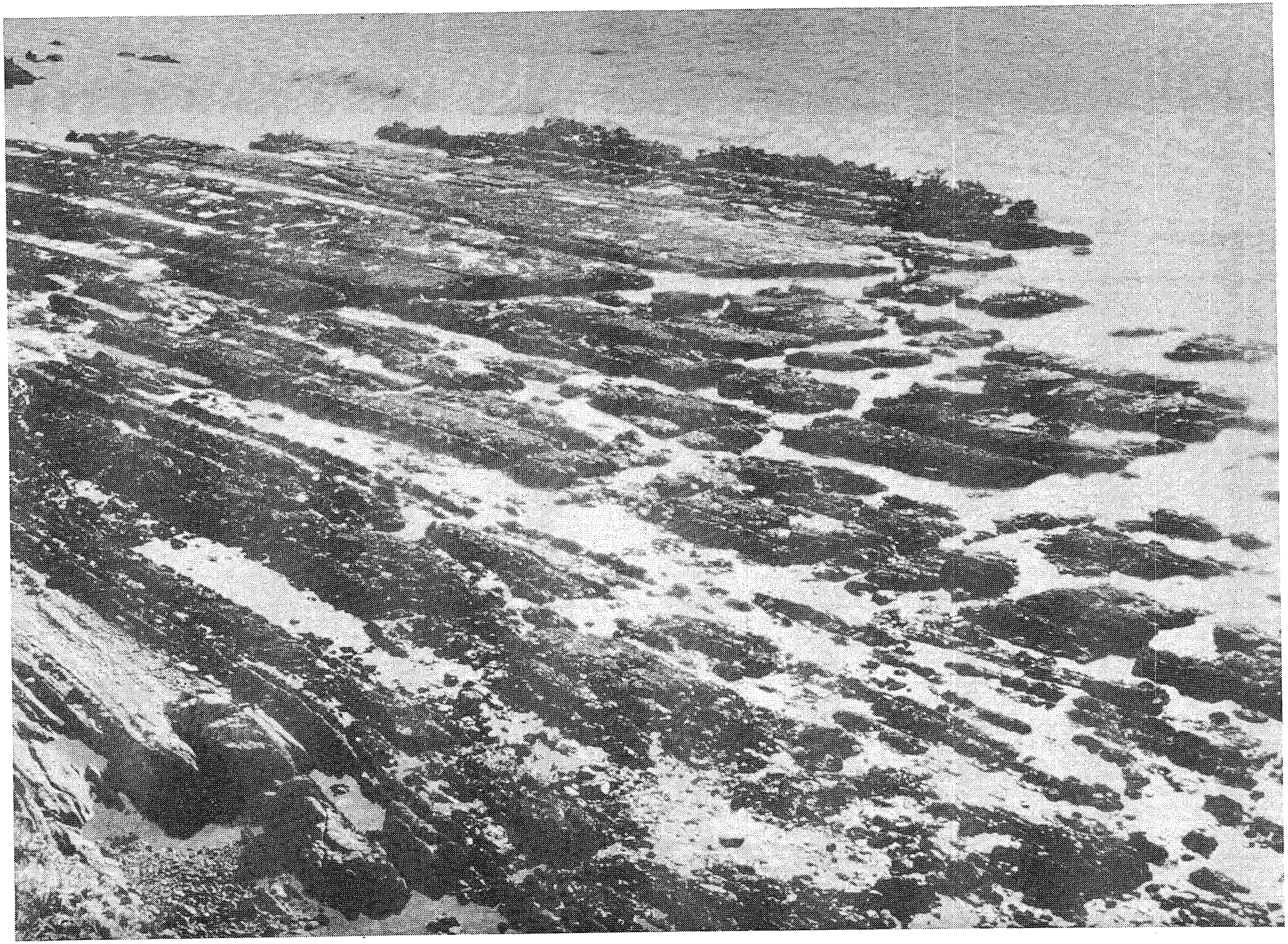
*Clinton L. Whitney, Executive Director*

Cover Photograph:

Kelp Beds at Saunders Reef

Area of Special Biological Significance

Printed:
September 1980



Kelp Beds at Saunders Reef Area of Special Biological Significance

## STATE WATER RESOURCES CONTROL BOARD
## AREAS OF SPECIAL BIOLOGICAL SIGNIFICANCE

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

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

CALIFORNIA MARINE WATERS
AREAS OF SPECIAL BIOLOGICAL SIGNIFICANCE
RECONNAISSANCE SURVEY REPORT

KELP BEDS AT SAUNDERS REEF
MENDOCINO COUNTY

STATE WATER RESOURCES CONTROL BOARD
SURVEILLANCE AND MONITORING SECTION

SEPTEMBER 1980
WATER QUALITY MONITORING REPORT NO. 80-3

## ACKNOWLEDGEMENTS

This State Water Resources Control Board Report is based on a reconnaissance survey report submitted by Michael S. Foster, Henry T. Mullins, Michael Reilly and Daniel Reed of Moss Landing Marine Laboratories. The latter report was prepared in fulfillment of an agreement with the California Department of Fish and Game, which has coordinated the preparation of a series of Area of Special Biological Significance Survey Reports for the Board under an Interagency Agreement.

## ABSTRACT

Kelp Beds at Saunders Reef Area of Special Biological Significance is located 4.6 mi (7.5 km) south of Point Arena in northern California. The ASBS is bounded on the east by an exposed, rocky intertidal shoreline and includes an offshore reef surrounded by a bull kelp, Nereocystis luetkeana, forest. The area is geologically complex, containing parts of four geologic formations which produce very heterogeneous substrata. Terrestrial vegetation adjacent to the ASBS is a characteristic maritime bluff association, and the intertidal biota is typical of that found on wave-exposed rocky shores. Sea urchins, bull kelp, and encrusting coralline algae are the most conspicuous organisms on subtidal rocks, associated with a variety of other plants and animals. The substrata and organisms both reflect the effects of large and frequent seas and swells. Although no unique components were found, a population of large red abalone in the southeast portion of the reef is noteworthy.

Lack of access, rough sea conditions, and the presence of red abalone all suggest that the area has not been greatly affected by man's activities. This may change with increasing skin diver use and greater coastal access. Some of the surrounding land is subdivided for home construction and present and future development could increase bluff erosion and restrict the view of the reef. Maintenance activities on Highway 1 and continued, unrestricted use of the bluffs overlooking the ASBS by private cars could also increase bluff erosion and destroy bluff vegetation. The use of home septic tank systems has the potential of allowing polluted water to enter the ASBS. The nearest point source of pollution is a soon-to-be upgraded waste water discharge 5 mi (8 km) south of the ASBS.

TABLE OF CONTENTS

| | Page |
|---|---|
| ACKNOWLEDGEMENT | i |
| ABSTRACT | ii |
| LIST OF TABLES | iv |
| LIST OF FIGURES | v |
| FINDINGS AND CONCLUSIONS | 1 |
| INTRODUCTION | 3 |
| ORGANIZATION OF SURVEY | 5 |
| PHYSICAL AND CHEMICAL DESCRIPTION | 7 |
| Location and Size | 7 |
| Nearshore Waters | 7 |
| Topography and Geomorphology | 11 |
| Climate | 14 |
| BIOLOGICAL DESCRIPTION | 15 |
| Subtidal Biota | 15 |
| Intertidal Biota | 24 |
| Landside Vegetation | 33 |
| Unique Components | 36 |
| LAND AND WATER USE DESCRIPTION | 37 |
| Marine Resource Harvesting | 37 |
| Municipal and Industrial Activity | 37 |
| Agribusiness | 38 |
| Governmental Designated Open Space | 38 |
| Recreational Use | 38 |
| Transportation Corridors | 39 |
| ACTUAL OR POTENTIAL POLLUTION THREATS | 40 |
| Point Sources | 40 |
| Nonpoint Sources | 40 |
| SPECIAL WATER QUALITY REQUIREMENTS | 40 |
| ANNOTATED BIBLIOGRAPHY | 41 |

## LIST OF TABLES


| Table | | Page |
|---|---|---|
| 1 | Air and Water Temperature, Rainfall . . . . . . . . | 10 |
| 2 | Subtidal Algae . . . . . . . . . . . . . . . . . . . . | 18 |
| 3 | Subtidal Animals . . . . . . . . . . . . . . . . . . | 19 |
| 4 | Intertidal Algae . . . . . . . . . . . . . . . . . . | 26 |
| 5 | Intertidal Animals . . . . . . . . . . . . . . . . . | 28 |

LIST OF FIGURES


| Figure | | Page |
|---|---|---|
| 1 | ASBS Location and Major Features . . . . . . . . . . . | 8 |
| 2 | Geological Features . . . . . . . . . . . . . . . . . . . . | 12 |
| 3 | Survey Locations Within ASBS . . . . . . . . . . . . . . | 16 |

# FINDINGS AND CONCLUSIONS

## Findings

1. The ASBS is a geologically complex area bounded on the east by cliffs supporting a characteristic maritime bluff flora.

2. The intertidal zone can be divided into three habitats: the relatively flat terrace in the north, protected areas south of the terrace and north of Iversen Point, and wave exposed, generally vertical cliffs in the central portion. These habitat differences appear to account for the biotic differences in the three regions.

3. The species composition and distribution of organisms on the reef differ depending on substratum availability, degree of water motion, and depth. The generally turbid water appears to reduce the abundance of large foliose algae below 39 ft. (12 m). Grazing by sea urchins may also reduce algal growth.

4. Natural cliff erosion may be accelerated by maintenance activity on Highway 1, unrestricted use of the bluffs for sightseeing, and home construction.

## Conclusions

1. Activity around and west of Highway 1 should be carefully planned to avoid increased erosion, view alteration and possible waste water escape into the ASBS. At present, turnouts could be improved to avoid driving on the bluffs, and some areas could be blocked to prevent vehicle access.

2. The ASBS appears to be relatively pristine. If public access is increased, more people will be able to directly enjoy the area but their activity will cause changes in both its physical and biological characteristics including reduced populations of edible species, erosion, and loss of organisms via trampling.

3. If future comparative surveys are planned to assess impacts of various activities, detailed, quantitative, long-term studies of the communities

in the area should be carried out. If impacts are to be predicted, these surveys should be combined with field experiments to test the effects of possible perturbations.

## INTRODUCTION

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

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

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

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

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

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

In order for the State Water Resources Control Board to evaluate the status of protection of Kelp Beds at Saunders Reef ASBS, a reconnaissance survey integrating existing information and additional field study was performed by Michael S. Foster, Henry T. Mullins, Michael Rielly and Daniel Reed of the Moss Landing Marine Laboratories. The survey report was one of a series prepared for the State Board under the direction of the California Department of Fish and Game and provided the information compiled in this document.

Kelp Beds at Saunders Reef Area of Special Biological (Saunders Reef ASBS) were designated as such because of the abundance of the bull kelp, Nereocystis luetkeana, which surrounds the relatively large off-shore reef. The ASBS includes the reef, portions of which are exposed at low tide, as well as a section of wave-exposed rocky intertidal shore. The area is located in a relatively pristine portion of the northern California coast just south of Point Arena.

The purpose of this reconnaissance survey is to provide a general description of the ASBS environment and to discuss current and potential effects of man's activities on the area.

## ORGANIZATION OF SURVEY

The only published information on Saunders Reef is a geological description of the region contained in a masters thesis on the geology of Point Arena (Boyle, 1967). Gotshall, et. al. (1974) conducted extensive intertidal and subtidal biological surveys around Point Arena, but did not study the ASBS. A number of useful terrestrial (Munz and Keck, 1973; Barbour and Major, 1977) and marine (Ricketts and Calvin, 1968; Miller and Lea, 1972; Smith and Carlton, 1975; Abbott and Hollenberg, 1976; Gotshall and Laurent, 1979) publications exist which include information on what organisms can be expected in particular habitats in northern California but, again, do not deal specifically with the ASBS. As a result, most of the information presented was gathered during reconnaissance surveys of the area between November, 1978 and July, 1979.

The senior author visited the area on November 11, 1978 and made general notes on shore characteristics, bull kelp distribution, and access points for future surveys. Six investigators surveyed the intertidal and nearby terrestrial biota and geological features between May 29 and 31, 1979. The terrestrial vegetation and geological characteristics were surveyed by walking the entire length of the ASBS and driving and walking through adjacent areas east of Highway 1. The low relief intertidal reefs in the northern portion of the ASBS and the protected area near Iverson Point were surveyed by noting the kinds and distribution of common macroorganisms along a number of transects from just above the splash zone to the water's edge (including tide pools) during two days of low tides and relatively calm seas. The intertidal cliffs in the southern portion of the ASBS are inaccessible from shore. Observations on plants and animals present were made from an inflatable boat launched at Saunders Landing.

Subtidal surveys of the reef and surrounding areas were made on July 24, 25, and 26, 1979. Approximately ten dives were made at depths of 13 to 68 feet (4 to 21 m) to determine the composition and distribution of the biota around the reef. Six additional dives were made from depths of 39 to 49 feet (12 to 15 m) up the sides of the reef until surge prevented further upward movement. These transects were used to describe environmental changes with depth around the reef. During all surveys, common organisms not identifiable in the field were collected, preserved, and later determined in the laboratory.

Information on land and water use and actual and potential pollution was obtained from observations in the field as well as interviews with knowledgeable people.

Catherine Agegian, Cynthia Annett, Valerie Breda, Mark Carr, Jim Cowen, John Ricker, Dennis Rose, and Steve Royce assisted with the field work.

## PHYSICAL AND CHEMICAL DESCRIPTION

### Location and Size

Saunders Reef ASBS is located in southern Mendocino County along the northern coast of California (38°51'N, 123°40'W), 4.6 miles (7.5 km) southeast of the town of Point Arena. The small town of Anchor Bay is located 5 miles (8 km) to the south. The ASBS includes an area of approximately 618 acres (250 ha), bordered on the east by 1 mile (1.6 km) of rocky intertidal zone extending north from Iverson Point, and on the west by the 100 ft. (30 m) isobath (Fig. 1). The exposed portion of the reef occurs in the south-central portion of the ASBS, approximately .6 mile (1 km) west of Saunders Landing and is marked by a navigation buoy. Cliffs, up to 100 ft. (30 m) high, border the eastern mean high tide boundary and Highway 1 parallels the ASBS near the edge of the cliffs. The legal description of the location is:

> Ocean waters beginning at Point 1 determined by the intersection of the mean high tide line and a line extending due west from USGS Bench Mark 111 at Iverson Point; thence extending northward along the mean high tide line to Point 2 determined by the intersection of a line extending due west from the midpoint of the western boundary of Section 33, T12N, R16W, MDB&M; thence extending due west along said line to its intersection with the 100-foot isobath; thence a meander line following the 100-foot isobath southerly to a point due west of Bench Mark 111; thence due east to Point 1." (State Water Resources Control Board, 1976)

### Nearshore Waters

Like most of the California coast north of Point Conception, the circulation in the region of Saunders Reef ASBS is dominated by the southward flowing California Current. This current is most important in nearshore waters during summer and early fall. Highest velocities occur in winter; at that time the current is located over 125 mi. (200 km) offshore at Cape Mendocino, north of the ASBS (Hickey, 1979). The strong, storm-associated northwest and southerly winds of fall and winter contribute to the formation of the Davidson Current which flows northward inside the California Current. This current is best developed in late fall

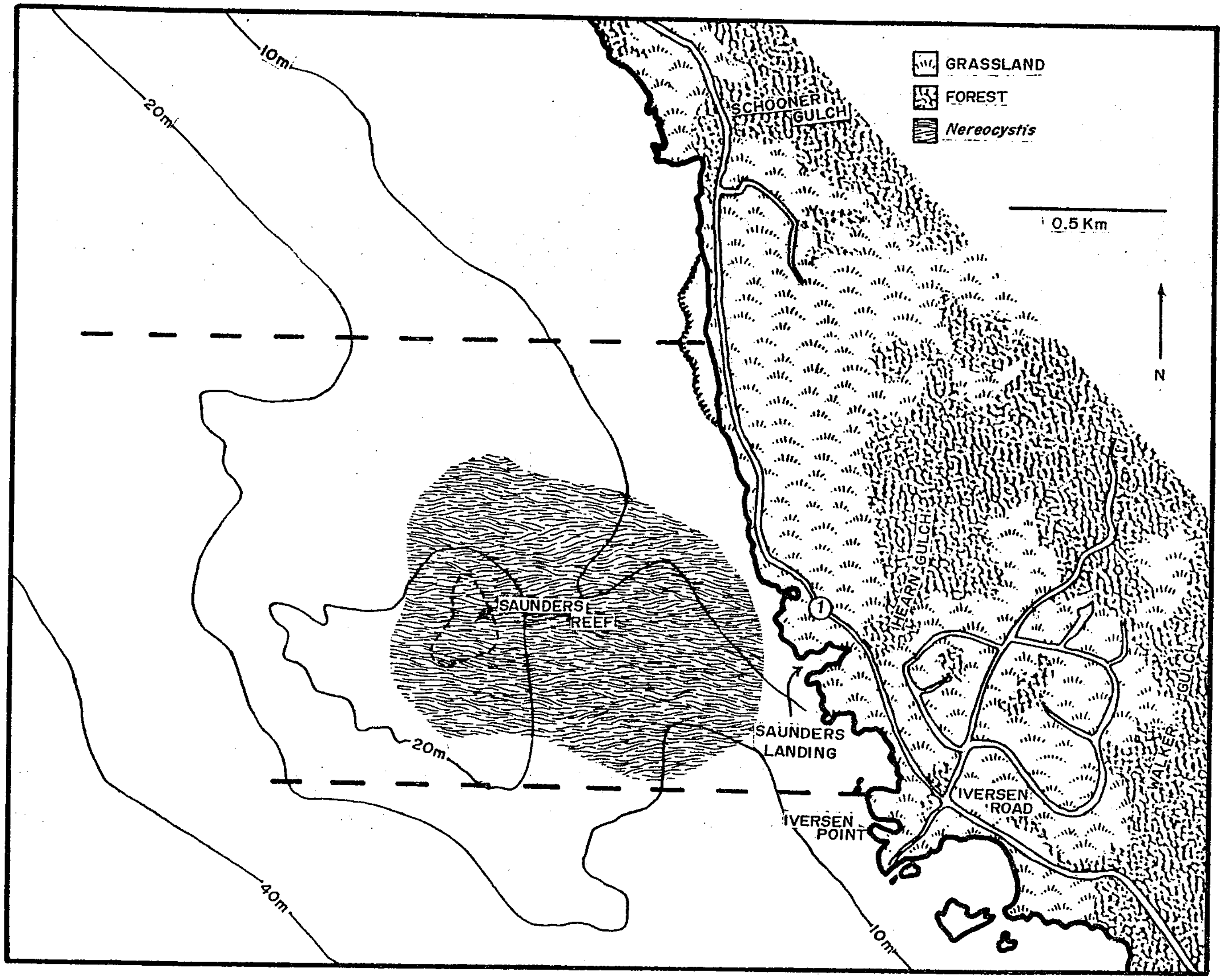



Figure 1: Saunders Reef ASBS showing location of major features. Large dotted lines mark north and south boundaries.

and winter, but northward flowing inshore currents may develop in any season if winds are favorable (Hickey, 1979).

Although no data are available for the Saunders Reef area, upwelling probably dominates the nearshore waters in spring and early summer, and may also occur at other times under favorable wind conditions. Upwelling, common along most of the California coast, brings cold, nutrient-rich water inshore which is an important stimulus to phytoplankton and, probably, macroalgal growth.

The northern location combined with cold currents and upwelling produces relatively low nearshore water temperatures. In 1978, the highest monthly mean surface temperature measured near Salt Point (south of the ASBS) was 57.2°F (13.8°C) in March and the lowest was 48.5°F (9.6°C) in December; Table 1. Although only partial records are available, temperatures at Point Arena are lower (Table 1). Records for 1975 and 1976 at Salt Point indicate that consistently low water temperatures are typical of this region.

In addition to current patterns, upwelling, and low temperatures, the shallow water around the ASBS is also strongly influenced by exposure to the large seas and swells characteristic of the northern California coast. The bottom around the reef, the cobble and boulder beaches, and the presence of the intertidal kelp, Lessoniopsis littoralis, all indicate this is an area of extreme surge and surf. Because of the high water motion, the reef and intertidal areas are accessible by small boat only a few days per year. In addition, the high water motion keeps the shallow water well mixed, maintaining high nutrient levels and low water clarity. During the three trips to the area, visibility from the surface never exceeded 5 ft. (1.5 m) and underwater visibility was less than 6.5 ft. (2 m) except in deep water on the southwest side of the reef. At the time of the surveys, the high turbidity may have been caused by both the resuspension of bottom sediments by seas and swells and by plankton blooms. Although not visited in winter, visibility during this period is probably reduced by sediment runoff from the gulches bordering the ASBS.

Table 1. Air temperature and rainfall data for Point Arena (from Anon., 1979a) and nearshore water surface temperatures for Salt Point and Point Arena (from Anon., 1979b)

Air Temp. °C

| | Highest average monthly maximum | Lowest average monthly minimum | Rainfall (inches) |
|---|---|---|---|
| 1975 | 18.0 (July and Aug.) | 0.9 (Jan.) | 43.7 |
| 1976 | 19.8 (July and Aug.) | 0.7 (Jan.) | 21.2 |
| 1977 | 19.7 (Oct.) | 1.4 (Jan.) | 29.9 |
| 1978 | 21.0 (Sept.) | 0.8 (Dec.) | 41.1 |

Mean Surface Water Temperatures, 1978

°C

| Month: | J | F | M | A | M | J | J | A | S | O | N | D |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Salt Point | 13.6 | 13.2 | 13.8 | 13.2 | 10.7 | 10.4 | 11.7 | 12.4 | 12.0 | 12.0 | 10.9 | 9.6 |
| Point Arena | -- | -- | 11.9 | 11.5 | 9.0 | 10.1 | 10.6 | -- | -- | -- | -- | -- |

-- No data available

## Topography and Geomorphology

The Saunders Reef area is part of the Gualala Block (Weaver, 1944), which comprises all the rocks west of the San Andreas Fault between Fort Ross and Point Arena (Fig. 2). The block consists of over 3.8 mi. (6 km) of Upper Cretaceous to Recent marine sediments that are highly faulted and folded (Boyle, 1967). Geologically, the Saunders Reef area is complex. Sandstones and basalts are well exposed along the sea cliffs and sea stacks in the area. These rocks are, in turn, overlain by a series of Pleistocene marine terraces.

Stratigraphy: There are four major geological units in the study area: (1) the German Rancho Formation; (2) the Iverson Basalt; (3) the Gallaway Formation; and (4) marine terrace deposits.

German Rancho Formation: This formation is over 1.9 mi. (3 km) thick in the Gualala Block (Wentworth, 1966). However, it is found only in the southern portion of the study area near Iverson Point, as well as landward of California Highway 1, where it underlies the marine terrace deposits.

The German Rancho Formation is middle Eocene in age and consists of massive sandstones interbedded with mudstones and conglomerates (Boyle, 1967). The sandstones consist of medium to very coarse sand that is normally graded with sharp or erosional bases (Boyle, 1967). Deposition of these marine sandstone beds occurred via turbidity currents in quite deep waters. The sands are angular and poorly sorted and are mainly comprised of quartz and k-feldspar with muscovite and carbonaceous material. The mudstones in this formation contain muscovite, montmorillonite, kaolinite, feldspar and quartz (Boyle, 1967). These sandstones and mudstones are also cut by numerous small faults.

Iversen Basalt: The absolute age of this basalt unit is not known. However, stratigraphically, it overlies the German Rancho Formation and underlies the Gallaway Formation. Because these basalts are extrusive volcanics and they are interbedded with the lower part of the Gallaway Formation, they are most likely Oligocene-early Miocene in age.

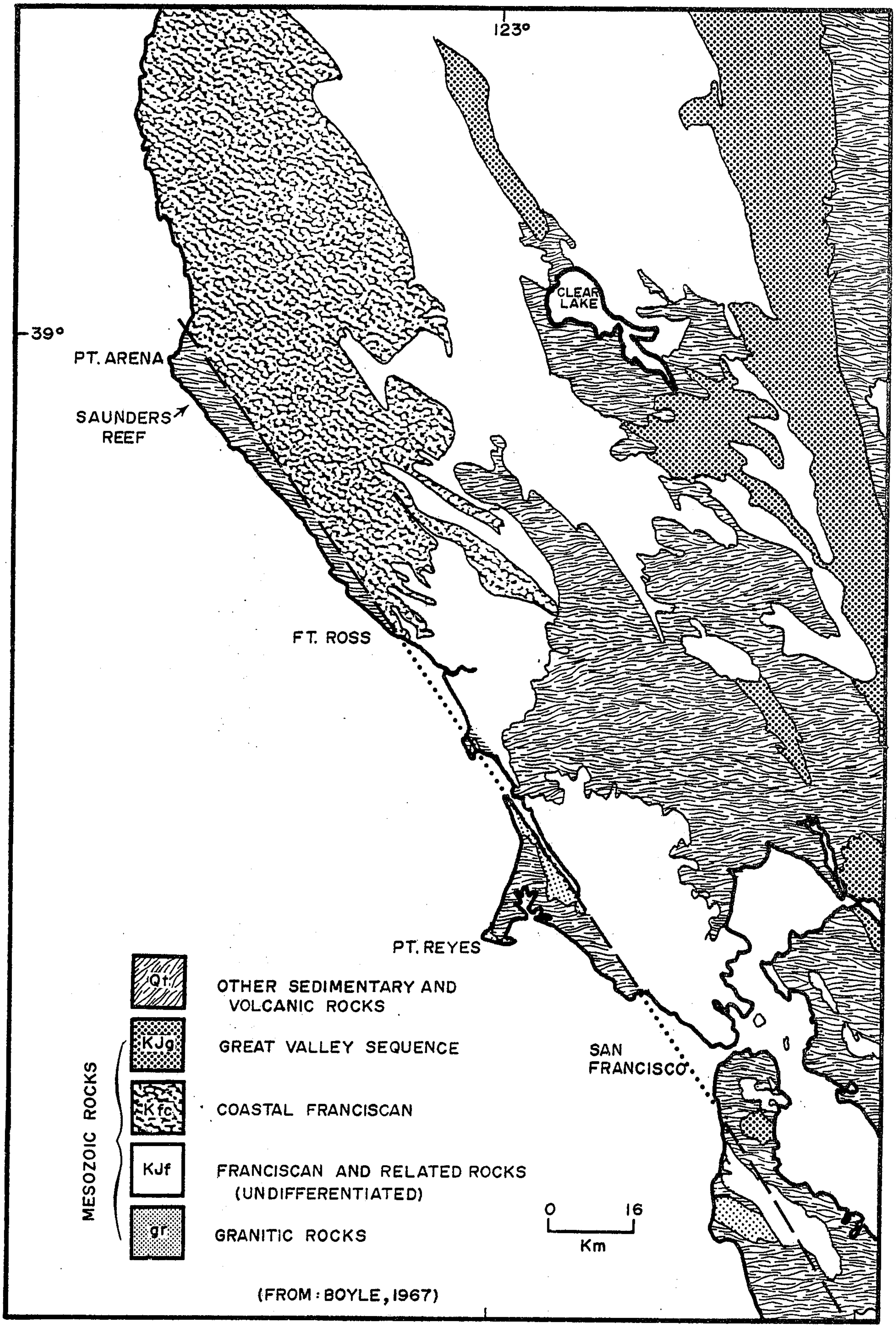



Figure 2: Geologic map of northern California coast including Saunders Reef

The Iversen Basalt outcrops in the sea cliffs along most of the ASBS study area from Iversen Point north to just south of the northern boundary. Only along the northern-most part of the study area is the Iversen Basalt not found along the sea cliffs. The Iversen Basalt also comprises all of the sea stacks found in the southern part of the ASBS.

<u>Gallaway Formation</u>: The early-Miocene Gallaway Formation consists of cemented sandstones, mudstones and occasional porcelanite, as well as some dolomite concretions and benitonite beds (Boyle, 1967). The mudstones consist of quartz, feldspar, calcite, montmorillonite, pyrite, glauconite and organic matter (Boyle, 1967). The sandstones consist predominately of quartz and feldspar (Boyle, 1967). The sandstones commonly occur as units 3 to 6 ft. (1 to 2 m) thick, but beds up to about 26 ft. (8 m) thick have been reported (Boyle, 1967).

This formation is exposed in the intertidal only in the northern-most part of the ASBS study area. The broad, intertidal terrace in the northern portion of the ASBS study area is underlain by the Gallaway Formation.

Rock samples obtained by SCUBA divers indicate Saunders Reef is part of the Gallaway Formation. The reef is actually a complex of low parallel ridges and outcrops from 1.5 to 39 ft. (.5 to 12 m) high. Some of these are exposed at low tide. The bottom between the ridges and outcrops is composed of rock, cobble and coarse sand. Large ripple marks were found in this area indicating very high surge velocities.

<u>Marine Terraces</u>: On land, there are at least three marine terrace levels immediately adjacent to the Saunders Reef area. These Pleistocene terraces lie at elevations of up to 197 ft. (60 m), providing evidence of the relatively recent tectonic uplifting which has occurred in this area.

<u>Beaches and Sea Cliffs</u>: Beaches along the Saunders Reef ASBS are cobble-boulder beaches with little sand. The only sandy beaches are found in protected "pockets" where small streams provide a supply of sand, such as at Saunders Landing. Elsewhere, during high tides, waves break directly at the base of the sea cliffs. Apparently, the wave energy is great

enough to remove almost all sand, yet leave the larger cobbles and boulders to form very narrow, discontinuous beaches.

The sea cliffs at the northern-most part of the study area are of the Gallaway Formation. Massive sandstones form the face of the cliffs and due to the massive nature of the sandstones and the precipitous cliffs, rock falls are very common.

The remainder of the sea cliffs in the ASBS are composed of the massive Iversen Basalt. Consequently, the cliffs are steeper than they are to the north and, in some places, are actually overhanging.

Due to rock falls and fresh water runoff, the sea cliffs in the area appear to be retreating rapidly landward. In fact, along some old faults or joints, headward erosion has undermined Highway 1, which, in some places in the study area, is perilously close to the sea cliffs.

## Climate

The climate of the ASBS is typical of central and northern California coastal areas with fog and afternoon northwest winds in the spring and summer and storms in the fall and winter. The highest average monthly temperatures occur in late summer and fall, and the lowest in December and January (Table 1). The moderating influence of the ocean results in equable temperatures along the coast compared with inland areas (Felton, 1965).

Although rainfall since 1975 varied between 21 and 43 inches (53 and 109 cm) (Table 1), the highest values are more typical as 1976 and 1977 were drought years. Highest rainfall occurs from January through March and lowest from June through October. Information on wind velocities indicate that small craft warnings are typical and gale and storm force winds are common, especially during the late fall and winter storm season.

## BIOLOGICAL DESCRIPTION

### Subtidal Biota

The subtidal substratum on the north, east, and south sides of Saunders Reef (Fig. 3, area A) is composed of ridges and large boulders separated by gravel in shallow, exposed areas and sand in deeper, protected areas. Sand and gravel decline and the substratum becomes almost all rock at the reef, which is made up of a number of closely-spaced ridges running parallel to the shore. The tops of some of these ridges break the surface at low tide, forming the visible portion of the reef. The almost constant white water (surf) surrounding the reef, the presence of gravel between rocks at depths of less than 40 ft. (12 m) and ripple marks in the gravel are all indicative of high water motion in the area. The bases of the rocks around this unstable substratum were often clean, while dead *Pterygophora californica* holdfasts are commonly found protruding through the sand and gravel. These observations indicate there is periodic scour and burial of hard substrata around the reef.

The southwest side of the reef (Fig. 3, area B) is more massive, with vertical walls dropping from 15 ft. (5 m) to depths of over 98 ft. (30 m). The bottom of these walls is surrounded by extensive boulder fields with rocks between .6 and 1.6 feet (.2 and .5 m) in diameter. These areas are probably more stable than the sand-cobble areas described above, but the generally low abundance of animals and high cover of encrusting coralline algae suggest the boulder fields are disturbed during periods of extreme water motion.

The area east of the reef is composed of rocky outcrops surrounded by sand and gravel, with sand and gravel cover increasing towards shore. Stream run off, sediment disturbance by water motion, and plankton blooms combine to produce turbid water in the ASBS. The resulting low light level probably limits the growth of the canopy forming bull kelp, *Nereocystis luetkeana*, to depths of less than 40 ft. (12 m). It was not observed growing deeper during the surveys. Since shallow areas fringe the western side of the reef and the water of almost the entire ASBS east of the

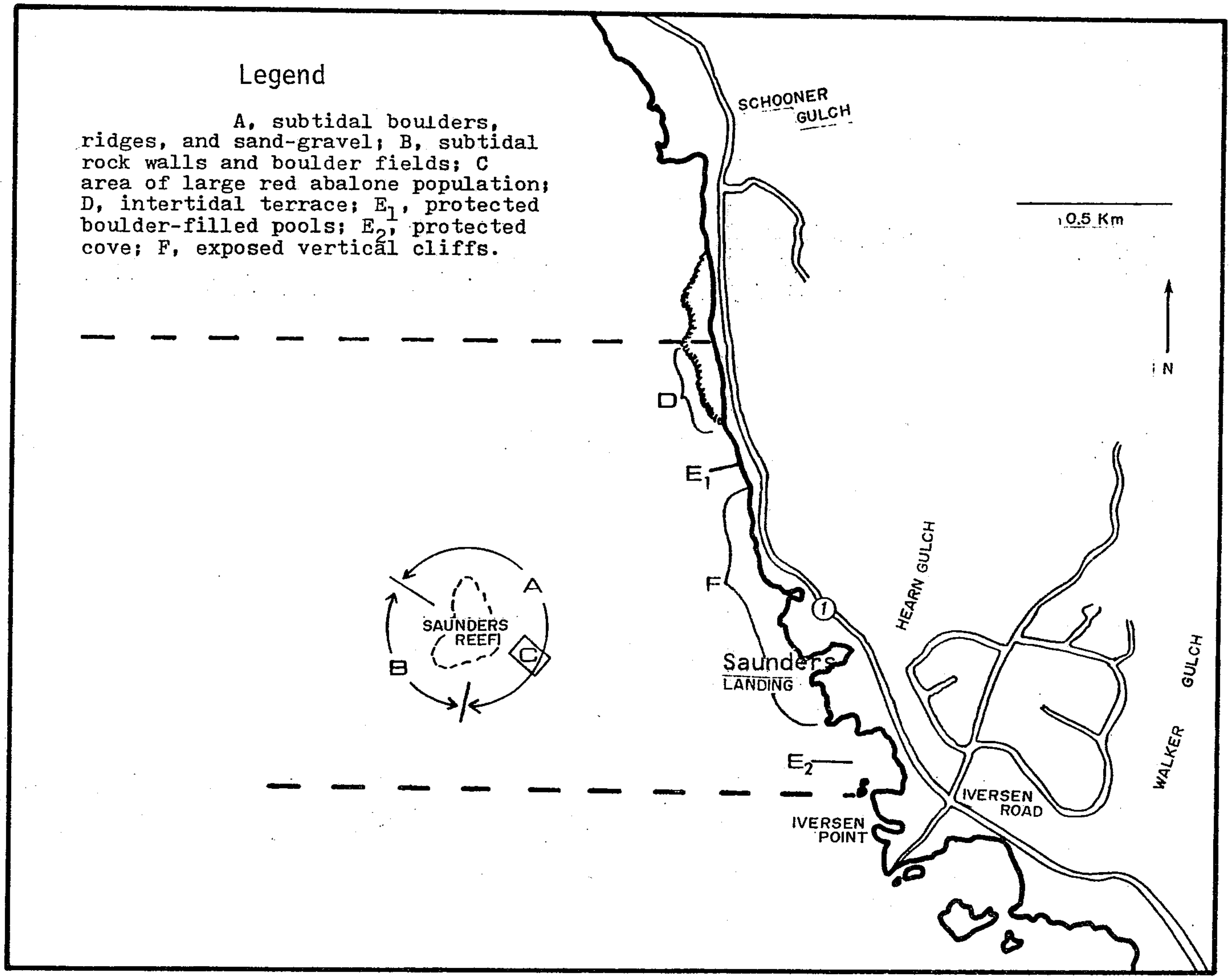



Figure 3: Survey Sites at Saunders Reef Area of Special Biological Significance

reef is 40 ft. deep or less, bull kelp could potentially occupy about 60 percent of the area if light were the only factor controlling its distribution. Bull kelp is an annual which is most highly developed in late fall prior to the first winter storms. Moreover, observations in central California indicate it does particularly well after periods of increased water motion (Foster et. al., 1979). Following the stormy winter of 1977-78, the bull kelp canopy in November, 1978, estimated to cover about 33 percent of the water surface of the ASBS, represented maximum development under the then physical and biological conditions (Fig. 1). By May, 1979, the canopy was reduced to an estimated area of about 7 acres (3 ha), due to normal annual loss as well as reduced recolonization following the relatively mild storms of winter 1978-79. The area was surveyed only in fall and summer but long-term surveys of other areas show that seasonal and year-to-year changes in N. luetkeana abundance is typical of bull kelp forests in central California (Foster et.al., 1979).

In addition to life history characteristics, light, and storms, bull kelp is also limited by available hard substratum and grazing. The occurrance of sand and gravel sets absolute limits on its abundance in the eastern portion of the ASBS.

Two other surface canopy-forming kelps occur in northern California, giant kelp, Macrocystis pyrifera, and the brown seaweed, Cystoseira osmundacea. C. osmundacea occurred occasionally during the surveys but no giant kelp was found (although it has been seen in drift on shore). These plants are probably more sensitive to removal by surge (Foster et. al., 1979) than N. luetkeana and giant kelp may be more susceptible to sea urchin grazing.

The other, more common organisms found in subtidal areas around the reef are discussed below by depth and habitat. A list of the algae is given in Table 2, and animals in Table 3. Given the duration of the surveys and the surge and poor visibility encountered while diving, these lists do not represent a complete marine flora and fauna of the area but only the most common, large organisms seen during the July, 1979 surveys.

Table 2. Subtidal algae observed during July, 1979 surveys. C, common; O, occasional; S, shallow (less than 10 m); D, deep (greater than 10 m)

Brown Algae
- *Alaria marginata* (C,S)
- *Costaria costata* (O,S)
- *Cystoseira osmundacea* (O,S)
- *Desmarestia kurilensis* (O,D)
- *D. ligulata* var. *ligulata* (C,S)
- *Dictyoneurum californicum* (O,S)
- *Laminaria dentigera* (C,S)
- *Macrocystis pyrifera* (in drift)
- *Nereocystis luetkeana* (C, S&D)
- *Pterygophora californica* (C,S)

Red Algae
- *Botryoglossum farlowianum* var. *farlowianum* (C,S)
- *Calliarthron tuberculosum* (C,S)
- *Callophyllis crenulata* (C,S)
- *C. flabellulata* (C,D)
- *Constantinea simplex* (O,D)
- *Corallina officinalis* var. *chilensis* (C,S)
- Encrusting corallines (C,S&D)
- *Fauchea laciniata* (C,S&D)
- *Neoptilota densa* (O,D)
- *N. hypnoides* (C, epiphytic on C. tuberculosum)
- *Opuntiella californica* (O,S&D)
- *Pikea californica* (O,D)
- *Polyneura latissima* (C,S)
- *Polysiphonia* spp. (C,D)
- *Porphyra nereocystis* (C, epiphytic on *N. luetkeana*)
- *Rhodymenia californica* (C,S&D)

Green Algae
- *Debesia marina* (O,S&D)

Table 3. Subtidal animals observed during July, 1979 surveys. C, common; O, occasional; S, shallow (less than 10 m); D, deep (greater than 10 m)

Sponges
*Acarnus erithicus* (O,S)
*Cliona celata* var. *californiana* (C, on shells)
*Isodictya quatsinoensis* (C,D)
*Leucilla nuttingi* (O,S)
*Ophlitaspongia pennata* (O,S&D)
*Polymastia pachymastia* (O,S&D)
*Tethya aurantia* var. *californiana* (O,D)
*Tetilla arb* (O,D)

Bryozoans
*Hippodiplosia insculpta* (O,D)
*Lichenopora* sp. (O,D)

Anemones, Hydroids, and Corals
*Aglaophenia struthionides* (C,S)
*Balanophyllia elegans* (C,S&D)
*Corynactis californica* (C,S&D)
*Eudendrium californicum* (C,D)
*Metridium senile* (C,D)
*Sertularia* sp. (C,D)
*Tealia coriacea* (O,D)
*T. lofotensis* (O,D)
*T. piscivora* (O,D)

Worms
*Chaetopterus* sp. (C,D)
*Diopatra ornata* (C,D)
*Dodecaceria* sp. (C,D)
*Eudistylia polymorpha* (O,D)
*Myxicola infundibulum* (O,D)
*Pista elongata* (C,D)
Serpulids (O,D)

Crustaceans
*Balanus nubilus* (O,S&D)
*Cancer antennarius* (O,S&D)

Molluscs
*Anisodoris nobilis* (O,S&D)
*Cadlina luteomarginata* (O,D)
*Calliostoma annulatum* (C,D)
*Ceratostoma foliatum* (C,D)
*Clinocardium nuttallii* (C, dead shells on sand and cobble)
*Cryptochiton stelleri* (O,S)
*Diaulula sandiegensis* (O,D)
*Diodora aspera* (C,S&D)
*Haliotis kamtschatkana* (O,D)
*H. rufescens* (O,S)
*Hinnites multirugosus* (O,S&D)

Table 3 (cont.)

Molluscs (cont.)
*Mitra idae* (O,S&D)
Pholid clams (O,S&D)
*Tegula brunnea* (O,S)
*T. pulligo* (C, on *L. dentigera*)
*Tonicella lineata* (C, on encrusting corallines)

Echinoderms
Brittle stars (C,D)
*Cucumaria miniata* (O,S&D)
*C. piperata* (O,D)
*Dermasterias imbricata* (O,D)
*Eupentacta quinquesemita* (C,D)
*Henricia leviuscula* (O,S&D)
*Leptasterias* sp. (O,S)
*Orthasterias koehleri* (O,D)
*Patiria miniata* (O,S)
*Pisaster brevispinus* (C,D)
*P. giganteus* (C,S&D)
*P. ochraceus* (O,S&D)
*Pycnopodia helianthoides* (O,S&D)
*Solaster stimpsoni* (O,S&D)
*Strongylocentrotus franciscanus* (C,S&D)
*S. purpuratus* (C,S)

Tunicates
*Archidistoma psammnion* (O,S)
*Clavelina huntsmani* (O,S)
*Didemnum* sp. (O,C)
*Diplosoma macdonaldi* (C,S)
*Pyura haustor* (O,D)
*Ritterella rubra* (O,S)
*Styela montereyensis* (O,S)

Fish (abundance and habitat not estimated due to poor visibility)
Cottids
*Damalichthys vacca*
*Embiotoca lateralis*
*Hexagrammos decagrammus*
Juvenile rockfish
*Ophiodon elongatus*
*Oxylebius pictus*
*Scorpaenichthys marmoratus*
*Sebastes melanops*
*S. mystinus*
*S. paucispinis* (juv.)

Birds and Mammals (sighted in, on, or over water)
*Cepphus columba* (pigeon guillemot)
*Larus occidentalis* (western gull)
*Pelecanus occidentalis* (brown pelican)
*Phalacrocorax pelagicus* (pelagic cormorant)
*Phoca vitulina* (harbor seal)
*Zalophus californianus* (california sea lion)

The shallow (less than 33 ft. or 10 m) tops and upper sides of the ridges and boulders around the eastern portion of the reef are almost completely covered with large brown and red algae. In very shallow water (less than 9.8 ft. or 3 m) the split whip kelp, *Laminaria dentigera*, forms an almost complete canopy about 3 ft. (1 m) tall over dense mats of the articulated coralline algae, *Corallina officinalis* var. *chilensis* and *Calliarthron tuberculosum*. In slightly deeper water, bull kelp forms a surface canopy with split whip and another kelp, *Pterygophora californica*, forming a patchy understory canopy. Other large understory brown algae include *Dictyoneurum californicum*, *Costaria costata*, and *Alaria marginata*. Articulated corallines are less abundant than in shallow water and occur within a dense bottom cover of the foliose red algae, *Botryoglossum farlowianum* and *Polyneura latissima*. The brown alga, *Desmarestia ligulata* var. *ligulata* was also abundant, as were various juvenile kelps (*N. luetkeana*, *L. dentigera*, and *P. californica*). Animals are uncommon in this region of extreme water motion. Turban snails, *Tegula* spp., occurred on the kelps; hydroids, especially *Aglaophenia struthionides* were found attached to the articulated corallines.

The mid and low portions of these rocks are generally dominated by the sea urchins, *Strongylocentrotus purpuratus* and *S. franciscanus*. The purple urchin, *S. purpuratus*, was more common in shallow areas, reaching high densities. At depths below 26 ft. (8 m), the giant red urchin, *S. franciscanus*, was extremely common and sometimes formed patches of almost complete cover. This animal is the most abundant large invertebrate on and around the reef. Shallow water populations tend to contain relatively small individuals with short spines while those in deep water contained individuals which commonly exceeded 15 cm in test diameter and had long spines. Where sea urchins form dense aggregations, the flora is reduced to encrusting corallines and a few scattered clumps of *Rhodymenia californica*. Where sea urchins are sparse, dense mats of the strawberry anemone, *Corynactis californica*, cover the substratum. Solitary corals, *Balanophyllia elegans*, occur in these areas, as well as various tunicates and sponges. The finger sponge, *Isodictya quatsinoensis*, which reaches the southern limit of its distribution around Point Arena (Gotshall and Laurent, 1979), was common.

In most areas the bottoms of these ridges and boulders are scoured bare or inhabited by the red sea urchin. However, in the southeast portion of the reef (Fig. 3, area C), red abalone, Haliotis rufescens, are extremely common, often partially buried by sand or cobble. When red abalone are present, red sea urchins occur above, but generally not with, them. Some low relief boulders were almost completely covered with abalone. The shells are covered with dense growths of algae and invertebrates, making them difficult to distinguish from the surrounding rock. The thick algal-invertebrate mats around the abalone and the bare areas beneath them suggest they are subsisting mainly on drift algae and do not actively forage on attached plants. A number of individuals were observed feeding on drifting kelp blades or with their foot lifted partially off the substratum, a posture presumably used to catch drifting plant material. In areas of solid rock, abalone were found concentrated in large crevices and channels, areas where drift also accumulates.

Although individual red abalone were occasionally found in other regions of the reef, large populations were only found in the southeast portion. If their distribution were being affected by sport divers, one would expect densities to be lowest here as this area is closest to the diver access point at Saunders Landing (Fig. 3). They may occur on the lee side of the reef because drift algae are transported with the predominant northwest swells into the area. J. DeMartini (pers. comm.) has observed similar abalone distributions in other regions of northern California and also suggests they are related to the distribution of drift algae.

The sand and gravel surrounding the rocks lacks large organisms, due to disturbance during high water motion. The tube worm, Diopatra ornata, occasionally occurs in patches, and numerous dead heart cockle shells, Clinocardium nuttallii, were found indicating these molluscs may occur in the substratum.

In deeper water (32 to 38 ft. or 10 to 12 m) Strongylocentrotus franciscanus continues to be quite common and, probably because of a combination of its grazing and low light, encrusting coralline algae cover most of the substratum with occasional patches of small red algal blades from

Opuntiella californica, and Desmarestia kurilensis. Invertebrates include various polychaete worms, the white sea cucumber, Eupentacta quinquesemita, and the sea stars, Pisaster ochraceus, P. giganteus, Solaster stimpsoni, and Pycnopodia helianthoides.

The tops of the vertical walls on the southwest side of the reef are covered with species similar to those found on the shallow ridge tops described above. However, because the rock falls off quickly into deep water, the area covered by this association is much smaller. The walls themselves are almost devoid of foliose macroalgae with most available space covered by encrusting coralline algae. Red sea urchins are also abundant here, as are anemones, including mats of the red anemone, Corynactis californica, clumps of Metridium senile and individual Tealia piscivora. Diopatra ornata occurs in cracks. The deep boulder fields contain occasional clumps of the algae Opuntiella californica and Desmarestia kurilensis growing on a cover of encrusting corallines. Brittle stars were common under boulders, and the stubby rose anemone, Tealia coriacea, and the orange sea cucumber, Cucumaria miniata were frequently found between boulders.

Fish observations were limited during the surveys by heavy surge and poor visibility. Species found are listed in Table 3. The blue rockfish, Sebastes mystinus, was especially common, as were juvenile boccacio, S. paucispinis, and other unidentified species of juvenile rockfish. The rockfish were most common in mid-water and under the surface canopy of bull kelp, Nereocystis luetkeana. Various perch were encountered over the shallow reefs, and lingcod, Ophiodon elongatus, kelp greenling, Hexagrammos decagrammus, cabezon, Scorpaenichthys marmoratus, and numerous small cottids were frequently seen on the bottom. Sea lions, harbor seals, and various sea birds (see Table 3) were observed in the water around the reef. Some of these birds nest on the cliffs above the ASBS but no seals were observed on land.

In general, the subtidal biota of Saunders Reef ASBS is typical of that found in rocky, wave-exposed nearshore areas in central and northern California. The major factors affecting the distribution of the macroorganisms appear to be the availability of suitable substrata, ability to persist under very high water motion and, for the algae in particular, suitable light and the grazing activities of red and purple sea urchins. The most striking feature is the dense but localized population of large red abalone on the reef. The continued existence of this population is probably a result of inaccessibility, high water motion, and water turbidity. All of these combine to make sport diving difficult in the area.

## Intertidal Biota

The intertidal portion of Saunders Reef ASBS is almost entirely rocky. The northern section is a low intertidal terrace (Fig. 3, area D) composed of mudstone and occasional sandstone. The terrace, up to 300 ft. (100 m) wide from east to west, is a series of ridges and channels which run parallel to the shore. Sandstone cliffs rise abruptly from the upper intertidal portion of the terrace. The narrow strip between the terrace and cliffs is sandy in the north but grades into gravel and then boulders farther south. The graduation suggests an increase in wave action from north to south. This is probably true as the coast turns west above the sandy beach at Schooner Gulch just north of the ASBS (Fig. 3), protecting northerly portions from northwest swells.

A large, relatively protected, boulder-filled area occurs between the end of the terrace and the intertidal cliffs to the south (Fig. 3, area $E_1$). South of the boulder area the intertidal zone is primarily vertical volcanic cliffs with a number of small coves and offshore rocks. The outer cliffs are exposed to the full impact of waves and are frequently undercut. Blowholes are common. Coves and offshore rocks increase in the southwest part of the ASBS between Saunders Landing and Iversen Point, forming a large protected region inshore. Small sandy beaches occur only at the head of Saunders Landing and the cove to the north.

The surveys indicate that the intertidal area can be divided into three habitats: the terrace (Fig. 3, area D) occupying about 1/4 of the length of the ASBS; relatively protected areas (Fig. 3, areas E1 and E2) occupying another 1/4 of the length of the ASBS; and the exposed vertical cliffs

(Fig. 3, area F) representing about 1/2 of the length of the ASBS. These habitats will be described in order below. The intertidal zonation of plants and animals typical of many places along the coast (Ricketts and Calvin, 1968) is obscured in most of these habitats due to topography (such as relatively flat terraces) and/or extreme water motion which wets areas high above the normal range of the tides. Therefore, the distribution of organisms within habitats will be discussed in general terms using high (away from the sea and/or greater than +4 ft. above Mean Lower Low Water), mid (generally about +1 to +4 ft. above MLLW) and low intertidal (+1 down to -0.1 ft. below MLLW, the lowest tidal level at the time of the surveys) as location designations. The kinds and distribution of only the more common plants and animals are discussed. A list of all intertidal plants observed is given in Table 4 and animals in Table 5.

The high, shoreward portion of the intertidal terrace is dominated by limpets, Collisella scabra and C. digitalis, with occasional patches of acorn barnacles, Balanus glandula, and the small Chthamalus dalli. Patches of the brown alga, Ralfsia sp., the red alga, Porphyra sp., and the green, Enteromorpha sp., occasionally occur in this region, particularly on high rocks surrounded by sand. The channels between the ridges are generally filled with sand or cobble-boulders, and the movement of this material during high tide keeps the channels free of attached organisms. Sand in this region is probably transported from the beach at Schooner Gulch, and cobbles and boulders may be supplied by rock falls from the cliffs.

Periwinkles, Littorina planaxis and L. scutulata, increase in abundance as one moves away from the cliffs, and macroalgae, Gigartina papillata and Endocladia muricata, typical of the high intertidal zone, begin to cover the tops of the ridges. The bladder-like red algae, Halosaccion glandiforme and the red iridescent, Iridaea flaccida, occur in channels free of sand, and tide pools are densely covered with red point, Prionitis lanceolata, and Corallina officinalis var. chilensis. Collisella digitalis is also common in this region.

Table 4. Intertidal algae observed during May, 1979 surveys. C, common; O, occasional; T, in terrace area; W, on vertical walls and cliffs; Q, in calm areas; H, in high intertidal; M, in mid-intertidal; L, in low intertidal; P, in tide pools.

Brown Algae
- *Alaria marginata* (C,all,L)
- *Analipus japonicus* (O,T&Q,M)
- *Costaria costata* (O,T,L&P)
- *Cylindrocarpus rugosus* (O,T,M)
- *Cystoseira osmundacea* (C,Q,L)
- *Desmarestia ligulata* var. *ligulata* (O,Q,L)
- *Egregia menziesii* (O,all; L&P)
- *Fucus distichus* (C,T,M)
- *Hedophyllum sessile* (O,Q&W,M&L)
- *Laminaria dentigera* (C,all,L)
- *L. sinclairii* (O,Q,L)
- *Lessoniopsis littoralis* (C,T&W,L)
- *Nereocystis luetkeana* (O,Q,L)
- *Pelvetia fastigiata* (O,Q,H)
- *Pelvetiopsis limitata* (O,T,H)
- *Postelsia palmaeformis* (C,T&W,L)
- *Ralfsia* sp. (C,T,H)
- *Scytosiphon lomentaria* (C,T,M)
- *Soranthera ulvoidea* (O,T, epiphyte on *O. floccosa* and *R. larix*)

Red algae
- *Bossiella orbigniana* (O,T&W,M&L&P)
- *Botryoglossum farlowianum* var. *farlowianum* (C,Q,L)
- *Calliarthron cheilosporoides* (O,Q,L)
- *C. tuberculosum* (C,Q,P)
- *Callithamnion pikeanum* (C,Q,M)
- *Corallina officinalis* var. *chilensis* (C,all,M&L&P)
- *C. vancouveriensis* (C,T,all)
- *Cryptopleura lobulifera* (C,T&W,L)
- *Delesseria decipiens* (O,Q,L)
- Encrusting corallines (C,all,all)
- *Endocladia muricata* (C,all,H&M)
- *Erythrophyllum delesserioides* (O,Q,L)
- *Gastroclonium coulteri* (O,T,M&L)
- *Gelidium* sp. (C,T,M)
- *Gigartina agardhii* (C,T,M)
- *G. papillata* (C,T,H&M)
- *Halosaccion glandiforme* (O,T,M)
- *Halymenia schizymenioides* (O,Q,L)
- *Iridaea* sp. (C,W,M&L)
- *I. cordata* (C,T&Q,M&L)
- *I. flaccida* (C,T&Q,M)
- *I. heterocarpa* (C,T&Q,M)
- *Laurencia spectabilis* (O,Q,L)
- *Lithophyllum imitans* (O,T&Q,M&L)
- *Melobesia mediocris* (C, on Phyllospadix)
- *Microcladia borealis* (C,T,L)

Table 4 (cont.)

Red Algae (cont.)
*Odonthalia floccosa* (C,T,M&L)
*O. washingtoniensis* (C,Q,L)
*Plocamium cartilagineum* (O,Q,L)
*Polysiphonia johnstonii* (C,Q,M&L)
*Porphyra* sp. (O,T,H)
*P. lanceolata* (O,T,M)
*P. perforata* (O,T,H)
*Prionitis lanceolata* (C,T,P)
*Pterosiphonia bipinnata* (O,Q,M&L)
*Rhodomela larix* (O,T,M&L)

Green Algae and Flowering Plants
*Bryopsis corticulans* (O,Q,M)
*Cladophora columbiana* (C,T,H&M&P)
*Enteromorpha* sp. (O,T,H)
*Phyllospadix* sp. (C,all,L&P)
*Spongomorpha coalita* (C,T&Q,M)
*Ulva* sp. (C,all,all)

Table 5. Intertidal animals observed during May, 1979 surveys. C, common; O, occasional; T, in terrace area; W, on vertical walls and cliffs; Q, in calm areas; H, in high intertidal; M, in mid-intertidal; L, in low intertidal; P, in tide pools.

Anemones and Corals
- *Anthopleura elegantissima* (C,T&Q,L&P)
- *A. xanthogrammica* (C,T,M)
- *Balanophyllia elegans* (O,Q,L)
- *Epiactis prolifera* (C,T&C,P)

Worms
- Nemerteans (O,T,L)

Crustaceans
- *Balanus cariosus* (C,T,M&L)
- *B. glandula* (C,all,H)
- *Cancer antennarius* (O,T,P)
- *Chthamalus dalli* (C,all,H)
- Hermit crabs (C,T&Q,M&L&P)
- *Idotea* sp. (O,T,L)
- *Ligia* sp. (C,T,H)
- *Pachygrapsus crassipes* (C,T,H&M)
- *Petrolisthes* sp. (C,T&Q,M&L)

Molluscs
- *Acmaea mitra* (C,T,M&L)
- *Collisella digitalis* (C,all,H)
- *C. pelta* (C,W, on L. littoralis)
- *C. scabra* (C,all,H)
- *Cryptochiton stelleri* (O,Q,L)
- *Katharina tunicata* (C,T&W,L)
- *Littorina planaxis* (C,T,H)
- *L. scutulata* (C,T,H&M)
- *Mopalia muscosa* (C,T,M&L)
- *Mytilus californianus* (C,T&W,M&L)
- *Notoacmea scutum* (C,T,M)
- *Nucella emarginata* (C,T,M&L)
- *Protothaca staminea* (O,Q,M&L)
- *Tegula brunnea* (O,Q,L)
- *T. funebralis* (C,T,H&M)
- *Tonicella lineata* (O,T&Q,L&P)

Echinoderms
- *Henricia leviuscula* (O,Q,P)
- *Leptasterias hexactis* (C,T,M)
- *Pisaster ochraceus* (C,all,M&L)
- *Strongylocentrotus franciscanus* (O,T&Q,P)
- *S. purpuratus* (C,all,M&L)

Table 5 (cont.)

Fish
- Cottids (C,T&Q,P)
- Juvenile rockfish (C,T&Q,P)
- Pricklebacks and/or gunnels (C,T&Q,P)

Birds (on cliffs and in or over intertidal)
- *Cepphus columba* (pigeon guillemot)
- *Corvus corax* (common raven)
- *Haematopus bachmani* (black oystercatcher)
- *Larus occidentalis* (western gull)
- *Petrochelidon pyrrhonota* (cliff swallow)
- *Phalacrocorax pelagicus* (pelagic cormorant)

The mid-portion of the terrace is composed of flat reefs separated by shallow channels. The reef tops have an almost 100 percent cover of turkish towel, Gigartina papillata, and nail brush, Endocladia muricata, with patches of the rockweed, Fucus distichus, and the red, sack-like alga, Halosaccion glandiforme. The aggregating anemone, Anthopleura elegantissima, and surf grass, Phyllospadix sp., commonly cover reef walls. The grazing snails, Littorina scutulata and Tegula funebralis, occur with the algae and in tide pools, and the predatory whelk, Nucella emarginata, occurs on patches of acorn barnacles. The deeper channels and tide pools are usually occupied by purple sea urchins, Strongylocentrotus purpuratus burrowed into the substratum, the ochre star, Pisaster ochraceus, and numerous hermit crabs. Algae dominate the shallow channels and include sea grapes, Gastroclonium coulteri, Calliarthron tuberculosum, and bottle brush, Odonthalia floccosa, with epiphytic Soranthera ulvoidea.

Species composition changes considerably towards the outer, seaward portion of the terrace. The alga Iridaea flaccida becomes dominant on top of the ridges, associated with I. heterocarpa and Gigartina agardhii. The chiton Mopalia mucosa is common under this algal cover. Further towards the sea, the sea palm occupies the ridges, along with dense patches of sea sac, goose-neck barnacles, Pollicipes polymerus, and California mussels, Mytilus californianus. Nail brush covers the mussel shells in high areas.

As wave exposure increases, overall cover of organisms decreases. In the most wave-exposed areas, Lessoniopsis littoralis, a massive kelp characteristically found in strong surf, replaces the sea palm. Two other kelps, split whip, Laminaria dentigera, and Neptunes quill, Alaria marginata, occupy the sides of the exposed ridges along with the purple sea urchin. Dense mats of the red algae Cryptopleura lobulifera and delicate sycophant, Microcladia borealis, occur beneath both L. littoralis and sea palm. Tide pools along the exposed edge of the terrace are dominated by burrowing purple sea urchins and the large, solitary anemone, Anthopleura xanthogrammica. Many of the anemones were feeding on purple sea urchins presumably dislodged by wave action.

The terrace curves towards the cliff at its southern end, and between the two is the large, boulder-filled area protected from wave action by the terrace to the north (Fig. 3, $E_1$). The flora in the mid-to-low intertidal zone and large tide pools is quite different from that on the terrace, being dominated by large, relatively delicate plants or larger forms of plants encountered on the terrace. These include surf grasses, Neptunes quill, split whip, red sea feather, Erythrophyllum delesserioides, bottle brush, Odonthalia washingtoniensis, Delesseria decipiens, and Botryoglossum farlowianum. Large numbers of chitons, Mopalia mucosa, and porcelain crabs, Petrolisthes spp., occur around the bases of the mid-intertidal zone boulders. The tops of large rocks are covered with the red algae Iridaea flaccida and Gigartina agardhii, and with occasional clumps of the brown alga, Hedophyllum sessile. Bull kelp, Nereocystis luetkeana, grows submerged in large pools, and harbors the epiphyte, Porphyra nereocystis.

The algae are distinctly zoned on the cliff at the far end of the boulder area, with bottle brush above delicate sycophant with a low zone of mixed Iridaea cordata and Neptunes quill. High areas behind the boulder-filled pools are similar in species composition to high terrace habitats.

The cliff mentioned above prevents further progress by foot, and most of the region to the south is high, exposed cliffs. The exception is the protected area between Saunders Landing and Iversen Point (Fig. 3, area $E_2$). The species composition in the large, shallow pools in this area is similar to that described for the boulder area. Zonation on the shore side of the rocks was obvious with barnacles and limpets growing above a zone of Gigartina papillata and Pelvetia fastigiata in the high intertidal. The mid intertidal was dominated by the red alga, Rhodomela larix. Purple sea urchins and clumps of Odonthalia floccosa were found below R. larix, followed by a mixture of Hedophyllum sessile, Cystoseira osmundacea, and larger O. floccosa at the waters edge. The chiton, Katherina tunicata, was the most abundant large invertebrate in the lowest exposed zone. The solitary coral, Balanophyllia elegans, was common in shaded habitats. In the very calm area below the cliffs, Iridaea cordata and Phyllospadix sp. form an almost complete cover in the mid- and low intertidal.

The exposed vertical cliffs in the rest of the ASBS are accessible only by boat; therefore, surveys were made while moving up and down with the swells in an inflatable boat so only the most conspicuous species were noted. High on the cliffs, sometimes 13 to 20 ft. (4 to 6 m) above the water, a sparse zone of acorn barnacles and nail brush occurs with the calcareous red algae, Corallina officinalis var. chilensis and Bossiella orbigniana forming a wide zone below. Sea palm occurs in patches below the corallines with iridescent seaweed, Iridaea sp., around it. Lessoniopsis littoralis dominates the next major association, and is the largest and most conspicuous organism on the cliffs. Beneath and below this alga is a mat of red fan, Cryptopleura lobulifera, which appears as a reddish band from a distance. Encrusting corallines, including Calliarthron tuberculosum, are also associated with L. littoralis; the limpet Collisella pelta lives on its stipes, and purple sea urchins and Katherina tunicata live around its holdfast. Split whip and various articulated coralline algae generally occur below L. littoralis, but were submerged during the surveys. As exposure decreases, sea palms become more abundant, L. littoralis disappears, and surf grasses and feather boa begin to grow intermixed with split whip.

Although the distribution of intertidal species is complex, the species composition of most of the ASBS is typical of that discussed by Ricketts and Calvin (1968) for exposed rocky shores, and contains many plants and animals found in the vicinity of Point Arena (Gotshall et.al., 1974). Abalone were conspicuously absent; not a single individual was found during many searches. Their absence may be a result of a 0.1 ft. tide as they generally occur lower in the intertidal zone.

The high cliffs above the intertidal zone contain nests of pelagic cormorants, pigeon guillemots, and cliff swallows. Western gulls were observed in the intertidal zone but black oystercatchers and common ravens were the only birds observed feeding during the surveys.

## Landside Vegetation

The terrestrial plant community bordering the Saunders Reef ASBS has been described as Northern Coastal Scrub (Munz and Keck, 1973). This community extends northward in a narrow strip from San Mateo County to southern Oregon and from Pacific Grove on Monterey Bay south to Point Sur. South of San Francisco, this community may alternate with Coastal Sage Scrub, which reaches its northern limit at this latitude (Barbour and Major, 1977). Barbour and Major (1977) describe two phases within this community, one dominated by coyote brush, *Baccharis pilularis* var. *consanguinea*, and another dominated either by tree lupine, *Lupinus arboreus*, or by the prostrate form, particolor lupine, *L. varicolor*.

The coyote brush phase is most dominant along the disturbed edges of the highway and on the steeper slopes around the bluffs surrounding Saunders Landing (Fig. 3). It does not occur in Hearn Gulch, a deep canyon which extends approximately 4,920 ft. (1500 m) inland behind the landing. Coyote brush probably does not invade this area because of the dense canopy of coast live oak, *Quercus agrifolia*, madrone, *Arbutus Menziesii*, and white alder, *Alnus rhombifolia*. At the sites where coyote brush is dominant, the understory is comprised of low shrubs such as salal, *Gaultheria Shallon*, california blackberry, *Rubus ursinus*, and the ferns, wood fern, *Dryopteris* spp., and sword fern, *Polystichum* sp. The herbaceous cover forms a dense mat with little exposed soil. The dominant forbs are catchfly, *Silene gallica*, Puget Sound gum plant, *Grindelia nana integrifolia*, and wild strawberry, *Frageria californica*. The associated shrubs in the area of Hearn Gulch are California wax myrtle, *Myrica californica*, California coffeeberry, *Rhamnus californica*, and poison oak, *Rhus diversiloba*. The grassy terraces to the north have a few well-spaced individuals of coast live oak on north-facing slopes. The canyon drains through culverts beneath Highway 1, and the cover in continuously wet areas around the culverts is dominated by the fresh water indicators, sedge, *Carex* sp., spike rush, *Eleocharis* sp., and horsetail, *Equisetum* sp. The lupine phase dominates the landside vegetation in other areas west of Highway 1, with both the shrub and the prostrate forms represented. The shrub phase, with individuals of tree lupine up to 5 ft. (1.5 m) tall, is common at the heads of small ravines and in the lee of irregularities in the contour of the bluff. The shrub form occasionally invades the more exposed tops of the bluffs. Where this occurs, the understory is sparse with a bare zone around the base of the plants. Small herbs become more common outside of this bare zone, and include rip-gut grass, Bromus sp., and Briza sp., as well as several forbs, such as false clover, Trifolium variegatum, gum plant, Grindelia sp., Malacothrix sp., and several species of plantain, Plantago. The broad leaf plantain, P. insularis, is restricted to wetter sites.

A narrow strip along the extreme seaward edge of the bluffs is dominated by the prostrate particolor lupine. A comparative study of tree lupine and particolor lupine, found that particolor lupine was able to withstand higher summer soil and air temperatures, higher levels of salt deposition, finer soil and generally higher amounts of soil moisture (Barbour and Major, 1977). However, this plant does not occur east of Highway 1, perhaps because it cannot compete with plants growing at lower soil salinities. Particolor lupine is spaced evenly within these boundaries, but most common within the first few meters inland from the edges of the bluffs. The more abundant associates along the edges and, at times extending down the face of the cliffs, are common thrift, Armeria maritima var. californica, a perennial herb. In the coves in the southern part of the ASBS are basaltic towers with sparse plant cover except for an abundance of thrift. Paint brush, Castilleja Wightii, is also abundant along the bluff edges and is found in association with clumps of biscuitroot, Lomatium, sp. In areas of slumping or on rocky outcrops, live forever, Dudleya farinosa is also common, On gently sloping bluff faces and behind the few sandy beaches, there are dense patches of yarrow, Achillea borealis, columbine, Aquilegia formosa, musk flower, Mimulus moschatus, poison oak, Rhus diversiloba, and, in wet sites, Phacelia californica. Dense mats of gum plant occurred along most of the bluffs, as did seaside daisy, Eriophyllum staechadifolium, Plantago maritima var. californica, a small, fleshy plant restricted to very exposed sites; coast buckwheat, Eriogonum nudum, and sea fig, Mesembryanthemum chilense. There is a transition of grasses from the bluff edge to the highway, with rattlesnake grass at the leading edge, shifting to canary grass, Phalaris sp., and dense stands of slender wild oat, Avena barbata, nearer the roadside.

The riparian community at Hearn Gulch is comprised of slopes rising steeply from the sandy beach at Saunders Landing and extending .6 mi (1 km) inland. These slopes are covered with a dense undergrowth of small shrubs and forbs. Sea rocket, Cakile maritima, is the most seaward-extending plant and leads upslope to a stand of coyote brush. The canyon to the east of the highway has an understory of tan oak, Lithocarpus densiflora, with white alder and madrone forming a thick canopy which allows little light to penetrate to the forest floor. The understory includes wood fern, sword fern, and horsetail. Where more light penetrates, manroot, Marah fabaceus, and thimbleberry, Rubus parviflorus, are abundant. Along stream banks, a carpet of mosses, and the liverwort Marchantia sp., cover the ground. The upper edges of the canyon slopes rise to an elevation of approximately 230 ft. (70 m), and on the north ridges, numerous individuals of beach pine, Pinus contorta, intergrade into a well-developed, closed-cone pine forest. On south-facing ridges, coast live oak and California wax myrtle are abundant. The grassland to the south is maintained as pasture land. Along the north side of Iversen Road, the hills have been cleared inland approximately 230 ft. (70 m) to the pine forest, with roads apparently constructed to accommodate a housing development. This was evidently done some time ago as the coyote brush is abundant in the drainages created by these roads, as well as in the grasslands between them. Houses have not been built.

In summary, this area of Coastal Strand consists of three loosely interwoven components: a maritime bluff and cliff face dominated by the prostrate particolor lupine, L. varicolor, the ravines at the edge of the bluffs extending inland to the highway dominated by coyote brush, Baccharis, and the riparian community of Hearn Gulch, dominated by madrone, A. menziesii, and white alder, A. rhombifolia.

## Unique Components

No biological components unique to Saunders Reef ASBS were found during the reconnaissance survey. The localized high population densities and large size of individual red abalone on the reef, although not unique, are certainly exceptional. The ASBS appears to be relatively undisturbed by man's activities.

## LAND AND WATER USE DESCRIPTIONS

### Marine Resource Harvesting

No commercial fishing occurs within the ASBS due to navigation hazards and rough sea conditions. Sport fishing is rare as the nearest small boat launching facilities are at Point Arena to the north and Anchor Bay to the south. Sea conditions make the trip from either site to Saunders Reef hazardous in a small boat. Sport diving in the area is also limited by both access and sea conditions. No roads, and only two foot trails lead to the water within the ASBS, one at Saunders Landing and one at the large cove north of Iversen Point. Divers using the area must carry their equipment on foot down relatively steep terrain and this, combined with the rough sea conditions, makes sport diving difficult. A very rough road leads to the beach at Schooner Gulch north of the ASBS but it appears to be little used. The abundance of red abalone on the reef further indicates that sport diving for these and other animals is limited. The intertidal terrace in the northern part of the ASBS is accessible on foot from Schooner Gulch. The extent of intertidal collecting in this area and the areas around the two trails within the ASBS are unknown.

Use of the ASBS for fishing and other forms of recreation could increase. The Department of Fish and Game has noted that divers are beginning to explore more inaccessible areas along the northern California coast (S. Schultz, pers. comm.). Any increase in coastal access would also encourage greater use of the shore and offshore reef in the ASBS.

### Municipal and Industrial Activities

There is no municipal or industrial activity in or around the ASBS. The nearest town, Point Arena, is 4.7 mi (7.5 km) to the north. However, three subdivisions exist at the southern end of the ASBS: Island Cove, Iversen Point, and Saunders Point. Island Cove subdivision is located adjacent to the large cove south of Iversen Point. Iversen Point subdivision occupies both sides of Iversen Road and Iversen Point west of Highway 1 (Fig. 1). Some homes have been built on the south side of Iversen Road; but, although the road is constructed, no homes have been built on the north side. Saunders Point subdivision includes the land from Iversen Point to Saunders Landing on the west side of Highway 1. The North Coast Regional Coastal Commission is concerned over bluff stability at the planned building sites. This concern seems warranted given the natural erosion, slumping, and rock falls noted along the cliffs during this survey. Increased runoff during and after construction, in addition to increases in soil water caused by the use of septic tanks, could accelerate this natural process.

## Agribusiness

The grassland east of Highway 1 from Saunders Landing to the northern end of the ASBS is currently part of a large ranch and is used for cattle grazing. No other agribusiness exists in the immediate area although timber is cut in the hills further east.

## Governmental Designated Open Space

No designated open space exists in the ASBS. Bowling Ball Beach north of Schooner Gulch has been proposed as a State Beach, but its establishment depends on acquisition of funds and nomination by the Parks and Recreation Commission.

## Recreational Use

The major recreational use of the ASBS is sightseeing. A number of turnouts (some properly maintained, others simply used by driving off the highway onto unfenced land) exist along the margin of the ASBS west of Highway 1. During the surveys, many people used these turnouts as rest stops and to view the ocean and reef. This activity would be limited by the construction of homes west of Highway 1. None of the area west of the highway is fenced and, where possible, vehicles drive for considerable distances over the bluffs to the cliffs. This commonly occurred on the land just north of Saunders Landing. Such unregulated use could contribute to the destruction of vegetation and to bluff erosion.

The only other known recreational use is skin diving and intertidal sport fishing, discussed under Marine Resource Harvesting above. Although not observed, the intertidal terrace area is probably used for observation, photography, and general shore enjoyment. Campers were seen around Schooner Gulch.

## Transportation Corridors

No roads exist in the ASBS although two foot trails exist and cars are driven on the bluffs. Highway 1 closely parallels these bluffs overlooking the ASBS. Serious erosion problems exist at various places along the highway as evidenced by fencing, telephone poles, and pieces of asphalt and concrete in the coves which occur directly beneath the highway.

## ACTUAL OR POTENTIAL POLLUTION THREATS

### Point Sources

There are no point sources of pollution within the ASBS. Point Arena presently discharges into Point Arena Creek, but will soon switch to land disposal. Anchor Bay presently discharges less than 20,000 gallons per day of primary treated wastewater into the intertidal zone south of the town. Anchor Bay is currently under a cease and desist order and the sewage treatment system will soon be changed. Plans call for ultra-violet sterilization combined with recirculating sand filters which will produce an effluent of higher quality than normal secondary treatment. Discharge will continue in the same location. However, given the volume involved and distance from Saunders Reef, this point source certainly will not pollute the ASBS.

### Nonpoint Sources

The houses built (and planned) in the subdivisions at the southern end of the ASBS use septic tanks. Soils are poorly developed in the area, and some of the wastewater may escape into the ASBS. Whether or not this occurs or would occur, and what impacts it has or would have on marine life in the ASBS are unknown. Whiskey Shoals, a condominium complex planned just south of Point Arena will probably use septic tanks or a treatment plant with spray irrigation. Given the distance, the project will not affect the ASBS. The gulches draining into and near the ASBS are a potential source of increased sedimentation if they are ever developed.

## SPECIAL WATER QUALITY REQUIREMENTS

No unique components identified in the ASBS; therefore, there are no special water quality requirements along this section of the coastline.

## ANNOTATED BIBLIOGRAPHY

(only site specific sources are annotated)

Abbott, I. and G. Hollenberg. 1976. Marine Algae of California. Stan- Univ. Press, Stanford. 827 pp.

Anonymous. 1975. Area, of special biological significance. State Water Resources Control Board, Office of Public Affairs, Sacramento. 55 pp. (ASBS locations.)

Anonymous. 1978. Surface water temperatures at shore stations. United States West Coast 1975-1976. University of California, Scripps Institution of Oceanography, La Jolla. Ref. 78-5. 55 pp. (Surface temps. for Salt Point.)

Anonymous. 1979a. Climatological data, California 1975-1979. NOAA environmental Data and Information Service, National Climatic CenterAsheville. (Air temps. and rainfall for Point Arena.)

Anonymous. 1979b. Surface water temperatures at shore stations. United States West Coast. 1978. University of California, Scripps Institution of Oceanography, La Jolla. Ref. 79-9. 49 pp. (Surface temps. for Salt Point and Point Arena.)

Barbour, M. and J. Major (eds.). 1977. Terrestrial vegetation of California. J. Wiley, New York. 997 pp.

Boyle, M. 1967. The stratigraphy, sedimentation and structure of anarea near Point Arena, California. MA thesis, Univ. of Calif., Berkeley. 71 pp. (The geology of the Point Arena area including the region around Saunders Reef.)

Daubenmire, R. 1974. Plant communities: a text of synecology. Harper and Row, New York. 422 pp.

Felton, E. 1965. California's many climates. Pacific Books, Palo Alto. 169 pp.

Foster, M., R. Cowen, C. Agegian, D. Rose, R. VanWagenen, and A. Hurley. 1979. Continued studies of the effects of sea otter foraging on kelp forest communities in central California. Mimeo, report to Dept. of Fish and Game, State of California, Sacramento. 107 pp.

Gotshall, D., R. Lea, L. Laurent, T. Hoban, and G. Farrens. 1974. Mendocino power plant site ecological study final report. Department of Fish and Game, State of California, Sacramento. Administrative report 74-7. 291 pp. (Results of extensive intertidal and subtidal surveys of the marine organisms around Point Arena. Although Saunders Reef was not surveyed, its species composition and distribution are similar.)

Gotshall, D. and L. Laurent. 1979. Pacific Coast subtidal marine invertebrates. Sea Challengers, Los Osos. 112 pp.

Hickey, B. 1979. The California Current system - hypotheses and facts. Prog. Oceanog. 8:191279.

Koenig, J. 1963. Geologic map of California. Santa Rosa sheet. State of Calif., Div. of Mines. Scale 1:250,000.

Miller, D. and R. Lea. 1972. Guide to the coastal marine fishes of Calfornia. State of Calif., Dept. of Fish and Game. Fish Bull. 157. 235 pp.

Munz, P. and D. Keck. 1973. A California flora and supplement. Univ. of Calif. Press, Berkeley. 1905 pp.

Ricketts, E. and J. Calvin. 1968. Between Pacific Tides (4th ed.). Stanford Univ. Press, Stanford. 614 pp.

Smith, R. and J. Carlton (eds.). 1975. Light's manual: intertidal invertebrates of the central California coast (3rd ed.). Univ. of Calif. Press, Berkeley. 716 pp.

Weaver, C. 1944. Geology of the Cretaceous (Gualala Group) and tertiary formations along the Pacific Coast between Point Arena and Fort Ross, California. Univ. of Wash. Pub. in Geol., Seattle 6:1-29.

Wentworth, C. 1966. The Upper Cretaceous and Lower Tertiary rocks of the Gualala area, northern coast ranges, California. Ph.D. thesis, Stanford Univ., Stanford. 200 pp.

## STATE WATER RESOURCES CONTROL BOARD
## P. O. Box 100, Sacramento, CA 95801

## CALIFORNIA REGIONAL WATER QUALITY CONTROL BOARDS

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

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

**CENTRAL COAST REGION (3)**
1102–A Laurel Lane
San Luis Obispo, California 93401
(805) 549–3147

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

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

**Fresno Branch Office**
3374 East Shields Avenue
Fresno, California 93726
(209) 445–5116

**Redding Branch Office**
100 East Cypress Avenue
Redding, California 96001
(916) 246–6376

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

**Victorville Branch Office**
15371 Bonanza Road
Victorville, California 92392
(714) 245–6583

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

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

**SAN DIEGO REGION (9)**
6154 Mission Gorge Road, Suite 205
San Diego, California 92120
(714) 265–5114