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INTERTIDAL STUDY OF THE
SOUTHERN CALIFORNIA BIGHT

VOLUME I

~~12~~

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Department of the Interior
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1.0 INTRODUCTION

This volume summarizes those aspects of the BLM Southern California OCS baseline study program carried out in the intertidal and subtidal environments during 1976-1977, the second year of a three-year project. Data gathered in 1975-1976 were analyzed jointly with those of the current year in order to establish a two-year baseline of information.

The purpose of the study was to extend the first-year baseline of descriptive information on the variability of major biotic and physio-chemical factors in space and time throughout the OCS region. A principal feature of the program was broad geographic coverage; that is, focus was deliberately decentralized so as to provide the maximum information over the broadest geographic range. Theoretically, this permits the results to be extended to specific locations not actually studied. In fact, geographic variability is so great, especially with respect to biological communities, that such extrapolation remains at this point tenuous. The results of the third-year island coastal aerial surveys should alleviate this problem in part.

2.0 PROGRAM STRUCTURE

The general study area consists of the reach of coastline between Point Conception and the Mexican border, the Channel Islands and the subtidal Tanner-Cortes banks (Figure I-1). Study sites have been established at 14 sandy-beach, 3 slough, 12 rocky intertidal and 4 banks locations (Figure I-2); three-dimensional mussel-bed communities were also investigated at 11 of the 12 rocky intertidal sites. Sediments and biological samples were collected from a total of 9 sandy beach and 9 rocky intertidal stations.

Overall structure of the 1976-1977 program of study is given in Figure I-3. The disciplines included biology, chemistry, geochemistry, sedimentology and aerial reconnaissance. The program was managed by scientists at Science Applications, Inc. and studies were conducted by investigators from the following institutions and organizations :

- Science Applications, Inc.
- University of California, San Diego
 - (Scripps Institution of Oceanography)
- University of California, Irvine
- University of California, Los Angeles
- University of California, Berkeley
- University of Southern California
- California State University, Northridge
- California State University, Fullerton
- San Jose State University, (Moss Landing Marine Laboratories)
- Analytical Research Laboratory, Inc.
- Escatech, Inc.

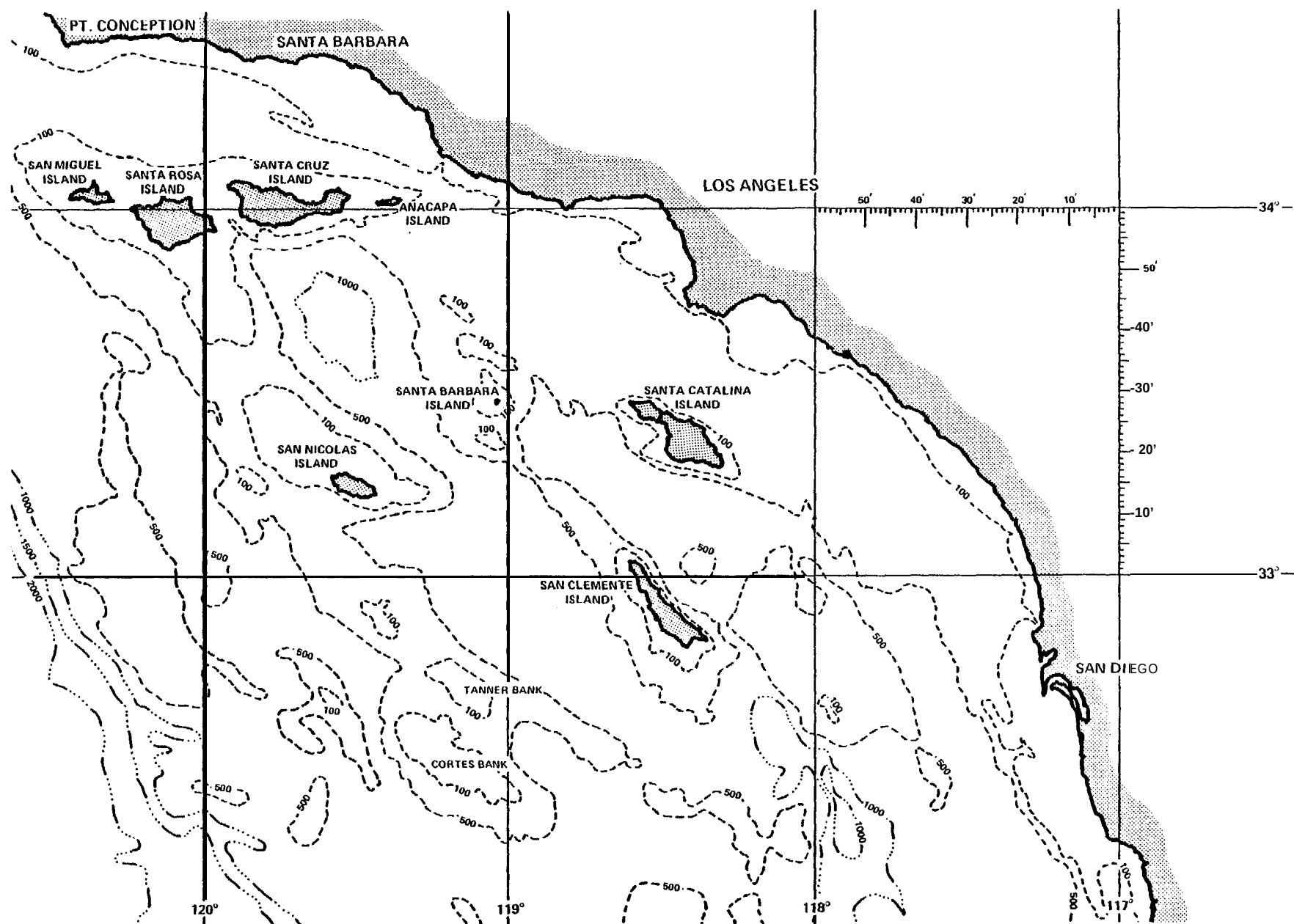


Figure I-1. Area Bathymetry Map.

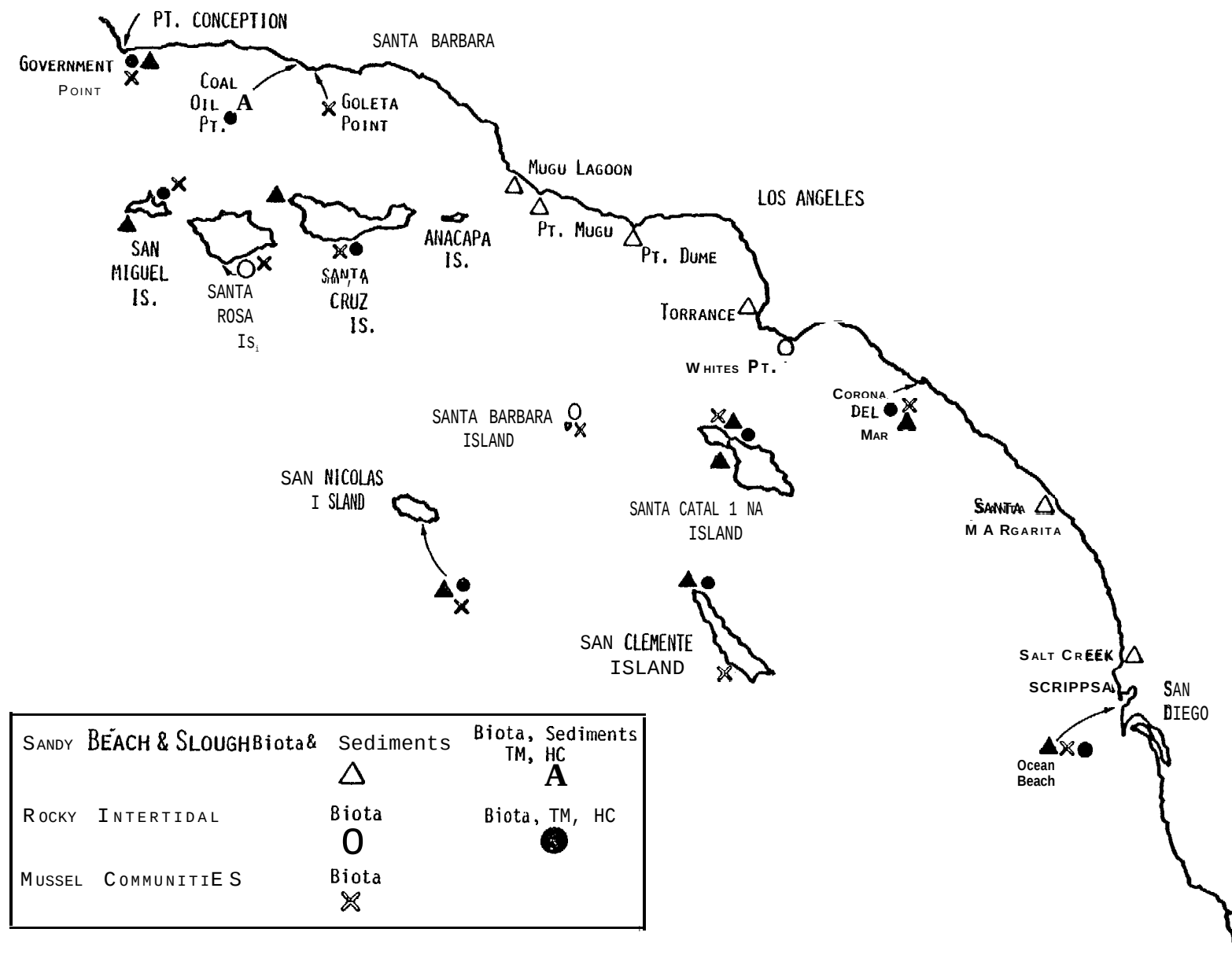


Figure I-2. Intertidal Year II Sampling Sites.

3.0 PRINCIPAL FINDINGS

3.1 Rocky Intertidal Biome

The rocky intertidal sub-program of the Southern California Baseline studies consisted of several investigations. Intertidal flora and fauna were collected and studied seasonally for analysis of community structure and analysis of high molecular weight hydrocarbons and selected trace metals content. The results of these studies, summarized herein, provide a description of the range of biological, chemical and selected physical conditions of the various island and mainland rocky intertidal sites throughout the Southern California region.

Community Structure

Community data accumulated during Year II (1976-1977) corroborated the principal findings of the first year with only minor exceptions. The most significant new information was obtained by the addition of new study sites at Government Point and Santa Rosa Island (new mussel-bed sites were also initiated at previously established rocky intertidal sites: Corona del Mar and San Clemente).

The Government Point site is unusual owing to the prevalence of mixed species assemblages; more macrophyte taxa were recorded there than at any other site. Again, the island sites were dominated by forms associated with mature communities. The substrate heterogeneity at San Nicolas Island is matched by a mosaic of mature and opportunistic communities. While sand scouring is common to most of the sites, the most affected sites are Coal Oil Point and San Nicolas Island where the invertebrate-dominated upper intertidal is replaced by sandy beach. The shifting boulder substrate at Corona del Mar constitutes another type of natural perturbation resulting in proliferation of opportunistic species.

Recovery patterns following petroleum-related disturbance should be substantially different at sites dominated by immature communities than at those with zonally developed mature communities. Studies of succession following experimental and natural perturbation suggest that (1) opportunistic species recovery would be fastest, (2) macrophytes are more responsive following disturbance than macroinvertebrates, (3) the lower intertidal would tend to recover first, and (4) recovery of some species by new recruitment is more likely than by encroachment from undisturbed areas.

Perhaps the most interesting finding of the mussel-bed study (apart from the 481 invertebrate taxa recorded) is the hierarchy of bed similarity. Replicate cores from a single bed show greater affinity

than those from adjacent beds at different tide heights (or locations). Similarly, the beds at one site are more alike than beds at different sites, and the sites appear to group by geographic position as described below.

Certain gross generalizations have been made concerning the intertidal biogeography of the Southern California OCS region but little specific information on distributions of species associations is available. Point Conception and the outer northern Channel Islands represent a biogeographic break point, but the transitions for particular species are typically either spread over considerable distance or are inadequately documented. The Point Conception area is populated by mixtures of so-called warm and cold-water species as well as algae at or near the northern (e.g., Colpomenia sinuosa, Halidrys dioica) or southern (e.g., Rhodomela larix) limits of their distributions.

The BLM OCS program has resulted in the accumulation of extensive data in the form of species abundance, if only at a few sites throughout the region. Although complete analysis of the data from the standpoint of biogeography has not been accomplished, certain patterns are evident.

The mussel bed abundance data suggest close affinities between northern biota and between southern biota: the northern islands (San Miguel, Santa Rosa, Santa Cruz) group together, as do the southern islands (Santa Barbara, San Clemente and Santa Catalina); the two outermost islands (San Nicolas and San Miguel) which are closest to the cold California current are closely aligned; northern and southern mainland sites are most widely separated and group with their neighboring islands. The elucidation of this pattern is made possible by the relatively high fidelity of replicate surveys at a given site.

Cluster analysis in the overall rocky intertidal study was based on species-specific cover, biomass and frequency data rather than enumeration, as was the case in the mussel-bed study. The site affinity patterns differ substantially between these parameters so that no direct comparison is possible at this stage. Moreover, the mussel bed studies were conducted within a microcosm of the rocky intertidal; that is, mussel beds are more directly comparable among sites than are complete rocky intertidal sites owing to problems stemming from zonation and upper-level sand inundation, etc., in the latter. However, the results of this program suggest that island sites are distinct from mainland sites, especially regarding the lower intertidal where intersite comparability is greatest. The island means (among sites) were substantially greater than those on the mainland with respect to percent cover and biomass indicating that islands may be more lush than the mainland. This pattern is consistent with the hypothesis that anthropogenic pollution sources have caused long-term reductions in algal flora on the mainland.

Organism Chemical Levels

Comparison of patterns of community structure and intersite distributions of hydrocarbon and trace metal body burden in rocky intertidal organisms is not supported by adequate data. It is likely that the direct effects of pollutants on community structure are far overshadowed by the affects of local exposure to waves, insolation, sand inundation, substrate instability and hydrographic conditions. Coal Oil Point, which is most impacted by petroleum, appears to be more influenced by sand scouring than by oil pollution. Mytilus californianus from this site have been reported to exhibit elevated tolerance to oil, and plant forms considered most susceptible to petroleum contamination are prominent. Thus, any attempt to relate community structure to the effects of pollution would have to be rigorous and intensively focused.

One of the important outcomes of the first two years of the Southern California OCS program is the realization of hydrocarbon analytic precision adequate to distinguish between tissue levels at different sites and even at different areas within sites. The most significant results derived from analysis of Mytilus samples, which underscores the utility of this cosmopolitan genus as a bio-indicator of environmental hydrocarbon levels; Mytilus is currently so employed in both state and national monitoring programs.

The principal tissue hydrocarbon findings are (1) Government Point and Coal Oil Point organisms are most heavily contaminated with petrogenic hydrocarbons due to local seeps, (2) Corona del Mar and San Diego mussels may be influenced by refined petroleum products associated with nearby harbors, (3) San Nicolas and other island sites are characterized by generally low levels of mixed biogenic and petrogenic hydrocarbons in organisms, (4) differences in tissue burden associated with tide height or exposure to excessive splash and oil stranding may be important, (5) concordant seasonal variation in Mytilus hydrocarbon levels on the mainland and at San Nicolas Island show winter peaks, in the latter case apparently due to biogenic sources, and (6) a number of criteria used to determine hydrocarbon source can be successfully combined in a single index which lends objectivity to such determinations.

Trace metal levels in Mytilus, Macrocystis and Haliotis were also monitored at rocky intertidal sites. While Coal Oil Point is clearly an important site to monitor for tissue levels of hydrocarbons, levels of most trace metals in tissues from this site are equal to or lower than those of other coastal sites. As suggested from Year-I (1975-1976) results, Corona del Mar generally showed the highest metal levels among all biota assayed.

Tissue Cu levels were significantly lower in island samples of Mytilus and Macrocystis than in mainland samples. These species recorded the highest Pb concentrations at Corona del Mar, San Diego and Santa Catalina Island, while the highest Zn and V levels were observed at Corona del Mar and San Diego. Conversely, Cd variation in Mytilus and Macrocystis was discordant: the lowest levels in Mytilus were found at Coal Oil Point and San Diego, while the highest levels were recorded at San Nicolas Island and Corona del Mar; the lowest Cd levels in Macrocystis were at San Nicolas Island.

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No seasonal differences were detected in Macrocystis trace metal concentrations, though such a finding does not rule out this possibility. Seasonal differences were, however, observed in metal concentrations in Mytilus, but they appear to be confounded with differences associated with shell length. Significant intrasite differences were also noted from Cd and Cr in Mytilus from Corona del Mar; however, the interpretation is again obscured by possible size dependency.

A number of statistically significant metal/metal relationships were found in Mytilus and Macrocystis. These relationships, together with calculated prediction intervals, should provide a more sensitive monitoring tool than observation of simple elemental concentrations. Their success depends in part upon continued sampling of a minimum of twenty individuals per survey point.

Haliotis specimens were collected at only one site; their low density and protected status on the mainland limits their usefulness as a trace metal bio-indicator except among island sites.

Attempts were made to correlate trace metal tissue levels with hydrocarbon tissue levels, using the Bodega Oil Pollution (BOP) Index, despite the fact that "clean techniques" required their analysis in separate specimens. Cd and Cu showed significant inverse correlations with BOP indices, and all other contrasts were insignificant. This result probably reflects the different sources of these contaminants: trace metals from anthropogenic sources and hydrocarbons from petrogenic or secondarily petrogenic (refined products) sources.

3.2 Subtidal Biome

In addition to the studies of the rocky and sandy intertidal habitat, the Southern California Baseline studies program included a study of the subtidal ecology of the offshore banks of Tanner and Cortes located off San Diego. This portion of the program, prompted by current active interest in potential oil reserves in this area, was designed to provide a description of the subtidal communities and levels of hydrocarbons and selected trace metals concentrations in the biota of this ecologically important area. A summary of the results of these studies is presented in this section.

Community Structure

Four subtidal study sites on Tanner and Cortes Banks were chosen on the basis of selecting sites which were representative of the major habitat types in order to present a realistic overview of the shallow-water ecology of the area. Though it is difficult to extrapolate the data from these four study sites to other areas on the outer Banks, owing to such differences in habitat as depth and substrate type, this study has gone far to describe some of the community assemblages typical of the Banks and their general habitat preferences.

The invertebrate and algal species present were found to consist to a large extent of those species typical of subtidal communities of the Southern California Mainland and Channel Islands. However, due in part to the pristine nature of the water which bath the Banks area and the lack of significant human perturbation, patterns of species abundance and distribution show substantial differences.

Most significant in this respect is the fact that many of the species identified in this study, though typical of subtidal communities elsewhere in Southern California, occur in significantly higher abundance on the Banks. Similarly, some common mainland subtidal species are absent here, (e.g., Giant Kelp; Garibaldi). Upwelling of deep nutrient-rich water, high water clarity and lack of human impingement may be important in determining the composition of the rich subtidal flora and fauna.

The sea palm, Eisenia arborea occurs abundantly at a depth of 20 m on the banks but is rarely found at this depth on the mainland. The purple hydrocoral Allopora californica found on the Banks occurs primarily on offshore banks and pinnacles. The red form, which is sympatric with the purple form on the Tanner-Cortes Banks, is exceedingly rare. The Banks subtidal communities are unique, therefore, in that they consist of a particular subset of the mainland species which attains unusually high abundance offshore.

Two primary biological communities which were distinguished in this study were distributed primarily on the basis of depth. Shallow areas were characterized by a so-called "ridge-top" community dominated by the brown algal, Eisenia arborea. Ostensibly limited by light availability, this species and its related community gave way to a "crust" community at a depth of approximately 25 m. This community consisted of the encrusting alga Lithophyllum proboscideum and associated fauna including the anemone Corynactis californica, the solitary corals Balanophyllia elegans and Paracyathus stearnsii, and often dense beds of the brittle star Ophiothrix spiculata.

The distribution of these two distinct communities within the sites was also dependent upon topographic homogeneity. The North Cortes site, the shallowest, was located along a ridge and was relatively invariant with respect to habitat while the South Tanner site, the deepest, was similarly uniform. Community structure reflected the homogeneous nature of the substrate, with the Eisenia community dominating North Cortes and the Lithophyllum community dominating at South Tanner.

The other two sites, South Cortes and North Tanner, were more heterogeneous in nature with respect to topography, and the community associations reflected the mosaic character of the substrate. The North Tanner site appeared to be located at the transition depth between ridge and crust communities, and was characterized by both Eisenia (ridge and pinnacle tops) and Lithophyllum (deeper areas) communities. South Cortes was also populated by both communities. However, the shallow depth (20 m) of this site permitted the growth of other algal species in the Lithophyllum crust at an abundance unique among the sites studied. This pattern stresses the importance of depth, or perhaps more directly, light availability, on the distribution of marine algae and associated faunal communities on the Banks. Comparison of biomass, number of macrophyte species and diversity with depth support this hypothesis.

Within the range of depth covered by this study, 20-29 m, the preceding descriptions of general community structure is considered representative of the area, based on initial and subsequent diver visual surveys of much of the areal extent of the banks. The community at South Tanner, the deepest of the four stations (29 m), was most distinctive of the four stations surveyed, and qualitative observations of both Tanner and Cortes Banks at and below about 30 m suggest that this community may be widespread on the banks.

On the whole, communities found on Cortes and Tanner Banks were not fundamentally different. Valid extrapolations of community distribution are limited to those areas with similar depth and habitat regimes. Though the detailed surveys reported here provide an excellent data base from which to work, broad-area cursory surveys, perhaps by video tape television, are recommended to provide better descriptive areal coverage on the Banks communities for the purpose of managing this ecologically unique area.

Organism Chemical Levels

Three species were collected from the subtidal stations on the Banks for trace metal and hydrocarbon assay: the echinoderms Patiria miniata and Pisaster giganteus and the sea palm kelp Eisenia arborea.

Trace metal assays yielded no significant geographic or seasonal trends, except for an elevation in Cr in samples from South Tanner relative to other sites. Sufficient samples were not collected to allow such comparisons, and synoptically collected sediment or water column samples are not available for comparison.

Hydrocarbon burdens in the subtidal samples collected from the banks were generally one to two orders of magnitude lower than the levels found in intertidal organisms collected from the island locations. However, it is not known whether this difference reflects lower water-column hydrocarbon levels or differences in bio-accumulation by the various sampled species.

The limited data suggest elevated levels of hydrocarbons in biota from Winter 1977 samples at Tanner Bank. The values for the Bodega Oil Pollution (BOP) Index and the appearance of the chromatograms suggest that the source of hydrocarbons on the Banks is biogenic in nature. This is inconsistent with data from the 1975-1976 Benthic/Water-Column study in which the presence of an active underwater seep was suggested from chromatograms of deep water column samples at Tanner Bank. Several stations in the area of Tanner and Cortes Banks, and the Santa Rosa - Cortes Ridge were found to contain higher concentrations of hydrocarbons in deep water samples than in shallow, sub-surface samples, in contrast to the remainder of water-column stations which displayed the inverse pattern. In the absence of water-column samples collected synoptically with biota, however, no conclusions can be substantiated at this time.

In order to investigate the possibility of a relationship between tissue hydrocarbon and trace metal concentrations, data from synoptically collected Patiria and Pisaster samples were pooled and subjected to regression analysis. Hydrocarbon burdens (BOP Index) were found to be negatively correlated with Pb, Zn and Ba. All other contrasts were insignificant. High Ba and Pb levels relative to hydrocarbon burdens may reflect input of these metals from drilling operations which were underway at the time of the BLM surveys. No other explanation is obvious.

3.3 Sandy Beaches and Sloughs

As the case in the Rocky Intertidal study, the Sandy Beach intertidal program consisted of several investigations. Included in this study were seasonal community analyses, substrate (beach sand) characterization, and trace metal and petroleum hydrocarbon analyses on the beach sands and selected biota. These programs are summarized in this section with emphasis on describing the range of biological, geological and chemical conditions of the varied sandy intertidal environments (mainland and island) found throughout the Southern California OCS.

Community Structure

The same sites were surveyed in 1976-1977 as in 1975-1976 with the exception that a site in the lee of Government Point was added and the site at Outer Cabrillo was deleted. While the species composition at the various sites and the specific site affinities (cluster analysis) changed substantially between study years, the basic intersite pattern remained unaltered. The finding that surveys at a given site tend to produce higher biotic affinities than those of surveys conducted at different sites was corroborated in the second year. Sites for which data sets did not group closely by cluster analysis (Point Mugu, Corona del Mar) were those exhibiting the fewest taxa and individuals and thus yielding the least information. The affinity between Twin Harbors and the Isthmus on Santa Catalina Island was increased in 1976-1977 over the first year, primarily on the basis of increased abundance of the polychaete Hemipodus borealis at Twin harbors (possibly an artifact of fewer surveys in the second year) and more equitable abundance of the beach hopper Orchestoidea corniculata at the two sites.

The lack of geographic pattern among study sites was evident again in the second year. Rather, the community structure of the various sites appears to be related to physical variables which comprise beach physiography. Among sandy beaches, number of taxa and Shannon-Weaver diversity are highly correlated ($p < .005$) with beach length, grain size and moisture content. Long, gently sloping beaches are characterized by relatively fine-grained sands and communities of high diversity with strong representation among annelid, nemertean and sipunculid worm groups. Short, steep beaches with highly focused wave impact zones (not necessarily high incident wave energy) harbor depauperate communities composed often of only one or two species. The sand crab Emerita dominates these communities as well as the extensively disturbed region between berm and mid-intertidal on those beaches with mixed (concave upper limb and flat foreshore) profiles.

Similarly, the communities observed among slough sites appear to be governed by annual salinity regime rather than geographic province. A continuum of salinity variables is associated with the length of time the respective sites are confluent with the ocean. At one end, Mugu Lagoon is open all year and shows little salinity variation; at the other Santa Margarita (a river estuary) is impinged by both fresh and salt water, and manifests a salinity range of 10 to 37 ‰.

Twin Harbors remains an enigmatic site which defies assignment to either the beach or the slough category. It is likely that the combination of protection from wave impact, which favors deposition of muds and permits formation of stable animal burrows without chronic disruption, and extensive mud and silt components of local soils constitutes a significant factor in the maintenance of the unique fauna at Twin Harbors. The substrate stability extant at this

site and the three slough sites may be responsible for the observation that only here were the same unique species recorded during both study years.

The new study site at Government Point yielded the greatest number of taxa among exposed sandy beaches (even excluding the marine algae which were collected from rocks uncovered by sand losses) which is paralleled by rocky intertidal macrophyte diversity. More unique taxa were also seen here. This may be attributable to the pivotal position of this northernmost site with respect to hydrographic conditions.

An unexplained observation is that the number of taxa recorded at all sites except Coal Oil Point, Corona del Mar and Santa Cruz Island was smaller in 1976-1977 than during 1975-1976. In addition, many differences in species composition were observed among sites between the two years. This reduction in diversity might be associated with the change from quarterly to biannual sampling at most sites. Coal Oil Point was surveyed four times in the second year as opposed to two in the first year. Such explanation is not, however, consistent with the drop in observed taxa at San Nicolas Island while maintaining quarterly survey intervals.

Geochemistry and Bioassay of Emerita

Sediment textural parameters during the second year's analyses appeared to agree with the first years results. The relationship between beach slope and grain size was confirmed. Particle size was nearly invariant with respect to season, whereas beach slope varied by 0.01, with the steeper profile occurring during the Summer season. As was demonstrated last year, the intertidal zone shows a coarsening-upwards sequence in grain size. That is, the lower tide sample has the finest particle size and the upper tide the coarsest. This is contrary to work conducted by others. At a given tidal level grain size and carbonate content increase slightly with depth in a core.

Grain size and beach profile are probably the two most important, and easily measured, indicators of the physical environment of a beach. This physical environment is not likely to be altered by development in the offshore area, but its importance is that of a control. During a monitoring phase, after several years of oil exploration, a study of a nearby beach may show a less diverse fauna than was present during this baseline. If the grain size and beach profile are also quite different, then it may indicate that the physical environment is in a state of flux, whether from natural processes or from some artificial modification aside from petroleum development (e.g., breakwaters, groins, piers, building of upstream check dams, artificial nourishment of beaches, etc.). Although there may not be

an established cause-and-effect relationship between faunal diversity and slight-to-moderate changes in grain size and the beach profile, such coincidence cannot be ignored in attempting to assess the effects of petroleum resource development.

Of the sedimentary properties investigated in this study (total organic carbon, grain size distribution, and percent calcium carbonate), only percent calcium carbonate displays a significantly wide range of values, from a low of <1% at Santa Cruz and Santa Catalina Islands to a high of 50% at San Miguel Island.

Total organic carbon (TOC) content in intertidal sediments is extremely low, ranging from about .04 percent at Point Loma and Santa Cruz Island to .66% at San Miguel Island. High TOC values are correlated with high carbonate contents. However, the organic carbon present is not indigenous to the carbonate but more likely is due to blue-green algae coating the grains.

In general, low total Ba and high total transition metals are associated with low calcium carbonate. The only major exception to this is San Clemente Island which also has a high total organic carbon content. Santa Catalina Island also has a fairly high total organic carbon level, possibly explaining its elevated leachable metal fractions.

A significant geographical trend in the sandy beach metal data is the obvious similarity between Coal Oil Point and Government Point. This kinship can be seen in most of the geochemical data accumulated in this study. There certainly is no outstanding evidence of anthropogenic perturbation of metal levels at either site, nor at the other two mainland sites. Interestingly, several organisms collected at rocky and sandy areas near Corona del Mar during this period showed some seasonal elevation in most of the transition metals.

The four locations sampled on a seasonal basis during the 1976-1977 survey, Government Point, Coal Oil Point, Corona del Mar and San Nicolas, revealed a few noteworthy trends; however, too little control of many variables exists to generate satisfactory explanations. Presumably the major seasonal factor which could cause observable variations in trace metal content of beach sands is the accretion/erosion cycle resulting from wave energy fluctuations.

The two most protected beaches, Government Point and Coal Oil Point, show essentially no seasonal changes. A few minor trends, which appear significant relative to the listed standard deviations, are probably within the normal intrasite variability (i.e., inhomogeneity) inherent in re-sampling a beach. The lack of uniform trends makes it difficult to invoke seasonally related cause and effect. Perhaps the strongest trend is the intermittent increase in some elements at some locations in the Spring sampling period. Examples are total Al at Government Point and San Nicolas Island.

Agreement between the 1975-1976 and 1976-1977 surveys is sufficiently good to maintain the distinctions between the beaches throughout the Southern California OCS based on heavy metal content. A point has been reached where, with the possible addition of one annual sampling survey, some confidence could be had in our understanding the spatial and temporal variabilities among and within beach settings. With this achievement the documented ambient baseline levels can be used for comparison with development and post-development conditions.

Ambient trace metal levels in Emerita, based on relatively few data, showed several patterns. Emerita Cd concentrations at San Nicolas Island were high, reflecting the Cd enrichment, possibly due to upwelling. As was the case with other species assayed at Corona del Mar, almost all metals were elevated in Emerita, presumably from anthropogenic sources. Similarly, the concordance of metal concentrations and specimen size observed in Mytilus was also recorded in the sand crab. Interpretation of this finding is difficult, since correlations were not positive in all cases.

Sediment hydrocarbon data reflect both geographic and seasonal trends. The mainland beaches show higher levels than island sites and, for the majority of the analyses indicate petroleum sources. The petrogenic nature of the mainland sites (also Catalina - Twin harbors) is confirmed by high pristane and phytane levels, large hydrocarbon/TOC values, low odd-carbon preference, a large UCM, and the detection of aromatic hydrocarbons. In contrast to the mainland sites, the island beaches (except Twin Harbors) contain hydrocarbons which are primarily comprised of plant waxes. Secondary sources are petroleum and marine biogenic hydrocarbons. Associated with the biogenic nature of the island beach hydrocarbons are a diminished UCM, high odd carbon preference (especially above nC_{25}), and the inability to detect aromatic hydrocarbons by GCMS techniques. The prevalent occurrence of polyolefins in beaches with high carbonate content may be a result of algal coatings of carbonate grains.

At a given beach, hydrocarbon content increases with decrease in tidal height. This trend was observed the first year (1975-1976) and may reflect temporal differences in the subaerial exposure of the different tidal heights. In cases where this trend was reversed, the resolved/UCM ratio was greater, possibly indicating that the hydrocarbon source was recent and not extensively weathered.

At all seasonally sampled sites the total resolved hydrocarbon concentrations are greatest in the winter and spring seasons. Likewise, during these same seasons, the abundance of unsaturated hydrocarbons is greater relative to saturated hydrocarbons.

This trend of greater resolved and unsaturated hydrocarbons in the Winter season may be due to source changes initiated by currents or a higher precipitation/evaporation ratio. However, it may also be governed by a decrease in the rate of weathering due to a decrease in temperature, solar radiation and microbial processes.

While the number of Emerita analoga samples was small compared to the sediment program, both data sets show the same geographic and seasonal trends. Levels were high at the mainland sites and during the Winter season. However, the distribution of hydrocarbons changed significantly for the "Winter samples, with an increase in the unsaturates (polyolefin) in the Winter season at both mainland and island sites. During the Winter season, the olefins were more prominent at San Nicolas Island whereas the UCM was prevalent at Corona del Mar.

Beyond the foregoing synopsis, attempts were made to compare variability among several geochemical parameters. Significant contrasts were few and may be due to chance rather than any real basis. For sediments collected at the same depth (5-20 cm) Ni was negatively correlated with total hydrocarbons, as was TOC, but all other contrasts between hydrocarbons and trace metals, grain size or organic content were insignificant. Considering the larger group of samples collected at the same horizontal position but at different depths (TM - 5-20 cm; HC, GS and TOC - 0-5 cm), grain size was positively correlated ($p < .01$) with Fe, but all other contrasts were not significant.

The general lack of agreement among site-specific levels of hydrocarbons and trace metals in sediments is not surprising in the absence of a massive oil spill. The geochemical and bio-accumulation pathways of the two are quite dissimilar. Except in the vicinity of large point sources such as sewer outfalls, trace metals tend to reflect local mineralogy and to be rather resistant to perturbation. In other words, low-level inputs to the environment are normally obscured by the larger scale variability associated with mineral provenances. In contrast, hydrocarbons (especially petrogenic sources) exhibit rapid response to input due to weathering processes and catabolic detoxification by marine organisms. No broad-scale source exists to mask the effects of natural (seep) or anthropogenic input.

It is important to keep in mind that the principal thrust of the intertidal baseline program was to produce descriptive information on a number of important variables over an extensive geographic range. Incidental observations of predictive value (i.e., relating to natural processes) are naturally sought by investigators, but definitive resolution of biological and geochemical mechanisms will require special, experimental studies recommended as follow-on to this program.

.4 Kelp-Bed Biome

The forest-like habitat formed by the columnar stipes and massive surface canopy of the giant kelp Macrocystis creates refuge, substrate and food for a host of organisms including many sport fish. Macrocystis beds comprise a discrete ecologic entity widely distributed in the nearshore subtidal of the Southern California OCS region.

Quarterly surveys during 1975-1976 and 1976-1977 have revealed widespread fluctuations in canopy area and density which are nonetheless small by comparison with changes over a much longer time scale. Response to particular local conditions seems to prevail over broad geographic trends, at least within the time frame of this study.

Current studies show that while temperature and storm activity are prominent factors in the control of bed growth and regression, the relative strength of the two varies with locale. Thus, while the extensive beds off the Point Loma (San Diego) area exhibited an inverse relationship to temperature, response to storms appeared more important in the case of island beds. Here, beds on the weather sides of islands appeared to regress under conditions of heavy wave impact, whereas those on the lee sides were not so affected by storms.