ACKNOWLEDGEMENTS

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ABSTRACT

Southeast Farallon Island is located at 37°41'57"N latitude and 123°00'02"W longitude offshore of San Francisco Bay. The closest township is Bolinas, Marin County, California, which is 22.8 miles (36.7 km) northeast of the island.

Southeast Farallon Island is 65 acres (26 ha) in area. The total water area within the boundaries of the ASBS is 1885 acres (762 ha).

The Farallon Islands are located near the edge of the continental shelf. From the west, Southeast and Middle Farallons rise steeply from a depth of about 60 fathoms over a distance of 1 to 2 miles, with a maximum water depth of 30 fathoms between them. The North Farallons rise more steeply from a depth of 60 to 80 fathoms over a distance of less than a mile. The subtidal and intertidal substrate is made up of granodiorite and quartz diorite.

The major current systems affecting the Farallon Islands are the California Current and the Davidson Current, both of which are major components of the general northeast Pacific circulation pattern.

The temperature on the islands varies little throughout the year. Rainfall occurs primarily during the winter. The sky is generally clear during the spring and fall; fog prevails during the summer.

The biota of the ASBS are extremely rich and diverse, reflecting the variety of habitat in the area. Important marine organisms identified in the survey were: California mussel, giant green anemone, feather boa algae, elephant seals, California sea lions, harbor seals and Stellar sea lions. The California sea lion is the most numerous of the four mammals on the island.

Recreational activities which take place in the vicinity of the Farallon Islands include: 1) natural history/bird watching tours, 2) sport fishing, 3) skin and SCUBA diving, 4) pleasure sailing, and 5) sail and motorboat racing.

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FINDINGS AND CONCLUSIONS

Preliminary data from the State Mussel Watch Marine Monitoring Program suggests that chlorinated hydrocarbons, petroleum hydrocarbons, and lead concentrations are high at the Farallon Islands.

Several animals on the rare and endangered species list frequent the Farallons and adjacent waters. These animals include: the brown pelican, *Pelicanus occidentalis*; Peregrine falcon, *Falco peregrinus anatum*, blue whale, *Balaenoptera musculus*; fin whale, *Balaenoptera physalus*; grey whale, *Eschrichtius gibbosus*; humback whale, *Megaptera movaeangliae*; sei whale, *Balaenoptera borealis*; and the sperm whale, *Physeter catodon*. These animals are affected either directly or indirectly by the water quality around the ASBS.

A permanent monitoring program for heavey metals, chlorinated hydrocarbons and petroleum hydrocarbons in the water column, sediments, and animal tissues would be required to adequately understand the effects of these pollutants upon the ecology of the ASBS. To be effective, such a monitoring program would need to include close examinations of possible sources, such as shipping and land based municipal and industrial discharges. Ideally, monitoring would be sufficiently intensive to allow comparison of coastal, island and pelagic stations.

INTRODUCTION

The State Water Resources Control Board, under Resolution 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 Board's Administrative Procedures, September 24, 1970, Section XI. Miscellaneous--Revision 7, September 1, 1972).

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

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

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

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

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

In order for the State Water Resources Control Board to evaluate the status of protection of the Farallon Islands ASBS, a reconnaissance survey integrating existing information and additional field study was performed by the Farallon Research Group of the Oceanic Society of San Francisco. 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.

ORGANIZATION OF SURVEY

The reconnaissance survey of the Farallon Islands Area of Special Biological Significance employed a number of differing means of investigation. These included a literature review, interviews, a search of records, map reconnaissance, and shoreline observations.

The intertidal regions were assessed by literature review and by active surveys, utilizing the accumulated personal knowledge of the investigators.

Photographs of the shoreline and adjacent land mass were taken and are arhived at the State Water Resources Control Board.

PHYSICAL AND CHEMICAL DESCRIPTION

Location and Size

Southeast Farallon Island*, which is included in the boundaries of the City and County of San Francisco, is located at 37°41'57"N latitude and 123°00'02"W longitude. The closest township is Bolinas, Marin County, California, which is 22.8 miles (36.7 km) northwest of the island.

The official boundary description, as stated in the State Water Resources Control Board publication Areas of Special Biological Significance (1976), is as follows:

> "Waters within one nautical mile from the Southeast Farallons including Maintop Island, Middle Farallon, the North Farallons, and Noonday Rock."

The rugged coastline of Southeast Farallon Island, excluding the 7 islets, is 4.8 mi. (7.8 km) in perimeter. The island is 65 acres (26 ha) in area. (Huxley, BLM, personal communication). The total water area in the ASBS is 1885 acres (763 ha). There is no surface water on the islands.

*Middle and North Farallon Islands are virtually inaccessible, and therefore could not be measured. Also, no maps or charts were found that were adequate for making accurate measurements of these islands. As little information exists for these islands, much of the information in this report will pertain only to Southeast Farallon Island; Middle and North Farallon Islands are, however, mentioned where information is available.

Nearshore Waters

The major current systems affecting the Farallon Islands are the California Current and the Davidson Current, both of which are major components of the general northeast Pacific circulation pattern. The California Current is the eastern portion of the clockwise circulation of the North Pacific Ocean. This current flows southward from British Columbia to southern California (where it turns southwestward at about 25° N latitude) bringing water which is cooler, less saline and higher in oxygen than the waters further offshore (Reid, Roden and Wyllie, 1958). From February through November the eastern boundary of this current lies close to the coast. In the region of central California the California Current moves at about 0.5 knots and is several hundred kilometers wide, thus encompassing the Farallon Islands during this period. During the same period, a countercurrent flows at depths greater than 650 ft. (200 m) (Reid, Roden and Wyllie, 1958) bringing warmer, more saline waters from the south. From October through April, when the northerly winds are weaker, this countercurrent rises to the surface between the eastern boundary of the California Current and the coast, and is called the Davidson Current. The Davidson Current flows at a rate of 0.5 to 0.9 knots and may be as much as 50 mi. (80 km) wide (Schwartzlose, 1963); therefore, it may encompass the Farallon Islands during late fall and winter.

In addition to the California and Davidson current systems, two other major movements of water may affect the Farallons; however, their effects are less well-known and have not been studied here. These two movements are outflow from the San Francisco Bay estuary system, and upwelling.

The effect of outflow from San Francisco Bay is uncertain, but there are indications that, at least during periods of high discharge, the effects may extend as far as the Farallons. Several workers (Carlson, et al. 1975; Carlson and McCulloch, 1974; Carlson and Harden, 1975) have studied dispersal patterns of suspended particulate matter in San Francisco Bay and the Gulf of the Farallons. Carlson and McCulloch (1974) found that visible sediment plumes rarely extended more than a few miles seaward from the Golden Gate strait; they also found that even during a winter storm, when the inflow of water to San Francisco Bay was unusually high, the plume at its maximum extended only 19 mi. (30 km) seaward. A less distinct sediment plume adjacent to but separate from the one from San Francisco Bay was observed at one time extending several miles southwest of Southeast Farallon Island. According to Carlson and Harden (1975), satellite imagery generally shows visible plumes extending up to 2 mi. (3 km) offshore and usually within 60 mi. (10 km) of the shoreline. The only data of Carlson and Harden (1975) which include the Farallons show that, from the Golden Gate Bridge to the Farallons, salinity increased from 32.4 o/oo to 34 o/oo. Secchi disc readings increased from 13 ft. (4 m) to 39 ft. (12 m) in August, 1973, a period of relatively low discharge from San Francisco Bay. Flynn (1957) found that the shore station at Southeast Farallon Island recorded an abrupt annual minimum in salinity in March coincident with peak discharge from the San Joaquin and Sacramento Rivers.

The fact that upwelling occurs in the vicinity of the Farallons is evident from the temperature data shown in Fig. 1. In the absence of upwelling, water temperatures begin to rise steeply in May due to increased insolation. Upwelling causes a damping of the temperature increase until later in the summer (usually late July or August). Comparison of temperatures (Fig. 2) obtained near the Farallons (Station 60.60) with those obtained southwest of the Golden Gate (Stations 60.100 and 60.120) show that temperature increases are in fact earlier and larger at the two offshore stations. Winzler and Kelly (1977) state that, in the vicinity of the Farallons, temperature and salinity data indicate that upwelling commences in April-May with maximum surface temperatures of 52.3°-52.5°F (11.3°-11.4°C), peaks in June-July with surface salinities greater than 33.9 o/oo, and subsides by September-October.

Three oceanographic seasons are recognized for ocean waters along the central California coast. Descriptions of the periods and characteristics of these seasons, which were derived primarily from studies in

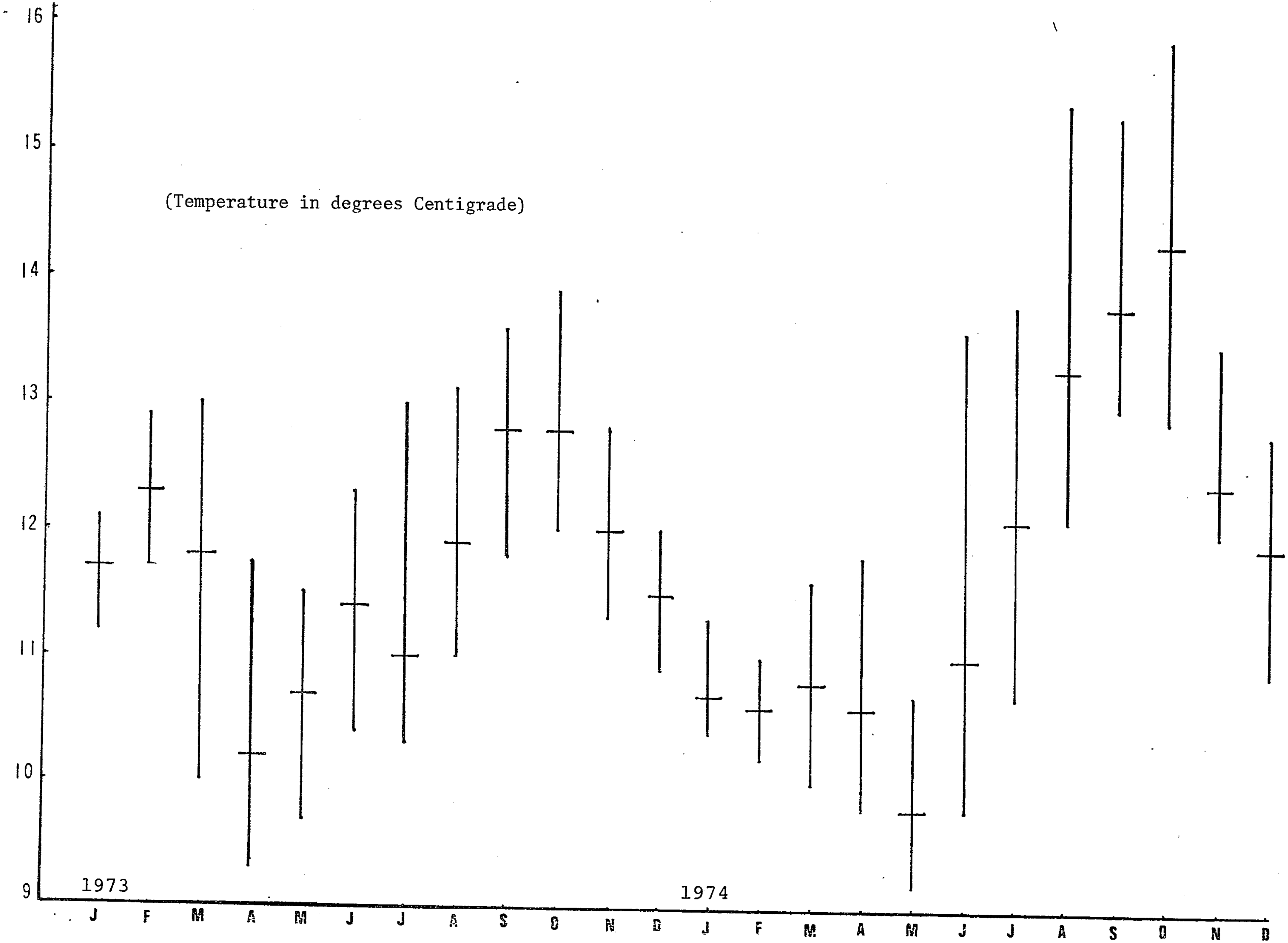

Fig. 1. Surface water temperatures (range and mean) for SE Farallon Island, 1973-1974.

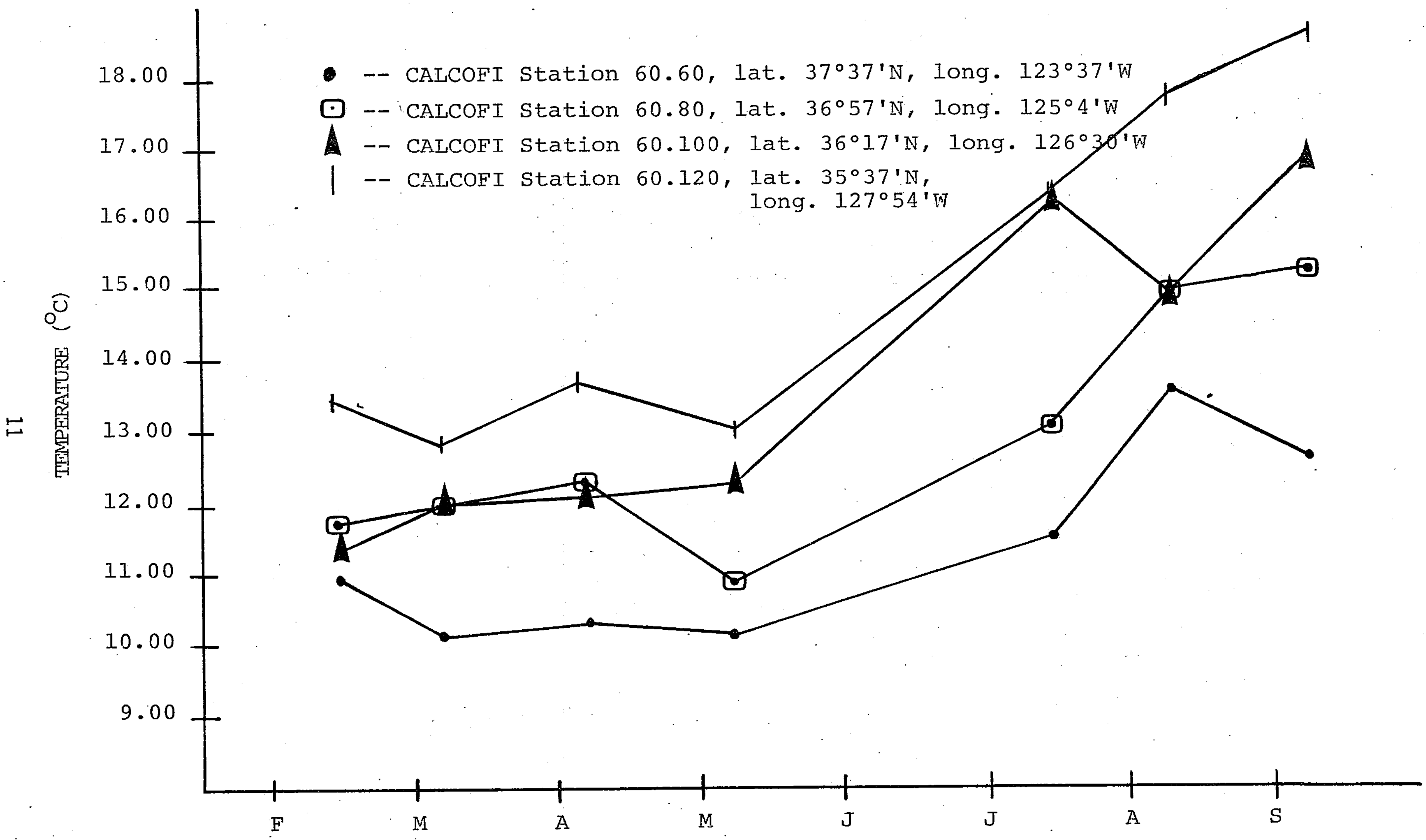

Fig. 2. Graphs of 10-meter temperatures at selected CALCOFI stations west of the Golden Gate (SIO, 1963).

Monterey Bay and are only generally applicable to the Farallons, are summarized from Bolin and Abbott (1963) as follows:

1) The beginning of the Davidson Current period (mid-November to mid-February) is the most sharply defined and easily recognized of the three oceanographic seasons as it is characterized by an abrupt decline in surface water temperature. Upwelling ceases as winds become more southerly. The Davidson Current brings oceanic water from the south into the area; thus, surface temperatures are relatively high for winter and after the abrupt drop at the beginning of the season, temperatures decline less than 1.8°F (1°C) per month in Monterey Bay. Surface salinities are low, variable, and declining as this is the season of highest precipitation.

2) The Upwelling Period (mid-February to September) begins with intermittent shifts in wind direction from south to northwest, lessening or reversing the northward flow of surface water. By spring, winds are steady from the northwest. During spring and summer the California Current flows southward, and the surface water is carried offshore. Deeper water flows up to replace surface water along the coast. The surface water temperature usually reaches the lowest of the year in April, and by May solar radiation causes the surface water temperature to begin rising. By July the strong northwest winds are decreasing and intermittent, surface temperatures are variable and there may be a pause in upwelling. Over this period, upwelling may occur in one or more pulses due to wind changes.

   Increases in salinity during the first half of the upwelling period are due to the cessation of winter storms and the rise of high salinity water from the depths. Salinity reaches its yearly maximum in June or July, then decreases slowly with the subsidence of upwelling.

The northern Gulf of the Farallons is known to be a major area of upwelling (Winzler and Kelly, 1977).

3) The Oceanic Period (September to mid-November) is a period of relative calm, with wind stress almost lacking as the northwest winds decrease. Previously elevated cold water sinks and is replaced by a thin layer of warm surface water which is characterized by higher salinity, clear blue color, and zooplankton, typical of oceanic rather than coastal waters.

Although Bolin and Abbott (1963) state that these cyclic changes take place over the entire northeast Pacific and are not unique to Monterey Bay, the Farallon Islands area is sufficiently different from Monterey Bay that some differences in timing and/or intensity of oceanographic seasons may be expected. The greater depth of water, greater distance from a coastline, and lack of submarine canyons (which are known to be major routes for upwelling water) may all result in a damping of features characteristic of the seasons. Also, the Farallons may be affected by the high volume of freshwater discharge from San Francisco Bay during the winter seasons. Conomos, et al. (1970) reported a new bottom current flowing into San Francisco Bay from as far offshore as 13.5 mi. (21.5 km) from Bolinas Point, suggesting that the estuary could induce a shoreward flow of deeper water similar to that of submarine canyons.

At Southeast Farallon Island, the temperature change initiating the Davidson Current Period is not always as clearly defined (Fig. 1) as that reported by Bolin and Abbott (1963). In 1973 the largest drop in mean temperature for a single month was 2.9°F (1.6°C) in March and the next largest was less than 1.8°F (1°C) in December. The drop which should signal the beginning of the Davidson Current Period was also less than 3.4°F (1.9°C) in October, more clearly indicating the beginning of the Davidson Current. Surface salinities are declining over this period (Fig. 3) as is also characteristic of Monterey Bay.

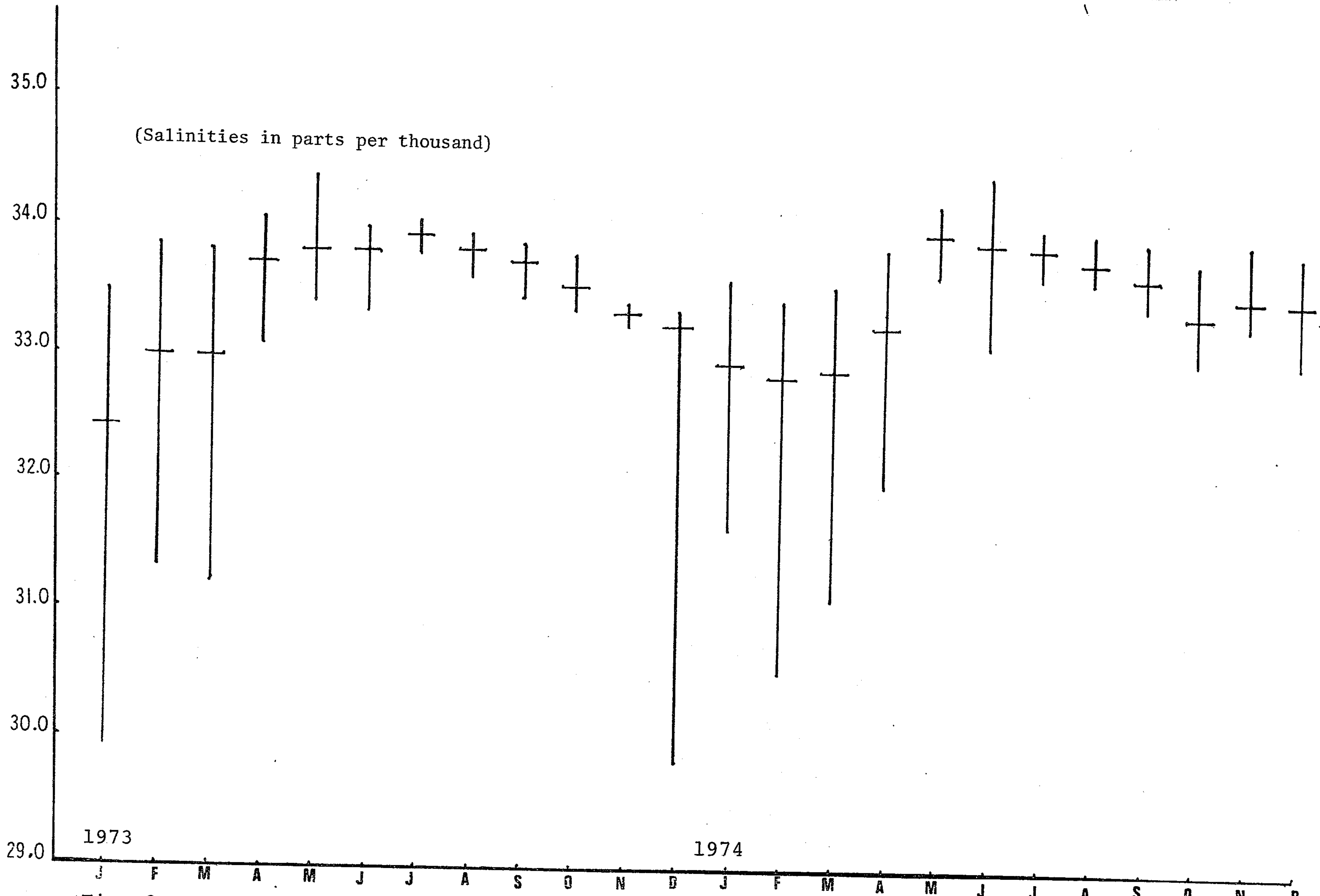

Fig. 3. Surface water salinities (range and mean) for SE Farallon Island, 1973-1974.

Topographic and Geomorphic Characteristics

Submarine Topography: The Farallon Islands are located near the edge of the continental shelf, in a line roughly parallel to the shelf edge. From the west, Southeast Farallon and Middle Farallon rise steeply from a depth of about 60 fathoms (110 m) over a distance of 1 to 2 miles (1.6 to 3.2 km), with a maximum water depth of 30 fathoms (55 m) between them. The North Farallons rise more steeply, from a depth of 60 to 80 fathoms (110 to 146 m) over a distance of less than a mile. Submerged Noonday Rock, the northernmost member of the Farallon group, is located on Fanny Shoal, a bank of 10 to 20 fathoms (18 to 37 m) depth, which is about 1.5 mi. (2.4 km) wide at its maximum dimension. The shoal rises precipitously from a surrounding depth of 60 to 80 fathoms (110 to 146 m).

About 4.5 mi. (7.2 km) southwest of the Farallons, the submarine slope increases abruptly. This is the beginning of the continental slope. Five miles (8 km) southwest of Southeast Farallon Island the ocean floor exceeds depths of 400 fathoms (732 m). The 1000 fathom (1829 m) line is about 15 mi. (24 km) southwest of the islands.

To the east, the Gulf of the Farallons separates the islands from the coast. The depth of the Gulf averages 30 fathoms (55 m) and from this depth the Farallon Islands rise with a slope somewhat less than on the western side.

No major submarine canyons are in the immediate vicinity of the Farallon Islands. The closest such feature is Pioneer Canyon, 20 mi. (32 km) to the south. Cordell Bank, an important fishing ground, lies 17 mi. (27.4 km) northwest of Noonday Rock. (Reference: National Ocean Survey Map 18680.)

Subtidal Geology: The Farallon Islands are high points on a ridge of basement rock at the edge of the continental shelf. The ridge is at least partially granite (granodiorite and quartz diorite) (Hanna, 1951, 1952; Chesterman, 1952; Ross, 1972) and is presumed to be continuous from south of Cape Mendocino to south of Point Piedras Blancas (Curry, 1966).

Cooper (1973) reports a steep, easterly gradient along the landward edge of the ridge near the Farallon Islands as being indicative of faulting, along which uplift occurred in the late-middle Miocene. The sediments of the continental slope west of the Farallon Islands are in part Miocene (Hanna, 1952; Uchupi & Emery, 1963). Sediments east of the Farallon Islands are also Miocene, mostly overlain by a thick section of Pliocene sediments; lower Tertiary rocks underly these in certain sediment-filled troughs. Locally the subtidal substratum is not well known. The bottom, at a depth of 30 to 40 ft. (9 to 12 m) around much of the east side of the island (from Fisherman's Bay to between Mussel Flat and Saddle Rock), is composed of large boulders and pockets of sand (probably derived from granite and shell material). Near East Landing, the substratum consists of sand between ridges of granite.

Intertidal Geology: The intertidal substratum is weathered and deeply fractured granodiorite and quartz diorite as described by Hanna (1951) and by Ross (1972). The rock is composed of feldspar, quartz, biotite, mica, and hornblende and commonly contains crystals as large as 3/8 in. (10 mm) across. Accessory minerals include sphene, zircon and apatite.

The intertidal zone is generally rugged and steep. Around much of the island, a narrow discontinuous shelf exists near sea level. Mussel Flat on the southeast side of the island is a much broader, somewhat higher shelf. Wave-cut surge channels and sea caves extending into the highly jointed and fractured granite rock are a major feature of the intertidal zone on all sides of the island. Some fissures in the rocks are partly filled with a granitic conglomerate (Blankinship, in Blankinship & Keeler, 1892). There is no intertidal sand except at the heads of surge channels and sea caves where coarse sand derived from granite rock and groundup shell material is found with wave-rounded cobbles.

Adjacent land mass: The island itself is also very steep, except for remnants of at least three elevated wave-cut terraces (Hanna, 1952). The most obvious and only extensive terrace is on the south and southeast sides of the island and is about 50 ft. (15 m) above present sea level

(Blankinship, in Blankinship & Keeler, 1892). Hanna (1951) reported a terrace of the same level on West End. Several dry caves extending into high points on the island are also at this level. The island is granite throughout, except for a conglomerate veneer near the top of the south slope of Sugarloaf.

Seepage in the caves is common. Fractures in the granite fill with a phosphatic mineral, known as minervite, which is evidently derived from bird guano. This mineral sometimes forms small stalactites in the caves; Hanna describes on West End with minervite stalagmites. Minervite has been reported from only one other locality, an island off the coast of Italy, where it is also associated with bird guano. Guano deposits may be a foot or more deep on the terrace of West End. Well rounded pebbles of jasper (chert) and other erratics ranging in diameter from 0.5 to 2 in. (1 to 5 cm) are scattered about the island. Hanna (1951, 1952) thought their occurrence might be explained by one of three possibilities: 1) the pebbles were derived from a formation no longer evident in the area; 2) they were transported to the island by man for construction material; or 3) they were transported to the island by wildlife. It now seems the first hypothesis, the pebbles are remnants of a formation, is the most likely as the conglomerate veneer near the top of Sugarloaf contains similar pebbles.

The granite rock of Southeast Farallon has been dated by the potassium argon method at 89.5 million years before present (BP); similar granite rocks at Montara Mountain and Point Reyes are dated at 91.6 and 83.9 million years BP, respectively (Curtis, et al., 1958).

Climate

The temperature on the islands varies little throughout the year. During a ten-year period the average maximum was 55°F (12.7°C) and the average minimum was 51°F (10.5°C). The average rainfall over a ten-year period was 25.29 in. (64.2 cm) yearly. Rainfall occurs primarily during the winter. The sky is generally clear during the spring and fall; fog prevails during the summer (Coulter, 1972).

The following wind direction and speed data (Table 1) was summarized on a monthly and annual basis. The data was obtained from weather observations taken aboard vessels of various registry. Frequently there is no concrete evidence to prove or disprove the validity of questionable data. Therefore, the accuracy of the data is unknown.

Table 1. Percentage Frequency of Wind Direction by Speed *

Period: (Primary) 1949-1968
(Overall) 1854-1968

Area 025 San Francisco
36-38N Coast-126W

WIN DIR	0-3	4-10	11-21	22-33	34-47	48+	TOTAL OBS	PCT FREQ	MEAN SPD
	WIND SPEED (KNOTS)								
N	.5	3.1	5.6	2.8	.3	*	4453	12.3	16.3
NNE	.2	.8	.9	.2	*	.0	789	2.2	12.9
NE	.2	.8	.4	.1	*	.0	517	1.4	10.2
ENE	.1	.5	.3	*	*	.0	337	.9	9.7
E	.2	.6	.3	*	*	.0	421	1.2	8.4
ESE	.1	.5	.2	*	.0	.0	326	.9	8.5
SE	.3	.9	.6	.2	.1	*	743	2.1	11.6
SSE	.2	1.0	1.1	.4	.1	*	987	2.7	14.3
S	.4	1.9	1.7	.5	.1	.0	1648	4.6	12.5
SSW	.2	1.2	1.0	.2	*	*	965	2.7	11.7
SW	.3	1.8	1.1	.2	*	.0	1225	3.4	10.3
WSW	.3	1.7	.9	.1	*	.0	1086	3.0	9.9
W	.6	3.2	2.0	.3	*	*	2200	6.1	10.3
WNW	.4	3.2	3.4	.7	.1	.0	2787	7.7	12.6
NW	.6	6.0	11.2	4.2	.3	*	8075	22.4	15.7
NNW	.3	4.3	11.8	6.7	.6	*	8552	23.7	17.9
VAR	*	*	.0	.0	.0	.0	11	*	2.5
CALM	2.7						975	2.7	.0
TOT	2718	11387	15372	6002	601	17	36097	100.0	14.2
PCT	7.5	31.5	42.6	16.6	1.7	*	100.0		

* U.S. Naval Weather Service Command: Summary of Synoptic Meteorological Observations, North American Coastal Marine Areas, Vol. 8, May 1970.

BIOLOGICAL DESCRIPTION

Subtidal Biota

Fishes: Follett and Ainley (1976) published the following list of fish which were taken from Pigeon Guillemot nests on Southeast Farallon Island. They reported that the birds do not forage extensively in the intertidal zone.

Chimaeridae

Ratfish, *Hydrolagus colliei*

Scorpaenidae

Yellowtail rockfish, *Sebastodes flavidus*

Shortbelly rockfish, *Sebastodes jordani*

Black rockfish, *Sebastodes melanops*

Blue rockfish, *Sebastodes mystinus*

Canary rockfish, *Sebastodes pinniger*

Cottidae

Scalyhead sculpin, *Artedius harringtoni*

Roughback sculpin, *Chitonotus pugetenis*

Brown Irish lord, *Hemilepidotus spinosus*

Frogmouth sculpin, _Icelinus_ _oculatus_

Spotfin sculpin, _Icelinus_ _tenuis_

Sailfin sculpin, _Nautichthys_ _oculofasciatus_

Snubnose sculpin, _Orthonopias_ _triacis_

Darter sculpin, _Radulinus_ _boleoides_

Grunt sculpin, _Rhamphocottus_ _richardsonii_

Cabezon, _Scorpaenichthys_ _marmoratus_

Agonidae

Rockhead, _Bothragonus_ _swani_

Pygmy poacher, _Odontopyxis_ _trispinosa_

Bathymasteridae

Ronquils, _Rathbunella_ sp.

Clinidae

Crevice kelpfish, _Gibbonsia_ _montereyensis_

Cebidichtyhidae

New genus, new species

Stichaeidae

Mosshead prickleback, _Chirolophus nugator_

Pholidae

Red gunnel, _Pholis schultzi_

Bothidae

Speckled sanddab, _Citharichthys stigmaeus_

Invertebrates: There is at present no collection of subtidal invertebrates from within the ASBS. Because of the dangerous diving conditions in the area due to a high incidence of shark attacks, no attempt was made to secure specimens for inclusion in this report.

Attached Aquatic Plants: A list of aquatic plants (Appendix 1) was compiled in October 1973 by the Farallon Research Group. The algae were collected in shallow water (0 to 39 ft; 0 to 12 m) in Fisherman's Bay, the north side of Shubrick Point, and between Mussel Flat and Saddle Rock with the aid of SCUBA on October 19 and 20, 1973. Species from the orders of Chlorophyta, Phaeophyta and Rhodophyta are represented.

Intertidal Biota

Intertidal areas of Southeast Farallon Island have certain basic features in common. The intertidal substrate is granodiorite and quartz diorite which is highly fractured, providing many cracks, crevices and surge channels, at the heads of which sand and cobbles occur.

The entire East Landing area is characterized by nearly vertical rock faces on both sides of a long surge channel. At the end of the channel is Garbage Gulch, a sand and gravel beach on which elephant seals frequently haul out. The surge channel faces south-southeast and is usually protected from heavy wave action; waves generally break at the mouth of the channel. On the east side of the surge channel there is a sea cave, the mouth of which is completely submerged except at very low tides.

The eastern side of the peninsula bordering East Landing is almost vertical rock except for a discontinuous shelf at about the +3 to -4 ft. (+0.9 to 1.2 m) tide level. The shelf is about 5 to 6 ft. (1.5 to 1.8 m) wide, with a slope of approximately 20-40°.

Near the southern end of the peninsula is a shallow sea cave (Jewel Cave) with a large tidepool, approximately 6x7x4 ft. (1.8x2.1x1.2 m), in its floor. The tidepool is usually extremely high in diversity of marine invertebrates (e.g. over 20 species of sponges on one wall). There is a surge channel and shelf in front of the cave; California mussel, *Mytilus californianus*, is predominant on the shelf.

North of Jewel Cave there are many small, exposed tidepools along the shelf. California mussel and coralline algae are dominant and the great green anemone, *Anthopleura xanthogrammica*, is common in the tidepools. The shoreline is subject to high wave impact even during flat seas, and no turnable rocks occur within this area. There is no shell debris and sand, even in deep tidepools, which confirms observations of heavy wave action.

Mussel Arm is a narrow peninsula (120x38 ft. or 36x12 m) which slopes away from land in both directions. A pair of high intertidal tidepools on Mussel Arm contains the purple sea urchin, *Strongylocentrotus purpuratus*, ochre seastar, *Pisaster ochraceus*, solitary California mussels, corallines, a few patches of surfgrass, *Phyllospadix torreyi*, and red point, *Prionitis* spp. The larger pool is over 5 ft. (2 m) deep and has large, bare cobbles in the bottom. The red barnacle, *Tetraclita squamosa rubescens*, occurs on rocks above the water line. A second, smaller pair of tidepools, lower on the peninsula, contain California mussel, the owl limpet, *Lottia gigantea*, feather boa, *Egregia menziesii* and iridescent seaweed, *Iridaea* spp. Both of these sets of tidepools interconnect during rising and falling tides.

The low intertidal zone on the seaward side of Mussel Arm and the shoreline of this area is marked by coralline algae and solitary California mussels. Also in the low intertidal area are feather boa, the brown algae, Alaria marginata and the red algae, Gigartina spp. Mussel beds, with associated clumps of barnacles, begin in the lowest mid-intertidal area, extend to the flat top of the peninsula, and are covered successively by feather boa, by Porphyra spp., and by the red algae, Iridaea cordata/splendens and I. flaccida in the high intertidal zone. Porphyra spp. extend above the California mussel beds and overlap with Endocladia muricata, another red algae. The owl limpet is common in the region along with the acorn barnacle, Balanus glandula, the limpets, Collisella digitalis and C. scabra, and the periwinkle, Littorina planaxis. Littorina planaxis continues above the algae zone to well beyond +12 ft. (3.6 m) above sea level, accompanied by the lined shore crab, Pachygrapsus crassipes, in the crevices. At Mussel Arm, California mussel beds occur on the seaward side around to the tip of the peninsula and in lower flat areas as well as in small tidepools and crevices. The California mussel and the owl limpet often have the epizoic limpet, Collisella scabra attached to them. Zonation of the leeward side of Mussel Arm is more compressed than the seaward side; feather boa is lacking there.

Along the shore near Mussel Arm, a black stain of unknown origin (possibly oil or guano related) was noted on the rock above the splash zone. Above this narrow black band is guano covered rock, seasonally occupied by kelp flies and sea gulls. Mice have been observed in the high intertidal zone.

North-northeast of Mussel Arm the intertidal zone is very similar to the eastern side of the East Landing-Jewel Cave peninsula, with a discontinuous shelf, small tidepools, and with California mussel and coralline algae dominant.

Great Murre Cave was inaccessible due to the presence of cormorants and murres. Observations from several hundred yards offshore are of a cathedral-ceilinged cave probably 50 ft. (15 m) in height with very steep walls and some water in the bottom of the cave, even at lowest tide.

Little Murre Cave, just to the southwest of Great Murre Cave, is about 20 ft. (6 m) in height and about 50 ft. (15 m) in length. The mouth of the cave is a V-shaped channel blocked by a large boulder near the mouth. This boulder effectively breaks the force of the surf so that water pours in under and around the boulder. Behind this large boulder are smaller boulders, most of which are still too large to be turnable. On the boulders and lower walls, sponges, tunicates, the aggregating anemone, *Anthopleura elegantissima*, and the great green anemone dominate. Bat stars, *Patiria miniata*, are common. The cave ends in a steeply sloping sand and shell beach having an angle of about 30 to 45°. Coralline algae is dominant outside the cave and common inside. The floor near the back of the cave is sand. Several feet above the splash zone, the red alga, *Rhodochorton purpureum* occurs in areas inside the mouth of the cave.

From Shubrick Point to a point northeast of Tower Peak, the presence of seabirds, cormorants in particular, made this area inaccessible and observations were made from a murre blind atop Shubrick Peak, a distance of about 100 to 300 ft. (30 to 90 m). About 20 to 30 ft. (6 to 9 m) below Shubrick Peak is a broad, gently sloping terrace about 40 ft. (12 m) wide, where murres and cormorants nest in breeding season. From the terrace, the rock slopes steeply (70 to 90°) for about 10 to 15 ft. (3 to 5 m) into the intertidal zone. The splash zone appears bare from this distance. The upper intertidal region consists of a band of green algae about 1 ft. (0.3 m) wide which appears to be a mixture of young Iridescent seaweed and *Enteromorpha* spp. Below this is a wider band of red algae and below that, coralline and sturdy brown algae predominate.

The west side of this area is bounded by a narrow surge channel with almost vertical rock walls. However, the algal zonation is similar to that described above. There are a few tide-washed boulders in the channel.

On the northwest side of the channel is a broad terrace that, like the one on Shubrick Point, is a nesting place for seabirds. Several feet below this is a second, narrower terrace on which sea lions haul out. On this second terrace there are two large, stagnant-looking splash pools. The slope of the intertidal zone is less steep, about 50°, but the flora is similar to those below Shubrick Point.

Most of the area from the east side of North Landing to the north side of Aulon Gulch has been off-limits due to the presence of elephant seals and sea lions. The only area accessible was the North Landing surge channel; the remainder was viewed from a boat moored in Fisherman's Bay.

The surge channel at North Landing consists of a long, wide channel ending in a cobble-boulder beach where elephant seals and sea lions haul out. Sea lions also haul out in large numbers on the east side of the surge channel. On both sides of the channel, the rock rises almost vertically for 10 to 15 ft. (3 to 4.5 m). The channel faces north-northeast and is subject to heavy wave action. The subtidal region here is sand and cobble so the area is scoured. Iridescant seaweed and coralline algae are dominant and other algae occurs, but there are few invertebrates. West of the surge channel, In Fisherman's Bay, the rock forms a very low terrace with sand in the intertidal zone. Intertidal zonation appeared lacking.

Cormorant Cove in Maintop Bay consists of a large, slanting (about 25°), discontinuous rock surface or shelf extending from about -1.5 ft. (-0.5 m) tide level to about +3.0 ft. (+0.9 m). This shelf, as elsewhere on the island, is highly fractured with many cracks and crevices. The cove is open to the northwest and is unprotected by offshore rocks. The rest of this area is steep and inaccessible and is dissected by deep surge channels. The surge channels are rimmed by shelves at approximately the level at which Cladophora and Enteromorpha grow. The portion of the shelf at the extreme southern end of the cove is accessible and bears many tidepools, some deep and many shallow. There were no turnable rocks in the lower tidepools. In the splash zone there are several large stagnant pools with cobble in the bottom.

Algae such as *Enteromorpha* spp., *Cladophora* spp. and *Porphyra* spp., are common on the highest rocks of the shelf, with small amounts of nail brush, *Endocladia muricata*, in sheltered situations. Two other species of red algae, *Iridaea flaccida* and *Gigartina papillata*, are found spottily farther down. The tidepools are lined with encrusting and jointed corallines, *Corallina* spp. There are clumps of *Prionitis lanceolata*, *P. linearis* and *Hymenena multiloba*. Surfgrass is present on the most exposed lower parts of the shelf. Feather boa is present in slightly more sheltered areas, such as the walls of adjacent surge channels. In the tidepools at about the zero ft. level, small (about 3 in. or; 7.5 cm) purple urchins, sponges and tunicates predominate. In spite of recent storms these pools were not scoured.

The owl limpet and a variety of other limpets are common in upper and middle intertidal regions. Isolated patches of the red barnacle were found in these regions. Among crevices and on the sides of protected rock faces, clusters of goose-neck barnacles, *Pollicipes polymerus*, were seen. Isolated tidepools often contained a single great green anemone with cottid fishes hiding in the shelter provided by the anemones.

Mussels are scarce in the upper intertidal region, but show a moderate abundance in the lower and middle intertidal regions. An aggregation of cloning anemones line the leeward edge of one of the higher tidepools. Small patches of red sponge and colonial tunicates are present under overhangs.

The middle and lower regions of the cove contain a large number of red algal forms including dense carpets of coralline algae; California mussel becomes evident in this region and species of idoteid isopods were found here.

To the west of Cormorant Cove is a point with a narrow channel separating it from two large offshore rocks (one of the rocks is actually joined to the island by a narrow arch). The rocks provide protection for the point and for a small cove nearby. The area is generally steep, almost vertical rock, but on the west side the rock forms a small shelf.

There are few tidepools here but there are many cracks and crevices. Few conspicuous organisms occur except for discrete patches of red sponge and very abundant coralline algae. On the south side there is one fairly small mussel bed high in the intertidal. Because this area is protected it seems curious that the diversity is so low.

The small cove narrows at its upper end, becoming a high surge channel that passes beneath a natural arch. The channel ends at or above the high water mark in unrounded cobble. The cove contains one large complex of tidepools sheltered by a rocky ridge on their seaward side. Beneath this ridge the pools are fairly deep. In this sheltered situation delicate algae are found; *Iridaea cordata*, *Erythrophyllum delesserioides* and *Hymenena flabelligera* are common. Feather boa is abundant and kelp crabs, *Pugettia* sp. were observed on the algae. Sponges, tunicates, anemones of various species (*Epiactis prolifera*, *Anthopleura elegantissima*, *A. xanthogrammica*) and cottid fish were also common.

South of this area is Breaker Cove, a very deep channel with absolutely vertical walls which are, in contrast to most of the other intertidal rocky areas, very smooth. The substrate in the channel and on a small beach adjacent to a narrow cave is sand and gravel. The area is well scoured but red sponge is present. In the cave are many large chitons and large gooseneck barnacles but almost no other flora or fauna.

West End, a large islet separated from the main body of the island by Jordan Channel, is usually off-limits; therefore, observations were made by spotting scope from the lighthouse on Tower Peak.

On West End, the northern side of Maintop slopes down to sea level at an angle of about 70°. The shoreline appears to take a great deal of wave shock. Algal zonation in April appears to consist of much young iridescent seaweed and *Enteromorpha* spp. with corallines and sturdy brown algae predominating below. Many murres and cormorants were observed on the higher rocks during nesting season.

A cove just west of Maintop has two sea caves side by side on the innermost margin. There appears to be sand and/or gravel at the mouths of the caves. Above this is a very broad shelf with little algae.

Further to the west is an even broader shelf which extends into the mouth of Maintop Bay. The shelf, which is well inundated at high tide and exposed to surge at low tide, has a great deal of green algae on the surface. Seagulls and cormorants roost here. Just above the intertidal region is a sandflat with a great deal of driftwood indicating that it may be waveswept in rough weather.

The outermost of the rocks in this cove is similar to Maintop in that its slope is steep and the algal zonation is the same; pelicans are known to roost here.

From Indian Head to the south side of Maintop, the intertidal zone slopes at about 30 to 40°. There is also a sand flat here where elephant seals haul out.

The area just to the west of Jordan Channel has a 30 to 40° slope. Algal zonation is similar to that described for Maintop. Except for some algae, intertidal flora and fauna were not identifiable on West End because of the distance from which observations were made.

On the south side of the island, the intertidal zone south of Falcon's Roost consists of a long slender channel, deep in the middle, with some deep pools and a large mussel bed. Dominant algae on the sides of the channel were corallines, iridescent seaweed, and feather boa. A good number of ochre seastars, not associated with the mussel bed, were seen. A species of red sponge, *Ophlitaspongia pennata*, was very common. Many small boulders, a few small enough to be turnable, occur. This channel opens to the southeast and does not seem to experience much wave shock. A number of red abalone were seen in the channel.

To the east of Falcon's Roost is a small, very protected cave and channel. Inside the cave, shell debris forms the floor. There is a hole in the roof of the cave with large quantities of guano on the sides, giving rise to the local name of Funky Arch. Compound ascidians are abundant in the channel in front of the cave. In both the channel and the cave the brown turban snail, Tegula brunnea, is common although they have rarely been seen in other intertidal areas.

The cove between Low Arch and Mussel Flat opens to the south toward Saddle Rock. The marine terrace, which forms much of the south side of the island, slopes steeply and irregularly to the intertidal shelf. The tops of the boulders are covered with Porphyra spp., iridescent seaweed, nail brush, and Enteromorpha spp. The double channel at the western limit of the cove ends in a sandy bottom with a few rocks. Young elephant seals haul out here and many play in the water outside the channel. The mouths of both channels consist of cobbles and sand, the sand extending above the intertidal zone and onto the island, forming Mirounga Beach; this beach is the site of the major elephant seal breeding colony on the island. Large driftwood pieces on Mirounga Beach imply heavy impact from large storm waves.

There are a number of large surge channels in this area, all with steep rocky walls and bottoms of coarse sand, cobble, and some large rocks covered with coralline algae. These surge channels often undercut the rock to form small caves at the backs of the channels. The occasional tidepools contain mostly coralline algae.

One of the largest of the channel caves consists of a narrow channel with a small cave at the back, in its entirety about 50 ft. (15 m) long, with a cobble and sand beach in the cave. The channel and cave contained, at one observation, 20 or more large red urchin, S. franciscanus, apparently loose on the floor as though they had been carried in during a recent storm. The only leather star, Dermasterias imbricata, yet found on the island was observed here. There were many large irregular patches of red sponge.

Just to the east of the channel is a very large sea cave, Low Arch Cave (Fig. 4). The mouth of the cave is somewhat protected by a few

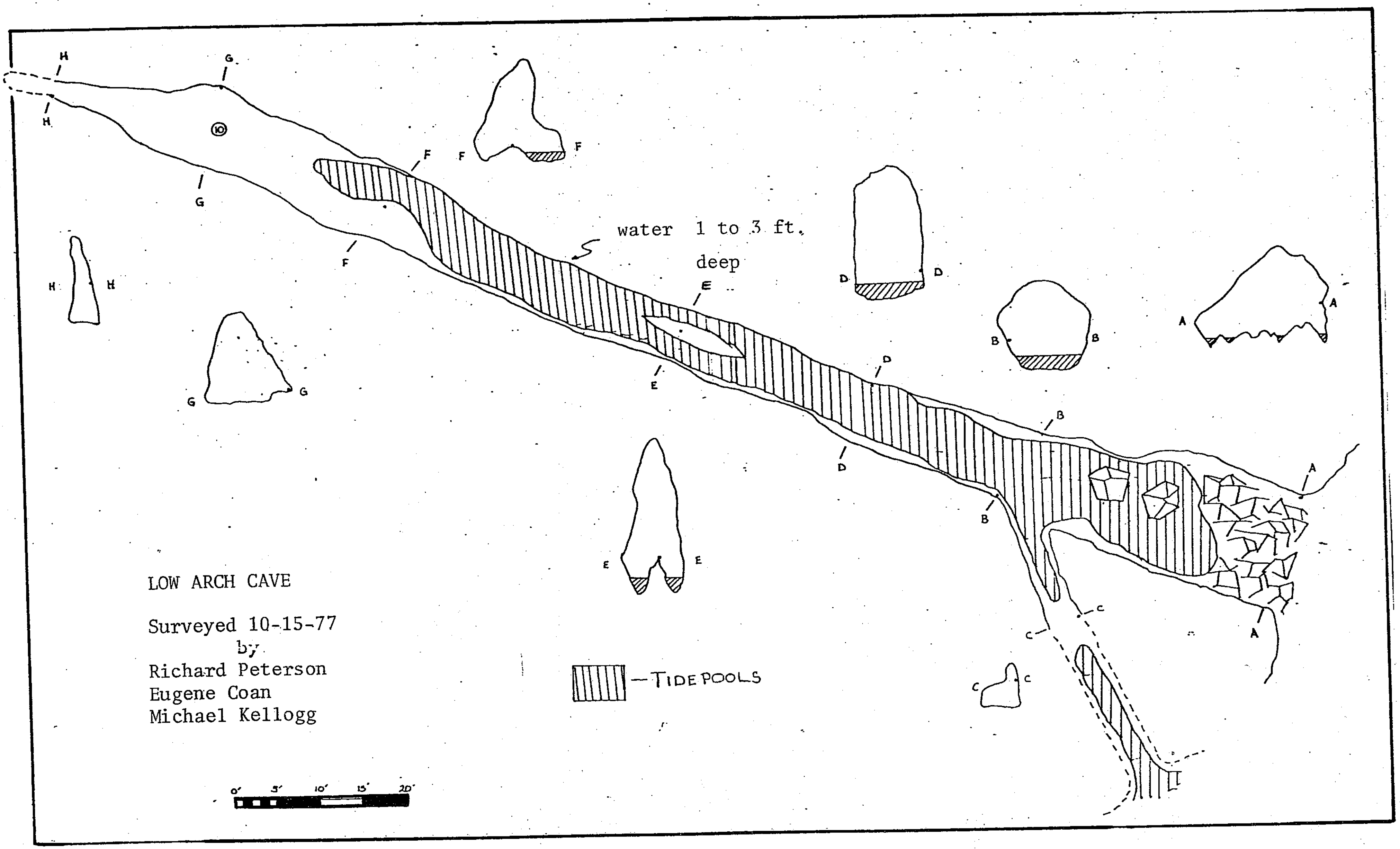

Figure 4. Low Arch Cave on Southeast Farallon Island.

very large boulders. Inside, the floor of the cave is coarse sand and cobble with large rocks. Rough weather occasionally deposits large pieces of driftwood and much drift algae in the back of the cave. The red sponge, Ophlitaspongia, sp. is abundant in the outer portions of the cave and extends in patches about two-thirds of the distance to the back. Under large rocks at the mouth are ophiuroids (brittle stars) and sabellids (plumed worms). Many sea bats, Patiria miniata, (both five and six rayed forms) are common. After a storm, many purple urchins and red urchins were in the cave; they were not noted several days previously.

East of Low Arch Cave the irregular intertidal shelf continues, with tidepools containing coralline algae, large Anthopleura spp. and other anemones, some red and brown algae and vascular surfgrass on outer boulders. The areas between tidepools are covered with young iridescent seaweed, young Enteromorpha muricata and small Gigartina spp., with coralline algae on the lower and outermost regions. Feather boa and some of the other sturdy brown algae occur on the outer edge of this intertidal shelf.

One large surge channel ends directly in front of and about 300 ft. (90 m) south of one of the houses on the island. This channel has 5 to 10 ft. (1.5 to 3.0 m) vertical rock walls, covered with corallines and some brown algae. At the end of this channel are cobbles and a few large boulders. A fair amount of driftwood accumulates in the back of the channel. Sewage from the houses on the island enters the water here. Elephant seals were seen hauling out at the time of observation.

The top of Mussel Flat is irregular at upper tidal levels; it is completely inundated at high tides. Below this, the flat drops almost vertically into two surge channels on the north side and with a somewhat shallower slope on the seaward side. On the top of the flat there are several large tidepools. Several species of sponges are common. Due to the large amount of horizontal relief cut by surge channels, tidepools, and overhangs, the diversity on Mussel Flat is higher than elsewhere on the island. On the island side of the two surge channels, the rock slopes upward from the intertidal region at an angle of about 30° to the marine terrace. This area is protected from wave shock by the mussel flat. The solitary great green anemone occurs in most tidepools; limpets and mussels predominate and most of the mussel shells bear barnacles and the limpet, *Collisella scabra*.

The southeast area of the island differs from the Mussel Flat area in being subject to heavier wave shock and in having more fractures or surge channels. The fractures criss-cross through an intertidal shelf in many different directions. The shelf extends outward perhaps 100 ft. (30 m) or more at low tide, rising gently at an angle of about 20 to 30° to a second, broad, flat area.

Those surge channels which are oriented at 90° to the shoreline have cobbles and some gravel at the landward end. Larger rocks and boulders in the channel are covered with upright coralline algae and smaller rocks are covered with encrusting corallines. Surge channels which are subject to reduced wave shock have broad-thallus red algae at the bottom, along with upright corallines.

Tidepools contain coralline algae, both upright and encrusting, as well as many other types of red algae. Some of these pools also contain shell rubble. Most of the shelf area can be termed 'mid-intertidal', with *Endocladia muricata*, *Cladophora* spp., iridescent seaweed, California mussels, and goose-neck barnacles predominating.

There are two surge channels which undercut the rock, forming short 'tunnels' along part of their lengths. Both of these end in another undercut portion of rock, forming an overhang or small cave. The walls of both of these channels are for the most part vertical, with a narrow shelf near the bottom of one of them. There are a number of shallow, stagnant pools just above the splash zone. These pools are green with algae and apparently receive an influx of water with only the largest waves and/or the highest tide.

To the east, towards East Landing, tidepools seem to be subjected to more surge. The purple urchin, *Strongylocentrotus purpuratus*, is found in most of the pools, and feather boa, Egregia menziesii, becomes more common. The shoreline becomes steeper and more irregular.

See Appendix 2 for a complete species list of invertebrates and attached aquatic plants found in the intertidal region.

Land Vegetation

The terrestrial flora of Southeast Farallon Island consists of about 35 species, of which only 13 are considered native (Coulter, 1972). The flora is composed mostly of annual species which occur on the mainland; there are no species or subspecies unique to the island. Moldenke (1975) reported that 100% of the Farallon flora are capable of self-fertilization, 70% habitually self-fertilize, and 40% are obligate self-fertilizers. He also found 17 species of flower visiting herbivores. Workers previous to Coulter have reported a somewhat smaller flora. Blankinship listed 27 species (10 native and 17 introduced; also listing an additional 6 non-flowering species); Ornduff (1961) found only 20 species (10 native and 10 introduced). The differences in species numbers seem to reflect differing amounts of time available to the collectors. The differences also reflect actual changes in the flora. One native and 8 introduced species have disappeared since 1892; 3 native species have disappeared since 1960. See Table 2. Most of the species lost since 1892 were reported by Blankenship to be confined in a garden which has since been abandoned, leaving the plants easy forage for the rabbits introduced to the island in the nineteenth century. The last of these rabbits was eliminated from the island in 1974. Most of the introduced species have arrived with man's help.

The soil is decomposed granite and guano and is extremely rich in both phosphorous and nitrogen compounds. The activities of nesting sea birds and, until recently, foraging rabbits combined with unique soil conditions severely restrict the composition of the flora (Ornduff, op. cit.; Coulter, 1972).

Table 2. Plant species found on Southeast Farallon Island in 1892 but not in 1960 or 1968 and those found in 1892 and 1960 but not in 1968.

Species found in 1892 but not in 1960 or 1968	Species found in 1892 and 1960 but not in 1968
PTEROPHYTA	ANTHOPHYTA
Polystichum munitum	Juncas bufonius
ANTHOPHYTA	Psilocarphus tenellus var. tenuis
*Avena fatua	Sagina occidentalis
*Cerastium viscosum	
*Malva parviflora	
*Medicago hispida	
*Melilotus indicus	
*Polygonum aviculare	
*Trifolium bifidum var. decipiens	
*Trifolium microcephalum	

* Introduced

Coulter has characterized the general vegetation patterns (Figure 5) and the following comments are mostly summarized from his work. Except for an extensive terrace, the island is of steep relief and offers little foothold for plants. On the rocky cliffs the main plants are seaside daisy, *Erigeron glaucus*, the abundant Farallon weed, *Lasthenia minor* ssp. *maritima*, and sand-spurrey, *Spergularia macrotheca*, and *S. marina*. On the slope above North Landing the vegetation is largely *Lasthenia* and common chickweed, *Stellaria media*. On the terrace, where the soil is soft and loose, Farallon weed grows in thick mats up to 1.5 ft. (0.4 m) tall, and is the dominant vegetation. The southeastern and eastern portions of the terrace, where the soil is not so loose, are dominated by a grassy vegetation comprised mainly of barley, *Hordeum leporinum*, and fescue, *Vulpia bromoides*. Coulter recognized additional vegetation zones on the south side of the island. between the living quarters and power house and also just south of the carpentry shop, small grasses, fescue sparsely interspersed with annual bluegrass, *Poa annua* grow in thin, fine and gravelly soil. Directly in front of the living quarters where the soil is hard and gravelly, Coulter found the perennial herb, *Plagiobothrys reticulatus* var. *rossianorum*, pigmy weed, *Crassula erecta*, miner's lettuce, *Claytonia perfoliata*, and wart cress, *Coronopus didymus*. Snow thistle, *Sonchus asper*, and *S. oleraceus*, common groundsel, *Senecio vulgaris*, and goosefoot, *Chenopodium murale*, are found along the cement walks, tram tracks, and foundations east of the power house. In the north and northeast parts of the island, plants are inhibited from growing in a well fertilized area by the activities of nesting colonies of Brandts Cormorants. See Appendix 3 for a complete listing of plant species found on Southeast Farallon Island.

Aquatic Birds and Mammals

The Farallons, with 12 species of breeding seabirds, is the largest seabird colony in the contiguous U.S.; in addition, five species of pinnipeds, at least four and perhaps all of which have bred there, occur on the islands.

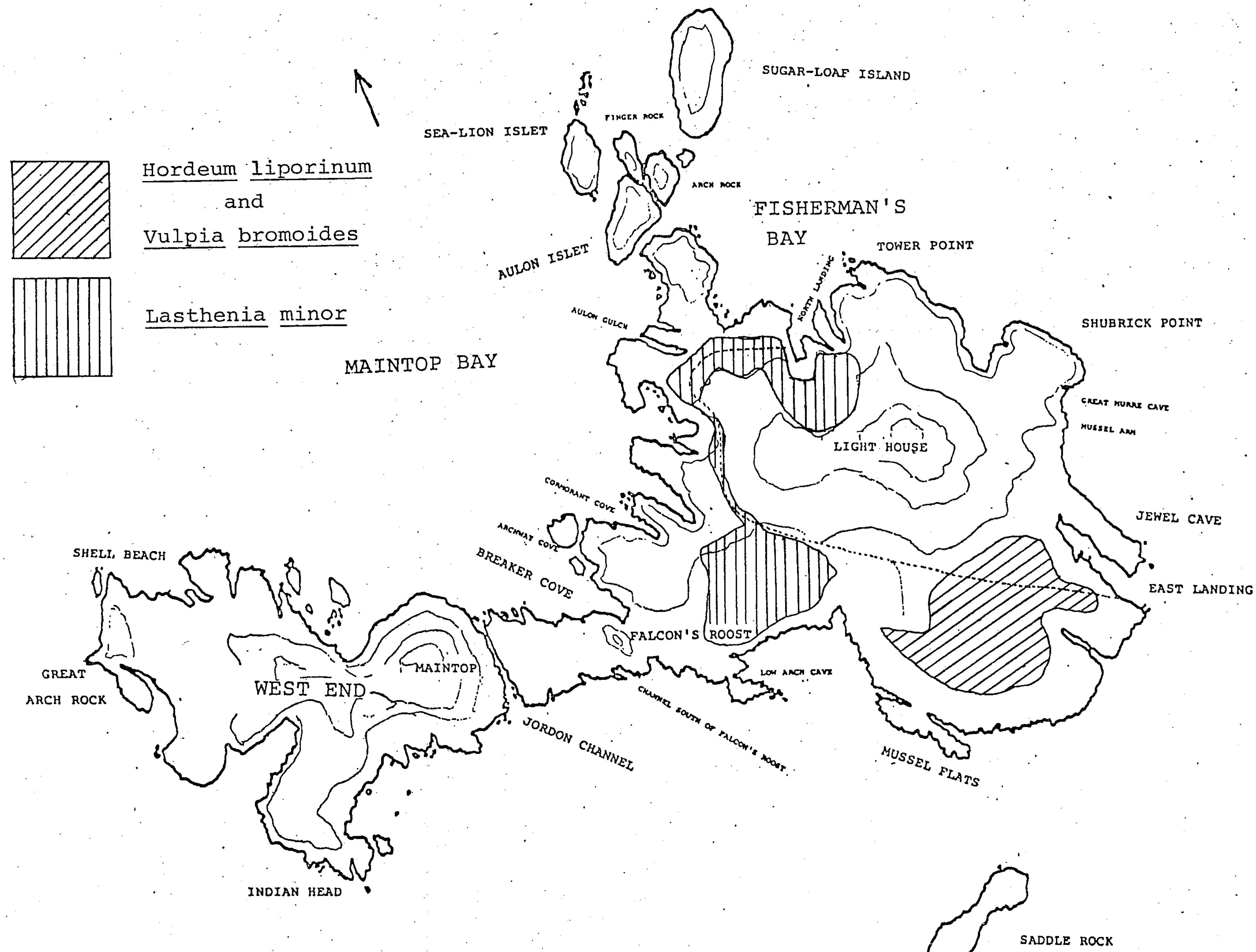

Fig. 5. Major vegetation zones (after Coulter, 1972).

During the nineteenth and early twentieth centuries, the Farallons were subject to much human disturbance. Sealers exterminated fur seals, elephant seals and sea otters, and hunted sea lions for food during the early 1800's (Scammon, 1974; Riddell, 1955; Doughty, 1971). A lighthouse was established in 1854 and has been maintained ever since. Throughout most of that time at least four families, with their associated pets and mules, lived on the Farallons year round. In 1854 a commercial egg company began an unregulated harvest of Murre eggs that continued until the turn of the century with apparently little regard for other wildlife. During recent years, the presence of the U.S. Coast Guard, to maintain the navigational aids, has deterred unwanted visitors. In 1969 Southeast Farallon was included in the Farallon National Wildlife Refuge which had been in existence since 1909.

Point Reyes Bird Observatory (PRBO) biologists have been on the island since April 1968. In 1972 when the Coast Guard automated its equipment and left the island, PRBO entered into a cooperative agreement with the U.S. Fish and Wildlife Service to provide a protective "presence" on the island for the Farallon wildlife. Helicopters were found to be very disturbing to the wildlife, causing harbor seals to abandon their hauling out areas and birds to leave their nests. In 1974, at the recommendation of PRBO, the Coast Guard agreed to greatly restrict helicopter use between 15 March and 15 August, when the harbor seals, many of which haul out near the landing pad, are present in greatest numbers. This is also the time when most marine birds are breeding on the island.

Shooting of marine mammals near the island has decreased since PRBO biologists began working on the island. From 1970 to mid-1975 there were 13 instances of shooting at sea lions. Since then, shooting has been confined to seabirds except for one incident of fishermen shooting at sea lions in Fisherman's Bay in the spring of 1977.

There is some disturbance of sea lions on Saddle Rock and at Sea Lion Cove by abalone divers and curious boaters who approach too close to the animals and cause them to go into the water.

Several sites in the vicinity of Southeast Farallon were used for disposal of radioactive waste materials between 1946 and 1966. It was recently discovered that containers holding the waste are ruptured. The effects of this are not yet known although a variety of marine organisms, some of which are in the marine mammal food chain, are to be tested by the Environmental Protection Agency.

Pinnipeds: The highest number of pinnipeds use the island during the spring when the elephant seal females and immatures haul out to molt. California sea lion males haul out briefly while on their southward migration, and Steller sea lions and harbor seals arrive for the breeding season. Pinniped numbers are lowest in the summer when only adult male elephant seals are molting and small breeding populations of the other three species are present.

All pupping, except for elephant seals which breed December to March, occurs in the spring. The California sea lion and northern elephant seal colonies on the Farallons are the northernmost breeding populations for these species; the Steller sea lion, is in the southern end of its range. The pinniped population fluctuates and the number of pups born on the Farallons for the last five years is summarized in Tables 3 and 4.

Steller sea lions, Eumetopias jubatus: The Steller sea lion is found from northern Japan to the Sea of Okhotsk, across the Bering Sea to the Pribilof and Aleutian Islands and down the west coast of North America as far as southern California (Scheffer, 1958). Along the California coast, the adult males are present only during the breeding season, moving northward in winter. Some of the adult females remain at the rookery throughout the year with their pups while others migrate northward in the fall after the breeding season is over. The bulls arrive on the breeding grounds in May in order to set up territories. The cows that have migrated northward return to pup a few weeks after the bulls arrive. Most of the pupping occurs in June and copulation takes place shortly after pupping season. The pups are able to swim soon after birth, and the cows leave them periodically to feed in the

Table 3. Peak number of pinnipeds on Southeast Farallon Island 1972-1977

Year	Eumetopias	Zalophus	Phoca	Mirounga
1972	120	561	5	141
1973	121	196	17	189
1974	261	1403	15	299
1975	176	1374	15	311
1976	187	1163	23	446
1977	246	1593	26	523

Table 4. Pinniped reproduction Southeast Farallon Island 1973-1977 (number of pups born)

Year	Eumetopias	Zalophus	Phoca	Mirounga
1973	9	0	0	2
1974	10	1	1	17
1975	19	1	3	35
1976	14	1	3	60
1977	27	1	3	104

ocean. Some of the young are not weaned until the birth of a pup the following year. The bulls are sexually mature at 5 and the cows at 3 years (King, 1964).

As is true throughout the southern part of its range, the Steller sea lion population on the Farallons is 4 to 6 times lower than it was 40 and 50 years ago (Bonnet, et al., 1938; Bartholomew, 1967; Ainley, et al., 1975). The Southeast Farallon population peaks to as many as 260 animals during April and May when southward migrating animals haul out briefly. The breeding population (present in June and July) appears to have stabilized at about 130 animals (Figure 6). Populations studied in Oregon by Mate (1973) are similar to the Farallon population with a peak of migrating animals before the breeding season. Both these populations differ from the Ano Nuevo population which has peak numbers during the June and July breeding season (Orr and Poulter, 1967; Gentry, 1970). The female to male ratio of 5.1:1 on the Farallons is similar to the 4.3:1 ratio determined by Gentry (1970) for Ano Nuevo Island (Ainley, et al., 1975).

Although the pregnancy rate is low and the pup mortality rate is high (Table 4), the Farallon breeding population has remained consistent since 1974 and appears to have stabilized at about 130 animals. Most of the pup mortality is due to premature births, some occurring as early as February but most of them in April. It is possible that organochlorine pollutants, which are responsible for a high rate of premature pupping in California sea lions from Southern California (Delone, et al., 1973), are also responsible for the premature births in Steller sea lions on the Farallons (Ainley, et al., 1975). The Farallon rate of premature births is nearly 10 times higher than the 4% found by Mate (1973) in Oregon (Table 5). In years of severe storms, such as 1975, pup mortality is increased (Table 5).

Both California and Steller sea lions tend to congregate on the windward side of the island (Figure 8) with Steller sea lions in the more exposed areas including Saddle Rock. Sea lions are also found on the rocks of the North Farallons, 7 mi. (11 km) to the north. It is

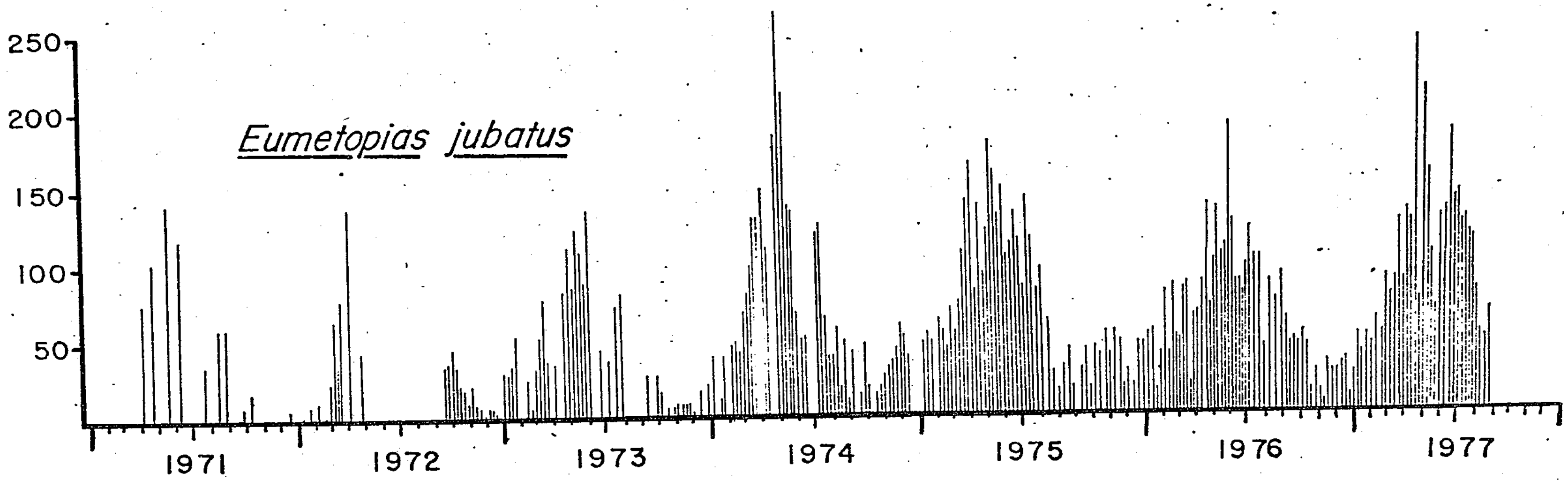

Figure 6. The annual fluctuations in numbers of Eumetopias at the Farallons 1971-1977.

Table 5. Reproductive success of female *Eumetopias* on Southeast Farallon Island 1973-1977

Year	# ♀♀ present	# pups born	% pregnancy	# premature & still births	pup deaths other causes	% mortality
1973	73	9	12	3	--	33
1974	110	10	9	4	--	40
1975	98	19	19	4	5	47
1976	98	14	14	5	1	43
1977	111	27	24	11	--	41

not clear just how much movement exists between these two areas or what controls the movement; whether it is storms, food availability or some other factor.

Stomachs of Steller sea lion carcasses salvaged in north central California, showed evidence of a diet consisting mainly of rockfish, hake, flatfish, cusk-eel, lingcod and cephalopods and less frequently mackerel, anchovy, herring, midshipman, eelpout, osmerids, cat shark, and snailfish. From the island, Stellers have also been seen feeding on skates or rays in the spring (PRBO journal).

California sea lion, Zalophus californianus: The California sea lion breeds in the eastern Pacific from the Farallon Islands (Ainley, et al., 1975) south to the islands off Baja California, in the Gulf of California and along the west coast of Mexico (King, 1964). Breeding males and subadults move as far north as British Columbia in the fall after the breeding season, returning to the southern rookeries in the spring. The females and young remain near the breeding grounds and some even move south in the winter (Peterson and Bartholomew, 1967).

The California sea lion is found year round on the Farallons and is the most numerous pinniped present (1,593 animals in spring 1977); there is a strong peak of migrating animals present in the spring and a smaller peak of migrating animals in the fall (Figure 7). This fall peak is consistent with all other census studies conducted north of major breeding areas (see Lance and Peterson, 1968; Orr and Poulter, 1967; Mate, 1973); however, the spring peak on the Farallons is an anomaly. It is possible that the spring southerly migration, in contrast to the fall northerly migration, occurs further offshore and thus animals show up on the Farallons but not at coastal sites where all other census studies have been conducted. Possibly the high numbers of California sea lions are due to the presence of hake which are also most abundant near the Farallons in the spring. Some combination of these possibilities may be more correct; for instance, the south migration may be offshore because the hake are offshore at that time. Then, when the hake move closer to the coast later in the year the California sea lion may follow that food source in their northward migration.

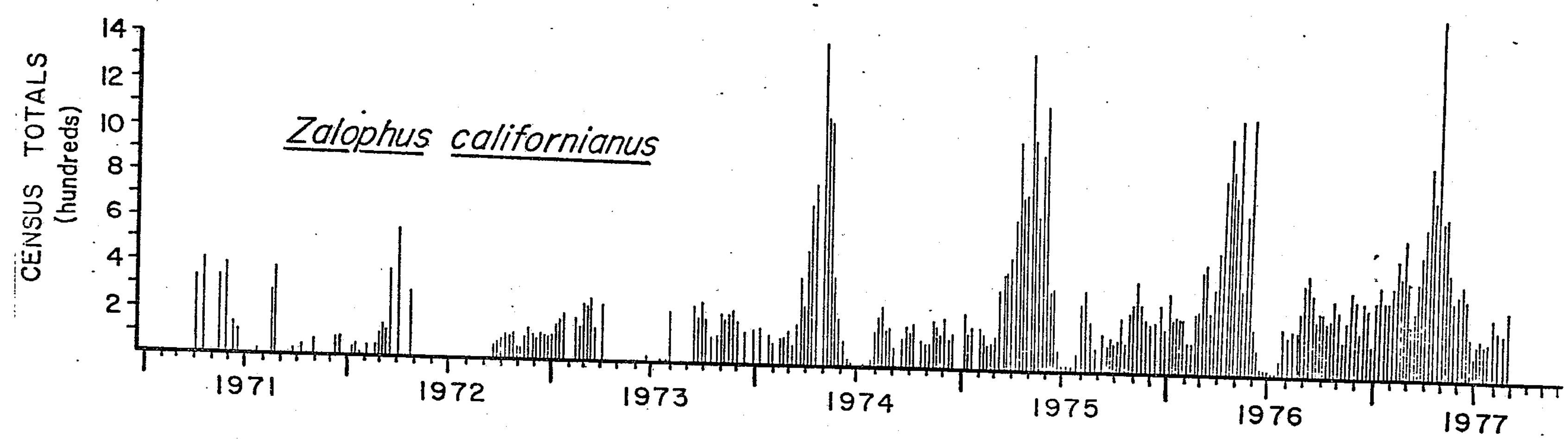

Figure 7. The annual fluctuations in numbers of Zalophus at the Farallons 1971-1977.

Most of the California sea lions on the Farallons are adult and subadult males. In 1974 a cow pupped on the Farallons; by 150 mi. (250 km), this was the northernmost record for a live California sea lion female (Pierotti, et al., 1977; Ainley, et al., 1975). Since then, a single pup has been born each year, probably to the same female. Except in 1976, when presumably the pup died, pups have been seen with the cow late into August. At least one bull remained with the cow and her pup each year and it is presumed that since 1974 mating took place on the Farallons. Whether this cow remains unique or whether her pups will also begin breeding on the island remains to be seen. In the fall of 1975 a new trend began; a large number of yearlings (152), the majority of them males, was observed.

Unlike the Steller sea lion, the number of California sea lions has steadily increased on the Farallons over the last 40 years. This increase is similar to what has been recorded at the Channel Islands. (Bartholomew and Boolootian, 1960; Bartholomew, 1967; Odell, 1971) and is probably a result of the larger breeding populations to the south (Rice, et al., 1965).

It is not clear yet if the California sea lion is displacing the Steller sea lion in the southern part of its range. However, one possible explanation for changes in the pinniped populations is a change in fish populations. Between the 1930's and 1950's, at least two offshore fish populations have disappeared, the sardine, *Sardinops caeruleus*, and the Pacific mackerel, *Scomber japonicus*. During this same time period, the sea lion populations have changed, and some evidence indicates that Steller sea lions, particularly offshore populations, would be more likely to have fed on these fish species than California sea lions (Ainley, et al., 1975; Ainley and Lewis, 1974).

Feeding habits of California sea lions on the Farallons have been studied by examination of regurgitated fish bones, otoliths, and squid beaks. Table 6 shows how their diet changes with seasons. When peak numbers of California sea lions are present they feed almost exclusively on hake, *Merluccius productus*; as the number of sea lions declines in the fall their diet becomes more diversified (Ainley, et al., 1977).

Table 6. Seasonal change in the diet of California sea lions at the Farallon Islands. Data are based on otoliths and squid beaks regurgitated by sea lions at haul out sites, 1974-1977.

PREY	MONTHS[1] J	F	M	A	M	J	J	A	S	O	N	D	TOTAL ITEMS %(n)
SQUID		1	9					1	1				1(6)
FISH													
Merluccius productus	54	38	6	93	93	94	100	81	21	32	100	50	80(1999)
Sebastes spp.	45	27	81	5	7	1		14	20	8		50	11(282)
Parichthys notatus ?		1		1		1		1	2	45			2(48)
Engraulis mordax		21						1					1(34)
Glyptocephalus zachirus		1							27				1(34)
Otophidium scrippsi		8				3			6	1			1(22)
Parophrys vetulus		1						1	6				1(12)
Genyonemus lineatus						1		1	4	3			1(11)
Citharichthys sordidus		1							5	4			1(10)
Microgadus proximus		1	3					1	2				1(9)
Atherinopsis californiensis								1	2				1(4)
Leptocottus armatus									1	3			1(3)
Zalembius rosaceus									1	3			1(3)
Trachurus symmetricus								1	1				1(2)
Clupea pallasii								1					1(1)
Lyopsetta exilis									1				1(1)
TOTAL (n) ITEMS	11	140	32	450	969	111	5	553	122	71	6	2	100(2481)

[1]Figures beneath each month are percentages based on totals at the bottom of each column.

The California sea lion, like the Steller sea lion, tends to concentrate on the windward side of the island (Figure 8). However, the California sea lion is found in the more sheltered areas of Sea Lion Cove and in Fisherman's Bay and are observed higher up on the rocks.

Northern Fur Seal, Callorhinus ursinus: In North America the northern fur seal breeds almost exclusively on the Pribilof Islands, Alaska. After the breeding season, mainly immature animals and adult females migrate south through California waters, 10 to 91 mi. (16 to 145 km) offshore, while most of the adult bulls remain in the Gulf of Alaska. Small breeding populations have begun recently on Castle Rock and San Miguel Island in southern California (Peterson, et al., 1968).

Fur seals probably bred on the Farallons before the sealers of the nineteenth century exterminated them. From 1970 to 1976, single fur seals were seen every other year hauled out on Southeast Farallon. In 1977 two fur seals were seen in July and August, most probably different individuals. All the fur seals observed on Southeast Farallon have been female or immature animals and all but one were seen in Sea Lion Cove near California or Steller sea lions. Fur seals are much more common near the North Farallons, 7 mi. (11 km) to the north; on boat trips between the two groups of islands, 1 to 12 fur seals were seen in the water in 1977.

In December 1977 a fur seal pup from San Miguel Island was released in Fisherman's Bay by the Department of Fish and Game after rehabilitation. It was not seen again.

The stomachs of fur seal carcasses from north central California were examined and found to contain anchovies and cephalopods.

Harbor seal, Phoca vitulina: The eastern Pacific subspecies of the harbor seal, Phoca vitulina richardi, is found along the North American coast from Alaska to Baja California (King, 1964). Migratory movement among the population is local with numbers building up at the rookeries during the peak of pupping and breeding; the timing of the pupping and

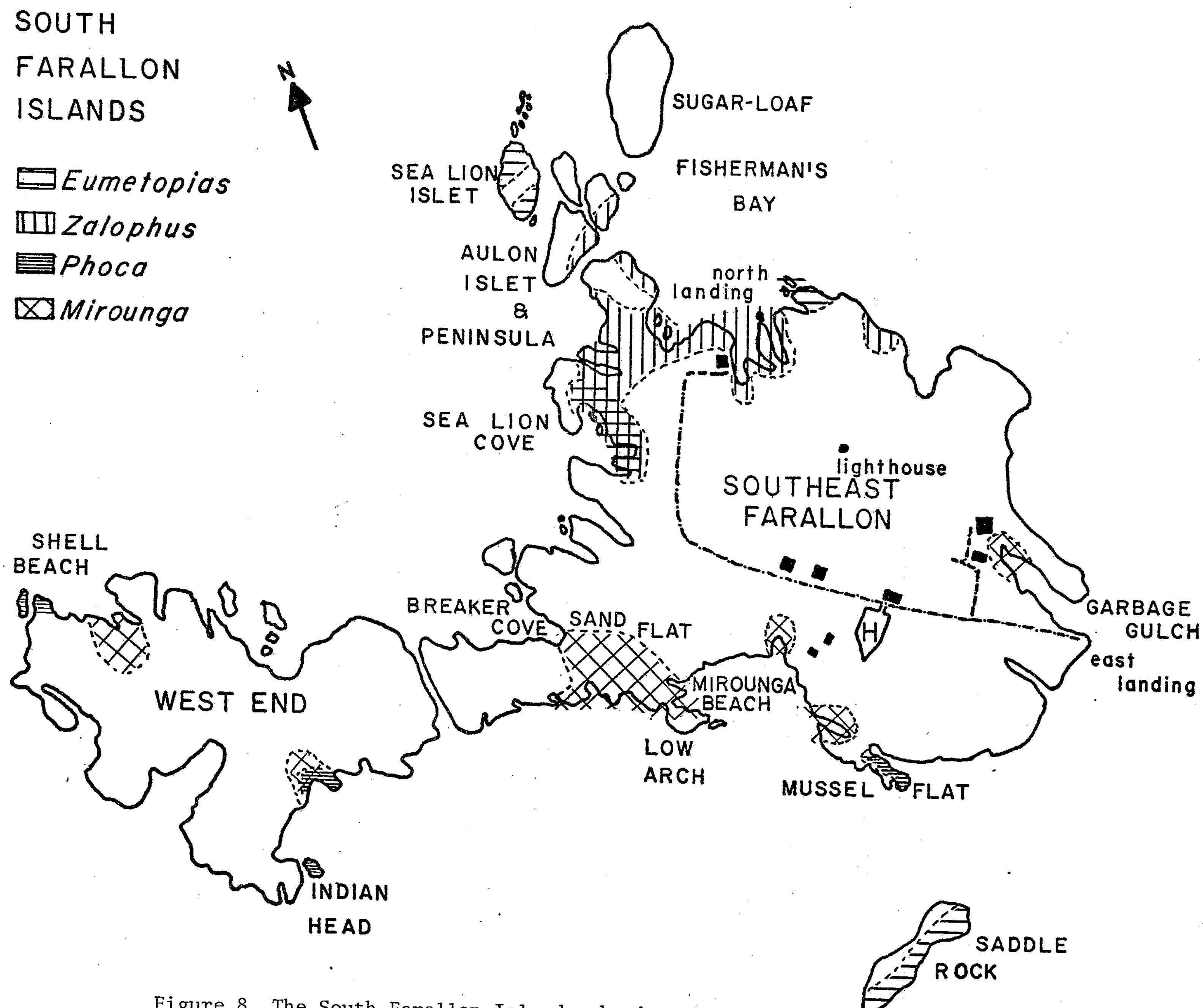

Figure 8. The South Farallon Islands showing the usual areas where various pinnipeds haul out.

breeding season varies according to latitude. For harbor seals on the Point Reyes peninsula, where the population is about 1,000 animals, pupping occurs from late March to early June. After 6 to 8 weeks the pups are weaned and the adults begin molting in late June and July. In August, mating occurs at the rookeries; during the fall and winter, the animals disperse to other areas (Sarah Allen, pers. comm.).

Early reports of Farallon wildlife mention harbor seals only briefly as occasional winter residents (Gruber, 1884; Blankinship and Keeler, 1892; Ray, 1934). This pattern of the harbor seal as a winter resident continued during the early years of observation of PRBO biologists (1968-1972). However, during 1973 the number of sightings, and the number of animals seen, increased (17 were observed in March) and for the first time animals were observed during the summer breeding season (Figure 9). It was not until the following year that the first pup recorded for the Farallons was born (Ainley, et al., 1975). Since then, 3 pups have been observed each year and the population has slowly increased. In 1977, 26 harbor seals were seen.

Harbor seals are found in three major areas on the island: Mussel Flat, Indian Head Beach and Shell Beach (Figure 8). The number of animals observed on Shell Beach seems to be increasing and it appears to be the most likely spot for pupping to occur because it is slightly more protected from high seas and swells.

Although the population is still small, Southeast Farallon Island is an important area for the seals as it is undisturbed by people or dogs. Human disturbance of the mainland rookeries may be one reason breeding on the Farallons began.

Stomachs of harbor seals washed ashore in north central California contained evidence of embiotocids, eelpout, cephalopods, greenling, flatfish, tomcod, rockfish, hake and hagfish.

Northern elephant seal, *Mirounga angustirostris*: In the early 1880's the northern elephant seal was breeding from the Point

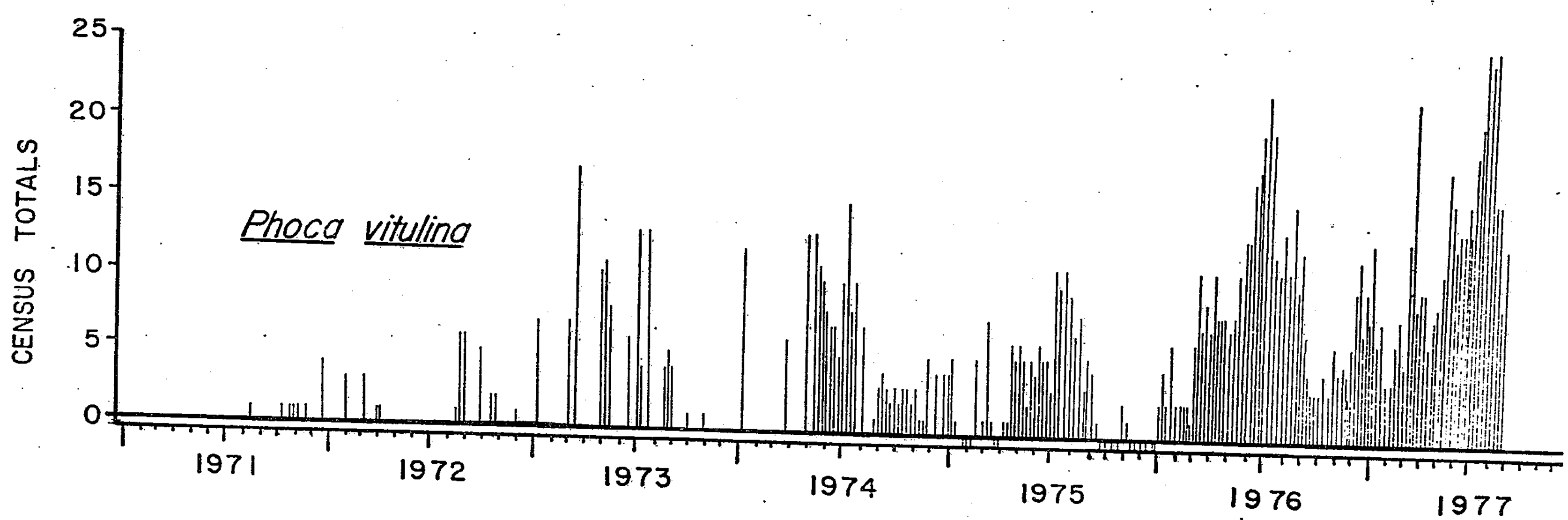

Figure 9. The annual fluctuations in numbers of Phoca hauled out at the Farallons 1971-1977.

Reyes peninsula in northern California to the islands off central Baja California. Seal hunters in the nineteenth century reduced the population to less than 100 animals at the turn of the century (Bartholomew & Hubbs), 1960). Since the 1920's, under protection from the Mexican and U.S. governments, the elephant seal has recolonized its former range and even expanded to the mainland at Ano Nuevo Point. The population now stands at about 50,000 (LeBoeuf, 1977).

The first elephant seal seen on the Farallons after a lapse of more than 150 years was an immature female in 1959 (Thoresen, 1959). Thirteen years later, breeding began with the birth of a single pup. The breeding population has steadily increased; 104 pups were born in 1977 and 523 animals were recorded at the spring peak in 1977.

Some elephant seals are seen on the island throughout the year (Figure 10) but the population structure changes with the seasons. Breeding season begins in December with the arrival of the bulls and continues as cows stagger their arrival between late December and early February. The bulls leave in mid-March, a few days after the last cow departs. Most of the pups remain on the island until April teaching themselves to fish and swim. The spring molt of females and immature animals begins in April and there is a peak of animals in late May. The adult bulls molt in August. In October a fall peak of yearlings and other immature animals occurs. At the Farallons this peak nearly reaches the height of the spring peak; at other rookeries the spring peak is much higher than the fall peak.

Sightings of animals tagged as pups on the Farallons indicates that the young travel as far south as San Miguel Island, California, and as far north as Cape Arago, Oregon.

A summary of pup mortality from 1972-1977 appears in Table 7. The mortality rate has fluctuated considerably - from 7 to 71%. The extremely high mortality of 71% occurred because all but two of the cows pupped on one small beach. This beach was strongly affected by storms and high tides which radically increased the density of the beach. In the resulting

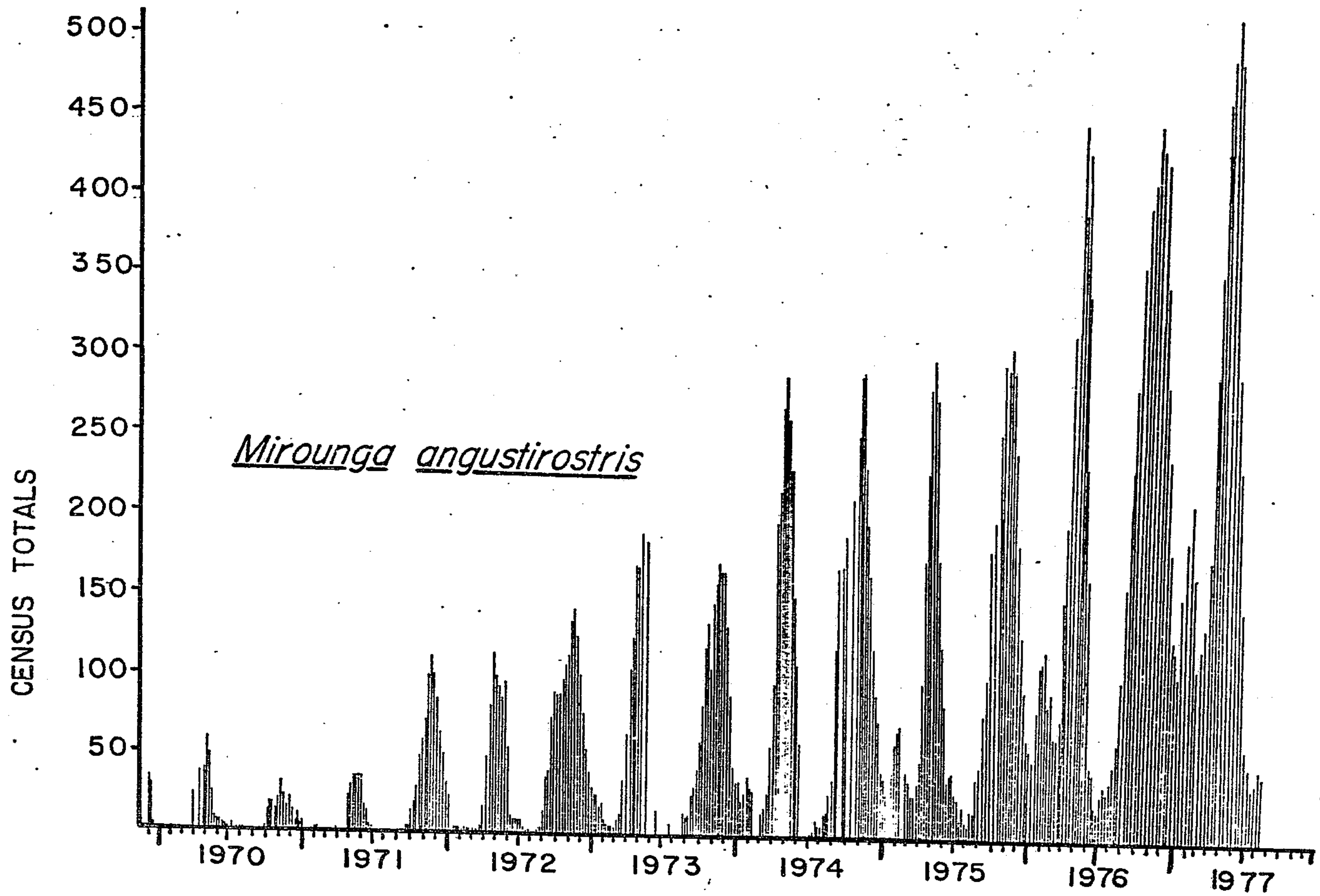

Figure 10. Numbers of Mirounga at the Farallons 1970-1977.

Table 7. Pup mortality for *Mirounga* on Southeast Farallon Island 1974-77 -- causes of death.

Year	# pups born	# pups died	% mortality	separated from cow	washed away by storms	crushed by bull	stillborn	other
1974	17	12	71	8	2		1	1
1975	35	7	20		3	2	1	1
1976	60	4	7	1	1	1	1	
1977	104	20	19	7	6	5	2	—
				16	12	8	5	2

confusion many cows and their pups were separated. Most separated pups die from starvation or from bites inflicted by alien cows. From 1975 on, most of the cows pupped on a large area unaffected by tides and so pup mortality decreased dramatically. There is some mortality each year to healthy weaners. They are crushed by adult or subadult males either during an attempted copulation or because they were blocking an escape route for the bulls (Ainley, et al., 1977). From tag returns of animals tagged as pups on the Farallons, only about a quarter of the pups born survive their first year (Table 8).

As the Farallon colony has grown, the areas used by the elephant seals during the spring and fall haul out periods and during the breeding season have changed. The use of small coves and gulches, some adjacent to large haul out areas, has increased over the years during the spring and fall. It appears that younger animals use the peripheral areas while the older animals use established hauling out places. In recent breeding seasons the West End has been used as a small pupping area as has the Marine Terrace (an area close to the major breeding area but 150 to 300 ft. (50 to 100 m) further from the water). If use of the Marine Terrace continues or increases, the potential for breeding population increase is very great if space, and not some other resource, is the limiting factor.

A study on the short-term effects of an oil spill on elephant seals found no deleterious effects (Simpson and Gilmartin, 1970). Nor were there any differences found between oil contaminated and uncontaminated pups in a 15 month study after the same oil spill (LeBoeuf, 1971).

Stomach contents of elephant seal carcasses washed ashore in north central California contained the remains of hake and cat shark.

Pinniped Predation: All four of the breeding pinniped populations appear to be preyed upon by sharks. All species except the harbor seal have been observed with fresh and healed shark wounds. Since the elephant seal population has increased, the number of incidences of shark attacks on pinnipeds has also increased. The majority of attacks seen near the Farallons have been on elephant seals by great white sharks, _Charcharodon_

Table 8. Elephant Seal Pup Survival 1974-1976

	1974 n=17		1975 n=35		1976 n=60		TOTAL n=113	
	#	%	#	%	#	%	#	%
Pups surviving to weaning (first spring	5	29%	28	80%	56	93%	89	78%
First fall	3	18%	11	31%	22	37%	36	32%
Second spring	3	18%	10	29%	17	28%	30	26%
Second fall	3	18%	9	26%				
Third spring	3	18%	7	20%				
Third fall	2	12%						
Fourth spring	2	12%						

carcharias, although the stomach of a blue shark, Pironace glauca, collected 0.6 mi. (1 km) from the island contained half of a harbor seal.

Killer whales, which are periodically seen in the vicinity of the island, are probably also predators of the Farallon pinniped population. The only attack, seen from the island, by a killer whale on a marine mammal was on a gray whale. It appeared to be unsuccessful.

Cetaceans: Ten species of cetaceans have been seen in the waters around the Farallons since PRBO biologists began observing in 1970. Some are seen regularly and others are seen less frequently. Those seen most often are gray, humpback and killer whales.

Gray whales, Eschrichtius robustus: Gray whales are seen each year from late November until June or July and occasionally into August. The largest numbers are seen during December and early January while the grays are on their southerly migration to breeding grounds in Baja California. Grays are also seen on their return migration to the arctic feeding grounds in the spring. The whales then often spend several days feeding around the island and some recognizable individuals even summer near the Farallons (Ainley, et al., 1975).

Humpback whales, Megaptera novaeangliae: These whales are seen regularly in the late summer and early fall during their southward migration. In 1977, for the first time, a cow and her calf were seen in the spring (Ainley, et al., 1977).

Killer whales, Orcinus orca: The killer whales have been seen between mid-April and early December, often in pods of 6 or 7 and mainly in a family unit including a bull, cow and calf.

Other cetaceans seen from Southeast Farallon include the finback whale, Balaenoptera physalus, sei whale, Balaenoptera borealis, sperm whale, Physeter catodon, Minke whale, Balaenoptera acutorostrata, and Dall's porpoise, Phocoenoides dalli. A dead Risso's dolphin, Grampus *griseus*, washed ashore in 1973. A single blue whale, *Balaenoptera musculus* was seen near the North Farallons in 1976.

Unique Components

The most unique component of the Farallons ASBS is the abundance of bird and marine mammal wildlife. It is this abundance of wildlife that has so affected the history of the Farallons, and it is this abundance which makes the Farallons a priceless California resource.

LAND AND WATER USE DESCRIPTION

Marine Resource Harvesting

Commercial Fishing: The commercial trawling efforts within the ASBS boundaries are limited and of little consequence. Most of the trawling around the Farallon Islands occurs outside the ASBS boundaries at the 40 fathom and 80 fathom contours. Two species of rockfish, *Sebastes goodei* and *Sebastes paucispinis*, represent the largest portion of the catch at the 80 fathom contour, while several species of flounder *Parophyrys vetulus*, *Psettichthys melanostictus*, *Glyptocephalus zachirus* and *Eopsetta jordani* compose the bulk of the catch at the 40 fathom contour.*

Commercial salmon fishing represents a major activity around the Farallon Islands. Most of the fishing occurs in the months of June, July and August. Some of the largest king salmon caught in California come from the waters around the Farallon Islands.**

It was not possible to accurately estimate the actual fishing effort within the ASBS boundaries; however, the Farallon Islands continue to be a major resource for commercial salmon fishing in central California.

Sport Fishing: Most sport fishing around the Farallon Islands occurs within the boundaries of the ASBS. Lingcod, *Ophiodon elongatus*, cabezon, *Scorpaenichthys marmoratus*, and several species of rockfish are the predominate species included in the sport fishing catch within the ASBS. Detailed accounts of the sport fishing catches for the years 1974-1976 are given in Tables 9 to 11.

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* Tom Jow, DF&G, personal communication.

** Karen Sjogren, DF&G, personal communication.

Table 9. Sport Fishing Catch Data 1974*

Blocks 457 and 458**

Month	Number of Fish	Number of Anglers	Number of Angler Hours	Number of Boat Days
01	1,549	138	546.0	6
02	7,683	918	4,102.5	78
03	6,101	915	4,004.0	48
04	7,170	1,442	6,190.5	108
05	12,037	4,506	20,055.4	368
06	18,928	5,212	23,345.0	398
07	19,481	3,642	15,277.5	259
08	22,230	1,652	6,145.5	62
09	25,834	1,826	7,599.5	69
10	29,899	2,090	7,539.5	79
11	19,927	1,463	5,098.5	60
12	10,850	796	2,616.5	39
Totals	181,689	24,610	102,518.4	1,542

Fish	Month	Number of Fish Caught	Total Annual Number of Fish
Pacific Mackerel	07	4	
	08	16	
	09	25	
	10	3	48
Jack Mackerel	07	468	
	08	510	
	09	188	
	10	46	
	11	3	1,215
Blue Shark	07	33	
	08	3	36
Jack Smelt	04	1	1

*Leo Pinkas, DF&G , personal communication.
**Blocks 457 and 458 taken from Central California Fisheries Chart (Fig. 11).

Table 9. Sport Fishing Catch Data 1974 (cont'd)

Fish	Month	Number of Fish Caught	Total Annual Number of Fish
Lingcod***	01	175	
	02	490	
	03	233	
	04	284	
	05	106	
	06	296	
	07	370	
	08	692	
	09	1,720	
	10	1,353	
	11	820	
	12	505	7,044
California Halibut	06	6	
	07	4	
	09	2	
	10	1	13
Sanddab	05	8	
	06	22	
	07	40	70
Flounder	01	30	
	02	30	
	03	8	
	04	17	
	05	5	
	06	48	
	07	26	
	08	89	
	09	186	
	10	30	
	11	44	
	12	42	555
Rockfish***	01	4	
	02	30	
	03	4,504	
	04	5,890	
	05	5,563	
	06	11,027	
	07	14,603	
	08	20,798	
	09	23,660	
	10	28,388	
	11	19,302	
	12	10,302	151,227

***Abundantly caught within ASBS

Table 9. Sport Fishing Catch Data 1974 (cont'd)

Fish	Month	Number of Fish Caught	Total Annual Number of Fish
Cabezon***	01	4	
	02	30	
	03	12	
	04	3	
	05	10	
	06	36	
	07	35	
	08	36	
	09	48	
	10	26	
	11	1	
	12	1	242
Kelp Greenling***	03	1	
	04	3	
	05	2	
	06	2	
	07	1	
	09	1	10
Salmon	02	1,005	
	03	1,338	
	04	963	
	05	6,288	
	06	7,425	
	07	3,887	
	08	85	
	09	4	
	10	52	
	11	37	21,084
King Salmon	04	8	
	05	2	
	06	31	41
Silver Salmon	04	1	
	05	45	
	06	24	70
Steelhead	06	1	1
Striped Bass	07	4	4
White Croaker	03	5	
	07	6	11

***Abundantly caught in ASBS

Table 9. Sport Fishing Catch Data 1974 (cont'd)

Fish	Month	Number of Fish Caught	Total Annual Number of Fish
Wolf-Eel	05	2	2
Ocean Whitefish	08	1	1
Pacific Hake	05	6	
	06	6	12
Octopus	06	2	2

Table 10. Sport Fishing Catch Data 1975*

Blocks 457 and 458**

Month	Number of Fish	Number of Anglers	Number of Angler Hours	Number of Boat Days
01	11,950	796	2,493.5	32
02	11,560	1,157	4,572.5	56
03	13,648	1,251	4,501.5	65
04	14,760	4,781	20,747.6	371
05	16,454	4,293	18,625.3	336
06	18,347	2,680	11,010.0	165
07	26,125	6,033	26,113.2	450
08	24,818	3,421	14,448.0	204
09	24,041	1,904	7,869.5	79
10	12,681	1,303	5,528.5	66
11	4,440	706	3,221.0	37
12	824	99	510.0	6
Totals	178,648	28,422	119,640.8	1,867

Fish	Month	Number of Fish Caught	Total Annual Number of Fish
Pacific Mackerel	07	2	3
	10	1	
Jack Mackerel	07	38	
	08	165	
	09	382	
	10	206	791
Blue Shark	07	2	2

*Leo Pinkas, DF&G, personal communication.
** Blocks 457 and 458 taken from Central California Fisheries Chart (Fig. 11).

Table 10. Sport Fishing Catch Data 1975 (cont'd)

Fish	Month	Number of Fish Caught	Total Annual Number of Fish
Ling Cod***	01	871	
	02	580	
	03	326	
	04	287	
	05	355	
	06	693	
	07	332	
	08	901	
	09	2,080	
	10	511	
	11	327	
	12	58	7,341
California Halibut	02	1	
	04	1	
	07	2	
	08	2	6
Sanddab	03	7	
	06	4	
	09	8	19
Flounder	02	15	
	03	7	
	04	46	
	05	55	
	06	19	
	07	48	
	08	135	
	09	31	
	10	40	
	11	46	
	12	25	467
Rockfish***	01	11,079	
	02	10,283	
	03	13,087	
	04	8,428	
	05	11,386	
	06	16,548	
	07	21,023	
	08	22,000	
	09	21,277	
	10	11,648	
	11	3,935	
	12	741	151,435

***Abundantly caught in ASBS

Table 10. Sport Fishing Catch Data 1975 (cont'd)

Fish	Month	Number of Fish Caught	Total Annual Number of Fish
Cabezon***	04	11	
	05	21	
	06	3	
	07	10	
	08	7	
	09	13	
	10	5	70
Kelp Greenling***	04	2	
	05	1	
	06	1	4
Salmon	02	681	
	03	219	
	04	4,982	
	05	4,626	
	06	1,065	
	07	4,660	
	08	1,604	
	09	235	
	10	178	
	11	131	18,381
King Salmon	05	1	1
Silver Salmon	05	9	9
Steelhead	07	2	2
Striped Bass	06	2	
	07	6	
	08	8	
	09	1	
	10	59	108
White Croaker	06	12	12
Wolf Eel	03	1	
	11	1	2
Pacific Hake	07	1	1
Miscellaneous Fish	03	1	
	04	3	4

***Abundantly caught in ASBS

Table 11. Sport Fishing Catch Data 1976*

Blocks 457 and 458**

Month	Number of Fish	Number of Anglers	Number of Angler Hours	Number of Boat Days
01	3,733	304	1,137.0	17
02	5,176	753	3,177.5	44
03	16,797	1,535	6,244.0	80
04	18,722	3,015	13,481.5	231
05	19,373	4,889	22,428.7	386
06	22,722	3,908	18,491.2	279
07	23,925	2,143	9,546.0	100
08	19,275	1,704	8,017.0	68
09	23,074	1,861	7,709.5	79
10	27,796	2,335	10,214.5	103
11	14,672	1,227	5,051.0	58
12	12,117	835	2,935.0	35
Totals	207,382	24,509	108,432.9	1,480

Fish	Month	Number of Fish Caught	Total Annual Number of Fish
Albacore	08	2	2
Pacific Mackerel	08	10	
	09	53	63
Jack Mackerel	06	2	
	07	78	
	08	183	
	09	97	
	10	7	367
Shark	01	1	1
Bonito Shark	10	1	1

*Leo Pinkas, DF&G, personal communication.
** Blocks 457 and 458 taken from Central California Fisheries Chart (Fig. 11).

Table 11. Sport Fishing Catch Data 1976 (cont'd)

Fish	Month	Number of Fish Caught	Total Annual Number of Fish
Blue Shark	06	1	
	07	15	
	08	11	
	09	30	
	10	2	59
Ling Cod***	01	138	
	02	382	
	03	572	
	04	382	
	05	241	
	06	420	
	07	1,083	
	08	972	
	09	1,333	
	10	1,782	
	11	807	
	12	871	8,983
California Halibut	04	2	
	08	1	
	09	1	
	10	2	6
Sanddab	03	1	
	06	7	
	10	21	29
Flounder	01	46	
	02	19	
	03	161	
	04	56	
	05	1	
	07	117	
	08	31	
	09	56	
	10	5	
	11	20	
	12	15	552
Rockfish***	01	3,543	
	02	4,697	
	03	15,886	
	04	15,559	
	05	10,514	
	06	18,081	

*** Abundantly caught within ASBS

Table 11. Sport Fishing Catch Data 1976 (cont'd)

Fish	Month	Number of Fish Caught	Total Annual Number of Fish
Rockfish***(cont'd)	07	22,224	
	08	17,891	
	09	21,327	
	10	25,687	
	11	13,742	
	12	11,229	180,378
Cabezon***	01	3	
	02	6	
	03	30	
	04	21	
	05	61	
	06	1	
	07	1	
	08	4	
	09	9	
	10	4	
	12	1	141
Kelp Greenling***	07	5	
	08	1	6
Salmon	01	2	
	02	74	
	03	147	
	04	2,702	
	05	8,502	
	06	4,089	
	07	392	
	08	165	
	09	24	
	10	46	16,143
Striped Bass	07	10	
	08	3	
	09	22	
	10	7	42

***Abundantly caught within ASBS

Table 11. Sport Fishing Catch Data 1976 (cont'd)

Fish	Month	Number of Fish Caught	Total Annual Number of Fish
White Seabass	10	9	9
Opah	11	1	1
Pacific Hake	06	25	25
Octopus	12	1	1

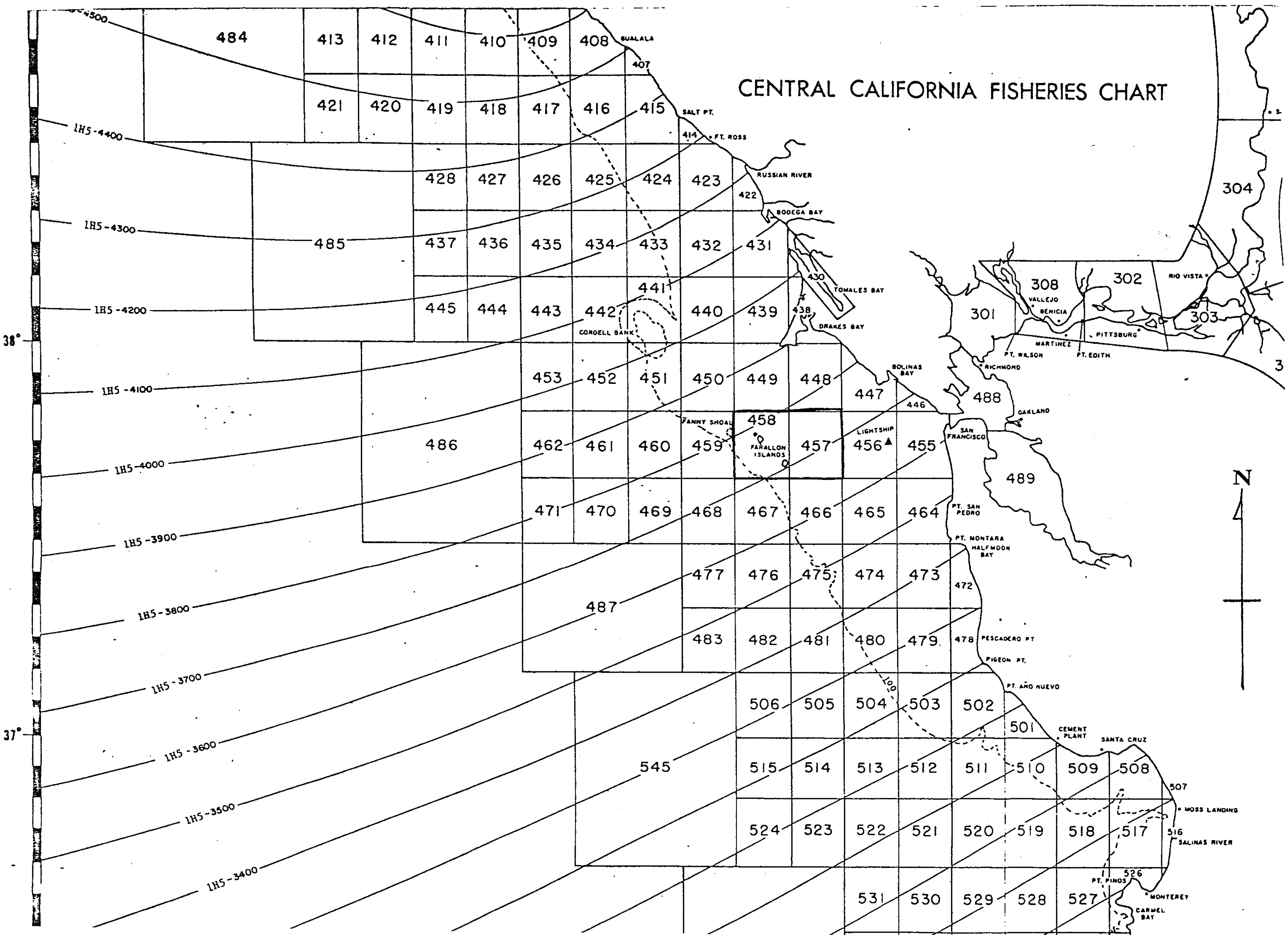

Figure 11. Central California Fisheries Chart

Sport fishing activities at the Farallon Islands occur year round; however, there is a decreased bottom fishing effort during the summer months when the sport fishermen concentrate on salmon and albacore. Most of the salmon and albacore are caught outside the ASBS boundaries.***

Municipal and Industrial Activities

Power generation for the Farallons is confined to Southeast Farallon Island and is accomplished by means of diesel fueled generators for the lighthouse and for the two houses.

Governmental Designated Open Space

The Farallon National Wildlife Refuge consists of Southeast, Middle, and North Farallons, submerged Noonday Rock, and surrounding waters. Established by Executive Order in 1909, the Farallon Reservation included only Middle and North Farallons, and Noonday Rock. Southeast Farallon Island was added by Public Land Order in 1969. In 1974 the Farallon Wilderness was established to include Noonday Rock, Middle and North Farallons, and the West End of Southeast Farallon.

The Fish and Wildlife Service of the United States Department of the Interior has jurisdiction over the land area of the refuge to the high tide mark. From the high tide mark to 1,000 yards (914 m) offshore is controlled by the California Department of Fish and Game. Other agencies having jurisdiction over the islands include the City and County of San Francisco and the United States Coast Guard. All waters within 1 mi. (1.6 km) of the Farallon Islands are included in a California State Bird Refuge. The State Water Resources Control Board has designated the nearshore waters of the Farallon Islands an Area of Special Biological Significance.

*** Jack Baxter, DF&G, personal communication.

Recreational Uses

Recreational activities which take place in the general vicinity of the Farallon Islands include: 1) Natural history/birdwatching tours; for purposes of observing sea birds, marine mammals and other marine life. These trips are usually led by naturalists familiar with the area and the wildlife encountered. 2) Sport fishing, which usually takes place from commercially owned "party boats", as well as privately owned vessels. For the years 1974 through 1976, a yearly average of 25,847 anglers on 1,155 boat days participated in this activity. More detailed information concerning species caught, number of fish caught, etc. can be found in Tables 8 to 10. 3) Skin and SCUBA diving in the vicinity of the Farallon Islands is somewhat limited, due to the frequency of white shark attacks on divers in the area. The Farallon Islands are one of three areas listed in the NOAA Dive Manual as being too dangerous for diving activities because of the shark attack problem. In spite of this, however, some diving activities take place here each year. Divers interested in gathering abalone, spearfishing, and underwater photography are attracted to the Farallons because visibility is often quite good. Also, due to the relative lack of diver predation, hunting is reputed to be quite successful. 4) Pleasure sailing; sailboat owners from the San Francisco Bay Area often sail to the Farallons. An average of about 6 boats per month have been observed from the island. 5) Boat racing; several times per year sailing and motoring clubs sponsor races which use the Farallons as a turning point in the race course.

Scientific Study Uses

The Farallon Islands have been mentioned occasionally in the scientific literature since the mid-nineteenth century. Man's use of the islands began with the exploitation of their resources; today the islands are a National Wildlife Refuge and the major human effort is directed towards scientific research. Because the Middle and North Islands are inaccessible to humans due to sheer cliffs, scientific research has largely been limited to Southeast Farallon Island.

The vast majority of scientific and popular articles written about the Farallon Islands (see bibliography) is concerned with their large and diverse bird fauna. The Point Reyes Bird Observatory has maintained a permanent research station on Southeast Farallon since 1968. Their current long-term ornithological research includes the following topics: 1) The occurrence rate of birds on the island. A study of land birds and water birds based on daily censusing is now in its tenth year, and is designed to learn about the dispersal of birds as well as the yearly and seasonal timing of their movements. 2) The ecology of a subarctic marine bird community. A study of the 12 breeding marine bird species, including their use of the island and its marine resources, and their breeding biology is now in its eighth year. Short term projects include: 1) the feeding ecology of Black Oyster-catchers; and 2) the effects of petroleum ingestion on the breeding physiology and productivity of sea birds. This latter work is being conducted in conjunction with the University of California at Davis and currently involves Cassin's Auklets. PRBO also has an active marine mammal research program emphasizing the process of recolonization by pinnipeds. PRBO biologists take daily seawater temperatures and water samples for Scripps Institution of Oceanography; salinity data is obtained from the water samples. They also send daily weather reports to the U.S. Coast Guard and National Weather Service.

The Farallon Research Group, formed in 1973, is documenting the marine intertidal flora and invertebrate fauna of Southeast Farallon Island. Projects now in progress include: 1) sea cave zonation studies; and 2) a drift card study of surface currents in the Gulf of the Farallons. Studies involving invertebrates preyed upon by birds are being considered.

Other scientific uses of the Farallon Islands during the last few years have included a study of fog by the University of Nevada Desert Research Institute in Las Vegas, and the collection of mussels for organic and heavy metal analyses done by the Environmental Protection Agency, the California State Water Resources Control Board, California Department of Fish and Game, Scripps Institute of Oceanography, Bodega Bay Institute, and Moss Landing Marine Laborities. The U.S. Geological

Survey has maintained a seismograph on the island since 1974. Injured or sick pinnipeds are often released at the Farallon Islands after treatment by the Marine Mammal Center in Marin County.

Transportation Corridors

There are no transportation corridors on the island, or within 1 mi. (1.6 km) radius designated for this study. Travel on the island is by foot, and transportation of materials (food, personal effects, etc.) is by push-cart. Boats call at the island once or twice a week and sometimes less. These boats approach from the east and moor at buoys in East Landing or Fisherman's Bay.

The nearest designated transportation corridors are two major shipping channels for vessels (300 gross tons and over) destined for San Francisco Bay. The northwestern limit of the Main Traffic Lane is 2.6 mi. (4.2 km) south of Southeast Farallon Island and the southwestern limit of the Northern Traffic Lane is 8.7 mi. (14 km) north of Middle Farallon (Figure 12); these are the closest distances between corridors and islands. Vessels not calling at San Francisco Bay pass west of the Farallons within designated lanes except when they travel direct between Point Arguello and Point Arena.

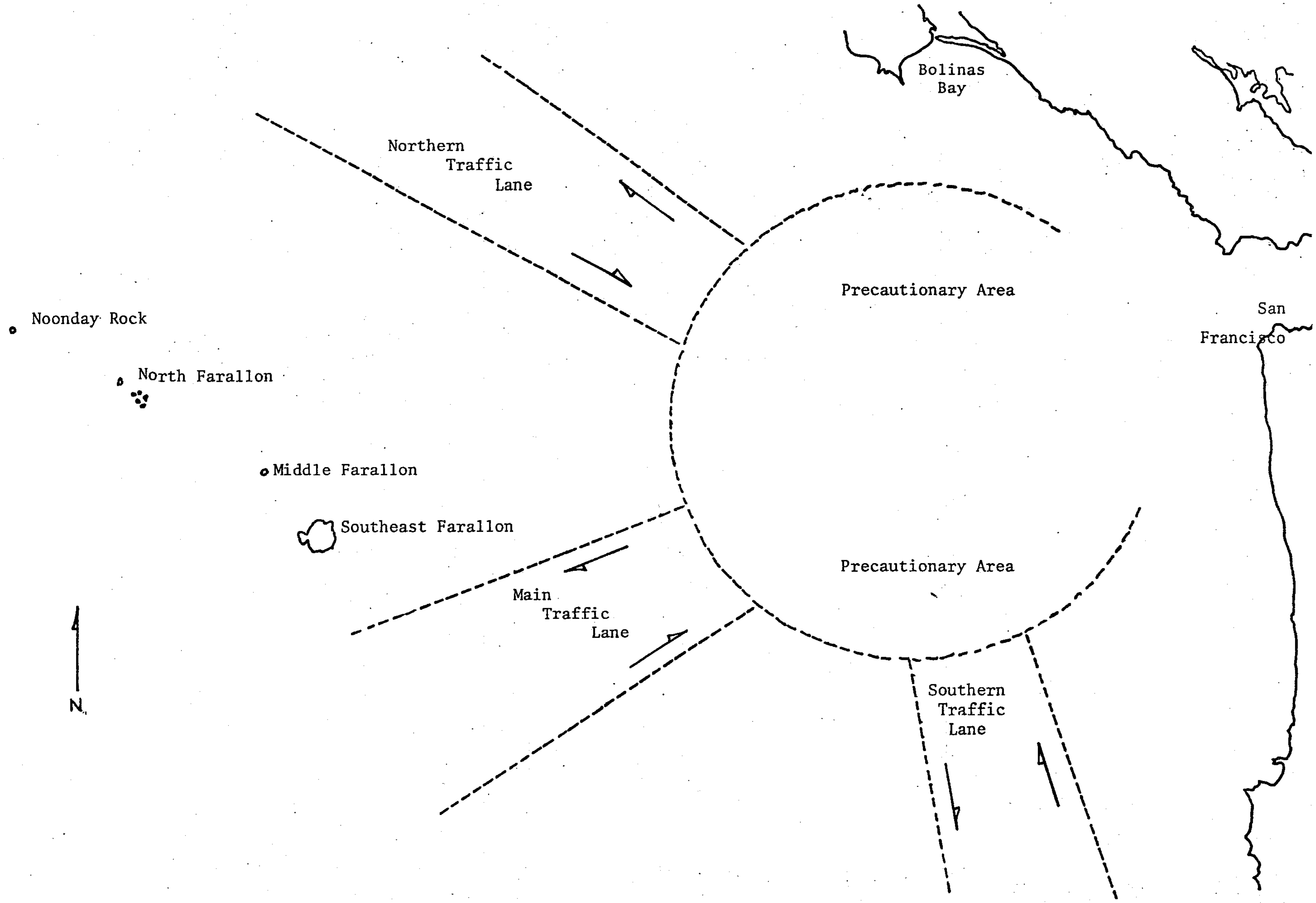

Figure 12. Gulf Of The Farallons Shipping Lanes.

ACTUAL OR POTENTIAL POLLUTION THREATS

Point Sources

Municipal and Industrial Wastes: The only waste disposal on the island is untreated sewage from the two residence houses. The total number of people on the island rarely exceeds 12 and averages 2 to 5 so the volume of sewage is quite small. This sewage is discharged into an intertidal surge channel in front of the house. There is no visible evidence that this effluent affects the intertidal region as the zonation is similar to that of adjacent areas (for detail see Intertidal Biota description) and elephant seals frequent the small beach (Ron LeValley, PRBO, personal communication).

Dredge and Spoil Disposal: Since 1935, various materials have been dumped in the vicinity of the Farallon Islands. Most of this material has been dredge spoils. However, before 1972 when Federal Water Pollution Control Act regulations governing disposal went into effect, various types of materials were dumped; much of it at sites only vaguely specified as west of San Francisco (Winzler and Kelly, 1977). The types and quantities of materials dumped since 1935 include:

Category	Period	Estimated Total
refinery wastes	1966-1972	315 million gallons
acid wastes	1948-1971	240 million gallons
cannery wastes	1960-1972	246 thousand tons
radioactive wastes	1946-1968	44,563 containers
munitions	1968-1969	746 tons
dredge spoil	1935-1972	1 million cubic yards

(Table reproduced from Winzler and Kelly, 1977, data from MacFarlane, 1974)

Subsequent to 1972 apparently only two dump sites have been approved, neither of which is within a 1 mi. (1.6 km) radius of the Farallons. Both of these sites are for dredge spoils only. One site, located at 37°41'N, 123°75'W is about 4 mi. (6.4 km) southwest of Southeast Farallon and was used only in 1975 as a study site for the U.S. Army Corps of Engineers. The other site, located at 37°31'N, 122°59'W is about 11 mi. (18 km) south of Southeast Farallon Island and has been in use since its designation as SF-7 in 1973.

Ocean disposal of dredge spoils has been found to be a costly alternative to other methods of dredge disposal (i.e. dumping the spoils near the dredge site) and is only used when the heavy metal content of the spoils exceeds the limits allowed for disposal in San Francisco Bay. Apparently, for this reason, site SF-7 has only been used 2-3 times per year since its designation. During calender year 1977 the site was used 3 times for an approximate total of 68,000 cubic yards (52,000 cubic meters) (John Adsit, COE, personal communication). The fate of dredge spoils dumped on the ocean floor is uncertain. Studies have indicated that, at least for short periods of time, the spoils are mounted on the bottom as a cohesive mass (John Sustar, COE, personal communication; Stephen Pace, MLML, personal communication), and it is believed that in the absence of strong currents there is little longterm movement.

<u>Radioactive Wastes</u>: Between 1946 and 1966 several sites within 4 to 14 mi. (6 to 23 km) of Southeast Farallon Island were used for disposal of radioactive waste materials. Review of the records for this period indicates that approximately 47,750 containers were dumped, mostly 55 gallon drums containing 'low level radiation' such as contaminated rubber gloves, rags, glass and liquid waste mixed into concrete (Joseph, et al., 1971). These containers were distributed over a wide area southwest of the island at depths ranging from 50 to 1,000 fathoms (300 to 6,000 ft.).

In 1974 and again in 1975 and 1977 Interstate Electronics Corporation, under contract with the Evironmental Protection Agency, performed surveys of the dump sites, assessed the condition of the containers and collected samples for radioanalysis. Underwater television and still photography indicated that approximately 25% of the containers were ruptured, either having imploded as a result of increasing hydrostaticpressure as they sank to the bottom or having corroded during the time since they were dumped. Baseline analyses of sediment core samples for plutonum (^{238}Pu and $^{239+240}$Pu) have yielded average fallout values varying between 4.5 and 18 pCi/kg dry weight in the top 5 cm of bottom sediment in regions between 35°-40° N latitude (Bowen, et al., in press). In sediments collected within a cluster of both intact and breached containers at the 900 meter Farallon dumpsite, the "level of $^{239+240}$Pu contamination in surface sediments is shown to be 2 to 25 times higher than the maximum expected concentration that could have resulted from weapons testing fallout." (Dyer, 1976)

A more recent survey conducted by scientists from the Lawrence Livermore Laboratory (Noshkin, et al., 1978), however, concludes that total $^{239+240}$Pu and ^{137}Cs in Farallon water columns and in fish and invertebrates from the disposal region are within global fallout levels. This study found ^{238}Pu concentrations exceeding anticipated fallout levels in bottom sediments of the 6,600 ft. (2,000 m) Farallon disposal site, and the authors dispute Dyer's (1976) method of assessing concentration levels. Resolution of this apparent controversy awaits the analyses of Dyer's more recent samples which were collected late in 1977.

<u>Offshore Oil Development</u>: The leasing of oil drilling sites is phrobited within 3 mi. (4.8 km) of the coastline. This would include a three mile radius around the Farallon Islands. Leasing of remaining open water area is conducted according to a leasing schedule established by the Bureau of Land Management Pacific Outer Continental Shelf Office.

The Outer Continental Shelf Lands Act Amendment established a 15 mi. (24 km) radius around Point Reyes in which drilling would be prohibited. An amount of money to be allocated to a 'clean up fund' in the event of an oil spill is part of this bill.

Vessel Discharge: The 1973 World Oil Pollution Act prohibits any bilge pumping within a 50 mi. (80 km) limit of all coast lines. This distance would include the Farallon Islands.

Nonpoint Sources

Oil Spills and Seeps: The United States Government prohibits any type of oil spill or seepage within 12 mi. (19 km) of land. The law includes fish oil and crude oil and its products and applies to ocean waters within a 12 mi. (19 km) radius of the Farallon Islands.

Records of oil spills on or in the vicinity of the Farallon Islands are contained in the Point Reyes Bird Observatory Farallon log book or can be supplied by the U.S. Coast Guard. Most of the incidents are concerned with oil soaked birds, and rarely is there any mention of oil slicks on nearshore waters or oil-covered rocks on the Farallon Islands. The U.S. Coast Guard documents open-water slicks within a 45 mi. (72 km) radius of the island. None of these slicks have reached the island. Occasionally operator-error in filling the diesel fuel containers on Southeast Farallon Island have caused small spills of fuel; in one instance, the generator began leaking, causing oil to flow over East Landing. See Table 12 for a more detailed account of the oil spills and slicks in the vicinity of the Farallon Islands for the period 1970 to early 1978.

Land Development: There are two houses and several other U.S. Coast Guard structures on Southeast Farallon Island; however, no new construction is planned.

Harbor Development: In March 1978 the U.S. Coast Guard placed a mooring buoy in Fiserhman's Bay, an otherwise unimproved anchorage.

Solid Waste Disposal: Burnable garbage is incinerated. Nonburnable material is carried off the island by boat while vegetable matter is composted.

Table 12. Summary of Oil Spill Information for The Farallon Islands

Sources: Point Reyes Bird Observatory Farallon Log Records and U.S. Coast Guard Oil Spill Reports.

(PRBO Farallon logs report incidents of oiled birds on the island, or slicks in adjacent waters; Coast Guard information is for a 40 mile radius around the island.)

Date	Incident	Source of Information
1970		
4 Feb	1 oiled ashy petrel	PRBO Log
16 Aug	oil in small coves on the north side of the island	PRBO Log
17 Aug	more oil still flowing around the island. Lots of dead algae and invertebrates	PRBO Log
18 Aug	oil in Breaker Cove	PRBO Log
19 Aug	1 oiled phalarope	PRBO Log
23 Aug	oil still in Breaker Cove	PRBO Log
27 Aug	1 oiled pigeon guillemot	PRBO Log
5 Nov	1 oiled Scoter	PRBO Log
11 Dec	elephant seals and driftwood have heavy oil spots; few common murres and gulls with oil also	PRBO Log
21 Dec	oil in water by north side of island	PRBO Log
1971		
13 Jan	1 oiled rhino auklet	PRBO Log
18 Jan	major oil spill under Golden Gate	news services
20 Jan	oiled birds: 111 murres, 4 western gulls, 5 glaucus-winged gulls	PRBO Log
21 Jan	oiled birds: 187 oiled murres, 1 western grebe, 1 white-winged scoter	PRBO Log
22 Jan	oiled birds: 127 murres, some dead, 1 western grebe, 1 white-winged scoter	PRBO Log
23 Jan	few oiled murres	PRBO Log
24 Jan	45 dead and oiled murres	PRBO Log
25 Jan	20% of murres with oil spots, 29 oiled murres around island	PRBO Log
26 Jan	20-25% of common murres around north landing with oil spots	PRBO Log
27 Jan	1 new oiled bird	PRBO Log
28 Jan	3 new oiled birds	PRBO Log
30 Jan	1 new oiled bird, tar around island	PRBO Log
1 Feb	1 elephant seal with oil on belly, oil in Fisherman's Bay	PRBO Log
2 Feb	more tar and straw in Fisherman's Bay	PRBO Log
14 Mar	2 birds with oiled faces	PRBO Log
29 Dec	1 oiled murre	PRBO Log

Table 12. Summary of Oil Spill Information for The Farallon Islands (cont'd)

Date	Incident	Source of Information
1972		
4 Jan	1 oiled murre	PRBO Log
18 Jan	1 oiled murre	PRBO Log
17 Sep	1 oiled western gull, 1 oiled western sandpiper	PRBO Log
18 Sep	1 oiled red phalarope	PRBO Log
19 Sep	1 oiled red phalarope, probably same as yesterday	PRBO Log
23 Nov	1 oiled murre in Breaker Bay	PRBO Log
7 Dec	1 oiled rhino auklet in Fisherman's Bay	PRBO Log
1973		
14 Jan	oil splattered on shore and on birds	PRBO Log
19 Jan	5 oiled murres	PRBO Log
26 Feb	oiled murre in Fisherman's Bay	PRBO Log
30 Mar	2 oiled murres	PRBO Log
5 May	1 oiled common murre	PRBO Log
10 May	1 oiled murre at East Landing	PRBO Log
16 May	1 oiled murre at East Landing, still alive	PRBO Log
7 Jun	gasoline at $38^{\circ}02'$N, $123^{\circ}07'$W, from gasket failure on a tank barge of 0-149 gross tons (amount of spill 1 gallon) near Pt. Reyes	Coast Guard
16 Jun	2 oiled guillemots and 1 oiled murre at East Landing, 1 oiled guillemot at North Landing	PRBO Log
17 Jun	3 oiled murres, 2 oiled guillemots	PRBO Log
18 Jun	5 oiled murres, 3 oiled guillemots	PRBO Log
21 Jun	large oil slicks 5-6 miles east of the island, many large globs of heavy oil closer to island, slick looks to be 1/2 to 3/4 mile long and 2,000-3,000 yards wide	PRBO Log
19 Sep	100+ gallons diesel fuel overflowed from tanks onto marine terrace during pumping, fuel allowed to drain downhill to boat	PRBO Log
31 Oct	again, overflow of diesel fuel during pumping	PRBO Log
12 Nov	20% of elephant seals, 1 common loon and many washed-up feathers show signs of oiling	PRBO Log
5 Dec	6 oiled murres	PRBO Log

Table 12. Summary of Oil Spill Information for the Farallon Islands (cont'd)

Date	Incident	Source Information
1974		
10 Jan	1 dead oiled ancient murrelet	PRBO Log
17 Jan	oil washed in as gobs of tar	PRBO Log
21 Jan	lots of oil washing in on North side, 1 oiled bird	PRBO Log
30 Mar	16 oiled murres	PRBO Log
4 Jun	1 oiled phalarope	PRBO Log
24 Jul	15 gallons of heavy crude oil spilled from a marine transportation facility at 38°01'N, 122°58'W (Drakes Bay) cause unknown	Coast Guard
30 Dec	1 oiled murre	PRBO Log
1975		
9 Mar	oiled birds, 7 murres and 1 auklet	PRBO Log
25 Mar	25 gallons of unidentified light oil spilled at 37°35'N, 123°16'W. Source and cause unknown	Coast Guard
18 Apr	150 gallons of waste oil intentionally discharged from tank cleaning or stripping at 37°25'N, 123°15'W. Source unknown	Coast Guard
14 May	side of generator smashed allowing oil to spill over edge of East Landing	PRBO Log
27 Jun	1 badly soaked murre, plus several others with oil spots. 1 oil covered guillemot egg	PRBO Log
28 Jun	5% of murres have oil spots. 3 murres and 2 quillemots hauled out on East Landing because they were badly oil soaked. 1 gull with smear	PRBO Log
2 Jul	oil soaked guillemot died	PRBO Log
3 Jul	oiled birds, 1 murre at East Landing, 1 rhino auklet at North Landing	PRBO Log
1976		
1 Feb	1 badly oiled murre	PRBO Log
17 Feb	1 black kittiwake oiled	PRBO Log
18 Feb	1 black kittiwake with oil on breast	PRBO Log
23 Feb	1 northern phalarope slightly oiled	PRBO Log
6 May	10 gallons of #5 fueloil spilled from a dry cargoship at 38°00'N, 122°52'W. cause unknown	Coast Guard
16 May	1 oiled artic loon	PRBO Log
16 Aug	100 gallons of waste oil spilled, source and cause unknown. spilled at 37°46'N, 122°44'W	Coast Guard
15 Nov	1 oiled murre	PRBO Log
30 Nov	presence of oil drops in water (comprizing approximately 1 gallon	PRBO Log

Table 12. Summary of Oil Spill Information for the Farallon Islands (cont'd)

Date	Incident	Source of Information
1977		
11 Jan	1 oiled murre washed up in Log Channel	PRBO Log
14 Mar	unknown source, cause and amount of heavy diesel oil spilled at 37°30'N, 122°50'W	Coast Guard
20 Mar	1 oiled common murre	PRBO Log
22 Mar	1 oiled kittiwake	PRBO Log
28 Mar	1 oiled bird	PRBO Log
30 Apr	oil spill at East Landing, bilge pumping from fishing boat?	PRBO Log
22 Aug	1 gallon of gasoline spilled from an onshore bulk cargo transfer due to a transportation pipeline rupture or leak due to faulty materials at 37°55' N, 122°55'W	Coast Guard
13 Nov	1 oiled artic loon	PRBO Log
1978		
7 Jan	12 oiled murres	PRBO Log
8 Jan	9 live, 1 dead oiled murres	PRBO Log
9 Jan	7 live, 1 dead oiled murres	PRBO Log
10 Jan	2 live oiled murres	PRBO Log
11 Jan	1 oiled murre, live	PRBO Log

SPECIAL WATER QUALITY REQUIREMENTS

Although sufficient research has not yet been conducted to determine the levels of various toxic substances which might be considered detrimental to marine species, there are indications that levels of some toxicants are higher at the Farallons than might be desirable. Beginning in 1976, Southeast Farallon Island was included as a sampling site in the State and Federal research and monitoring program called Mussel Watch. Preliminary results of analyses of California mussel tissues collected and analyzed with carefully standardized techniques provide an indication of relative water quality in the vicinity of Southeast Farallon Island. Chlorinated hydrocarbon (DDE, DDD, PCB1254 levels were elevated 2 to 3 times above other northern California coastal samples (Point Reyes, Bodega Head) although they were significantly below levels found in southern California (Point Fermin) or on the Atlantic coast (New Bedford Harbor) (Risebrough, BBI, personal communication). Similarly, petroleum hydrocarbons were significantly higher in Farallon mussel tissue than at other northern Callifornia coastal or Channel Island sampling stations (Risebrough, 1978). Heavy metal concentrations in *Mytilus* tissues from Southeast Farallon Island were within the normal ranges for silver, cadmium, copper, nickel, zinc and manganese, but lead concentrations were significantly higher than at other northern California sites (Martin, MLML, personal communication).

Review of the above data on radionuclides, chlorinated hydrocarbons, petroleum hydrocarbons and heavy metals from Southeast Farallon suggest that the ASBS is extremely important for research and monitoring purposes due to its location and wildlife. The nearly 30 mi. (48 km) of ocean separating the island from the mainland might be expected to insulate this ecosystem from the more direct influences of land based, man-made pollution and yet many of the parameters reviewed appear unaccountably elevated. The significance of these increases is not known at this time.

Thorough documentation of significant water quality problems at the islands will be required to substantiate these preliminary data. It might be desirable to provide added protection for nearshore water quality, after reviewing sources of water pollution affecting the ASBS. It is important that high water quality standards be met, as several rare and endangered species frequent the Farallons and adjacent waters in large numbers, and are affected directly or indirectly by water quality in the ASBS.

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APPENDIX 1

Attached aquatic plants found in the subtidal region of Farallon Islands.

CHLOROPHYTA

Codiales

Derbesia sp.

Codium setchellii Gardner

PHAEOPHYTA

Chordariales

Compsonema serpens Setchell & Gardner

Laminariales

Dictyoneurum californicum Ruprecht

Nereocystis luetkeana (Mertens) Postels & Ruprecht

RHODOPHYTA

Goniotrichales

Goniotrichum alsidii (Zanardini) Howe

Goniotrichopsis sublittoralis Smith

Bangiales

Erythrotrichia sp.

Porphyra sp.

Nemaliales

Acrochaetium spp.

Pterocladia caloglossoides (Howe) Dawson

Cryptonemiales

Peyssonellia meridionalis Hollenberg & Abbott ?

Melobesia marginata Setchell & Foslie

Mesophyllum lamellatum (Setchell & Foslie) Adey

Clathromorphum parcum (Setchell & Foslie) Adey

Lithophyllum grumosum (Foslie) Foslie

Chiharaea bodegensis Johansen

Bossiella californica (Decaisne) Silva

Bossiella californica schmittii (Manza) Johansen

Bossiella plumosa (Manza) Silva

Bossiella corymbifera (Manza) Silva

Calliarthron cheilosporioides Manza

Calliarthron tuberculosum (Postels & Ruprecht) Dawson

Pugetia fragilissima Kylin

Callophyllis violacea J. Agardh ?

Choreocolax polysiphoniae Reinsch

Gigartinales

Schizymenia epiphytica (Setchell & Lawson) Smith & Hollenberg

Opuntiella californica (Farlow) Kylin

Plocamium cartilagineum (Linnaeus) Dixon

Rhodoglossum californicum (J. Agardh) Abbott

Rhodoglossum sp.

Rhodymeniales

Fauchea laciniata J. Agardh

Rhodymenia californica Kylin

Ceramiales

Antithamnion defectum Kylin

Antithamnion dendroideum Smith & Hollenberg

Platythamnion villosum Kylin

Ceramium gardneri Kylin

Microcladia coulteri Harvey

Callithamnion biseriatum Kylin

Pleonosporium vancouverianum (J. Agardh) J. Agardh

Griffithsia pacifica Kylin

Tiffaniella snyderiae (Farlow) Abbott

Ptilothamnionopsis lejolisea (Farlow) Dixon

Branchioglossum woodii (J. Agardh) Kylin

Delesseria decipiens J. Agardh

Cryptopleura corallinara (Nott) Gardner

Botryoglossum farlowianum (J. Agardh) DeToni

Polysiphonia pacifica Hollenberg

Pterosiphonia dendroidea (Montagne) Falkenberg

Herposiphonia parva Hollenberg

Ceramiella sp. ?

APPENDIX 2

Invertebrates and attached aquatic plants
found in the intertidal region of Farallon Islands ASBS.

PORIFERA

DEMOSPONGIA

Aplysilla glacialis (Dybowski, 1880)

Aplysilla polyraphis de Laubenfels, 1930

Spongia idia de Laubenfels, 1932

Haliclona sp. A

Xestospongia vanilla (de Laubenfels, 1930)

Toxadocia sp.

Mycale psila (de Laubenfels, 1930)

Zygherpe hyaloderma de Laubenfels, 1932

Antho lithophoenix (de Laubenfels, 1927)

Axocielita originalis (de Laubenfels, 1930)

Clathria sp.

Ophlitaspongia pennata (Lambe, 1895)

Acarnus erithacus de Laubenfels, 1927

Anaata spongigartina (de Laubenfels, 1930)

Hymedesmia sp. A

Hymenamphiastra cyanocrypta de Laubenfels, 1930

Lissodendoryx firma (Lambe, 1895)

Lissodendoryx topsenti (de Laubenfels, 1930)

Myxilla incrustans (Esper, 1805-14)

Tedania gurjanovae Koltun, 1958

Plocamia karykina de Laubenfels, 1927

Halichondria panicea (Pallas, 1766)

Suberites sp.

PORIFERA (Cont'd)

DEMOSPONGIA (cont'd)

Tethya aurantia (Pallas, 1766)

Stelletta clarella de Laubenfels, 1930

CALCAREA

Leucosolenia eleanor Urban, 1905

Scypha sp.

Leucandra heathi Urban, 1905

Leucilla nuttingi (Urban, 1902)

CNIDARIA

HYDROZOA

Stylantheca porphyra Fisher, 1930

ANTHOZOA

Anthopleura elegantissima (Brandt, 1835)

Anthopleura xanthogrammica (Brandt, 1835)

Epiactis prolifera Verrill, 1869

Tealia crassicornis (Muller, 1776)

Tealia lofotensis (Danielssen, 1890)

Balanophyllia elegans Verrill, 1864

Corynactis californica Carlgren, 1936

ANNELIDA

POLYCHAETA

Halosydna brevisetosa Kinberg, 1855

Hesperonoe sp.

Pareuythoe californica (Johnson, 1897)

Nereis sp.

Nereis eakini Hartman, 1936

ANNELIDA (cont'd)

POLYCHAETA (cont'd)

Nereis _grubei_ (Kinberg, 1866)

Nereis _vexillosa_ Grube, 1851

Anaitides sp.

cf. _Genetyllis_ _castanea_ (Marenzeller, 1897

Autolytus sp.

Trypanosyllis _gemmipara_ Johnson, 1901

Typosyllis _aciculata_ Treadwell, 1945

Arabella _semimaculata_ (Moore, 1911)

Lumbrineris _japonica_ (Marenzeller, 1897)

Lumbrineris _zonata_ (Johnson, 1901)

Nothria _stigmatis_ (Treadwell, 1922)

Polydora sp.

Polydora _alloporis_ Light, 1970

Cirratulus sp.

Dodecaceria _fewkesi_ Berkeley and Berkeley, 1954

Terebella _californica_ ? Moore, 1904

Thelepus _crispus_ Johnson, 1901

Salmacina _tribranchiata_ (Moore, 1923)

Serpula _vermicularis_ Linnaeus, 1767

Marphysa _stylobranchiata_ Moore, 1909

MOLLUSCA (Almost entirely from Lindberg & Carlton, MS)

POLYPLACOPHORA

Cryptochiton stelleri (Middendorff, 1846)

Cyanoplax hartwegii (Carpenter, 1855)

Cyanoplax dentiens (Gould, 1846)

Ischnochiton regularis (Carpenter, 1855)

Lepidozona cooperi (Pilsbry, 1892)

Lepidozona mertensii (Middendorff, 1846)

Lepidozona lineata (Wood, 1815)

Nuttalina californica (Reeve, 1847)

Katharina tunicata (Wood, 1815)

Mopalia ciliata (Sowerby, 1840)

Mopalia lignosa (Gould, 1846)

Mopalia muscosa (Gould, 1846)

Mopalia hindsii (Reeve, 1847)

Leptochiton internexus (Carpenter & Pilsbry, 1892)

Chaetopleura gemma Dall, 1879

GASTROPODA

Haliotis cracherodii Leach, 1814

Haliotis kamtschatkana Jonas, 1845

Haliotis rufescens Swainson, 1822

Haliotis walallensis Stearns, 1899

Sinezona rimuloides (Carpenter, 1865)

Diodora arnoldi McLean, 1966

Diodora aspera (Rathke, 1833)

Megatebennus bimaculatus (Dall, 1871)

Tectura rosacea (Carptenter, 1864)

MOLLUSCA (cont'd)

GASTROPODA (cont'd)

Acmaea mitra Rathke, 1833

Collisella asmi (Middendorff, 1847)

Collisella digitalis (Rathke, 1833)

Collisella limatula (Carpenter, 1864)

Collisella ochracea (Dall, 1871)

Collisella pelta (Rathke, 1833)

Collisella scabra (Gould, 1846)

Collisella strigatella (Carpenter, 1864)

Collisella triangularis (Carpenter, 1864)

Notoacmea persona (Rathke, 1833)

Notoacmea scutum (Rathke, 1833)

Lottia gigantea Sowerby, 1834

Calliostoma ligatum (Gould, 1849)

Lirularia succincta (Carpenter 1864)

Margarites salmoneus (Carpenter, 1864)

Tegula brunnea (Philippi, 1848)

Tegula funebralis (A. Adams, 1855)

Tegula pulligo (Gmelin, 1791)

Astraea gibberosa (Dillwyn, 1817)

Homalopoma baculum (Carpenter, 1864)

Homalopoma luridum (Dall, 1885)

Tricolia pulloides (Carpenter, 1865)

Lacuna marmorata Dall, 1919

Littorina planaxis Philippi, 1847

MOLLUSCA (cont'd)

GASTROPODA (cont'd)

Littorina scutulata Gould, 1849

Alvinia carpenteri (Weinkauff, 1885)

Alvinia compacta (Carpenter, 1864)

Alvinia dinora (Bartsch, 1917)

Alvinia purpurea (Dall, 1871)

Barleeia haliotiphila Carpenter, 1864

Barleeia subtenuis Carpenter, 1864

Mistostigma albidum (Carpenter, 1864)

Omalogyra sp.

Caecum californicum Dall, 1885

Fartulum occidentale Bartsch, 1920

Dendropoma lituella (Morch, 1861)

Petaloconchus montereyensis Dall, 1919

Bittium eschrichtii (Middendorff, 1849)

Bittium purpureum (Carpenter, 1864)

Cerithiopsis carpenteri Bartsch, 1911

Epitonium tinctum (Carpenter, 1865)

Opalia wroblewskyi (Morch, 1875)

Balcis thersites (Carpenter, 1864)

Aclis shepardiana (Dall, 1919)

Hipponix cranioides Carpenter, 1864

Crepipatella lingulata (Gould, 1846)

Crepidula perforans (Valenciennes, 1846)

MOLLUSCA (cont'd)

GASTROPODA (cont'd)

Crepidula sp. cf. C. nummaria Gould, 1846

Crepidula adunca Sowerby, 1825

Velutina sp. cf. V. velutina (Muller, 1776)

Trivia californiana (Gray, 1827)

Ceratostoma foliatum (Gmelin, 1791)

Ocenebra atropurpurea Carpenter, 1865

Ocenebra interfossa Carpenter, 1864

Ocenebra lurida (Middendorff, 1848)

Nucella canaliculata (Duclos, 1832)

Nucella emarginata (Deshayes, 1839)

Alia carinata (Hinds, 1844)

Mitrella tuberosa (Carpenter, 1864)

Amphissa columbiana Dall, 1916

Amphissa versicolor Dall, 1871

Nassarius mendicus (Gould, 1850)

Granulina margaritula (Carpenter, 1857)

Cymakra aspera (Carpenter, 1864)

Diaphana californica Dall, 1919

Odostomia sp.

Trimusculus reticulatus (Sowerby, 1835)

Onchidella borealis Dall, 1871

Rostanga pulchra MacFarland, 1905

Archidoris montereyensis (Cooper, 1863)

MOLLUSCA (cont'd)

GASTROPODA (cont'd)

Anisodoris nobilis (MacFarland, 1905)

Diaulula sandiegensis (Cooper, 1862)

Cadlina luteomarginata MacFarland, 1966

Cadlina modesta MacFarland, 1966

Triopha catalinae (Cooper, 1863)

Hermissenda crassicornis (Eschscholtz, 1831)

BIVALVIA

Philobrya setosa (Carpenter, 1864)

Modiolus carpenteri Soot-Ryen, 1963

Mytilus californianus Conrad, 1837

Mytilus edulis Linnaeus, 1758

Musculus pygmaeus Glynn, 1964 ?

Hinnites giganteus (Gray, 1825)

Pododesmus cepio (Gray, 1850

Diplodonta orbella (Gould, 1851)

Lasaea cistula Keen, 1938

Lasaea subviridus Sall, 1899

Kellia laperousii (Deshayes, 1839)

Chama arcana Bernard, 1976

Irus lamellifer (Conrad, 1837)

MOLLUSCA (cont'd)

BIVALVIA (cont'd)

Transennella tantilla (Gould, 1853)

Protothaca staminea (Conrad, 1837)

Petricola carditoides (Conrad, 1837)

Milneria minima (Dall, 1871)

Cryptomya californica (Conrad, 1837)

Hiatella arctica (Linnaeus, 1767)

Penitella conradi Valenciennes, 1846

Entodesma saxicola (Baird, 1863)

Mytilimeria nuttallii Conrad, 1837

CEPHALOPODA

Octopus sp.

SIPUNCULIDA

Phascolosoma agassizii Keferstein, 1867

ARTHROPODA

PYCNOGONIDA

Achelia chelata (Hilton, 1939)

Achelia spinoseta (Hilton, 1939)

Lecythorhynchus hilgendorfi (Bohm, 1879)

Nymphopsis spinosissima (Hall, 1912)

Pycnogonum stearnsi Ives, 1892

ARTHROPODA (cont'd)

CRUSTACEA

<u>Pollicipes polymerus</u> Sowerby, 1833

<u>Balanus cariosus</u> (Pallas, 1788)

<u>Balanus nubilus</u> Darwin, 1854

<u>Acanthomysis</u> sp.

<u>Anatanais normani</u> (Richardson, 1905)

<u>Paranthura elegans</u> Menzies, 1951

<u>Exosphaeroma inornata</u> Dow, 1958

<u>Idotea fewkesi</u> Richardson, 1905

<u>Idotea schmitti</u> (Menzies, 1950)

<u>Idotea stenops</u> (Benedict, 1898)

<u>Idotea urotoma</u> Stimpson, 1864

<u>Idotea wosnesenskii</u> (Brandt, 1851)

<u>Ianiropsis kincaidi derjugini</u> Gurjanova, 1933

<u>Cirolana harfordi</u> (Lockington, 1877)

<u>Limnoria algarum</u> Menzies, 1957

<u>Ligia pallasii</u> Brandt, 1883

<u>Littorophiloscia richardsonae</u> (Holmes and Gray, 1909)

<u>Paradynoides benedicti</u> (Richardson, 1899)

<u>Porcellio americanus</u> Arcangeli, 1932

<u>Oligochinus lighti</u> Barnard, 1969

<u>Elasmopus serricatus</u> Barnard, 1969

<u>Hyale</u> cf. <u>H. grandicornis californica</u> Barnard, 1969

<u>Hyale</u> sp.

<u>Allorchestes anceps</u> (Barnard, 1969)

<u>Parallorchestes ochotensis</u> (Brandt, 1851)

ARTHROPODA (cont'd)

CRUSTACEA (cont'd)

Parallorchestes sp.

Melita californica Alderman, 1936

Polycheria osborni Calman, 1898

Metacaprella aff. *M. anomala* (Mayer, 1903)

Alpheus dentipes Guerin, 1832

Hapalogaster cavicauda Stimpston, 1859

Oedignathus inermis (Stimpson, 1860)

Pagurus hirsutiusculus (Dana, 1851)

Petrolisthes cinctipes (Randall, 1839)

Loxorhyncus crispatus (Stimpson, 1857)

Pugettia gracilis Dana, 1851

Pugettia producta (Randall, 1839)

Scyra acutifrons Dana, 1861

Pachygrapsus crassipes Randall, 1839

Fabia subquadrata Dana, 1851

Lophopanopeus leucomanus heathii Rathbun, 1900

ECHINODERMATA

ASTEROIDEA

Patiria miniata (Brandt, 1835)

Dermasterias imbricata (Grube, 1857)

Leptasterias sp.

Piaster ochraceus (Brandt, 1835)

Pycnopodia helianthoides (Brandt, 1835)

ECHINODERMATA (cont'd)

OPHIUROIDEA

Ophiopteris papillosa (Lyman, 1875)

Ophioplocus esmarki Lyman, 1874

Amphiodia occidentalis (Lyman, 1860)

Amphipholis squamata (Delle Chiaje, 1829)

Ophiopholis aculeata forma _kennerlyi_ (Lyman, 1860)

Ophiothrix spiculata LeConte, 1851

ECHINOIDEA

Strongylocentrotus franciscanus (Agassiz, 1863)

Strongylocentrotus purpuratus (Stimpson, 1857)

HOLOTHUROIDEA

Cucumaria curata Cowles, 1907

CHORDATA

UROCHORDATA

ASCIDIACEA

Didemnum carnulentum Ritter and Forsyth, 1917

Attached aquatic plants - This list is compiled from the FRC collections and from the collection reported by Blankinship (*in* Blankinship & Keeler, 1892).

Chlorophyta

Uliotrichales

Ulva lactuca Linnaeus

Enteromorpha compressa (Linnaeus) Greville

Enteromorpha clathrata (Roth) Greville

Prasiolales

Prasiola meridionalis Setchell & Gardner

Cladophorales

Cladophora columbiana Collins

Cladophora graminea Collins

Codiales

Bryopsis corticulans Setchell

Codium fragile (Suringar) Hariot

Phaeophyta

Chordariales

Leathesia difformis (Linnaeus) Areschoug

Analipus japonicus (Harvey) Wynne

Dictyosiphonales

Coilodesme californica (Ruprecht) Kjellman

Desmarestiales

Desmarestia ligulata (Lightfoot) Lamouroux

Laminariales

Laminaria dentigera Kjellman

Egregia _menziesii_ (Turner) Areschoug

Pterygophora _californica_ Ruprecht

Macrocystis _pyrifera_ (Linnaeus) C. Agardh

Nereocystis _luetkeana_ (Mertens) Postel & Ruprecht

Alaria _marginata_ Postels & Ruprecht

Costaria _costata_ (C. Agardh) Saunders

Fucales

Fucus _distichus_ _edentatus_ (de la Pylaie) Powell

Pelvetia _fastigiata_ (J. Agardh) De Toni

Cystoseira _osmundacea_ (Menxies) C. Agardh

Rhodophyta

Bangiales

Porphyra _perforata_ J. Agardh

Porphyra _nereocystis_ Anderson

Smithora _naiadum_ (Anderson) Hollenberg

Nemaliales

Gelidium _purpurascens_ Gardner

Gelidium _robustum_ (Gardner) Hollenberg & Abbott

Rhodochorton _purpureum_ (Lightfoot) Rosenvinge

Cryptonemiales

Pikea _californica_ Harvey

Grateloupia _doryphora_ (Montagne) Howe

Farlowia _compressa_ J. Argardh

Endocladia _muricata_ (Postels & Ruprecht) J. Agardh

Corallina _officinalis_ var. _chilensis_ (Decaisne) Kützing

Calliarthron _cheilosporioides_ Manza

Melobesia _mediocris_ (Foslie) Setchell & Mason

Bossiella californica (Decaisne) Silva

Erythrophyllum delesserioides J. Agardh

Prionitis lanceolata Harvey

Prionitis lyallii Harvey

Prionitis linearis Kylin

Callophyllis flabellulata Harvey

Callophyllis obtusifolia J. Agardh

Callophyllis violacea J. Agardh

Gigartinales

Gigartina corymbifera (Kützing) J. Agardh

Gigartina leptorhynchos J. Agardh

Gigartina papillata (C. Agardh) J. Agardh

Gigartina canaliculata Harvey

Gigartina exasperata Harvey & Bailey

Iridaea flaccida (Setchell & Gardner) Hollenberg & Abbott

Iridaea heterocarpa Postels & Ruprecht

Iridaea cordata var. *splendens* (Setchell & Gardner) Abbott

Gymnogongrus linearis (Turner) J. Agardh

Gracilaria sjoestedtii Kylin

Plocamium cartilagineum (Linnaeus) Dixon

Plocamium violaceum Farlow

Rhodymeniales

Rhodymenia pacifica Kylin

Gastroclonium coulteri (Harvey) Kylin

Ceramiales

Ceramium gardneri Kylin

Ceramium pacificum (Collins) Kylin

Centroceras clavulatum (C. Agardh) Montagne

Microcladia coulteri Harvey

Microcladia borealis Ruprecht

Ptilota filicina (Farlow) J. Agardh

Neoptilota densa (C. Agardh) Kylin

Hymenema multiloba (J. Agardh) Kylin

Polyneura latissima (Harvey) Kylin

Botryoglossum ruprechtianum (J. Agardh) DeToni

Botryoglossum farlowianum (J. Agardh) DeToni

Cryptopleura violacea (J. Agardh) Kylin

Nienburgia andersoniana (J. Agardh) Kylin

Odonthalia floccosa (Esper) Falkenberg

Pterosiphonia baileyi (Harvey) Falkenberg

Pterosiphonia dendroidea (Montagne) Falkenberg

Pterochondria woodii (Harvey) Hollenberg

Laurencia spectabilis Postels & Ruprecht

Anthophyta

Monocotylendoneae

Phyllospadix torreyi Watson

APPENDIX 3

Species list of plants found on Southeast Farallon Island. *

BRYOPHYTA

Funaria hygrometrica Sibthorp. Abundant in 1892.

CONIFEROPHYTA

*Cupressus macrocarpa Hartweg. MONTEREY CYPRESS. Two trees about 25 feet tall grow next to the Coast Guard house. Blankinship reported no trees on the island in 1892. Ray (1934) mentioned a grove of 20 Monterey cypresses in a protected situation. Ornduff failed to mention the trees and Coulter gives the location of the old grove as near the fog horn.

*Pinus radiata D. Don. MONTEREY PINE. One tree east of the power house. The tree is only about 10 feet tall but its branches extend radially to a radius of about 7 feet.

ANTHOPHYTA

Dicotyledoneae

Amsinckia spectablis Fischer & Meyer. Found sparsely in the south and southeast portions along the tram tracks and among the foundations. O

*Anagallis arvensis Linnaeus. Along the tram tracks and near East Landing. B, O

Calandrinia ciliata (Ruiz & Pavon) Candolle var. menziesii (W.J. Hooker) Macbride. RED MAIDS. Along the tram tracks.

*Chenopodium murale Linnaeus. Common along tram tracks and sidewalks in southeast portion. B?,O?

*Cirsium vulgare (Savi) Tenore. BULL THISTLE. Around carpentry shop.

Claytonia perfoliata Donn [=Montia perfoliata (Donn) Howell]. MINER'S LETTUCE. Common along tram tracks. B,O

*Coronopus didymus (Linnaeus) Smith. One specimen found in front of the living quarters.

*Cotula australis (Sieber) J.D. Hooker. Common along tram tracks. O

Crassula erecta (W.J. Hooker & Arnott) Berger [=Tillaea erecta H. & A.]. PIGMY WEED. Found with Plagiobothrys reticulatus where the soil is fine, gravelly, and firm, around the living quarters and in the southeast and east parts of the island. B,O

*Cymbalaria muralis J. Gaertner, Meyer & Scherb. KENILWORTH IVY. One patch at back door of Coast Guard house.

Erigeron glaucus Ker-Gawler. SEASIDE DAISY. Found sparsely on all the rocky cliffs on the island. B

*Erodium cicutarium (Linnaeus) L'Heritier. Found along tram tracks. B,O

*Erodium moschatum (Linnaeus) L'Heritier. Found along tram tracks.

Heloptropium curassavicum Linnaeus var. oculatum (Heller) Johnston. Small patch in front of the carpentry shop.

Lasthenia minor (Candolle) Ornduff ssp. maritima (Gary) Ornduff [=Baeria m. (DC) Ferris ssp. m. (Gray) Ferris]. FARALLON WEED. Most abundant plant on the island found sparsely among rocks but thickly in the open areas of the north and south parts of the island. B,O

*Lavatera arborea Linnaeus. East and southeast part of the island.

Plagiobothrys reticulatus (Piper) Johnston var. rossianorum. Johnston. Common around living quarters and power house growing with Crassula erecta. O

*Senecio vulgaris Linnaeus. COMMON GROUNDSEL. Common in the southeast part of the island along the tram tracks, sidewalks and among foundations.

*Sonchus asper Linnaeus. Also found along tram tracks, sidewalks and among foundations. B,O

*Sonchus oleraceus Linnaeus. Same distribution as S. asper.

*Spergularia macrotheca (Hornemann) Herhhold. Common among rocks where the soil is thin in the north and southwest, sparsely in the southeast. 0

Spergularia marina (Linnaeus) Grisebach. Common in thin soil among rocks in the south and southeast parts of the island. B?,0?

*Stellaria media (Linnaeus) Villars. COMMON CHICKWEED. Found along the tram tracks, around the carpentry shop and above North Landing. B

*Tetragonia tetragonoides (Pallas) Ktze. One large patch located between living quarters.

Trifolium variegatum Nuttall. Located between living quarters and power house.

*Urtica urens Linnaeus. DWARF NETTLE. Found around living quarters and east of the power house. 0

Monocotyledoneae

*Bromus diandrus Roth [=B. rigidus Roth]. RIPGUT GRASS. Found in small clumps in the south and southeast portions of the island.

*Hordeum leporinum Link. BARLEY. Common in south and southeast portions of island growing with Vulpia bromoides. B,0

*Poa annua Linnaeus. ANNUAL BLUEGRASS. Found sparsely where the soil is thin, fine and gravelly around the living quarters and in the south and southeast parts of the island. B,0

*Polypogon monspeliensis (Linnaeus) Desfontaines. Growing in thin soil on path to the lighthouse and in the southeast part of the island. B?,0

*_Vulpia bromoides_ (Linnaeus) S.F. Gray [=_Festuca dertonensis_ (All.) Asch. & Graebn.]. Grows commonly and thickly with _Hordeum leporinum_. B?,O

*_Zantedeschia aethiopica_ (Linnaeus) Sprengel. CALLA LILLY. Among foundations in the southeast and in front of the carpentry shop.

Lichens

Buellia petraea (Flat., Koerb.) Tuck.? On rocks.

Placodium sp. On rocks.

Theloschistes lychneus (Nyl.) Tuck. var. pygmaeus Fr. On high rocks.

*The list of plants is that of Coulter (1972), except for lichens and Bryophyta which are from Blankinship (_in_ Blankinship & Keeler, 1892). The list pertains only to the main portion of Southeast Farallon Island, not to West End or any of the surrounding islets or rocks, nor to Middle or North Farallons. The vegetation of these inaccessible areas is sparse and probably similar to that of the rocky cliffs on the main island. The annotations are mostly those of Coulter (op. cit.) as is the nomenclature; the name used by Munz and Keck (1959) is in synonymy where it differs. If the species was also reported by Blankinship (op. cit.) or Ornduff (1961) the entry is followed by "B" or "O" respectively. An asterisk denotes an introduced species.