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Volume II
SYNTHESIS OF FINDINGS

BIOLOGICAL AND GEOLOGICAL RECONNAISSANCE AND CHARACTERIZATION SURVEY OF THE TANNER AND CORTES BANKS

Prepared for
UNITED STATES DEPARTMENT OF INTERIOR
BUREAU OF LAND MANAGEMENT
under contract AA551-CT8-43

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This study was supported by the Bureau of Land Management, Department of the Interior under contract AA551-CT8-43

SEPTEMBER 1979

Prepared by

OCEANIC ENGINEERING OPERATIONS
INTERSTATE ELECTRONICS CORPORATION

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VOLUME II

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Section 1

INTRODUCTION

1.1 BACKGROUND

The Outer Continental Shelf Lands Act of 1953 charged the Secretary of the Interior with the responsibility for administering the exploration and development of mineral resources on the Outer Continental Shelf (OCS) outside the territorial boundaries of individual states. In turn, the Secretary assigned to the Bureau of Land Management (BLM), as the administrative agency, responsibility for leasing submerged Federal lands, and assigned to the U.S. Geological Survey (USGS) the responsibility for supervising oil exploration and production.

The National Environmental Policy Act (NEPA) of 1969 requires that all Federal actions and programs significantly affecting the quality of human environment be accompanied by an environmental impact statement describing the ways an actual program, including alternatives, would affect the environment.

The OCS Lands Act Amendments of 1978 and Code of Federal Regulations (CFR) indicate that the principal objective of BLM's studies program is to "...establish information needed for prediction, assessment, and management of impacts on the human, marine, and coastal environments of the OCS and nearshore areas which may be affected by oil and gas activities in such area or region" (Federal Register 43:3893, January 27, 1978; 43 CFR Part 3301.7). Also, in the interest of protecting and conserving our coral reef resources, the Secretary of Interior placed additional management responsibilities on BLM by issuing Secretarial Order 2978 "Outer Continental Shelf Protection of Coral Reefs." This order requires that the BLM prepare rules and regulations governing the protection and conservation of coral reefs on the OCS.

The Department of Interior initiated an environmental studies program with baseline studies in the Southern California Bight, including the Tanner and Cortes Banks area in 1975, to meet the BLM responsibilities under the above-noted authorities prior to any exploration for oil and gas and coral harvesting on Tanner and Cortes Banks. These studies were to provide information on the status of the environment upon which predictions of the impacts of exploration and development can be based which, in turn, will be the basis for leasing decisions. The studies provide information on the ways and extent that development can potentially affect human, marine, biological, and coastal areas, and provide a basis for future monitoring of OCS operations. These studies have generated significant new information about the geologic structure and the marine biology of the area; especially the biology on four intensively studied rock-bottom sites within SCUBA diving depth range. The Tanner and Cortes Banks, two of the westernmost topographic highs in the basin and ridge province and typical of the Southern California offshore area, are located at 32'30°N, 119'15°W, approximately 150 km (80 miles) southwest of Los Angeles (Figure II-1). Previous studies have provided BLM with useful information about the marine environment of the Banks. However, the overall composition, and extent and structure of the biological communities found on and around the shallow rocky bottom areas on Tanner and Cortes Banks were largely unknown prior to this study.

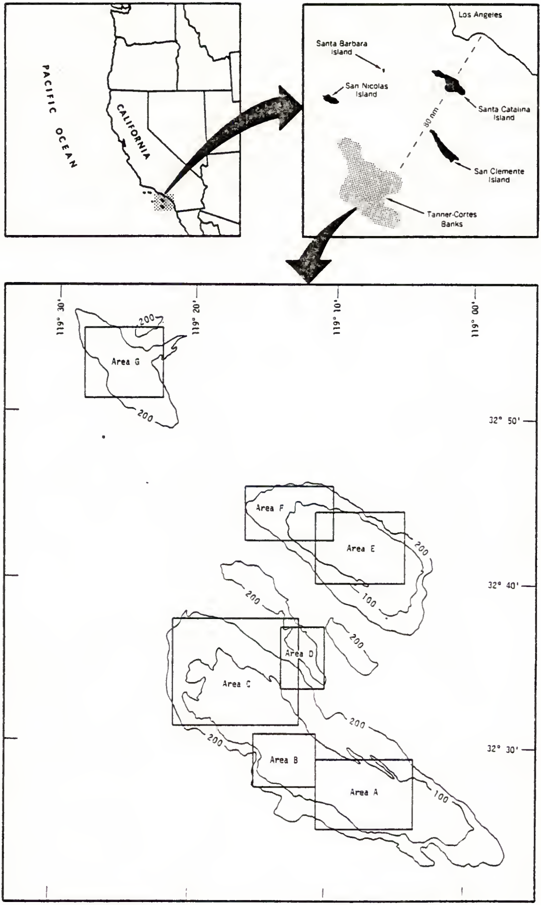

Figure II-1. Location Map of Tanner and Cortes Banks and the Seven Study Areas (A-G)

1.2 STUDY OBJECTIVES

The primary objective of this "Biological and Geological Reconnaissance and Characterization Survey" was to observe and map the distribution, composition, and relative abundance of the dominant benthic and biological communities found on and around five rocky outcrop areas on Tanner and Cortes Banks, and two rocky outcrop areas in deeper waters adjacent to the Banks and on the Santa Rosa Cortes Ridge. The seven areas of high relief (labeled A through G, as shown on Figure II-1 and defined below) were chosen by BLM for further study under this contract on the basis of previous mapping (Green et al., 1975). Of special interest were the coral Allopora californica and other hydrocoral species found on and around the rocky outcrop habitats in waters less than 60 meters deep. Secondary emphasis was placed on surveying the rocky outcrop habitats on the Banks and two adjacent areas to a depth of 150 meters.

Area	Name
A	Bishop Rock
B	Nine-Fathom Reef
C	North West Cortes Bank
D	Tanner and Cortes Trough
E	Central Tanner Bank
F	Northwest Tanner Bank
G	Santa Rosa - Cortes Ridge

Supportive objectives for this study were to map the detailed bathymetry and the general surface geological features for each of seven rocky outcrop study areas. The purpose of the detailed bathymetric mapping and geological interpretations was to describe and map the habitats available to the benthic biological communities in the seven selected study areas.

Using the precision bathymetric and side scan sonar records, maps were constructed for each of the seven bank top areas. In addition, specific geological objectives accomplished for each of the seven study areas were the preparation of:

- Two original detailed bathymetric maps at a scale of 1:12,000.
- Two overlay maps of the extent of the rocky outcrops, areas of sediment accumulation, and visible geological features.
- Two overlays displaying the lease block grid and the bathymetric and side scan sonar transects.
- A scientific report discussing important observed salient geologic and geomorphic trends.

The biological reconnaissance survey provided an extensive volume of quality data that was used to prepare overlay maps and a scientific report. The biological objectives accomplished were as follows:

- Performed a biological reconnaissance and characterization survey using photography and a scientific observer in a manned submersible.

- Mapped the communities of five priority areas of rocky outcrops less than 60 m depth: Bishop Rock, Nine Fathom Reef, Central Tanner Bank, Northwest Tanner Bank and Northwest Cortes Bank and one area of lower priority, Santa Rosa Ridge.

- Surveyed and mapped areas of rocky habitat between 60 and 150 m depth in the six areas of study.

- Evaluated the distribution and abundance of Allopora californica relative to proposed harvesting.

- Described coral, resident fish, and macroalgae distribution, and defined community associations.

- Compared the methods and results of the present study with historical data sources.

- Prepared a report, discussing observations, findings, comparisons and conclusions for each of the study areas.

The objectives of this program were achieved by performing comprehensive field surveys and data analysis. Ships and a submersible carrying scientific observers using precise navigation were used to gather extensive quantities of bathymetric, side scan sonar, photographic (both still and movie), audio, video and scientist/observer records. This material, which provides information on the areas rocky bottom habitats and environment, will assist BLM in preparing future environmental impact statements; in making management decisions regarding tract selection for lease sales; in adopting special lease stipulations to mitigate potential adverse impacts from exploratory and development activity; for selecting pipeline corridors (if development and production proceeds); analyzing pending applications to harvest coral. Furthermore, it provides a basis for future monitoring of Tanner and Cortes Banks.

1.3 NOTABLE FINDINGS OF THIS STUDY

The species observed on Tanner and Cortes Banks are similar to those found in the Southern California mainland and Channel Islands coastal zone. Biological communities identified on the Banks are similar to those of the Channel Islands, however they are somewhat different from those observed on the mainland. Of major biological significance is that the depth ranges and deepest depths of occurrence of some communities and species are greater on the Banks than have been previously noted for other areas of the Southern California Bight. In particular, algae, invertebrates, and the fish associated with the algal communities show an increased depth range.

The character of the study area exists because of its excellent water clarity, the probability of intense upwelling near and around the Banks, and their isolated position which results in an essentially unpolluted environment only slightly affected by commercial and sport fisheries activities.

The extreme water clarity results in the relatively high biomass and productivity of the Banks and the extension of algal community depths from less than 50 m (165 ft) to over 100 m (330 ft). This allows the development of extensive populations of organisms, including corals not commonly found elsewhere. Several Southern California Bight species unique to the area appear to reach their maximum densities in the Tanner and Cortes Banks area.

Noticeably absent from the Banks are such common coastal species as the giant kelp Macrocystis, the gorgonians Muricea californica and Muricea fruticosa, and the kelp bass (Paralabrax clathratus). Although other limiting factors are involved, the fact that none of these species are found north of Point Conception suggests that the oceanography of Tanner-Cortes Banks is more northerly in character than comparable areas in Southern California.

High concentrations of phytoplankton and zooplankton occur in the waters surrounding Tanner and Cortes Banks relative to other areas in the Southern California Bight (Fleminger, personal communication). This increased production stems from the island-mass effect (Doty and Oguri, 1956), which involves enhancement of vertical mixing and nutrient recycling due to sharp changes in bottom topography, circulation and other physical characteristics. High primary and secondary production levels at the Banks account for the abundance of filter-feeding organisms (corals, other coelenterates, bryozoans, sponges, crinoids and ophiuroids), as well as the presence of large schools of planktivorous fish (senorita and squarespot rockfish).

Of major significance is the occurrence of species previously known only from more northern or southern waters. Such occurrences show Tanner and Cortes Banks to be relatively important within the general transition of the Southern California Bight as an area of overlap of northern and southern species distributions. The extension of depth ranges of many species and the high diversity of corals and other organisms in the study area demonstrates that the banks act as an important refuge for many Southern California Bight organisms currently disappearing from more heavily impacted nearshore areas.

It must be remembered that some aspects discussed are "unique" due to lack of comparable data, as similar studies have not been done in other shelf areas. Nevertheless, the body of geological, physical and biological evidence presented in Volume II is considered adequate to establish the uniqueness of Tanner and Cortes Banks.

1.4 POTENTIAL IMPACTS

Any activity on the Banks will have some effect on the natural environment. Oil exploration and production (if it occurs) will have a impact on the present resource utilization of the area. Vessel and rig activity release minor amounts of effluents, drilling may affect the turbidity and anchors and chain may cause damage to the seafloor and benthic organisms. Short-term degradation of aesthetics and disruption of recreational activities, such as fishing and scuba diving, might occur if drilling operations are located on or near shallow areas.

The most serious impact of oil drilling on marine life at Tanner and Cortes Banks would be from an accidental oil spill. The impact of a spill depends upon a number of factors, including the type and volume of oil, weather and oceanographic conditions. Crude oil may be toxic to the marine life on the Banks and further effects would likely occur from the tar-like residue which may be dispersed during high wave conditions but could settle to the bottom under calm conditions.

The scientific literature generally indicates that normal offshore production does not have a significant long-term adverse effect upon the health of the marine community. However, the potential threat of an oil spill on Tanner and Cortes Banks needs to be considered in contingency plans. Information pertaining to the effects of oil on corals is limited, but in this area they may sustain only a limited adverse impact by an oil spill because they are found at considerable depth on Tanner and Cortes Banks.

Due to the extremely patchy distribution and relatively short distances Allopora larvae are able to travel before settling, the destruction of a coral patch would probably not be followed by repopulation. This is supported by information relating to the idea that the Allopora beds on Tanner and Cortes Banks represent a relict population maintained in the area by its isolation from the mainland. Deliberate harvesting and accidental destruction due to fisheries and recreational activities must be considered. Harvesting Allopora would most likely produce a severe impact in the easily accessible populations. It is unlikely that harvesting would totally destroy any given coral patch, but the rate of growth is so low that the sustained yield of the banks could support only a very small coral harvest. The greatest value of the Tanner and Cortes Allopora beds is from its use as a recreational and scientific study area.

1.5 ACKNOWLEDGEMENTS

The following consultants assisted the Interstate Electronics staff and contributed to the Biological and Geological Survey of Tanner-Cortes Banks:

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4. Presurvey Species List Compilation
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6. Review of unique features and Coral Harvesting potential
7. Methods review, review of endemic species and Allopora
8. Fisheries statistics
9. Methods review, fish population ecology

Section 2

FIELD AND DATA ANALYSIS METHODS

2.1 GEOLOGY

The Phase I survey plan developed for the bathymetric and geological reconnaissance of Tanner and Cortes Banks was designed to map in detail, using bathymetric soundings and side scan sonography, the topography and morphology of selected shallow portions of the Tanner and Cortes Banks region where rocky outcrops were anticipated. These data were to be used to generate detailed bathymetric and geomorphic maps of selected regions and to aid in locating submersible transects for future surveys.

During the September 1978 Phase I survey, bathymetric and side scan data for each of the seven study areas (A-G) was collected over a grid of primarily north-south oriented tracklines. Two hundred and thirty nine tracklines covering over 916 kilometers were run. Priority areas A, B, E, and F were covered by transects spaced at 200 m. Lower priority areas C, D, and G were profiled at a 300 m spacing. (See Figure II-1) The Phase I Survey Cruise Report perviously submitted to BLM (Appendix A) details the collection effort.

Once ashore, bathymetric and side scan data were corrected and plotted on 1:6,000 scale maps. After interpretations were made and checked, final maps were drawn and then reduced to a 1:12,000 scale for delivery.

2.1.1 <u>Research Vessel R/V VELERO IV</u>

The R/V VELERO IV, operated by the University of Southern California was used for Phase I studies. Bathymetric soundings were taken using a hull mounted EDO UQN-1 transducer coupled with an EDO Model 444 transceiver. The KLEIN side scan towfish coupled with the remainder of the KLEIN 400 series profiling system was towed behind the 33.5 m long and 8 m abeam ship at a speed of approximately 6 knots.

2.1.2 <u>Navigation</u>

A Cubic Argo Model DM-54 navigation system provided primary range-range fixes throughout the survey. A Motorola Mini-Ranger III Radio Positioning System was used for backup and calibration of the primary system. Both systems were provided and operated by Navigation Services Inc., of Ventura, California. Navigation fixing information was either automatically acquired and processed by Hydrocarta computers aboard ship or manually annotated at intervals along tracklines. Precise navigation information was recorded at 100 or 200 m intervals along preplotted tracklines. Shotpoint data processed by Navigation Services Inc. and Gardline Hydrographic Survey Inc. was plotted on a 1:6,000 scale for working maps and 1:12,000 scale for final deliverable maps. Navigational accuracy of each of the data shotpoints is estimated to be on the order of ± 5 m. (Additional information is provided in Appendixes A, B, C and D.)

2.1.3 Bathymetry

Professional hydrographic services were provided by Gardline Hydrographic Surveys, Inc., Houston, Texas. The primary system used for the detailed bathymetric studies was a fully automated data acquisition and control system manufactured by Hydrocarta, Inc. This system acquired digitized depth soundings while simultaneously obtaining navigation data and provided a real-time track plot and display to alert the helmsman of deviations from the preplotted trackline. (Supplemental information is provided in Appendix B.)

After this system failed (upon completion of 25% of the profiles) semiautomatic backup techniques were adopted. Sounding profiles were acquired on analog EDO Models 550 and 551, 19-inch graphic recorders. Recorder sweep speed was 1/4 second; the 19-inch full-scale record represented 125 milleseconds of time or approximately 200 m. Navigation fixes were provided by operators at preplotted 100 m intervals. At the shotpoint intervals navigation fixes were output onto a digital printer and to the graphic recorder for an event mark across the analog profile. Event marks were annotated by hand with their respective shotpoint numbers by the graphic recorder operator. (Supplemental information is provided in Appendix B.)

2.1.4 Side Scan Sonar

Side scan sonographs of the sea floor were collected along with bathymetric soundings and profiles. Professional services of consultant Charles Finkelstein coupled with the Klein 400 Series side scan system resulted in the collection of excellent sea-floor records.

To maximize the potential resolution of the sidescran system, the fish was "flown" as close to the bottom as was prudent and safe. Records were marked and annotated in a similar fashion as were the bathymetric profiles. (Additional information pertinent to the collection of the side scan records is provided in Appendix C - Report of Side Scan Sonar Charting.)

2.2 BIOLOGY

2.2.1 Cruise Plan Preparation

The Phase II Survey plan developed for the biological reconaissance of Tanner and Cortes Banks was written to define the responsibilities of the participants in the survey, schedules for mobilization, normal operations and contingencies, equipment lists, and shipboard procedures. The cruise plan was supplemented by the Interstate Electronics submersible observer's manual, (Appendix G) which covered procedures for collecting and recording data underwater.

2.2.2 Equipment Preparation

Equipment was mobilized and bench tested at Interstate Electronics and then delivered to the ship prior to each leg of the survey. Interstate Electronics planned for both a dockside test during mobilization and a day of test dives. Test cruises were made on October 19 and again on November 3, 1978, off San Diego, to ensure that all systems were functioning properly with the submersible in operation. A list of the equipment provided for use during the surveys is presented as in Appendix D Table D-2.

2.2.3 Submersible Operations

The two-man submersible NEKTON GAMMA and support vessel SEAMARK were leased from Nekton, Inc., Sorrento Valley, California (see Figure II-2). (Specifications for the NEKTON GAMMA are listed in Appendix D.)

A dive time budget of 3 hours was established to allow sufficient time for stopping, bottom sitting, or close maneuvering about a site for photographic or video documentation of representative or characteristic organisms and species associations. Cruise speed and duration of NEKTON GAMMA is reportedly 1.5 knots for 3.5 hours or 2.5 knots for 1 hour. In our operations, submersible speed varied from 0.1 to 2.4 knots. At greater speeds, apparent relative motion precludes careful assessment of details and sufficient lead time for effective photographic or video pass shots of key subject material.

The preselected dive sites were located using ARGO and Mini-Ranger navigation. Dives were made between 0615 and 1915, which spanned the daylight hours and provided observations on biological activity before dawn and after dusk. The support vessel monitored the submersible's course and position by taking frequent ranges and bearings on the towed marker buoy. Navigational fixes were taken by the surface ship to establish its own positioning, and submersible positioning was calculated using bearings and distances to determine the actual bottom position (Appendix D).

Both automatic and manual camera systems were used. The exterior camera system consisted of a Benthos Model 372 Standard Camera matched with a Model 382 Flash. Mounted forward on the starboard side of the submersible in place of the mechanical arm; it an be clearly seen in Figure II-2. The camera was positioned vertically with the lens one meter above the bottom of the submersible. The camera system operated in a fully automatic mode, with an initial fixed 43-second interval between photographs.

The observers used 35mm still cameras inside the submersible to photograph individual species or areas of interest. Illumination was provided by the sub running lights, and/or ambient light in shallow water. Nearly all video footage was taken with an interior hand-held video camera.

2.2.4 Transect Activities

Typically, the submersible traversed as close to the bottom as was practical along the transect line. All survey activity was carried out as accurately as possible along the lines specified. Data collected included automatic Benthos bottom photographs, observer-triggered photographs, black-and-white video of the sea floor, and a tape recorded description of the community structure observed and organisms sighted. In addition, other observations associated with community structure, size, density, topography and bottom type were noted.

Throughout the submersible operations, synchronization of data collection was a primary objective. The navigational system clock was the reference time source. (Additional information is presented in Appendix D Detailed Field Methods and Appendix G Cruise Reports.)

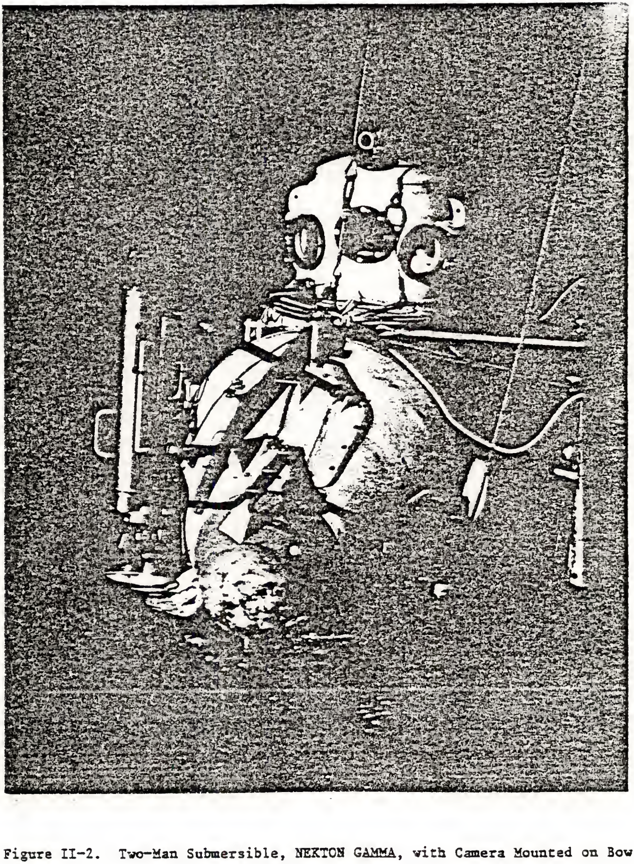

Figure II-2. Two-Man Submersible, NEKTON GAMMA, with Camera Mounted on Bow

2.2.5 Movie Production

Site selections for movie dives were based on information from transect dives in a given area. A marker buoy was placed near features of biological and geological significance and the submersible traversed past the buoy during filming. Movies were photographed with an Arriflex 35mm movie camera. Exterior lighting was provided by two 1,000-watt Birns & Sawyer "Snooper" movie lights, balanced for color temperature. (Details of movie operations are given in Appendix D.)

2.3 ANALYSIS

2.3.1 Geology

2.3.1.1 Bathymetry - Two methods of applying sounding corrections were used during this project. For digitized echo soundings, which were recorded by the shipboard computer system, an off-line program converted the depth in feet (at 4,800 ft/sec) to meters and corrected for the actual velocity of sound in seawater relative to depth. A tide and transducer depth correction was applied, and the sounding rounded to the nearest meter was plotted on the chart.

Depth corrections for sound velocity were calculated and added to recorded depths. The corrections for sound velocity, due to the effects of deviations of temperature and salinity from the standard, were calculated from standard tables for the area and month of September.

Corrections for tide level were applied to the measured depths. These corrections were calculated for the specific time and date from the standard 1978 NOAA tide tables for the area.

For echo soundings scaled directly from the analog record, a scaling template was constructed to read depths in meters and correct for transducer draft. Tide correction and sound velocity corrections were applied, and the corrected sounding rounded to the nearest meter and inked onto the chart. Irregularities on the analog record due to swell were compensated for when scaling the raw depths. Similarly, discrimination between true bottom and (false) side echoes were made during the scaling process.

After all soundings were plotted they were contoured by hand at 2 m intervals to 100 m and at 5 m intervals for depths exceeding 100 m. Maximum and minimum depths on closed features were annotated. It was found in some extremely rugged areas that coverage with the echo sounder system was such that some features could not be resolved by contouring. Interpretations were drafted at the working scale of 1:6,000, then reduced 50% to the deliverable scale of 1:12,000.

2.3.1.2 Side Scan Sonar - Drag caused by the weight of the tow and cable and the influence of surge close to the bottom caused a variable catenary in the tow cable. This, coupled with imprecise wire-out readings, made it impossible to calculate an accurate location of the side scan tow fish from the navigation mast. Because the ship's transducer was beneath the navigation mast, it was possible to correlate prominances on the bathymetric profiles with the same prominances on side scan records. Thus, geomorphic features derived from side scan could be plotted in their correct positions, within the precision of the navigation system.

Due to the reconnaissance nature of this study, it was not found to be necessary to correct the distortion inherent in the side scan recorder to plot individual features on the 1:6,000 scale working geomorphic maps. Instead, locations of contacts between discernable geomorphic signatures were estimated from trackline to trackline. Overlap of information on neighboring profiles allowed the compilation of a crude mosaic, aiding in the final interpretation of the geomorphic patterns. Geomorphic signature definitions were based on both relative relief measurements and discernable lithologic rock types. Geomorphic interpretative maps were drafted at the working scale then reduced to the 1:12,000 deliverable scale.

2.3.1.3 Maps and Overlays - The final products of the bathymetric and geological phases of the project are a base map and two overlays. Plate 404-1 base maps (maps 1-7) depict detailed bathymetric interpretations for each of the BLM study areas (Figure II-1). Plates 404-2 and 404-3 which are overlain over these mounted base maps show shotpoint locations of navigation fixes for bathymetric data and geomorphic interpretations, respectively, of each of the seven areas. (Tracklines surveyed during the Phase I survey are listed and approximately plotted in Table 1-1 and Figures 1-2 to 1-8 of Appendix A.) All maps are plotted on the Universal Transverse Mercator, Zone 11, using Clarke 1866 Spheroid. Where appropriate gridmarks were plotted along the map borders at 1,000 m intervals. Latitude and longitude gridmarks have been superimposed on the UTM grid projections at one minute intervals. California State Coordinate System and Universal Transverse Mercator grid block boundaries appear superimposed over the UTM grid system on Plate 404-2.

Shotpoints represent the position of the navigation signal receivers and must always be corrected for the distance of the acoustic sensors from the mast of the survey vessel. During the Phase I survey the positions of the ships transducer and navigation system receivers were identical and the accuracy of the depth data is considered to be ± 5 m.

Trackline numbers, aligned to grid north, correspond to UTM easting in kilometers. Shotpoint designations along a line are obtained from the middle three numbers of the UTM northing and correspond with the numbered event marks on the analog bathymetric and side scan records.

2.3.2 Biology

Biological information gathered by Interstate in preparation for the survey consisted mainly of prior studies at and near the Banks and life history information on the organisms found in the area. Primary sources for this material were various Government agencies and academic institutions.

An illustrated species reference card file (Figure II-3) encompassing approximately 300 species was compiled from the edited species list for the area. Both pre-dive observer preparations and post-dive debriefings were made more productive through the use of this card file. (A full discussion of the analysis methods is presented in Appendix D; the following is a brief description of that material.)

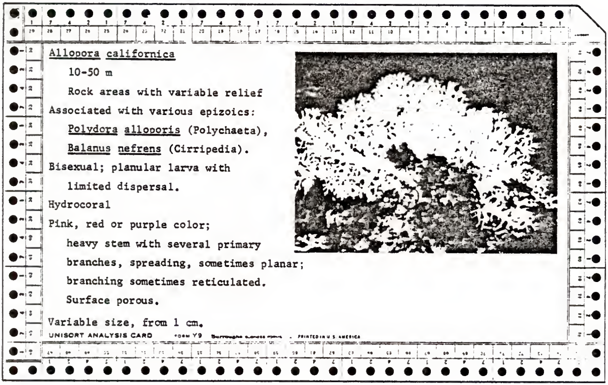

Figure II-3. Species Card

2.3.2.1 Data Reduction and Tabulation

Observer audio recordings, video tapes, Benthos photographs, observer photographs and movies from the submersible dives were studied for relevant information, which was recorded and prepared for submittal to BLM. (Examples of the integrated dive transcripts and accompanying photographic and video records are presented in Appendix E. The complete dive log record is in Volume III.)

2.3.2.2 Observer Audio Recordings and Log Books - Onboard ship each observer transcribed his own audio tapes in a log book as soon as possible following his dive. The video tapes were viewed for supplementary information, additional species, and any other details. Observations were broken into one-minute time intervals to facilitate coordination with the video and Benthos records, and the submersible positioning data.

2.3.2.3 Video Tape Analysis - After analysis of the observer audio record, the video tapes from each dive were reviewed. Video analysis consisted of recording substrate, identifying organisms, and making additional pertinent comments.

2.3.2.4 Benthos Photo Analysis - Every frame on every Benthos dive roll was examined by a team of observers who noted all of the species visible, the substrate, water clarity, and general comments. Data was recorded quantitatively whenever possible, as numbers of individuals or percent cover.

Because the camera-to-substrate distance could not be measured, the coverage of each frame had to be approximated. Quantitative data for density estimates was taken only from correctly-exposed slides (Appendix D).

2.3.2.5 Observer Photo Analysis - Hand-held photographs were used to record unusual or characteristic species and assemblages that might not have been recorded by the Benthos or video cameras.

2.3.2.6 Movie Editing and Analysis - Approximately 45 minutes of 16 mm movie footage were taken at each of three areas and edited to the required 15 minutes. Film segments were selected to maximize the value of the footage in characterizing a given area.

2.3.2.7 Selection of Species for Density Distribution Analysis - Species categories were selected for density and distribution analysis on the basis of adequacy of identification and frequency of observation. A preliminary list of 20 species was expanded to 30 species categories following a discussion of community definitions with consultants Dr. William Newman and Dr. Richard Rosenblatt. Separate size classes were distinguished for Allopora and Sebastes hopkinsi. Density-depth plots for these species are presented in Appendix F. Less common species, which were not selected for detailed analysis, were tabulated by hand for species descriptions, associations and community definition.

2.3.2.8 Entry of Species Density Data - The data recorded by observers, video, and Benthos cameras were summarized and entered into the computer by use of a form entry procedure. This procedure uses a formatted entry page which is displayed on a graphics cathode ray tube (CRT).

In addition to species counts and percent cover data, qualitative data and indefinite numbers of individuals were entered as codes. The source (observer, video, or Benthos photograph) of every value was recorded with the value.

Substrate was recorded as the predominant size class observed: boulder, rock, cobble, pebble, gravel, or sand.

Reported depths of the observations were also entered into the data base. Approximate depths for each minute of transect were provided by linear interpolation between recorded depths.

2.3.2.9 Entry of Position Data - The ship log of submersible navigation positions was carefully evaluated, coded, and submitted to Navigational Services Incorporated for calculation and plotting of the submersible positions. The resulting data were coded on computer tape and transferred directly to a Hewlett-Packard computer, and integrated with times and data on submersible stops. Any discrepancies were resolved prior to plotting.

2.3.2.10 Compilation of Data - After extensive checking, the species count data and submersible positioning data files were merged by generating interpolated submersible positions for every minute of transect time. The compiled and edited data were summarized in tabular form, giving the depth range, mean depth, and percent occurrence (minute intervals observed) of each of the 30 species categories over each area and for the entire study.

2.3.2.11 Density or Occurrence vs Depth - The depth distribution of each species over the entire study and in each area was extracted, tabulated and plotted (Appendix F).

2.3.2.12 Density or Occurrence by Location - The distribution of the organisms was studied by plotting their relative abundance on latitude/longitude grids, assigning each data point to one of five density categories.

2.3.2.13 Source Limitations - Overall, the highest-quality observations were made by direct observation from the submersible. Video is primarily useful for evaluating the large macroalgae cover, fish population densities, and substrate, whereas the Benthos camera records are more useful in identifying and counting smaller macroalgae and invertebrate populations.

2.3.2.14 Community Analysis

The community dominants observed and described by the present study were interpreted largely on the scientific judgment of the biological observer team including scientific consultants as well as Interstate personnel, and were further verified by a review of observer, video, and photographic records. The distribution and densities of selected dominants and other important species such as *Allopora* were determined by computer analysis of the data for each species.

The above transect data were integrated into a comprehensive record coordinating time and depth with all observations (Appendix E). Any discrepancies in identification were resolved prior to further analysis. The community structure of the Banks was determined by:

- Density *vs* depth analyses for each of the dominants and subdominants. Two graphs were done for each species, one with qualitative and the other with quantitative density scales. This was considered the most meaningful approach, based on the variation in the types of data. These two graphs were complementary, although in most cases the quantitative graph was used simply to check relative peaks and overall changes with depth.

- Comparing and contrasting density curves for different species, in each area and for the six areas combined, to detect any consistent species assemblages.

- Generating species ratios and similarity coefficients for recurring groups.

- Considering substrate types to resolve discrepancies and clarify community structure.

A comparison between paired values obtained independently by the three methods of observation provided an estimation of the overall magnitude of difference between the methods. These estimates ranging from 12 to 20%, include both observational error and microhabitat variation components.

A comparison of the species reported between different intersecting dives yielded shared species levels of 82 to 86%. Data cataloguing was standardized by using one observer to analyze all video records and one team of two observers to analyze Benthos photograph records.

By an analysis of shared species, it was found that 50% of all species reported, regardless of rareness or size, or 83% of the fifteen most commonly observed speces, were shared by matched observations i.e., observations in a given area traversed by two intersecting submersible dives transects. This high consistency of observations between replicates indicates not only that the data is an adequate description of the biological conditions observed, but also that an overall consistency exists in navigational and related factors which make such comparisons possible.

Analysis of the Tanner and Cortes survey data, as in most submersible and SCUBA surveys, employs a less strict method of taxonomic classification than used in laboratory identification. The approach used maximizes the use and applicability of the data based on prior geographical and ecological knowledge of the species present or likely to be present in an area. Direct sampling followed by detailed observation of a survey area is necessary to verify the occurrence of expected taxa.

The taxonomic uncertainty is not necessarily between genera or species in a single family, but could represent a choice between different phyla. The submersible observation method is limited to those taxa that can be identified in the field and as such, has limited use for some groups such as the red algae. The present submersible survey was most useful in identifying common or large organisms, but was less sensitive in recognizing rare or new species.

2.3.2.15 Distribution of Selected Species - The distribution plots of the various species were divided into taxonomic categories and submitted to specialists on the respective group for review and subjective analysis. The distribution of each species was evaluated in terms of community membership, depth distribution, substrate characteristics and species associations.

Six conditions listed in Appendix D were scored as indicators of community composition in the study area. If the given conditions were met during one minute of survey data, the community was scored as present.

2.3.2.16 Density of Selected Species - The numbers per square meter, percent coverage, and organism sizes were evaluated. Densities for dominant fish, algae, and coral populations were determined and tabulated using appropriate units (number per square meter, percent cover, size).

2.3.2.17 Community Mapping - Using biological and geological data obtained during this survey, persistent species assemblages were mapped along the transect lines, and superimposed on bathymetric base maps. This depicted relative distribution of communities in terms of substrate, depth range, topographic features and exposure. Community definitions were developed and/or refined, and the community structure extrapolated to outlying areas. Mapping of communities consisted of outlining substrates which supported a uniform biological community followed by detection and outlining of bathymetric contours which defined species associations within areas of uniform (no detectable biological differences) substrate.

Section 3

GEOLOGY AND OCEANOGRAPHY DISCUSSION

3.1 GEOLOGY

3.1.1 Geologic Setting

Tanner and Cortes Banks are located at the southernmost part of the Santa Rosa-Cortes Ridge, one of the most persistent geomorphic features within the Southern California Continental Borderland. The Santa Rosa-Cortes Ridge trends southeasterly, extending uninterrupted for 210 km from its northern terminus at Santa Rosa Island, 100 to 145 km off the mainland coast. The ridge is structurally complex, and has numerous folds and faults, with topographic highs reflecting underlying anticlinal structures (Vedder et al., 1974).

Tanner and Cortes Banks and the Santa Rosa-Cortes Ridge lie near the western edge of the Continental Borderland. The Banks are expressed as two submarine prominances upon the persistent submarine ridge; the total structure rising 2,000 m above surrounding basins. Minimum water depth over the Banks (4 m) occurs at Bishop Rock. The two banks, connected by a shallow saddle, have a total area of approximately 700 sq km. The edge of the Banks is marked by a break in slope at depths of 110 to 160 m. Discontinuous north-and northwest-trending en echelon folds and faults control the local geologic structure (Greene and others, 1975) (Figure 3-1).

Striking physiographic features of the banks are topographic highs of resistant rock fringed by wave-cut marine terraces. Barton (1976) describes the distribution of Tanner and Cortes rock units as follows:

> Topographic highs of Tanner and Cortes Banks are composed primarily of Miocene basalt (Vedder et al. 1974); Greene et al. 1975). Undifferentiated Miocene sedimentary and igneous rocks comprise another large portion of the bank tops. These strata are chiefly shale interlayered with basaltic to rhyolitic rocks (Vedder et al., 1974).
>
> Oligocene, Eocene and Paleocene sedimentary rocks of the northwestern ends of the banks are mostly interbedded sandstone and siltstone. The outer portions and slopes of both banks are composed of Miocene claystone and siltstone with lesser amounts of sandstone and conglomerate. Holocene, Pleistocene and Pliocene sediment and sedimentary rock more than 50 m thick are found in the intervening saddle and on the northeastern side of Cortes Bank. This material is chiefly semiconsolidated clay, silt, sand and gravel (Vedder et al., 1974). The bank crests display low to moderate relief, with bedrock ledges and boulder accumulations and patches of unconsolidated sediment. Lower slopes of the bank tops are overlain by sediment layers from 6 to 15 m thick. Thinner accumulations, from 1 to 2 m thick, cover more shallow regions on the bank tops. Wave-cut marine terraces encircle both bank tops, and also appear in seismic records

(Greene et al., 1975) on the most northwesterly of the low ridges in the interbanks area. Overlying the destructional terraces are constructional marine terrace deposits of probable Pleistocene age. Terrace widths range from an average value of 0.5 km to as much as 4 km.

3.1.2 Pertinent Previous Studies

There are few publically available geologic and related studies of Tanner and Cortes Banks. Holzman (1952) provided the first detailed examination of the submarine geology of Tanner and Cortes Banks. Prior to this, the Banks had been mentioned only in reconnaissance studies (Emery and Shepard, 1945; Revelle and Shepard, 1939). Not until two decades later were the Banks again seriously studied, this as a result of the potential for oil leasing and parallel governmental management and regulatory concerns.

More recent descriptions of the geologic setting of the Banks area appear in Moore (1972) and Vedder et al. (1974), who considered Tanner and Cortes Banks in discussions of the geology of the Southern California Borderland. Greene et al. (1975), under the auspices of the BLM, investigated the geologic hazards which could affect the development of Banks petroleum resources; faulting, sediment slumping, creep and erosion, and natural oil seeps were investigated using high resolution reflection profiles, supplemented by deep penetration seismic reflection records, side scan sonography, underwater television transects, and sediment studies.

During 1975-1976, BLM funded baseline and analyses programs for the Southern California Bight. Fischer et al. (1976) provided, as part of this program, a general characterization and analysis of more than 100 sediment samples collected from Tanner and Cortes Banks.

Availability of both the USGS and BLM sediment samples for further analyses has spawned university research of the area. Thus, Barton (1975), Blake (1976), and Limerick (1977), all from the University of Southern California, have studied different aspects of the sediments, including sediment petrography, micropaleontology, and animal-sediment relationships.

Other studies, both proprietary and public, have concentrated on detailed examinations of individual lease blocks, such as by McClelland Engineers (1978), in support of OCS lease sale 48.

3.1.3 Applicability of Previous Studies

It is important to understand that the applications and utility of data derived from geological or other surveys are dependent upon scale. Table II-1 roughly defines the maximal scale differences of data types available for synthesis in the geological phases of the present study.

Available data spans several orders of magnitude in its coverage. Geological information (bathymetry and side scan) was collected during this project at 200 m spacings. This is essentially an order of magnitude more detailed than other historical geological information (Table II-1). Prior studies considering the banks area as a whole required the broader coverage in order to map a greater area. While this historical information was valuable to the present study for background, geologic setting and regional geology/ geomorphology, the generally broad coverage of these sources resulted in few sediment sampling stations or geophysical tracklines intersecting the shallow bank areas investigated during this project.

TABLE II-1. SCALES OF PERTINENT DATA

Area (sq km)	Scale Area (Assume dimension is unity)	Data Type
6	6 x 1	Bottom photographs
60	60 x 1	Submersible observations
600	600 x 1	Side scan and bathymetric transect spacing
6,000	6,000 x 1	Historical sediment sample spacing, historical geophysical line separation

One of the geologic objectives of this study was an attempt to directly compare remotely sensed (side scan and bathymetric) data with submersible photographs and observations. However, information at a scale smaller than the scale of mapping was found to confuse, rather than aid in the overall definition of geologic or geomorphic environments. Scientific information from submersible observers or bottom photographs was sparingly utilized in the broad mapping and interpretation of the major geological trends, which was the requirement under this contract.

3.1.4 Interpretations

3.1.4.1 Bathymetry - The bathymetric coverage was limited to the areas of high relief, rocky outcrops occurring on the banktops (Figure II-4). Tracklines were terminated when a continuous surficial sediment veneer was encountered, usually near the break in slope, at the interface of the prominent destructional terrace level and the irregular rocky outcrop terrain. In general, the rocky outcrop areas as mapped by Greene et al. (1975), conformed to those mapped during the present study.

In some cases the ruggedness of the bathymetric features was greater than could be completely resolved by the bathymetric profiling system. Chosen analog scales and profile spacing did not completely resolve the features and "ghosts" caused by diffraction within crevices and narrow canyons on the highly irregular rocky prominences sometimes yielded spurious depth soundings. Side scan profiles were used to help identify and locate prominances missed between bathymetric profile lines and hand-contouring at a scale of 1:6,000, allowing interpretative mapping and definition of the trends of some of these features.

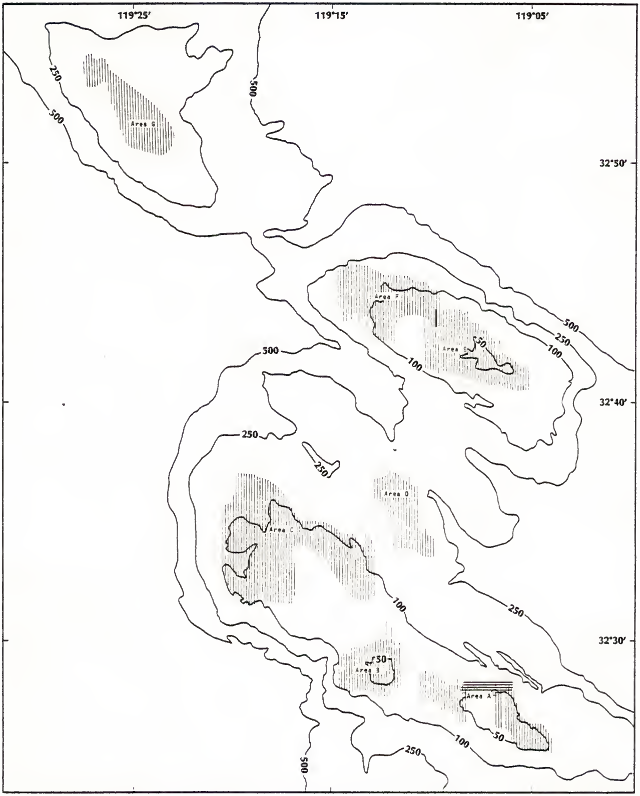

Figure II-4. Bathymetric and Side Scan Sonar Survey Areas

The bathymetric maps were contoured at 2 m intervals to a depth of 100 m, and at 5 m intervals deeper than 100 m on the 1:6,000 scale. The bathymetric maps were later reduced to a scale of 1:12,000 to meet contractual deliverables. The mounted bathymetric maps appear as Plate 404-1 maps 1 to 7. Figure II-5 is an example of the bathyymetric map of Tanner Bank (Area E) contoured on a 10 m interval.

3.1.4.2 Geomorphology - Multidimensional distortion within side scan records made isometric re-creation of individual features an arduous task--far beyond the scope of this project. Instead, geomorphic units were mapped; larger regions display the same geomorphic signatures. For each BLM area, side scan records were laid out in a crude mosaic, and terraces were differentiated by differences in their reflective acoustic signatures. Distinguishing criteria differentiating reflection signatures for each area were jointing patterns, outcrop relief, truncated folds, dissection, bed attitude, sediment cover, general lithology and primary features developed within sediments. Once a geomorphic unit was discerned by its reflective properties and determined to have sufficient areal extent to map, interpretation of its origin was attempted, relying upon published information and knowledge of known similar occurrences in nearby regions. Figure II-6 is an example of the reconnaissance geology and geomorphology of Tanner Bank (Area E).

In many areas side scan information was too detailed. Because of this, many small individually unmappable features, were mapped as a common terrain; this terrain is composed of numerous discrete outcrops, small ridges, inselbergs, or boulders.

Seven generalized geomorphic divisions were adopted throughout the banktop region, generally discriminated by topographic relief and bedrock lithology. Signatures for mapping were individually chosen by area (Appendix C). These arbitrary divisions are not specifically correlative between each of the seven study areas. An individual set of legend designations was based upon relative differences between morphologies in each specific BLM study area. For each individual area the descriptions of the chosen geomorphic terrains are described in the text. It should be noted that legend designations appearing on maps of different areas do not necessarily identify identical geologic/geomorphic units.

3.1.5 Bathymetric and Geomorphic Analyses of Study Areas

Additional details of the field survey data collection, processing, and presentation are reported in Appendices A, B, and C.

3.1.5.1 Study Area A - Bishop Rock (Plates 404-1, 404-2 and 404-3; Map 1 of 7)

(1) Bathymetry

Approximately fifty side scan and bathymetric profiles transect the Cortes Bank, Bishop Rock study area. These profiles define a shallow rock ridge, elongated in a northwesterly direction, rising above a surrounding broad platform. Immediately surrounding the topographically irregular ridge is a beveled, wave-cut surface cut into consolidated sedimentary and volcanic

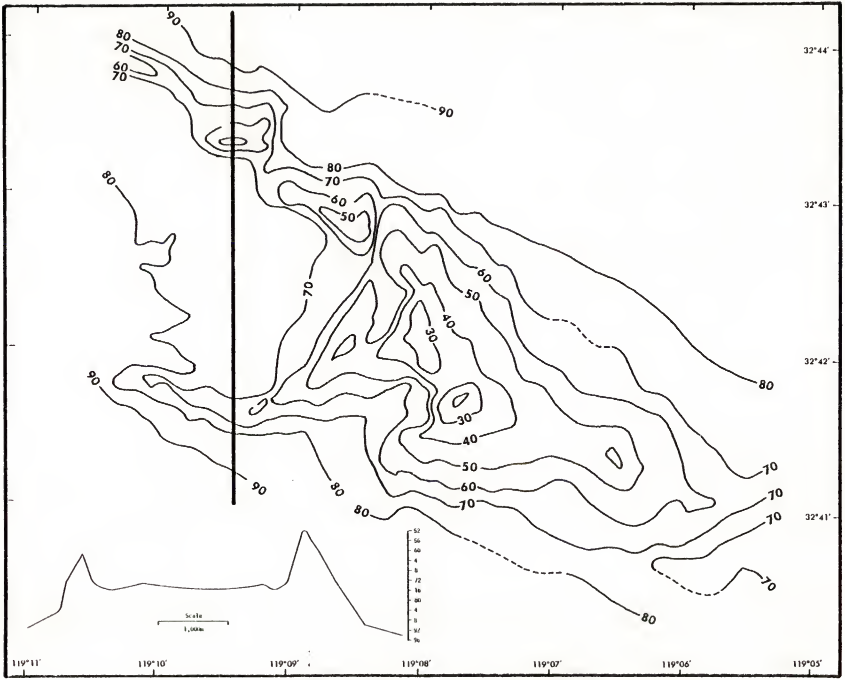

Figure II-5. Bathymetry and Cross-Section--Tanner Bank (Area E)

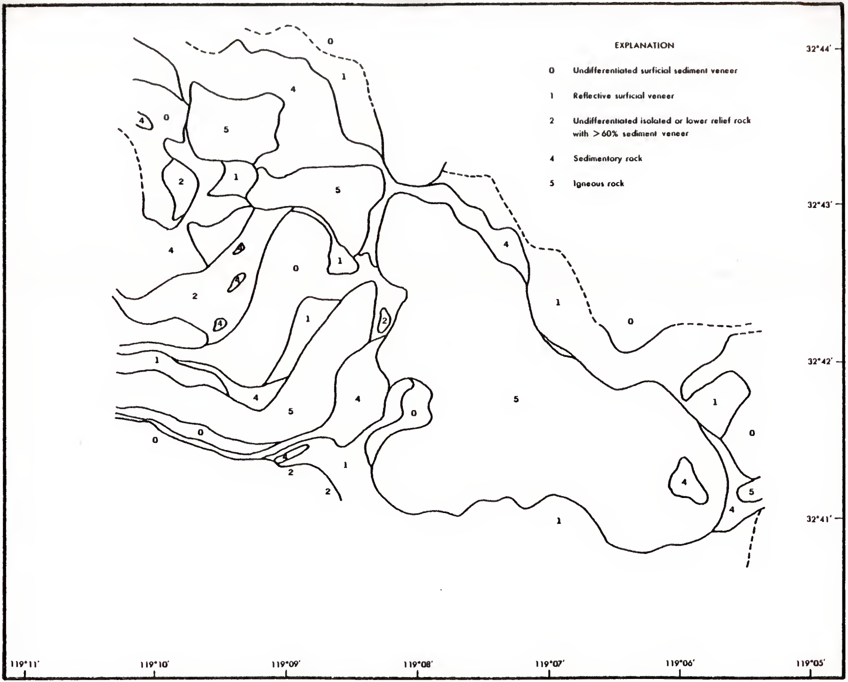

Figure II-6. Reconnaissance Geology and Geomorphology of Tanner Bank (Area E) bedrock of probable Tertiary age. Fringing the beveled surface are unconsolidated constructional marine terrace deposits whose seaward edge forms the upper reaches of the steep submarine slopes which bound the platform area.

Analysis of bathymetric profiles reveals that three major individual segments, separated by topographic saddles, comprise the ridge, in agreement with Green et al. (1975). The ridge crest is shallow, reaching a minimum 4 m (MLLW) at Bishop Rock. Bishop Rock itself occurs on the central of the three major ridge segments. Because of navigational risks of working in extremely shallow water with a large ship, the area immediately around Bishop Rock was not surveyed during this study. However, scientific observations from the submersible suggest that this area is of extremely high relief. On the narrow northwest segment, ridge crest topographic highs successively deepen, reaching a depth of 52 m at the extreme northwesterly end. On this and the central ridge segment, ridge slopes are characteristically steeper on the northern flanks. The southeastern ridge segment gradually deepens in a southeasterly direction, reaching a maximum ridge crest depth of 18 m. Northeastly portions of this ridge segment are extremely dissected, and steep, closely spaced features are partially unresolvable by the sounding methods employed. The ridge segment progressively smooths to the southeast, in which sharp dissected slopes gradually become a more rounded transecting bathymetric profile.

(2) Geology and Geomorphology

The Bishop Rock study area is geomorphically the most complex of the seven areas. Five geomorphic units are mapped, based upon side scan acoustic signatures. In order of increasing mean relief they are:

- Nonreflective undifferentiated surficial sediment veneer
- Reflective sediment veneer
- Undifferentiated isolated or lower relief rock with greater than 60 percent sediment veneer
- Undifferentiated lower relief rock
- Igneous rock
- Higher relief igneous rock.

A low acoustic return is characteristic of some of the sediments which cover the truncated platform surrounding the irregular ridge. This flat-lying surficial veneer characteristically occurs below depths of 80 m along northern and central ridge segments, and below 50 m on the shallower southern segment. Closer to the ridge, but still lying atop the truncated bedrock surface, are expanses of highly reflective surficial sediments. Along the margin of the northern segment these streaks of reflective sediment are interspersed with regions of nonreflective undifferentiated surficial sediments. Acoustic reflections from sediment bedforms appear to cause the pattern; dark regions corresponding to areas of sand waves, light areas defining a formless sediment veneer. Scientific observations from the submersible confirm the presence of a system of undulating sand ridges and troughs (separated by a distance of 1 to 2 m), a lag of coarse pebbles lying within the troughs. On the southern end of the northwestern ridge segment bedforms appear to dwindle; however, the reflective signature continues, perhaps maintained by variable amounts of cobbles and coarse debris overlying the truncated surface. A similar signature persists along the central and southern ridge segments. Where sediment cover relative to the amounts of low relief bedrock exposed decreases, bedrock with greater than 60 percent sediment veneer is mapped. At the junction of the truncated platform surface and flanks of the northerly rocky ridge segment, apparently low dipping beds of undifferentiated low relief rocks appear devoid of surficial cover.

Three major rock units were mapped along the ridge. (1) High relief, blocky outcrops, interpreted to be igneous (volcanic), occupy the centers of each of the ridge segments. Although not definitive, side scan data suggests these massive units to be emplaced. The presence of this high relief province on the central ridge segment surrounding Bishop Rock is by inference only. (2) On the southern ridge segment, areas of lower relief igneous (volcanic) rock surround the high relief areas. (3) Both emplaced rock and boulders derived from the erosion of the ridge crest are suggested to surround the higher relief areas. This geomorphic unit is typically recognized by more gradual slopes.

A completely different pattern occurs on the northern segment. While some lower relief emplaced igneous (volcanic) rock and boulders appear to fringe the central massif, areas of layered bedding are exposed especially upon the southern ridge flank. These rocks, mapped as undifferentiated lower relief rocks also occur within the saddle separating the northern and central banks.

3.1.5.2 Study Area B - Nine Fathom Bank (Plates 404-1, 404-2 and 404-3; Map 2 of 7)

(1) Bathymetry

Nine Fathom Bank is the central topographic high of three large regular topographically prominant areas which protrude above the flattened top of Cortes Bank. Approximately 24 side scan and bathymetric profiles, spaced at 200 m intervals, define this feature which rises to a depth of 17 m below MLLW. This shallow prominance is actually composed of two smaller features separated by a narrow saddle. The easterly segment is dome shaped, with numerous small incised canyons on its evenly sloping flanks. In contrast, the smaller western dome is severely dissected, numerous canyons separating small isolated prominances which rise to a minimum depth of 65 m. Slopes on individual prominences on this section of Nine Fathom Bank are much steeper than those to the east, and the general topography is significantly more rugged despite its overall greater depth.

(2) Geology and Geomorphology

Four geomorphic units were mapped, based upon side scan signatures. In order of increasing mean relief these units are:

- Undifferentiated surficial veneer
- Undifferentiated isolated or lower relief rock with greater than 60 percent sediment veneer

- Igneous rock
- Higher relief igneous rock.

Although no dart core transects (Vedder et al., 1974) cross the area of interest, the appearance of the outcrops (which form the two domed prominances within the study area), is similar to other Tertiary igneous (volcanic) rocks observed within the region. Two igneous units are discriminated on the basis of mean relief, but the division is arbitrary, appearing to be primarily a result of the relative amounts of erosion. Approximately equal amounts of the blocky, but poorly jointed igneous and higher relief igneous rocks, are present on the western domed feature continuous to a depth of nearly 80 m. Higher relief rocks appear to form the steeper slopes of the dome, primarily on central and southern portions. The eastern dome area appears to be totally dominated by the higher relief rock unit, consistent with its highly dissected bathymetric expression.

The change in slope at the base of the rocky prominance, variable in depth around the large domed submarine feature, does not distinctly separate the area of irregular rocky outcrops from the beveled wave-cut platform surrounding it. Discontinuous low relief (truncated) outcrops of primarily igneous rock appear from side scan profiles to extend outward from the irregular prominance, outcrops protruding slightly above the wave-cut surface. Interspersed between these low ridges are areas of undifferentiated sediment displaying low acoustic reflectance. Occasional small patches of sand waves are indicated in sediments between these discontinuous outcrop regions. This pattern of alternating ridges and expanses of sediment is especially well developed within the saddle separating the two domed prominances. The amount of sand relative to the amount of the low rocky exposures increases as the truncated surface deepens. An undifferentiated surficial sediment veneer of undetermined thickness and of variable areal extent occurs in protected spots throughout the area, especially within topographic lows between prominances. The sediment veneer also mantles the wave-cut platform in deeper reaches of the study area.

3.1.5.3 Study Area C - Northwest Cortes Bank (Plates 404-1, 404-2 and 404-3; Map 3 of 7)

(1) Bathymetry

Three prominant bedrock ridges in study area C are located on the northwest portion of the plunging Cortes Bank platform, and are found at elevations slightly below those of other BLM study areas to the southeast. Within the area, bedrock areas of irregular relief surround a central, low-relief, wave-cut platform. A rocky tongue of high relief rock forms the eastern ridge. The convex central ridge section connects eastern and western prominances across the large central beveled wave-cut platform. The northwestern portion of the area broadens into an area with two rugged topographic highs up to 3,400 m across, separated by wide channels exhibiting low relief. The rocky ridge tongue in the southeast lies 10 to 20 m above similar topographic highs in the broad western portion of Area C.

The bathymetry and geomorphology of this area are based on 38 side scan and bathymetric profiles spaced at 300 m intervals. Elevation plunges from a depth of 57 m at the most rocky projections in the SE to a depth of 150 m at the NW end of Cortes Bank.

In both the eastern and western portions of Area C, the high relief igneous rock is flanked by lower relief rock. In the eastern portion, the slope of high and low relief rock is fairly consistent. However, in the west, the steeply sloping irregular relief of igneous highs typically gives way to gradual slopes and plateaus of lower relief rock. These low relief areas are portions of the wave-cut terrace. Differences in rock type are indicated by changes in slope of the western cliffs and terraces. These observed contrasts in bedrock type do not seem to appear in the evenly sloping eastern part of the study area.

(2) Geomorphology

Four major geomorphic units were noted within the study area. Limited USGS dart cores, and submersible observations in this vicinity, substantiate differences in rock and sediment type noted on side scan records. The bedrock and sediment signatures recognized in order of increasing relief are:

- Undifferentiated sediment veneer
- Reflective surficial veneer
- Undifferentiated lower relief rock, and
- Igneous rock.

As in the other areas of Cortes Bank, the igneous rock is the most prominent, and generally appears to be emplaced. The undifferentiated lower relief rock category is mapped for a range of less rugged emplaced igneous rock, large loose boulders of volcanic and/or sedimentary origin, and sedimentary formations; all of which show similar reflective patterns on side scan sonar profiles.

Two sediment signatures are indicated in Area C. The most obvious characteristic of the undifferentiated sediment is its lack of reflectivity. To some extent this trait indicates consistency of sediment type and a bottom barren of sediment bedforms or rubble. The fact that this sediment is a component of the streaky patterns which characterize the reflective surficial veneer is a reminder of the transience of any one sediment pattern which may appear on the high energy banks area. In general, the undifferentiated sediment is important basically as a contrast. In areas of high relief and deep crevices resolution of deeper areas is low; however, it is possible to ascertain that some type of sediment collects in the narrow valleys between pinnacles and lumps of igneous rock. Scientific observations from the submersible show that reflective surficial patterns in the sediment can be attributed to a variety of sedimentary features and textures.

Undifferentiated lower relief rock most often flanks the areas of high relief igneous rock. Based on consistent slope patterns, the undifferentiated lower relief rock in the eastern part of the area may be more weathered components of the irregular igneous rock. Scientific observations in the western part of the area show dense boulder fields adjacent to the igneous bodies. Dart cores taken be Vedder et al., 1974 have recovered Miocene mudstones, siltstones, and claystones. Evidence of these sedimentary rock types can sometimes be seen in the side scan sonar profiles as gently sloping terraced areas. Differential erosion of folded sediments and minor faulting can be easily seen. Areas designated as undifferentiated low relief rock are areas often rich in boulders and usually contain more surface rock of either igneous or sedimentary origin than surficial sediments.

The igneous rock unit, being a prominent pinnacle and cliff former, is the most easily described. Dart cores have determined that much of this may be Tertiary basalt. The three igneous bodies of Area C are bound by low relief rock, much of which appears to be boulders. In the west these igneous bodies are dissected by sediment-filled channels which wind in irregular paths between them.

3.1.5.4 Study Area D - Tanner and Cortes Trough (Plates 404-1, 404-2 and 404-3; Map 4 of 7)

(1) Bathymetry

Greene et al. (1975) map as an area of bedrock exposure one of the protuberances within the saddle between Tanner and Cortes Banks (Figure II-4). The bedrock topographic high rises to a minimal depth of 141 m above the 200-250 m deep surrounding saddle. The feature is dome shaped, with three distinct highs equally spaced along the elongated trend of the feature, separated by topographic lows. Morphology of the dome is smooth, and little dissection is evident. Slopes are steep but regular, especially on the western flank. Both the bathymetric and side scan profiles suggest that the domed feature is blanketed by an unknown thickness of surficial sediment. Presumably the surficial thickness is less than the resolution of the USGS uniboom system used by Greene et al. (1975), therefore sediment thickness is on the order of less than 3 m. Non-recovery of sediment samples on the protuberance by the USGS (Greene et al., 1975) may be a result of the steep slopes rather than the presence of exposed bedrock.

(2) Geomorphology

Side scan definition of the feature is poor. Because of the feature's depth, the side scan towfish was towed higher off the bottom resulting in lower resolution of the features. Three geomorphic units, listed according to their relative mean relief, were mapped. They are:

- Undifferentiated surficial sediment veneer
- Reflective surficial veneer
- Undifferentiated lower relief rock.

On only two side scan profiles was there departure from the uniform acoustic reflections which were indicative of sediments. Rock is indicated, but whether it is emplaced or loose, volcanic or sedimentary is unclear.

Reflective sediment signatures are evident on the crest of the ridge, changing on deeper slope flanks to low reflectivity sedimentary signatures. Although differences in reflectivity could be a result of grain-size variation or bedforms, it is more likely the result of the aspect angle of the sidelooking sonar fish; thus, the changes in reflectivity are caused by differences in slope.

3.1.5.5 Study Areas E and F - Central and Northwest Tanner Bank (Plates 404-1, 404-2 and 404-3; Maps 5 and 6 of 7)

(1) Bathymetry

Although historical bathymetric mapping suggests a topographic break between irregular highs protruding above the Tanner Bank platform, detailed analysis of approximately 78 bathymetric and side scan profiles collected over the ridge crest shows bathymetric trends to be continuous between the two areas (Figure II-5). Three major terrains occur. A well expressed doubly plunging anticlinal fold (Greene et al. 1975) appears to control the expression of these major topographic elements.

The southeast one-third of the combined study areas is composed of a symmetric segmented ridge which narrows in a southeasterly direction. Several isolated protuberances rise above the regular profile of the ridge in the northern and eastern portion of this ridge segment, the shallowest rising to 24 m (MLLW). Small canyons and saddles separate prominances within this zone of higher mean relief conincident with the axis of the ridge.

The central element of the three topographic terrains is dominated by two narrow resistant submarine ridges which trend in a northwesterly direction. The northern of the two parallel ridges is continuous above the 70 m contour, but is segmented at shallower depths. Four individual elongated segments (the shallowest, reaching a minimum depth of 49 m) are aligned along this ridge segment. The southern of the two parallel ridges is narrower and may not be completely continuous. Operations by the drillship GLOMAR CORAL SEA prevented the investigation of a portion of the southern ridge. Ends of the ridges appear to merge at the northwest end of the central segment. Enclosed by the persistent ridges is a low-relief terrain with small isolated prominances rising above it. Sinuous bathymetric contours apparent in this enclosed area are the topographic expression of a folded rock sequence. A typiccal cross-section across area E is depicted in Figure II-5.

Surrounding the ridges, and extending over the northwest one-third of the combined study areas, is a low-relief area exhibiting undulating topography of alternating highs and depressions. Except for several isolated protuberances rising to minimum depths of 89 m, topographic features generally reflect erosional patterns of the underlying bedrock; differential erosion causing features such as ledges, hogbacks, and small isolated ridges segments.

(2) Geology and Geomorphology

Five geomorphic units were mapped over the combined study areas. In order of increasing mean relief these units are:

- Undifferentiated surficial sediment veneer

- Reflective sediment veneer
- Undifferentiated isolated or lower relief rock with greater than 60 percent sediment veneer
- Sedimentary rock
- Igneous rock.

Dart core samples taken by Vedder et al. (1974) reveal that the highest relief topographic elements are composed of igneous rocks (andesite, diabase). These prominent rocky areas are recognized on side scan records by their characteristic blocky appearance, high reflectivity, high relief and well developed jointing patterns. It is not specifically clear from the side scan records whether these areas are composed completely of emplaced outcrops, or are a combination of projections of emplaced material, fringed by an apron of rubble derived from erosion of the core rock formations. The high relief igneous formations are a continuous geomorphic feature commencing in the southeast with a large singular ridge, bifurcating into two parallel ridges as it trends to the northwest. In the northeastern third of the study area these outrops of resistant igneous rocks are expressed as isolated protuberances rising above the wave-beveled platform surface.

The sharp contact between the wave-cut platform surface and prominant irregular outcrops is well developed, most likely the result of sharp differences in resistance to erosion. Within study areas A and B on Cortes Bank the contact is not as sharp, probably the result of resistant volcanic formations interbedded within the less resistant sedimentary rocks cropping out upon the truncated platform surface. Sedimentary rocks alone are suggested to compose the platform immediately surrounding the resistant ridge terrain on Tanner Bank.

Truncation of a folded sedimentary sequence during beveling of the platform surface, has resulted in a distinct morphology of low relief sedimentary ridges, especially in the northwest third of the combined areas where northeast trending ridges and shallow dipping exposures of smooth sedimentary rocks predominate. Surficial sediment cover over these exposures of bedrock appears to increase with concommitant lessening of the mean relief of the ridge structures. The undulating topography in the area is controlled by the alternation of ridges and troughs; their morphology caused by erosion of more resistant and less resistant sedimentary formations respectively. Accumulations of unknown thicknesses of surficial sediments occur between ridge segments. Where sediments predominate over exposures of sedimentary rock, the geomorphic unit of "undifferentiated isolated or lower relief rock with greater than 60 percent sediment veneer" is mapped to demonstrate the relatively greater accumulations of surficial material.

Variable expanses of surficial material occur on the truncated platform and in protected areas between both igneous (volcanic) and sedimentary ridge segments. Areas of highly reflective surficial sediments are primarily a result of acoustic reflections from sediment bed forms and accumulations of detrital debris (gravel, cobbles and boulders). Bedforms usually occur close to or between prominant ridge structures, suggesting that the irregular outcrop areas may affect current velocities or the texture of the surficial material deposited there.

3.1.5.6 Study Area G - Santa Rosa-Cortes Ridge (Plates 404-1, 404-2, and 404-3 Map 7 of 7)

(1) Bathymetry

Twenty-two side scan sonar and bathymetric profile lines, spaced at 300 m intervals, cover the rocky outcrop areas. Topographic expression of this ridge segment is similar to that of Tanner and Cortes Banks which lie to the southeast. Steeply sloping submarine slopes below approximately 150 m flank a wave-cut platform. Noticeably absent in this area are the massive, irregular exposures of consolidated bedrock which rise above the other truncated platforms as rocky outcrops. Instead numerous individual small protuberances, reaching minimum depths of 94 m, rise above the flattened ridge tops.

Detailed bathymetry reveals that this segment is comprised of two major plateaus, separated by a topographic saddle. Approximately eight small protuberances rise above the truncated surface. Closures around the individual prominances appear to shallow in a southeasterly direction, features in the north closed by 120 m isopath those in the south generally closed by the 110 m isobath. Shallows and depths of northern and southern plateau prominances are 94 m and 96 m, respectively. Between the two plateaus, withhin the saddle area, occurs a transverse depression and a flattened area with numerous topographic depressions within it.

This portion of the ridge segment is generally characterized by low topographic relief. Although some prominances exhibiting 30 m of relief are found, they are generally small and isolated.

(2) Geology and Geomorphology

Selected bottom samples taken by Vedder et al. (1974) on dart core transects across the ridge distinguish a region dominated by sandy siltstone and claystone bedrock. Middle Miocene ages are assigned to many of these samples. One sample of glassy, vesicular basalt was collected from one of the prominances on the northern ridge segment.

Three geomorphic units are mapped on this segment of the Santa Rosa-Cortes Ridge from the side scan information. Provinces in order of increasing mean relief are:

- Undifferentiated surficial sediment veneer
- Reflective surficial veneer
- Undifferentiated lower relief rock.

Non-reflective surficial sediments are recognized on side scan records by a very low acoustic return, presumably because the surface is smooth. Scientific observations from the submersible and bottom photography suggest that the sand substrate is generally medium-grained with few bedforms. These sediments appear to be restricted to protected areas (within the topographic saddle) or confined to small plains between higher bedrock outcrops.

Reflective sediments cover most of the truncated erosional surface. The dark side scan signature is rarely of equal density, suggesting lateral variability within the surficial substrate. A "streaky" appearance may indicate alternation between smoother sand and rougher substrate. Submersible observations and bottom photographs show that the platform surface is covered by extremely variable amounts of sand, gravels, cobbles and boulders. It is hypothesized that the dark reflections are caused by backscatter from the rock strewn surface. Some cobble/boulder fields are evident on side scan records; however, many fields may be below the resolution of the side scan system and may, therefore, by unresolvable. Linear reflectors on the ridge may indicate the presence of differentially eroded and truncated low dipping sedimentary formations overlain by these variable thicknesses of surficial sands and large gravels and cobbles.

Undifferentiated low relief rock is easily recognized on the side scan records as it protudes above the platform surface. The absence of definite layering or jointing patterns precludes however its classification as either igneous or sedimentary. Each of the occurrences of this low-relief rock is associated with a bathymetric protuberance, suggesting that these rocky outcrops are more resistant to erosion than bedrock on the surrounding terrace surface. Collection of basalt by Vedder et al. (1974) from one of the northern prominances suggests that perhaps other such features are composed of the same more resistant igneous rock.

3.1.6 Regional Findings

3.1.6.1 Geologic Hazards

No new information pertaining to the presence of geologic hazards on the rocky protuberances of the Tanner and Cortes Banks area was found during this investigation.

Although slopes of the primarily volcanic bedrock exposures are generally steep, the little unconsolidated material that is present is confined to ponds between bedrock ridges, or within interstital spaces of boulder accumulations. On the relatively flat truncated surface where thicker sediments do accumulate, the potential for slumps, slides, or creep does not appear to exist because of lower declivities. Greene et al. (1975) map no occurrences of sediment slump or creep near areas of rocky outcrops under present consideration; this is consistent with our lack of hazards identification.

No oil and gas seeps were evident over the region mapped, which is in agreement with Wilkinson (1971) and Greene et al. (1975). Numerous faults were mapped throughout the region by Greene et al. (1975), and while the detailed side scan records may, in the future, be useful in a detailed analysis of recent faulting, such determinations were beyond the scope of the present project.

3.1.6.2 Surficial Sediments

Because of the magnitude of scale difference between prior studies and the present one, historical sediment data can only yield information concerning regional patterns of sedimentation. From information obtained from studies by Greene et al. (1975), and Fischer et al. (1976) it appears that sediments coarser than 2 phi are restricted to bank-top areas, while finer grained sediments are prevalent on submarine slopes surrounding the truncated platform area. Relatively few samples were collected specifically from the exposures of rocky outcrops on the ridge crest during these investigations because of sampling difficulties due to the predominance of exposed Tertiary igneous (volcanic) rocks. Significant sediment accumulations upon the irregular ridges are interspersed between boulder accumulations and in channels between bedrock exposures. Bank-top sediments are generally coarse-grained, composed primarily of broken calcareous and siliceous organic debris (Greene et al., 1975).

Indirect evidence from side scan sonar profiles suggests significant variability in surficial sediments exists on and near the crests of the bank-top. Differences in the acoustic signatures of the presumed surficial veneer suggests rapid changes in both the thickness and grain size of the sedimentary deposits. Changes in the acoustic signature are suggested related to:

- Grain-size distribution
- Competence of currents
- Composition (sediment source)
- Veneer thickness.

The variability is manifested in rapid fluctuations between fields of bedforms, gravel and cobble accumulations, exposures of barren bedrock surfaces and expanses of uniform low reflective sediments. Local observations of high velocity currents (Ecomar, 1978) caused by the rough topography of irregular ridge tops and flanks are suggested primary factors causing variability within the sediments.

3.2 OCEANOGRAPHY

The Banks are located within the California Current, which is defined to originate where the North Pacific Current (West Wind Drift) intersects the North American continent at 45° to 50° north latitude and turns south, along the California Coast (Figure II-7). The current is 600 to 1,000 km (370 to 620 mi) wide and 100 to 500 m (328 to 1,640 ft) deep. Sverdrup and Fleming (1941) estimated that more than 90 percent of the California Current transport occurs within 800 km (500 mi) of the coast in depths of 0 to 300 m (0 to 980 ft). The current is strongest during the summer, and weakest and most meandering in the winter.

According to Maloney and Chan (1974) the average velocity of the California Current is about 12.5 to 25 cm/sec, although short-term velocities of 50 cm/sec, have been reported. Ecomar (1978) reported a current velocity range of from 0 to 77 cm/sec, with changes in current direction, both with time and depth, and periodic rotation of surface and midwater current directions on Tanner Bank.

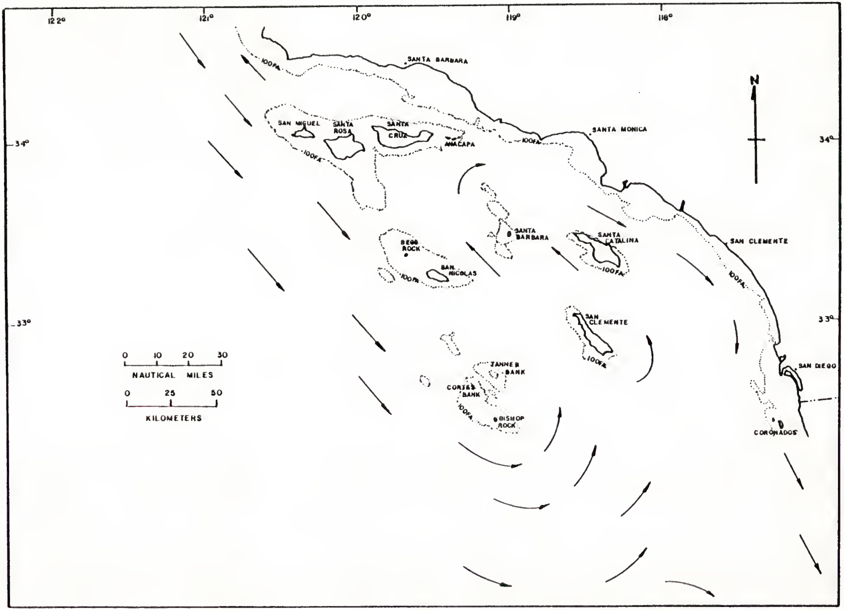

Figure II-7. Surface Circulation to 100-meter Depth in Southern California Bight. Arrows Indicate Approximate Direction of Flow. (Source: Jones, 1971)

The current's main contribution to the Banks is as a transport mechanism of the cool, low salinity, subarctic water, modified along the route by influx from river outflow and by gradual warming as it moves south. The current moves near the coast to within 40 to 150 km (25 to 93 mi) in the region north of Point Conception, and is found some 200 km (124 mi) offshore to the south of the Point where the indentation of the coastline forms the Southern California Bight.

The Banks are subjected to diverse, but frequent, wave activity in their position at the edge of the Borderland. Locally generated waves from the passage of fronts and low pressure cells provide short wave-length, short period waves. While much of this activity is low amplitude, high winds (to 50 knots) occur, and high waves can be generated when the fetch or duration is increased.

Distant swells come to the Southern California Bight from storms in the Aleutians, the Hawaiian area, the western North Pacific typhoon region, the tropical storms west of Mexico, and the pressure gradient around the Pacific High Pressure cell in the North Pacific, as well as from the New Zealand area and the South Pacific high latitude region. The swell derived from northern hemispheric storms approaches the coast from the west in contrast with the southern hemispheric swell, which arrives from the south and the southwest.

Swell from the northern hemisphere predominates during the winter and spring, when the storm systems are more intense. Southerly swells occur during the summer and fall, when hurricanes off southern Mexico and extratropical storms are present in the southern hemisphere (Maloney and Chan, 1974). Wave heights can reach 15 m (Stewart and Stewart, 1975), but both height and period vary and are generally low with occasional higher values. Very long wave lengths will cause surging on the Banks with short-term, high-speed currents generated to several hundred meters depth.

Internal waves (which are usually associated with pycnocline development) are sources of dynamic activity, such as surge, which can resuspend sediment, dislodge organisms and refresh micro-environments as reflected by high densities of sessile organisms. Riffenburg (1973) has estimated internal wave height extremes in the region to be on the order of 9 to 10 m with periods of 17 to 18 seconds, resulting in extreme bottom surge velocities on the order of 200 cm/sec at 20 m depth, and of 15 cm/sec at 200 m depth.

Temperatures in the Borderland range from 11°C to 23°C in surface waters, 8.5°C to 16°C at 100 m and from 100 to 300 m variation from 6.5°C to 11°C are reported (Churgin and Helminski, 1974). A thermocline of 3°C to 7°C is noticeable to depths of 10 to 50 m becoming better developed in summer (SCCWRP, 1973). The California Current is thought to extend only to about 300 m depth, which is below the lower limit of the present submersible survey results. Salinities of 33.5 °/oo are indicative of the California Current at depth with 33.4 to 34.6 °/oo salinities in the surface waters (about 10 m depth).

Waters of the California Current are generally saturated with oxygen to the thermocline and are near saturation to 200 m but decrease rapidly at greater depths. Some seasonal variation occurs, with a maximum value in surface dissolved oxygen during winter, falling to an annual minimum in July or August. Nutrients are plentiful. Thus, phosphate ranges between 0.43 and 0.52 ug-at/liter near the surface to between 2.50 and 2.82 ug-at/liter at 300 m.

Insufficient data exist to adequately describe the variations through space or time of silicates or nitrogen-based nutrients, but nitrate at 10 m depth has been observed to be about 0.1 ug-at/liter, and at 100 m between 15.0 and 20.0 ug-at/liter during a January cruise (CALCOFI, 1974). Silicate was 20 ug-at/liter at 10 m and about 20 ug-at/liter at 100 m during summer cruises.

The strong bottom surge, together with the trench-ridge type topography of Cortes Bank, are thought to combine to enhance upwelling by creating such turbulence that the deeper bottom water (so much richer in nutrients) is brought nearer the surface. Despite the assumed nutrient-rich water, the water is clear, with visibility usually ranging from 11 to 31 m (35 to more than 100 ft) during calm to moderate seas. The increased water visibility may be due to the fact that much of the nutrients may be tied up in bottom macrophytes rather than phytoplankton.

Available solar radiation is governed to a great extent by cloud cover which reaches a maximum percentage of time for obscuration in July and August and a minimum in January, with an annual percentage of frequency occurrence of about 30%. The excellent clarity of the Banks enhances the potential for high productivity to depths of surface light transmission.

Section 4

BIOLOGICAL OBSERVATIONS

The biological communities living on Tanner and Cortes Banks and the south Santa Rosa Ridge area were surveyed using a manned submersible. Figure II-8 shows the submersible survey transect coverage. Data consisted of scientific observer notes and audio tapes, Benthos camera photographs, observer photographs, video tapes, and color movies made during 41 dives in the study area (see Appendix G for cruise reports). Transect lines were located to maximize coverage of the rocky substrate terrain above 150 m depth. Observations were designed to maximize information on corals, resident fish and macroalgae, although considerable additional information was collected. A review of available historical data and literature prior to the submersible operations yielded comprehensive species lists, which were combined with taxonomic data and photographs to assure a high level of taxonomic precision in species identifications.

The bathymetric and geomorphological data obtained during the first survey was used to plan the biological survey transect locations, and to assist in the interpretation of the results of the biological survey. Computer techniques facilitated data summarization, presentation and condensation, including interpolation of submersible depths and positions during each minute of transect time. All data have been compared to data in previous studies and evaluated by specialists in relevant areas. Species distributions and densities have been studied and compared to such factors as substrate and depth. Observed species associations and the distributions of dominant organisms have been interpreted and described as resident benthic communities. Unique features of Tanner and Cortes Banks have been described and discussed.

4.1 COMMUNITIES

Five major benthic biological communities were established for Tanner and Cortes Banks over the survey range of 14-149 m. Four of these were rock substrate communities and one is a sand community. Because the emphasis of the survey was on rock outcrops, the sand community was subdivided in general qualitative terms only. However, thorough analysis and careful consideration revealed nine more-or-less distinct subcommunities on hard substrate. The four rock substrate communities showed well-defined, consistent depth distributions. However, within each community the various subcommunity dominants typically showed patchy distributions and sometimes extreme variations in abundance.

Table II-2 summarizes the species association and depth ranges for the various communities. The communities are discussed in detail below, first in order of increasing depth and then by area. Unusual or characteristic species associations, species abundance and diversity, range extensions and endemic populations are discussed where appropriate.

The observed communities in the Tanner and Cortes Banks study area appeared to be regulated primarily by substrate and depth (Table II-2). Differences in rock sizes (bedrock, boulders) did not significantly affect species composition although significant differences in the biota of low rock exposures and high rocks or cliffs may be related to differences in exposure.

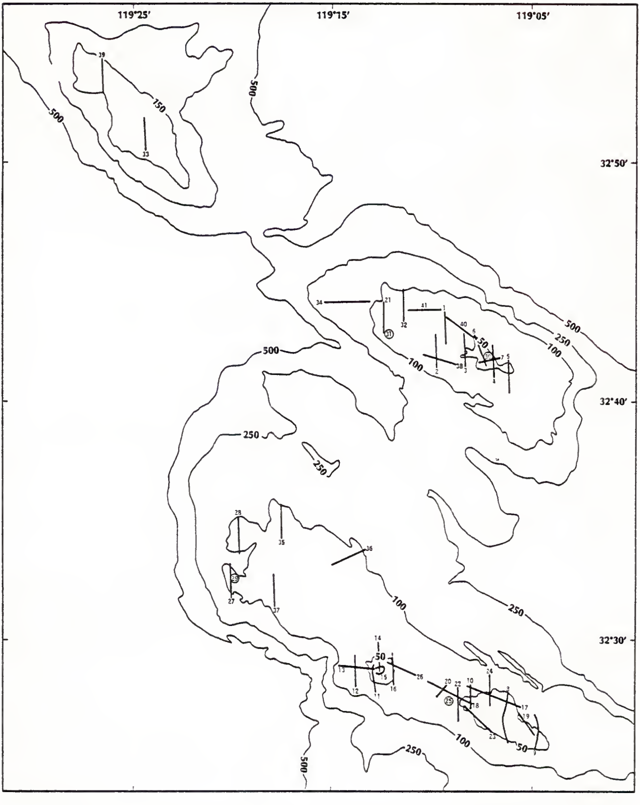

Figure II-8. Submersible Survey Transect Coverage

The wide range of microhabitats or niches available in the generally rough terrain resulted in a wide diversity of organisms being observed at any given time. The abundance and distribution of dominant organisms were considered indications of the community structure of the banks. Distribution and abundance of subdominants were far less consistent and subcommunities were patchy in their distribution.

TABLE II-2. COMMUNITIES OBSERVED AT TANNER AND CORTES BANKS

	COMMUNITY DOMINANTS	DEPTH RANGE	SUBCOMMUNITY DOMINANTS
		——	
1	Eisenia/Calliarthron	14-26 m	Gelidium
		14-40 m	Laminaria/Agarum
		14-40 m	Ophiothrix
		26-40 m	Zonaria
2	Agarum/Laminaria	40-60 m	Calliarthron
		40-60 m	Eugorgia/Mediaster
		40-60 m	Zonaria
3	Encrusting Coralline	60-68 m	Mediaster
		68-89 m	Plumarella/Mediaster/sponge
4	Florometra/ophiuroid	89-149 m	
5	Sand Community	Various	Lytechinus/asteroids

4.1.1 Eisenia/Calliarthron Community - The Eisenia/Calliarthron community (Appendix F, Figures F-8 and F-7, respectively) was found from 14-40 m (45-130 ft.) on Bishop Rock, Nine Fathom Reef, and Central Tanner Bank. The Central Tanner Bank community was poorly developed with only scattered stands of Eisenia. On Bishop Rock and Nine Fathom Reef Eisenia commonly reached densities of 4-6 plants per square meter. Four distinguishable subcommunities were found: (1) Gelidium subcommunity occurred on the southeast margin of Bishop Rock apparently due to a sheltering effect from the generally northwesterly storms and swell (Appendix F, Figure F-11). (2) A Zonaria subcommunity, was found from 20 to 40 m on Bishop Rock, primarily on the exposed north side of the bank in direct contrast to Gelidium. (3) A small Ophiothrix spiculata dominated subcommunity occurred on the leeward side of Central Tanner Bank. (4) The Laminaria/Agarum subcommunity was generally prevalent throughout the community. In the northwestern margin of the Laminaria/Agarum subcommunity of Bishop Rock, Nine Fathom Reef, and Central Tanner Banks, were occasional areas of the erect coralline, alga, Bossiella.

The Eisenia/Calliarthron community occurs primarily in areas dominated by rocks and boulders. In some areas sediment transport at the lower end of the depth range is indicated by scoured rock faces, but it is not known how much this process affects distribution of the algae. Overall species composition does not indicate sand transport or scouring.

Calliarthron occurred as dense bushy clumps 20 to 30 cm (8" to 12") tall, occasionally forming extensive beds on exposed rock faces. Consistent changes in size and density with depth, common in other macroalgae, were not pronounced. Distribution appeared to be affected mainly by localized physical conditions (exposure, slope, percent rock).

Conversely, Eisenia showed distinct regular changes in both stipe length and density with change in depth. Length and density were maximized at the same depth range (30 to 33 m [90 to 100 ft]). This length-density relationship was also seen in Agarum, another laminarian algae. At the shallowest working depth (about 10 m, or 33 ft), Eisenia generally occurred as small (15 cm, [or 6 in]) plants, in densities of less than one plant per square meter. From 10 to 27 m (40 to 90 ft), Eisenia density increased to approximately 15/m^2, with stipes as long as three feet. Both height and density decreased below 33 m (100 ft), with Agarum/Laminaria first appearing at about 36 m (120 ft). Between 36 to 45 m (120 to 150 ft), Agarum/Laminaria abundance increased while that of Eisenia decreased. By 45 m (150 ft), Agarum/Laminaria was well established and Eisenia was no longer seen (Figure II-9).

The Eisenia/Calliarthron community generally had a higher number of species than deeper communities. Several factors may influence this, including light penetration, turbulence and habitat diversity. Eisenia has a well-developed erect stipe which provides protection and additional habitat space for an increased number of understory organisms. However, within the limits of the present survey, no well defined changes in species composition could be detected which were directly related to the presence or absence of Eisenia.

In the deeper-ranging laminarian algae, such as Agarum, a "clear zone" was commonly observed around individual plants. This zone was swept by the large single blade, moving in a full circle due to the variability of the surge. Establishment of benthic organisms is affected somewhat by this sweeping action.

Green algae, which are generally restricted to shallow water, were associated almost exclusively with the Eisenia/Calliarthron communities, whereas most red and brown algae ranged into deeper water (Figure A). Only one encrusting species of the green alga Codium (possibly C. hubbsi or C. setchellii), occurred throughout the Agarum/Laminaria zone, and extended into deeper communities as well. Except for Eisenia, brown algae were generally low-growing or had narrow branches or blades (Zonaria, Dictyopteris, Cystoseira), and were not well represented among the associated species. Several red algae, including Gelidium, Gigartina and various foliose and dichoflabellate forms occurred with Eisenia and Calliarthron.

Benthic invertebrates and demersal fishes, although common, were sometimes obscured by the algae which presumably serves as both food and protection for these organisms. Epiphytic bryozoans (Aetea on Gelidium, and Membranipora on Eisenia) were commonly seen; bryozoans are discussed in more detail in Section 4.7.3.2. Coelenterates (36 species) and sponges (about 14 species) were the best-represented phyla in these communities, with molluscs somewhat less abundant (6 common species). Hard corals (Allopora, Astrangia, Balanophyllia, Coenacyathus, and Paracyathus) and sea anemones (Corynactis and Stomphia venosa) were seen regularly. Demospongia comprised the majority of the sponge species, although calcareous forms also were seen.

Fish diversity appeared to be highest in the shallow communities. In addition to wide-ranging species such as Coryphopterus nicholsi and Hydrolagus collei, sightings of embiotocids (Embiotoca jacksoni, E. lateralis, Hyperprosopon spp., Hypsurus caryi, Rhacochilus toxotes, and R. vacca), labrids (Pimelometopon and Oxyjulis), hexagrammids (Oxylebius pictus), Chromis, Girella, and

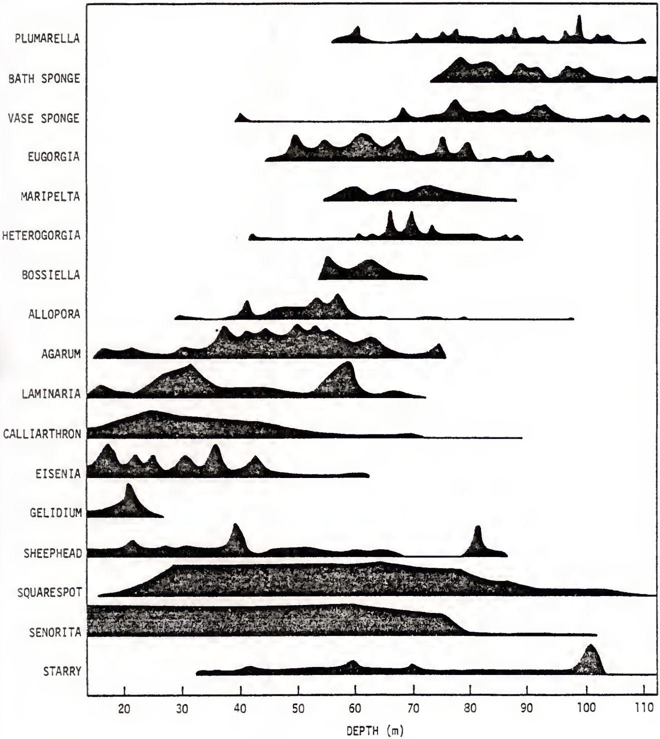

Figure II-9. Relative Abundances by Depth of Common Organisms

Medialuna were also recorded. Blue rockfish (Sebastes mystinus) and squarespot rockfish (S. hopkinsi) were seen, but only blue rockfish were consistently observed in this depth range. Transient schools of jack mackerel (Trachurus symmetricus) were infrequently seen.

Within the Eisenia/Calliarthron community are extensive beds of Calliarthron occurring without Eisenia. These areas may constitute a separate community, with Calliarthron the sole dominant species.

4.1.2 Agarum/Laminaria Community - The Agarum/Laminaria community was found from 40 to 60 m on rocks, boulders, and cobbles. The intergradation with the Eisenia/Calliarthron community is described above. This community was characterized by the presence of encrusting corallines. Three subcommunities were found: (1) Erect corallines (Calliarthron cheilosporides) and occasional bat stars (Patiria miniata) were characteristic of a subcommunity found on Bishop Rock, Nine Fathom Reef and Central Tanner Bank. Patiria were replaced by Mediaster aequalis and bath sponges in this subcommunity on Northwest Tanner Bank. (2) A Eugorgia/Mediaster subcommunity was found on northwestern Bishop Rock. Eugorgia rubens commonly reached densities of 4-5 fans per square meter in this subcommunity. Also characteristic of this subcommunity was the occurrence of patches of the erect coralline algae, Bossiella and the brown alga Zonaria. A fairly extensive band of Zonaria formed a subcommunity between the Eugorgia/Mediaster and Calliarthron subcommunities on Bishop Rock and on the eastern slope of Nine Fathom Reef. The Agarum/Laminaria community was absent from the deeper areas, (Northwest Cortes Bank and Santa Rosa Ridge) below 60 m depth. Predominant fish were rockfish (olive, blue, bocaccio, and square spot), blacksmith, senorita, ocean whitefish and blackeye gobies.

4.1.3 Encrusting Coralline Community - The encrusting coralline community occurred in areas of greater than 50% rock, boulders, cobble, or pebble from approximately 60 to 149 m depth on Tanner and Cortes Banks (Areas A, B, C, E and F). Other common organisms are red, green, orange, tan, and yellow crusts that consist of algae, bryozoans, tunicates, sponges, and other unidentified encrusting organisms. Sub-dominants in the community include the gorgonian Plumarella, Mediaster, and sponges. Density-depth plots for encrusting corallines, Plumarella, Mediaster, vase sponges, and bath sponges are presented in Appendix F, Figures F-10, F-22, F-17, F-30 and F-6, respectively. Two distinct subcommunities may be defined on the basis of these subdominants:

(1) A Plumarella/Mediaster/sponge subcommunity was found between 68 and 89 m on all areas except area G. Densities of 4-5 Plumarella longispina per square meter were observed in areas E and F (see Coelenterates Section 4.7.4).

(2) A Mediaster subcommunity consisting of more or less evenly scattered Mediaster and locally dense populations of the glass sponge "Staurocalyptus", and the calcareous sponge "Clathrina" (See Porifera, Section 4.7.8).

The classification of encrusting corallines as a community dominant below 60 m (200 ft) does not mean that they are necessarily insignificant in shallower waters. However, relative to the macroalgae, the effects of encrusting corallines on community structure are probably low. Encrusting coralline algae were present and frequently extensive throughout the depth range surveyed (14-146 m), but were obscured by erect and foliose macroalgae above 60 m (200 ft). Encrusting corallines could be added to the dominant list for the shallower communities as well.

Allopora, Coenocyathus, Corynactis, and several species of bryozoans, hydroids, and sponges were occasionally observed on rocky outcrops in the encrusting Coralline community (Areas A, B, C, E, and F). The deepest occurrence of Allopora recorded during the survey was from 123 m at Cortes Banks (Area C). Large, isolated, highly branched heads were observed (approximately 20 cm tall and 30 cm wide), however the overall coral density in the community was low and extremely patchy (See Coelenterate Section 4.7.4).

Common invertebrates in the encrusting coralline community include the polychaete Protula superba, starfish Mediaster aequalis, Patiria miniata, and Peridontaster crassus, the cup corals Paracyathus stearnsi and Balanophyllia elegans, and the brachiopod Laqueus californica. Algae is uncommon and usually consists of red algae such as Maripelta, Botryocladia, "Iridaea", and dichoflabellate reds such as Rhodymenia. Common fish in the encrusting coralline community include several species of Sebastes (S. hopkinsi, S. rosaceus, S. paucispinis, S. ovalis, and S. chlorostictus/rosenblatti), senorita (down to 100 m), and cottids.

4.1.4 Florometra/ophiuroid Community

The Florometra/ophiuroid community was found from 89-149 m primarily on Santa Rosa Ridge (Area G), but was also observed in parts of Areas C and F. This rock community is the only one characterized by non-algal dominants (i.e., invertebrates).

The Florometra/ophiuroid community is characterized by the crinoid Florometra serratissima and ophiuroids including "Ophiopsila" and "Ophiopholis/Ophiocantha" which are extremely abundant along the transects at Santa Rosa Ridge (Area G). Also common in this area are glass sponges including "Staurocalyptus," calcareous sponges such as "Leucetta," the anemone Stomphia coccinea, and the basket star Gorgonocephalus caryi. Sebastes spp. (primarily Sebastomus and S. chlorostictus/rosenblatti) and the ratfish Hydrolagus collei also occur here. Erect algae are absent to rare.

There are several differences distinguishing the encrusting coralline and Florometra/ophiuroid communities from shallower communities (above 60 m depth): (1) the scarcity of erect macroalgae, (2) the corresponding decrease in the number of invertebrate grazers (such as gastropods: Cypraea spadicea, Astraea spp., Megathura crenulata, and Tegula spp.). (3) the increased abundance and size of calcareous and hexactinellid (glass) sponges and a decrease in abundance of Demospongiae, (4) the increased abundance of deepwater fish (Sebastes rubrivinctus, S. chlorostictus/rosenblatti, S. macdonaldi, S. hopkinsi, and Hydrolagus)and (5) a decrease in abundance of shallow-water fish (Chromis, Oxyjulis, Pimelometopon, Embiotocidae, Oxylebius).

In general the number of species of algae and invertebrates is lower in the deeper ranging communities than in the shallower communities, although this observation is based only on large macrophytes and macroinvertebrates.

4.1.5 Sand Community

The sand community occurred throughout the depth range of the survey (14-149 m), with grain sizes as estimated by observers ranging from coarse sand to silt. In general, sediment covered areas became more extensive with depth, being reduced to pockets and channels of sand between rock outcrops in shallow water (above 40-60 m) and finer material and silt in deeper water below 75 m. Ripple marks were seen frequently indicating that bottom surge occurred down to at least 85 m (280 ft). Windrows observed in depositional areas contained shell litter, pebbles and drift algae. Bioturbation from gastropod trails or asteroid depressions (i.e., from burrowing by Luidia) were also seen in sand areas.

Soft substrate areas were not subjected to the same detailed scientific analysis as was performed on areas of hard substrate, but some generalized conclusions were reached. The sand community structure differed considerably from that in rocky areas, owing to sediment transport and a lack of attachment sites for sessile organisms. Observable substrate differences had different species assemblages, but it was not established whether or not these biotic differences constituted separate sub-communities.

Typically open sand areas extended beyond the limit of visibility (i.e., 20-50 m radius), and contained either of two species assemblages. The white urchin Lytechinus anamesus and the starfish Mediaster aequalis were the dominants in some of these areas although both showed patchy distributions and highly variable abundances. Both species were observed on rocks at the rock-sand interfaces, so their associations with sand are not exclusive. In other open areas, a mixed asteroid community was observed which included Mediaster, Astropecten, Luidia, Patiria and/or Rathbunaster and Lytechinus. All asteroids were patchy in distribution and none were ever abundant. The sea pens Ptilosarcus gurneyi and "Stylatula" were seen occasionally in open sand.

Some regions apparently consisted of hard substrate covered by a thin (1-10 cm) layer of sand. Observed in these areas were Lytechinus and Mediaster, along with the anemones Tealia spp. and Stomphia coccinea. Stony corals (Paracyathus stearnsi, Balanophyllia elegans, Dendrophyllia oldroydi) were also observed in these areas, along with small algal tufts and colonial coelenterates.

Encrusting coralline algae were typically found on pebbles in sandy areas, but coverage never appeared to be significant.

The pink urchin Allocentrutus fragilis occurred in deeper areas where silty sand was mixed with cobbles and pebbles or covered hard substrate. This species was usually intermixed with the Florometra/ophiuroid community described above.

As compared to rocky areas, few fish species were seen in the sand areas. Sebastomus was found in sandy areas throughout the depth range surveyed, but usually within about 10 m of a rock outcrop. Other fish species found primarily on sand, or at rock-sand interfaces, were combfish (Zaniolepis), ronquils (Rathbunella), flatfish (Bothidae and Pleuronectidae), and the typical white color morph of the blackeye goby (Coryphopterus nicholsi). The halfbanded rockfish (Sebastes semicinctus) was the only rockfish observed strictly over sand, between 61-91 m (200-300 ft).

4.2 AREA DESCRIPTIONS

The biological communities were fairly uniform in terms of dominant species. However, the six areas showed major differences in the distribution of subcommunities. These differences were largely associated with differences in depth, although sand scour and exposure appeared to be responsible for the occurrence of subcommunities within the Eisenia/Calliarthron and Agarum/Laminaria communities.

4.2.1 Bishop Rock Communities (Area A Plate 5 Map 1)

Ten transects and one movie dive were made between 14 and 85 m, totalling 28, 250 m of coverage. Figure II-10 illustrates the benthic communities observed in area A. Bishop Rock is dominated by an Eisenia/Calliarthron community above 40 m depth on rocky terrain. Other dominant and subdominant organisms of this community include encrusting corallines, Laminaria, Agarum and Calliarthron. Agarum and Laminaria are less abundant and more scattered in the northern and eastern regions (dives 17 and 19, respectively; see Figure II-8) than in the rest of the community. Also occurring are scattered patches of Bossiella (mostly along the northern margin of the community), the batstar Patiria miniata, (dive 8) and the red alga Gelidium. Gelidium attained 100 percent cover on the low relief rocky plateau on the southeastern end of the area (dive 19), but was sparse elsewhere. This unique Gelidium subcommunity probably occurs as a result of the sheltering effect of the high rough relief of Bishop Rock from northwest currents.

A broad Agarum/Laminaria community extended from 40-60 m depth. Laminaria was patchy throughout this community. A unique subcommunity of Eugorgia rubens, Mediaster aequalis, and less commonly Bossiella, was found on the northwest side of Bishop Rock, with Eugorgia rubens extending north and west along the rise. This community passed directly into the sand flats on the eastern end of the bank.

Below 60 m depth, on the western end of the bank, was a narrow encrusting coralline community (Mediaster subcommunity) in which Eugorgia rubens also occurred. This subcommunity extended continuously to the surrounding sand flats on the western end of the bank.

The submersible survey of the area below 68 m depth was insufficient for definite conclusions, but where rocks were found, an occasional Plumarella longispina was observed.

4.2.2 Nine-Fathom Reef Communities (Area B, Plate 5 Map 2) - Seven transects totalling 16,500 m were made between 15 and 91 m depth. Figure II-11 illustrates the benthic communities observed in area B. The community structure of Nine Fathom Reef conformed to the depth and substrate limitations seen in the other areas. The deepest community seen was the encrusting coralline community below 89 m depth. Neither Florometra nor ophiuroids were reported at these depths, however less than five minutes were spent in this community at the start of two dives (dives 12 and 13) on a sandy bottom with scattered cobbles and pebbles.

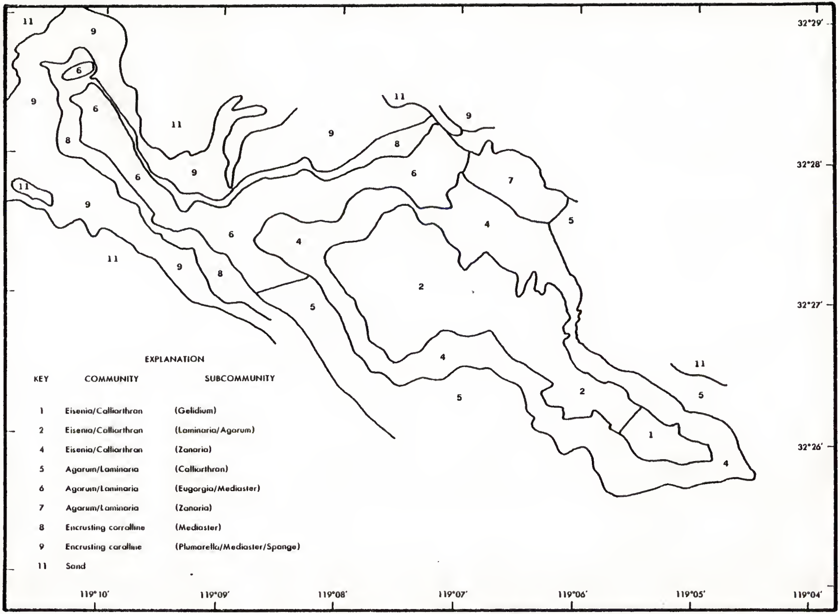

Figure II-10. Benthic Communities Observed in Area A

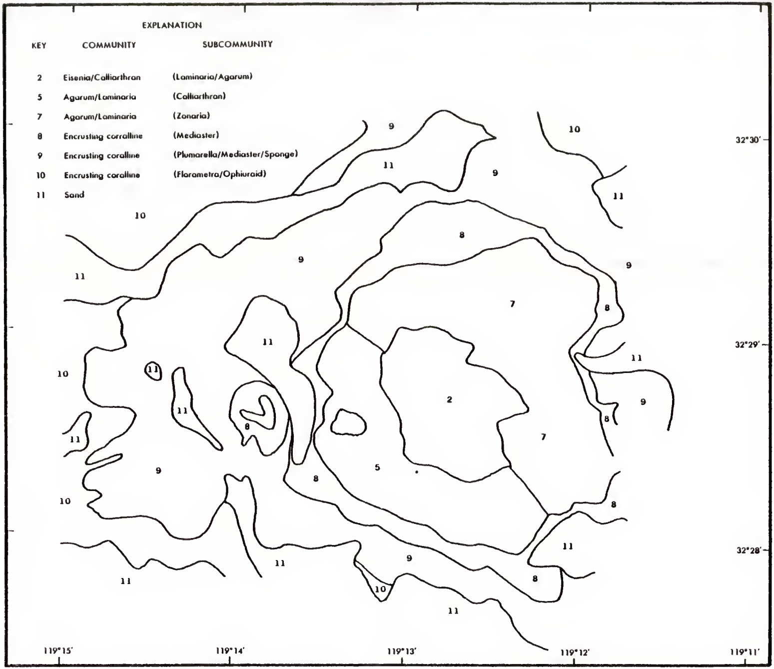

Figure II-11. Benthic Communities Observed in Area B

Between 68 and 89 m, a Plumarella/Mediaster/sponge subcommunity with a few Eugorgia rubens was found on the south and west side of the bank (dives 11 and 12). Low rocky substrate including cobble, pebble, and sand flats were reported scattered throughout this community.

The encrusting coralline community extended upward to 60-68 m on the north, south and west sides of the bank, and to 63-68 m on the east side of the bank. This marginal area was characterized primarily by the starfish Mediaster, although this zone may represent a transition zone between deeper and shallower communities. In general, this subcommunity ringed Nine Fathom Reef (Area B), although areas around the small western rise appeared to be separated from the main ring by a deeper intervening sand channel.

The depression of the upper limit of the encrusting coralline community from 63-68 m on the east side of the bank is due to the encroachment of the Agarum/Laminaria community into this slightly deeper area. Agarum extends to 69 m on the south and east sides of the bank but is only occasionally observed at this depth (dives 11, 16, and 26). Laminaria extends to 66 m on the north (dive 14) and 72 m on the east sides of the bank (dives 16 and 26), but again is only occassionally seen at these depths.

From the encrusting coralline community boundary (60-63 m) up to 40 m depth is a fairly extensive area dominated by beds of the brown bladed algae, Agarum and Laminaria. On the northeastern side of the bank and on the top of the small western rise were extensive areas characterized by the algae Zonaria. The southwestern side of the bank lacked significant coverage of Zonaria. Also found in this community was the erect coralline alga Calliarthron, the bat star Patiria miniata, and occasional stands of the thick erect coralline alga Bossiella.

Above 40 m was found an Eisenia dominated community (Laminaria/Agarum subcommunity). Although Calliarthron was commonly reported, it was not sufficiently dense to be more than a subdominant throughout the shallower portion of this community. Patiria, Zonaria and Mediaster, which were commonly seen in the deeper communities were only occasionals in the Eisenia community, though the heavy algal cover could have obscured many invertebrates and small algae.

4.2.3 Northwest Cortes Bank Communities (Area C, Plate 5 Map 3) - Five transects totalling 13,400 m and one movie dive were made between 61-123 m. Figure II-12 illustrates the benthic communities observed in area C. A fairly uniform encrusting coralline community was found throughout Northwest Cortes Bank, (area C). The starfish Mediaster aequalis occurred throughout most of the area but was noticeably absent below 89 meters on the northeast region of the area and below 94 meters on the north side of the southern rises (north part of dive 27). Only encrusting corallines and white fan corals (Plumarella longispina) were found below these depths.

Bath sponges ("Clathrina") occurred primarily above 80 m depth on the northwest side of the bank (dive 28). Vase sponges ("Staurocalyptus") were found primarily in the southern area (dives 27 and 37). The western area above 74 meters was somewhat unique with the large bladed brown alga Laminaria, and the erect coralline alga, Bossiella, occurring on bedrock with

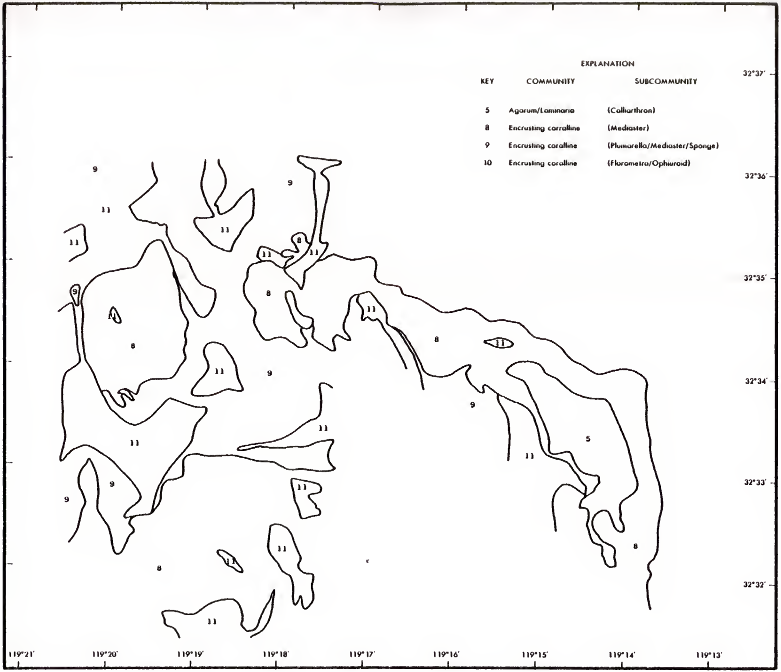

Figure II-12. Benthic Communities Observed in Area C the white urchin Lytechinus, and the bat star, Patiria (dive 36). In the deeper areas Lytechinus was primarily associated with sand patches and the white fan coral Plumarella longispina was fairly common.

4.2.4 Central Tanner Bank Communities (Area E, Plate 5 Map 5)

Nine transects totalling 2,550 m and one movie dive were made between 30 and 92 m depth. Figure II-13 illustrates the benthic communities observed in area E. The deeper western region of Central Tanner Bank at 90 to 68 m depth was dominated by extensive sand flats and scattered patches of boulders (dives 1, 2, 3, 6 and 38) common organisms include encrusting corallines, Mediaster, Plumarella, and sponges. Between 68 and 60 m on the rocky areas was a very similar community, except that Plumarella longispina was no longer seen.

The shallower eastern region, above 60 m depth was characterized by Agarum, Calliarthron, Laminaria and Patiria. Bossiella was common on all dives except dive 3.

In the shallowest areas of the bank, mostly above 40 m depth, a few scattered stands of Eisenia were found. These stands probably represent a transition zone between the deeper Agarum/Laminaria community and the shallower Eisenia/Calliarthron community seen on Bishop Rock and Nine Fathom Reef. A small Ophiothrix spiculata subcommunity was found on the leeward side of the Eisenia/Calliarthron community (dive 7).

4.2.5 Northwest Tanner Bank Communities(Area F, Plate 5 Map 6)

Four transects totalling 10,550 m and one movie dive were made between 50 and 146 m. Figure II-14 illustrates the Benthic Communities observed in area F. Two distinctive rocky substrate communities were observed on Northwest Tanner Bank (area F).

A community consisting of boulders on sand (streaky sediments) with large sand patches and occasional white fan corals (Plumarella longispina) occurred in the north and west regions of the bank below 98 m. White urchins (Lytechinus anamesus) and vase sponges were scattered in the western area (dive 34) and in dense patches in the northern area (end of dive 32).

A shallower encrusting coralline community dominated by encrusting corallines, the starfish (Mediaster aequalis) and bath sponges ("Clathrina") was found above 98 m on bedrock rising in the south eastern region. Scattered along these transects (dives 31, 32 and 41) were seen patches in which the white urchin (Lytechinus), the white fan coral (Plumarella longispina), and vase sponges ("Staurocalyptus") were very common and probably constituted community subdominants.

Along the northern side of the encrusting coralline community was a narrow east/west rise above 68 m depth which had encrusting corallines, Mediaster, bath sponges and a few small patches of Calliarthron, but lacked Plumarella and Lytechinus. This shallower area is considered to represent a transition zone into a small Agarum/Laminaria community found here above 56 m (dive 32). This was the shallowest community found in area F and was dominated by encrusting corallines with Agarum, Laminaria, Mediaster, and Lytechinus also occurring.

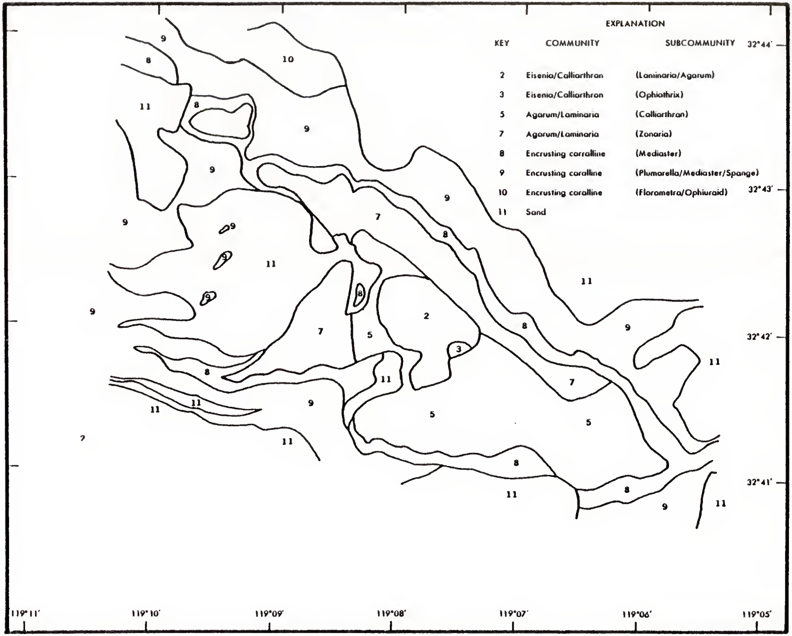

Figure II-13. Benthic Communities Observed in Area E

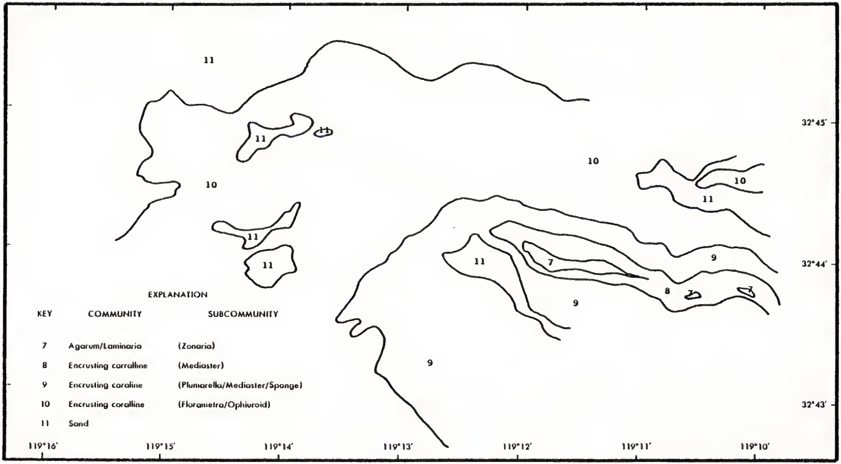

Figure II-14. Benthic Communities Observed in Area F

4.2.6 Santa Rosa Ridge Communities (Area G,)

Two transects totalling 5,000 m were made on south Santa Rosa Ridge between 94 and 137 m. A fairly uniform deep Florometra/ophiuroid community was found throughout both transects. The substrate consisted of boulders on sand with occasional patches of cobbles or outcrops of rocky ledges. The dominant organisms were crinoids (Florometra serratissima) and several species of ophiuroids. Vase sponges and basket stars (Gorgonocephalus caryi) occurred in low densities on both transects. Basket stars were most common on the south end of the northern transect (dive 39), while vase sponges were largely restricted to the southern transect (dive 33). The components of this community reached sufficiently high densities to cover every ridge, boulder and cobble available, appearing to be limited only by substrate availability. It was concluded from these observations that the crinoid/ophiuroid community on area G is uniform throughout the Santa Rosa Ridge Area, except for occasional small sand flats.

4.3 CORAL DISTRIBUTION AND DENSITY

Three groups of corals were found to be common components of the benthic communities of the study area: hydrocorals (Hydrocorallia), stony corals (Scleractinia), and fan corals (Gorgonacea).

4.3.1 Hydrocoral - The taxonomy and much of the ecology of Allopora californica Verrill (1866) (? Stylantheca porphyra Fisher, 1931), is still not well known. The taxonomic uncertanties are unresolved (Light's Manual, 1975), and even though Fisher (1938) transferred his species to Allopora, both genera are considered valid (Boschma, 1956). Similarly, the question of whether or not the color morphs of Allopora constitute separate species has been raised. The generic confusion should be resolvable by a hydrocoral systematist, while gel electrophoresis would probably clarify the species problem. The primary hydrocoral observed at Tanner and Cortes banks in the present survey will be referred to as Allopora californica.

The persistent color of the Allopora colonies is due to a bound carotenoid (Fox and Wilkie, 1970) and the binding to the aragonite skeleton involves a complexing of the cartenoid with the protein alloporin (Ronneberg et al., 1979). Small differences in the protein produce marked differences in color, and may be the basis for the color morphs seen in Allopora as it is in Corynactis, Metridium, certain starfish and other organisms (Fox, pers. comm). Since the protein differences are inheritable, closely related individuals will tend to be the same color and occur in the same localized area, as Allopora broods its eggs and releases a planula of limited dispersal capabilities (Ostarello, 1973). Therefore, the patchy distribution of color forms observed on the offshore banks is to be expected.

This uneven distribution is related to other factors, as well at Tanner and Cortes Banks A. californica is found mainly along the edges of cliff faces and tops of steep sided outcrops at depths between 18 and 123 m. Furthermore the microhabitat of the species (steep outcrop faces) at Tanner and Cortes Banks is also extremely patchy. While a large percent of the substrate is rocky, over 90% is not of sufficient vertical relief to support Allopora. Thus the patchy distribution of Allopora may be directly related to the patchy (and rare) distribution of the microhabitat.

Little is known of the natural history of Allopora. Ostarello (1973) has reported on the reproductive biology of A. californica. Her study was based on subtidal SCUBA surveys off Carmel, California, and includes ecological observations on recruitment, mortality, the effect of suspended sediments on survival, and commensal species. She was unable to link mortality with predation and considered the degree of sedimentation to be limiting, corroborating the observations in the present report.

Allopora occurs up into the low intertidal in Northern California, to about San Francisco (Smith and Carlton, 1976), but undergoes submergence at lower latitudes, occurring only subtidally in Southern California. It may occur occasionally along the coastal shallows, but nowhere is it as abundant nor as large as on the offshore islands and banks notably Farnsworth, Tanner and Cortes Banks (Newman, pers. comm).

Several different colors of Allopora californica were seen at the Banks. Pink was the most common colony color often with redder basal areas and white branch tips. Red, purple, orange, yellow and pinkish-white colonies were also reported by the observers.

The pink colonies occurred in two distinctive growth forms, one having thick dichotomous branches arranged to form a loose bush-like colony, and the other having fine delicate branches, densely branched in a single plane to form a lacy fan-shaped colony. The purple colonies were coarse fan-shaped colonies intermediate between the two pink growth forms, neither as delicately branched, nor as densely branched as the pink colonies. The pinkish white colonies appeared identical to the pink colonies in growth form. Only three of the yellow and orange colonies were seen. These color morphs may represent distinct taxa as they appeared to have heavier coarser branches and sparser branching than the other color forms. No distinctive species-level morphological differences could be seen between samples (collected by divers for the Los Angeles County Museum and the Bureau of Land Management) of the pink and purple varieties from the study area (Newman, personal communication). None of the Allopora from the study area attained the massive growth form of the purple Allopora from Mexican waters (Smith, 1976; Newman, personal communication).

Allopora was found on rocks and boulders at depths ranging from 18 m (60 ft) down to a few isolated colonies growing on the tops of rocks at a maximum depth of 90 to 123 m (300-404 ft) (Figure II-15 and Table II-3; Appendix F, Figures F-2, F-3). In every community the Allopora was patchy with very limited distribution. From 18 to 30 m (60-100 ft) the colonies were found almost entirely on cliff faces and the sides of large boulders and reefs. The colonies appeared to occur only on those exposed surfaces receiving the greatest current associated transport, as Allopora commonly occurred oriented perpendicular to currents. Below 30 m (100 ft) there was an increasing tendency for the Allopora to occur on the uppermost edges of cliffs, reefs, and boulders, apparently to maximize exposure to currents at these depths. The lack of Allopora on rock tops in the shallower water is probably due to storm damage and scour, as well as harvesting; deposits of Allopora rubble were associated with the coarsest sands and gravels of the shallowest (above 40 m) areas. The reduction of Allopora below 90 m (300 ft) is probably attributable to the reduced turbulence at these depths probably (Pequegnat, 1964).

Allopora beds covered 10 to 100% of the rocky substrate in a few patchy centers of abundance, mostly in areas A, B, and E (Bishop Rock, Nine Fathom Reef and South Tanner Bank, respectively). Maximum densities were usually reported for pink colonies growing between 30 m (100 ft) and 60 m (200 ft) (Table 4-3). A small stand of purple Allopora occurred in area C at 96 m (320 ft) consisting of 15 to 30 cm tall fans, 25 to 38 cm across, with 4-5 colonies per square meter. One other large stand of purple Allopora was seen at Bishop Rock (area A) at 45 m (150 ft) depth, growing on pinnacles of rock near the rock sand interface. In these centers of abundance the Allopora colonies commonly reached maximum heights of 20 to 25 cm and maximum breadths of 30 to 40 cm. Most colonies were considerably smaller, however being only 5 to 10 cm tall with a maximum breadth of 20 cm. Between centers of abundance the Allopora colonies typically consisted of single fingers of coral from 1 to 8 cm tall with an overall density of considerably less than 1% (Appendix F-2).

In areas A, B and E Allopora was found in all three major rocky substrate communities (Eisenia/Calliarthron, Agarum/Laminaria, and encrusting coralline communities). In area C Allopora was found only in the encrusting coralline community. In area F Allopora was found in both the Agarum/Laminaria and encrusting coralline communities.

Allopora was never seen in close association with sand scoured areas and the surrounding substrate used for attachment was noticeably clean of sedimentary material.

The distribution of Allopora was found to be patchy from 23 m on area A, to its maximum reported depth of 123 m on area C. Except for area C, nearly all of the Allopora was shallower than 70 meters depth. It was generally coextensive with Laminaria in the Agarum/Laminaria and Eisenia/Calliarthron communities. Allopora was commonly found on the northern and western sides of high relief rocky ridges.

At Bishop Rock (area A, Plate 7, Map 1; Figure II-16), Allopora was found primarily in the Eugorgia/Mediaster subcommunity on the northern and western sides of Cortes Bank. The densest most extensive Allopora stands were found between 14 and 60 m along the rise west of Bishop Rock.

At Nine-Fathom Reef (area B, Plate 7, Map 2; Figure II-17), Allopora was found primarily in the Eisenia community above 40 meters depth. It was more limited on the eastern side of Nine Fathom Reef, extending to only 30 m depth, than on the north and west sides of the reef where it extended to 48 and 62 m depth, respectively.

At Northwest Cortes Bank (area C, Plate 6, Map 3) essentially all of the observed Allopora was below 80 m depth in the encrusting coralline community, Plumarella/Mediaster/sponge subcommunity. This area is unique in the absence of Allopora above 70 meters depth on the eastern side or the bank. The depth extension seen in this area may be related to the presence of high relief and an absence of sand scour since the other areas consisted of low relief rock on sand at this depth.

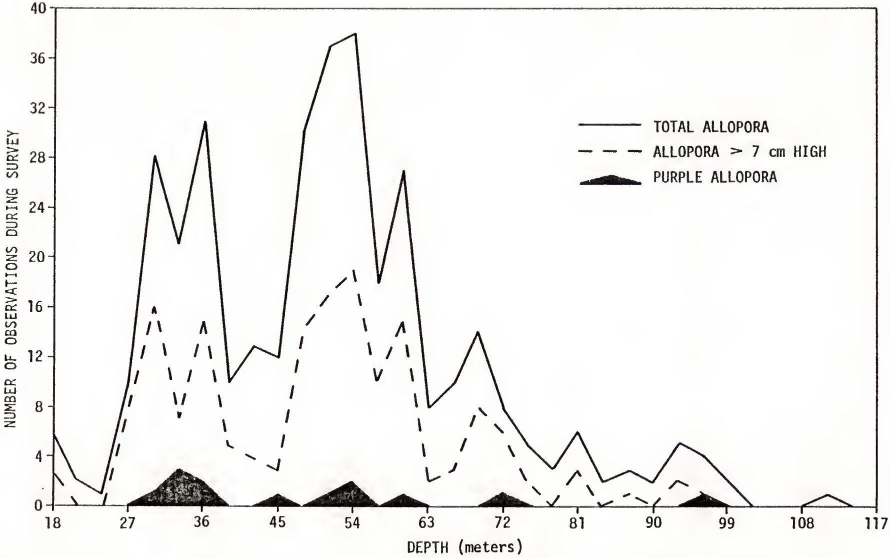

Figure II-15. Depth Distribution of Allopora Californica for Colonies of all Sizes, Colonies Taller than 7 cm and Purple Colonies (Other Colonies are Probably Pink in Color).

TABLE II-3. DEPTH DISTRIBUTIONS (METERS) OF ALLOPORA IN STUDY AREAS WITH MAXIMUM HEIGHT, WIDTH, COVERAGE AND DENSITY ESTIMATES FOR EACH COMMUNITY

Community \ Area	Bishop Rock A	Nine Fathom Reef B	North Cortes C	South Tanner E	North Tanner F	Santa Rosa Ridge G	Max. Height, cm	Max. Width, cm	Max. Coverage, %	Max. Density, per m^2
Eisenia/Calliarthron	18-37	26-40	-	24-27	-	-	18	36	100	-
Laminaria/Agarum	59	-	-	44	-	-	20	-	50	-
Laminaria + Gelidium	-	-	-	-	-	-	-	-	-	-
Laminaria + Zonaria	43-76	37	-	44	50-58	-	30	38	-	12
Laminaria + Eugorgia	46-52	-	-	-	-	-	5	-	15	-
Laminaria + Ophiothrix	-	-	-	-	-	-	-	-	-	-
Laminaria + Cup Corals	-	-	-	-	-	-	-	-	-	-
Laminaria + Plumarella	-	-	-	-	-	-	-	-	-	-
Laminaria + Cup Corals	52	-	-	-	-	-	10	15	1	12
Laminaria (Agarum absent)	52-61	-	-	-	-	-	3	-	15	-
Agarum (Laminaria absent)	46-64	34-40	-	30-53	49	-	20	61	50	20
Encrusting Corallines	55-76	37-61	-	41-79	61-64	-	28	30	50	90
Encrusting + Plumarella	-	-	82	70	-	-	-	-	-	-
Encrusting + Ophiuroids	-	-	98	-	73	-	30	38	10	5
Encrusting + Sponges	52-61	58-61	76	-	61-76	-	25	30	90	5
Encrusting + Florometra	-	-	88-91	-	-	-	30	30	1	2

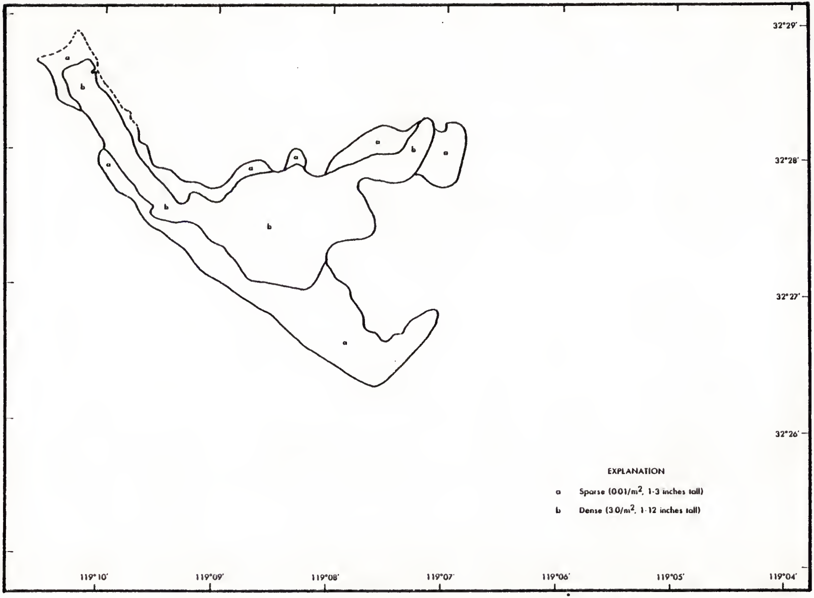

Figure II-16. Distribution of Allopora californica Area A

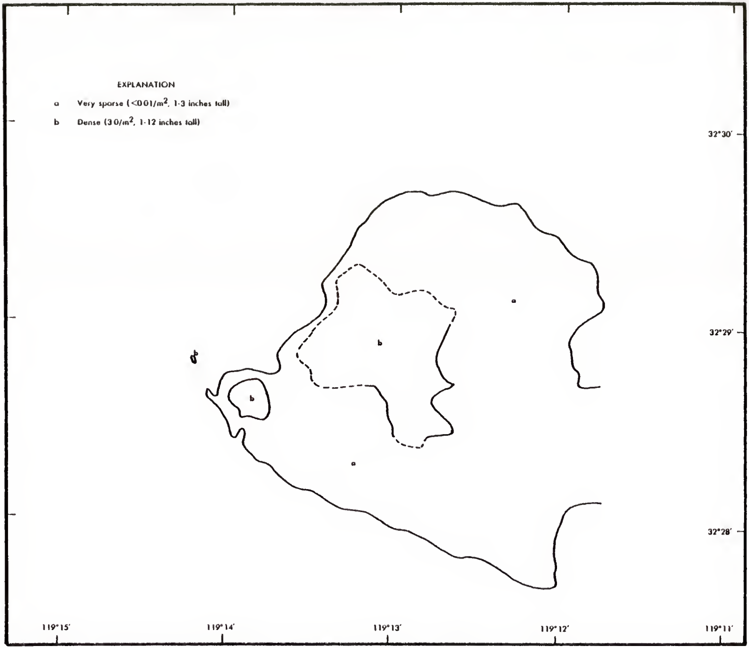

Figure II-17. Distribution of _Allopora californica_ Area B

At South Tanner Bank (area E, Plate 7, Map 5; Figure II-18) the Allopora was seen primarily above 70 m depth. Only four sightings of Allopora fingers less than 3" high were made between 73 and 87 m depth. The stands of Allopora tended to be clustered on the northwestern side of the bank.

At North Tanner Bank (area F, Plate 7, Map 6; Figure II-19) the Allopora was found at or above 70 m depth on the two narrow rises found in the area.

4.3.1.1 Allopora Standing Crop

The following estimate of the Allopora standing crop is subject to several limitations. The submersible survey was limited to rocky areas detected by side scan sonar, and the occurrence of Allopora in area C (Northwest Cortes) in a deep low relief sandy canyon suggests that the total habitat of Allopora was not totally surveyed. However, the deeper records of Allopora, which should reflect the density of colonies in the unsurveyed areas, show that only a small percentage of the population extends deeper than the limits of the survey area.

Within the surveyed area only narrow transects were actually surveyed and the Allopora habitat and colony density were inferred from these observations. A deliberate effort was made to cross through areas known to contain Allopora so that any estimation errors would be overestimates of population densities, rather than underestimates.

The extreme patchiness of the distribution was handled by dividing the habitat into three density regions on the basis of the percentage of observations made in each density region. This approach avoids many of the problems inherent in standing crop estimates of very patchy organisms. The density estimates themselves are approximations with a maximum error estimated to be in the 10% range.

The primary difficulty in making density estimates is in the visual identification of Allopora colonies less than 7 cm in height with a resulting tendency to underestimate densities of smaller colonies. However, this bias may be balanced by a tendency to overestimate the extent of the habitat of the low density area. In any case, the total contribution of these small colonies in the sparsely inhabited region to the total Allopora standing crop is very small.

Occurrences of Allopora were recorded for only 6 percent of the submersible transect coverage in areas A (Bishop Rock), B (Nine Fathom Reef), C (Northwest Cortes), E (Central Tanner), and F (Northwest Tanner) (Table II-4). No Allopora was observed in area G (Santa Rosa Ridge). Although no dives were made on area D (Tanner and Cortes Trough), the depth and limited hard substrate indicated by bathymetric and side scan sonar data suggest absence of Allopora in the area.

The total areal distribution of Allopora is 16.7 km^2, calculated by interpolation between submersible transects on the basis of bottom topography. 5.2 km^2 are considered marginal habitat with sparsely distributed colonies smaller than 7 cm in height (Table II-5). The main Allopora habitat, consisting of 11.5 km^2 of rocky substrate, may be divided into two regions on the basis of maximum colony height. An average of 66 percent of the main

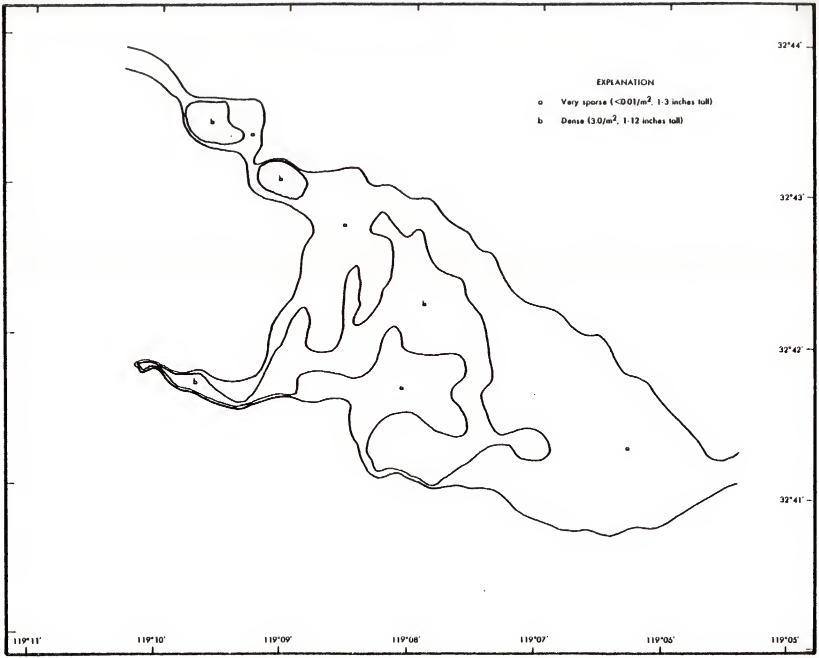

Figure II-18. Distribution of <u>Allopora californica</u> Area E

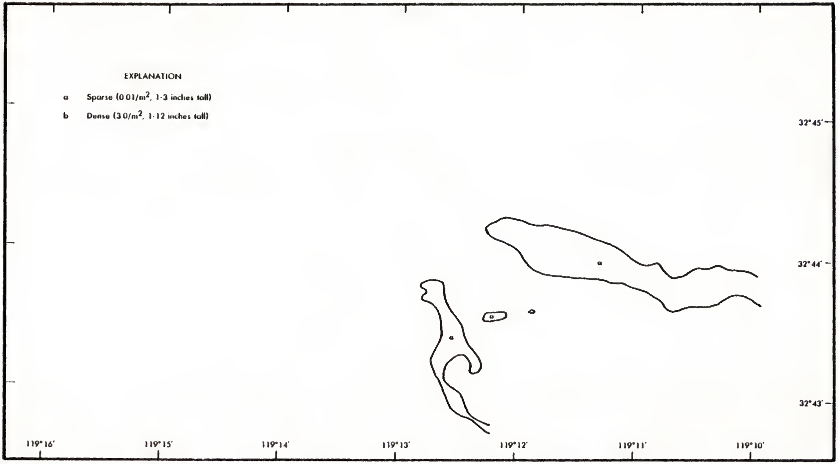

Figure II-19. Distribution of Allopora californica Area F

Allopora habitat included observations of colonies taller than 7 cm in size, with the remaining third of the main habitat being probably inhabited by colonies under 7 cm in height (Table II-6).

TABLE II-4. THE ESTIMATED EXTENT OF ROCKY HABITAT AND FREQUENCY OF OBSERVATION OF ALLOPORA COLONIES IN EACH AREA. AREAS D AND G ARE NOT SHOWN DUE TO THE PROBABLE ABSENCE OF ALLOPORA

AREA	ESTIMATED ROCKY HABITAT (sq km)	TOTAL TRANSECT LENGTH	ALLOPORA OBSERVATIONS			
			TOTAL		OVER 7 cm HEIGHT	
			LENGTH	%	LENGTH	%
A	28	28,400 m	2,200 m	8	1,400 m	5
B	18	14,100 m	1,100 m	8	900 m	6
C	30	12,800 m	600 m	5	350 m	3
E	25	21,500 m	700 m	3	600 m	3
F	20	9,200 m	550 m	6	250 m	3

TABLE II-5. ESTIMATED SUITABLE HABITAT (SQUARE KM) AVAILABLE TO ALLOPORA ON TANNER AND CORTES BANKS

Area	Main Habitat	Additional Marginal Habitat	Total Habitat
A	4.1	2.8	6.9
B	1.9	0.1	2.0
C	0.5	0.5	1.0
D	0.0	0.0	0.0
E	4.0	0.6	4.6
F	1.0	1.2	2.2
G	0.0	0.0	0.0
	11.5	5.2	16.7

TABLE II-6. ALLOPORA COLONY SIZE DISTRIBUTION, LISTED AS PERCENT OF TOTAL ALLOPORA RECORDS

AREA	TALLER COLONIES (> 7 cm)	SHORTER COLONIES (< 7 cm)
A	59 %	41 %
B	82 %	18 %
C	58 %	42 %
D	-	-
E	86 %	14 %
F	46 %	54 %
G	-	-
Average	66 %	(34 %)

The areal extent of habitats having colonies taller than 7 cm (Table II-7) is estimated to be 8.2 by multiplying the percent of observations of colonies taller than 7 cm (Table II-6) by the areal extent of the main habitat.

TABLE II-7. ESTIMATED DISTRIBUTION (SQUARE KM) OF COLONIES GREATER OR LESS THAN 7 CM IN HEIGHT FOR EACH AREA

AREA	LARGE COLONY HABITAT (> 7 cm)	SMALL COLONY HABITAT (< 7 cm)		
		Main Habitat	Marginal Habitat	Total
A	2.4	1.7	2.8	4.5
B	1.6	0.3	0.1	0.4
C	0.3	0.2	0.5	0.7
D	0.0	0.0	0.0	0.0
E	3.4	0.6	0.6	1.2
F	0.5	0.5	1.2	1.7
G	0.0	0.0	0.0	0.0
TOTAL	8.2			8.5

The mean density of Allopora was estimated from the numbers of colonies seen per minute of transect using an average of 80 square m of bottom observed per minute of submersible transect (Table II-8). The numbers of colonies seen was estimated by multiplying the number of observations by the median observed number of colonies per minute of transect as it was not possible for the observers to physically count and record individual colonies. These density estimates agree well with the previously derived density estimates for the main Allopora habitat (0.24 colonies/m^2) and the overall Banks area (0.07 colonies/m^2, Smith et al. 1978). In the present study, the median density value was used instead of the mean to correct for bias, since observers tended to report densities more frequently in the more densely populated areas. Thus, density estimates in the sparsely populated area reflect highest densities in the overall area. Also, four density estimates in the sparsely populated area exceeded 100 colonies/m^2. These colonies were generally less than 1 cm in height and represent newly recruited individuals (first year) on what appeared to be recently scoured or exposed substrate. However, the survival capability of these young colonies is unknown.

TABLE II-8. DENSITY OF ALLOPORA REPORTED BY SUBMERSIBLE OBSERVERS

	ESTIMATED COLONIES	OBSERVATIONS (60 m^2 units)	MEAN (Colonies/obs)	DENSITY (Colonies/m^2)
DENSE	18600	309	60.2	0.75
MODERATE	61220	3090	19.8	0.24
SPARSE	4890	1751	2.8	0.04
TOTAL	84710	5150		

The observers reported densities of 5-20 large Allopora colonies/m (up to 50% coverage in localized areas) and 1-5 colonies/m^2 (10 to 20% coverage) during only eleven minutes of transect time (four and seven minutes, respectively). Records of less dense Allopora stands (less than one colony/m^2, or about 5% coverage) amounted to 283 transect minutes (96%). With 5,150 m of transects recording the presence of Allopora and one minute of transect being approximately 20 m of travel, the densest stands of colonies represented less than 220 m of travel, or 4.3% of the total distribution (718,000 m^2) (Table II-9).

Since the extent of main Allopora habitat is 8,200,000 m (Table Table II-7), this leaves 7,482,000 m^2 of main habitat with only a moderate density of colonies (Table II-9). Due to the extreme patchiness of Allopora, it is best to discuss its distribution in terms of these three density regions. Colony height appeared to be correlated with density in these three regions with colonies 15 to 30 cm tall found primarily in the regions of maximum density and colonies under 7 cm tall being characteristic of the sparsely populated region.

The number of colonies of Allopora in each density region may be estimated by multiplying the estimated mean density of colonies by the area of the region (Table II-9).

TABLE II-9. ESTIMATED ABUNDANCE OF ALLOPORA ON TANNER AND CORTES BANKS

	DENSITY (#/m^2)	AREA (m^2)	ABUNDANCE (Colonies	MEAN HEIGHT (cm)	MEAN WEIGHT (kg)	STANDING CROP (kg)
DENSE	0.75	718,000	539,000	10.0	0.63	340,000
MODERATE	0.24	7,482,000	1,796,000	3.5	0.008	14,000
SPARSE	0.04	8,500,000	340,000	1.8	0.002	700
TOTAL		16,700,000	2,674,000			354,700 (390 tons)

Colony heights were reported for 1,134 specimens of Allopora during the submersible study. The mean colony height was found to be 3.47 cm in the main habitat, 10.08 cm in the densest patches, and 1.8 cm in the marginal habitat. The median colony height is 0.63 in the main habitat, 6.9 in the densest patches and 0.57 in the marginal habitat. Due to bias in these observations resulting from unequal and non random sampling of colony height by observers, these values should only be considered approximations.

A mean weight of 0.00237 kg was found for nine colonies averaging 2.66 cm in height. A mean weight of .990 kg was found for 245 harvested colonies (Smith et al. 1978) averaging 12.69 cm in height (median height = 12.94 cm, Smith personal comm.) The best fit equation to these 245 points (Figure II-20) is: y = 6.14 X 2; with y = weight (gm) and X = height (cm). This equation was used to estimate mean colony weight for the observed mean colony heights (Table II-9).

The standing crop of Allopora may be estimated by multiplying the estimated number of colonies by the mean weight per colony (Table II-9). This procedure yields an estimate of 350,000 kg of Allopora (390 tons) of all sizes in the total standing crop on Tanner and Cortes Banks.

The estimated standing crop is considerably smaller than the figures in the EIC report (640-1600 tons). Generally, mean values and the Point Centered Quarter Method yield density estimates which are as much as three times high for highly clustered (patchy) organisms (Griff, 1979, personal comm.). The data also shows (Table II-9) that 96% of the total standing crop is found in 4% of the total habitat. Thus, extrapolations of total standing crop based on surveys conducted in regions of high density further overestimate total standing crop (328 tons estimated for 6.7 km^2 on the Cortes Bank, Smith et al. 1978). Of those colonies whose height was observed in the densest populations of Allopora, 52% were under 7 cm in height. Since 98.4% of the colonies collected during a typical harvest of coral were over 7 cm in height (Smith, personal communication), it may be concluded that approximately 48% of the Allopora colonies in the densest population patches is of harvestable size. This agrees well with a previous estimate of 55% of the populations being of harvestable size (Smith et al., 1978).

Assuming the standing crop of Allopora californica on Cortes and Tanner Banks is 350,000 kg, it is possible to calculate the value of the resources on a sustained basis.

Research on the pink coral Corallium secundum in Hawaii has shown that approximately 2% of the standing crop of this species can be harvested annually on a sustainable basis (Grigg, 1976). Application of a similar coefficient to Allopora is not unreasonable in view of similarities in life history between Corallium and Allopora (Ostarello, 1973; Grigg, 1976). If the 2% figure is used for Allopora, the annual yield would be about 7000 kg (7.8 tons). However, it would be necessary to spread harvesting as uniformly as possible over the entire habitat to avoid local depletion at this level of harvesting.

If a mean dockside value of $9.92/kg ($4.50/pound) of pink and red coral (Smith et al., 1978) is used to calculate the value of the total annual harvest, the annual yield is worth about $69,000. This estimate is close to the current annual demand for the resource and therefore might be considered an estimate of the maximum current potential of an Allopora fishery on Cortes and Tanner Banks.

If the Allopora resource on the Cortes and Tanner Bank were to be completely protected, a fishery potential of approximately $69,000 would not be realized.

Since 60 percent of the Allopora is below safe SCUBA diving depth (45 m) it would be safer to propose a sustained yield of only 2800 kg ($28,000).

Currently, an estimated half of the probable annual yield of Allopora on Tanner and Cortes Banks (3600 kg) is being harvested from federal waters (Gibson, 1979). As this harvesting is concentrated in very limited shallow water areas, this level of harvesting, if it is all from Tanner and Cortes Banks, would be expected to have a visible effect on shallow water coral stands in a very short period of time, and is 8% (500 kg) more than the sustained yield estimate for SCUBA harvesting.

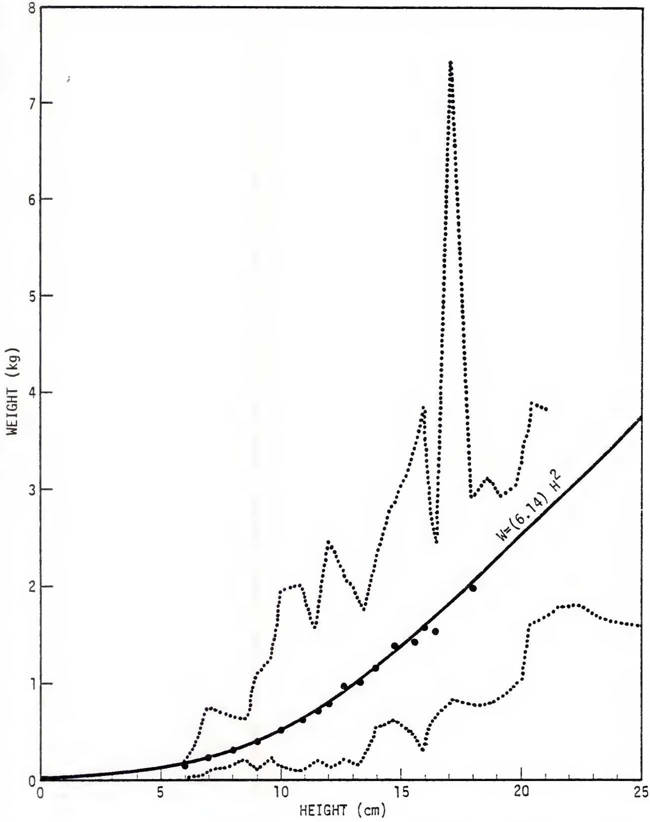

Figure II-20. Allopora Height/Weight Curve Showing Mean (o) Values (3) for Height Intervals for 245 Colonies Harvested from Bishop Rock (Smith, 1978, Unpublished Data). Range in Values Indicated by Dotted Lines

Since 66% of the Allopora colonies seen in the main habitat were larger than 7 cm in height (Table 4-4c), and since 98% of all Allopora harvested is also taller than 7 cm (Smith, personal comm.), this serves as an estimate of total harvestable Allopora. This compares well to an estimate of 55% of the natural population as being of harvestable size (Smith et al. 1978). Further, since 60% of the colonies seen were below 45 m depth, only 92,000 kg of harvestable coral are within safe scuba diving depth (45 m) in the entire area of the Banks. It is not known how much coral is destroyed during harvesting but a reasonable estimate is 20 percent (Smith et al. 1978). This would leave a potential dockside harvest of 74,000 kg.

Several arguments can be advanced as justification for prohibiting the harvest of Allopora californica on the Cortes and Tanner Banks (Grigg, 1979, personal comm.).

First, the value of the resource can be estimated on the basis of recreational use. The BLM report (1978) contains an estimate of 800 diver-days for sport diving on the Cortes Bank. If each diver would pay $50 per day for this activity, this would produce a revenue of $40,000. This alone is almost equal to the maximum potential value of the coral fishery. It is reasonable to assume that the fishery would impair recreational use, although to what degree is unknown.

Second, the cost of managing the fishery would probably greatly exceed the potential value of the resource.

Third, the value of the Tanner and Cortes ecosystem preserved for ecological research should be weighed against the benefits to society of harvesting Allopora on the banks. This argument should take into account the unique ecological attributes of Cortes and Tanner Banks described in this report. Scientific studies on the Banks would be most valuable if conducted in an undisturbed setting. Surely the value to society of this unique resource for scientific research greatly exceeds the value of an Allopora coral fishery.

4.3.2 Stony Coral - Three species of cup corals and two species of colonial corals occur in the study area.

The most widely distributed cup coral was Paracyathus stearnsi which was found from the shallowest dives at 18 m (60 ft) to a maximum depth of 102 m (340 ft). It occurred in nearly all boulder substrate communities, but was conspicuously absent from area G and from the Laminaria/Agarum community. It ranged in density from 2 to 100 individuals per square meter. These cup corals commonly reach a height of 5 cm and were often seen sticking out of the sand, indicating hard substrate with sand overlay.

Balanophyllia elegans was not as widely distributed but occurred in higher densities than Paracyathus (Appendix F, Figures F-4, F-18). It was most commonly seen in the Eisenia/Calliarthron and encrusting coralline communities, although occasional observations show that it was associated with Laminaria, Agarum, Zonaria, and Allopora. In the Eisenia/Calliarthron community, Balanophyllia was found above 39 m (130 ft) in areas A, B and E in densities from 2 to 35 individuals per square meter (up to 20% coverage). In the encrusting coralline community in all areas, Balanophyllia was found below

66 m (220 ft) in densities of 2 to 100 individuals per square meter. Balanophyllia occurred in two colorations, orange and yellow, in intermixed populations. The cups reached a maximum height of approximately 3 cm and width of about 3.5 cm.

The most common colonial stony coral was Coenocyathus bowersi which occurred on boulder and rock substrates, primarily on vertical cliff faces and ledge overhangs in all areas except area G. The coloration varied from pale orange and pink to nearly white with heads ranging from 45 cm diameter to single polyps. Where it occurred, Coenocyathus rarely exceeded 1% coverage and could not be considered very common. Coenocyathus reached its shallowest depth, 42 m (140 ft) on area E, not occurring shallower than 54 m (180 ft) in the other areas. It reached its deepest extent, 96 m (320 ft), on area C, not occurring deeper than 75 m (250 ft) in other areas.

The remaining species of stony coral were rare in the study area. The red-orange cup coral Astrangia lajollaensis, was fairly common at 27 m (90 ft) in area B and was occasionally reported from area A at 65 m (215 ft) areas C and F at 102 m (310-340'). Dendrophyllia oldroydi, a brown branching coral, was observed between 65 m (215 ft) and 72 m (240 ft) in areas A and F. It has previously been observed by GOI in canyons below 200 m south of Bishop Rock, and is common off Mexico.

4.3.3 Fan Corals - A remarkably diverse assemblage of seventeen species of the subclass Gorgonacea was observed in the study area. Each species tended to occur alone, with the exception of Heterogorgia papillosa which was frequently associated with both Plumarella longispina and Swiftia kofoidi. Though Eugorgia rubens occasionally occurred with Allopora californica, Eugorgia tended to replace Allopora in sandier areas. The distributions of the fan corals may be considered good indicators of faunal transition zones because of their widespread nonoverlapping populations.

Eugorgia rubens occurred from 30 m (100 ft) to 87 m (290 ft) in all hard substrate communities, with the exception of subcommunities with Laminaria, Allopora, Plumarella, and Florometra. The reddish purple fans reached a maximum height of 35 cm and breadth of 60 cm. Maximum densities in the Agarum/Laminaria community of $2-4/m^2$ were reached in depths of 51 m (170 ft) to 60 m (200 ft) on boulder substrate (Appendix F-10).

Eugorgia rubens occurred with Allopora only in localized areas lacking Laminaria. The density of Eugorgia rubens increased to $3-10/m^2$ on boulders and rocky substrate in the Agarum and encrusting coralline communities in those areas where both Plumarella and Florometra were absent. Eugorgia rubens was seen growing on sand presumably from underlying rocky substrate in some areas in densities as high as $3/m^2$. No evidence of deterioration of these fans was observed. It appears that this species thrives in areas of sand transport from which other corals such as Allopora and Plumarella have been eliminated.

Eugorgia sp. D. (Harden, 1979), was observed in areas A, B, E and F on large boulders and cliff faces 51 m (170') to 87 (290') depth. This tall, slender branched, purple, white polyped, bush coral reaches heights of 90 cm and breadths of 120 cm. These corals were only reported to be common in area A at 57 m.

Lophogorgia chilensis was sighted on boulders in areas A, B and E in 26 m (85') to 63 m (210') depth in Eisenia, Laminaria and Agarum communities. These colonies reached a maximum height of 75 cm and width of 60 cm in area B at 63 m. Two colonies 30-45 cm tall were seen on boulders at 72 to 77 m in area E. In addition, several small red, pink, or orange gorgoniid corals less than 7 cm in height were seen once or twice below 60 m (200 ft) in areas A, C, E, F and G in the encrusting coralline community on boulders and rock substrate.

In the Eisenia/Calliarthron community of areas A and B at depths of 29 m (95 ft) to 45 m (150 ft) were several white whip corals, which are externally similar to Lophogorgia alba. However, Lophogorgia alba has not previously been reported further north than central Baja California, Mexico, and it is possible that these white corals represent albino forms of Lophogorgia chilensis.

Lophogorgia sp. D (Harden, 1979), was reported on rocks in area A at 69 m (230 ft) and in area E at 84 m (280 ft). This large tan bush coral is rare throughout its known range.

Heterogorgia papillosa was primarily found in the deeper encrusting coralline community on boulders and cobbles in areas A, B and E from 54 to 84 m, area C from 78 to 93 m, and area F from 72 to 141 m depth (Appendix F-12). This sparsely branched yellow to orangish yellow gorgonian reached a maximum height of 15 cm in the deepest samples, and rarely exceeded 7 cm in depths shallower than 117 m. This species was recorded in five instances from 51 to 66 m in the Laminaria/Agarum community where it was nearly obscured by the algae.

Heterogorgia tortuosa was only sighted once in each of three areas. This tangled pinkish-white gorgoniid occured at 72 m in areas A and E and at 141 m in area F.

Swiftia kofoidi was an occasional in area A from 51 to 54 m in the Eugorgia rubens subcommunity (Laminaria/Agarum community). It reached maximum densities of $2/m^2$ in the encrusting coralline community at depths of 57 to 84 m in area A and area E. This shaggy pinkish-tan gorgoniid reached a maximum height of 30 cm in the deeper range on area A.

Plumarella longispina occurred in all areas on boulder and rock substrate in the encrusting coralline community. This delicate white fan reached a maximum density of $4/m^2$ (5% coverage) with a maximum height of 27 cm and width of 36 cm. It ranged in depth (Appendix F-21) in area A from 54 to 96 m, area B from 81 to 87 m, area C from 79 to 99 m, area E from 75 to 84 m and area F from 66 to 141 m. A single sighting was made in area G at 118 m depth. One colony was reported on cobbles at 84 m in area F. Three colonies were seen associated with Agarum between 54 and 63 m depth in areas A and B.

Placogorgia ramosa was found on the tops of cliffs, in area A at depths of 48 to 72 m primarily in the encrusting coralline and Agarum/Laminaria communities. The maximum density observed was one colony every two meters at 65 m depth. The largest colony was 30 cm tall and 36 cm across.

An unidentified gorgonian (possibly Thesea or Swiftia) of a peanut butter orange color was seen on boulders in areas C, E and F in depths of 59 to 90 m depth. It had loose dichotomous branching with large flattened calyces that were irregularly distributed along the stems and was easily differentiated from other species in the study area.

One observation of the orange-red plexaurid Adelogorgia phyllosclera was made in area A at 72 m depth. The colony was 30 cm tall, 24 cm wide and had white polyps.

Muricea fruticosa (=Muricea plantaginea, Harden, 1979) was seen on boulders at 25 m in area B in the Eisenia/Calliarthron community, at 90 m in area C in the encrusting coralline community, and at a maximum density of about $1/m^2$ on a rock wall at 39 m in area A in the Agarum/Laminaria community.

Thesea variabilis was seen on rocks and boulders in areas A and B in depths of 63 to 86 m in the encrusting coralline and Agarum/Laminaria communities.

An unnamed rarely branched white species of Thesea (probably the same coral misidentified as Swiftia casta, Nutting 1910) was observed 84 m on silty sand in area F. Although the juvenile colony probably attaches to hard substrate, the colonies observed in this study and off Los Coronados Island at 300 m were lying on silty sediment, apparently unattached, or attached to small pebbles.

A small (less than 5 cm tall) unbranched coral arising from a spreading base was rarely observed in the Agarum/Laminaria community in area B at 45 m depth, and in the encrusting coralline community in areas A, B and F at 65 to 69 m depth. Similar specimens collected from Santa Rosa Ridge have been tentatively assigned to the genus Anthothela (Dr. Eric Hochberg, Santa Barbara Mus. Nat. Hist., personal comm.).

Two sea fans, Plumarella longispina and Swiftia kofoidi represent range extensions of northern populations. Plumarella longispina has been collected from over 400 m depth off northern California, and between 108 to 162 m depth off Santa Barbara. The increasingly shallow distribution in the southern limit of its distribution reaches an extreme of 54 to 118 m depth in the study area. It is possible that this is due to the presence of cold water upwelling locally on the Banks.

Swiftia kofoidi which has been collected from 360 to 2,000 m depth as far south as San Mateo Co., Calif., reaches its shallowest depth, (51 to 84 m) and most southern extreme in the study area.

Four sea fans Adelogorgia phyllosclera, Eugorgia sp. D, Heterogorgia tortuosa and Thesea sp. have been reported from Scripps Canyon southward, occurring at similar depths in Scripps Cannyon and in the study area. Placogorgia ramosa has been reported at 136 m depth off Oceanside, and to 315 m depth in the Magellan Strait off the tip of South America. In this study, Placogorgia ramosa occurred considerably shallower at 52 m depth.

The remaining sea fans have been reported from the Channel Islands at similar depths. The depth ranges of Muricea fruticosa and Eugorgia rubens were not extended. Lophogorgia sp. D may be extended from 60 m to 84 m depth. Lophogorgia chilensis was extended from 54 m to 141 m, assuming the deeper records (63 to 141 m) of small pink, red and orange whips actually belong to this species. Heterogorgia papillosa was extended from 90 m to 141 m. Thesea variabilis was extended from 54 to 87 m depth.

4.4 FISH

The fish fauna observed at Tanner and Cortes Banks was abundant and diverse around rock outcrops, with 82 species recorded. Rockfish (family Scorpaenidae) were dominant in terms of number of species, (29), and sometimes biomass, as well. Surfperch (family Embiotocidae) diversity was second highest with nine species, although their biomass was probably negigible. Fishing with rockfish jigs yielded specimens of many of the fishes observed underwater, which aided in verifying identifications (Table II-10). Some specimens were identified from photographic slides by Jack Word (SCCWRP; observer-consultant for the surveys) and Dr. Richard Rosenblatt (Scripps Institution of Oceanography).

Due to their mobility, fishes tend to have broad vertical distributions. As such, the depth range of a given fish may span two or more contiguous rock substrate communities, with depth changes only slightly affecting fish species composition. Virtually all fishes observed were associated directly or indirectly with the sea floor, indicating associations with one or more benthic communities. Only four truly pelagic species were seen: jack mackerel (Trachurus symmetricus; seen in schools of up to several thousand fish), Pacific mackerel (Scomber japonicus), yellowtail, (Seriola dorsalis), and blue shark (Prionace glauca).

Above 91 m (300 ft) the fish species present in rock substrate communities usually appeared at characteristic distances (zones) off the bottom. Distance off bottom was based on feeding habits, size/year class, and degree of schooling/aggregative behavior. Three general overlapping zones comprised this layer, which extended as much as ten meters (33 ft.) off the bottom. These zones represent recurring trends observed in fish associations and distributions, but require additional study for complete characterization and boundary definitions. Vertical positioning must be considered in light of diurnal activity cycles, as several species observed at Tanner and Cortes show considerable vertical migration in kelp forests (Ebeling and Bray, 1976).

The lower zone (from 0 to 2 meters off the bottom) contained the demersal fishes, which alternate sitting on the bottom with short spurts of swimming. The ubiquitous blackeye goby, Coryphopterus nicholsi, was found here, along with schools of very young rockfish. Adult Sebastomus individuals occupied this zone regularly. Other rockfish observed here included Sebastes constellatus, (Appendix F, Figure F-23) S. rosaceus, (Appendix F, Figure F-28) and S. elongatus. These species feed largely by remaining motionless and ambushing live prey ("sit and wait" predators). Depth changes appeared to have little effect on species composition, although S. elongatus was not seen above approximately 60 m (200 ft.). Abundance of rockfish decreased somewhat in shallower waters.

The middle zone (from 2 to 5 meters off the bottom) is characterized by fishes with strong schooling behavior. The species present feed primarily on plankton suspended in the water column, spending little or no time close to the bottom. The senorita, Oxyjulis californica (Appendix Figure F, F-17),

Table II-10. SPECIES LIST OF FISH TAKEN USING ROD AND REEL DURING TANNER AND CORTES BANKS SURVEY

SPECIES	AREA							TANNER, UNSPECIFIED	CORTES, UNSPECIFIED	SAN CLEMENTE ISLAND
	A	B	C	D	E	F	G			
Caulolatilus princeps*	●					●			●	
Citharichthys sordidus					●					
Citharichthys sp.						●				
Decapterus hypodus										●
Lepidopsetta bilineata						●				
Medialuna californiensis										●
Pimelometopon pulchrum									●	
Scomber japonicus						●				
Scorpaena guttata	●				●				●	
Scorpaenichthys marmoratus	●									
Sebastes caurinus			●					●		
S. chlorostictus					●					
S. chlorostictus/rosenblatti	●		●		●	●		●	●	
S. constellatus*			●			●		●		
S. elongatus								●		
S. entomelas					●	●				
S. hopkinsi					●					
S. levis					●					
S. macdonaldi	●								●	
S. mystinus*	●		●		●	●			●	
S. ovalis									●	
S. paucispinis*	●		●		●	●		●	●	
S. rosaceus*	●		●		●	●		●	●	
S. serranoides*			●		●	●		●	●	
S. serriceps					●					
S. umbrosus					●			●		
Sebastomus spp.					●	●				
Squalis acanthias									●	

* CAUGHT ON FIVE OR MORE SEPARATE OCCASIONS

characterized this zone down to about 90 m (300 ft). Above 45 m (150 ft), the blacksmith, (Chromis punctipinnis), occured in schools of 20 to 50 individuals. Chromis was generally situated higher in the water column than the senorita, but intermixing was regularly seen. Sebastes hopkinsi (Appendix F, Figures F-24, F-25, F-26), the only rockfish observed with persistant schooling behavior, was most often seen in the middle zone, at depths exceeding 30 m (100 ft). Squarespot schools showed no consistent patterns in relative position within this zone, in contrast to schools of the other two species.

The upper zone (from 5 to 10 meters off the bottom), the most diffuse of the three, has a variety of larger fishes (more than 25 cm long), and considerable change in composition with depth. The primary feeding mode is omnivory by active foraging and pursuit of prey. This behavior is seen in the water column by olive rockfish (Sebastes serranoides) and bocaccio (S. paucispinis), while the ocean whitefish (Caulolatilus princeps) forages on or close to the bottom. Other bottom-feeders (Sebastomus Spp., Rhacochilus vacca) are occasionally seen.

Above 40 m (140 ft) Sebastes mystinus (blue rockfish) becomes the dominant water-column feeder in the upper zone, replacing the other rockfish. Sheephead (Pimelometopon pulchrum; Appendix F-20) similarly replaces ocean whitefish as the common benthic forager. Despite their documented feeding habits, sheephead and ocean whitefish are considered upper-zone species based on their typical positioning when observed from the submersible. Shallow water also harbored herbivores such as halfmoon (Medialuna californiensis) and blacksmith (Chromis punctipinnis). The latter species mixed more-or-less freely between the middle and upper zones.

Pronounced shifts in species composition, and the absence of fish layering, were observed in the encrusting coralline community (from 75 to 150 m). Sculpins (family Cottidae), ratfish (Hydrolagus collei), and combfishes (Zaniolepis sp.) were commonly seen, along with Sebastes elongatus and S. macdonaldi. A variety of rockfishes were occasionally or rarely observed, including Sebastes nigrocinctus and S. ruberrimus.

In summary, stratification of fish species was observed in several communities above 90 m (300 feet). The trophic level represented by each of three general zones was essentially constant with depth, although some species were not found throughout the entire depth range. Species diversity appeared to be higher above 45 m (150 feet) especially in the uppermost layer.

Fishing from the SEAMARK was done with rockfish jigs, using cut-up fish for bait. The jigs were dropped to the seafloor and then played up and down until a strike was made. Fishing periods varied in duration, time of day, cloud cover and number of fishermen. Fishing was done after dark as well as in daylight, but the data are insufficient to determine diel variation in catch size or composition. Twenty-seven species were taken on the Banks (Table II-10). 67% and 83% of the species caught during submersible operations (October and November, respectively) were rockfish. Specimens obtained were used to verify identifications and as indicators of fish species likely to be observed during the transect dives.

Ten rockfish species were observed in at least five of the six study areas. All ten species except the flag rockfish, Sebastes rubrivinctus, were also caught by hook and line fishing. Seven species were taken on each Bank, and four of these (Sebastes constellatus, S. paucispinis, S. rosaceus, and S. serranoides) were caught on both Tanner an Cortes Banks, and during both legs of the survey. An average of six species were caught per fishing period.

Of the 27 species taken in the six areas, three rockfish species taken on Tanner Bank were not recorded in the same area by other available data sources (observer log, Benthos camera, and video). These species included copper rockfish (Sebastes caurinus), widow rockfish (S. entomelas), and honeycomb rockfish (S. umbrosus). All of these catches occurred during Submersible Operations II. Copper and honeycomb rockfish were observed in other areas on the Banks, but the widow rockfish is listed here solely on the basis of specimens taken on rod and reel.

Feeding activity of fishes noted by the observers corroborated observations made in previous studies (Quast, 1968; Bray and Ebeling, 1975; Hobson and Chess, 1976). Senorita (Oxyjulis) were seen picking particles from the water. An olive rockfish (Sebastes serranoides) was seen catching and eating a senorita (Oxyjulis californica). A blackeye goby (Coryphopterus) was observed avoiding a Sebastomus which swam just off the bottom and made two rapid dives toward the goby. A head-on encounter between a bocaccio (S. paucispinis) and a smaller squarespot (S. hopkinsi) resulted in the latter being swallowed whole headfirst. The latter two events were videotaped for documentation. Finally, a cowcod (S. levis) was observed diving repeatedly into sand, a behavior recorded for sheephead (Pimelometopon) and other wrasses, but no prey was seen.

4.5 FISH DISTRIBUTION

Figure II-21 is an example from Area E Tanner Bank, of the fish distribution maps that accompany this report. Substrate and depth were the primary factors determining fish distributions. Overall, the maps of the dominant fish populations were less differentiated than those for benthic communities. This is due to the higher diversity of common benthic organisms, the high mobility and broad depth ranges of most fish, and the low number of fish species whose distributions can be effectively mapped on a large scale. Senorita (Oxyjulis californica), squarespot rockfish (Sebastes hopkinsi), and all other rockfishes combined less Sebastes levis and S. chlorostictus (referred to as Sebastes spp.) comprise the three groups mapped. Density-depth plots for these three categories are presented in Appendix F.

A great deal of overlap exists between the density depth plots for these groups in each area, and the distributions of the deeper-ranging species encompass those of the shallower species. Rather than mapping each species/group separately, the data are plotted as three assemblages. In order of increasing depth, these assemblages are: Sebastes spp. - S. hopkinsi - Oxyjulis, Sebastes spp. - S. hopkinsi, and Sebastes spp. alone. The boundary of each category thus represents the lower limit of the shallowest component of that group. Geomorphology and depth,and to a lesser degree exposure, were considered to determine boundaries.

Santa Rosa Ridge (Area G) shows no trends in distribution or density, due to the limited coverage. The other five areas of Tanner and Cortes Banks exhibit gradients along the northwest-southeast axis produced by the combined effects

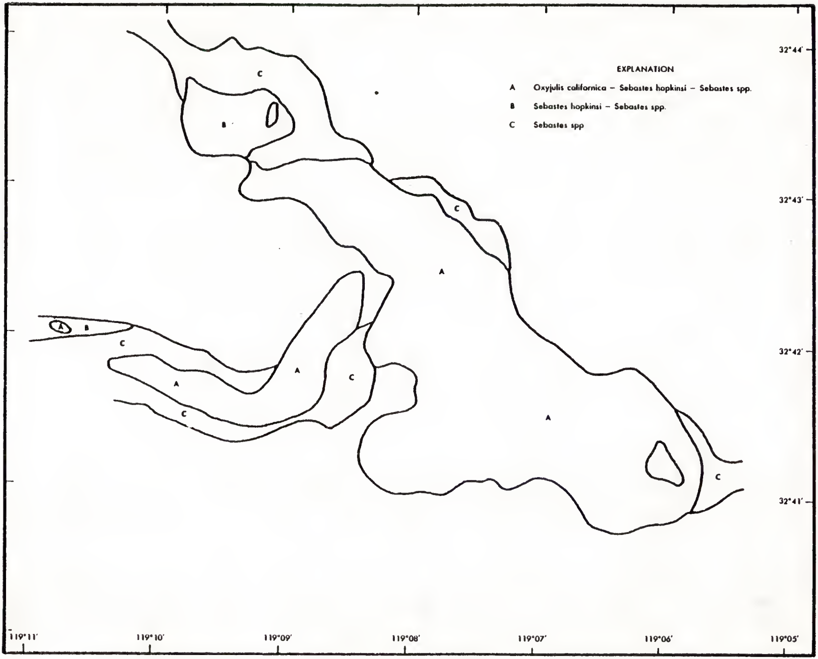

Figure II-21. Fish Distribution Tanner Bank Area E of substrate, depth, and exposure. Most apparent of these gradients are those for senorita distribution and (in some areas) abundance. Distributional gradients may be artifacts insofar as the northwest-facing slopes were studied most intensively.

Time of day must be accounted for when mapping fish populations, as many species show marked diel changes in distribution and abundance. For example, senorita have strict diurnal activity patterns, retreating into holes or even burrowing at sundown (Ebeling and Bray, 1976; Hobson and Chess, 1976). Survey times in areas A through F spanned the daylight hours, to detect any diurnal variations present. Typically, senorita emerge between 0900 - 1000 and begin feeding in the water column. Feeding activity decreases in the afternoon (Bray and Ebeling, 1975), and the fish disappear completely at roughly 1800 hours, depending on cloud cover and sea conditions. Transect dives made about the same time on different days in a given area showed excellent consistency in abundance changes. During three evening dives at Bishop Rock (Area A) the senorita disappeared between 1820 and 1830 hours.

In all cases, species distributions were associated with some type of hard substrate, with deeper-ranging species occurring over a wider range of substrate types--i.e., grading down into boulders, cobbles and pebbles on sand. Localized concentrations of fish were seen in several areas along interfaces, either rock-sand, or sedimentary-igneous rock as at North Tanner Bank (Area F).

At Bishop Rock (Area A, Plate 6 Map 1) the substrate is primarily igneous rock, grading through boulders and cobble and pebble beds to open sand. All three species occurred over every type of hard substrate, so the boundaries are based largely on depth. This area exemplifies the northwest-southeast gradients observed for senorita and rockfish. Maximum density for senorita was recorded from the southeast end of the bank, while Sebastes spp. were most abundant at the northwest end. Squarespot abundance peaks lie between these two points on the northwest-facing slope of the bank. Senorita were the dominant fish, with well over 1,000 individuals seen in a single school. Squarespots attained numbers of 400 to 600 per observation. Other rockfish species were scattered and in low numbers throughout the area.

At Nine-Fathom Reef (Area B, Plate 6 Map 2), the distributions of squarespot rockfish and senorita were virtually identical. As such, no "intermediate" (Sebastes spp. and S. hopkinsi, less Oxyjulis) areas were found. Maximum density of senorita occurs at the central peak and decreases with increasing depth. A northwest-southeast gradient is present insofar as the northwest corner lacks senorita, and the peak abundance is southeast of this zone. Schools of 1,000 to 2,000 senorita were recorded periodically, with pulses to 5,000 fish per observation. Squarespot abundance occasionally reached 200 to 250 per observation. Squarespot concentrations occurred within the senorita range but east and west of the senorita peak, rather than to the northwest. Other rockfish were patchy and in low numbers.

North Cortes Bank (Area C, Plate 6 Map 3) consists of a cluster of five rises of igneous rock, and is relatively deep. Senorita occur in very low densities in an arc spanning the three northern rises, and show a relative maximum to the southeast. The bridges between these three rises consist of igneous rock and are within the observed depth range of senorita. In contrast, the bridges between northern and southern areas are approximately at the lower depth limit for senorita, and consist of sand and gravel with some cobbles and pebbles.

Squarespot rockfish occur throughout North Cortes, and are most widespread and abundant along the northwest-facing side. They are more closely correlated with rock and boulders than are senorita. Other rockfish extend into cobble and pebble beds, and are persistently patchy.

Central Tanner Bank (Area E, Plate 6 Map 5) has sedimentary rock mixed in with the igneous formations. Senorita are primarily associated with igneous rock, as on Cortes Bank, and are aligned along the northwest-southeast axis. Up to 100 Squarespot rockfish per minute interval occur northwest of the senorita. Sebastes spp. are found throughout this area, somewhat patchy and locally abundant. Squarespots occur over sedimentary and igneous rock, while Sebastes spp. is found on sand as well.

North Tanner Bank (Area F, Plate 6 Map 6) is similar to North Cortes in that it is relatively deep and senorita are scarce. Senorita occur between 50 and 80 meters (mainly from 60 to 70 meters), which is well within the extent of the igneous rock. Squarespots are widespread over sedimentary and igneous rock, with abundances of 60 to 70 individuals. Sebastes spp. extends at least to 120 m, but appears to be most abundant around 60 m. Rock occupies only the southeast quarter of this area, so the gradient seen in other areas is not so apparent here. Although senorita abundance may increase to the southeast, squarespot rockfish dominate the rocky areas of the region surveyed. The senorita contour is not shown as continuous along the slope of the bank due to scarcity of data, the narrow depth band, and comparison with the other areas.

Santa Rosa Ridge (Area G) lies below the observed depth limit for senorita. However, both Sebastes hopkinsi and Sebastes spp. are present, although patchy and in low numbers. Due to scarcity of data for this area extrapolation is very difficult so conservative limits of rockfish distribution were drawn.

Situated at the edge of the continental shelf, Tanner and Cortes Banks lie along an interface between open-ocean currents and the Southern California Gyre. Deep-water mixing and variable relief may combine to produce upwelling currents, and surge as deep as 109 m. These conditions are significant, as turbulence sweeping irregular bottom features appears to create important feeding regions for fishes (Quast, 1968). Food items can be deposited, concentrated, or even sorted by such a process.

Uneven topography and substrate heterogeneity work to create pronounced habitat diversity in benthic populations, as well. Fish in turn are attracted by high productivity and abundance of potential food items.

Senorita (Oxyjulis californica) were recorded down to 100 m (330 ft), considerably deeper than the limit of 54 m (180 ft.) given in Miller and Lea (1972). The increased water clarity may help to account for this depth extension, as senorita feed on zooplankton and epiphytic animals. Increased light transmission facilitates algal growth at greater depths, providing substrate for epiphytes, and causes zooplankton to migrate deeper in the daytime, due to negative phototaxis. Macroalgae are largely confined to boulder and rock areas, so the strong senorita-substrate correlation observed would be expected. Also, senorita retreat into holes and crevices during the night.

Exposure appears to have some effect on senorita density as Bishop Rock (Area A) shows maximum abundance of Oxyjulis downcurrent at the southeastern end of the bank. Senorita distribution is primarily associated with hard substrate to the lower depth limit of its (local) distribution.

Young senorita rely on plankton-laden currents for food and so are commonly found in unprotected areas. Even so, the effects of exposure and substrate may be hard to distinguish. Exposed areas often show sediment deposits, possibly obscuring whether senoritas are absent from an area because of severe current action, or because of the soft substrate.

Cortes Bank (Areas A, B, and C) provides the most usable senorita density data. Oxyjulis abundance peaks are evident only at Bishop Rock and Nine-Fathom Reef. In both cases, depth is the determining factor, as both maxima occur at or near the shallowest point in their areas. As with Bishop Rock, exposure appears to produce a relative abundance peak in southeastern North Cortes Bank. However densities are much lower at North Cortes, as the senorita present constitute a marginal population near the lower distributional limit.

Sebastes hopkinsi distribution and density patterns shows even less individual effects of substrate, depth, and exposure. The straightforward topography of Nine-Fathom Reef indicates that exposure has no large effect on squarespot distribution. Areas A, C and E are relatively complex to analyze in this fashion. North Tanner Bank (Area F), however, exhibits very sharp substrate changes. Accordingly, substrate determines both distribution and density to a large degree. Squarespot density peaks show greater affinity to Sebastes spp. peaks than to those for senorita.

Squarespot rockfish (Sebastes hopkinsi) like senorita, are microcarnivores which feed in the water column. Squarespots are less dependent than senorita on hard substrate for refuge or attachment sites for prey, and correspondingly range into areas of cobbles and pebbles. Their reported depth range (18 to 180 m) extends beyond the scope of this survey, as their distribution was limited only by soft substrate. Overall abundance is associated with exposed northwest-facing slopes.

The other species of rockfish recorded are too scarce to plot individually. Nevertheless, the very broad distribution indicated by the extent of "Sebastes spp." on the maps is not necessarily artificial, as four rockfish were recorded from all six areas surveyed, and many range over 330 m (1000 ft) depth.

It should be noted that sightings of squarespot rockfish (especially in schools) may encompass any of several similar species, as well. Speckled rockfish (Sebastes ovalis), widow rockfish (S. entomelas), and juvenile bocaccio (S. paucispinis) were all positively identified during survey operations. Intermixing of schools created some taxonomic uncertainty, but proportions of these other species appeared to be quite low overall.

Sebastes hopkinsi, and juvenile Sebastomus, were frequently seen in loosely aggregated schools numbering several hundred. The vast majority of rockfish however do not school and are generally territorial and sedentary. However, multispecies aggregations of 25 to 75 rockfish, 0.6-1 m long, occasionally were seen in areas bounded by rock walls, and along rock faces. Some of the fishes in these assemblages retreated into crevices or under ledges when approached and re-emerged later.

Perhaps the outstanding feature of the fish fauna of the banks is the diversity and abundance of the species of Sebastes. Some 29 species were observed, which is almost half the species known for California and represents almost all the species which might be expected at that latitude in the habitats represented. Although the species of Sebastes are important as commercial and sport fishes, the bank populations have been little exploited.

One-third of all fish species recorded from Tanner and Cortes Banks are rockfishes, with all but one of those in the genus Sebastes. Six rockfish species (one-fifth of the scorpaenids recorded) were sighted in all six areas surveyed, and four more species occurred in five of the six areas. Three of the latter were absent only from the deepest area surveyed, Santa Rosa Ridge (Area G). Of all other fish species recorded only the ratfish, Hydrolagus collei, and the blackeye goby, Coryphopterus nicholsi, were observed throughout the entire survey area.

Depth extensions were noted for several species, including Oxyjulis californica, Sebastes macdonaldi (upper limit), Coryphopterus nicholsi, and Rhacochilus (=Damalichthys) vacca. The latter two species were also seen and photographed with previously unrecorded coloration or markings. A chrome-yellow color morph of Coryphopterus was observed, while specimens of R. vacca were seen with two to four black bars on the sides, in contrast to the usual single bar.

Yellow coloration in C. nicholsi has not been previously recorded, although the species ranges from Baja California to British Columbia and has often been observed and collected throughout its range. The yellow color morph may be an undescribed species of Coryphopterus, but this cannot be determined without specimens. It is also possible that the yellow morph will be found on other offshore banks; however, it is presently known only from Cortes and Tanner Banks.

Coryphopterus showed a general correlation between color and substrate, with most yellow specimens found on rocks and most white forms found in sand. These associations suggest markedly different adaptations, as the yellow color morph is highly conspicuous, especially on rock substrates, while the white morph is cryptically colored against the sand.

Most of the fish species which might have been expected to occur at the Banks but which were not observed are small and cryptically colored, and thus difficult to observe from a submersible. Many cottids, clinids and eel-blennies are in this category. One goby genus that probably would have been seen if present is Lythrypnus. A few other species that were expected but were not seen included: the California moray (Gymnothorax mordax), sargo (Anisotremus davidsoni), and black croaker (Cheilotrema saturnum).

Two species which are abundant along the mainland and the Channel Islands are represented in the survey by single sightings. These are kelp bass (Paralabrax clathratus), an important component of the California sport fishery, and garibaldi (Hypsypops rubicundus). The habitat at the banks appears to be appropriate for both species. Their absence is probably attributable to lack of suitable habitat for juveniles. Juvenile garibaldi settle in shallow water (about 3 m) and move down as they grow and mature. Similarly, juvenile kelp bass are abundant in bays and in shallow water kelp beds. The lack of exposed land masses and very shallow habitat probably prevents settlement of such species at Cortes and Tanner Banks.

Surfperches (family Embiotocidae) were more abundant than garibaldi and kelp bass, but were still much less common than in coastal areas, due in part to the same habitat restriction. However, surfperches are strongly associated with the giant kelp Macrocystis, which is absent from the Banks and has no counterpart there. Furthermore, the live birth phenomenon characteristic of embiotocids greatly reduces dispersal to isolated areas. These additional factors (and possibly others) probably produce much lower relative abundances of surfperches at the Banks.

Overall, the fish fauna showed a very strong positive correlation with hard substrates but no specific community associations. Rock outcrops create ecotones (interfaces between two different habitats, characterized by relatively high diversity and/or productivity), benefit water-column feeders by altering circulation patterns, create refuges for both predators and their prey, and provide nursery areas for larval and juvenile fish. Extensive sand areas harbored only occasional rays (Raja sp.), flatfish and shortbelly rockfish (Sebastes jordani). Larger rockfishes, particularly Sebastes elongatus and S. chlorostictus/rosenblatti (Appendix F, Figure F-22), were seen occasionally over sand, but almost always within sight of a rocky area.

4.6 MACROALGAE - The macroalgae observed at Tanner and Cortes Banks included species of green (Chlorophyta), brown (Phaeophyta), and red (Rhodophyta) algae; a species list is provided in Appendix H. Density-depth plots for Agarum, Bossiella, Calliarthron, Eisenia, encrusting corallines Gelidium, Laminaria and Maripelta are presented in (Appendix F, Figures F-1, F-6, F-7, F-8, F-9, F-11, F-13, and F-15) respectively. Because specimens were not collected during the survey, field identifications by biological observers were usually limited to large and distinctive taxa. Identification of some specimens from benthos camera and observer photographic slides was provided by Robert Setzer (Allan Hancock Foundation, University of Southern California), and Dr. Mark Littler (University of California, Irvine).

Algae that were categorized as community dominants and subdominants include the red algae Calliarthron, Gelidium, and encrusting corallines, and the brown algae Agarum fimbriatum, Eisenia arborea, Laminaria farlowii, and Zonaria farlowii.

Most species of algae observed are characteristic of exposed, open coasts and are adapted to the high energy conditions occurring on the Banks by having strong holdfasts and heavy, erect stipes. Species in this category observed during the present and earlier surveys include Calliarthron, Bossiella, Cystoseira, Eisenia, Laminaria, Agarum, and Pterygophora (Lewbel et al., 1978, Ecomar 1978, Smith et al., 1978, Chan and Smith 1976). It is likely that the rarity of the kelp Macrocystis on the Banks is also related to the heavy surge and swell conditions characteristic of the area. The record of Macrocystis pyrifera from Area A is based on a single observation and otherwise was not observed during the present survey except as surface or bottom drift algae.

The excellent water clarity affects both the species composition and the apparently large depth range observed for many species. Horizontal visibility was high but variable, and was estimated by biological observers to be in excess of 60 meters on some submersible dives. The general water clarity of the Tanner and Cortes area can be inferred from observations made of encrusting coralline algae growing at depths exceeding 122 m (400 ft), indicating a very deep euphotic zone relative to more shoreward areas. A comparison of the depth ranges for some algae observed during the present survey and records of the species occurrence in other areas is presented in Table II-11. Particularly noteworthy are the depths observed for Codium (91 meters), Gelidium (61 meters), Laminaria (131 meters), Eisenia (79 meters), Agarum (82 meters), Zonaria (91 meters), Maripelta (112 meters) and Botryocladia (105 meters). It should be noted that the records for these species at Tanner and Cortes do not represent isolated observations but frequent occurrences at these depths. Since there is generally a strong association between the occurrence of algae and the distribution of some invertebrates and fish, increased depth ranges for algae should similarly affect the depth ranges of the animals. Depth range extensions for invertebrates and fish observed during the survey are listed in Table II-11.

Several studies including the present one describe the biological communities at Tanner and Cortes Banks as "rich" "diverse", and "abundant" (Chan and Smith 1976, Ecomar, 1978). Because of the possibility of nutrient upwelling near the Banks (Section 3.2), the abundance of fish and invertebrates may be correlated with enhanced primary production by algae, however comparative data for Tanner and Cortes Banks, the Channel Islands, and the Southern California mainland need to be collected.

The zonation of algae on the Banks was pronounced and was related to both depth and substrate. Shallow rock substrate from 9 to 40 meters is characterized by the erect coralline alga Calliarthron and isolated stands of the palm kelp Eisenia arborea. Below 40 meters Laminaria farlowii and Agarum fimbriatum are the community dominants although Calliarthron and Eisenia are still present. Within the Laminaria/Agarum Community several genera of low growing red and brown algae occur including Cystoseira, Dictyopteris, Dictyota/Pachydictyon, Pterygophora, Zonaria, Gelidium, foliose reds, "Opuntiella", and dicho-flabellate reds such as Rhodymenia, "Callophyllis", "Stenogramme", and "Fryeella". Gelidium "nudifrons" and Zonaria farlowii occurred in some areas in densities up to 80% cover and on this basis were classified as sub-dominants in the community. Below 58 meters depth the density of Agarum and Laminaria increased, and the density and frequency of understory algae decreased with the exception of Zonaria which still occurred in densities up to 30% cover. With the decrease in density of large brown and red algae, lower growing species of red algae became more evident. These include encrusting corallines, "Bossiella", "Iridaea", dicho-flabellate reds (Appendix H), Botryocladia, and Maripelta. The apparent increase in percent cover of encrusting corallines from 60 to below 90 meters is due in part to the obscuring effect of erect algae in shallow depths. When this observational bias is considered the encrusting corallines are seen to be present and often extensive in all the hard-substrate communities examined. From 60 to 90 meters depth encrusting corallines are the algal community dominants. Also occurring in this zone are various algae of the "Cryptopleura" type (Rhodophyta) and undetermined dark to light-green crusts. Foliose and

TABLE II-11. OMPARISON OF DEPTH RANGES OF COMMON SPECIES OCCURRING AT TANNER AND CORTES WITH OTHER AREAS OF THE SOUTHERN CALIFORNIA BIGHT (Depth in Meters)

Fish[†]	Reference	Tanner-Cortes	Coastal*	Lasuen Bank*	Santa Barbara Oil Tower*	Pipe*
Oxyjulis californica	0-55	14-101	0-23	N.O.	3-18	N.O
Pimelometopon pulchrum	0-55	14-88	2-27	"	N.O.	"
Sebastes chlorostictus/ rosenblatti	49-200**	87-123	53-183	"	"	"
S. constellatus	24-274	28-146	to 120	"	"	"
S. hopkinsi	18-180	15-115	0-66	"	"	"
S. rosaceus	15-128	18-143	to 23	110	"	"
Algae[††]						
Agarum fimbriatum	115+***	15-85	--	--	--	--
Calliarthron cheilosporides	I-S	14-90	I-14	--	--	--
Eisenia arborea	I-10	14-82	I-25	--	--	--
Gelidium spp.	S-30	14-60	I-30	--	--	--
Laminaria spp.	S-50	14-85	I-25	--	--	--
Maripelta rotata	S-30	52-90	S-30	--	--	--
Zonaria farlowii	I-20	--	I-20	--	--	--
Encrusting corallines	(I-10)	14-136	I-125	--	--	--
Invertebrates:						
Allopora californica	--	18-112	N.O.	N.O.	N.O.	N.O.
Eugorgia	--	28-96	6-61	N.O.	31	N.O.
Heterogorgia	--	43-87	N.O.	110	N.O.	N.O.
Plumarella	--	37-143	N.O.	N.O.	N.O.	N.O.
Balanophyllia	--	16-131	I-S	N.O.	N.O.	N.O.
Paracyathus	--	15-112	12-37	110	31	N.O.
Mediaster aequalis	--	20-134	15-200	N.O.	N.O.	50-100
Patiria miniata	--	14-90	I-64	N.O.	0.31	10-30

* J. Word, M. Moore, L. Harris, unpublished review
† Miller and Lea, 1972
** Range listed is for S. chlorostictus
†† Abbott and Hollenberg, 1976
*** Depth of occurrence at Channel Islands
I = Intertidal
S = Subtidal

flabellate reds are rare in this zone (less than $1/m^2$), although at times certain highly visible iridescent species such as Maripelta appeared to be more common than less distinct species, particularly in the Benthos camera record.

4.7 OTHER SELECTED SPECIES

4.7.1 Annelida

The only annelid worms seen were Protula superba, serpulid and sabellid worm tubes and a few nereids. Protula superba was common in the encrusting coralline community from 57 to 123 m depth in areas C and F, although it also occurred in the other areas.

4.7.2 Brachiopoda

Two brachiopods, Laqueus calfornica and Terebratalia transversa were seen in densities up to $9/m^2$ in the encrusting coralline community below 78 m depth.

4.7.3 Bryozoa (Ectoprocta)

The common types of bryozoans on the Banks were erect branching or foliose forms, but some of the encrusting species seen (Membranipora) frequently covered extensive areas on the blades of macroalgae. The erect species usually formed small heads, two to six inches in diameter, although heads of Diaperoecia, were often 1 m in diameter. All species observed are listed in the comprehensive species list (Appendix H). The distribution of some bryozoans and macroalgae (particularly browns) appeared to be strongly associated. Aetea was prominent on dense beds of Gelidium, while Membranipora encrusted the larger brown algae, mainly Eisenia. Lichenopora/Disporella occurred only in the shallowest areas. Head-forming species (Diaperoecia, Phidolopora, Hippodiplosia, et al.) also occurred in shallow water, with density peaks roughly near the transition of the Eisenia/Calliarthron-Agarum/Laminaria communities (36-42 m [120-140 ft]). Below the macrophyte zone (deeper than 60 m or 200 feet), the most commonly observed ectoproct was the "snowflake" bryozoan. This species, which could not be identified without a specimen, was also observed in the deeper Agarum/ Laminaria community.

In summary, three zones of bryozoan distribution were observed corresponding fairly well with the main algae communities:

Shallow Above 40 meters	Intermediate 40 to 60 meters	Deep Below 60 meters
Eisenia/Calliarthron Lichenopora/Disporella	Agarum/Laminaria Most Species	Encrusting coralline Snowflake bryozoan

4.7.4 Coelenterata

Several species of non-coral coelenterates were found in the study area. Two hydroids (Aglaophenia and Abietinaria) and one anemone (Stomphia venosa) reached sufficient densities to be considered significant community components. Five anemones (Corynactis californica, Stomphia coccinea, Tealia columbiana, Tealia piscivera, and Metridium senile) and two sea pens (Ptilosarcus gurneyi and Stylatula) were common in certain areas. Also seen were several zoanthids including Parazoanthus lucificum (area A, 39-58 m), several small anemones including three unidentified forms of Tealia (area A, 18 m; area B, 24-36 m; area E, 39-40 m), and several scyphozoans (jelly-fish).

The hydroids Abietinaria (probably A. pacifica) and Aglaophenia were fairly common on rocky substrates in the encrusting coralline community of areas A,B,C,E and F at 1-3% coverage and reaching a maximum coverage of 50% in small patches from 59-92 m depth. In the Laminaria/Agarum community at 36-69 m Abietinaria was consistently reported at less than 1% coverage and Aglaophenia was considerably denser with up to 10% coverage. Abietinaria was not seen below 18 m in either the Agarum/Laminaria or the Eisenia/Calliarthron communities, whereas Aglaophenia was fairly common below 18 m, reaching 100% coverage in patches of about 50 cm^2.

Corynactis californica, a colonial anemone, was absent from many areas but attained maximum densities of 50% on mixed coral reefs occurring primarily from 63 m (210 feet) to 72 m (240 feet) on area F. Areas A,B,C and E rarely had densities over 2% on cliff ledges and pinnacles. Corynactis occurred in several color phases from pale to dark pink and red. In all cases it was found on boulder or rock substrate, except for isolated occurrences on pebbles in pebble beds from 50 m (168 ft) to 54 m (180 ft) on area A. Corynactis occurred at 56 m (185 ft) on area F with 2% coverage in patches on the rocks.

Stomphia venosa, a sea anemone with a purple or brown column, was seen in all areas and all communities from the shallowest (18 m) to the deepest (120 m) areas. It was usually found on boulders associated with sand pockets and channels. It was also seen on sand, presumably attached from subsurface rock substrate, and on pebble or cobble flats. A wide variety of oral surface and tentacle colorations were seen from pure white, through light pink and avacado green, to dark red, purple, and brown.

Stomphia coccinea was seen on boulders in the encrusting coralline community in areas C,F, and G in depths of 93 to 141 m. This distinctive orange and white mottled anemone was also seen in the Agarum community in area E at a depth of 54 m.

The anemone Tealia piscivera was seen on boulders in the Eisenia/Calliarthron community (area A and B, 30-45 m), the Zonaria subcommunity (areas A,B, and E, 32-60 m), the Agarum/Laminaria community (areas A,B,E, and F, 39-75 m), and the encrusting coralline community (area A,B,C, and F, 59-79 m).

The anemone Tealia columbiana was seen on boulders and rocks in the Eisenia/Calliarthron community (areas A and B, 18-33 m) and Agarum/Laminaria community (areas A,B and E, 43-60 m). It extended onto cobble fields in the Agarum/Laminaria community (areas A and E, 51-72 m) and pebble and sand flats in the encrusting coralline community (areas A,B, and E, 60-81 m).

The white anemone Metridium senile was infrequently sighted below 104 m in areas A, F and G.

The two sea pens, Stylatula and Ptilosarcus gurneyi were seen in the sand communities in localized patches below 60 m depth. Purple, brown, yellow and white Stylatula-like sea pens were also seen.

Most of the remaining species of coelenterates have such poorly known distributions that they could nearly all be considered range extensions. In particular, Stomphia coccinea has not previously been reported further south than the Monterey area. This supports the observation that northern species are occurring on the Banks. The anthozoan Liponema brevicornis is typically deep water and has not previously been reported as shallow as is reported in this study.

4.7.5 Crustacea

Due to their small size and cryptic or nocturnal habits, crustaceans were rarely observed during these surveys. Except for Balanus and other barnacles, all species recorded were decapods. Despite the apparently low numbers of animals and limited species list, however, decapods were widely distributed, being found in all of the six areas surveyed.

Identification of certain specimens from Benthos camera frames and hand-held camera slides was provided by Dr. Mary Wicksten (Allan Hancock Foundation, University of Southern California). The comprehensive species list (Appendix H) includes all crustaceans observed in the surveys.

All crustaceans recorded are associated with rocky areas, although several Loxorhynchus were seen and photographed on open sand. Shrimp (including Pandalus) were much more visible in the evening than during daylight hours but still did not lend themselves to calculations of density.

All crustaceans were seen in variable medium-to-high relief areas, where ledges, cracks and crevices were numerous and extensive. Crabs recorded include the genera Cancer, Mursia, Chorilia, and Loxorhynchus, as well as some galatheids. The spiny lobster Panulirus interuptus was also seen. Crustacean data were too sparse to establish community associations. Balanus tintinnabulum was recorded from a single dive on Tanner Bank.

Other barnacles may be present in the area, as the Benthos films showed patches of small raised objects, white to light orange in color. These objects were tentatively identified as acorn barnacles, but could not be verified.

It is likely that crustacean biomass is considerably larger in the Banks area than is apparent from these data. Rockfish density and biomass are both very high in this area, and decapods are preferred food items for many scorpaenids (Quast, 1968).

4.7.6 Echinodermata (sea urchins, sea cucumbers, sea lilies, sea stars and brittle stars)

The echinoderms observed during the survey included representatives of each of the five classes: starfish (Asteroidea, at least 19 species), brittle and basket stars (Ophiuroidea, at least 4 species), sea cucumbers (Holothuroidea, 2 species), sea lilies (Crinoidea, 1 species), and sea urchins (Echinoidea, 6 species). Echinoderms are important in benthic communities as carnivores (asteroids), scavengers (asteroids, ophiuroids, echinoids), and grazers (echinoids), and in the present survey were dominants to sub-dominants in terms of biomass in the Laminaria/Agarum, encrusting coralline, Florometra/ophiuroid and sand communities. Field identifications of the echinoderms were verified by Dr. Andy Lissner (IEC) and Jack Word (Southern California Coastal Water Research Project). A comprehensive species list is presented in Appendix H. Density-depth plots for Lytechinus, Mediaster, and Patiria are presented in Appendix F, Figures F-14, F-16 and F-19).

The most common echinoderms in shallow rocky communities from 9 to 60 meters depth were the asteroids Mediaster aequalis, Patiria miniata, Pisaster giganteus, and Henricia leviuscula; the echinoids Strongylocentrotus franciscanus and S. purpuratus; and the ophiuroid Ophiothrix spiculata. From depths of approximately 60 to 90 the asteroids Patiria miniata, Mediaster aequalis, Peridontaster crassus, and less commonly Henricia leviuscula were observed. It is noteworthy that Peridontaster was observed in the majority of the benthos camera slides taken between 61 to 107 meters depth, and was noted as common by the observers. Below approximately 91 meters at least two species of ophioroids ("Ophiopsila" and "Ophiopholis/Ophiocantha") were common. These ophiuroids snd the crinoid Florometra serratissima were notable as community dominants along the Santa Rosa Ridge transects (Area G) and deeper areas of Cortes (Area C) and Tanner Banks (Areas E and F). The great abundance of these three species was well documented by observer records and Benthos camera photographs. Also common at Santa Rosa Ridge were the basket star Gorgonocephalus caryi and the echinoid Allocentrotus fragilis.

In areas of rock/sand interfaces the common echinoderms were the asteroids Mediaster aequalis and Patiria miniata, and the echinoid Lytechinus anamesus. Sand areas were characterized by Lytechinus anamesus and several asteroids including Mediaster aequalis, Luidia foliolata, and Astropecten verrilli.

Increased depth records were noted for the following species: the asteroids Henricia leviuscula (91 meters), Patiria miniata (119 meters), and Pisaster giganteus (90 meters), and the echinoids Strongylocentrotus franciscanus, and S. purpuratus (113 and 85 meters, respectively). A unique color and morphology were noted for S. franciscanus occurring below approximately 87 to 91 meter depth: the test shape and red color were similar to shallow occurring specimens of S. franciscanus but the spines of the deeper variety were greatly lengthened and the spine color of many of them was similar to the lavender color of S. purpuratus.

4.7.7 Mollusca

Forty species of molluscs were observed in the study area, however, only six species could be considered common (Calliostoma annulatum, Tegula regina, Astraea gibberosa, Acmaea funiculata, Nassarius insculptus, and Cidarina cidaris). Also seen were scaphopods, pectens, octopods (Octopus), limpets (Megathura crenulata, Acmaea mitra), cowries (Cypraea spadicea), nudibranchs (Triopha carpenteri, Pleurobranchus, Tritonia, Flabellinopsis iodinea, Cadlina, Archidoris montereyensis, Anisodoris nobilis, Acanthodoris, and Doriopsilla), and other gastropods (Tegula aureotincta, Fusitriton oregonensis, Conus californicus, Norrisia norrisii, Epitonium, Antiplanes, Puncturella cucullata, Mitrella carinata, Erato, Macrarene cookeana, Ceratostoma, whelks, trochids, and an unknown cancellarid).

A single small abalone (Haliotis) was reported at 50 feet depth on Bishop Rock. It is probable that the absence of this commercially important species is due to both lack of observations above 14 m and commercial fishing efforts/pressure throughout the SCUBA zone. Encrusting growths and semicryptic behavior can also obscure identification of abalones from a submersible, and may reduce the number of sightings.

Calliostoma annulatum was found primarily in the encrusting coralline community below 60 m on rocky substrates. It was seen most frequently in areas C and F, but also occurred in areas A,E and G. Three other species of this genus have been tentatively identified from the Benthos photographs: Calliostoma turbinum, C. variegatum, and C. gloriosum (J. McLean, L.A. Co. Mus.).

Tegula regina and Astraea gibberosa were observed in all areas from 20 to 90 m depth and in all communities except the Plumarella subcommunity or the Florometra/ophiurod community. Both species reached maximum densities of 1-2/m^2 in localized patches.

The orange limpet, Acmaea funiculata, was fairly common, although patchy in distribution, reaching a maximum density of 3-4/m^2 on boulders, primarily in the Eisenia/Calliarthron community in areas A and E, the Agarum/Laminaria and community in areas A,B and E, and the encrusting coralline community in areas A and F.

Several species of rare molluscs were identified from Benthos photographs (J. McLean, L.A. Co. Mus.). These include Fusitriton oregonensis (which has one previous record this far south from San Nicholas Is.), Calliostoma ?turbinum, a rare or new species of the Muriceidae or Cancellaridae, and a peculiar unidentified banded snail.

4.7.8 Porifera (Sponges)

The sponges identified included representatives of three classes: Calcarea, Demospongiae, and Hexactinellida. Encrusting and massive sponges were common constituents of all rocky communities observed, however, size identifications usually require the collection of specimens only general groups or types of taxa could be identified on the basis of the present survey. Dr. Gerald Bakus (University of Southern California) classified some of the sponges recorded on photographic slides. A comprehensive species list is presented in Appendix H. Density-depth plots for bath sponges and vase sponges are presented in Appendix F Figures F-5 and F-30.

Red, orange, brown, blue, gray, yellow, tan and white encrusting and massive Demospongiae were observed from depths of at least 12 to 106 meters. The most common identifiable types were Trikentrion, Tethya aurantia, and "Axocielita". Calcareous sponges were less commonly observed but this is probably due to their smaller size, cryptic habit, and lighter coloration.

Calcareous and hexactinellid (glass) sponges were common along some transects and were classified as sub-dominants in the encrusting coralline community below 91 meters. Included in this group are the calcareous bath sponge "Clathrina", and the vaselike glass sponge "Staurocalyptus". Other sponges occurring in this deep zone are various ridge and bracketshaped glass sponges and the calcareous sponge "Leucetta".

4.7.9 Urochordata (Tunicates)

Numerous tunicates were seen attached to rocky substrate in all communities and areas, although without specimens they could not be identified. The most common sightings were of various solitary tunicates, a few of which may belong to the genus Rhopalea (areas A and B, 27-30 m). Massive colonial tunicates were seen only in the encrusting coralline community from 81 to 113 m depth. Encrusting tunicates, resembling white, orange, yellow, tan, and grey Sea Pork was covered 1% of the rocks in area A (Agarum/Laminaria and encrusting coralline communities), area E (Eisenia/Calliarthron, Agarum/Laminaria and encrusting coralline communities), and areas C, F and G (encrusting coralline community).

4.7.10 Comparison with Historical Data

Recurring species groups may be defined as communities and are often named after one to several dominant organisms (Thorson, 1957). Marine intertidal organisms commonly occur in bands or zones that are characterized by specific community constituents and environmental conditions. Species zonation has also been observed in a few studies of the marine subtidal. However, the subtidal communities have not been well defined due to the general lack of adequate subtidal SCUBA and submersible survey data. The following discussion compares the communities and associated species observed at Tanner and Cortes Banks during this survey with several previous studies conducted in rocky subtidal areas of the Southern California Mainland, the Channel Islands, and Tanner and Cortes Banks.

4.8 PREVIOUS STUDIES

Table II-12 is a summary of the major subtidal studies available for Tanner Bank, Cortes Bank, Santa Rosa Ridge, the Southern California mainland and the Channel Islands. Significant previous studies of the fish, invertebrates, and algae of the Southern California Bight providing data pertinent to the survey area are listed below with a brief description of each study:

- Southern California baseline study, intertidal, Year II. Biological features of the rocky subtidal community of Tanner and Cortes Banks. A scuba survey listing species, percent cover, percent frequency, biomass, and diversity of macroinvertebrates and macrofauna from four sites at 20-29 m depth. Observations of fish and general impressions are also recorded. (Littler et al., 1978).

- Southern California baseline study, benthic and water column, Year II. Box core survey including Tanner Bank and Santa Rosa Ridge. Characterizes common invertebrates in predominantly sandy areas by season, taking replicate samples from 52 to 203 m. (Fauchald and Jones, 1978).

- Southern California baseline study, benthic macrofauna, Year I. Box core and trawl dredge survey including Tanner and Cortes Banks. Characterizes bank top and trough invertebrates. (Jones and Fauchald, 1977).

TABLE II-12. SUMMARY OF PREVIOUS SUBTIDAL STUDIES
A = ALGAE, F = FISH, I = INVERTEBRATES

Tanner Bank	Cortes Bank	Santa Rosa Ridge	Channel Islands	So. Cal. Mainland
Littler et al., 1978 (A,F,I; 20-29 m; scuba)	Littler et al., 1978 (A,F,I; 20 m; scuba)	Fauchald & Jones, 1978 (I; 105-203 mi box core)	Smith et al., 1975 (A,F,I; 6-58 m; scuba)	SCCWRP Review (A,F, I; scuba/trawl)
Fauchald & Jones, 1978 (I; 52-102 mi; box core)	Jones & Fauchald, 1977 (I; box core/ trawl)	Cal. Dept. Fish & Game Catch Block Statistics (F)	Given & Lees, 1967 (A,F,I; 0-60 m; scuba) Santa Catalina	Allen et al., 1976 (A,F,I; 10-100 mi scuba/sub)
Jones & Fauchald, 1977 (I; box core/trawl)	Smith et al., 1975 (A,F,I; 15-61 m; scuba)		Given review (A,F,I; scuba/ sub)	Pacific OCS Ref. Papers, 1978 II & III (S/I)
Smith et al., 1975 (A,F,I; 24-34 m; scuba)	Smith et al., 1978 (scuba)	Bonnell et al., 1978 (seabirds & mammals)	Bonnell et al., 1978 (seabirds & mammals)	
Ecomar, 1978 (A,F,I; 30-63 m; scuba/sub)	SCCWRP memo., 1978 (A,F,I; 9-26 m; scuba)		Neushul et al., 1967 (A & I, S/I) Pacific OCS Ref. Papers, 1978 II & III (S/I)	Pequegnat, 1964 (A, I; scuba)
Mearns et al., 1978 (F, I; 137-275 mi trawl)	Cal. Dept. Fish & Game Catch Block statistics (F)		So. Cal Ocean Studies Consortium, 1974 (S/I)	Quast, 1968 (F; scuba)
Cal. Dept. Fish & Game Catch Block statistics (F)	Bonnell et al., 1978 (seabirds & mammals)			So. Cal. Ocean Studies Consortium, 1974 (S/I)
Bonell et al., 1978 (seabirds & mammals)				
Benech et al., 1978 (Allopora)				

- Preliminary biological survey (subtidal) of Tanner and Cortes Banks and San Clemente Island, offshore Southern California with emphasis on the hydrocoral Allopora californica. Scuba survey characterizing species and densities of invertebrates, algae and fish in rocky outcrop areas from 15 to 61 m depth. Provides information on densities and sizes of Allopora. (Smith et al., 1975).

- Pacific OCS Coral Environmental Assessment report for Tanner and Cortes Banks. Scuba survey and literature review of the macroflora and fauna of Tanner and Cortes Banks including marine birds and mammals. Provides information on densities and sizes of Allopora at Cortes Bank from 10-40 m depth. (Smith et al., 1978).

- Tanner Bank mud and cuttings study: Reef reconaissance. Submersible and scuba survey listing the invertebrates, algae, and fish occurring at Tanner Bank from 30-63 m depth (Ecomar, 1978).

- Health, abundance and diversity of bottom fish and shellfish populations at proposed and existing offshore drilling sites in the Southern California Bight. Trawl Survey at Tanner Bank over areas of rock and sand listing the dominant fish and invertebrates at 137-275 m depth. (Mearns et al., 1978).

- Distribution patterns of Allopora on Tanner Bank. Review and discussion of survey results from Ecomar (1976 and 1978). (Benech et al., 1978).

- SCCWRP memorandum (May 24, 1978) regarding: marine life at Cortez Bank. Scuba reconnaissance listing common invertebrates, fish and algae observed at Cortes Bank from 9-26 m depth. (M. Moore, unpub., 1978.)

- A new monoplacophoran limpet from the Continental Shelf off Southern California. Description of a new species collected at Santa Rosa-Cortes Ridge between 174 to 388 m depth. The collection area is northwest of the present survey area G, and does not overlap our survey. (McLean, 1979).

- Fish Catch Block statistics for 1973-1975 compiled by California State Department of Fish and Game for areas including Tanner and Cortes Banks and Santa Rosa Ridge. (L. Pinkas, C, F & G, personal communication).

- Santa Catalina Island Biological survey. Scuba survey of algae, fish and invertebrates from the intertidal to 60 m depth. (Given and Lees, 1967).

- Pacific OCS Reference Papers Nos. II and III, 1978. Description of the Coastal Environment from Point Reyes to Punta Eugenia. Includes literature review of the common marine invertebrates, algae, and fish, and the marine environment of Southern California and the Channel Islands.

- Summary of rocky subtidal communities of the Southern California mainland based on studies conducted by the Southern California Coastal Water Research Project. (J. Word, M. Moore, and L. Harris unpublished review, 1979.)

- Summary of rocky subtidal communities of the Channel Islands based on scuba and submersible observations (Dr. R. Given, Catalina Marine Science Center, unpublished, 1979).

- Marine organisms around outfall pipes in Santa Monica Bay. Scuba and submersible survey from 10 to 100 m depth listing invertebrates, fish and algae. (Allen et al, 1976).

- Fish associated with kelp beds in San Diego. (Horn, 1974).

- Description of shallow subtidal zonation (0-6 m depth) near Carmel. (McLean, 1962).

- Factors affecting the distribution of algae at the Channel Islands. (Neushul et al., in Philbrick, 1967; North, 1971).

- Summary report of marine mammal and seabird surveys in the Southern California Bight (1975-1978). Geographic area includes the Southern California mainland, Channel Islands, and Tanner and Cortes Banks. (Bonnell et al., 1978).

- Summary of knowledge of the Southern California Coastal Zone and Offshore Areas. Biological environment. General review of common invertebrates, algae, and fish. (So. Cal. Ocean Studies Consortium, 1974).

- Monthly SCUBA surveys of a nearshore reef off Corona del Mar. Community structure and correlations between water movement and suspension feeder concentrations (Pequegnat, 1964).

A site specific comparison was made between the survey data collected in this study and five previously surveyed sites at Tanner and Cortes Banks (1976-77 SAI subtidal study and 1978 Ecomar study). The previously surveyed sites are indicated on Plates 404-4 and 404-5.

The species and community dominants observed during the present survey are very similar to those observed on the Channel Islands. However, many species occur in relatively greater abundances at Tanner and Cortes than at Santa Catalina Island (R. Given, unpublished review).

Furthermore, although many of the same species also occur along the Southern California coastline and Tanner and Cortes Banks, their relative abundances are different. An exception to this is shallow water Eisenia dominated communities (Word et al., unpublished review).

It is particularly notable that many species and communities occur at greater depths and with extended depth ranges at Tanner and Cortes Banks than on the Southern California mainland or the Channel Islands. The fish observed at Tanner and Cortes Banks generally occurred within documented depth ranges as these ranges usually incorporate large amounts of offshore data. However, many species of algae and invertebrates showed increased depth ranges and deeper depths of occurrence presumably due to increased water clarity and light penetration. These comparisons are based on the review of numerous data sources including those listed in Table II-13. A comparison of the depth ranges of selected common species observed during the present survey at Tanner and Cortes Bank with those of the mainland and the Channel Islands is presented in Table II-11. At least some of these depth extensions are due to the lack of comparable data from offshore areas at similar depths.

The results of this study have produced depth extensions for many species of invertebrate and macroalgae, but only a few for fish. The reason for this difference is that depth distribution data in offshore areas is far more extensive for fish than for other organisms. These data are available largely from records of commercial and sport fishing activity. Fish species that showed pronounced depth extensions (senorita, blackeye goby, pile perch) are of little or no commercial importance, and would not normally be taken by standard nets and trawls, owing to small size or near-bottom habitat preference. As such, their depth ranges would be expected to be the least well known.

In this regard, two important contributions of the present study include:

(1) Supplying offshore depth and distributional data for macroalgae and invertebrates, which for many species is apparently the first set of this type of data recorded.

(2) Supplying data on associations between fish known to range into deep water offshore and sessile organisms never recorded from similar depths. Fish populations are generally dependent on hard substrate, but more directly on organisms associated with hard substrate. Algal communities provide abundant and diverse food items, as well as refuges from larger predators.

4.8.1 Shallow Water Communities - Algae such as Cystoseira, Egregia, Calliarthron, Eisenia, and the surfgrass Phyllospadix, all of which have strong holdfasts are commonly found in shallow nearshore areas of the Southern California Mainland in depths less than 5-10 m (POCS ref. Pager II, 1978). In addition, McLean (1962) defined two subtidal zones in central California as consisting of (1) a Calliarthron zone from 0 to 3 m depth which commonly includes the polychaete Eudistylia and the bryozoan Hippodiplosia, and (2) a Pterygophora zone from 3 to 6 m depth which commonly includes sponges such as Tethya aurantia, tunicates, the jewel anemone Corynactis, and the cup coral Balanophyllia.

Eisenia dominated communities occur off the Southern California mainland with subdominants consisting of understory algae (Calliarthron, Gelidium, Laminaria, and Agarum) where densities of Eisenia do not exceed 7 adult plants/m^2 (Word et al., unpublished review).

A similar community is seen in rocky subtidal areas at Santa Catalina Island from the lower intertidal to 7 m depth and includes Eisenia, encrusting coralline algae, articulated coralline algae such as Lithothrix and Calliarthron, Codium hubbsii/setchellii, Cystoseira, Sargassum spp., Zonaria

TABLE II-13. TYPES OF DATA COLLECTED AND APPROXIMATE QUANTITIES OF MATERIAL REVIEWED FOR THE COMPARISON OF COASTAL SHELF COMMUNITIES TO THE TANNER AND CORTES BANKS AND THE SANTA ROSA RIDGE

Observatiun Type	Coastal Intertidal and Subtidal	Coastal Banks or Reefs			
		Lasuen	Santa Barbara Oil Tower	Pipe Surveys	Santa Monica Bay
Fish and Inverts:					
Otter Trawls	700 otter trawls; uver 100 hours of bottom trawls Depth range 10 - 500 m	NA	NA	36 trawls 6 hours 60 - 100 m	30 NA
35mm Camera	100 hours bottom time, 2,000 photographs, Depth range 10 - 500 m	3 hours 60 photos Depth range 109 m	1,000 photographs 0 - 33 m	400 photos 10 - 100 m	30 hours 600 photos 10 - 400 m
Special Palos Verdes Dive Survey	30 manhours; Depth 6 and 15 m	NA	NA	NA	NA
Towed Television	Over 50 hours on bottom time; Depth range 10 - 138 m	NA	3 hours Depth - 33 m	10 hours 10 - 60 m	30 hours 10 - 138 m
Dive, Personal	300 hours; Depth Range 0 - 50 m; majority	NA	32 hours	NA	NA
Literature		NA	NA	NA	NA
Hook and Line	111 hours of sampling: 19 stations Depth range 18 - 180 m	2 hours	NA	NA	NA
Algae:		NA	NA	NA	NA
Literature	100 + hours; review of literature for past years	NA	NA	NA	NA
Dives	Several hundred man hours - interviewed specialists fur this study	NA	NA	NA	NA

After J. Word, M. Moore, and L. Harris (unpublished review) farlowii, and Gelidium sp., and the invertebrates Corynactis, sponges (Demospongiae), starfish (Pisaster giganteus and Linckia columbiae), gastropods (Norrisia norrisii, Tegula sp., Megathura crenulata), hydroids, bryozoans, and tunicates (Given and Lees, 1967; Lissner, personal observation).

On the leeward side of Santa Catalina Island, Eisenia is patchy in intertidal areas, and occurs locally to depths approaching 30 m. Calliarthron does not usually occur as a co-dominant, but Eisenia is known to occur with Laminaria and Agarum beginning at about 20 m. Corallines, both encrusting and erect, are more abundant on the windward side over a wide depth range, but Eisenia, Laminiaria and Agarum begin at somewhat deeper depths than on the leeward side. Gelidium is abundant from the lower intertidal to about 10 m on the windward side, and is present in lower densities on the leeward side (Given, unpublished review).

Calliarthron of large size (to 30 cm high) seen at Tanner and Cortes Banks is not seen at Santa Catalina, at least not often enough to make it a dominant member of a community. Agarum and Laminaria both appear on the leeward side at about 18 to 20 m, with greatest abundance at 20 to 30 m. In some areas they compete with Eisenia for space on the rocks, forming an extremely dense cover about 45 to 60 cm high (Given, unpublished review.)

The Codium association described in the Eisenia/Calliarthron communities at Tanner and Cortes Banks is not commonly seen on the Channel Islands, although an occasional erect plant of that genus may be seen in shallow depths. On Ship Rock, and at Farnsworth Bank offshore from Catalina, Agarum and Laminaria are found to about 60 m, with Eisenia occuring at somewhat shallower depths. The other algae described for Tanner and Cortes are variously present on the other islands at the same general depths, but with local variation in the upper and lower limits of vertical distribution (Given, unpublished review.)

Tanner and Cortes Banks possess shallow water species that are similar to those found in the subtidal zones of Carmel, California, the nearshore areas of the Southern California mainland, and the rocky subtidal of Santa Catalina Island. However, the depth ranges for species observed at Tanner and Cortes Banks are much greater than those of the Southern California mainland or the Channel Islands, and there is a difference in the relative abundance of many species.

The palm kelp Eisenia arborea and the articulated coralline red alga Calliarthron were the dominant organisms observed from 9 to 21 m depth on Cortes Bank (Littler et al., 1978; SCCWRP, 1978; and Smith et al., 1975 and 1978). Littler et al. (1978) noted that Eisenia predominated on rock ridges and out-crops while Calliarthron was more common in areas of lower relief. In addition to Eisenia, SCCWRP (1978) and Smith et al., (1978) noted extensive beds of surf grass (Phyllospadix sp.). Common algae included the red algae Gelidium nudifrons, Plocamium and Corallina, the brown algae Dictyota/Pachydictyon and Laminaria farlowii, and the encrusting green alga Codium sp.. Common sessile invertebrates included sponges (Demospongiae), hydroids (including Aglaophenia sp.), encrusting bryozoans (Lichenopora/Disporella), and the jewel anemone Corynactis californica (Littler et al., 1978; Smith et al., 1975 and 1978). Cup corals (Balanophyllia and Paracyathus), the anemone Tealia, and the algae Dictyota and Gelidium were locally abundant but their distributions were patchy (Littler et al., 1978, Smith et al., 1978). Motile invertebrates included the sea urchin Strougylocentrotus franciscanus, the starfish Henricia leviuscula, Patiria miniata, and Pisaster giganteus, and the gastropods Norrisia norrisii, Megathura crenulata, and Cypraea spadicea.

At Tanner Bank, rocky areas from 20-25 m depth were also characterized by a dense cover of Eisenia arborea with an extensive understory of red and brown algae including encrusting corallines, Rhodymenia sp., Dictyota, and Plocamium. Dominant invertebrates include the jewel anemone Corynactis californica, and various sponges (Demospongiae) (Littler et al. 1978).

Similar shallow water associations were observed during the present survey and are referred to herein as the Eisenia/Calliarthron community (Section 4.1.1). Our survey showed the depth range of this community to be much greater (10 to 40 m) than reported by previous studies. The species composition is similar to composition of shallow water communities listed for the mainland, the Channel Islands, and the previous Tanner and Cortes surveys. Common species of algae include low growing species such as Codium sp. (encrusting), Zonaria farlowii, Cystoseira sp., Dictyopteris sp., Dictyota/Pachydictyon, Gelidium and Plocamium. Common invertebrates include sponges (Demospongiae), bryozoans, hydroids, sea anemones (Tealia and Corynactis), sea urchins (Strongylocentrotus franciscanus and S. purpuratus), starfish (Pisaster giganteus), and gastropods. Common fish include embiotocids, blackeye gobies, halfmoon, opaleye, sheephead and senorita.

4.8.2 Mid-Depth Communities - Below 8 m depth at Anacapa Island Eisenia is replaced by Macrocystis, Agarum and Pterygophora (Neushul, Clark, and Brown, in Philbrick, 1967.) A survey conducted from 9 to 34 m depth by Smith et al. (1975) at San Clemente Island reported that the dominant algae were Eisenia, Macrocystis, Pelagophycus porra (bull kelp), and encrusting and articulated coralline red algae.

Kelp bed communities dominated by the giant kelp Macrocystis pyrifera are common elements of rocky subtidal areas in the Southern California Bight. Approximately 40% of all kelp beds in the Bight occur at the Channel Islands (BLM, POCS Ref. Paper II, 1978). Wave action generally limits nearshore occurrences of M. pyrifera to 5-10 m depth, while offshore vertical distribution is usually light-limited (North, 1971). In clear water, the average offshore range is 25-30 m depth, but in turbid water this can be reduced to 15-20 m.

Dawson (1966) suggested that the kelp bed community consists of layers or stories of algae, each with an associated group of invertebrates and fish. The layers of algae consist of (1) the giant kelp Macrocystis (2) algae with heavy, erect stipes such as Eisenia, Pterygophora, and Desmarestia, and (3) low-growing red, brown, or green algae that are tolerant of lower light levels produced from shading by the upper story algae such as Macrocystis. POCS reference Paper II (1978) lists common macrophytes in kelp bed communities of the Southern California Bight as including Phyllospadix, the brown algae Cystoseira, Dictyota, Egregia, Eisenia, and the red algae Calliarthron, Bossiella, Corallina, Plocamium, Rhodymenia, Peyssonelia, and Acrosorium.

An extensive species list of the common invertebrates associated with kelp beds in Southern California is given by North (1971). Well represented families of fish in Southern California kelp beds include the Scorpaenidae (rockfish and scorpionfish), Embiotocidae (surfperch), Hexagrammidae (greenlings), and Gobiidae (gobies) (POCS Ref. Paper II, 1978). Horn (1974) lists the most common fish in kelp beds near San Diego as kelp bass (Paralabrax clathratus), sheephead (Pimelometopon pulchrum), and blacksmith (Chromis punctipinnis). Quast (1968) reports that the kelp bass was the most commonly encountered fish in rocky subtidal areas of Southern California. Fish commonly observed at Santa Catalina Island include surfperch, blacksmith, gobies, greenlings, garibaldi (Hypsypops rubicundus), kelp bass, sheephead, senoritas, opaleye (Girella nigricans), and halfmoons (Medialuna californiensis) (Given and Lees, 1967).

Differences noted by Littler et al. (1978) and Smith et al. (1975; 1978) between Tanner and Cortes Banks, and the Channel Islands or the Southern California mainland include the rarity or absence of garibaldi (Hypsypops rubicundus), kelp bass (Paralabrax calthratus), giant kelp (Macrocystis spp.), and sea fans (Muricea spp.). Fish distributions are discussed separately in Section 4.5.

Though relevant data is not available it is likely that the absence of Macrocystis is related to temperature, upwelling, or surge and swell conditions that occur at Tanner and Cortes Banks. The absence of any true kelp beds at Tanner and Cortes Banks should affect the species composition and availability of habitats by decreasing habitat heterogeneity. Notwithstanding the differences noted above, many of the species observed at Tanner and Cortes Banks are similar to those in kelp beds and mid-depth (10 to at least 30 m depth) communities of the Southern California mainland and the Channel Islands. The major difference between the areas is the greater depth range of communities and species at Tanner and Cortes Banks.

At Santa Catalina Island there is an intimate association of the Agarum/Laminaria with the Eisenia-Calliarthron community, and the separation between the two is not clear cut. (Given, unpublished review.)

On the leeward side of Catalina Patiria is common from the shallow subtidal to over 70 m, while Mediaster is seen occasionally, at depths of 60 m and deeper. However, on the windward side the distribution is nearly reversed, with Mediaster being most common beginning at about 15 m and continuing down to at least 70 m. Mediaster is the most common asteroid on Farnsworth Bank. (Given, unpublished revies.)

The gorgonian Eugorgia is present at Catalina but is nowhere found in enough abundance to be described as a subdominant. (Given, unpublished review.)

In contrast to previous studies of Tanner and Cortes Banks the present survey observed an Agarum/Laminaria community from 40 to 60 m depth. Within the Agarum/Laminaria community three subcommunities were found: (1) Calliarthron, (2) Eugorgia and Mediaster, and (3) Zonaria. Ecomar (1978) also noted that Agarum was common between 40-55 m but did not list any subcommunities.

At Cortes Bank Smith et al. (1978) noted that the abundance of Eisenia decreased between 21 to 27 m depth but did not observe the Agarum/Laminaria community. Common invertebrates at these depths included the anemone Corynactis, lobster (Panuliris interruptus), abalone (Haliotis spp.), starfish (Henricia, Patiria and Pisaster giganteus), bryozoans (Diaperoecia spp., Lichenopora spp., and Hippodiplosia insculpta) and the sea cucumber Parastichopus parvimensis (Smith et al., 1975 and 1978). Lobster and abalone were rarely observed in the present study. Below 26 to at least 61 m depth, encrusting coralline algae predominated (Smith et al., 1975).

At Tanner Bank below 25 m (83 ft) depth there was a notable decrease in the density of Eisenia and understory algae and the predominant community elements were low-growing, encrusting forms including Corynactis, Codium sp. (encrusting), and encrusting coralline algae (Littler et al., 1978, Smith et al., 1975). Common invertebrates included cup corals (Paracyathus and Balanophyllia), gastropods (Cypraea spadicea, Tegula regina, Astraea gibberosa, and Calliostoma annulatum), sea urchins (Strongylocentrotus franciscanus and S. purpuratus), starfish (Patiria miniata and Henricia leviuscula), sponges (Demospongiae), bryozoans (Lichenopora/Disporella) and the brittle star Ophiothrix spiculata. Common algae included reds such as Calliarthron cheilosporides, Opuntiella, and Fryeella. Ophiothrix, Corynactis, hydroids, and the bryozoan Phidolopora were locally abundant (Littler et al., 1978, Smith et al. 1975). Other characteristic invertebrates were the starfish Pisaster giganteus and Orthasterias koehleri, and the sea anemone Tealia. Lobsters (Panulirus interruptus) and abalone (Haliotis sp.) were reportedly common, but were observed only outside of the study sites, and were not found to be common in the present survey.

At approximately 30 m depth at Tanner Bank Ecomar (1978) reported encrusting corallines, Calliarthron and Ophiothrix as the community dominants. Encrusting coralline algae were common at all depths observed during the present survey but macroalgae such as Agarum were also common to at least 60 m depth. The encrusting coralline communities observed below 20 to 30 m depth by Smith et al. (1975 and 1978), Ecomar (1978), and Littler et al. (1978) are probably not representative of most of the Tanner and Cortes Bank areas at these depths but are indicative of the patchiness of distribution of some species and the relatively small areas previously surveyed. The large survey area covered by the present study (95.2 km of transects) allowed a more complete analysis of the extent of the biological communities.

The encrusting coralline community observed during the present survey occurred down to at least 125 m (discussed in Section 4.1.3). Subcommunities included Mediaster (60 to 68 m), and Plumarella/Mediaster/sponge (68 to 89 m). The community is characterized by the absence or rarity of large erect algae and invertebrates and the presence of encrusting algae, sponges tunicates, and hydroids.

The species observed as subdominants in the encrusting coralline community at Tanner and Cortes are present on the mainland but do not occur in the same relative abundances (Word et al., unpublished review).

Observations to 90 m on the leeward side of Catalina Island showed mostly Staurocalyptus, Adelogorgia, encrusting corallines, Maripelta, and an epifaunal covering of hydroids, bryozoans, stony corals, and solitary ascidians. (Given, unpublished review.)

Diversity estimates were outside the scope of the present study, however, it is the collective opinion of the scientific observers that the number of species decreases with depth. This relationship is supported by comparing the number of species recorded from relatively shallow areas (A,B,E, and F) with deeper areas (C and G) and is summarized below in Table II-14.

TABLE II-14. NUMBER OF SPECIES OBSERVED ON TANNER AND CORTES BANKS

	Number of Species					
	A	B	E	F	C	G
Algae and Invertebrates	140	122	130	98	93	41
Fish	61	43	55	41	39	24
Total	201	165	185	139	132	65

Fish are abundant at Tanner and Cortes Banks between 20-63 m depth and include sheephead (Pimelometopon pulchrum), senoritas (Oxyjulis californica), convict fish (Oxylebius pictus), black-eyed gobies (Coryphopterus nicholsi), blacksmith (Chromis punctipinnis), jack mackerel (Trachurus symmetricus), ocean whitefish (Caulolatilus princeps), and several species of rockfish including Sebastes mystinus, S. rosaceus, S. serranoides, and S. paucispinis (Ecomar, 1978, Littler et al., 1978, and Smith et al., 1975, and SCCWRP, 1978). Densities of sheephead, blue rockfish and ocean whitefish were determined to be .06, .12, and .10 per m^3, respectively (Smith et al., 1975). Fish were most abundant at depths less than 40 m (Ecomar, 1978). Ecomar (1978) noted that the widow rockfish (Sebastes entomelas) was the most common fish observed, in contrast to the present survey in which the most commonly observed fish was the squarespot rockfish (S. hopkinsi). Squarespot and widow rockfish could be confused by some observers and this may have influenced the Ecomar observations. Additionally, at Cortes Bank Smith et al. (1975) noted that embiotocids were common, and that spiny dogfish (Squalus acanthias) were the dominant vertebrates (August only). Several giant sea bass (Stereolepis gigas) were also observed. Smith et al., 1978 reported that horn sharks and swell sharks (Heterodontus francisci and Cephaloscyllium ventriosum) were common.

Fish catch block statistics compiled by the California State Department of Fish and Game for 1973-1975 (Table II-15) indicate that the common fish caught in area 871 (near IEC area E, Tanner Bank) were Pacific mackerel (Scomber japonicus), jack mackerel (Trachurus symmetricus), rockfish (Sebastes spp.), and bonito (Sarda chiliensis). Common fish caught in area 872 (near IEC area F, Tanner Bank) include rockfish and pacific mackerel (L. Pinkas, Calif. Dept. Fish & Game, personal communication).

Several species of fish were caught near Cortes Bank from 1973-1975 (L. Pinkas, personal communication).

Catch block 889 includes areas near Cortes Bank, 890 includes IEC areas B (Nine-Fathom reef) and C (Northwest Cortes), and 897 includes IEC area A (Bishop Rock).

Fish catch block data for area 855 at Santa Rosa Ridge (Area G) indicate that the common fish caught from 1973 to 1975 included rockfish (Sebastes sp.) and albacore (Thunnus alalunga) (L. Pinkas, personal communication).

TABLE II-15. FISH CATCH BLOCK STATISTICS FOR DOMINANT SPECIES

Species	Catch Block
Pacific mackerel (Scomber japonicus)	889,890,897
Rockfish (Sebastes sp.	889,890,897
Bonito (Sarda chilensis)	889,890,897
Bluefin Tuna (Thunnus thynnus)	889,890
Jack mackerel (Trachurus symmetricus)	880,897

The species of fish seen during the present survey are very similar to those abserved during other surveys at Tanner and Cortes Banks. Fish that were commonly seen during other surveys but were not observed or were rare during the present survey include widow rockfish, spiny dogfish, horn sharks, and swell sharks. The occurrence of spiny dogfish may be seasonal; swell sharks and horn sharks may have been hidden under the cover of Eisenia, Agarum or Laminaria and therefore could not have been easily seen during our survey. Bonito, bluefin tuna and albacore were reported from catch block statistics but were not observed during our survey. These differences are probably related to (1) the large size of the catch blocks which also include areas surrounding Tanner and Cortes Banks and (2) the seasonality in occurrence of these species.

4.8.3 Deep-Water Communities - Few surveys have been conducted at Tanner and Cortes Banks at depths greater than 60 m. A trawl and dredge survey was conducted at Tanner Bank over areas of sand and rock between 137-275 m depth. The common invertebrates reported by this survey were the sea urchin Allocentrotus fragilis, the starfish Luidia foliolata, the sea cucumber Parastichopus californicus, and the gastropod Nassarius insculptus (Mearns et al., 1978). Allocentrotus and Luidia were commonly observed during the present survey; Parastichopus and Nassarius were uncommon.

Two stations at depths of 93-102 m South Tanner Bank and 52-73 m on Central Tanner Bank were sampled using box cores in areas of sand substrate (Fauchald and Jones, 1978). At South Tanner Bank, the dominant invertebrates included polychaetes, and two species of brittle stars. At Central Tanner Bank the dominant invertebrate was the polychaete Chloeia pinnata.

Few biological data are available for Santa Rosa Ridge (Area G). The BLM Southern California Bight baseline survey sampled a predominantly sand area (site 818) from 105 to 203 m depth and determined that the dominant invertebrates were polychaetes (Chloeia pinnata), amphipods (Ampelisca cristata), and brittle stars (Amphiodia (Amphispina) urtica) (Fauchald and Jones, 1978).

The depths sampled during these box core surveys were similar to the present survey, however, the species listed are small-sized or have a cryptic habit and consequently were not seen by our observers if they were present.

A trawl and dredge survey conducted at Tanner Bank determined that the most common fish from 137-275 m depth was the green-striped rockfish (S. elongatus) (Mearns et al., 1978). Other common fish included the slender sole (Lyopsetta exilis), sanddabs (Citharichthys spp.), and the threadfin sculpin (Icelinus filamentosus). Sanddabs and other flatfish were observed during the present survey in sand areas from 30 to at least 100 m depth; the threadfin sculpin was observed but was not common. Sebastes spp. including S. elongatus were common to at least 145 m depth. Differences between the results of Mearns et al., (1978) and the present survey are probably due to relative differences in sampling time at various depths.

4.8.4 Allopora

The distribution of Allopora in the Southern California Bight is restricted to several offshore islands and banks including San Clemente, Santa Barbara, Santa Cruz, San Nicholas (Begg Rock), Santa Catalina (Farnsworth Bank) and Tanner and Cortes Banks (Bureau of Land Management, 1979).

Allopora is abundant in large heads at Farnsworth Bank, beginning at about 23 m and extending down to about 60 m. The heads of Allopora are large in this optimum depth range, growing to 25 cm tall and 75 cm in diameter. Allopora is also found at Santa Cruz Island and San Clemente Island, in much shallower water. (Given, unpublished review.)

Allopora was abundant along transects surveyed at San Clemente Island by Smith et al. (1975). Densities of Allopora were 11.6, 12.3, and 16.9 colonies per m^2. Mean sizes were 16.0 $\pm$ 13.1, 21.4 $\pm$ 12.8, and 9.0 $\pm$ 8.1 cm, respectively. Smith et al. (1978) conducted an extensive survey in the vicinity of Bishop Rock (Cortes Bank) from 17 to 34 m depth and determined that the overall density of Allopora was .07 colonies with the mean density being 0.24 colonies/m^2 inthe areas where Allopora was found. Since overall density depends on the percent of Allopora habitat included in the survey, this estimate cannot be compared with the estimates from the present study (see Section 4.3.1.1). A diver propulsion vehicle survey estimated that the densities were approximately $1/m^2$. Allopora was common at approximately 27 m depth and occurred to 43 m at one study site with mean densities of $1.8/m^2$. Allopora was found to be patchy. Allopora did not occur at the Cortes Bank sites studied by Littler et al. (1978).

At Tanner Bank Allopora was common in the Eisenia communities between 20-25 m depth (Littler, et al., 1978), and was one of several co-dominant species occurring on rock ridges and spurs from 24-34 m depth (Smith, et al., 1975). Densities and sizes of Allopora are included in the results of the latter study. The mean density at the site was approximately $1/m^2$ and it is notable that the rare red color phase was more common that the normally observed purple color phase. At the Tanner Bank area studied by Ecomar (1978), average densities of Allopora were less than $1/m^2$. Allopora was rare below 25 m depth (Littler et al., 1978; Ecomar 1978) and was not observed below 46 m (Ecomar, 1978). Based on the results of the Ecomar surveys, Benech et al. (1978) concluded that the distribution of Allopora on Tanner Bank was patchy (high to low densities) and is best explained by mechanisms of habitat selection and mode of reproduction.

These conclusions agree with the results of the present survey. The distribution of Allopora on Tanner and Cortes Banks was definitely patchy. Areas of 100% coverage occurred on Cortes Bank, however, the mean density was much less than 1%. Peak densities at Tanner and Cortes Banks occurred at 27-37 and 45-60 m depth. The range of occurrence was from 23 to 123 m depth with the majority of Allopora occurring above 70 m.

4.8.5 Marine Mammals - Large numbers of California sea lions (Zalophus californianus) were reported feeding in the area of Tanner and Cortes Banks by Littler et al. (1978) and Smith et al. (1975 and 1978) and were also seen during the present survey. A survey of marine mammals and seabirds in the Southern California Bight (Bonnell et al., 1978) indicated that there are major feeding routes leading to Tanner and Cortes Banks from sea lion rookeries on San Nicholas, San Clemente, and Santa Barbara Islands. It is thought that the large distances traveled from the Islands are related to the great abundance of fish at the Banks that provide a food supply for the sea lions.

4.8.6 Site-Specific Comparisons - The communities and species observed during previous surveys of Tanner and Cortes Banks are very similar to those seen during the present survey. The differences observed in subdominant species composition may be attributed to (1) substitutions of functionally equivalent species, (2) local species associations and social behavior resulting in a locally patchy distribution, (3) large changes in the substrate composition from elevated rocky reefs to boulders to sand, and (4) differences among the surveys in the relative size of area studied and methods used for observation.

Previous surveys of Tanner and Cortes Banks included SCUBA surveys using nondestructive and destructive sampling methods that were conducted by SAI (Littler et al., 1978) during four sampling periods in 1976 and 1977; and a submersible survey conducted at Tanner Bank by Ecomar (1978).

The surveys and sites that are compared are summarized in the following text. The previously surveyed sites are indicated on Plates 404-4 and 404-5.

Overall the biological communities described by SAI and Ecomar are characteristic of the major communities observed during the present survey. However, because of the smaller geographic areas surveyed they only partly characterize the range of subcommunities that we observed.

The major differences between our survey and the previous studies were the smaller size areas surveyed by SAI and Ecomar and the smaller size range of organisms that could be seen using SCUBA as compared to a submersible.

In this regard the present study provided for a documentation of the large-scale biological components of the Banks in preference to smaller scale details that are best examined by other techniques such as SCUBA.

(1) Cortes Bank (Area A) Data from South Cortes, (Littler et al., 1978) (SAI) are compared with data from Interstate Electronics Corporation dives 9 (time = 1439) and 19 (time = 1503). Data were recorded from areas that were 110 m apart. The depths at the SAI and Interstate sites were 20 m.

The sites are located in similar appearing areas of rock outcrops and boulders with some areas of sand. Overall, similar communities were found at the sites: both surveys reported that the dominant macroalgae was Eisenia, encrusting coralline algae, and Calliarthron. Fish common to both surveys were senoritas, sheephead, and blacksmith. Twenty-eight species of algae and fifty species of invertebrates were recorded by SAI (excluding data from harvested quadrats) as compared to 13 and 10 species, respectively, recorded by Interstate Electronics Corporation. The species reported by SAI which were not confirmed in the preent study were all either microscopic or cryptic.

The algae Gelidium, Zonaria, Dictyota/Pachydictyon, Corallina, Cystoseira, and Codium sp. (encrusting) were recorded by both surveys, although, Gelidium Zonaria, and Cystoseira occurred in notably higher densities in the IEC areas. Strongylocentrotus franciscanus and Pisaster giganteus were the common motile invertebrates reported by both surveys. Laminaria was common in both areas; Agarum was reported only by Interstate Electronics Corporation. Allopora was not reported by either survey. SAI reported hydroids, anemones, bryozoans, and sponges as the dominant sessile invertebrate. In contrast, sessile invertebrates (sponges and encrusting forms) were rarely seen at the IEC sites.

(2) Cortes Bank (Area B) Data from North Cortes, Littler et al., 1978 (SAI) are compared with data from Interstate Area B dives 13 (time = 1017), 15 (time = 0734), and 14 (time = 1855). Data were recorded from overlapping areas. The depths at the SAI site and the Interstate sites were 20 m and 18 to 30 m, respectively.

All sites were located in areas of rock ridges, with additional boulders, cobble, and sand chanels reported at the Interstate sites. Overall, the communities were similar at the sites: both surveys reported Eisenia arborea as the dominant macroalgae with an extensive understory comprised of red and brown algae, andd sessile suspension feeding invertebrates including hydroids, bryozoan, and sponges.

Fish common to both surveys were senoritas, sheephead, blacksmith, and convict fish. Twenty-nine species of algae and forty-eight species of invertebrates were recorded by SAI (excluding data from harvested quadrats) as compared to 10 and 14 species, respectively recorded by Interstate.

The algae Laminaria farlowii, Dictyota/Pachydictyon, encrusting coralline algae, Gelidium, Codium sp. (encrusting) were recorded by both surveys, however, Calliarthron and Cystoseira occurred in notably higher densities in the IEC areas. Rhodymenia/ Callophyllis, Plocamium, and Corallina were reported only by SAI. A difference between the surveys is that the jewel anemone (Corynactis californica) was reported to be the dominant invertebrate (13% cover) by SAI but comprised only 1-2% cover in the IEC areas. The three common motile invertebrates reported by SAI were the starfish, Pisaster giganteus, the sea urchin, Strongylocentrotus, and the gastropod, Cypraea spadicea; the Interstate observations included only S. franciscanus. Allopora was reported by Interstate to be patchy and comprise less than 1% cover, but was not listed by SAI.

(3) Tanner Bank (Area E) Data from North Tanner, Littler et al., 1978 (SAI) are compared with data from Interstate dive 6 (time = 1333). Data were recorded from areas that were 185 m apart. The Interstate and SAI sites are located at 36 and 20-40 m depth respectively.

The SAI site is an area of rock ridges, in contrast to the Interstate site which consists of both cliff ledges and sand channels. Both surveys reported that encrusting coralline algae is common. Interstate reports that Agarum is dominant on cliff ledges (to $15/m^2$) whereas Agarum was not reported by SAI.

Fish common to both surveys include sheephead, blacksmith, blackeye goby and rockfish. Blue rockfish (Sebastes mystinus) were the dominant vertebrate at the Interstate site.

Stronglocentrotus franciscanus and the starfish Henricia leviuscula were the common motile invertebrates reported by SAI. Interstate reported Henricia, but not S. franciscanus. The starfish Patiria miniata, Pisaster giganteus, and Mediaster aequalis, the brittle star Ophiothrix spiculata, and the gastropod Astraea gibberosa were observed during both surveys. Rhodymenia/Callophyllis, Plocamium, and Dictyota were the common low-growing algae observed by SAI, but were not reported by Interstate.

The green alga Codium sp. (encrusting), and sessile suspension feeding invertebrates including Corynactis, hydroids, sponges and bryozoans were common at the SAI site but comprised less than 5% cover at the Interstate site. Allopora was common at both sites reaching 50% cover on cliff ledges (Interstate). Interstate reported that the bryozoan Diaperoecia was commonly observed on cliff ledges near Allopora.

(4) Tanner Bank (Area E) Data from South Tanner, Littler et al., 1978 (SAI) are compared with data from Interstate dive 7 (time = 1750). Data were recorded from areas 55 m apart. The depths at the SAI and Interstate sites were 29 and 35 m respectively.

Both sites were located in areas of low rock relief. The communities were similar in both areas with encrusting coralline algae comprising the dominant algae cover.

Fish common to both areas included sheephead, blacksmith and rockfish. Twenty species of algae and 43 species of invertebrates were recorded by SAI (excluding data from harvested quadrats) as compared to 6 to 19 species, respectively recorded by Interstate.

Motile invertebrates observed by both surveys included the starfish Patiria, Henricia, and Pisaster giganteus, and the sea urchins Strongylocentrotus franciscanus and S. purpuratus. A notable difference between the surveys is that the brittle star Ophiothrix was reported to be the dominant invertebrate by SAI but was only reported as present in low densities by Interstate. The cup corals Paracyathus and Balanophyllia, and the anemone Corynactis were common at the SAI site, but were only noted as present at the Interstate site. Erect macroalgae were uncommon at both sites with the exception of Eisenia (Interstate and SAI) and Agarum (Interstate only).

(5) Tanner Bank (Area E) Data from Ecomar (1978) are compared with data from Interstate dives 6 (time = 1352) and 3 (time = 1213). Data were recorded from areas that were 600 m (dive 6) and 450 m (dive 3) from the Ecomar site. The surveys were conducted at depths of 40 (Interstate, 6), 52 (Interstate, 3) and 30-63 m (Ecomar). Because of the difference in depth coverage, Interstate data was compared with Ecomar data from 40 to 55 m depth.

All sites were located in areas of rock ridges with some areas of sand channels. The communities were similar in both areas: both surveys reported encrusting coralline algae and Agarum fimbriatum as the common macroalgae. The algae Calliarthron was recorded by both surveys. Opuntiella, Schizymenia, Callophyllis, and Fauchea were reported only by Ecomar; Gelidium, Iridaea, and Zonaria were reported only by Interstate.

Common sessile invertebrates reported by both surveys included sponges, hydroids, bryozoans, and the cup coral Paracyathus. Common motile invertebrates included starfish Henricia, Patiria, and Pisaster giganteus, sea urchins (Strongylocentroutus franciscanus) and brittle stars (Ophiothrix spiculata).

Fish common to both surveys include senoritas, sheephead, convict fish, and rockfish (Sebastes mystinus, S. rosaceus, S. paucispinis, and S. serranoides). It is notable that the common rockfish reported by Interstate was S. hopkinsi, while Ecomar (1978) did not observe this species and reported S. entomelas as the most common fish.

4.9 UNIQUENESS

Perhaps the most unique feature of the Tanner and Cortes Bank complex is the fact that no other comparable banks exist on the outer continental shelf off Southern California. Tanner and Cortes Banks are further offshore than any banks on the continental borderland and are closer to the Patton Escarpment than any other shallow water feature of major geologic significance. The Banks are situated directly within the California Current and therefore are exposed to oceanographic conditions which differ from those in the Southern California Bight. Currents are typically stronger than in areas closer to shore (Malony and Chan, 1974), and swell and surge at Cortes Bank are consistently greater than conditions in more coastal areas (Stewert and Stewert, 1975).

Landsat imagery indicates that upwelling around the Banks may be more intense than that at shoreward areas (Hendricks, personal communication). Upwelling, excellent water clarity, and relatively cold water temperatures probably combine to produce the high productivity and great abundance of many organisms observed on the Banks.

Many species appear to occur at greater depths on Tanner and Cortes Banks than elsewhere. However, noticeably rare of absent from the Banks are common coastal species such as the giant kelp Macrocystis, the gorgonians Muricea california and Muricea fruticosa, and the kelp bass Paralabrax clathratus. Although other limiting factors are involved, the fact that none of these species are found north of Point Conception suggests that the oceanography of Tanner and Cortes Banks is more northerly in character than comparable areas in Southern California.

High concentrations of phytoplakton and zooplankton occur in the waters surrounding Tanner and Cortes Banks relative to other areas in the Southern California Bight (Fleminger, personal communication). This increased production stems from the island mass effect (Doty and Oguri, 1956), which involves enhancement of vertical mixing and nutrient recycling due to sharp changes in bottom topography, circulation and other physical characteristics. High primary and secondary production levels at the Banks account for the abundance of filter-feeding organisms (corals, other coelenterates, bryozoans, sponges, crinoids and ophiuroids), as well as the presence of large schools of planktivorous fish (senorita and squarespot rockfish).

Invertebrate species recorded from Tanner and Cortes Banks but not observed during our survey also indicate unique conditions in the area. For example, the offshore islands and banks are apparently the center of distribution for the association of Allopora californica and one of its commensals, the barnacle Armatobalanus nefrens (Zullo, 1963). This species is the sole representative of the genus in the Eastern Pacific, being a relic of a Tethyan distribution. Both species are short-range endemics inhabiting the Californian Transition Zone (Newman, in press). The Banks thus constitute a refuge area for A. nefrens.

This conclusion is strengthened by the discovery of a monoplacophoran limpet, Vema hyalina, on the outer continental shelf (McLean, 1979). This class was believed extinct until Neopilina galatheae was discovered living at abyssal depths off Mexico (Lemcke, 1957). Living monoplacophorans are only found elsewhere in very deep seas, though they were common in shallow water from the Cambrian to the Silurian (Knight and Yochelson, 1960). Therefore the conditions on the offshore banks are sufficiently unique to allow V. hyalina to survive there in relatively shallow water.

The reason for the persistnce of these forms and the high species diversity at the Bank is that the Southern California Bight lies in the so-called Californian Transition Zone, the region where the Oregonian and Californian faunal provinces overlap. The short-range endemics are apparently exploiting the incomplete resource utilization which is due to the rapid faunal changes and environmental instability (Newman, in press). Thus, the isolation and unbalanced biota of the offshore islands and especially of the banks are responsible for preserving in relative abundance otherwise "extinct", rare or unusual forms (Newman and Ross, 1977).

Tanner and Cortes Banks provide feeding grounds for large numbers of the California sea lion, Zalophus californianus (Smith et al, 1975, 1976, 1978; Bonnell, 1978; Littler et al., 1978; present study). The patchy distribution of sea lions in the Southern California Bight "is a highly non-random pattern, resulting from the distinct tendencies of sea lions to aggregate...(on) the island shelves...and the bank, ridges, and escarpments where much of the feeding takes place...(Bonnell et al, 1978). Most foraging is done within 60 km (37 miles) of the nearest hauling ground, although the three nearest hauling grounds are 75-110 km from Tanner and Cortes. "Animals venturing this far from their hauling grounds are apparently extending their typical foraging limits in order to reach a foraging ground of exceptional appeal. Perhaps the increased distance and risk is balanced by the probability of finding sufficient food to allow a quick return to the rookery---especially important to nursing females during the breeding season". (Bonnell et al, 1978.)

Large numbers of sea lions were consistently observed at only a few locations in the Bight. At the Banks, the feeding area farthest offshore, sea lion packs were seen at least nine months of the year. Use of Tanner and Cortes Bank as a primary feeding ground provides further indications of the area's high productivity and uniqueness.

It should be noted that some aspects described herein as unique may be due to the lack of comparable data from other shelf areas. However, the body of geological, physical, and biological evidence presented here is considered adequate to establish the uniqueness of Tanner and Cortes Banks. The Banks comprise an isolated geologic formation on the outer continental shelf and the Banks are situated at two major interfaces: one between continental shelf and deep-water oceanic currents, and the other a transition zone between northern and southern faunal provinces. The geographic isolation, complex circulation, and faunal transitions - interact to create a truly unique area of tremendous scientific and aesthetic value.

Section 5

SUMMARY AND CONCLUSIONS

Tanner and Cortes Banks and the Santa Rosa-Cortes Ridge lie near the western edge of the Southern California Continental Borderland. The Banks are expressed as two submarine prominences on the persistent submarine ridge, the total structure rising 2,000 m above surrounding basins. Minimum water depth above the Banks (4 m) occurs at Bishop Rock. The two banks, connected by a shallow saddle, comprise a total area of approximately 700 square km.

The Banks lie along an interface between open-ocean currents and the Southern California gyre. Deep water mixing and variable relief may produce upwelling and surge as deep as 100 m (330 f). Limited temperature data, and species extensions from northern populations suggest that the banks may represent an area of decreased overall water temperature. These conditions combine with high water clarity in areas of rocky substrate to produce an area of apparent high productivity with macroalgae occurring in high densities to 60 m depth . Evidence of this high productivity is seen in the abundant and diverse fish, and coral, sponge, echinoderm and mollusc populations found.

On the basis of previous mapping seven areas of high relief anticipated to be rocky outcrops were chosen by BLM for further study under this contract AA551-Ct-43 with Interstate Electronics Corporation.

The primary objective of this Biological and Geological Reconnaissance and Charaterization Survey was to observe and map the distribution, composition, and relative abundance of the dominant benthic and biological communities found on and around five rocky outcrop areas on Tanner and Cortes Banks and two rocky outcrop areas in deeper waters adjacent to the Banks and on Santa Rosa-Cortes Ridge. Emphasis was placed on determining distribution and abundance of dominant benthic biological populations including the coral Allopora californica, rockfish, and dominant macroalgae found in areas of rocky substrate in less than 60 m of water. Secondary emphasis was placed on surveying the rocky outcrop communities on the Banks and two adjacent areas to a depth of 150 m.

Supportive objectives for this study were to map the detailed bathymetry of seven rocky outcrop areas on the banks and to map the general surface geological features for each of seven study areas. The purpose of the detailed bathymetric mapping and the visual geological observations was to describe and map the habitats available to the benthic biological communities in the seven selected study areas.

5.1 GEOLOGY

The bathymetric coverage was limited to the areas of high relief rocky outcrops occurring on the banktops. Tracklines were terminated when a continuous surficial sediment veneer was encountered. This was usually proximal to the break in slope at the interface of the prominent destructional terrace level and the irregular rocky outcrop terrain. In general the rocky outcrop areas as mapped by Greene et al. (1975) conformed to those mapped in the present study. The bathymetric maps were contoured at 2 m intervals to a depth of 100 m, and at 5 m intervals deeper than 100 m on the 1:6,000 scale. They were later reduced to the 1:12,000 scale to meet contractual deliverables. The mounted bathmetric maps appear as Plates 404-1 (1-7).

Multidimensional distortion within side scan records made isometric re-creation of individual features an arduous task, far beyond the scope of this project. We instead mapped geomorphic units; larger regions displaying the same geomorphic signatures. Seven generalized geomorphic divisions were observed throughout the banktop region, generally discriminated by topographic relief and bedrock lithology.

High relief igneous (volcanic) rocks compose the central cores of each of the three ridge segments of study area A. On the northern ridge segment primarily on the southern slopes, these rocks appear to be surrounded by undifferentiated igneous and sedimentary rocks. The wave-cut platform surrounding the ridge is covered by a surficial sediment veneer, with bedforms exhibited in northern reaches. On the southern ridge flank no sedimentary rocks are suggested, rather the high relief rocks are flanked by an apron of lower relief rock, both loose and emplaced. The truncated terrace surface appears to be covered by variable amounts of coarse surficial debris (cobbles and boulders alternating with regions of sand) giving way to expanses of coarse sand alone at greater depths of the study area.

Igneous (volcanic) rock units of variable relief compose the two major dome-shaped areas of irregular relief, which together comprise study area B. Within the saddle between the rocky exposures and surrounding the area of irregular relief is a zone of alternating low relief rocky ridges and interspersed expanses of surficial debris. An undifferentiated surficial sediment veneer occurs in protected areas of the massif and on deeper reaches of the truncated platform surrounding it.

Area C consists of three main components, an eastern north-south trending igneous ridge, a central narrow rocky saddle, and a western portion consisting of two main igneous bodies. Differential erosion has caused the formation of low relief wave cut terraces and channels with surficial sediments especially in the western half. Expanses of variable sediments are ubiquitous within the study area.

Only one exposure of bedrock is indicated in the deep study area D. The topographic high appears to be mantled by a continuous surficial veneer of unknown but presumably low thickness.

Truncated sedimentary formations surround a core of more resistant igneous (volcanic) rocks in study areas E and F. A network of low relief ridges within truncated sedimentary formations reflects differential erosion within the folded sequence. Variable amounts of surficial material covers the beveled surface with sediment bedforms proximal to both topographically expressed sedimentary and volcanic ridges.

Rocky outcrop prominences (probably igneous) protrude above a truncated platform surface covered by variable expanses of sand, cobbles and boulders in study area G. Areas of uninterrupted smooth sediment are found only in topographic lows or in protected areas between rocky outcrop exposures.

5.2 OCEANOGRAPHY

Cortes Bank and Tanner Bank are within the California Current. The main contribution of the California Current to the Banks is as a transport mechanism of the cool, low-salinity subarctic water, modified along the route by influx from river outflow and by gradual warming as it moves south. The current moves near the coast to within 40 to 150 km (25 to 93 mi) in the region north of Point Conception and is found some 200 km (124 mi) offshore to the south of the Point where the indentation of the coastline forms the Southern California Bight.

The strong bottom surge and trench-ridge type topography of Cortes Bank are thought to interact to enhance upwelling. Despite the assumed nutrient-rich water, water visibility usually ranged from 11 to 31 m (35 to more than 100 ft) during calm to moderate seas.

5.3 BIOLOGY

5.3.1 Community Structure and Macroalgae Distribution

Five major communities (dominant species associations) were observed in the Tanner Cortes Banks survey. Three of these, the *Eisenia/Calliarthron*, the *Agarum/Laminaria*, and the encrusting coralline communities are characterized by the dominant macroalgae seen on rocky substrates. The fourth is a deep-water *Florometra*/ophiuroid community; the fifth is a sand community lacking macroalgae.

The *Agarum/Laminaria* and *Eisenia/Calliarthron* communities supported a higher diversity and biomass of organisms than the deeper encrusting coralline community. Echinoderms (38 species), coelenterates (36 species), sponges (14 species) and molluscs (40 species) were the best represented invertebrate phyla on the banks. Although only a few crustaceans were seen they comprise an important fish food item and are probably common in the study area.

Although several species, notably fish and gastropods, were fairly common in several communities, most species distributions conformed fairly well to community boundaries.

The most widespread species, which were seen throughout the depth range and in all areas of the survey included two anemones (*Stomphia venosa* and *Tealia piscivera*), a hydroid (family Plumulariidae), a sea urchin (*Lytechinus anamesus*), a starfish (*Mediaster aequalis*), and several encrusting and massive sponges.

The *Eisenia arborea/Calliarthron cheilosporides* community (14-40 m), included (1) a shallow *Gelidium* subcommunity above 26 m on the leeward side of Bishop Rock, (2) a small *Ophiothrix spiculata* dominated area on the leeward side of Central Tanner Bank, (3) a *Zonaria* subcommunity on the north sides of the banks from 26 to 40 m, and (4) a general background subcommunity characterized by *Laminaria* and *Agarum*, and occasionally *Bossiella*.

The *Agarum fimbriatum/Laminaria farlowii* community (40 to 60 m), included (1) an extensive *Eugorgia rubens/Mediaster aequalis* subcommunity north and west of

Bishop Rock which also had patches of Bossiella and Zonaria, (2) an extensive area characterized by the subdominant Zonaria which occurred in a band across Bishop Rock and on the eastern slope of Nine Fathom Reef, and (3) a general background subcommunity of Calliarthron cheilosporides in which the starfish Patiria miniata or Mediaster aequalis commonly occurred.

The encrusting coralline community below 60 m was characterized by the presence of variously colored crusts (algae, bryozoans, sponges, tunicates), the calcareous tube worm, Protula superba, brachiopods (Laqueus and Terebratalia), a "snowflake" bryozoan, a sea anemone (Stomphia coccinea), a hydroid (Abietinaria), and the purple top shell (Calliostoma annulatum). Distinct depth-limited subcommunities included (1) the Mediaster aequalis subcommunity from 60-68 m depth with scattered vase sponges ("Staurocalyptus") and calcareous bath sponges ("Clathrina") and (2) the Plumarella longispina/ Mediaster aequalis/sponge ("Staurocalyptus" and "Clathrina") subcommunity from 68 to 89 m, which also included most of the colonial anemones Corynactis californica on mixed coral reefs covered with Allopora californica, Coenocyathus bowersi, Paracyathus stearns and Balanophyllia elegans.

The Florometra serratissma/ophiuroid subcommunity below 89 m included the deep fish community (Sebastomus, S. elongatus, combfish (Zaniolepis), and Hydrolagus collei) below 120 m.

5.3.2 Community Comparisons and Species Distributions Between Areas

Species associations and community boundaries followed depth contours with great consistency, interrupted only by areas of sand, suggesting that the invertebrates and fish of the banks are directly or indirectly regulated in their distribution by the algal communities. The algal communities may represent most of the algal productivity of the banks and thus the food and shelter available to the resident species. Since algal production and distribution may be directly related to water clarity it may be assumed that any change in water clarity would have an overall effect on the total productivity of the banks.

Local abundances of various benthic organisms that did not correspond to the depth zonation seen were related to the northwesterly current structure which produces a more exposed habitat on the northwest slopes and a more protected habitat on the southeast slopes of the banks.

Some fish species showed pronounced lower depth extensions related to the extreme water clarity and extension of algal growth to greater depths. However, the corals showed extensions into shallower waters from both northern and southern populations probably as a result of the relatively shallow banks interfacing between open ocean currents and the Southern California Gyre.

Fish communities tended to be less differentiated than invertebrate and algae communities, apparently because of the greater mobility and broad depth ranges of the fish species. Species associations within each fish community were consistent overall, but no specific associations were found between fish assemblages and benthic communities. Instead, each fish community spanned two or more benthic communities.

Allopora californica was found to be associated with exposed northwest slopes and occurred mainly on the sides and tops of rocks projecting laterally into the strongest prevailing currents. However, in the shallowest, presumably maximum-energy regimes, Allopora was not found and this may be attributable to storm breakage of the brittle branches. This hydrocoral was also absent from areas which were subject to sand scour or silt deposition. It may be concluded that Allopora californica requires moderately high energy currents or surge essentially clean from silt or sand.

Allopora californica was patchy throughout its distribution (18 to 123 m), and occurred in all areas except for Santa Rosa Ridge which was apparently too deep. Most of these colonies were pink or red in color with only small stands of the more typical purple variety primarily at 45 m depth north of Bishops rock and at 96 m on Northwest Cortes Bank. Only on Northwest Cortes was Allopora commonly seen below 70 m depth. It was coextensive with Laminaria in the shallower communities.

Allopora was most frequently seen between 27 and 72 m depth with peaks between 27 to 37 m and 45 to 62 m. The total area of Allopora habitat was estimated to be 16.7 km^2, with 5.2 km^2 considered as marginal (sparsely inhabited by small colonies). Compared to the total area surveyed, the Allopora habitat amounted to only 3-8% of the Banks. Sixty-six percent of the main Allopora habitat (7.6 km^2) included colonies taller than 7 cm. The habitat for Allopora over 7 cm tall was most extensive on areas A (2.4 km^2), B(1.6 km^2), and E (3.4 km^2) with only small amounts reported for areas C (0.3 km^2) and F (0.5 km^2). Allopora comprised were less than 5% coverage in 96% of the observations made on this coral. The densities observed reflected the extreme patchiness of this coral. The sparsely inhabited marginal habitat was found to have a density of 0.04 colonies/m^2. The main Allopora habitat consisted of a moderately dense area of 0.24 colonies/m^2 and a dense area of 0.75 colonies/m^2.

The standing crop (biomass) of Allopora was estimataed to be 350,000 kg (390 tons). On a sustained yield basis, only 7,000 kg could be harvested annually with only 2,800 kg from SCUBA diving depths (45 m). The current value of the resource for recreational diving ($40,000) probably far exceeds the potential value of the resource as a commercial fishery. Also, the scientific value of the Banks as a relatively undisturbed habitat for a wide range of Southern California Bight species argues favorably for minimal harvesting.

Bishop Rock (Area A) is dominated by an Eisenia community above 40 m depth, and by an Agarum/Laminaria community from 40 to 60 m depth. Below 60 m depth an encrusting coralline community occurred. Two unique subcommunities were observed, the Eugorgia/Mediaster subcommunity to the northwest, which included much of the Allopora of the bank, and the Gelidium subcommunity to the southeast.

Nine Fathom Reef (Area B) is dominated by Eisenia above 40 m depth with Calliarthron ocurring only sparsely. An Agarum/Laminaria community was observed from 40 to 68 m depth with encrusting coralline occurring below 68 m.

Northwest Cortes (Area C) is characterized by a fairly uniform encrusting coralline community that was expected to be common because of the deeper depths surveyed (60 to 123 m) relative to areas A,B,E, and F. This area had an extension of the Mediaster subcommunity from 89 to 94 m on the north slope of the southern rises, and a possible transition zone into an Agarum/Laminaria community above 74 m on the western bank. Allopora reached its deepest extreme on this bank, occurring from 80 to 123 m in the Plumarella/Mediaster/ sponge subcommunity.

Central Tanner (Area E) has only scattered areas of Eisenia above 40 m depth, and is dominated by an Agarum/Laminaria community between 40 to 60 m. This area had unique areas dominated by Ophiothrix spiculata at 40 m depth on the southeast side in very dense populations of crinoids and brittle stars in the Florometra/ophiuroid community at 100 m depth. Allopora was only an occasional above 70 m depth.

Northwest Tanner (Area F) is dominated by an Agarum/Laminaria community between 50 to 56 m depth, and by encrusting corallines below this depth. This area had an extension of the Plumarella/Mediaster/sponge subcommunity from 89 to 98 m on the southeastern rise. Both Allopora and senorita were scarce in this area.

Santa Rosa Ridge (Area G) was uniformly dominated by dense populations of crinoids, basket stars and brittle stars, which occupied most of the available rock substrate.

5.3.3 Fish Distribution and Density

The fish fauna was abundant and diverse around rocky substrates, with 67 species observed. Rockfish (family Scorpaenidae) represented the greatest number of species (28) and were commonly the dominant fish group observed in an area. Fish distribution did not correspond to benthic community boundaries, but instead showed a general correlation with rocky substrate.

In addition to the rockfish, two species of mackerel (Trachurus symmetricus and Scomber japonicus), and yellowtail (Seriola dorsalis) were seen in large schools which may be of commercial importance.

The fishes were found to be stratified into three zones: (1) blackeye gobies (Coryphopterus nicholsi) and two rockfish (Sebastes constellatus and S. rosaceus) were found less than two meters from the bottom, (2) Chromis punctipinnis, Oxyjulis californica, and Sebastes hopkinsi, were found from 2 to 5 m off the bottom, and (3) large predatory fish (Caulolatilus princeps, Sebastes serraroides, S. paucispinis, S. mystinus and Pimelometopon pulchrum) were found 5 to 10 m off the bottom.

The maximum depth of senorita (Oxyjulis californica was extended in the present study from 54 to 100 m, and is thought to be related to the excellent water clarity and the vast areas of high relief rocky outcrop found at these depths on the banks. Senorita reach maximum densities southeast of the shallower banks over rough high relief igneous rocks whereas squarespot rockfish peaked either to the northwest or on either side of the senorita peak.

Several fish species were conspicuously absent from the Banks. Factors responsible included a lack of shallow areas for breeding and nursery areas (i.e., exposed land masses and protected shallow water), absence of Macrocystis kelp forests, limited dispersal to offshore areas, and the relative isolation of the Banks.

5.3.4 Comparisons

Many species observed during the present survey are also observed on the Channel Islands and the southern California mainland. However, many of these species occur in greater relative abundances at Tanner and Cortes Banks.

It is particularly notable that the depth ranges and deepest depths of occurrence of many species and communities are greater at Tanner and Cortes Banks than on the Southern California Mainland or the Channel Islands. In general, the fish observed at Tanner and Cortes were within documented depth ranges, however the algae and invertebrates showed increased depth ranges and deeper depths of occurrence. This differential is due to the much more extensive data base for depth distribution of fish, due to commercial and sport fisheries.

5.3.4.1 Shallow Water Communities - Shallow nearshore areas of the Southern California Mainland less than 5-10 m depth are characterized by algae such as Cystoseira, Egregia, Calliarthron, Eisenia, and the surfgrass Phyllospadix which have strong hold fasts (POCS Ref. Paper II, 1978). Common constituents of rocky subtidal areas at Santa Catalina Island from the lower intertidal to at least 7 m depth include the algae Eisenia, encrusting coralline algae, Lithothrix, Calliarthron, Codium hubbsii/setchellii, Cystoseira, Sargassum spp., Zonaria farlowii, and Gelidium spp., and the invertebrates Corynactis, sponges, starfish (Pisaster giganteus and Linckia columbiae), gastropods (Norrisia norrisii Tegula sp., Megathura crenulata, hydroids, bryozoans, and tunicates (Given and Lees, 1967).

The palm kelp Eisenia arborea and the articulated coralline red alga Calliarthron were the dominant organisms observed from 9 to 21 m depth on Cortes Bank (Littler et al., 1978, SCCWRP, 1978, and Smith et al., 1975 and 1978). Common algae included the reds Gelidium nudifrons, Plocamium and Corallina, the browns Dictyota/Pachydictyon and Laminaria farlowii, and the green alga Codium sp. (encrusting). Common sessile invertebrates included sponges (Demospongiae), hydroids (including Aglaophenia sp.), encrusting bryozoans (Lichenopora/Disporella), and the jewel anemone Corynactis californica (Littler et al., 1978, and Smith et al., 1975 and 1978).

At Tanner Bank rocky areas from 20-25 m depth are also characterized by a dense cover of Eisenia arborea with an extensive understory of red and brown algae including encrusting corallines, Rhodymenia sp., Dictyota, and Plocamium. Dominant invertebrates included the jewel anemone Corynactis californica, and various sponges (Demospongiae) (Littler et al., 1978).

The species composition of the Eisenia/Calliarthron community observed during the present survey is very similar to shallow water communities listed for the Mainland, the Channel Islands, and the previous Tanner and Cortes surveys. Our survey showed the depth range of this community to be much greater (10 to 40 m) than reported by previous studies.

The distribution of Allopora in the Southern California Bight is restricted to several offshore islands and banks including San Clemente, Santa Barbara, Santa Cruz, San Nicholas (Begg Rock), Santa Catalina (Farnsworth Bank) and Tanner and Cortes Banks (U.S. Dept. Int., 1979).

Allopora was abundant along the transects surveyed at San Clemente Island by Smith et al. (1975). Smith et al. (1978) conducted an extensive survey in the vicinity of Bishop Rock (Cortes Bank) from 17 to 34 m depth. Allopora was common at approximately 27 m depth and occurred to 43 m at one of their study sites but was not observed at other sites. Allopora did not occur at the Cortes Bank sites studied by Littler et al. (1978). At Tanner Bank Allopora was common in the Eisenia communities between 20-25 m depth (Littler et al., 1978), and was one of several co-dominant species occurring on rock ridges and spurs from 24-34 m depth (Smith, et al., 1975). Allopora was rare below 25 m depth (Littler et al., 1978, Ecomar 1978) and was not observed below 46 m (Ecomar, 1978). Based on the results of the Ecomar (1978) surveys Benech et al. (1978) concluded that the distribution of Allopora on Tanner Bank was patchy (high to low densities) and is best explained by mechanisms of habitat selection and mode of reproduction.

These conclusions agree with the results of the present survey. The distribution of Allopora on Tanner and Cortes Banks was definitely patchy. The maximum densities (100% cover) occurred on Cortes Bank, however, the mean density was much less than 1%. Peak densities at Tanner and Cortes Banks occurred at 27-37 m and 45-60 m depth. The range of occurrence was from 23 m to 123 m depth with the majority of Allopora occurring above 70 m.

5.3.4.2 Mid-Depth Communities - Below 8 m depth at Anacapa Island Eisenia is replaced by Macrocystis, Agarum and Pterygophora (Neushal, Clark, and Brown in Philbrick, 1967). A survey conducted from 9 to 34 m depth by Smith et al. (1975) at San Clemente Island reported that the dominant algae were Eisenia, Macrosystis, Pelagophycus porra (bull kelp), and encrusting and articulated coralline red algae.

Kelp bed communities dominated by the giant kelp Macrocystis pyrifera are common elements of rocky subtidal areas in the Southern California Bight. Approximately 40% of all kelp beds in the Bight occur at the Channel Islands (POCS Ref. Paper II, 1978).

Differences noted by Littler et al. (1978) and Smith et al. (1975 and 1978) between Tanner and Cortes Banks, and the Channel Islands or the Southern California Mainland include the rarity or absence of garibaldi (Hypsypops rubicundus), kelp bass (Paralabrax clathratus), giant kelp (Macrocystis spp.), and sea fans (Muricea spp.).

The absence of any Macrocystis kelp forests at Tanner and Cortes Banks should affect the species composition and availability of habitats by decreasing habitat heterogeneity. Notwithstanding the differences noted above, such as a greater depth range for the species observed at Tanner and Cortes Banks many of the species found on the Banks are common in kelp beds and mid-depth (10 to 30 m depth) communities of the Southern California Mainland and the Channel Islands.

The present survey showed that an Agarum/Laminaria community occurred from 40 to 60 m depth. At Cortes Bank Smith et al. (1978) noted that the abundance of Eisenia decreased between 21 to 27 m depth but did not observe an Agarum/Laminaria community. Based on previous surveys common invertebrates at these depths included the anemone Corynactis, lobster Panulirus interruptus), starfish (Henricia, Patiria and Pisaster giganteus), bryozoans (Diaperoecia spp., Lichenpora Disporella and Hippodiplosia insculpta) and the sea cucumber Parastichopus parvimensis Smith et al. (1975 and 1978). Below 26 to at least 61 m depth, encrusting coralline algae predominated Smith et al. (1975). At Tanner Bank below 25 m depth there was a notable decrease in the density of Eisenia and understory algae and the predominant community elements were low-growing, encrusting forms including Corynactis, Codium sp. (encrusting), and encrusting coralline algae (Littler et al., 1978, Smith et al., 1975).

At approximately 30 m depth at Tanner Bank Ecomar (1978) reported encrusting corallines, Calliarthron and Ophiothrix as the community dominants. Encrusting coralline algae were common at all depths observed during the present survey but macroalgae such as Agarum and Laminaria were also common to at least 60 m depth. The encrusting coralline communities observed below 20 to 30 m depth by Smith et al. (1975 and 1978), Ecomar (1978), and Littler et al. (1978) are representative of only some of the communities observed at these depths during our survey. The difference is probably related to the patchiness of the distribution of some species and the relatively small areas surveyed during these earlier studies. The large survey area covered by the present study 92 km (52 nmi of transects) allowed a more complete analysis of the extent of the biological communities.

The encrusting coralline community observed during the present survey occurred at depths of 60 to at least 125 m. The community is characterized by the absence or rarity of large erect algae and invertebrates and the presence of encrusting algae, sponges tunicates, and hydroids.

Fish are abundant at Tanner and Cortes Banks between 20-63 m depth and include sheephead (Pimelometopon pulchrum), senorita (Oxyjulis californica), convictfish (Oxylebius pictus), black-eyed gobies (Coryphopterus nicholsi), blacksmith (Chromis punctipinnis), jack mackerel (Trachurus symmetricus), ocean whitefish (Caulolatilus princeps), and several species of rockfish including blue (Sebastes mystinus), rosy (S. rosaceus), olive (S. serranoides), and bocaccio rockfish (S. paucispinis) (Ecomar, 1978, Littler et al., 1978, and Smith et al., 1975; and SCCWRP, 1978). Fish were most abundant at depths less than 40 m (Ecomar, 1978). The species of fish seen during the present survey are similar to those observed during other surveys at Tanner and Cortes Banks, the Southern Califoria Mainland and the Channel Islands.

5.3.4.3 Deep Water Communities - A few surveys have been conducted at Tanner and Cortes Banks at depths greater than 60 m. A trawl and dredge survey was conducted at Tanner Bank over areas of sand and rock between 137-275 m depth (Mearns et al., 1978). The common invertebrates reported by this survey were the sea urchin Allocentrotus fragilis, the starfish Luidia foliolata, the sea cucumber Parastichopus californicus, and the gastropod Nassarius insculptus. Allocentrotus and Luidia were commonly observed during the present survey. Parastichopus was uncommon and Nassarius was only locally common in deep sand patches.

Two stations in areas of sand substrate were sampled at Tanner Bank using a box core at depths of 93-102 m (South Tanner Bank) and 52-73 m (Central Tanner Bank) (Fauchald and Jones, 1978). The species obtained during these surveys were small-sized or have a cryptic habit and consequently were not seen by our observers if they were present.

5.3.4.5 Site-Specific Comparisons - The communities and species observed during previous surveys of Tanner and Cortes Banks are very similar to those seen during the present survey. The differences observed in subdominant species distributions may be attributed to (1) substitutions of functionally equivalent species, (2) local species associations and social behavior resulting in a locally patchy distribution, (3) large changes in the substrate composition from elevated rocky reefs, to boulders, to sand, and (4) differences among the surveys in the relative size of area studied and methods used for observation.

Cortes Bank (Area A) - Data from South Cortes, (Littler et al., 1978) (SAI) are compared with data from Interstate Electronics Corporation dives 9 (time = 1415) and 19 (time = 1425). Data were recorded from areas that were 110 m (0.06 nmi) apart. The sites are located in similar appearing areas of rock outcrops and boulders with some areas of sand. Overall, similar communities were found at the sites: both surveys reported that the dominant macroalgae was Eisenia, encrusting coralline algae, and Calliarthron. The algae Gelidium, Zonaria, Dictyota/Pachydictyon, Corallina, Cystoseira, and Codium sp. (encrusting) were recorded by both surveys, although, Gelidium Zonaria, and Cystoseira occurred in notably higher densities in the Interstate Electronics Corporation areas.

Allopora was not reported by either survey. SAI reported hydroids, anemones, bryozoans, and sponges as the dominant sessile invertebrates. In contrast, sessile invertebrates (sponges and crusts) were observed rarely at the Interstate Electronics Corporation site.

Cortes Bank (Area B) - Data from North Cortes, Littler et al., 1978 (SAI) are compared with data from Interstate Electronics Corporation Area B dives 13 (time = 1017), 15 (time = 0734), and 14 (time = 1855). Data were recorded from overlapping areas. All sites were located in areas of rock ridges, with additional boulders, cobble, and sand channels reported at the Interstate Electronics Corporation sites. Overall, the communities were similar at the sites. Both surveys reported Eisenia arborea as the dominant macroalgae with an extensive understory comprised of red and brown algae, and sessile suspension feeding invertebrates including hydroids, bryozoan, and sponges.

Tanner Bank (Area E) - Data from North Tanner, Littler et al., 1978 (SAI) are compared with data from Interstate Electronics Corporation dive 6 (time = 1333). Data were recorded from areas that were 180 m (0.1 nmi) apart. The SAI site is an area of rock ridges, in contrast to the Interstate Electronics Corporation site which consists of both cliff ledges and sand channels. Both surveys reported that encrusting coralline algae is common. Interstate Electronics Corporation reports that Agarum is dominant on cliff ledges (to $15/m^2$) whereas Agarum was not reported by SAI. Allopora was common at both sites reaching 50% cover on cliff ledges.

Tanner Bank (Area E) - Data from South Tanner, Littler et al., 1978 (SAI) are compared with data from Interstate Electronics Corporation dive 7 (time = 1750). Data were recorded from areas 54 m (.03 nmi) apart. Both sites were located in areas of low rock relief. The communities were similar in both areas with encrusting coralline algae comprising the dominant algae cover. A notable difference between the surveys is that the brittle star Ophiothrix was reported to be the dominant invertebrate by SAI but was only reported as present in low densities by Interstate Electronics Corporation.

Tanner Bank (Area F) - Data from Ecomar (1978) are compared with data from Interstate Electronics Corporation dives 6 (time = 1352) and 3 (time = 1213). Data were recorded from areas that were 66 m (.33 nmi) dive 6 and 460 m (0.25 nmi) dive 3 nmi from the Ecomar site. Because of the differences in depths Interstate Electronics Corporation data was compared with Ecomar data from 40 to 55 m depth. All sites were located in areas of rock ridges with some areas of sand channels. The communities were similar in both areas. Both surveys reported encrusting coralline algae and Agarum fimbriatum as the common macroalgae.

Section 6

RECOMMENDATIONS

6.1 GEOLOGY

Data acquisition and mapping techniques used in this study proved useful in the mapping of shallow, high-relief environments, and should be used for future surveys of this type.

Even though there was a failure in the Hydrocarta system, that method is recommended for future surveys because it is an automated system. Such a system allows more data to be collected and plotted than can be done with manual techniques. Automation also allows scale changes, rapid processing, and data plotting.

The combined use of sidescan and bathymetry helped determine proper side scan towfish stepback and aided in better definition of protuberances not completely resolved on bathymetric profiles. Unless sophisticated acoustic tracking devices are deployed to accurately "fix" the position of the towfish relative to the ship, analog bathymetric records should be run concurrently with the side scan in future surveys, as they were in this survey.

Because detailed quality bathymetry was an objective, ships tracks were closely spaced (200 to 300 m); however, the side scan data could be collected on alternate track lines (400 m spacing) using a wider scale and/or a greater height from the bottom. This would allow an increase in ship speed on lines without side scan and a reduction in the total field survey time without impacting the quality of the final product maps.

If definition of geologic hazards (faults, slumps) or other visible geologic features (seeps, mounds) are of particular importance, in future work the side scan and bathymetry alone are insufficient. The use of a high-resolution profiling system such as a 3.5 or 7 kHz transducer system would add the capability of gas seep recognition.

Even though geological syntheses were carried beyond the simple requirement to determine the extent of rocky outcrops, much more information can still be obtained from the high-quality side scan records delivered on this contract. The detailed mapping of apparent fold and fault trends, bedding attitudes, jointing and fracture patterns, and the precise mapping of smaller-scale features (including individual prominances, boulder fields, sediment wave form concentrations) can be accomplished by detailed isometric reconstruction of the sidescan records.

6.2 BIOLOGY

6.2.1 Submersible Techniques

The use of a manned submersible in performing the survey greatly facilitated the collection of data needed to determine biological communities and species abundances, and is highly recommended for use in future reconnaissance studies. However, submersibles should not be used indiscriminately, and it is recommended that the following points be considered for future programs:

- Submersibles are effective carriers of special equipment and trained scientific observers. Thus, considerable information (e.g., observer's notes, Benthos exterior-mounted camera, video camera, and handheld camera) may be collected per unit time of operation.

- "Free-swimming" submersibles allow miles of tracklines to be covered daily at sustained speeds of about one knot. This speed was found to optimize submersible bottom time, providing extensive bottom coverage while still allowing adequate time for the observers to characterize and record the organisms and communities. SCUBA and surface sampling methods could not be used to survey an area of similar size in a comparable time, although they could survey smaller areas (at shallow depths) in greater detail.

- Reconnaissance submersible survey techniques are similar to those used by a SCUBA diver; however, SCUBA divers cannot provide information from depths much below 60 meters (200 ft). Submersible surveys could routinely provide comprehensive information to 300 m depth.

- Because the substrate of the Banks is characterized by areas of high relief involving rock pinnacles and canyons, rock dredges and other remote sampling gear are generally unsuccessful because of fouling problems (Mearns et al., 1978). Submersibles have the obvious advantage of being able to maneuver around sea floor irregularities while maintaining transect position.

- Local oceanographic and meteorological conditions are critical considerations in selecting appropriate survey techniques. Submersible use can be restricted under conditions of heavy sea and swell, surge, strong currents, and poor water visibility. However, submersible survey techniques yield tremendous quantities of information in a short period of time, allowing the survey to take full advantage of any good weather windows that may develop.

- Although small submersibles of the Nekton class are adequate for this type of survey, the need for more on-board lights, to obtain either color movies or color video, and increased bottom time would necessitate utilization of a larger class submersible having considerably more self-contained battery power. However, increased cost is a major consideration.

6.2.2 Data Collection

Several methods of sampling and observation are available for marine biological survey work including indirect (remote) methods using corers, grabs, dredges, trawls, video cameras and photography, and direct methods using manned submersibles or scuba divers.

The optimal choice of method or technique is dependent on at least four considerations:

- Type of survey to be performed (general reconnaissance, baseline or monitoring).
- Water depth at the site.
- Substrate (sand, rock outcrops, etc.), and relief.
- Anticipated oceanographic and meteorological conditions.

In reconnaissance surveys direct observation yields significantly more and higher quality data than remote techniques. Based on a comparison of the number of identifiable species of fish, algae and invertebrates it was determined that direct observation by scientists resulted in a significantly greater number of species recorded than by video or Benthos cameras alone.

The Benthos camera and strobe system, with its self-contained power, produced an optimal quality record and is a recommended tool for future surveys.

The use of project-dedicated, trained, broadly experienced scientists as observers provided a high level of data consistency, and this approach is recommended for future surveys.

The use of expert consultants is highly recommended as a means of achieving consistency with historical information, and making the study useful for future comparisons and decisions.

The use of overlapping data collection techniques provided backup information in the event of failure of one system. Data collection soures (e.g., audio tape recorder) should be connected to the submersible power system and have battery packs available during dives as backups.

The use of cross transects is recommended as a means of checking the consistency of information between observers, and to extend the data outward or beyond the transect line.

Identification of species and communities was enhanced by the use of three overlapping data collection techniques. No single technique could provide the amount and quality of information obtained using the combination of biological observer, video camera and Benthos camera. The supplemental information provided by hand-held documentation photographs was valuable in verifying specific observations. Biological observers were better than video or Benthos camera for determining densities and species of fish, large macroalgae (such as laminarians), and benthic invertebrates larger than 6 cm. The Benthos camera was used to determine densities of small invertebrates such as cup corals, and small macroalgae, such as <u>Zonaria</u>. The video camera record was used primarily as a supplement to the Benthos camera and observer records, and was used to indicate large-scale community boundaries and the occurrence of dominant species and topographic features. Due to the lack of definition in the video record it was often not possible to differentiate between <u>Allopora</u>, algal tufts, and gorgonians on the basis of the video image alone. Of the three data sources, the video records are not recommended as a sole data source, although they were invaluable as supplementary data.

6.2.3 Data Analysis

Data analysis was designed to provide community definitions for mapping and was not intended to be a comprehensive analysis of the data.

Integration of observer data, video and Benthos photographs in a comprehensive time-coordinated log revealed minor inconsistencies between the recorded times and navigational times because of small calibration differences on clocks or cameras. Coordinated data compilation resolved the initial errors. Correctional procedures are costly, but necessary whenever several overlapping data collection techniques are used and the accuracies are as close as those required in this survey (±30 meters). Incorporation of an audio signal into the data collection/sub-to-surface communications systems would maintain a precise synchronization of all biologial and positioning data. The expense of such a system, producing "beeps" or "clicks" one every minute, should counterbalance the time spent afterward in correctional procedures.

The use of computers use for data manipulation is recommended as a time-saving procedure. Computer entry techniques pointed out the importance of using multiple data sources in providing consistent data. In the final data entry, all three data sources yielded significant information which would have been lost if that specific source had not been used.

Computer entry provided a superior means of editing and cross-checking data values. Errors were detected which were not found during general editing of the transcript. Interpolation of depths, positions and velocities during each minute of travel could not have been accomplished and community mapping was greatly simplified by the use of computer printouts.

6.2.4 Adequacy of Existing Data

Based on the data collected during this survey and previous studies adequate reconnaissance-level information now exists on the biological communities and their general distribution on Tanner and Cortes Banks. It is recommended that these data be used in making management decisions concerning offshore development.

The location and distribution of the species and communities as mapped may be considered as preliminary baseline data, as no obvious impacts due to commercial fishing or harvesting were seen. To determine the effects of offshore development, it is recommended that additional oceanographic information be obtained, and a monitoring program be implemented.

The existing data are inadequate for most measurements of species diversity, and a more intensive sampling and collecting program similar to that done by Littler et al. (1978), is needed to collect this type of information for the entire Banks area.

6.2.5 Recommendations for Additional Data

6.2.5.1 Field Techniques and Equipment - During the present survey several common species could not be fully identified because they could not be collected for positive taxonomic identification in the laboratory. Rare or small species were probably not recorded effectively because of low population densities or due to the limitations of the method of data collection. The present survey could be significantly enhanced by a few days of specimen collection using the submersible.

During several submersible dives completed at night, observers noted changes in the activity and abundance of some species, particularly rockfish and crustaceans (primarily galatheid shrimp). In order to document day versus night differences in abundance, and to record any important species that are observable only at night, it is recommended that night submersible dives be made in some of the areas surveyed during the present study.

6.2.5.2 Data Analysis - As the data are now available for comprehensive analysis, it is recommended that specific analyses be carried out, that would clarify the community structure, and aid in modeling probable impacts due to exploration and development of specific resources in the area.

Complex associations and community structure could be clarified by a more complete application of diversity indices and correlation analysis (such as Fager's Recurrent Group Analysis or Cluster Analysis).

Relationships between parameters should be studied by the application of factor analysis and inverse factor analysis techniques to make an appropriate correlation matrix.

Trend surface analysis (polynomial mapping) techniques should be applied to the study of events associated with the exploration and development of the areas natural resources.

6.2.5.3 Coverage - The greatest submersible coverage and data recording occurred from depths of 42 to 84 meters (150 to 300 ft.) along the transects. Communities at depths less than 42 meters (150 ft.) and deeper than 84 meters (300 ft) received uniform coverage, and the results of the present survey indicate that the overall data coverage for these depths was adequate.

In general, the ten transects conducted in Area A provide adequate coverage for most of the area. However, there is a region near Bishop Rock that could not be surveyed because of the shallow depths and hazardous conditions. It is recommended that SCUBA or diver propulsion vehicle surveys be conducted in this area to verify community interpolations made in the present survey.

The transects conducted in Areas C and G are broadly spaced and interpolations of community distributions had to be made for large areas. Areas C and G are characterized primarily by deep water encrusting coralline communities (60 to 100 meters depth), and *Florometra*/ophinroid communities, respectively. It is unlikely that additional submersible transects in Areas C or G would significantly improve the community interpolations as presently indicated. The community dominants in these areas were easily observable on the video tapes collected and it is recommended that additional data between transects be obtained using a remote-controlled video camera.

The substrate in Area D, based on the side scan records, does not appear to be similar to the substrate observed in other Areas. Therefore, interpolations of community composition were not made. It is recommended that at least one characterization transect be conducted using a manned submersible in this area. Some interpolations probably could be made using data from a remote video camera.

In the Proceedings of the Recommendations for Baseline Research in Southern California Relative to Offshore Resource Development, Gordon (1970) presents a general outline for benthic surveys of the Southern California Bight. Two primary aspects are recommended: (1) surveying in two phases, to first determine the nature of the bottom, and then to characterize habitats, and (2) beginning with the outermost (and therefore least known) areas and progressing to the island groups and inshore.

Interstate's biological and geological reconnaissance of Tanner and Cortes Banks satisfies both geological and biological survey objectives for the outermost areas in the Bight. The results of this work should prove a valuable step in a comprehensive, systematic characterization of Southern California Waters.

Section 7

REQUIRED MAPS AND OVERLAYS

7.1 MAPS AND OVERLAYS

The maps and clear mylar overlays have been supplied in duplicate, separate from the text, as Plates 404-1--404-7. They are presented at a scale of 1:12,000, fully titled and noted with a legend notation. The Bathymetry Base Maps have been mounted on foam-core boards which have brackets to hold the overlays.

PLATE #	TITLE	AREAS
404 - 1	Bathymetry Base	A, B, C, D, E, F, G
404 - 2	Bathymetry and Sidescan	A, B, C, D, E, F, G
404 - 3	Reconnaissance Geology and Geomorphology	A, B, C, D, E, F, G
404 - 4	Submersible Tracklines	A, B, C, E, F, G
404 - 5	Benthic Communities	A, B, C, E, F
404 - 6	Fish Distribution	A, B, C*, E, F
404 - 7	Allopora Distribution	A, B, C , E, F

* Combined with 404-7

7.2 MICROFILM AND MICROFICHED DATA

The scientific and technical data have been microfilmed and microfiched to meet the requirements of the contract.

The precision bathymetric and side scan sonar records are each on separate rolls of 35 mm film by area A to G. If one is interested in looking at a feature from area A on the side scan sonar record, he simply determines which north south line he is interested in, such as [295,0]00 E which corresponds to line 295.0, and then a specific point along that line such as 3,5(94,2)00 N which corresponds to shot point 942. (Trackline numbers, aligned to grid north, correspond to UTM easting in kilometers. Point designations along a line are obtained from the middle three numbers of the UTM northing and correspond with the numbered event marks on the analog bathymetric and sidescan records.) From there, he checks the line listing recorded on the beginning of the film for area A and simply rolls thru the record until he reaches line 295.0 and then rolls on that individual record until he reaches shot point 942 marked on the side of the record.

One survey line may be divided into several microfilm frames. A similar process will also allow one to find any bathymetric feature on the original record. Profile annotation marks are listed in Appendices A, B and C.

The remainder of the material is on microfiche in the following order:

(a) Survey vessel log R.V. VELERO IV
(b) Copies of project leader vessel logs Bathymetry
(c) Bathymetric and side scan sonar tracklines
(d) Survey vessel log R.V. SEAMARK
(e) Project leader vessel logs submersible operations
(f) Submersible dive log position records
(g) Post plot coordinates submersible operations
(h) Copies of scientific observers' field log books:

Scientific Observers:

- R. Grigg
- D. Harden
- J. Word
- A. Lissner
- K. Stoddard
- J. Engle

If one wished to read the speciefics of a dive from area A, he simply looks at the submersible track overlay for area A, selects the dive number such as dive #20 and then turns to Appendix E and looks up dive #20. After reading that material wherein observations, video data, and benthos photographic data were combined, if he so chooses, knowing that K. Stoddard was the scientific observer, he could then go to the microfiche, look for K. Stoddard's log book, look up dive #20, and read the original report written in the field.

Section 8

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APPENDICES

Appendix A

BATHYMETRIC CRUISE REPORT

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CRUISE REPORT

PHASE I SURVEY FOR

DETAILED BATHYMETRIC CHARTING

CHARACTERIZATION SURVEYS OF TANNER

AND CORTES BANKS

Prepared for

UNITED STATES DEPARTMENT OF INTERIOR

Bureau of Land Management
Los Angeles, CA

November 1978

by

INTERSTATE ELECTRONICS CORPORATION
Oceanic Engineering Division

EXECUTIVE SUMMARY

On 18 September 1978 the Interstate Phase I Survey, designed to map in detail the morphology of selected shallow regions of the Tanner-Cortes Banks Region, commenced mobilization aboard the Velero IV at Wilmington, California.

Over the ensuing thirteen day survey period, profile lines in the seven study areas stipulated by the BLM were surveyed for bathymetry and sidescan sonography. No survey time was lost due to weather as unseasonably good weather and sea conditions prevailed. Serious time loss, a result of mechanical and electronic failures in leased survey equipment, forced the use of available contingency time, extending the survey to its maximum allowed duration.

Section 1

INTRODUCTION

The Phase I survey of the Biological and Geological Survey of Tanner and Cortes Banks was designed to map in detail, using bathymetry and sidescan sonography, the morphology of selected shallow regions of the Tanner-Cortes Banks region where rocky outcrops were anticipated. These data were to be used to generate detailed bathymetric and geomorphic maps of these selected regions, and to aid in the locating of submersible transects for future surveys.

During the Phase I survey, bathymetric and sidescan data for each of the seven areas prescribed by the Bureau of Land Management were collected (Figure 1-1). Two hundred thirty-nine tracklines covering over nine hundred sixteen kilometers were run. Each of the seven prescribed survey areas was covered by a grid of primarily north-south oriented tracklines. Primary areas A,B,E, and F, were covered by transects spaced at 200 meters. Lower priority areas C,D, and G were profiled at a 300 meter spacing to insure that all areas were satisfactorily covered by the end of the contracted survey period.

Table 1-1 lists the times, start and end points, and lengths of each of the lines profiled during the Phase I survey effort. Table 1-2 lists the affiliations, duties and tenure of participants directly involved with the survey effort. Figures 1-2 through 1-8 depict the coverage for each of the seven study areas. The operational cruise plan already submitted to BLM, served as the basis for the administration of the survey effort.

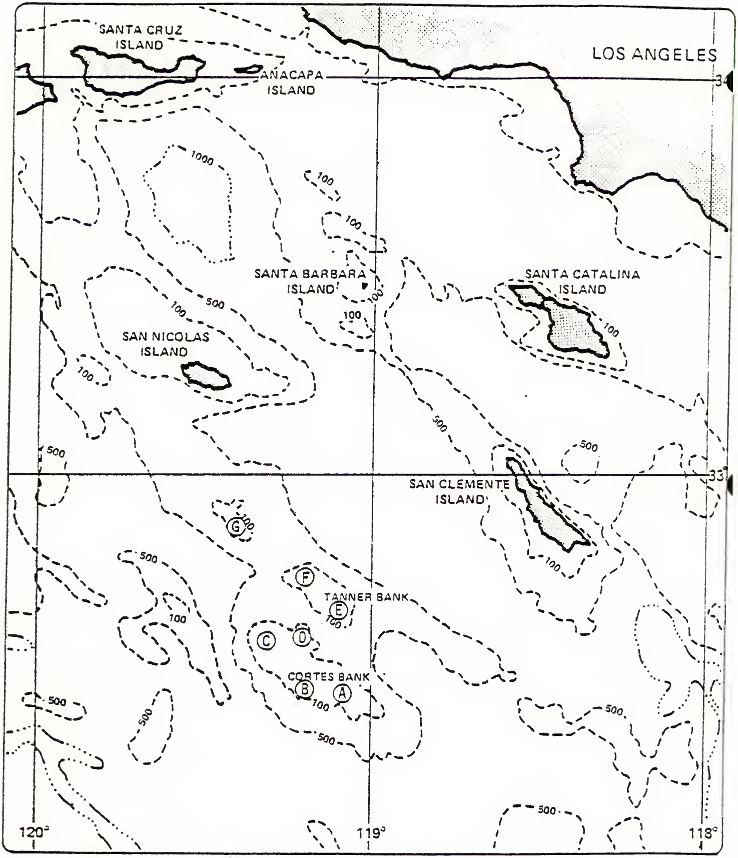


Figure 1-1. Location Map of Tanner Cortes Study Area

TABLE 1-1. PHASE I SURVEY TRACKLINES - SEPTEMBER 1978

Line Number	Julian Day	Beginning of Line Time	Shot Point	End of Line Time	Shot Point	Length (meters)	Hydrocarta Bathymetry	Analog Bathymetry	Side Scan Sonar	Roll Number Bathymetry/ Side Scan	Survey Area	Date
303.0	263	1401	190	1411	178	1200	X	(Test Line)	X	-/001	E	20 Sep 78
302.6		1443	178	1456	198	2000	X		X			
302.2		1512	196	1532	172	2400	X		X			
301.8		1546	174	1602	200	2600	X		X			
301.4		1617	198	1633	174	2400	X		X			
301.0		1657	174	1726	214	4000	X		X			
300.2		1929	178	2010	220	4200	X		X	-/002	E	20 Sep 78
300.6		2021	216	2043	178	3800	X		X			
299.8		2123	214	2143	178	3600	X		X			
299.4		2203	182	2251	228	4600	X		X			
299.0		2307	224	2334	182	4200	X		X			
298.6	264	2351	182	0036	234	5200	X		X			21 Sep 78
298.2		0049	234	0120	184	5000	X		X			
297.8		0140	184	0221	236	5400	X		X			
297.4		0240	234	0314	188	4600	X		X			
297.0		0329	190	0357	230	4000	X		X			
296.6		0422	236	0457	188	4800	X		X			
296.2		0508	188	0530	224	3600	X		X			
295.8		0551	228	0621	180	4000	X		X			
296.0		1214	210	1229	188	2200			X	001/003	E	21 Sep 78
296.4		1238	188	1258	220	3200	X	X	X			
296.8		1314	214	1337	180	3400	X	X	X			
297.2		1355	188	1428	236	4800	X	X	X			
297.6		1441	236	1516	186	5000	X	X	X			
298.0		1530	185	1609	237	5200	X	X	X			
298.4		1623	236	1659	184	5200	X	X	X			
298.8		1716	186	1754	234	4800	X	X	X		E	
299.2		1805	234	1837	182	5200	X	X	X			
299.6		1854	182	1933	226	4400	X	X	X			
300.0		1945	226	2013	176	5000	X	X	X			
300.4		2026	176	2108	220	4400	X	X	X			
300.8		2119	220	2142	178	4200	X	X	X			
301.2		2157	178	2229	212	3400	X	X	X			
301.6		2240	212	2302	176	3600	X	X	X			
302.0		2312	176	2336	202	2600	X	X	X			
302.4	265	0001	202	0019	172	3000	X	X	X	001/004	E	22 Sep 78
302.8		0027	172	0054	202	3000	X	X	X			
303.2		0105	202	0125	172	3000	X	X	X			
303.6		0138	172	0203	202	3000	X	X	X			
303.8		0401	172	0414	190	1800	X	X	X			
304.0		0430	190	0441	174	1600	X	X	X			
303.0		0501	174	0519	200	2600	X	X	X			
303.4		0536	198	0553	176	2200	X	X	X			
192.0		0625	040	0705	950	9000	X					
293.4		1037	970	1059	940	3000	X	X	X	001/005	B	
293.0		1115	940	1155	992	5200	X	X	X			
292.6		1208	992	1253	931	6100	X	X	X		B	

TABLE 1-1. (continued)

Line Number	Julian Day	Beginning of Line Time	Shot Point	End of Line Time	Shot Point	Length (meters)	Hydrocarta Bathymetry	Analog Bathymetry	Side Scan Sonar	Roll Number Bathymetry/ Side Scan	Survey Area	Date
292.2		1309	934	1345	980	4600	X	X	X		B	
291.8		1401	979	1432	934	4500	X	X	X			
291.4		1446	936	1520	976	4000	X	X	X			
291.0		1540	976	1604	938	3800	X	X	X	002/006	B	
290.6		1624	938	1658	974	3600	X	X	X			
290.2		1707	974	1725	942	3200	X	X	X			
594.2		1730	907	1810	974	6700	X	X	X			
298.2		1857	942	1913	914	2800	X	X	X			
298.6		1923	914	1952	946	3200	X	X	X			
299.0		2001	946	2007	934	1200	X	X	X			
593.4		2007	935	2021	923	1200	X	X	X			
301.2		2027	935	2042	906	2900	X	X	X			
301.0		2055	906	2123	944	3800	X	X	X			
301.4		2141	944	2202	906	3800	X	X	X			
301.8		2217	906	2240	938	3200	X	X	X			
302.2		2251	938	2314	894	4400	X	X	X			
302.6		2330	894	2352	926	3200	X	X	X			
303.0	266	0004	926	0026	890	3600	X	X	X			23 Sep 78
303.4		0040	890	0054	910	2000	X	X	X			
303.8		0107	910	0115	904	0600	X	X	X			
298.0		0701	954	0726	920	3400		X	X	002/007	A	
297.6		0922	922	0935	942	2000		X	X			
297.2		0944	942	0958	922	2000		X	X			
296.8		1001	922	1024	950	2800		X	X			
296.4		1038	950	1052	929	2100		X	X			
296.0		1104	928	1125	959	3100		X	X	002/008	A	
295.6		1140	955	1157	930	2500		X	X			
295.2		1212	930	1230	954	2400		X	X			
295.0		1318	954	1330	934	2000		X	X			
295.4		1345	934	1401	956	2200		X	X			
295.8		1415	954	1430	930	2400		X	X			
296.2		1453	930	1512	956	2600		X	X			
296.6		1529	950	1542	925	2500		X	X			
297.0		1601	926	1616	945	1900		X	X			
297.4		1631	942	1644	918	2400		X	X			
297.8		1704	918	1724	942	2400		X	X			
594.6		1745	978	1800	012	2400						
145.0		1807	011	1828	045	5000						
303.8		1903	910	1915	890	2000		X	X			
304.2		1930	890	1948	911	2100		X	X			
304.6		1958	910	2009	890	2000		X	X			
305.0		2024	886	2037	903	1700						
305.2		2056	902	2105	886	1600						
304.8		2115	886	2134	908	2200						
304.4		2148	906	2158	888	1800						
304.0		2318	088	2334	911	2300		X	X			
303.6	267	0102	910	0116	888	2200		X	X			24 Sep 78
303.2		0130	888	0148	916	2800		X	X			
302.8		0205	916	0223	890	2600		X	X		A	

TABLE 1-1. (Continued)

Line Number	Julian Day	Beginning of Line Time	Shot Point	End of Line Time	Shot Point	Length (meters)	Hydrocarta Bathymetry	Analog Bathymetry	Side Scan Sonar	Roll Number Bathymetry/ Side Scan	Survey Area	Date
302.4		0237	890	0307	939	4900		X	X	002/009	A	
302.0		0403	938	0429	900	3800		X	X			
594.4		0539	1016	0600	985	3100		X	X			
594.0		0617	988	0644	1022	4000		X	X			
593.6		0701	1016	0726	980	3600		X	X			
591.8		0739	986	0802	1022	4800		X	X			
594.2		0821	1016	0842	986	3000		X	X			
298.4		0858	942	0918	914	2800		X	X			
315.0		0935	0	1000	34	3000		X	X			
594.2		1018	968	1042	936	3200		X	X		A	
293.6		1100	942	1125	978	3600		X	X		B	
293.2		1139	978	1210	930	4800		X	X			
292.8		1227	936	1258	979	4300		X	X			
292.4		1311	979	1339	933	4600		X	X			
292.0		1353	931	1427	980	4900		X	X			
291.6		1604	980	1630	935	4500		X	X			
291.2		1720	937	1748	976	6100		X	X	002/010	B	
290.8		1806	970	1825	940	3000		X	X			
290.4		1840	939	1904	974	3500		X	X	003/010	B	
290.0		1919	974	1939	939	3500		X	X			
289.6		1952	939	2015	966	2700		X	X			
289.2		2033	966	2051	936	3000		X	X			
288.8		2126	942	2146	970	2800		X	X			
288.6		2227	970	2248	937	3300		X	X			
289.0		2303	941	2321	966	2500		X	X			
289.4		2334	966	2352	937	2900		X	X			
289.8	268	0003	937	0023	969	3200		X	X		B	25 Sep 78
293.0		0330	214	0402	262	4800		X	X	003/011	F	
292.6		0418	262	0455	209	5300		X	X			
292.2		0511	210	0546	266	5600		X	X			
291.8		0606	266	0644	210	5600		X	X			
291.4		0654	209	0723	270	6100		X	X			
291.0		0752	267	0817	232	3500		X	X			
290.6		0834	227	0903	270	4300		X	X			
290.2		0922	270	0949	233	3700		X	X			
289.8		1008	238	1029	270	3200		X				
289.4		1042	270	1112	227	4300		X	X			
289.0		1132	238	1157	266	2800		X	X			
288.8		1213	266	1233	238	2800		X	X			
289.2		1247	238	1310	270	3200		X	X			
289.6		1324	270	1350	226	4400		X	X			
290.0		1405	226	1435	270	4400		X	X			
290.4		1749	267	1809	235	3200		X	X			
290.8		1827	236	1856	270	3400		X	X			
291.2		1905	270	1934	230	4000		X	X	003/012	F	
291.6		1951	226	2022	266	4000		X	X			
292.0		2032	266	2107	210	5600		X	X			
292.4		2125	215	2205	262	3700		X	X	003/012	F	
292.8		2218	262	2250	210	5200		X	X			
293.2		2309	210	2350	262	5200		X	X		F	

TABLE 1-1. (Continued)

Line Number	Julian Day	Beginning of Line Time	Shot Point	End of Line Time	Shot Point	Length (meters)	Hydrocarta Bathymetry	Analog Bathymetry	Side Scan Sonar	Roll Number Bathymetry/ Side Scan	Survey Area	Date
293.6	269	0000	262	0024	224	3800		X	X		F	26 Sep 78
294.0		0033	228	0101	262	3400		X	X			
294.4		0112	262	0133	30	2100		X	X			
294.8		0138	233	0157	258	2500		X	X			
295.2		0217	258	0236	233	2500		X	X			
295.6		0459	231	0516	257	2600		X	X			
296.0		0530	257	0550	228	2900		X	X			
296.4		0554	228	0610	250	2200		X	X			
296.8		0621	250	0637	229	2100		X	X			
297.0		0656	230	0710	250	2000		X	X			
296.6		0738	250	0800	220	3000		X	X			
296.2		0814	222	0827	252	3000		X	X			
295.8		0858	250	0916	226	2400		X	X			
295.4		0925	228	0948	257	2900		X	X			
295.0		1002	255	1020	230	2500		X	X			
294.6		1031	230	1058	259	2900		X	X			
294.2		1115	258	1143	231	2700		X	X	003/013	F	
293.8		1150	230	1210	259	2900		X	X			
293.4		1225	259	1251	207	5200		X	X		F	
291.6		1422	050	1447	010	4000		X	X	003/014	C	
291.2		1502	010	1544	062	5200		X	X			
290.6		1632	050	1650	010	4000		X	X			
290.2		1726	010	1807	062	5200		X	X			
289.8		1823	062	1852	010	5200		X	X		C	
269.7	271	1046	448	1056	426	2200		X	X	004/015	G	28 Sep 78
270.0		1103	426	1118	452	2600		X	X			
270.3		1133	452	1146	426	2600		X	X			
270.6		1204	426	1216	446	2000		X	X			
270.9		1226	446	1235	432	1400		X	X			
271.2		1256	428	1307	448	2000		X	X			
271.5		1318	448	1338	414	3400		X	X			
271.8		1344	414	1405	434	2000		X	X			
272.1		1420	434	1443	394	4000		X	X			
272.4		1501	394	1523	432	3800		X	X			
272.7		1533	432	1602	378	5400		X	X			
273.0		1613	378	1641	426	4800		X	X			
273.3		1651	426	1718	376	5000		X	X	004/016	G	
273.6		1735	378	1758	420	4200		X	X			
273.9		1807	420	1831	374	4600		X	X			
274.2		1841	374	1904	416	4200		X	X			
274.5		1913	416	1935	374	4200		X	X			
274.8		1943	374	2004	412	4000		X	X			
275.1		2012	412	2032	372	4000		X	X			
275.4		2042	372	2058	402	3000		X	X			
275.7		2106	402	2117	380	2200		X	X			
276.0		2127	380	2137	388	0800		X	X		G	
279.9	272	0008	086	0043	022	6400		X	X		C	29 Sep 78
280.2		0058	022	0132	086	6400		X	X			
280.5		0143	086	0225	014	7200		X	X			
280.8		0238	014	0402	112	9800		X			C	

TABLE 1-1. (Continued)

Line Number	Julian Day	Beginning of Line Time	Shot Point	End of Line Time	Shot Point	Length (meters)	Hydrocarta Bathymetry	Analog Bathymetry	Side Scan Sonar	Roll Number Bathymetry/ Side Scan	Survey Area	Date
281.1		0415	112	0507	008	10400		X			C	
281.4		0521	008	0611	114	10600		X				
281.7		0657	114	0756	006	10800		X	X	004/017	C	
282.0		0804	006	0855	114	10800		X	X			
282.3		0907	114	1002	006	10800		X	X			
282.6		1230	010	1322	110	9000		X	X			
282.9		1431	110	1520	018	9200		X	X			
283.2		1607	006	1702	110	10400		X	X			
283.5		1712	110	1804	006	10400		X	X			
283.8		1815	006	1908	110	10400		X	X			
284.1		1917	102	2005	006	9600		X	X			
284.4		2015	006	2102	098	9200		X	X			
284.7		2110	098	2154	006	9200		X	X			
285.0		2203	006	2246	090	8400		X	X			
285.3		2254	090	2311	054	3600		X	X			
285.6		2330	054	2341	076	2200		X	X	004/018	C	
285.9		2349	076	0000	054	2200		X	X			
286.2	273	0010	054	0020	074	2000		X	X			30 Sep 78
286.5		0031	074	0044	050	2400		X	X			
286.8		0054	050	0106	070	2000		X	X			
287.1		0116	074	0131	046	2800		X	X			
287.4		0143	046	0158	074	2800		X	X			
287.7		0208	072	0225	042	3000		X	X			
288.0		0238	042	0252	070	2800		X	X			
288.3		0303	070	0324	030	4000		X	X			
288.6		0506	030	0523	068	3800		X	X			
288.9		0536	068	0559	024	4400		X	X			
289.2		0611	024	0632	058	3400		X	X			
289.5		0640	058	0704	014	4400		X	X			
289.8		0722	016	0744	060	4600		X	X	005/018	C	
291.6		0834	090	0841	106	1600		X			D	
291.9		0849	106	0859	086	2000		X				
292.2		0909	086	0921	110	2400		X				
292.5		0931	110	0947	076	3400		X				
292.8		0954	076	1011	110	3400		X				
293.1		1019	110	1046	050	6000		X				
293.4		1055	050	1124	110	6000		X				
293.7		1141	110	1220	052	5800		X	X	005/019	D	
294.0		1252	052	1330	100	4800		X	X			
294.3		1358	108	1426	050	5800		X	X			
294.6		1444	050	1523	100	5000		X	X			
294.9		1534	100	1602	046	5400		X	X			
295.2		1618	046	1630	066	2000		X	X			
295.5		1641	066	1656	044	2200		X	X			
295.8		1709	044	1722	060	1600		X	X			
296.1		1734	060	1742	044	1600		X	X			
315.1		1820	000	1933	130	13800		X	X		D	
END OF SURVEY												

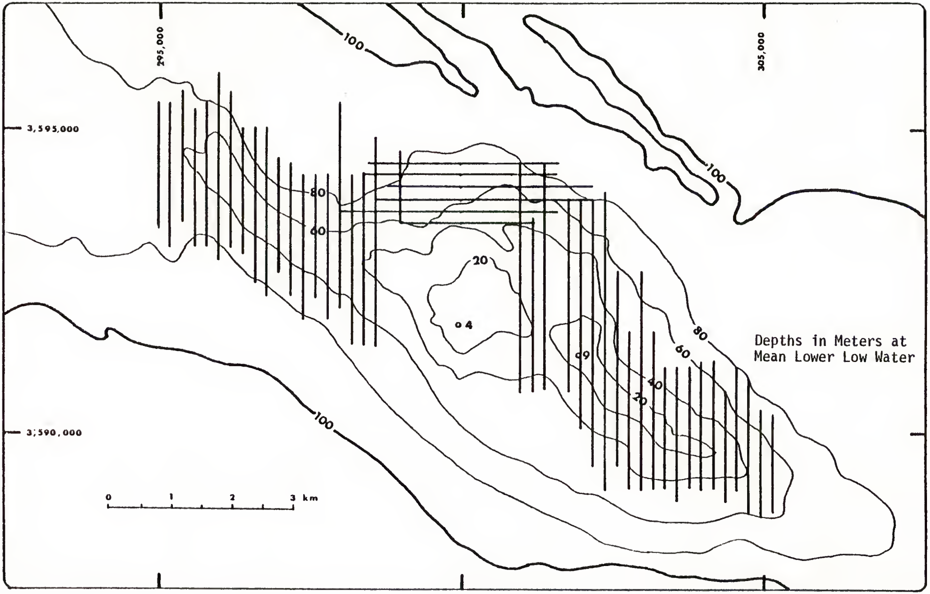


Figure 1-2. Area "A" Profiles, Bishop Rock Study Area

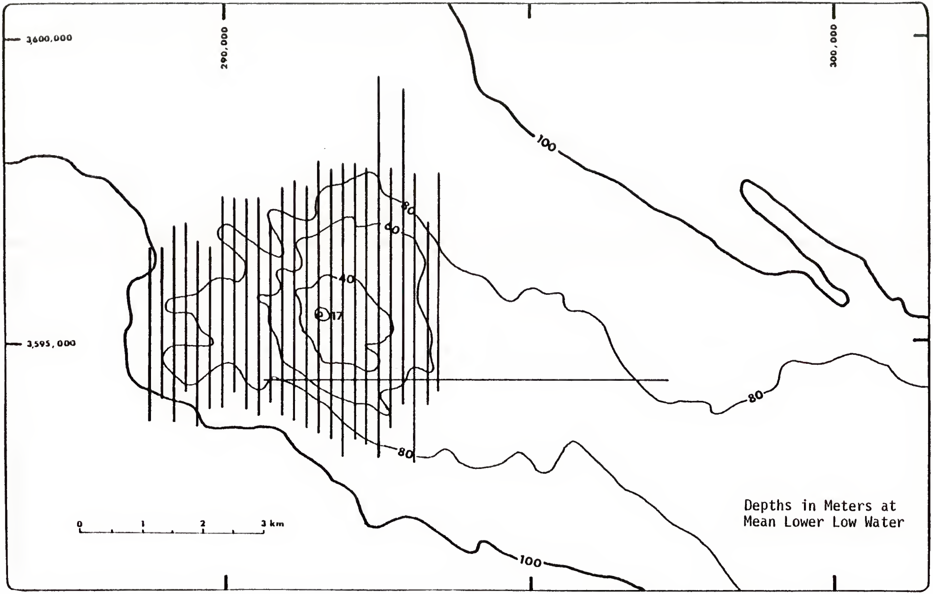


Figure 1-3. Area "B" Profiles, Nine-Fathom Reef Study Area

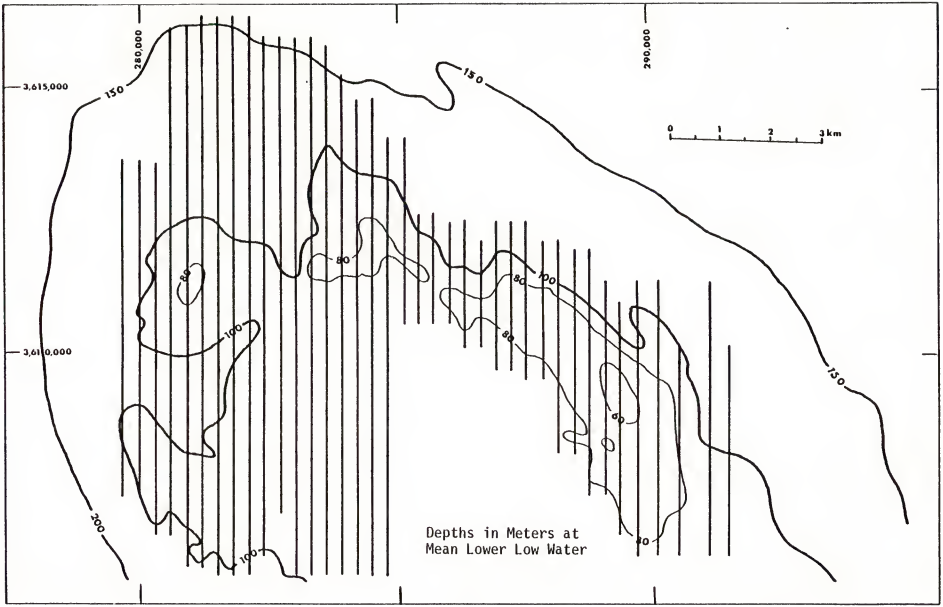


Figure 1-4. Area "C" Profiles, Northwest Cortes Bank Study Area

Figure 1-5. Area "D" Profiles, Tanner-Cortes Trough Study Area

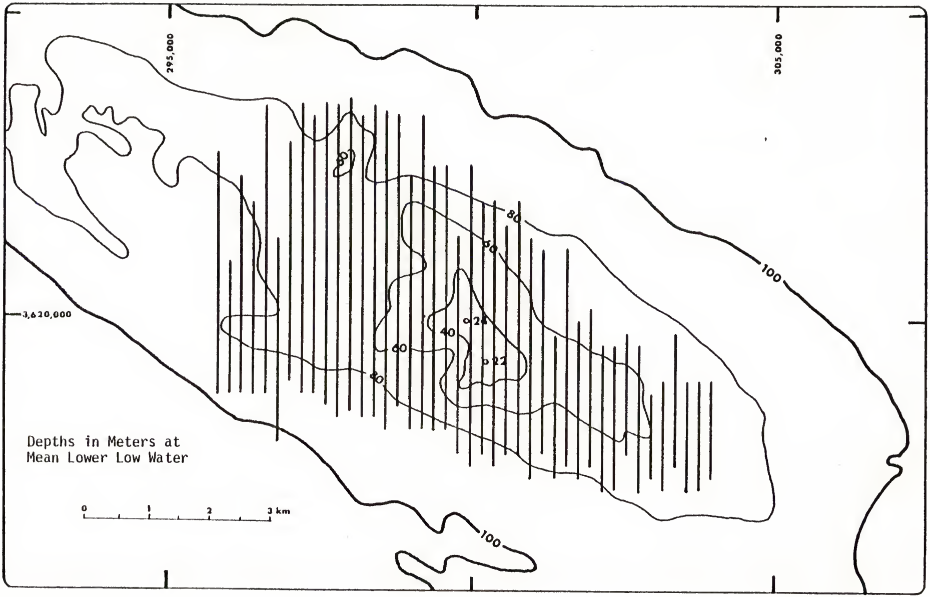


Figure 1-6. Area "E" Profiles, Central Tanner Bank Study Area

Figure 1-7. Area "F" Profiles, Northwest Tanner Bank Study Area

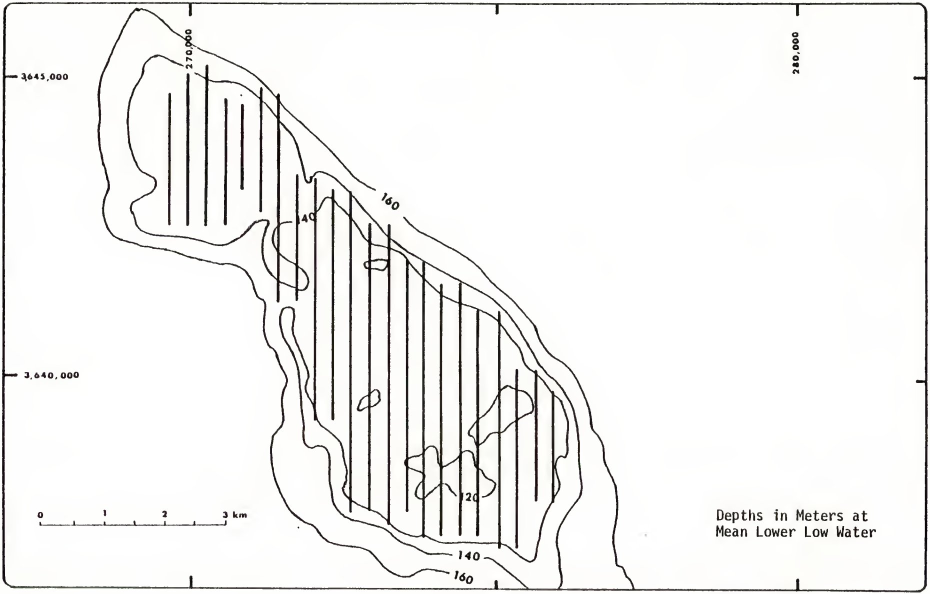


Figure 1-8. Area "G" Profiles, Santa Rosa-Cortes Ridge Study Area

TABLE 1-2. PARTICIPANTS: PHASE I BATHYMETRIC MAPPING OPERATIONS
CRUISE DURATION - 18 SEPTEMBER 1978 THROUGH 01 OCTOBER 1978

Interstate Electronics Corporation

Oceanic Engineering Division
707 E. Vermont Avenue - P.O. Box 3117
Anaheim, California 92803

714/772-2811 - 213/626-9422

Shipboard Party	Function	Participation
P.C. Day	Party Chief	Duration
C. Finklestein	Sidescan Specialist	Duration
D. Johnson	Bathymetry	Duration
E. Lawrence	Bathymetry	21 September - 01 October
J. Lettow	Sidescan	Duration
Shore Support		
C.F. McFarlane	Shore Support	Duration
W. Merselis	Program Manager	Duration

Navigation Services, Inc.

1600 Callens Road - P.O. Box 820
Ventura, California 93001

805/644-7405

F. Jerkovich	Navigator	Duration
R. Wollin	Navigator	Duration

Gardline Hydrographic Surveys, Inc.

9730 Town Park Drive
Houston, Texas 77036

Shipboard Party

E. Gibbon	Engineer	18-21 September
J. Jelks	Hydrographer	18-27 September
G. O'Brien	Hydrographer	18-27 September
A. Sibold	Hydrographer	18-27 September

Institute of Marine and Coastal Studies Support Facility

100 East Water Street
Wilmington, California 90744

213/830-7022 or 213/741-6977

Shipboard Party

W. Bradley	Marine Technician	Duration
A. Valois et al.	Master et al., R/V Velero IV	Duration

Shore Support

D. Newman	Supervisor, Technical Support Services	Duration

Bureau of Land Management
Outer Continental Shelf Office
300 N. Los Angeles Street
Los Angeles, California 90053

Shipboard Party

J. Lane	Shipboard Representative	18 - 21 September

Shore Support

R. Wilhelmson	Technical Program Representative	Duration

Section 2

SURVEY ITINERARY

2.1 INTRODUCTION

The Phase 1 survey effort may be conveniently divided into five major operational phases:

-	Mobilization	18 - 19 September
-	Leg 01 Survey	19 - 26 September
-	Refitting	27 September
-	Leg 02 Survey	28 September - 01 October
-	Demobilization	01 October

The following itinerary highlights some of the major events which occured during each of the five survey phases. As only sketchy descriptions are provided in this review, the reader is encouraged to refer to the original Survey Party Chief's and Watch Leaders' Logs for elaborations. During Mobilization, Refitting and Demobilization phases, a synopsis of a continuous sequence of events is offered. During Leg 01 and 02 Survey phases, any non-routine event which consumes more than 30-40 minutes of shiptime is noted and explained in the itinerary.

2.2 SURVEY ITINERARY

2.2.1 Mobilization

18 September (Day 1)

0700 - Commence mobilization aboard Velero IV at University of Southern California Marine Support Facility.

0915 - Assume possession of ship after laboratory spaces cleaned to Interstate's satisfaction.

1100 - All scientific equipment and personnel present at ship.

1600 - Navigation completely installed and tested - system "GO".

- Sidescan sonar bench-tested - system "GO".

- Work in progress to bring leased USC depth recorder on line.

- Work in progress to interface Hydrocarta computer with Argo navigation.

- Work in progress to repair hydraulic leak on leased Tetra Tech winch.

2200 - Work in progress on "down" systems. Progress reported on all but Tetra Tech winch, which upon testing was found to have bad motor bearing. Postpone systems mobilization until morning.

19 September (Day 2)

0800 - USC depth recorder tested - system "GO".

0830 - Winch motor located.

1000 - Hydrocarta interface with navigation functioning, however, interface to plotter malfunctioning.

1500 - Gardline reports Hydrocarta systems functioning except for plotter which is not critical for surveying. Plotter interface on order.

1515 - After extensive modification to new motor, winch is functioning - system "GO".

1600 - Clean and repair dirty and ill-maintained sliprings on winch.

1800 - After final preparations proceed for shakedown.

2110 - Return to port, receive plotter interface. Retain Hydrocarta engineer onboard to troubleshoot system. USC recorder fails to print, however provides good data to depth digitizer. Order spares.

2130 - Leave port for survey area, and troubleshoot equipment enroute. Plotter spares do not solve problem. Plotter still down, and helmsman display does not function. Must navigate manually using data generated from Hydrocarta.

2.2.2 Leg 01 Survey

19 September (Day 2)

2136 - Leave port, transit to Area E.

20 September (Day 3)

0634 - Calibration of Argo navigation system completed. Proceed to survey area.

0730 to
1230 - Attempts to digitize depths from alternate recorders fail. Digitize depths from USC Edo recorder, but no bottom trace on record.

- While digitizing problems being solved, mark winch wire into depth intervals to record wire out.

1230 - Deploy sidescan fish. Field test all systems.

1402 - Begin first profile (303.0), Area E.

1748 to
1829 - Profiles 300.6 must be rerun, due to Hydrocarta difficulties.

21 September (Day 4)

0049 - Continuous profiling (298.2), Area E.

0621 to
1214 - Interrupt profiling (296.0), Area E, to receive Rio Rita. Onload spare recorder and parts. Onload Lawrence. Offload Lane and Gibbon. Digitize new leased Edo recorder.

1214 - Continue profiling (296.0), Area E.

22 September (Day 5)

0001 - Continuous profiling (302.4), Area E.

0215 to
0401 - Profiles 304.0, 303.0, 303.4 must be rerun due to sidescan difficulties.

0705 to
0845 - Transit to Area B.

0845 to
1037 - Repair kink in electromechanical cable.

1730 - Profile to (594.2), Area A.

1820 to
1857 - Profile 298.2 must be rerun due to Hydrocarta difficulties.

23 September (Day 6)

0004 - Continuous profiling (303.0), Area A.

0115 - Abort profile 303.8. Hydrocarta down.

0115 to
0350 - Hydrocarta repairs attempted.

0350 - Hydrocarta down for duration. Alert NSI navigators that they will now provide positioning.

0500 - First navigation preplots available.

0701 - First line shot by navigators (298.0).

0726 to 0922 - Prepare navigation communications, remote marking systems

1230 to 1318 - Repair winch.

2158 to 2318 - Depth recorders down.

24 September (Day 7)

0102 - Continuous profiling (303.6), Area A.

0307 to 0403 - Depth recorders down.

0429 to 0539 - Bridge abort 298.8 (too shallow).

1018 - Profile to (594.2), Area B.

1427 to 1604 - Clean sliprings on winch.

1630 to 1720 - Avoid fishing boats.

2051 to 2126 - Avoid fishing boats.

2146 to 2227 - Avoid fishing boats.

Abort lines 288.4, 288.0, 287.8, 288.2 due to navigation hazard posed by fishing boats.

25 September (Day 8)

0003 - Continuous profiling (289.8), Area B.

0023 to 0330 - Transit to Area F.

1435 to 1749 - Clean sliprings, adjust sidescan tackle.

26 September (Day 9)

0000 - Continuous profiling (293.6), Area F.

0236 to 0459 - Crashed sidescan fish, minor damage only.

1251 to 1422 - Clean sliprings, adjust winch brake while in transit to Area C.

1544 to 1632 - Clean sliprings, adjust winch brake.

1825 to 1905 - Winch brake fails, posing a danger to personnel. Decision to proceed to port for repairs.

1905 to 2000 - Secure deck equipment.

2000 - Proceed to Wilmington for repairs.

27 September (Day 10)

0000 - In transit to port for winch repairs.

0830 - Arrive at USCMSF, commence repairs. Areas A,B,E, and F completed at 200 meter spacing. Will complete areas C,D, and G at 300 meter spacing. Offload Gardline personnel.

2.2.3 Refitting

1755 - Leave port after winch repairs (hydraulic hoses, sliprings, brake drum) completed and winch tested.

28 September (Day 11)

0000 - Enroute to Area G, heavy swell prevalent.

0430 - Although within range of San Nicholas RPS station there is no signal with which to calibrate Argo navigation system. Proceed back to Catalina to receive alternate station. Transit slow through heavy swell.

0712 - Calibration completed. Proceed back to Area G.

2.2.4 Leg 2 Survey

1010 - Sidescan fish in water.

1046 - Commence profiling (269.7), Area G.

2137 to 0008 - Transit to Area C.

29 September (Day 12)

0008 - Continuous profiling (279.9), Area C.

0611 to 0657 - Broken wire in sliprings.

1022 to 1230 - Argo navigation station at Santa Rosa down, switch to San Clemente.

1322 to 1431 - Weak navigation signal.

1520 to 1607 - Weak navigation signal, onshore repairs in progress.

30 September (Day 13)

0010 - Continuous profiling (286.2), Area C.

0324 to 0506 - Clean sliprings, adjust brake on winch.

0744 to 0834 - Transit to Area D.

Broken wires in sliprings repaired while bathymetry in progress. No sidescan lines 291.6, 291.9, 292.2, 292.6, 292.8, 293.1, 293.4.

1933 - Complete profiling Area D.

2025 - Deck secured, all operations completed. Head for port.

01 October (Day 14)

0000 - In transit to USCMSF after completion of all operations.

0800 - Arrive at USCMSF dock.

2.2.5 Demobilization

1030 - All gear offloaded and scientific laboratories cleaned. All personnel and equipment clear of ship.

Section 3

PHASE 1 SURVEY EQUIPMENT

Equipment failures were ubiquitous during Phase I survey operations. Although no equipment was lost during the course of the survey, not one of the systems listed in Table 3-1 was continually reliable. Second-, third- and fourth-order contingency equipment, as well as primary equipment, failed during the survey. Table 3-1 lists each major piece of equipment used during the survey and its supplier. Equipment shortcomings, damage and encountered problems are also tabulated.

TABLE 3-1. PHASE I EQUIPMENT LIST

Supplier	Equipment	Problem
Navigation Services Inc.	• Cubic Argo Navigation System Model DM-54 • Motorola Mini Ranger III Radio Positioning System • Preplot computers	Two base station failures accounted for several hours lost. Some pre-survey misinformation may have compounded Gardline's problems with the Argo-Hydrocarta interface.

Gardline Hydrographic Services	• Hydrocarta H.S. Survey System
	  • Argo Navigation Interface
	  • Depth Digitizer
	  • Plotter
	  • Helmsman Display
	  • Computer
		Online plotter and helmsman display never operational. Argo interface functional after an excessive 30-hour mobilization period. Total Hydrocarta system failure 78 hours after commencement of the Leg 01 survey.

University of Southern California	• R/V Velero IV • Gifft Graphic Recorder #GDR-19 • Hydro Products Model 4000 T Graphic Recorder • EDO Western Model 551 Graphic Recorder • EDO Western Model 444 Transceiver	Primary recorder Edo 551 crippled throughout the cruise. Although able to run, digitizer did not provide analog trace. Replaced by leased Edo Western 550 recorder, however was pirated for spare circuit boards. Hydroproducts and Gifft recorder saw slight duty and failed therein intermittently.

TABLE 3-1. (Continued)

Tetra Tech Inc.	• Klein Model 400 Series Sidescan Fish and Recorder • Spares Kit (Sidescan) • Sidescan Winch	Before commencement of the survey it was necessary to to overhaul and clean slip-rings, purchase, custom-machine and install a replacement motor, and repair the hydraulic oil filter assembly even after Tetra Tech had claimed recent winch overhaul. Failure of the brake drum and leaky hydraulic hoses forced return to port midway through cruise to initiate repairs. Side scan equipment intermittently failed, and was repaired with spares kit replacements. Ill maintained sliprings on the winch necessitated numerous cleanings, causing a significant loss in shiptime.
Carl Moller Inc.	• Klein Model 400 Series and Sidescan Fish Recorder	Spare sidescan system saw limited use and performed generally well. Helixes were cleaned and replaced.
EDO Western Corp.	• EDO Western Model 550 Graphic Recorder • Spares Kit	Replacement graphic recorder was shipped without power cord. Soon after put in use, a motor control board had to be replaced. A second motor control board had to be pirated from USC's recorder when the replacement board became inoperative.

Section 4

ACCOMPLISHMENTS

Table 4-1 lists the daily accomplishments of the Phase I survey. This detailed breakdown numerically describes the progress of work and the extent of down time on a daily basis. The results presented in Table 4-1 are based on the data generated in Table 1-1.

Occasionally, because of equipment or operational problems, some sidescan and/or bathymetry data are missing. Often, only a few shotpoints of data are missing, however in some cases whole lines of data are missing or unusable. The amount of missing or unusable data is estimated to be below 5 percent of the total data collected, however an exact percentage and the specific data gaps cannot be accurately determined until final bathymetric sounding maps are prepared by Gardline Hydrographics. Detailed information will be included in the monthly progress report submitted to BLM as it becomes available.

Portions of three areas were not surveyable as planned:

1. No lines within a radius of 1,000 meters of Bishop Rock (Area A) were surveyed. Concern for the safety of the ship near the shallow area prevented the survey party from running those tracks.

2. No lines were surveyed within a radius of 1400 meters of the drillship Coral Sea, located on the western end of Area E. Danger of fouling her anchor cables with our equipment forced us to stay outside of her marked anchor buoys.

3. Planned survey of the westernmost six lines in Area B was aborted because of the presence of a fishing fleet. Several close calls at night when profiling prior lines documented a distinct hazard to the ship.

TABLE 4-1. DAILY PHASE I SURVEY PROGRESS

Julian Day	Number Lines	Number Kilometers	Survey Time	Time Per Turn	Total Time for Turns	Downtime	Percent Day Survey	Percent Day Turns	Percent Day Downtime	Mean Daily Rate	Corrected Survey Speed On Line	Date
261	0	0	0	0	0	15.0 - Mobilization	0	0	100	0	0	18 Sep
262	0	0	0	0	0	18.0 - Mobilization 3.5 - Shakedown 2.5 - Transit						19 Sep
263	13	35.0	5.0	0.35	3.8	5.0 - Recorders 2.1 - Operations 1.8 - Hydrocarta 7.5 - Transit	20	46	34	1.4	7.0	20 Sep
264	24	103.2	11.7	0.24	5.4	5.9 - Operations	51	23	26	4.5	8.8	21 Sep
265	33	96.9	11.8	0.21	6.0	1.8 - Sidescan 1.7 - Transit 1.9 - Operations 0.6 - Hydrocarta	49	32	18	4.1	8.2	22 Sep
266	29	68.0	7.6	0.25	6.3	5.8 - Hydrocarta 2.0 - Operations 0.8 - Winch 1.3 - Recorders	32	26	42	2.9	8.9	23 Sep
267	29	103.8	11.3	0.27	7.5	1.0 - Recorders 1.1 - Operations 1.6 - Winch 1.7 - Operations	47	31	22	4.5	9.2	24 Sep
268	24	101.5	11.4	0.26	5.9	3.5 - Sidescan	48	38	15	4.2	8.9	25 Sep
269	27	77.2	9.1	0.28	6.0	2.4 - Sidescan 1.5 - Transit 0.8 - Winch 5.1 - Winch	37	30	33	3.1	8.5	26 Sep
270	0	0	0	0	0	24.0 - Winch	0	0	100	0	0	27 Sep
271	22	72.4	6.8	0.23	4.9	4.2 - Winch 6.0 - Navigation 0.5 - Operations	30	22	48	3.0	10.6	28 Sep
272	21	177	14.8	0.18	3.0	2.5 - Transit 0.8 - Winch 2.1 - Navigation 1.1 - Navigation 0.8 - Navigation	59	22	19	7.4	12.0	29 Sep

TABLE 4-1. (continued)

Julian Day	Number Lines	Number Kilometers	Survey Time	Time Per Turn	Total Time for Turns	Downtime	Percent Day Survey	Percent Day Turns	Percent Day Downtime	Mean Daily Rate	Corrected Survey Speed On Line	Date
273	20	81	10.6	0.22	6.4	1.5 - Winch 0.8 - Transit 4.5 - Transit	45	49	6	3.3	7.6	30 Sep
274	0	0	0	0	0	8.0 - Transit	0	100	0	0	0	1 Oct
PHASE I TOTALS	239	916.0	100.1	0.25	55.2	33.0 - Mobilization 3.5 - Shakedown 32.0 - Transit 7.3 - Recorders 13.5 - Operations 8.2 - Hydrocarta 7.7 - Sidescan 38.8 - Winch 10.0 - Navigation	42	32	26	3.8	9.0	

All time in hours.
All distances in kilometers.

Appendix B

REPORT OF BATHYMETRIC CHARTING

(Prepared by Gardline Hydrographics Inc.)

SECTION 1

INTRODUCTION

1.1 SCOPE OF REPORT.

This report describes the collection, reduction, and charting of bathymetric data over Tanner-Cortes Banks, California continental shelf.

Interstate Electronics Corporation (IEC) contracted with Gardline Hydrographic Surveys, Inc. (GHS) of Houston, Texas, to furnish and operate the automated hydrographic system aboard the survey vessel, and to produce the sounding charts at the conclusion of the survey. Bathymetric contouring and correlation of sounding data with sidescan records was to remain the responsibility of Interstate Electronics Corp. Refer to Cruise Plan "Detailed Bathymetric Charting for Characterization Survey of Tanner and Cortes Banks" produced by IEC (September 1978) for additional details on the scope and objectives of the project.

1.2 HYDROCARTA SYSTEM.

The automated hydrographic system HYDROCARTA was interfaced with an electronic position fixing system, ARGO, and also interfaced to the echosounder on the survey vessel, so that position and depth information could be logged onto magnetic tape for off-line and charting.

GHS equipment and personnel were mobilized to Long Beach Harbor, aboard the R/V Velero IV, on Monday, 18 September. The survey vessel sailed 19 September for Tanner-Cortes Banks. The HYDROCARTA system was utilized from 20 to 23 September, at which time a failure occurred in the ARGO/HYDROCARTA interface unit, effectively halting any continued use of the automated system to log positions and soundings.

After this point, survey work continued using conventional methods for navigation, and annotation of the analog echosounding records. On 27 September, R/V Velero IV returned to port for winch repairs, at which time GHS equipment and personnel were demobilized and returned to Houston, Texas. The analog echo-sounding record for 20-26 September was carried to Houston at this time, so that the sounding charts could be prepared by GHS hydrographers.

SECTION 2
CHARTING

2.1 CHART INDEX.

Charts are constructed at a natural scale of 1/6000, on a metric grid. Figures 2.1, 2.2, 2.3 and 2.4 are the chart layout index, showing the approximate chart limits of the GHS bathymetric charts

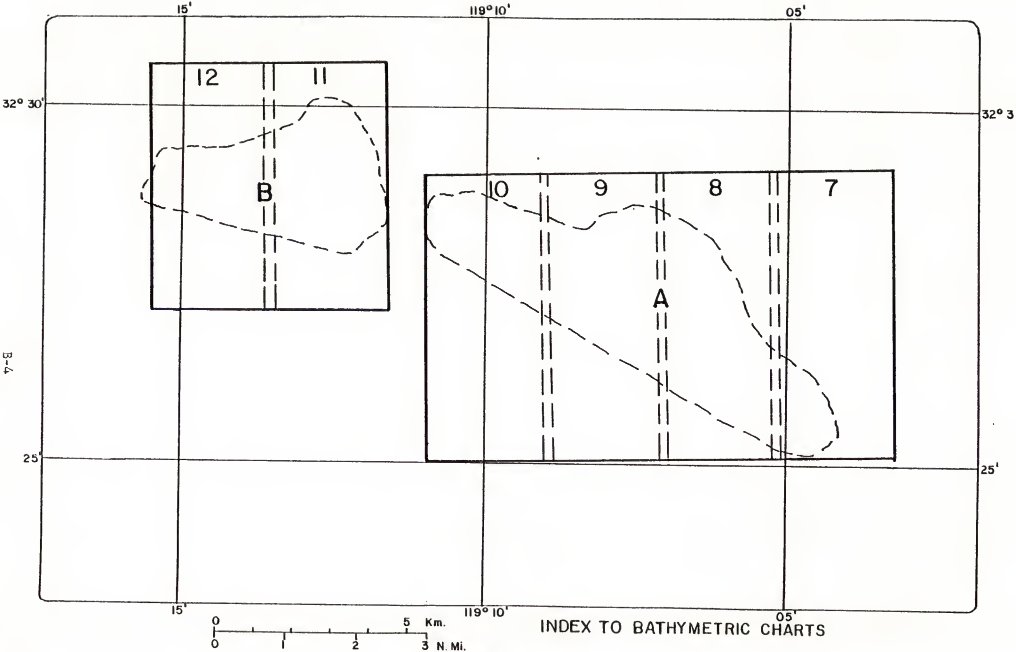
Bathymetric Chart	Study Area
1, 2 and 3	E (Central Tanner Bank)
4, 5 and 6	F (NW Tanner Bank)
7, 8, 9 and 10	A (Cortes Bank-Bishop Rock)
11 and 12	B (Cortes Bank-Nine Fathom Rock)
13	D (Tanner-Cortes Trough)
14, 15 and 16	C (NW Cortes Bank)
17 and 18	G (Santa Rosa-Cortes Ridge)

2.2 SOUNDING CHARTS.

All bathymetric charts are plotted on the Universal Transverse Mercator projection, Zone 11 (114^{o}W to 120^{o}W Longitude), using Clarke 1866 Spheroid. Grid intersections are plotted every 500 meters. In addition, latitude and longitude intersection ticks have been superimposed on the UTM grid projection at one minute intervals.

2.3 CHART ANNOTATION.

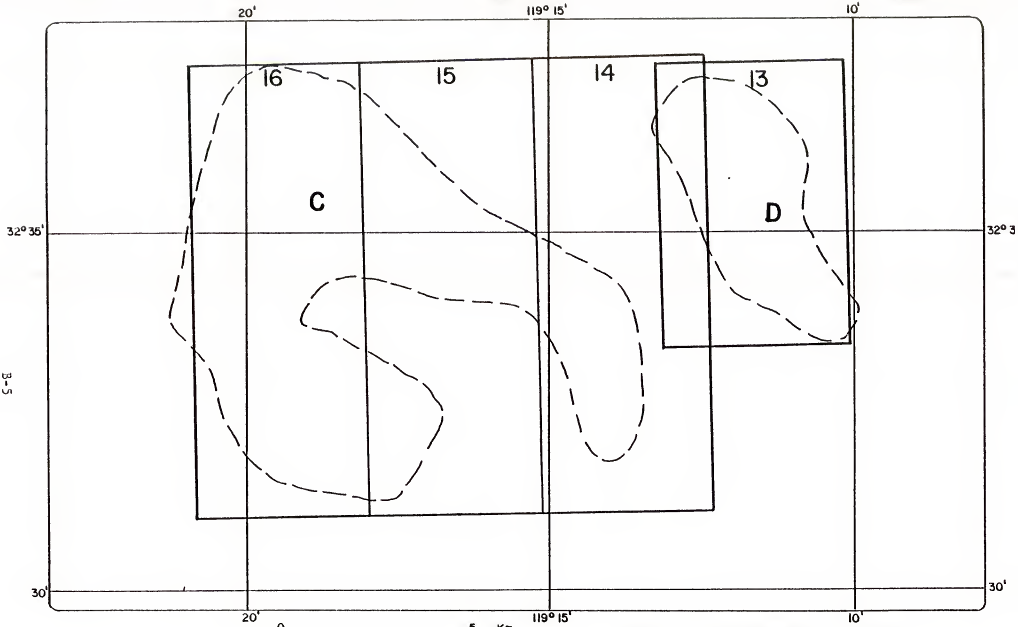
Line numbers correspond to UTM Easting (in Kilometers). Fix (shot point) numbers were obtained from middle three digits of the UTM northing, and correspond to the numbered event marks on the analog records.

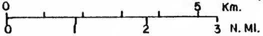


INDEX TO BATHYMETRIC CHARTS

CORTES BANK STUDY AREAS
BISHOP ROCK & NINE FATHOM REEF

Fig. 2.1

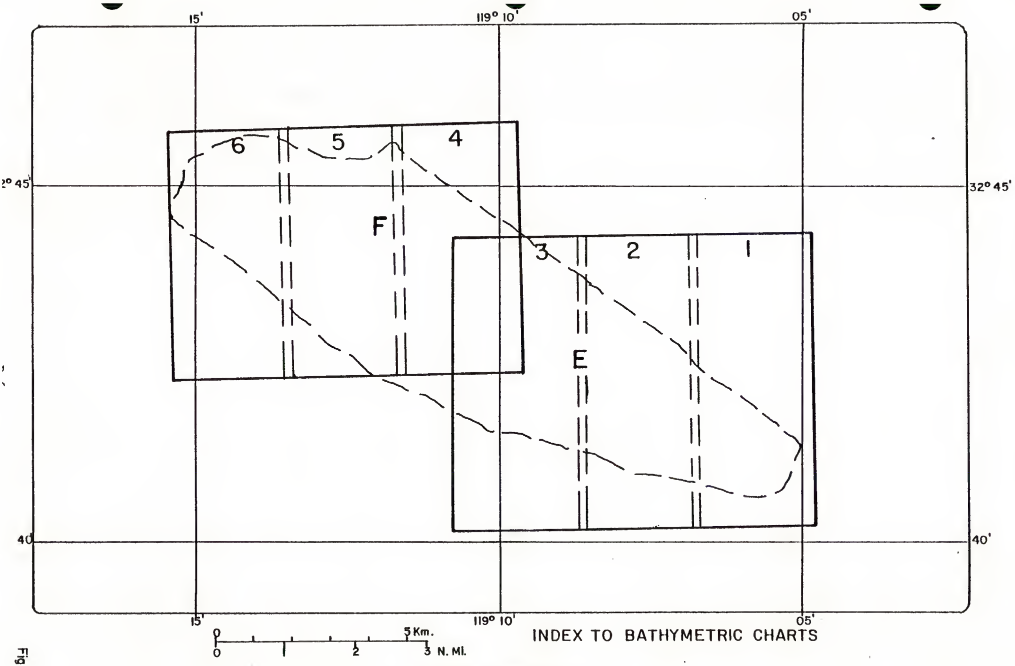




INDEX TO BATHYMETRIC CHARTS

NORTHWEST CORTES BANK &
TANNER-CORTES TROUGH STUDY AREAS

Fig. 2.2



INDEX TO BATHYMETRIC CHARTS

CENTRAL & NORTHWEST
TANNER BANK STUDY AREAS

Fig. 2.3

SECTION 3
HORIZONTAL CONTROL

3.1 CHAIN DATA.

Electronic navigation signals were furnished by NSI. The following parameters were furnished by them:

Lane Width: 84.748303 meters

Operating Frequency: 17.68 kHz

Station	Lat/Long.	UTM
Slave 1 (Upper Santa Rosa) Elev. 1466 Ft. MSL	33° 55' 15.787" N 120° 07' 16.751" W	E 211 426.1 N 3757 597.3
Slave 2 (East Mountain) Elev. 1563 Ft. MSL	33° 19' 04.905" N 118° 19' 02.325" W	E 377 378.2 N 3687 101.8

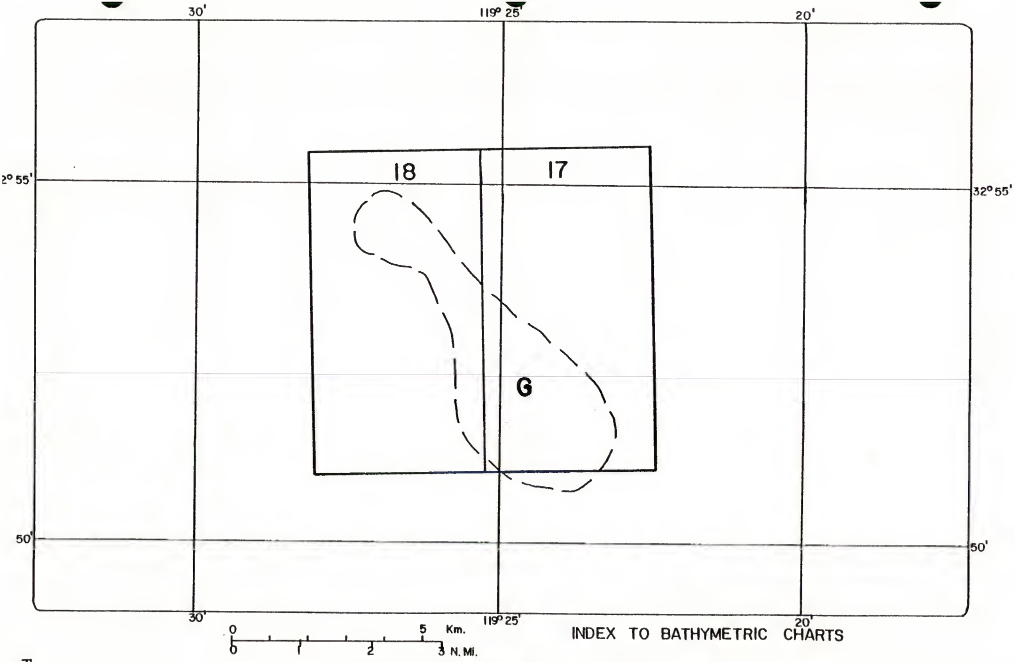
All calibration and performance checks were accomplished by NSI personnel aboard the vessel.

3.2 POSITION FIXING.

For the period 20-23 September, the unsmoothed digital output of the ARGO receiver was fed into the HYDROCARTA, and converted to UTM coordinates. ARGO receiver output was up-dated once every two seconds.

The survey vessel was conned along each preplotted line by utilizing the computed coordinates of the boat at each fix (shot point) printout. Postplots were subsequently added to the NSI-produced base maps by GHS.

For the period 23-26 September, vessel navigation and maneuvering was performed and logged by NSI personnel. ARGO preplots for each survey line were computed by GHS personnel. Base maps with postplots for 23-26 September and 28-30 September were produced by NSI.



INDEX TO BATHYMETRIC CHARTS

SANTA ROSA–CORTES RIDGE STUDY AREA

Fig. 2.4

SECTION 4

ECHOSOUNDING

4.1 ECHOSOUNDING EQUIPMENT.

Transducers, transceivers, and recorders were furnished by IEC and consequently are not discussed in detail within this report. However, the following notes are pertinent to evaluating and interpreting the plotted data.

The majority of the analog echosounding record was obtained using an EDO 19" recorder in conjunction with an EDO transceiver. The recorder and transceiver were interfaced to the HYDROCARTA through an IT Model 412 Depth Digitizer.

Transducer Frequency:	12 kHz (nominal)
Recorder Stylus Speed:	4800 ft/second
Transducer Draft:	11.6 ft. (furnished by IEC)
Depth Digitizer Sound Velocity:	4800 ft/second
Depth Digitizer Draft:	11.2 ft.

Six lines of soundings covering study area A (304.0, 303.6, 303.2, 302.8, 302.4 and 302.0) were recorded on a (wet paper) Gifft 19" recorder. No changes in the depth digitizer parameters were made for this brief period.

4.2 ECHOSOUNDING CORRECTIONS.

The analog echosounder records have scale lines in feet (normally 30 foot intervals, unless otherwise noted). The depth digitizer also furnished depth in feet for display and for transmission to the HYDROCARTA for logging. The bathymetric charts have soundings plotted in meters. Two methods of applying sounding corrections are applicable to this project. The tide corrections and velocity-of-sound corrections used for echosounding correction were furnished by IEC.

For echosoundings recorded on magnetic tape, an off-line program converted the depth in feet (at 4800 ft/sec.) to meters and corrected for actual velocity of sound. A tide correction was applied, and the sounding rounded to the nearest meter and plotted. The tide correction included +0.1 meter correction for the difference between actual transducer draft of 11.6 ft. and the digitizer setting of 11.2 ft.

For echosoundings scaled directly from the analog record (EDO or Gifft), a scaling template was constructed, to read depths directly in meters, and corrected for transducer draft. Tide correction (for time of day) and sound velocity corrections (for the raw depth) were next applied, and the corrected sounding was rounded to the nearest meter and inked onto the chart. Irregularities on the analog record due to swell were compensated for when scaling the raw depths. Similarly, discrimination between true bottom and (false) side echoes was made during the scaling process.

AREA A									
LINE NUMBER	JULIAN DAY	BEGIN LINE TIME	BEGINNING SHOT POINT	END LINE TIME	ENDING SHOT POINT	LENGTH (METERS)	HYDROCARTA BATHYMETRY	ANALOG BATHYMETRY	SIDE SCAN SONAR
295.0	266	1318	954	1330	934	2000		X	X
295.2	266	1212	930	1230	954	2400		X	X
295.4	266	1345	934	1401	956	2200		X	X
295.6	266	1140	955	1157	930	2500		X	X
295.8	266	1415	954	1430	930	2400		X	X
296.0	266	1104	928	1125	959	3100		X	X
296.2	266	1453	930	1512	956	2600		X	X
296.4	266	1038	950	1052	929	2100		X	X
296.6	266	1529	950	1542	925	2500		X	X
296.8	266	1001	922	1024	950	2800		X	X
297.0	266	1601	926	1616	945	1900		X	X
297.2	266	0944	942	0958	922	2000		X	X
297.4	266	1631	942	1644	918	2400		X	X
297.6	266	0922	922	0935	942	2000		X	X
297.8	266	1704	918	1724	942	2400		X	X
298.0	266	0701	954	0726	920	3400		X	X
298.2	265	1857	942	1913	914	2800	X	X	X
298.4	267	0858	942	0918	914	2800		X	X
298.6	265	1923	914	1952	946	3200	X	X	X
299.0	265	2001	946	2007	934	1200	X	X	X
301.0	265	2055	906	2123	944	3800	X	X	X
301.2	265	2027	935	2042	906	2900	X	X	X
301.4	265	2141	944	2202	906	3800	X	X	X
301.8	265	2217	906	2240	938	3200	X	X	X
302.0	267	0403	938	0429	900	3800		X	X
302.2	265	2251	938	2314	894	4400	X	X	X
302.4	267	0237	890	0307	939	4900		X	X
306.6	265	2330	894	2352	926	3200	X	X	X

AREA A (Continued)									
LINE NUMBER	JULIAN DAY	BEGIN LINE TIME	BEGINNING SHOT POINT	END LINE TIME	ENDING SHOT POINT	LENGTH (METERS)	HYDROCARTA BATHYMETRY	ANALOG BATHYMETRY	SIDE SCAN SONAR
302.8	267	0205	916	0223	890	2600		X	X
303.0	266	0004	926	0026	890	3600	X	X	X
303.2	267	0130	888	0148	916	2800		X	X
303.4	266	0040	890	0054	910	2000	X	X	X
303.6	267	0102	910	0116	888	2200		X	X
303.8	266	0107	910	0115	904	0600	X	X	X
303.8	266	1903	910	1915	890	2000		X	X
304.0	266	2318	088	2334	911	2300		X	X
304.2	266	1930	890	1948	911	2100		X	X
304.4	266	2148	906	2158	888	1800		X	X
304.6	266	1958	910	2009	890	2000		X	X
304.8	266	2115	886	2134	908	2200		X	X
305.0	266	2024	886	2037	903	1700		X	X
305.2	266	2056	902	2105	886	1600		X	X
315.0	267	0935	000	1000	034	3000		X	X
593.6	267	0701	1016	0726	980	3600		X	X
593.8	267	0739	986	0802	1022	4800		X	X
594.0	267	0617	988	0644	1022	4000		X	X
594.2	267	0821	1016	0842	986	3000		X	X
594.2	267	1018	968	1042	936	3200		X	X
594.4	267	0539	1016	0600	985	3100		X	X
594.6	266	1745	978	1800	996	1800		X	X
135.0	266	1807	011	1828	045	5000		X	X

AREA B									
LINE NUMBER	JULIAN DAY	BEGIN LINE TIME	BEGINNING SHOT POINT	END LINE TIME	ENDING SHOT POINT	LENGTH (METERS)	HYDROCARTA BATHYMETRY	ANALOG BATHYMETRY	SIDE SCAN SONAR
288.6	267	2227	970	2248	937	3300		X	X
288.8	267	2126	942	2146	970	2800		X	X
289.0	267	2303	941	2341	966	2500		X	X
289.2	367	2033	966	2051	936	3000		X	X
289.4	267	2334	966	2352	937	2900		X	X
289.6	267	1952	939	2015	966	2700		X	X
289.8	268	0003	937	0023	969	3200		X	X
290.0	267	1919	974	1939	939	3500		X	X
290.2	265	1707	974	1725	942	3200	X	X	X
290.4	267	1840	939	1904	974	3500		X	X
290.6	265	1624	938	1658	974	3600	X	X	X
290.8	267	1806	970	1825	940	3000		X	X
291.0	265	1540	976	1604	938	3800	X	X	X
291.2	267	1720	937	1748	976	6100		X	X
291.4	265	1446	936	1520	976	4000	X	X	X
291.6	267	1604	980	1630	935	4500		X	X
291.8	265	1401	939	1432	934	4500	X	X	X
292.0	267	1353	931	1427	980	4900		X	X
292.2	265	1309	934	1345	980	4600	X	X	X
292.4	267	1311	979	1339	933	4600		X	X
292.6	265	1208	992	1253	931	6100	X	X	X
292.8	267	1227	936	1258	979	4300		X	X
293.0	265	1115	940	1155	992	5200	X	X	X
293.2	267	1139	978	1210	930	4800		X	X
293.4	265	1037	970	1059	940	3000	X	X	X
293.6	267	1100	942	1125	978	3600		X	X
594.2	265	1730	907	1810	974	6700	X	X	X

AREA C									
LINE NUMBER	JULIAN DAY	BEGIN LINE TIME	BEGINNING SHOT POINT	END LINE TIME	ENDING SHOT POINT	LENGTH (METERS)	HYDROCARTA BATHYMETRY	ANALOG BATHYMETRY	SIDE SCAN SONAR
279.9	272	0008	086	0043	0022	6400		X	X
280.2	272	0058	022	0132	086	6400		X	X
280.5	272	0143	086	0225	014	7200		X	X
280.8	272	0238	014	0402	112	9800		X	
281.1	272	0415	112	0507	008	10400		X	
281.4	272	0521	008	0811	114	10600		X	
281.7	272	0657	114	0756	006	10800		X	X
282.0	272	0804	006	0855	114	10800		X	X
282.3	272	0907	114	1002	006	10800		X	X
282.6	272	1230	010	1322	110	9000		X	X
282.9	272	1431	110	1520	018	9200		X	X
283.2	272	1607	006	1702	110	10400		X	X
283.5	272	1712	110	1804	006	10400		X	X
283.8	272	1815	006	1908	110	10400		X	X
284.1	272	1917	102	2005	006	9600		X	X
284.4	272	2015	006	2102	098	9200		X	X
284.7	272	2110	098	2154	006	9200		X	X
285.0	272	2203	006	2246	090	8400		X	X
285.3	272	2254	090	2311	054	3600		X	X
285.6	272	2330	054	2341	076	2200		X	X
285.9	272	2349	076	0000	054	2200		X	X
286.2	273	0010	054	0020	074	2000		X	X
286.5	273	0031	074	0044	050	2400		X	X
286.8	273	0054	050	0106	070	2000		X	X
287.1	273	0116	074	0131	046	2800		X	X
287.4	273	0143	046	0158	074	2800		X	X
287.7	273	0208	072	0225	042	3000		X	X
288.0	273	0238	042	0252	070	2800		X	X

AREA C (Continued)

LINE NUMBER	JULIAN DAY	BEGIN LINE TIME	BEGINNING SHOT POINT	END LINE TIME	ENDING SHOT POINT	LENGTH (METERS)	HYDROCARTA BATHYMETRY	ANALOG BATHYMETRY	SIDE SCAN SONAR
288.3	273	0303	070	0324	030	4000		X	X
288.6	273	0506	030	0523	068	3800		X	X
288.9	273	0536	068	0559	024	4400		X	X
289.2	273	0611	024	0632	058	3400		X	X
289.5	273	0640	058	0704	014	4400		X	X
289.8	273	0722	016	0744	060	4600		X	X
289.8	269	1823	062	1852	010	5200		X	X
290.2	269	1726	010	1807	062	5200		X	X
290.6	269	1632	050	1650	010	4000		X	X
291.2	269	1502	010	1544	062	5200		X	X
291.6	269	1422	050	1447	010	4000		X	X

AREA D									
LINE NUMBER	JULIAN DAY	BEGIN LINE TIME	BEGINNING SHOT POINT	END LINE TIME	ENDING SHOT POINT	LENGTH (METERS)	HYDROCARTA BATHYMETRY	ANALOG BATHYMETRY	SIDE SCAN SONAR
291.6	273	0834	090	0841	106	1600		X	
291.9	273	0849	106	0859	086	2000		X	
292.2	273	0909	086	0921	110	2400		X	
292.5	273	0931	110	0947	076	3400		X	
292.8	273	0954	076	1011	110	3400		X	
293.1	273	1019	110	1046	050	6000		X	
293.4	273	1055	050	1124	110	6000		X	X
293.7	273	1141	110	1220	052	5800		X	X
294.0	273	1252	052	1330	100	4800		X	X
294.3	273	1358	108	1426	050	5800		X	X
294.6	273	1444	050	1523	100	5000		X	X
294.9	273	1534	100	1602	046	5400		X	X
295.2	273	1618	046	1630	066	2000		X	X
295.5	273	1641	066	1656	044	2200		X	X
295.8	273	1709	044	1722	060	1600		X	X
296.1	273	1734	060	1742	044	1600		X	X
315.1	273	1820	000	1933	130	13800		X	X

AREA E									
LINE NUMBER	JULIAN DAY	BEGIN LINE TIME	BEGINNING SHOT POINT	END LINE TIME	ENDING SHOT POINT	LENGTH (METERS)	HYDROCARTA BATHYMETRY	ANALOG BATHYMETRY	SIDE SCAN SONAR
192.0	265	0625	040	0705	950	9000	X		
295.8	264	0551	228	0621	180	4000	X		X
296.0	264	1214	210	1229	188	2200			X
296.2	264	0508	188	0530	224	3600	X		X
296.4	264	1238	188	1258	220	3200	X	X	X
296.6	264	0422	236	0457	188	4800	X		X
296.8	264	1314	214	1337	180	3400	X	X	X
297.0	264	0329	190	0357	230	4000	X		X
297.2	264	1355	188	1428	236	4800	X	X	X
297.4	264	0240	234	0314	188	4600	X		X
297.6	264	1441	236	1516	186	5000	X	X	X
297.8	264	0140	184	0221	236	5400	X		X
298.0	264	1530	185	1609	237	5200	X	X	X
298.2	264	0049	234	0120	184	5000	X		X
298.4	264	1623	236	1659	184	5200	X	X	X
298.6	263	2351	182	0036	234	5200	X		X
298.8	264	1716	186	1754	234	4800	X	X	X
299.0	263	2307	224	2334	182	4200	X		X
299.2	264	1805	234	1837	182	5200	X	X	X
299.4	263	2203	182	2251	228	4600	X		X
299.6	264	1854	182	1933	226	4400	X	X	X
299.8	263	2123	214	2143	178	3600	X		X
300.0	264	1945	226	2013	176	5000	X	X	X
300.2	263	1929	178	2010	220	4200	X		X
300.4	264	2026	176	2108	220	4400	X	X	X
300.6	263	2021	216	2043	178	3800	X		X
300.8	264	2119	220	2142	178	4200	X	X	X

AREA E (Continued)

LINE NUMBER	JULIAN DAY	BEGIN LINE TIME	BEGINNING SHOT POINT	END LINE TIME	ENDING SHOT POINT	LENGTH (METERS)	HYDROCARTA BATHYMETRY	ANALOG BATHYMETRY	SIDE SCAN SONAR
301.0	263	1657	174	1726	214	4000	X		X
301.2	264	2157	178	2229	212	3400	X	X	X
301.4	263	1617	198	1633	174	2400	X		X
301.6	264	2240	212	2302	176	3600	X	X	X
301.8	263	1546	174	1602	200	2600	X		X
302.0	264	2312	176	2336	202	2600	X	X	X
302.2	263	1512	196	1532	172	2400	X		X
302.4	265	0001	202	0019	172	3000	X	X	X
302.6	263	1443	178	1456	198	2000	X		X
302.8	265	0027	172	0054	202	3000	X	X	X
303.0	263	1401	190	1411	178	1200	X		X
303.0	265	0501	174	0519	200	2600	X	X	X
303.2	265	0105	202	0125	172	3000	X	X	X
303.4	265	0536	198	0553	176	2200	X	X	X
303.6	265	0138	172	0203	202	3000	X	X	X
303.8	265	0401	172	0414	190	1800	X	X	X
304.0	265	0430	190	0441	174	1600	X	X	X

AREA F									
LINE NUMBER	JULIAN DAY	BEGIN LINE TIME	BEGINNING SHOT POINT	END LINE TIME	ENDING SHOT POINT	LENGTH (METERS)	HYDROCARTA BATHYMETRY	ANALOG BATHYMETRY	SIDE SCAN SONAR
288.8	268	1213	266	1233	238	2800		X	X
289.0	268	1132	238	1157	266	2800		X	X
289.2	268	1247	238	1310	270	3200		X	X
289.4	268	1042	270	1112	227	4300		X	X
289.6	268	1324	270	1350	226	4400		X	X
289.8	268	1008	238	1029	270	3200		X	
290.0	268	1405	226	1435	270	4400		X	X
290.2	268	0922	270	0949	233	3700		X	X
290.4	268	1749	267	1809	235	3200		X	X
290.6	268	0834	227	0903	270	4300		X	X
290.8	268	1827	236	1856	270	3400		X	X
291.0	268	0752	267	0817	232	3500		X	X
291.2	268	1905	270	1934	230	4000		X	X
291.4	268	0654	209	0723	270	6100		X	X
291.6	268	1951	226	2022	266	4000		X	X
291.8	268	0606	266	0644	210	5600		X	X
292.0	268	2032	266	2107	210	5600		X	X
292.2	268	0511	210	0546	266	5600		X	X
292.4	268	2125	215	2205	262	3700		X	X
292.6	268	0418	262	0455	209	5300		X	X
292.8	268	2218	262	2250	210	5200		X	X
293.0	268	0330	214	0402	262	4800		X	X
293.2	268	2309	210	2350	262	5200		X	X
293.4	268	1225	259	1251	207	5200		X	X
293.6	269	0000	262	0024	224	3800		X	X
293.8	269	1150	230	1210	259	2900		X	X
294.0	269	0033	228	0101	262	3400		X	X

AREA F (Continued)									
LINE NUMBER	JULIAN DAY	BEGIN LINE TIME	BEGINNING SHOT POINT	END LINE TIME	ENDING SHOT POINT	LENGTH (METERS)	HYDROCARTA BATHYMETRY	ANALOG BATHYMETRY	SIDE SCAN SONAR
294.2	269	1115	258	1143	231	2700		X	X
294.4	269	0112	262	0133	030	2100		X	X
294.6	269	1031	230	1058	259	2900		X	X
294.8	269	0138	233	0157	258	2500		X	X
295.0	269	1002	255	1020	230	2500		X	X
295.2	269	0217	258	0236	233	2500		X	X
295.4	269	0925	228	0948	257	2900		X	X
295.6	269	0459	231	0516	257	2600		X	X
295.8	269	0858	250	0916	226	2400		X	X
296.0	269	0530	257	0550	228	2900		X	X
296.2	269	0814	222	9827	252	3000		X	X
296.4	269	0554	228	0610	250	2200		X	X
296.6	269	0738	250	0800	220	3000		X	X
296.8	269	0621	250	0637	229	2100		X	X
297.0	269	0656	230	0710	250	2000		X	X

AREA G									
LINE NUMBER	JULIAN DAY	BEGIN LINE TIME	BEGINNING SHOT POINT	END LINE TIME	ENDING SHOT POINT	LENGTH (METERS)	HYDROCARTA BATHYMETRY	ANALOG BATHYMETRY	SIDE SCAN SONAR
269.7	271	1046	448	1056	426	2200		X	X
270.0	271	1103	426	1118	452	2600		X	X
270.3	271	1133	452	1146	426	2600		X	X
270.6	271	1204	426	1216	446	2000		X	X
270.9	271	1226	446	1235	432	1400		X	X
271.2	271	1256	428	1307	448	2000		X	X
271.5	271	1318	448	1338	414	3400		X	X
271.8	271	1344	414	1405	434	2000		X	X
272.1	271	1420	434	1443	394	4000		X	X
272.4	271	1501	394	1523	432	3800		X	X
272.7	271	1533	432	1602	378	5400		X	X
273.0	271	1613	378	1641	426	4800		X	X
273.3	271	1651	426	1718	376	5000		X	X
273.6	271	1735	378	1758	420	4200		X	X
273.9	271	1807	420	1831	374	4600		X	X
274.2	271	1841	374	1904	416	4200		X	X
274.5	271	1913	416	1935	374	4200		X	X
274.8	271	1943	374	2004	412	4000		X	X
275.1	271	2012	412	2032	372	4000		X	X
275.4	271	2042	372	2058	402	3000		X	X
275.7	271	2106	402	2117	380	2200		X	X
276.0	271	2127	380	2137	388	0800		X	X

Appendix C

REPORT OF SIDESCAN SONAR CHARTING

APPENDIX C

REPORT OF SIDE SCAN SONAR CHARTING

C.1. SCOPE OF REPORT

This report describes the collection, reduction and interpretation of side scan sonar data collected over Tanner-Cortes Banks on the California Continental Borderland during September 1978.

Interstate Electronics Corporation personnel with the assistance of consultant Charles Finkelstein acquired the side scan field data and prepared the geomorphic overlays presented as Plate 404-3 (1-7). Refer to Appendix A the "Cruise Report, Phase I Survey for Detailed Bathymetric Charting; Characterization Surveys of Tanner and Cortes Banks, produced by Interstate (November 1978) for additional details on the scope and objectives of the project.

C.2. GEOMORPHOLOGICAL RECONNAISSANCE METHODS

The Phase I survey of the Biological and Geological Survey of Tanner and Cortes Banks was designed to map in detail, using bathymetry and sidescan sonography, the morphology of selected shallow regions of the Tanner-Cortes Banks region where rocky outcrops were anticipated. These data were to be used to generate detailed bathymetric and geomorphic maps of these selected regions, and to aid in the locating of submersible transects for future surveys.

During the September 1978 Phase I survey, sidescan data for each of the seven areas prescribed by the Bureau of Land Management were collected (Figure X-1). Two hundred thirty-nine tracklines totaling over 916 km were run. Each of the seven prescribed survey areas was covered by a grid of primarily north-south oriented tracklines. Primary areas A, B, E, and F, were covered by transects spaced at 200 meters. Lower priority areas C, D, and G were profiled at a 300 meter spacing to insure that all areas were satisfactorily covered by the end of the contracted survey period.

The BLM contract specifically called for the mapping of the extent of the rocky outcrop areas occurring on the shallow bank-tops. Using the sidescan records we improved upon this product significantly, differentiating on the basis of geomorphology, seven different rock and sediment types.

C.3. HORIZONTAL CONTROL

C.3.1 Navigation

A Cubic Argo Model DM-54 navigation system provided primary range- range fixes througout the survey. A Motorola Mini-Ranger III Radio Positioning System was used for backup and calibration of the primary system. Both systems were provided and operated by Navigation Services Inc., of Ventura, California. Navigation fix information was either automatically processed by Hydrocarta computers aboard ship or manually annotated at intervals along tracklines. In both cases precise navigation fix information was recorded at 100 or 200 meter intervals along pre-plotted tracklines. Shotpoint data processed by

Navigation Services land Gardline hydrographics Inc. was plotted at 1:6000 for working maps and 1:12000 for final deliverable maps. Navigational accuracy of each of the shotpoint is estimated to be on the order of plus or minus 5 meters.

C.3.2 Chain Data

Electronic navigation signals were furnished by NSI. The following parameters were furnished by them:

Lane Width	84.748303 meters
Operating Frequency:	17.68 kHz

Station	Lat/Long.	UTM
Slave 1 (East Mountain) Elev. 1466 Ft. MSL	33°55' 15.787" N 118°19' 16.75" W	E 211 426.1 N 3757 597.3
Slave 2 (East Mountain) Elev. 1563 Ft. MSL	33°19' 04.905" N 118°19' 02.325" W	E 377 378.2 N 3687 101.8

All calibration and performance checks were accomplished by NSI personnel aboard the vessel.

C.3.3 Position Fixing

Because the side scan towfish was flown as close to the bottom as was practical, it was necesary to constantly re-adjust the height of the fish over the rugged topography. Due to the changing catenary of the wire and the lack of a direct wire-out indicator it is impossible to accurately and reliably calculate the position of the towfish behind the ship mathematically.

This problem was overcome by comparison between prominences on the sidescan records with the positions of seafloor features on analog bathymetric records. For example if a hogback found at shotpoint 100 on a bathymetric profile can be recognized at shotpoint 102 on the sidescan record, the towfish is determined to trail the ship (navigation mast) by 200 meters.

The plethora of features recognizable on both records made relative position fixing of side scan information reliable. Annotation of fixes at 100 meter intervals along the profile lines made interpolation between fixes precise.

C.4. EQUIPMENT

A Klein Associates Inc. Model 400 Side Scan Sonar was used throughout the survey for seafloor mapping. The basic Klein system consists of a Side Scan Sonar Towfish, a Dual Channel Recorder and a Towing Cable. As described by Klein Associates Inc., the Side Scan Sonar Towfish contains transmitting circuitry to energize transducers which project high intensity, high frequency bursts of accoustic energy in fan shaped beams which are narrow in the horizontal plane and wide in the vertical plane. These sound beams project along the sea floor on both sides of the moving vessel. Objects or topographic features on the sea floor produce echoes which are received by the transducers. The echoes are amplified in the Towfish receiver and sent up the Tow Cable to the shipboard Recorder.

The Recorder processes the incoming echoes and prints them on a special multi-channel writing mechanism. This creates a permanent, continuous graphic record of a wide path along the sea floor. The recorder places each echo side by side so that coherent echo formations can be correlated by the eye. The Side Scan Sonar Recorder contains plug-in electronics which give various ranges, paper speeds, scale lines, time markers, internal external event marks, and versatile signal processing.

A range scale of 150 meters on each side was normally used for survey operation. Scale lines represent 15 meters horizontally for each scale used during the survey operations. Continuous operation of the system was guaranteed using dc voltage input from batteries rather than relying upon constant ships power.

C.5. DATA PROCESSING

C.5.1 Annotation

Closely spaced navigation fixes (100 meter intervals) and complete record annotation enhances the utility of recorded information. Codes and descriptions annotated on the sidescan records appear in Table C-1.

C.5.2 Data Reduction

As previously described it was possible to correlate prominences on the bathymetric profiles with the same prominences on side scan records. Because the ship's transducer was nearly beneath the navigation mast, geomorphic features derived from side scan records could be plotted in their absolute positions, within the precision of the navigation system.

TABLE C-1. SIDE SCAN SONAR CODES

Annotated Code	Description
BOL	Beginning of Line
EOL	End of Line
074	Shotpoint # at right margin
T-2000	Time (local at beginning and end of line)
Ci	Cable hauling in
Co	Cable paying out
1/8, 1/4, 1/2	Fraction of full speed at which cable is being payed out or hauled in
AG	Adjust gain setting
(320°)	Ships heading marked at each course change during transect
Pt	Turn to port
St	Turn to starboard
306.6	Profile line number

Due to the reconnaissance nature of this study, it was not found necessary to remove the distortion inherent within sidescan recording. Isometric reconstructions would have been necessary to accurately measure or plot individual features on the 1:6000 working geomorphic maps. Instead, trends of contacts between discernable geomorphic signatures were interpreted from trackline to trackline. Overlap of information on neighboring profiles allowed a mosaic to be assembled, aiding in the final plotting of geomorphic patterns. Geomorphic interpretative maps were drafted at the 1:6000 working scale then reduced to the 1:12000 deliverable scale.

The geomorphic signatures developed for each BLM Area are individually discussed in the body of the report. Seven signatures were recognized and mapped in different portions of the study areas (Table C-2). These signatures reflect both general substrate type and average relief of the morphologic elements.

A base map and two overlays are final products of the geological and morphological phases of the project. Plate 404-1 maps 1-7 depict for each of the BLM study areas (Fig. 1-2) detailed bathymetric interpretations. Plates 404-2 and 404-3 when overlaid on these mounted base maps show shotpoint locations of navigation fixes and geomorphic interpretations, respectively, of each of the seven areas. All maps are plotted on the Universal Transverse Mercator, Zone 11, using Clarke 1066 Spheroid. Grid ticks were plotted where appropriate along the map borders at 1000 meter intervals. Latitude and longitude ticks have been superimposed on the UTM grid projections at one minute intervals. California State Coordinate System and Universal Transverse Mercator grid block boundaries are also superimposed over the UTM grid system.

TABLE C-2.

GEOMORPHIC SIGNATURES LEGEND

0	Undifferentiated surficial sediment veener
1	Reflective surficial veneer
2	Undifferentiated isolated or lower releif rock with greater than 60 % sediment veneer
3	Undifferentiated lower relief rock
4	Sedimentary rock
5	Igeneous rock
6	Higher relief igneous rock

APPENDIX D

FIELD METHODS AND ANALYSIS

D.1 GEOLOGY

The Phase I survey plan developed for the Bathymetric and Geological Reconnaissance of Tanner and Cortes Banks was designed to map in detail, using bathymetric soundings and sidescan sonography, the topography and morphology of selected shallow portions of the Tanner and Cortes Banks region where rocky outcrops were anticipated. These data were to be used to generate detailed bathymetric and geomorphic maps of selected regions and to aid in selecting sumersible transects for future surveys.

During the September 1978 Phase I survey, bathymetric and sidescan data for each of the seven study areas (A-G) was collected over a grid of primarily north-south oriented tracklines. Two hundred and thirty-nine tracklines covering over 916 kilometers were run. Priority areas A, B, E, and F were covered by transects spaced at 200 meters. Lower priority areas C, D, and G were profiled at a 300-meter spacing. The Phase I Survey Cruise Report previously submitted to BLM (Appendix A) details the collection effort.

Once ashore, bathymetric and sidescan data were corrected and plotted on 1:6,000 scale maps. After interpretations were made and checked, final maps were drawn and then reduced to a 1:12,000 scale for delivery.

D.1.1 Field Methods

D.1.1.1 Research Vessel R/V VELERO IV - The R/V VELERO IV, operated by the University of Southern California, was used for Phase I studies. Bathymetric soundings were taken using a hull mounted EDO UQN-1 transducer coupled with an EDO Model 444 transceiver. The KLEIN sidescan towfish coupled with the remainder of the KLEIN 400 series profiling system was towed behind the 33.5-meter long and 8-meter abeam ship at a speed of approximately 6 knots.

D.1.1.2 Navigation - A Cubic Argo Model DM-54 navigation system provided primary range-range fixes throughout the survey. A Motorola Mini-Ranger III Radio Positioning System was used for backup and calibration of the primary system. Both systems were provided and operated by Navigation Services Inc., of Ventura, California. Navigation fixing information was either automatically acquired and processed by Hydrocarta computers aboard ship or manually annotated at intervals along tracklines. Precise navigation information was recorded at 100 or 200 meter intervals along preplotted tracklines. Shotpoint data processed by Navigation Services Inc. and Gardline Hydrographic Survey Inc. was plotted on a 1:6,000 scale for working maps and 1:12,000 scale for final deliverable maps. Navigational accuracy of each of the shotpoints is estimated to be on the order of ±5 meters.

D.1.1.3 Bathymetry - Professional hydrographic services were provided by Gardline Hydrographic Surveys, Inc., Houston, Texas. The primary system used for the detailed bathymetric studies was a fully automated data acquisition and control system manufactured by Hydrocarta Inc. This system acquired digitized depth soundings while simultaneously obtaining navigation data and provided a real-time track plot and display to alert the helmsman of deviations from the preplotted trackline. (Supplemental information is provided in Appendix B.)

After this system failed (upon completion of 25 percent of the profiles) semiautomatic backup techniques were adopted. Sounding profiles were acquired on analog EDO Models 550 and 551, 19 inch graphic recorders. Recorder sweep speed was 1/4 second; the 19 inch full-scale record represented 125 milleseconds of time or approximately 200 meters. Navigation fixes were provided by operators at 100-meter intervals. At the preplotted shotpoint intervals navigation fixes were output onto a digital printer and to the graphic recorder for an event mark across the analog profile. Event marks were annotated by hand with their respective shotpoint numbers by the graphic recorder operator. Supplemental information is provided in Appendix B - Report of Bathymetric Charting.

D.1.1.4 Side Scan Sonar - Side scan sonographs of the sea floor were collected along with bathymetric soundings and profiles. Professional services of consultant Charles Finkelstein coupled with the Klein 400 Series side scan system resulted in the collection of excellent sea-floor records.

To maximize the potential resolution of the side scan system, the fish was "flown" as close to the bottom as was prudent and safe. Records were marked and annotated in a similar fashion as were the bathymetric profiles. Additional information pertinent to the collection of the side scan records is provided in Appendix C - Report of Side Scan Sonar Charting.

D.1.2 Processing and Presentation Methods

D.1.2.1 Maps and Overlays - The final products of the geological and morphological phases of the project are a base map and two overlays. Plate 404-1 base maps (maps 1-7) depict for each of the BLM study areas (Figure II-2) detailed bathymetric interpretations. Plates 404-2 and 404-3 which are overlain over these mounted base maps show shotpoint locations of navigation fixes and geomorphic interpretations, respectively, of each of the seven areas. Tracklines surveyed during the Phase I survey are listed in and approximately plotted in Table II-I and Figures 1 to 7 of Appendix A. All maps are plotted on the Universal Transverse Mercator, Zone 11, using Clarke 1866 Spheroid. Grid ticks where appropriate and plotted along the map borders at 1,000-meter intervals. Latitude and longitude ticks have been superimposed on the UTM grid projections at one minute intervals. California State Coordinate System and Universal Transverse Mercator grid block boundaries appear superimposed over the UTM grid system on Plate 404-2.

Shotpoints represent the position of the navigation signal receivers and must always be corrected for stepback of the acoustic sensors from the mast of the survey vessel. During the Phase I survey the positions of the ships transducer and navigation system receivers were identical.

Trackline numbers, aligned to grid north, correspond to UTM easting in kilometers. Shotpoint designations along a line are obtained from the middle three numbers of the UTM northing and correspond with the numbered event marks on the analog bathymetric and sidescan records.

D.1.2.2 Bathymetry - Two methods of applying sounding corrections were used during this project. For digitized echo soundings, which were recorded by the shipboard computer system, an off-line program converted the depth in feet (at 4,800 ft/sec) to meters and corrected for the actual velocity of sound in seawater relative to depth. A tide and transducer depth correction was applied, and the sounding rounded to the nearest meter was plotted.

For echo soundings scaled directly from the analog record, a scaling template was constructed to read depths in meters and correct for transducer draft. Tide correction and sound velocity corrections were applied, and the corrected sounding rounded to the nearest meter and inked onto the chart. Irregularities on the analog record due to swell were compensated for when scaling the raw depths. Similarly, discrimination between true bottom and (false) side echoes were made during the scaling process.

After all soundings were plotted they were contoured by hand at 2-meter intervals to 100 meters and at 5-meter intervals for depths exceeding 100 meters. Maximum and minimum depths on closed features were annotated. It was found in some extremely rugged areas that coverage with the echo sounder system was such that some features could not be resolved by contouring. Interpretations were drafted at the working scale of 1:6,000 then reduced 50 % to the deliverable scale of 1:12,000.

D.1.2.3 Side Scan Sonar - Drag caused by the weight of the tow cable and the influence of surge close to the bottom caused a variable catenary in the tow cable. This coupled with imprecise wire-out readings made it impossible to calculate an accurate stepback of the side scan tow fish from the navigation mast. Because the ship's transducer was beneath the navigation mast, it was possible to correlate prominances on the bathymetric profiles with the same prominances on side scan records. Thus, geomorphic features derived from side scan could be plotted in their correct positions, within the precision of the navigation system.

Due to the reconnaissance nature of this study, it was not found to be necessary to correct the distortion inherent in the side scan recorder to plot individual features on the 1:6,000 working geomorphic maps. Instead, locations of contacts between discernable geomorphic signatures were estimated from trackline to trackline. Overlap of information on neighboring profiles allowed the compilation of a crude mosaic, aiding in the final interpretation of the geomorphic patterns. Geomorphic signature definitions were based on both relative relief measurements and discernable lithologic rock types. Geomorphic interpretative maps were drafted at the working scale then reduced to the 1:12,000 deliverable scale.

D.2 BIOLOGY

D.2.1 Historical Data Collection

Biological information gathered by Interstate in preparation for the survey consisted mainly of prior studies at and near the Banks and life history information on the organisms found in the area. Primary sources for this material were various Government agencies and academic institutions. Species lists were obtained from reports and from various taxonomic specialists, and edited to remove those species considered to be too rare, small, or cryptic for definite identification.

Historical data also provided information pertinent to making "isolated" observations from a submersible. Algal canopies, heavily-encrusting organisms, and other factors were noted by several authors as hindrances to submersible work, whereas SCUBA and sample collecting provide access to specimens for close examination. Awareness of these limitations helps to focus the observer's attention where it is most useful.

An illustrated species reference card file encompassing approximately 300 species likely to be encountered was compiled from the edited species list for the area. The file consists of 5 x 8 inch Unisort cards, each showing the scientific name and photograph of a given species, with information on size, depth range, habitat, associated species, life history, distinguishing characteristics (viewed from a distance) and general identification qualifiers ("big-visible," "small-cryptic," etc.). A typical species card is shown in Volume II. Both pre-dive observer preparations and post-dive debriefings were made more productive through the use of this card file. The backs of the cards were reserved for natural history observations and notes resulting from the survey.

D.2.2 Cruise Plan Preparation

A detailed cruise plan was written to define the responsibilities of the participants in the survey. Schedules for mobilization and for normal operations and contingencies were included. Equipment lists were presented, and shipboard procedures were delineated. The cruise plan was supplemented by the Interstate Electronics submersible observer's manual, (Appendix G) which covered procedures for collecting and recording data underwater.

D.2.3 Mobilization

D.2.3.1 Equipment Preparation - Equipment was mobilized and bench tested at Interstate Electronics and then delivered to the ship on October 17. Final mobilization, modifications, and installations on the submersible were made on October 18. Additional equipment for later submersible operations was tested and delivered to the ship on November 3 and November 15. As proper operation of each piece of equipment was necessary to obtain quality data, all systems were checked prior to loading and again when aboard the ship at the pier. After successful checkout, test cruises were made on October 19, and again on November 3 off San Diego, to ensure that all systems were functioning properly while the submersible was underway. The first cruise involved testing of transect operations, while movie procedures and equipment were tested on the second cruise. Table D-2 is a list of the equipment provided for use during the surveys.

During mobilization, every piece of equipment supplied by Interstate Electronics (cameras, strobes, movie lights, tape recorders) was checked individually and as a system. Backup or spares for every major component were on board.

D.2.3.2 System Test - Submersible Operation #1 - Even though all of the equipment was tested in the electronics laboratory and work shop, Interstate Electronics planned for both a dockside test during mobilization and a day of test dives. During the dockside test, the 200-watt-second flash system and

TABLE D-1. EQUIPMENT

Supplier	Equipment
Interstate Electronics Corp.	Benthos Underwater Camera and Strobe; Movie Camera, Lights, Cables and Generator; Hand-Held 35mm Camera; Video Tape Recording System; Tape Recorders for Data Logging; Film, Tapes, Supplies; Backup Systems for above.
Nekton Inc.	R.V. SEAMARK; Nekton Inc. Gamma Submersible; Spares and Supplies.
Navigation Services, Inc.	Cubic Argo Navigation System Model DM-54 Motorola Mini Ranger III - Radio Positioning System.
Ocean Contractors	Two 200-Watt-Second Flashes; Timer, Power Supply, Battery Charger; Two 1,000-Watt Birns and Sawyer Movie Light System; Color-Trans Light Transformer for Movies.

backup failed when immersed in sea water. Therefore, the backup Benthos strobe unit was substituted and a second backup unit located. Other equipment checked out correctly. On October 19, SEAMARK departed San Diego for a test area near the Coronado Canyon where we anticipated clear water and adequate bottom conditions to test the submersible with the mounted equipment.

At the test site the NSI navigation equipment operated properly. The Benthos camera, Video Sciences underwater T.V. and Interstate Electronics audio tape recording systems were mounted for the first test dive. A pinger was mounted on a line marker stand and lowered to the sea floor and buoyed off. Due to high motor noise inside the submersible, underwater sound transmission problems and an infrequent need for communication between the submarine and the ship, it was deemed not necessary to tape record on board the SEAMARK the communications to and from the submarine.

During the test dive, the camera, strobe, T.V. system, audio system and pinger tracking system all performed satisfactorily. The other components (timer, power supply, and battery charger) were functional and were left on board as a backup for the Benthos flash unit. A backup Benthos flash unit was leased from Intersea Research Corporation and sent to the ship on October 23. Because the video recording system cut out intermittently, probably due to humidity in the submarine, we tested the backup recording unit for use on future dives until the first unit could be serviced.

The second test dive was made to test the movie equipment. Lights were attached and all equipment loaded into the submarine and surface support Zodiac. In preparation for the test dive, the cable was paid out into the water and support floats were attached to make the cable neutrally buoyant. Within minutes, personnel were in the submarine, but before it was launched the wind suddenly changed from light airs from the east to strong wind from the southeast. Within five minutes, the wind was blowing 22 knots steady with gusts over 30 knots and appeared to be building rapidly. As the sea began to build, it became difficult and dangerous to handle the equipment. Finally, at 1510 hours it was decided to cancel the movie test dive and return to San Diego to off-load the movie gear that was not going to be used until the second survey. During the few minutes at dockside, final adjustments to the navigation antenna were made, a broken timer resistor wire in the Benthos strobe unit was repaired, and the weather conditions were checked with the Navy and the Interstate Electronics forecaster. A fast storm was expected to move through the Tanner and Cortes area, with a forecast for good weather by the next day. Therefore, at 1930 hours the ship departed for Tanner Bank.

D.2.3.3 System Test - Submersible Operation #2 - Even though most of the systems and equipment had been previously tested and proved to be functioning correctly during submersible operation #1, Interstate Electronics decided to conduct one additional test dive with the movie equipment to ensure proper performance before departing on submersible operations #2.

Two movie test dives were made on November 3 near the Coronado Escarpment. During the first test dive, one of the movie lights detached from the submersible and it was necessary to return to the surface to reattach the light. During the second test dive, all systems and equipment functioned properly and a test roll was filmed first with the movie lights on and finally with only the submersible lights for illumination.

After the SEAMARK returned to San Diego following the movie test dives, the Benthos camera system and the Video Sciences underwater TV were mounted on the submersible and retested. All systems were functioning properly, the weather forecast was favorable and the ship departed for Cortes Bank at 2300 hour on November 3.

D.2.4 Submersible Operations

D.2.4.1 Equipment - The two-man submersible NEKTON GAMMA and support vessel SEAMARK were leased from Nekton, Inc., Sorrento Valley, Calif. The NEKTON GAMMA has the following specifications:

General

Crew (pilot and observer)	2
Pressure listed depth	1,500'
Certified operating depth	1,000'
Collapse depth	2,500'
Weight (pounds)	4,700
Payload (pounds)	450
Viewports	17
Length overall	15'6"
Height overall	6'0"
Pressure hull diameter	42"
Pressure hull length	96"

Systems

Propulsion -- One 3.5 hp. D.C. motor

Power source -- Nickel-cadmium 4.5 kwh batteries.

Depth control -- Bow plane, water ballast, drop weights.

Navigation -- Magnetic compass, directional gyro, depth gauge; pinger, retractable marker buoy.

Communication -- Underwater telephone, CB radio.

Buoyancy -- 2 main ballast tanks, one auxiliary trim tank.

Life support -- 48 man hours.

Photographic -- Tungsten lamps to support interior hand-held cameras and video equipment. Exterior camera and strobe.

A dive time budget of 3 hours was established to allow sufficient time for stopping, bottom sitting, or close maneuvering about a site for photographic or video documentation of representative or characteristic organisms and species associations. Cruise speed and duration of NEKTON GAMMA is reportedly 1.5 knots for 3.5 hours or 2.5 knots for 1 hour. In our operations, submersible speed varied from 0.1 to 2.4 knots. At greater speeds, apparent relative motion precludes careful assessment of details and sufficient lead time for effective photographic or video pass shots of key subject material.

The preselected dive sites were located using Argo and Mini-Ranger navigation. The submersible was launched from the mothership by a deck-mounted articulating crane and lowered into the water close to the start of the transect.

Just prior to launch, a tracking float was secured to the submersible by a polypropylene line of sufficient length to allow for drag and still allow the float to trail on the surface as the submersible cruised just off the bottom. The transect was begun when the float had been deployed and the submersible reported itself ready on bottom after the scientific observer had characterized and recorded the bottom conditions. The support vessel maintained a position close behind the towed surface buoy to monitor the submersible's course and position by taking frequent ranges and bearings on the surface buoy. At approximately five-minute intervals, the ship's bow was aligned with the surface buoy with both vessels approximately on the same heading, the distance from the ship's bow to the buoy was visually estimated, and a positioning fix was taken for the ship. The distance from the bow to the buoy was always within 15 m (50 ft), and quite often within 6 m (20 ft). Submersible positioning was then calculated using the distances from the antenna amidship to the bow, from the bow to the surface buoy, and horizontal distance from the buoy to the submersible. This distance was calculated from the known depth of the submersible and the known length of line from the submersible to the surface buoy. The net distance and azimuth was provided to NSI who plotted the actual position of the submersible on the navigation sheets. Course corrections, general instructions, and distance traversed were communicated to the submersible by acoustic telephone at appropriate intervals. Dives were made between 0615 and 1915, which spanned the daylight hours and provided observations on biological activity before dawn and after dusk.

Two 150-watt tungsten filament lamps, directed forward and downward on each side of the NEKTON provided sufficient illumination on either side for direct viewing and for black and white video documentation forward and laterally. Hand-held 35mm still camera color photography was fully effective through the viewing ports to maximum operating depths, using ambient light and/or the submersible running lights to produce numerous good-quality photographs.

The exterior camera system consisted of a Benthos model 372 Standard Camera matched with a Model 382 Flash, mounted forward on the starboard side of the submersible in place of the mechanical arm. The camera was positioned vertically with the lens one meter above the bottom of the submersible, while the strobe was mounted aft of the camera, pointing forward and down at an angle of approximately 45 degrees. This arrangement minimized backscatter and produced some shadow effect in the photographs. Camera settings were f/8 at 5 feet, with a Kodak 82 filter. Eastman Color Negative II 5247 Tungsten film was used throughout the surveys.

The camera system operated in a fully automatic mode, with an initial fixed 43-second interval between photographs, determined from estimates of the time elapsed while traversing a ten-meter distance. This was later reduced to 30 seconds, to obtain more thorough photographic coverage in areas where the submarine's actual speed exceeded initial estimates.

The observers used 35mm still cameras with Kodak Ektachrome Tungsten 400 film inside the submersible to photograph individual species or areas of interest. Illumination was provided by the sub running lights, and/or ambient light in shallow water. Nearly all video footage was taken with an interior hand-held video camera, which was propped against the starboard down-looking port.

Movies were photographed with an Arriflex 35mm movie camera. Exterior lighting was provided by two 1,000-watt Birns & Sawyer "Snooper" movie lights, balanced for color temperature by a Color-Trans light transformer. Movie operations are discussed in detail in Section 2.2.4.6.

D.2.4.2 Dive Preparation - While positions were fixed and transect buoys placed at the predetermined end of the transect, the submersible was serviced. Batteries were charged, the air filter changed, oxygen and air tanks replaced, and any required minor maintenance completed. Tapes, film, camera setting, strobe setting, timing apparatus, backup equipment and materials were prepared, serviced and checked, and the ship positioned for the dive.

D.2.4.3 Observer Briefing/Preparation - Interstate and consultant observers undertook a thorough review and discussion of the illustrated species reference card file. Particular attention was paid to the photographs and distinguishing characteristics. Discrepancies in taxonomy were discussed and resolved, and several species were added or deleted. Each observer then reviewed the file individually to familiarize himself with species outside his discipline and with less common species. This process of individual review and exchange between observers continued throughout the submersible operations. Suggestions from consultant observers made during briefings were considered and incorporated into the survey operations whenever appropriate.

A submersible observers manual, prepared by Interstate, was reviewed by all participants. This manual established guidelines and a standardized format for reporting observations and synchronizing data collection. It was included in the cruise reports, and appears here as Appendix G.

Dive preparation included replaying tapes and discussing observations of previous dives. Observers studied the bathymetric chart for the upcoming dive and discussed relevant features of the terrain and anticipated points of scientific interest.

D.2.4.4 Submersible Launch and Retrieval - During submersible operation #2, the SEAMARK was positioned at the predetermined start of the transect, the submersible was launched, and the pilot ballasted the submersible to the bottom. This procedure differed from submersible operations #1 in that a start buoy was not placed. This type of operation resulted in the saving of one half hour per dive, and allowed one or two additional submersible navigation positions to be obtained during the first 20 minutes of each dive.

D.2.4.5 Transect Activities - The pilot navigated initially on a compass heading taken by the surface ship on the acoustic pinger buoy previously placed at the end of the transect. This course was followed until the acoustic signal from the pinger became audible to the pilot, roughly halfway through the transect. The pilot then navigated towards the pinger until the end buoy was reached. Typically, the submersible traversed as close to the bottom as was practical along the transect line. All survey activity was carried out as accurately as possible along the lines specified. Data collected included automatic Benthos bottom photographs, observer-triggered photographs, black-and-white video of the sea floor, and a tape recorded description of the community structure observed and organisms sighted. In addition, other observations associated with community structure, size, density, topography and bottom type were noted. Three primary observers and three submersible pilots participated in each leg of the survey, with backup personnel available on board. Teams were rotated so that pilots and observers each made one dive per day, on those days when three transect dives were accomplished.

D.2.4.6 Movie Production - Site selections for movie dives were based on information from transect dives in a given area. A marker buoy was placed near features of biological and geological significance and the submersible traversed past the buoy during filming. All the footage was shot through lateral - facing portholes using an Arriflex 35mm movie camera. Auxiliary illumination was provided by two 1,000-watt movie lights, attached to the front of the submersible. The lights were tethered by a power cable to a generator and light transformer in two Zodiac inflatable boats, lashed together for control and stability. Three-way radio communications were maintained between support vessel, the submersible, and the Zodiacs to enhance movie operations. The cameraman could ask that the movie lights be turned on or off, and obtain an indication of the submersible's movement relative to the site buoy. As a safety precaution, the entire movie light and cable system could be released from the submersible (as could the surface buoy), completely freeing the submarine from any surface connections.

This approach was effective overall, but because tethering and power generation required mild sea conditions, movie dives were more restricted than transect dives. On several occasions, a movie dive was postponed due to sea and swell conditions and a transect dive substituted, to minimize impact on survey scheduling.

Movie operations were planned to take place at night, to film the increased activity of the many nocturnal species observed, and to utilize more fully the equipment and personnel. Again, however, due to safety considerations involving the sub-to-surface electrical power cable, movie dives had to be performed only during daylight hours. Fortunately, several transect dives extended into evening or morning hours, coinciding with sunrise/sunset foraging activity peaks of many fishes and invertebrates.

Throughout the submersible operations, synchronization of data collection was a primary objective. The navigational system clock was the reference time source. Approximately ten minutes before each dive, this clock was used to set the bridge clock, submersible clock, and the observer's watch. The Benthos camera time signature was checked every morning and adjusted if necessary, when a fresh roll of film was loaded. The externally-mounted video system had an internal clock and time signature. When it flooded, it was replaced by a standard video camera positioned inside the submersible. The audio portion of this video system recorded the observer's time notations, thus synchronizing the entire system.

D.2.5 Cruise Report Preparation

A cruise report (Appendix G) was compiled for each of the two major legs of the submersible operations. Included were original and typed copies of the survey logs, the Interstate submersible observer's manual, and sections on survey preparation and field operations. These documents also served as progress reports, summarizing the accomplishments of each cruise.

D.2.6 Accomplishments

Biological observer and photography transects planned for the first phase of the submersible operations were successfully accomplished even through everything did not go exactly as planned. During the operations we were unable to accomplish three dives every day as planned, but because we were able to extend the length of some dives, 53.4 km (29.4 nmi) of seafloor transects were accomplished in 21 dives. Figures 2-1 throu 2-4 in Appendix G covering priority areas A, B, E and F show the location of the individual transects. Table 2-1 of Appendix G contains the details of each dive such as date, location, observer, depth and information gathered.

Biological observer and photography transects and movie dives planned for the second phase of the submersible operations were successfully accomplished although mechanical and weather problems prevented the completion of three movie dives and one transect in area F and area D. During the operations we were unable to accomplish three dives every day as planned, but because we were able to extend the length of some dives, 41.9 km (22.6 nmi) of seafloor transects were accomplished in 16 dives and 4 movie dives. Figures 2-1 thru 2-6 in Appendix G of areas A, B, C, E, F, and G show the location of the individual transects and movie dives. Table 2-1 in Appendix G contains the details of each dive such as date, location, observer, depth and information gathered.

D.3 DATA ANALYSIS

D.3.1 Data Reduction and Tabulation - Observer audio recordings, video tapes, Benthos photographs, observer photographs and movies were studied for relevant information, which was recorded, and prepared for submission to BLM. The dive transcripts, photographic and video records are presented in Appendix E.

D.3.1.1 Observer Audio Recordings and Log Books - Each observer transcribed his own audio tapes in a log book as soon as possible following each dive. The video tapes were viewed for supplementary information, additional species, and any other details. Another observer later replayed the audio tapes while reading the log book for each dive as a quality control task, to insure that all observations were properly recorded and standardized. Obvious changes made by the original--observer differing species identifications, and community characterizations--were taken into account. If necessary, the observer and submersible time was adjusted to navigational time, based on times recorded for discrete events: reaching the bottom, starting the transect, reaching the pinger, moving off the bottom, and reaching the surface. Observations were broken into one-minute time intervals to facilitate coordination with the video and Benthos records, and the submersible positioning data.

D.3.1.2 Video Tape Analysis - The video system used for the survey work was black and white, as color video would have required accessory lighting. Also, some of the video is indistinct or blurred, due to the higher speed and relatively short camera-to-bottom distance. These two factors, black and white tapes and blurred segments of the tapes, limited the amount of data obtainable from this medium. These realizations led to ranking the various data sources (observer, Benthos, and video), in regard to relative accuracy and reliability of data for a given parameter or organism type.

After analysis of the observer audio record, the video tapes from each dive were reviewed. These were synchronized at the onset of each transect and timed with a stopwatch, as the camera had no time signature. Video analysis consisted of recording substrate, identifying organisms, and making additional pertinent comments. These observations were then integrated with the audio data record and cross-compared for a more representative characterization of each transect area.

Finally, the audio portion of the video tapes was reviewed and analyzed to aid in resolving any remaining questions regarding timing, and to fill in any data gaps from the observer audio record. This component of data collection was limited in that the observer's voice was not always recorded. However, the pilot's voice was periodically recorded noting details such as time and depth. The audio track of the video tape served as a backup, providing the only audio record obtained for portions of a few dives.

D.3.1.3 Benthos Photo Analysis - The Benthos film rolls were processed by Technicolor Laboratories, and returned as a single roll. This was cut into individual dives, and these grouped by area. Each Benthos dive roll was examined, frame by frame, by a team of observers who noted all of the species visible, the substrate, water clarity, and general comments. Slide condition (over or under exposed) was also recorded. At least two observers analyzed each film strip and recorded the data on tabular summary sheets for later computer entry. Data was recorded quantitatively whenever possible, as a number of individuals or percent cover. Qualitative notations include "present", "many", "trace" (usually listed as 1% or less than 1%), and "obscure".

Analyzing an entire area at one time enhanced the results, as the observers became more aware of subtle differences between transects and reduced the search time for the components of a given community type. Because the camera-to-substrate distance could not be measured, the coverage of each frame had to be approximated. Quantitative data for density estimates was taken only from correctly-exposed slides, which still represented roughly half of the total usable frames. The range of acceptable lighting was sufficiently narrow to estimate distance from the bottom, based on camera's depth of field. Areal coverage of each slide was derived in turn from this distance.

In addition to complete identification and description of each slide, frames were noted for later documentation of identified species, unknowns, and general aesthetic photographs.

To estimate species densities, mean sizes were used for size reference organisms (such as Balanophyllia and Coryphopterus), chosen because they showed relatively uniform sizes. Benthos frames were projected life-size, and areal coverage extrapolated from the dimensions of the reference organisms. Estimates of species densities from derived areal coverage figures were subjected to an error rate analysis. Due to the lack of reference organisms with sufficient invariable size, the calculated densities are only approximations.

D.3.1.4 Observer Photo Analysis - Hand-held photographs were used to record unusual or characteristic species and assemblages that might not have been recorded by the Benthos or video cameras. Photography was noted on the audio tape to facilitate synchronization. These slides supplemented the more comprehensive Benthos records, and were analyzed in the same manner. Several species were added to the masterlist from hand-held documentation photographs.

D.3.1.5 Movie Editing and Analysis - Approximately 45 minutes of 16 mm movie footage were taken at each of the three areas and edited to the required 15 minutes on a Movieola Film Viewer. Film segments were selected to maximize the value of the footage in characterizing a given area.

Initial editing was based on film quality, with poorly-exposed footage being deleted. Secondary editing involved careful comparison of footage for specific biological and geological features. The transect observers participated in this phase to ensure inclusion of the most representative footage. Final editing reduced the film to its required 15 minutes. These data are considered documentation of habitats and communities and were not subjected to further analysis.

Due in part to additional lighting, the movies provided a more extensive look at the general topography than either the Benthos or Video cameras. With the sub off the bottom and the camera aimed horizontally, several segments were produced showing the extent of sand channels, boulder/cobble patches, and rock ridges.

D.3.2 Analysis - Recorded data was summarized and reduced by computer analysis. Reduced data was examined for patterns of distribution of organisms and plotted onto maps of the transect lines.

D.3.2.1 Selection of Species for Density Distribution Analysis - Species categories were selected for density and distribution analysis on the basis of adequacy of identification and frequency of observation. A preliminary list of twenty species was expanded to thirty species categories (*Allopora* and *Sebastes hopkinsi* being divided into size classes) following a discussion of community definitions with consultants, Dr. William Newman and Dr. Richard Rosenblatt. Density-depth plots (Appendix F) were obtained for all categories. Less common species, which were not selected for detailed analysis, were tabulated by hand for species descriptions, associations and community definition.

D.3.2.2 Entry of Species Density Data - The data recorded by observers, video, and Benthos cameras were entered into the computer by use of a form entry procedure. This procedure uses a formatted entry page which is displayed on a graphics cathode ray tube (CRT). The operator filled in indicated blanks on the form using a tab/entry technique. When the form is completed, the entire entry-page of data is transmitted to the system computer. Each entry-page of data represented one minute of submersible transect time. Editing, updating, and expanding the resulting data storage file is accomplished by the use of browse mode of the form entry program. For convenience, most of the observer and video data was entered first, followed by browse mode entry of the benthic photographic data.

In addition to species counts and percent cover data, qualitative data, including presence, absence, trace quantities (less than 1 sq m or 1%), and indefinite numbers of individuals were entered as codes. The source (observer, video, or Benthos photograph) of every value was recorded with the value. In all cases, except for 6 small species (e.g. cup corals, Maripelta, etc.) in which Benthos photograph densities were the primary data source, observer densities were given precedence over other observations. Benthos photograph densities were given precedence over video observations. However, in all cases numerical densities were given precedence over coded (presence, absence, trace, or many) entries.

Substrate was recorded based on the predominant size class observed in the following order of priority boulder, rock, cobble, pebble, gravel, or sand. Rock substrates include a wide range of rocky bottom habitats from very large boulders to long reef-like ledges or shelves of hard substrate. The percent rock (including boulders, cobbles, pebbles and gravel) was included to indicate the amount of usable substrate for attachment of benthic species. No attempt was made to differentiate sand habitats as this was beyond the intent of the study.

Reported depths of the observations were also entered into the data base. Approximate depths for each minute of transect were provided by linear interpolation between recorded depths.

D.3.2.3 Entry of Position Data - The ship log of submersible navigation positions was carefully evaluated to determine the heading and distance of the submersible relative to the support ship antenna. These data were coded and submitted to Navigational Services Incorporated for calculation and plotting of the submersible positions. The resulting data were coded on computer tape and transferred directly to the Hewlett-Packard computer. The time (hrs., min., sec.) of each position fix was entered into a separate file by manual entry from the ships log. The two files were merged to tie the time of navigational fix to the latitude and longitude coordinates. Another file was created for reporting stops along the transect. The submersible speed between position fixes was calculated allowing for the time the submersible was stopped on the bottom. These speeds were inspected and obvious errors corrected. In several cases a noticeable drift of several hundred feet was detected during reported stops. In every case where a discrepancy was detected, the logs were checked to verify the accuracy of the data. In three instances the submersible position had been incorrectly calculated and these positions were corrected prior to analysis.

D.3.2.4 Compilation of Data - After extensive checking, the species count data and submersible positioning data files were merged by generating interpolated submersible positions for every minute of transect time. The merged file was extensively checked for accuracy by comparing depths and other data at intersections between transects and generally evaluating all extreme values for accuracy. All detected errors were corrected. All Benthos photograph counts of numbers per photograph were corrected to approximate numbers per square meter by dividing by the approximate average areal coverage of a photograph (2 square meters). The compiled and edited data was summarized in tabular form, giving the depth range, mean depth, and percent occurrence (minute intervals observed) of each of the 30 species categories over each area and for the entire study.

D.3.2.5 Density or Occurrence With Depth - The depth distribution of each species over the entire study and in each area was studied by frequency and density methods. One method produced a smoothed frequency histogram of the number of occurrences of a species in all intervals within each ten foot depth range. The other method plotted organism maximum and average density by depth. The data for each plot was inspected prior to plotting and cases with fewer than 15 points were not plotted. The plots were produced by a PDP8 minicomputer using a Versatec plotter and by manual methods.

D.3.2.6 Density or Occurrence by Location - The distribution of the organisms was studied by plotting their relative abundance on latitude/longitude grids. This was accomplished by assigning the data to five density categories; absent, trace, present, common, and many. Numerical values were assigned to these categories by scaling the observations relative to the maximum abundances reported (Appendix F).

D.3.2.7 Distribution and Density Estimation Errors - Errors could have occurred because species identifications are not always consistent due to differences in the familiarity of the observer with the organism being identified, and the source of the observation (i.e. direct observation, video, or Benthos camera photograph). The magnitude of the error depends on the size of the organism; smaller organisms are usually more difficult to observe and quantify. Interpretation of survey data necessitates a thorough understanding of these limitations on the data.

D.3.2.8 Source Limitations - Overall, the highest-quality observations were made by the scientific observer. However, the observer is overloaded with information to report and as a result is not always able to record observations in a totally uniform and consistent manner. Factors which contributed to the quality of observer records were: (1) numerous points of reference for evaluating sizes and colors of organisms (including size perspective, shadows, overhangs) not always available in still photography and video records; and (2) more flexible field of vision (including broader depth of field) allows evaluation of both very large and very small organisms and features not available through either video or photography alone.

Both video and photographic records have the advantage of being available for lengthy perusal and evaluation. Video is primarily useful for evaluating the large macroalgae cover, fish population densities, and substrate, whereas the Benthos camera records are more useful in identifying and counting smaller macroalgae and invertebrate populations.

It must be stressed again that sizes, densities, and some species identifications reported are approximations which, although made by experienced observers were not supplemented by systematic physical sampling of the organisms and substrates. As a consequence, the resulting information is invaluable in a comparative sense, but should not be interpreted as absolute.

Three measures of size and density were used to estimate the organisms and populations observed: percent coverage, count per square meter, and length. Values were extracted from the data log where they were recorded by two or more methods of observation during a one minute time interval. Such values were considered paired values. A comparison between paired values obtained independently by the three methods of observation provided an estimation of the magnitude of difference between the methods. These estimates, ranging from 12 to 20%, include both observational error and microhabitat variation components. A 12% average difference was found between paired observer and

Benthos photograph estimates of percent coverage (n=17). A 15% average difference was found between paired video and benthic photograph estimates of percent coverage (n=11). The relative difference between estimates of numbers of organisms per square meter ranged from ± 1.2 to 1.6 organisms per square meter with the observer/video estimates (±1.2, n=16) being most similar as compared with the benthic photograph estimates (±1.6, n=19 observer/Benthos and 22 video/Benthos). The mean difference between observer and video length, height, and width estimates was found to be about 20% maximum.

D.3.2.9 Observer Limitations - By crosschecking and frequent comparison between opinions expressed by the observers, most differences in data quality due to individual observer bias were eliminated. A comparison of the species reported between different intersecting dives yielded shared species levels of 82 to 86%. In comparing observations made by two different observers at transect intersections, 86% of the species seen at the intersection location were reported on both dives (i.e. shared species). The average difference between observations made by two different observers at transect intersections differed only 4% from observations made by one observer intersecting his own transects (82% shared species). Data cataloguing was standardized by using one observer to analyze all video records and one team of two observers to analyze Benthos photograph records.

D.3.2.10 Consistency of Data - A comparison of replicate observations at nine intersections between transects yielded an estimate of the overall similarity between replicates. By an analysis of shared species, it was found that 50% of all species reported, regardless of rareness or size, or 83% of the fifteen most commonly observed species, were shared by matched observations. This compares to 33% of all species reported, or 57% of the fifteen most commonly observed species being shared among nonreplicate observations. Thus, data at intersections was 17 to 26% more similar than nonintersecting data. This high consistency of observations between replicates indicates not only that the data is an adequate description of the biological conditions observed, but also that an overall consistency exists in navigational and related factors which make such comparisons possible.

D.3.2.11 Species Identification - Species identifications are normally designated by listing the lowest taxon to which a particular specimen is known to belong. If there is uncertainty in the identification, a question mark (?) may accompany the classification, e.g., *Plumularia* sp.? to indicate uncertainty at the generic level. Following standardized rules of nomenclature, the specimen in the preceding example is distinct at the family level but less distinct at the generic level. Analysis of the Tanner and Cortes survey data as in most submersible and SCUBA surveys, employs a less strict method of taxonomic classification. This approach maximizes the use and applicability of the data and is based on prior geographical and ecological knowledge of the species present or likely to be present in an area. Direct observation or sampling of the survey area is necessary to verify the occurrence of expected taxa. As an example of this approach, historical data records indicated that orange-colored limpets (*Acmaea funiculata*) and orange cup corals (*Balanophyllia elegans*), were expected in the Tanner and Cortes area and both types of organisms were recorded by Interstate observers and consultants. Photographs of these taxa can appear to be similar depending on exposure and camera resolution. As such, a listing of *Balanophyllia* sp. ? does not mean that the specimen is distinct to the family level, but rather that the specimen is orange, circular to subcircular, and appears to be the orange-colored cup coral Balanophyllia. The taxonomic uncertainty is not necessarily between genera or species in a single family of coelenterates, but could represent a choice between different phyla. This method is most useful for those taxa that can be identified in the field, and so has limited use for some groups such as the red algae, tunicates and sponges. The present submersible survey was adequate for identifying common or large organisms, but was less sensitive in recognizing rare or new species.

D.3.3 Community Analysis - Benthic communities are usually named after one to several species (Thorson, 1957) which are dominant in terms of percent cover, density, biomass, or percent frequency. The community dominants described by the present study are based largely on the judgment of the biological observer team including scientific consultants and BLM representatives participating in the survey, and were further verified by a review of observer, video, and photographic records. The distribution and densities of selected dominants and other important species such as Allopora were determined by computer analysis of the data for each species. Community boundaries are coincident with the distributional ranges of community dominants and these data were used to map the biological communities of Tanner and Cortes Banks.

The above transect data were integrated into a comprehensive record coordinating time and depth with all observations (Appendix E). Any discrepancies in identification were resolved prior to further analysis. The community structure of the Banks was determined by:

- Density vs depth analyses for each of the dominants and sub-dominants. Two graphs were done for each species, one with qualitative and the other with quantitative density scales. This was considered the most meaningful approach, based on the variation in the types of data. These two graphs were complementary, although in most cases the quantitative graph was used simply to check relative peaks and overall changes with depth.

- Comparing and contrasting density curves for different species, in each area and for the six areas combined, to detect any consistent species assemblages.

- Generating species ratios and similarity coefficients for recurring groups.

- Considering substrate types to resolve discrepancies and clarify community structure.

D.3.3.1 Community Mapping - Persistent species assemblages were mapped along the transect lines, superimposed on the bathymetry. This depicted relative distribution of communities in terms of substrate, depth range, topographic features and exposure. Community definitions were developed and/or refined, and the community structure extrapolated to outlying areas. Distribution and extent of the final community structure was indicated by drawing or adjusting the perimeter for each community.

The distribution plots for the various species were compared to the substrate map. Species distributions were interpolated from the data and drawn on an overlay. The species distributions in each area were compared sequentially, with the distribution of Eisenia being interpreted first, followed by Agarum, Laminaria, Calliarthron, Gelidium, Eugorgia, Plumarella, sponges, Florometra, Lytechinus and Zonaria in that order. Species not used in developing the community map were analyzed relative to the mapped distributions of community dominants. The boundaries drawn between adjacent communities, especially complex transition areas, represent the subjective opinion of the scientific staff as to the relative importance of the various community components. Rare or more evenly distributed species were considered in detail in site characterizations and species descriptions, however, they contribute least to overall community distinctions.

D.3.3.2 Distribution of Selected Species - The distribution plots of the various species were divided into taxonomic categories and submitted to specialists on the respective group for review and subjective analysis. The distribution of each species was evaluated in terms of community membership, depth distribution, substrate characteristics, and species associations.

Six conditions were scored as indicators of community composition in the study area. If the given conditions were met during one minute of survey data, the community was scored as present. A computer listing was generated showing these scores along with the densities observed for the fourteen most important nonmotile species along with Mediaster, Patiria and Lytechinus. (1) The presence of both Agarum and Laminaria was scored as indicative of the extent of the middepth community. (2) The presence of either Agarum or Laminaria with Zonaria or Gelidium was scored to determine the extent of this association in the Agarum/Laminaria community. (3) The presence of either Agarum or Laminaria with Calliarthron or Eisenia was scored to determine the extent of overlap between the shallower Eisenia/Calliarthron and deeper Agarum/Laminaria communities. (4) The presence of either Calliarthron or Bossiella with Eisenia was scored as an indication of the extent of the shallow water community. (5) The presence of either vase or bath sponges with Plumarella was scored as an indication of the extent of this deepwater community. (6) The last condition scored was for the presence of Patiria, Lytechinus, or Mediaster as an indication of the transition from rock to sand substrate.

D.3.3.3 Density of Selected Species - The numbers per square meter, percent coverage, and organism sizes were evaluated and graphed for dominant fish, algae, and coral populations. The population characteristics which were indicated by the data were graphed manually.

D.3.3.4 Correlation of Communities and Selected Species with Geologic Parameters - After plotting biological transect data, correlations between biologic and geologic features were studied by overlaying the transect maps on the corresponding bathymetry and geomorphology maps of each area. A close correspondence was seen between biologic communities and the combined geologic features of each area. Major changes in substrate type corresponded with observed major changes in the biota. Clusters of species occurring within uniform substrates corresponded to major changes in the bathymetry. Mapping of communities consisted of outlining substrates which supported a uniform biologic community followed by detection and outlining of bathymetric contours which defined species associations within areas of uniform (no detectable biological differences) substrate.

Very good correlations were found between observed sand and the geomorphic maps of uniform soft substrate. The discrepancies consisted mostly of observer records of small patches of sand and sand channels not distinguished on the geomorphic maps.

No difference could be detected between species associations on the different rock types indicated on the geomorphic maps. Depth was the prime factor regulating species distributions on rocky or boulder substrate. Community boundary depths were found to be fairly consistent throughout all areas and occurred at 89, 68, 60, 40 and 26 meters depth. A secondary factor regulating species distributions was sand scour, but no physical parameters were measured during the submersible surveys.

Appendix E

TRANSCRIBED OBSERVER, VIDEO, AND BENTHOS DIVE LOGS

Appendix E

DATA RECORD

The data from observer, video, and Benthos camera records are listed for minute intervals of each transect dive. Time, depth, and observations (comments) are included. Data are not included for movie dives (nos. 25,29,30 and 31). Only records from dives 1 and 2 are included in this appendix with the remaining dives presented in Volume III.

In most cases only the generic name of each species is listed in the record to conserve space. Complete species names are listed in Appendix H. Other abbreviations used in the data record are listed in Table E-1.

Observer records are indicated in the column listed "time". Video records are indicated by the word "video" in the comments column followed by the time (hours and minutes). Benthos records are indicated by a six-place number in the comments column corresponding to hours, minutes and seconds. All times are based on the 24-hour clock.

Note: Benthos and observer/video records for some dives were standardized with navigational time records by determining time discrepancies and inserting the data record in the proper position. Observer and video time records were changed (i.e., retyped) where necessary to correspond to the correct navigational time. Benthos time records were not changed since they correspond to a time printed on each Benthos photographic slide. Benthos records were moved to the correct observer/video time sequence in the data record. The changes made to the original data record are listed in Table E-2.

TABLE E-1. ABBREVIATIONS USED IN DATA RECORD

Listed as:	Equivalent to:
Het. or Hetero.	Heterogorgia
many	too numerous to count
B or LL	Burned (overexposed photograph)
D	Dark (underexposed photograph)
O	Orange-colored
W	White-colored
Y	Yellow-colored
~	Partly
+ (following a species count)	The count indicated and possibly others.
+ (following a species name)	Obscure; bad camera exposure or camera view prevented accurate count

TABLE E-2. TIME CHANGES TO DATA RECORD

Dive #	Time Change (minutes)*	
	Benthos	Observer/video
1	+57	-5
2	+60	0
4	+3	-1
5	-3	0
8	-2	+4
9	+2	0
13	+2	0
18	-3	+56
23	0	-3
33	-120	0
34	-120	+5
35	-120	+5
36	-9	+6
37	0	+6
38	0	+5
39	0	+6
40	+3	+6
41	0	+5

* (-) reported times were moved back
(+) reported times were moved ahead

Area: E Location: Tanner Bank
Dive No.: 1 Date: October 20, 1978
Observer: Jack Word Pilot: Rick Olson
Comments: 1045 incorrectly called out as 11:45 and continued for a short while 1049 - time called out correctly. Entire dive run without sub lights due to bright ambient lighting.

Time	Depth	Comments
1039		Ballasting
1040		Underway
1042		(Startdown
1044	50′	Change in water color (possible thermocline) bright blue to greyish greenish blue
1046		(Bottom in site, 50′ above bottom); Rock cobble bottom with sand (white); (100′ visibility, no external lights); 70% of bottom covered
		094521 - 094938 Descent.
1047		Rock size: a) 1′ diameter (6-12"); b) some larger
		¬D/¬B/¬LL 095021 - Boulder, rock and cobble with 40% sand overlay; Encrusting corallines 60%; Mediaster (1); Heterogorgia (1); Orange bumps (M/+); Green crust less than 1%; Orange crust less than 1%; Fish (2); Algae less than 1%.
1048	250′	Rocks surrounded by white sand
		¬D 095104 - Rock, boulder and cobble with 60% sand overlay; Encrusting corallines 35%; Fish (1); Six-rayed asteroid (1); Gastropod (1) ?; Bath sponge (1); Green crust less than 1%; Red crust less than 1%.
		¬D 095147 - Rock, cobble and boulder with 45% sand overlay; Encrusting corallines 45%; Coryphopterus (Y) (1); Orange bumps approximately (20); Six-rayed asteroid (1); Orange crust less than 1%; Reds much less than 1%; Red crust less than 1%; Green crust less than 1%; Fish (4).
1049		Rockfish, small; encrusting coralline on boulders
		¬D 095230 - Boulder and cobble with 80% sand overlay; Encrusting corallines 10%; sixrayed asteroid (2); Green crust much less than 1%.
050	270′	Opaleye, small, 1 cm, white spot on back, 5" off bottom

Time	Depth	Comments
		D 095313 - Boulder, cobble and rock with sand overlay; Encrusting corallines 30%; Cottid (1) ?; Six-rayed asteroid (1); Orange bumps (M/+); Reds less than 1%; Calliostoma (1) ?; Polychaete (1) ?; Green crust much less than 1%.
		095356 - Boulder, cobble and rock with sand overlay; Encrusting corallines 30%; Cottid (Absent); Six-ayed asteroid (1); Orange asteroid (1); Orange bumps (M/+); Reds less than 1%; Calliostoma (1) ?; Polychaete (1) ?; Green crust much less than 1%.
1051		(Stopped); Cobble bottom 6-7", 70%; sand 30%; Kelletia; Coryphopterus nicholsi sitting on rock, 6-7′ apart
		D 095438 - 90% boulder with 40% sand overlay; Encrusting corallines 40%; Orange bumps (M/+); Fish (4+); Green and yellow crust 1%; Red crust less than 1%; Light green crust less than 1%; ? Heterogorgia (2); Reds less than 1%.
1052		(Stopped)
		D 095521 - 95% rock and boulder; Encrusting corallines (1); Sebastes (1); Fish (1); Red crust 2%; White branched sponge less than 1%; ? Heterogorgia (+).
1053		(Stopped). Opaleye, 20-30/m^2
		D 095604 - Rock and boulder; Encrusting corallines approximately 95%; Bath sponge (5+); Peridontaster (1); Sebastes hopkinsi (3); Red crust 2%+; Glass sponge (1);
		D 095647 - Rock and sand (+); ? Fish (1).
1054		(Underway); Large pile of rocks; Olive; Opaleye, 1 cm; Sebastomus, 50-60 over outcrops; Large massive rocks; Sebastomus - (50-60); Cow rockfish - 1 1/2-2′ long (1); Flag rockfish (1); S. paucispinis (1)
		D 095730 - Rock; Encrusting corallines (+); Bath sponge (2+); Fish (2+).
1055		Epiphytic growth; Large mounded sponges, yellowish, 10 mounds/m^2; Large flat boulders, upward directed rocks with sand filled crevices; Short belly rockfish 50-60.
		LL/D 095813 - Approximately 65% boulder; Encrusting corallines (+).

Time	Depth	Comments
		D 095856 - Approximately 75% boulder; Encrusting corallines 90%; Bath sponges (2+); Fish (1+); Crusts (+); Ophiuroids (+).
1056		Olive rockfish (1); Edge of rock outcropping; Many small shortbelly rockfish. Sand bottom with boulders; encrusting coralline on boulders; Sebastomus - 1/10 sqm off bottom - 1-2′
		LL/D 095939 - 90% rock and boulder; Encrusting corallines (+); Crusts (+).
1057		Eugorgia rubens, thin fan appears reticulated
		D 100022 - Rock; Encrusting corallines approximately 85%; Peridontaster (1); Crusts (+); Bath sponge (1).
1058		Large rise with rocks 10° rise; 5′ diameter boulders; Short belly rockfish schools, small. Sponges Spheciospongia; Gorgonians, thin reticulated fans, numerous
		D 100104 - Rock.
		D 100147 - Rock and sand (+); Fish (1).
1059		Large numbers of rockfish; Shortbellys with two eye stripes, hundreds; Large masses of boulders, 100-300′ across
		D 100230 - Approximately 95% rock and boulder; Encrusting corallines (+); Crusts (+).
1100		Spheciospongia, Hexactinellidae sponges, large; Rocks with encrusting coralline; (Buoy pulling sub off bottom)
		D 100313 - 90% boulder; Encrusting corallines 85%; Green crust 4%; Sebastes rosaceus (1); Red crust 5%; Orange crust 1%; Ophiuroids (2+); Reds less than 1%.
		D 100356 - 95% rock and boulder; Encrusting corallines (+).
1101		Small red algae - Rhodymenia; Shortbelly rockfish schools, 20′ off bottom; S. paucispinis rockfish, many, small; Sebastomus
		D 100439 - 95% rock and boulder; ? Fish (1+).
1102		Starry rockfish; Large cliff - 20′ high; Many large S. paucispinis - 2′ (6-20′ off bottom); Yellow Coryphopterus; (Topping rocky ridge); Sabellid worm; Aglaophenia; Opuntiella; Olive rockfish - 18" long; juvenileenileenile S. paucispinis - 100′s, some small, some 2′ long

Time	Depth	Comments
		D 100522 -
1103		Massive rocks; 1 1/2′ long S. paucispinis - 20-30 view port; Larger S. paucispinis shallower; Headed down; Rockfish, thousands
		100604 - 95% rock and boulder; Encrusting corallines (+); Crusts (+); Mediaster (2); Sebastes (1); Fish (2).
		¬D 100647 - 95% boulder; Encrusting corallines 80%; Coryphopterus (approximately Y) (1); Sebastes ? hopkinsi (1); Fish (5); Paracyathus (4); Red crust less than 1%; Dark crust 2%.
1104		Square spot rockfish; Sabellidae; encrusting coralline covers rocks; Eugorgia rubens
		100730 - Sand. Documentation. Lytechinus (8).
1105		Pink Surfperch ¬B 100813 - Sand with silt and ripples; Lytechinus (1+).
		¬B 100856 - Sand with silt; ? Lytechinus (1).
1106		Sandy bottom; Clean-white sand bottom; Lytechinus anamesus - 20/0.1 sqm; Mediaster aequalis; Small ripples in sed. - 1" high
		¬B 100939 - Sand with silt; Lytechinus (1).
1107		(Community stop); Small amounts of flocculent material; (No worms visible); Lytechinus, dominant; Mediaster
		¬B 101022 - Sand with silt and ripples; Lytechinus (2).
1108		(Stopped for pick up)
		101104 - Sand with silt and ripples; ? Lytechinus (1).
		¬D 101147 - Sand with silt and ripples; ? Lytechinus (2).
1109		(Audio tape changed to side 1b)
		¬D 101230 - Sand with silt and ripples; Lytechinus (1).
		¬B 101313 - Sand with silt.
		101356 - Sand with ripples; Lytechinus (4).
1111		Sandy bottom; Small rock ten rocks 6" to 3′ across; Sand covers surface of rocks; Sebastomus (1)

Time	Depth	Comments
		101439 - Fine sand; Lytechinus (7).
1112	245′	Citharichthys, light color; White sand, little or no silt; First area of parallel tracks - 2" deep - 2′ wide over 100′ area, longitudinal series of marks
		D 101522 - Sand with debris; Lytechinus (7+).
1113	$300/_1$	Lutechinus, increasing numbers, 2-3cm across Mediaster
		¯D 101604 - Sand with ripples; Lytechinus (40+).
		¯B 101647 - Sand with ripples.
1114		Linckia; (Horizon Area rocky); Sand bottom; 2nd area of parallel tracks: large area - erosion patterns; 30-40 parallel lines to port, 2" high, 10" wide
		D 101730 - Rock with 85% overlay; Coryphopterus (approximately Y) (1); Mediaster (1).
1115		Lytechinus; 10-12" wide; 2" deep; 30-40 of these parallel; Ptilosarcus (=Leioptilus) gurneyi; Henricia leviuscula; less Lytechinus
		D 101813 - Sand and ? rock.
		D 101856 - Sand with silt; Lytechinus (2).
1116		Large areas of boulders with sand; Eugorgia rubens; Sebastomus; Olive rockfish; Blue rockfish - 20-30 individuals (20-30′ off bottom); S. paucispinis
		¯D 101939 - Sand with silt and ripples; ? Lytechinus (1).
1117		Sand bottom white; No Lytechinus; Rathbunaster californicus 2′ across (2)
		¯D 102022 - Sand with silt and ripples.
1118	250′	Luidia foliolata (1); Mediaster aequalis; Ripple marks, 40° to sub heading; Tube worm sticking out of sediment
		¯B 102104 - Sand with silt and ripples.
		¯B 102147 - Sand with silt and ripples.
1119		One flat 30′ diameter rock, 80% covered with sand, fish on its surface. Rathbunaster californicus, 2′ across Henricia
		¯B 102230 - Sand with silt and ripples.

Time	Depth	Comments
1120	250'	(Stop for communication problems) sand bottom; Lytechinus anamesus
		‾B 102313 - Sand with silt and ripples; Lytechinus (test) (2+).
		‾B 102356 - Sand with silt and less than 1% pebble.
1121		(Stop continues)
		‾B 102439 - Sand with silt and less than 1% pebble; Lytechinus (test) (2).
1122		(Stop continues) Sand bottom
		‾B 102521 - Sand with silt.
1123		(Stop continues); Lytechinus, dominant; Fish, thousands
		‾B 102604 - Sand with silt. Frame shift 1025:21.
		‾B 102647 - Sand with silt. Frame shift 1025:21.
1124		(Stop continues, ship catching up to sub buoy
		‾B 102730 - Sand with silt.
1125		(Stop continues); Sand bottom
		‾B 102813 - Sand with silt. Frame shift, 1027:30.
		‾B 102856 - Sand with silt. Frame shift, 1027:30.
1126		(Stop continues, taking picture with ambient light)
		‾B 102939 - Sand with silt. Frame shift, 1027:30.
1127		(Stop continues, taking picture with sub lights) 103021 - Sand with silt and 1% debris.
1128		(Audio off) D 103104 - 85% rock with 10% sand overlay; Encrusting corallines 80%; Coryphopterus (Y) (2); Peridontaster (2); Sebastes hopkinsi (3); Reds 1%; ? Balanophyllia (2); Balanophyllia (2); ? Glass sponges less than 1%; Paracyathus (9+).
		‾D 103147 - Sand with silt and ripples.
1129		(Stop continues)
		D 103230 - Sand with silt and ripples.

Time	Depth	Comments
130		(Underway) ¬D 103313 - Sand with silt and ripples; Lytechinus (3).
		D 103356 - Sand with silt and ripples.
1131		Small rock outcrops, 10-15′ across; Sebastomus, (4); Rhodymenia on rock; Corynactis; Stylasterias forreri (1); Lytechinus, 30/m^2; Mediaster aequalis, 1/20m^2; Ratfish, small (1); Rathbunaster californicos (1); Rocky outcrop, small
		D 103438 - Silt and coarse sand; Lytechinus (4).
1132		Rathbunaster californicus (1); Lytechinus, few, varied appearance; Mounds of sand, 6" across, 3" tall, volcano shaped
		¬D 103521 - Silt with coarse sand overlay.
1133		Sand; Rathbunaster (1)
		¬D 103604 - Silt with coarse sand overlay.
		D 103647 - Silt with coarse sand overlay.
1134		Rocky Outcrop, boulders; Sand around rocks is coarse with shell debris; Rathbunaster californica (1)
		¬D 103730 - Silt with coarse sand overlay; Lytechinus (13).
1135		Luidia foliolata, 2′ across (1); Lytechinus, dominant; Ripple marks, 2′ across trough, 2-3" tall; Troughs filled with shell debris, white; Sand grey
		¬D 103813 - Silt with sand and ripples.
		103856 - Silt with sand and ripples.
1136		Sand
		103938 - Silty with sand.
1137		Small rocky outcrop, 1-6′ boulders; encrusting coralline cover dominant; Patiria? (1); Sebastomus, several species; Grey sand with white shell debris in troughs of small ripple marks
		104021 - Silt with sand; Lytechinus (3).
1138		Rathbunaster (1); Mediaster, dark colored; Citharichthys (sand dab) mottled color

Time	Depth	Comments
		104104 - Silt with sand. Documentation. Sebastes eos group (1) ?.
		104147 - Sand with silt and ripples.
1139		Rocky outcrop 50′ across; (Community stop); Coryphopterus, several; Paracyathus, several; Rhodymenia, resembles "Rhodoglossum"; S. paucispinis, 6" long (1)
		104230 - 2% rock on silty sand; Sebastes eos group (2) ?; Mediaster (1); Encrusting corallines (+); Reds 1%.
1140	250′	Paracyathus, some, jutting through sediment, must be on submerged rock surface.
		⁻B 104313 - Silty sand; Sebastes eos group (1).
		104356 - Silty sand. Frame shift, 1043:13.
1141	250′	(Stopped); Sebastomus sitting in front of window
		104438 - Silty sand; Sebastes eos group (1).
1142		(Taking pictures, stopped); Sebastomus (20)
		104521 - 5% boulder on silty sand with ripples; Encrusting corallines approximately 3%; reds 1%.
1143		(Stopped) Two coloration varieties of Sebastomus, some with white blotches
		104604 - Silty sand. Frame shift, 1044:38. Mediaster (1).
		104647 - Silty sand with 3% boulder. Frame shift 1044:38. Mediaster (1).
1144		(Taking pictures, stopped) Mediaster (definite I.D.)
		⁻D 104730 - Silty sand with ret. rips.; Mediaster (1).
1145		(Same) D 104813 - Silty sand with ret rips.; Mediaster (3).
		⁻D 104856 - Rock with 60% sand overlay; Encrusting corallines 40%; Coryphopterus (Y) (1); Peridontaster (1); Mediaster (1); ? Sebastes (2); Unbranched reds 1%+; Br. reds 1%; Fish (1); Heterogorgia (1).

Time	Depth	Comments
146		(Stop continues) Paracyathus on rocks
		D 104938 - Rock and boulder with 30% sand overlay; Encrusting corallines approximately 65%; Mediaster (1); Peridontaster (1); Reds 1%+; Solitary tunicates (10+).
1147	253′	(Underway fish nibbling on benthos cable)
		105021 - 3% boulder on sand with silt; Encrusting corallines 10%; Mediaster (2); Reds less than 1%; Lytechinus (3+).
1148		Small rocky outcrop; encrusting coralline and Paracyathus on rocks; Sand bottom; Mediaster; Luidia foliolata
		D 105104 - Rock with 50% sand overlay; Encrusting corallines 40%; Sponges approximately 3%; Reds 1%+; Heterogorgia (2); Solitary tunicates (14+); Ophiuroids (+).
		D 105147 - 2% rock on silt with sand; Mediaster (1).
1149		Larger rocky outcrop; (no gorgonians, no Allopora); Rockfish lying between rocks; 2′ ledge drop off
		105230 - Silt with sand.
150		Eugorgia rubens, gorgonid, flat fans, 1′ tall, light purple, dichotomously branched
		105313 - Silt with coarse sand and light debris.
		D 105356 - Silty sand with debris; Mediaster (1).
1151		Olive rockfish; Starry rockfish along one rock shelf; Coryphopterus
		D 105438 - Silt with sand.
1152		Coryphopterus
		D 105521 - Silt with sand; Mediaster (2).
1153		Rathbunaster on rocky outcrop; Henricia, several
		D 105604 - Silt with sand.
		D 105647 - Silt with sand.
1154		(Photographed Rathbunaster)
		D 105730 - Silt with sand; Mediaster (1).

Time	Depth	Comments
1155	258′	Sand bottom, small ripples 1′ apart with shell debris; Scattered 2′ rocks
		D 105813 - Silt with sand; Mediaster (1).
		105856 - Silt with sand.
1156		Pile of 2′ boulders, 20 of them; Ratfish, swimming off bottom a few feet then back into sand; Mediaster
		D 105938 - Silt with sand.
1157		Sandy bottom; Rathbunaster (2); Mediaster
		D 110021 - Silt with sand.
1158		Rathbunaster; Mediaster
		D 110104 - Silt with sand.
		D 110147 - Silt with sand.
1159		(Change to tape 2a)
		D 110230 - Silt with sand and approximately 3% rock; Encrusting corallines (+).
		D 110313 - Silt with sand (? overlay) and ripples with 1%+ rock; Reds less than 1%; Mediaster (1); Paracyathus (1); Lytechinus (5+).
		D 110356 - Rock with 90% sand ? overlay; Encrusting corallines 10%.
1201	253′	Sand bottom; Mediaster; Lytechinus, occasional; Rathbunaster
		D 110438 - Silt with sand and ripples; Mediaster (1).
1202		Rocky outcrop (100′ visibility), 3′ boulders; encrusting coralline; S. paucispinis, some; Sebastomus, many
		D 110521 - Silt with sand.
1203		Rocky outcrop, small; Rhodymenia; Small ravine with smooth "alluvial plain effect"
		D 110604 - Silt with sand.
		D 110647 - Silt with sand and ripples.
1204		Sand bottom; Mediaster
		D 110730 - Sand with ripples.

Time	Depth	Comments
205		Mediaster with 6 points ¬D 110813 - Silt with sand and ripples; Lytechinus (+).
		D 110855 - Silt with sand and ripples.
1206	255′	Sand bottom with shell debris between ripple marks; Mediaster; Lytechinus
		D 110938 - Silt with sand and ripples.
1207		(Same)
		D 111021 - Silt with sand.
1208		Rocks, a few in sand with encrusting coralline; Rathbunaster; Paracyathus, 1" across; Mediaster
		111104 - Silt with coarse sand and less than 1% pebble.
		111147 - Silt and coarse sand with heavy debris.
1209		Sand bottom; Rathbunaster, 16" across
		¬D 111230 - Silt with sand; Lytechinus (11).
1210		Rocks partly submerged in sand; Rhodymenia, 3" tall on rocks; (500 yards from pinger, buoy trouble, trailing 3 buoys)
		111313 - 2% rock on silt with sand; ? Dark crust 95%.
		111355 - Silt with sand and ripples.
1211		Sand bottom
		¬D 111438 - Silt with sand and ripples; Mediaster (1); Lytechinus (2+).
1212		Astropecten verrilli; Some rocks 1′ across in sand
		D 111521 - Silt with sand and ripples.
1213	258′	Paracyathus sticking out of sand, must be on submerged rock
		D 111604 - Silt with sand and ripples.
		D 111647 - Silty sand.
1214		(same)
		D 111730 - Silt with sand and ripples.

Time	Depth	Comments
1215		Citharichthys, sand dab (1); Rock in sand, 1′ across; Paracyathus (6)
		111813 - Silt with sand and ripples; Mediaster (2); Lytechinus (1).
		111856 - Silt with sand and ripples and less than 1% pebble; Lytechinus (2).
1216		Flat fish, 10′ off bottom, 1′ long
		111938 - Silt with sand and ripples; Lytechinus (1+).
1217		(Same) 112021 - Silt with sand and ripples; Lytechinus (2+).
1218		(Same)
		112104 - Silt with sand and ripples; Lytechinus (2+).
		¯B 112147 - Silt with sand; ? Lytechinus (1).
1219		Sand bottom (Tape batteries low)
		¯D/¯B 112230 - Silt with sand and ripples; Lytechinus (2+); ? Gastropod (1).
		112313 - Silt with sand and ripples; Lytechinus approximately (3).
		¯B 112355 - Silt with sand and ripples. Frame shift; 1123:13. Lytechinus (4+).
1221	259′	(Reached pinger, end transect)
		112438 - Silt with sand and ripples; Lytechinus (8).
		112521 - Silt with sand and ripples. Pinger can. Lytechinus (3).
		¯B 112604 - Silt with sand and ripples; Lytechinus (11).
		112647 - Silt with sand; Lytechinus (1+).
1224		(Releasing buoy)
		112730 - Silt with sand and light debris; Lytechinus (5+).
		¯B 112813 - Silt with sand; Lytechinus (2+).
		¯B 112855 - Silt with sand and ripples; Lytechinus (5+).

Time	Depth	Comments
.226		(Releasing sub buoy)
		D 112938 - Silt with sand and ripples; ? Lytechinus (1).
1227		(Audio stopped)
		113021 - Begin ascent.
		114104 - On surface.
1239		(on surface)

DIVE SUMMARY

SAND BOTTOM COMMUNITY (240-270')
Lytechinus anamesus - white sea urchin - most abundant
Mediaster aequalis tenellus
Rathbunaster californicus
Luidia foliolata
Astropecten verrilli
Ptilosarcus gurneyi
Henricia leviscula
Citharichthys spp. - sand dabs
Hydrolagus collei - ratfish

ROCKY BOTTOM COMMUNITY
Rocks covered with encrusting coralline
Nursery area? of many rockfish species
Shortbelly - S. jordani, S. paucispinis - (bocaccio)
juvenilespresent in water column
Sebastomus species - 4-5
Olive rockfish - S. serranoides
Square spot rockfish - S. hopkinsi
Coryphopterus nicholsi - black eyed goby
Cow rockfish - S. Laevis
Flag rockfish - S. rub
Stylasterias forreri
Ling cod - Ophiodon elongatus
Yellow goby
Sabellid
Gorgonian
Sponge
Parayathus stearnsi
Half banded rockfish

Area: E   Location: Tanner Bank
Dive No.: 2   Date: October 20, 1978
Observer: R. Grigg   Pilot: J. O'Donnell

Comments: Minimum depth - 230'; Maximum depth - 306's

Time	Depth	Comments
		134939 - Surface shots
		135518 - Descent 140310
1500		(At buoy. Begin dive) (Strobe is working)
1502200'		(Bottom in sight)
1503	306'	(On bottom); (Visibility - 60'); Flat sandy bottom; S. chlorostictus coming in approximately 10; individuals approximately 12" long. Lytechinus 1-10/
		140352 - Coarse sand with silt. Lytechinus (31+)
		⁻B 140435 - Coarse sand with silt. Lytechinus (10+)
1505	306'	(Heading 000°, 1/2 kr.); Sand with ripples; Mediaster aequalis abundant
		140518 - Coarse sand with silt, 5% pebble, debris. Lytechinus (18+)
1506		(Audio off)
		140601 - Silt, coarse sand; 3% pebble. Lytechinus (9+); orange asteroid (1)
		140644 - Silt, coarse sand; 2% pebble, debris. Lytechinus (10)
		140727 - Silt, coarse sand; 1% pebble, debris. Lytechinus (11)
		140810 - Silt, coarse sand; 7% pebble, debris. Lytechinus (14+)
		140853 - Sand with silt, 10% pebble, debris. Lytechinus (18+)
1509		Sand with 3' ripple mark wavelength. (8' off bottom)
		D 140936 - Sand, silt. Lytechinus (22+)
1510		Large outcrop 10' high rock; Olive rockfish at base of rocks. S. chlorostictus abundant - 50 or so
		D 141019 - Sand, silt. Fish (1+)

Time	Depth	Comments
1511		Large S. paucispinis (biggest fish); Hexactinellid sponges (tan demospongia type) abundant. Sand patch with Hydrolagus - ratfish (1) Pecten shell
		D 141101 - Approximately rock, boulder. Fish (3)
		¯D 141144 - Sand with silt. Lytechinus many/+
1512	294' 297'	Small sole (probably Petrale) (1), Dover sole; Henricia COMMUNITY DOMINANT; Lytechinus 5-10/m^2; some Henricia and sand dabs, Mediaster abundant 1/5m^2; few rockfish; cleanly swept
		¯D 141227 - Sand with silt. Lytechinus many/+
1513		Slender sole, swimming along side of sub. Lytechinus dominant, Henricia, Rock outcrop; Sand - rippled with biogenous material; Sand dab, 3" (2); Lytechinus very abundant 1/4-5m; Stylatula (1); Mediaster 1/4m^2; Rockfish over sand ranging off the bottom
		¯D 141310 - Sand with silt. Lytechinus many/+
		141353 - Coarse sand, 2% pebble, debris. Lytechinus many/+
1514		Sand cleanly swept with lighter color on peaks. Rock - Huge S. paucispinis 4-5 individual (Surge strong and current) Lytechinus very small 1" 25/sqm; S. jordani, small individuals, approximately, Mediaster; Rock fish 5-10' off bottom
		¯B 141436 - Fine sand. Lytechinus (12); ?Astropected (1)
1515		S. paucispinis (5), S. jordani/elongatus (30); Rock area - Sponges (tan Demospongia type) Haliclona?; Rock fish (100) white sponges. Spheciospongia
		D 141519 - 30% rock on sand (ret. ripples). Crusts (+); Asteroid (1)
1516		Lots of encrusting coralline, universal coverage on rocks; Relief 8-10' with sand between rocks. Coryphopterus nicholsii. Fish, small juvenile in large crevices and among rocks; S. elongatus, school, small
		¯D 141602 - 85% rock, 80% sand overlay. Sebastes ?hopkinsi (1); Peridontaster (1); Encrusting Coralline (+); Unbranched reds 1%; Tufts 10%; Algae (+); Fish (12+); Lytechinus (2+)

Time	Depth	Comments
		D 141644 - 85% Rock, boulder, 25% sand overlay. Encrusting coralline 70%; Dark crust 2%; Yellow crust less than 1%; ?Protula Tube (1); Tufts 5%; Fish (6); Br. reds 2%; Orange crust less than 1%; ? Anemone (1); Hydroids (+); Sponges (+)
1517	280′	Large rock reef, 15′ relief. Olive approximately 12" long (took photo); encrusting coralline; Opuntiella; Plumarella; aglaophenia; Small purple gorgonian - probably Eugorgia rubens
		D 141727 - 85% Rock, boulder. Encrusting coralline approximately 80%; Bath sponge (2+); Ophiuroids many/+; Orange crust (+); ?Gray sponge 1%
1518		Small irregular branched gorgonian = Lophogorgia (Eugorgia sp.)
		D 141810 - 30% Rock, 20% sand overlay. Encrusting coralline (+); Algae (+); Fish (2+); ?hydroids (+)
		D 141853 - Rock and sand (+)
1519		Small cottid, Artedius?; Paracyathus; Calliostoma; Hippodiplosia; S. jordani; Peridontaster (?) umbricated scales, tan color
		B 141936 - Coarse sand. Lytechinus (8+)
1520		S. paucispinis, largest rockfishes; Ocean white fish, 2′ long (1); Leiocottus; Leucilla sponge
		D 142019 - 85% Rock, boulder; 30% sand overlay. Encrusting coralline 55%; Solitary tunicates (8+); Green crust 2%; Red crust approximately 1%; Unbranched reds less than 1%; Sebastomus (1); Ophiuroids (+); Orange crust less than 1%; ?Glass sponges less than 15; Fish (6+); Hydroids approximately 5%; Tan branched sponge 3%; Heterogorgia (1+); Br. reds 2%; Dark crust approximately 1%
1521		Gorgoniid on rocks
		142102 - 40% Rock, 30% sand overlay. Encrusting coralline 60%; Green crust 3%; Heterogorgia (2+); Peridontaster (1); Cypraea (1); Br. reds 1%+; Solitary tunicates (3) (documentation); Hydroids 4%; Ophiuroids (+); Orange crust less than 1%; Red crust approximately 1%; Lytechinus (test) (1)
		142145 - Same as preceding
1522		(Stopped to discuss best viewing procedure)

Time	Depth	Comments
		142227 - Approximately 30% rock, 80% sand overlay. Frame shift. Encrusting coralline 10%; Reds 2%; Hydroids 3%; Red crust 2%; White bumps approximately (10)
1523		Rocky outcrops 15′ high; S. rubrivinctus; encrusting coralline (heavy coat cover on all rocks); Lophogorgia irregular branched, tan Eugorgia; S. jordani; Coryphopterus nicholsi on bottom; Haliclona?
		ˉD 142310 - 25% Rock. Frame shift from 142145. Peridontaster (1+); Heterogorgia (2+); Solitary tunicates (3); Hydroids approximately 5%; Coryphopterus (W) (1); Unbranched reds (1); Red crust 1%; Green crust (+); Lytechinus (test) (1)
		142353 - 25% rock, 75% sand overlay. Frame shift from 142227. Encrusting coralline 15%; Red crust 2%; Yellow crust less than 1%; Unbranched red (1); Hydroids 5%
1524		Sand between rocks looks more biogenous shell and coralline algae debris; Small tufts of Rhodymenia 142436 - Approximately 2% rock on coarse sand. Encrusting coralline 80%; Red crust 15%; white bumps approximately (6); Lytechinus (2); Dark crust 10%; Reds 2%
1525		Bugula; Coryphopterus; Small juvenile fishes approximately 1" long; Leucilla white sponge, Heterogorgia (several)
		ˉD 142519 - 20% Rock, boulder; 80% sand overlay. Encrusting coralline 10%; Dark crust 4%; Orange crust less than 15; Red crust 2%; Ophiuroid (1+); Lytechinus (5+)
1526		Small rock fish S. rosaceus and atrovirens (10′s); S. umbrosus; S. mystinus (2); S. ovalis; Rocky, High Relief, 15′
		142602 - Coarse sand, 40% boulder, 80% sand overlay. Encrusting coralline 15%; Red crust 3%; Dark crust approximately 1%; Orange crust 1%; Ophiuroids (3+); Unbranched red (1); Hydroids 2%+
		142645 - Coarse sand; 1% cobble, pebble. Lytechinus (4); Fish (1)
1527		Eugorgia sp., purple, finely branched fan (6-8′ off bottom); "Sebastomus" sp. most abundant middle size fish; Blue Rockfish; S. serranoides; S. constellatus; Senorita (1); Mediaster on bottom between rocks; Many tan sponges 1/2-3m^2, Spheciospongia; S. elongatus (35)

Time	Depth	Comments
		142728 - 20% boulder on coarse sand; 40% sand overlay. Lytechinus (10); hydroids 15%; Mediaster (2); Dark crust 2%
1528		Tan sponges, Spheciospongia; Can see 200 rockfish at once, (visibility approximately 75'); Eugorgia, purple (1); S. atrovirens, S. elongatus; S. constellatus
		D 142810 - 75% Rock, boulder; 75% sand overlay. Encrusting coralline 15%; R/C (1); Unbranched reds (2); tan branched sponge 3%; Green crust 1%; Solitary tunicates (5+); Br. reds less than 1%; Br. Bryozoan less than 1% ?; Orange crust 1%; Hydroids 6%; Lytechinus (1+)
		D 142853 - 35% rock, boulder; 25% sand overlay. Mediaster (1); Encrusting coralline 65%; Green crust 4%; Peridontaster (1); Hydroids 5%; Lytechinus (2+); Solitary tunicates (1); Tan branched sponge less than 1%; Red crust 2%; Br. reds 1%; ?Fish (1)
1529		Sebastomus spp. = rosaceus; eos/rosenblatti; constellatus; lentiginosus; chlorostictus; umbrosus
		D 142936 - 95% Rock. Encrusting coralline 85%; Sebastes (1); Dark crust (+); Green crust 1%+; Hydroids (+); Br. reds approximately 1%; Orange crust less than 1%; Yellow crust less than 1%; ?Glass sponges (2); Tan mass sponge less than 1%
1530	230'	(100' visibility) rockfish (50); Allopora on top rock (PHOTOS TAKEN)
		D 143019 - Approximately 95% rock, boulder. Encrusting coralline (+)
1531		(Turned around to look at Allopora cluster); Aglaophenia; Plumarella; Mediaster; Clusters of Astrangia on top of rocks, very abundant large clusters
		D 143102 85% rock, boulder. Encrusting coralline (+); Dark crust (+); Fish (2); ?Ophiuroids (+); Crusts (+)
		D 143145 - 95% Rock, boulder. Encrusting coralline approximately 85%; Sebastes hopkinsi (1); Yellow crust (+); Orange crust (+); Dark crust (+); Heterogorgia (1); Hydroids (+); Ophiuroids (+); Peridontaster (1)
1532		S. paucispinis dominant large fish in this community; Rockfish, juvenile (photos)
		D 143228 - 95% Rock, boulder. Encrusting coralline approximately 90%; Bath sponge (3+); Sebastes hopkinsi (4); Tan Br. sponge less than 1%; Mediaster (1); Ophiuroids (+)

Time	Depth	Comments
1533		Allopora common tops of rocks, 20′ boulders.
		D 143310 - 10% Rock on Sand. Asteroid (1)
		D 143353 - 30% Boulder, rock; 15% sand overlay. Encrusting coralline (+); Dark crust 35%; Mediaster (2); Hydroids 3%+; Lytechinus (9+)
1534		Flat rocky bottom, 1-2′ boulders; S. paucispinis dominant, Olives second. S. elongatus, S. atrovirens, Sebastomus
		D 143436 - Rock, 10% sand overlay. Encrusting coralline 85%; Maripelta (3); Bath sponge (4) (3-fused); Yellow crust less than 1%; Green crust 1%+; Orange massive sponge much less than 1%; Aglaophenia 3%; Orange crust 1%; Tan massive sponge 1%; ?Trichentrion (1+); Sebastes (1); Br. reds approximately 2%; Fish (1); Corynactis much less than 1%; Worm tube (1); Gray massive sponge less than 1%
1535		Sponges and gorgonians dom. on rocks; Rockfish, tan color, small, S. atrovirens (200-300)
		D 143519 - Approximately 90% rock, boulder. Encrusting coralline approximately 85%; Bath sponge (6) (4-fused); Dark crust (+)
1536	234′	Lithothamnion dominant on rocky flats; Tufts of hydroids, Paracyathus (6′) off bottom); Much fewer fish (10)
		D 143602 - 85% rock; 10% sand overlay. Encrusting coralline 80%; bath sponges (9) (5-fused); Br. bryozoan 2%; Orange crust less than 1%; Peridontaster (2); ?Henricia (1); Unbranched reds (2+); Br. reds 2%; Green crust 3%; Dark crust 1%+; Tan branched sponge 1%; ?Trichentrion (1); Sponges 1%
		D 143635 - Approximately 50% rock with sand overlay (+). Fish (+)
1537		Patiria miniata (2)
		D 143728 - 90% rock
1538		(Taking pictures)
		D 143811
		D 143853 - Rock. Fish (4+); Bath sponge (2+); Crusts (+)

Time	Depth	Comments
539		Mediaster; Calliostoma; Sand basin surrounded in 30' radius by 1' cobbles
		D 143936 - 90% Rock, boulder. Encrusting coralline approximately 85%; Dark crust (+); Sebastes hopkinsi (1); Mediaster (1); Bath sponge (1+); Hydroids (+); ?Coryphopterus (1); Fish (1)
1540		(Taking pictures)
		D 144019 - 90% Rock, boulder. Encrusting coralline approximately 85%; Dark crust 3%+; Sebastes (1); Orange crust (+); Yellow crust (+); Br. reds less than 1%; Fish (2+); Ophiuroids (+) D 144102 - 90% Boulder, rock. Encrusting coralline approximately 85%; Dark crust 5%+; Fish
1541		Sebastomus (40-50); Flat boulder area; Opuntiella; S. constellatus; Dominant algae = encrusting coralline; (Took photo 19)
		D 144145 - 90% Rock, boulder, 20% sand overlay. Encrusting coralline 75%; Coryphopterus (Y) (1); Orange crust 1%; Green crust 1%; Red crust approximately 4%; R/C 1%; Orange bumps many/+; Hydroids approximately 4%; Fish (1+); ?cup corals (2+)
542	254'	S. rosaceus, Rhodymenia - a very abundant algae; Flat boulder bottom
		144228 - 85% Rock, boulder, cobble. Encrusting coralline 80%; Red crust 5%; Green crust 1%; Orange crust 3%; Dark crust 2%; Orange bumps approximately (6); Lytechinus (3)
1543		Sand; Senorita on edge of boulder bed; Rhodymenia second to encrusting coralline in abundance; Lytechinus common
		D 144311 - 60% Rock and boulder. Encrusting coralline 70%; Red crust 10%; Tan sponge 1%; Green crust 1%; Dark crust 3%; Lytechinus (1); Reds 1%; Orange crust much less than 1%
		D 144353 - Rock and boulder with 45% sand overlay. Encrusting coralline 25%; Red crust 25%; Orange crusts 3%; reds 1%+
1544		Sand/boulder bed; Sebastomus, school (50), several size classes; S. paucispinis (1) juvenile; Ecotone between boulders and sand; Fish more abundant; Dermasterias imbricata; S. constellatus; Leather star, Patiria miniata

Time	Depth	Comments
		⁻D 144436 - Rock and boulder with 25% sand overlay. Encrusting coralline 55%; Red crust 10%; Dark crust approximately 10%; Green crust 2%; Orange crust less than 1%; Mediaster (1); White object (1); Orange bumps approximately (5); ?cup corals (+)
1545		Plumarella (gorgonian) (2); Balanophyllia; Sand with a few cobbles, boulders 1′ across covered with old save swept terrance of surf rounded cobbles. encrusting coralline covered.
		⁻D 144519 - Rock and boulder with 35%, sand overlay. Encrusting coralline 55%; Dark crust approximately 10%; Reds 1%; Orange crust 1%; Green crust 1%+
1546		Sebastomus, (several); Getting out onto sand now; Mediaster 1/10sqm
		144602 - 15% Rock on cobble sand (?overlay +). Encrusting coralling 85%; Green crust 1%
		144645 - 15% boulder on cobble, sand (?overlay +). Encrusting coralline 85%; Green/Dark Crust 10%; Reds 1%
1547		Smaller cobble patches and a few rock outcrops in the sand. Few Sebastomus spp., most abundant out over sand; umbrosus, lentiginosus, constellatus, rosaceus
		144728 - Approximately 50% boulder (overlay +). Encrusting coralline 30%; Red crust 60%; Green crust 4%; Orange crust 4%; Reds 1%; ?Ophiuroid (1)
1548		Sand with large ripples 2-3′ apart, parallel to sub path (west swell), 10" amplitude; Mediaster; Lytechinus; Poorly sorted sand; S. chlorostictus,
	254′	beautiful; Rocky again, very rugged, almost no sand ⁻D 144811 - Approximately 50% Boulder (overlay +). Encrusting coralline 70%; Dark crust 15%; Reds 1%; Orange crust 1%+
		144859 - 70% Boulder with 20%+ sand overlay. Frame shift, 144811. Encrusting coralline 65%; Green crust 4%; Red crust 1%; Reds 1%+
1549		S. elongatus; juvenile; S. paucispinis; E. rubens (8); Lophogorgia (several) 1" tall; Solid rock covered with encrusting coralline almost no sand; Tan sponges, Spheciospongia
		⁻D 144936 - 65% Boulder. Encrusting coralline 80%; Red crust 1%+; Dark crust approximately 15%; Lytechinus (3); Mediaster (4); Coryphopterus (Y) (1); Reds approximately 1%; R/C 1%; Orange crust (+)

Time	Depth	Comments
550	254′	High smooth rock exposure bed rock; (Community stop)
		D 145019 - 65% Boulder. Encrusting coralline (+); Crusts (+)
1551		(Change audio tape to 1b)
		D 145102 - 95% Rock and boulder. ?Asteroid (1); Sebastes rosaceus (1); ?Fish
		D 145145 - Boulder. Encrusting coralline approximately 95%; Sebastes (2); Fish (2); ?Peridontaster (1)
		D 145228 - 60% Boulder and cobble. Lytechinus many/+; Mediaster (2); Encrusting coralline approximately 85%; Crusts (+)
		D 145311 - 70% Boulder and cobble. Encrusting coralline (+); Reds (+); Lytechinus (+); Fish (1+)
		D 145359 - 20% Boulder in silty sand. Encrusting coralline approximately 80%; Lytechinus (+)
		¬D 145436 - Silt with cobble, sand. Lytechinus (5)
		¬D 145519 - Silt with sand. Lytechinus (2+)
		145603 - Silt with sand
		145645 - Silt with sand and approximately 5% Boulder. ?Astropecten (1); Encrusting coralline 30%
		¬D 145728 - Approximately 70% Rock and boulder with approximately 10% Sand overlay. Heterogorgia (1+); Reds 1%; Encrusting coralline 80%; Red crust 2%; Green crust 1%; ?cup corals (+); Tan Encr. Tunicate 3%?
		D 145811 - 90% Rock. Encrusting coralline (+); Fish (13+); Bath sponge (2); Heterogorgia (1+); Sol. Tunicates (+); Reds approximately 2%; Crusts (+)
		¬D 145854 - 95% Rock with 35% sand overlay. Encrusting coralline 65%; Reds 1%
1559		S. chlorostictus in sand
		¬D 145936 - Rock with 40% sand overlay. Encrusting coralline 60%; solitary tunicates (2+) (Documentation); Six-rayed Asteroid (1); Reds 1%+; ?Orange crust approximately 1%; Gray object (1)
1600	255′	Mostly sand with some cobbles
		150019 - Same as 145936 EXCEPT: Fish (2); Six-rayed asteroid absent; Ophiuroids (+)

Time	Depth	Comments
1601		Mediaster .1/m^2; Linckus, Sabellid worm
		150102 - Rock with 45% sand overlay. Encrusting coralline 50%; Bath sponge (1); Plumarella (1); Red crust less than 1%; Green crust much less than 1%; Solitary tunicates (2+); Tan Br. sponge 2%; Red and white object (1)?; Circular ?Bryozoan (3)?; Reds less than 1%; Orange crust less than 1%; Orange ?sponge less than 1%
		¬D 150145 - Rock with approximately 30% sand overlay. Encrusting coralline 65%; Vaselike glass sponge (1); Solitary tunicates (4+); Reds 1%; Tan branched sponge 2%; ?Polychaete (1)?; Circular ?bryozoan (1)?; Red crust less than 1%; Orange crust less than 1%; Green crust much less than 1%; ?Br. bryozoan 1%; ?Yellow Gorgonian (1)?
1602		Sand area with many boulders (6′ off bottom); combfish (1). Boulders and sand ripple marks differ, Sand troughs 2" apart; Paracyathus on rocks; Bugula on most boulders
		¬D 150228 - Rock with 30% sand overlay. Encrusting coralline 65%; Red crust less than 1%; Orange crust less than 1%; Solitary tunicates (1+); Reds less than 1%; White sponges less than 1%; ?Polyps (4); Encrusted strands 1%
1603		Halibut small; Mackerel in water column, 150′ about; Starfish, first one seen, took photo
		¬D 150311 - Rock with 30% sand overlay. Encrusting coralline 65%; Sebastes hopkinsi (1); Heterogorgia (1); Ophiuroids (+); Tan sponge (1); Solitary tunicates (1+); Tan Br. sponge 1%; ?Gastropod (1); Red crust less than 1%; Reds less than 1%
		¬D 150354 - Rock with 40% sand overlay. Encrusting coralline 55%; Vaselike glass sponge (1); Orthasterias (1); Reds 2%; Heterogorgia (2); Yellow Massive sponge 1%; Vaselike tan sponge; ?White nudibranch (1)?; Milky ?sponge less than 1%; ?Yellow tunicate (1)?
1604		(Audio off)
		¬D 150436 - Rock. Encrusting coralline approximately 85%; Mediaster (1); Sebastes hopkinsi (7+); Fish (+); Plumarella (1); Bath sponge (2); R.C./Reds approximately 15%; Serpulid (1)?

Time	Depth	Comments
605		Flatfish, many
		D 150519 - Rock and boulder. Encrusting coralline 80%; Vaselike glass sponge (1); Bath sponge (4); Sebastes (1); Reds approximately 5%
1606		(Taking photos); Rathbunaster (1); Rathbunaster Linckia; Mediaster and Astrometis; (Peridontaster?) 4 species in view
		D 150602 - 85% Boulder. Encrusting coralline (+); Fish (6+); Peridontaster (3+); Crusts (+); Reds (+)
		D 150645 - Rock and boulder; ?Overlay +. Fish (2+)
1607	267'	Sole; Sebastomus, small; S. constellatus (1)
		D 150728 - Silt with sand
1608		(Stopped for photo) D 150811 - Silt with sand and less than 1% Boulder. Fish (1)
		D 150854 - Approximately 75% Rock and boulder
1609		(Manuvering)
		D 150938 - Rock and sand (+).
1610	267'	Sand, flat bottom with occasional flat rocks; Sand tends to collect in lenses of biogenous material
		D 151019 - 35% Boulder, cobble, pebble on silty sand. Encrusting coralline 80%; Dark crust 15%; Ophiuroids (+)
1611		Ripples smaller, 5" tall, 18" apart; Rex sole (1); Luidia large 15", tan, symmetrical (1)
		D 151102 - Silty sand and gravel with 2% pebble. Mediaster (1); Coryphopterus (W) (1)
		D 151145 - Silt with sand and ripples
1612		Rathbunaster raised disc (2); Henricia (1); Mediaster (1); few fish; sand
		D 151228 - Rock and ?Overlay (+). ?Peridontaster (1+); Encrusting coralline (+)
1613		(Audio off)

Time	Depth	Comments
		D 151311 - Silty sand with ?Rock and ?Overlay (+). Mediaster (1); Tufts many/+
		D 151354 - Silty sand with 80% pebble and gravel and debris
1614		Sand with small ripples, 1′ apart, 2" high; Mediaster and Luidia common 0.1/sqm; (Lytechinus absent)
		D 151437 - Silt with sand and 35% debris and pebble. Mediaster (1); Heart urchin test (1)
1615	258′	Mediaster (8′ off bottom)
		D 151519 - Silt with sand and 50% pebble and debris. Mediaster (1)
1616		Mediaster; Broken shells
		D 151602 - Silt with heavy debris. Good shot. Citharichthys (1)?
		B 151645 - Silt with sand and heavy shell debris
1617		Sole, little
		151728 - Silty sand with heavy shell debris and 15% rock. Encrusting coralline 40%
1618	260′	Luidia; A few small rock outcrops
		151811 - Approximately 70% Rock with approximately 70% silty sand overlay. Encrusting coralline 30%; ?O approximately (4); Tan sponge 1%+?; Orange crust much less than 1%; ?cup coral (1)
		151854 - Silty sand with shell debris. Citharichthys (1) (partial)
1619		(Looking for pinger)
		D 151937 - Silty sand with lt. shell debris
1620		Sand with small rockfish over sand; Luidia, small; sole, small
		152019 - Silty sand with ripples and heavy shell debris. Mediaster (1)
1621		Rock outcrop with Rhodymenia and encrusting coralline, Mediaster; Paracyathus growing in more solitary fashion

Time	Depth	Comments
		152102 - Silty sand with ripples and heavy debris
		D 152145 - Silt with sand and ripples and lt. debris
1622		Cluster of Astrangia, Allopora, purplish pink color, small finger Paracyathus in clusters; Sole
		D 152228 - Silt with sand and ripples
1623		Lytechinus coming back in
		D 152311 - Silt with sand and ripples. Lytechinus (1)
		D 152354 - Silt with sand and ripples and heavy debris
1624		(Mediaster most consistant present species along with Rhodomenia); Harder bottom - more fish - juvenile S. paucispinis (1); Coryphopterus, Paracyathus 5-6/sqm on rocks
		D 152437 - Silt with sand and ripples. Lytechinus (2+)
1625		Mackerel (1000); Sabellid
		D 152519 - Silt with sand and ripples
1626		Solid rock
		152602 - Silt with sand and ripples
		D 152645 - Silt with sand and ripples and lt. debris. Lytechinus (2+)
1627		(Asking for directions)
		152728 - Silt with sand and ripples
1628	259'	School of Trachurus; Scomber japonicus (1000) around sub on entire dive.
		D 152811 - Silt with sand and ripples
		D 152854 - Silt with sand and ripples and lt. debris
1629		Sand; Mediaster, Linckia; Sebastomas spp. abundant; Tiny white starfish, 1 every 30 meters
		D 152937 - Silt with sand and ripples
1630		Balanophyllia on large rock in sand covered; Sabellids. Plumarella, possibly longispina; Small pebbles are blue rocks; Paracyathus common large rock in sand, 1/4" diameter; S. chlorostictus

Time	Depth	Comments
		D 153019 - Silt with sand and ripples and lt. debris
		D 153102 - Silt with sand and ripples
		D 153145 - 8% Boulder on silt with sand and ripples. Mediaster (1); Encrusting coralline (+); Balanophyllia many/+
1632		Plumarella, looks like two species, one finely branched, one plume shaped.
		D 153228 - Silt with sand and ripples
1633		Sandstone beach terrace - beach rock
		D 153311 - Silt with sand and ripples. Mediaster (1)
		D 153354 - 3% Boulder on silt with sand and ripples. Mediaster (1); Br. reds (1)
1634		Long lenticular smooth rocks
		D 153437 - Silt with sand and ripples; ?Rock and ?Overlay. No visible rock. Paracyathus (7+)
1635		SANDSTONE COMMUNITY, thin sand layer; Long lenticular rock; smooth with layer of sponge; Mediaster 1/2-3m^2 most abundant species and evenly spaced
		D 153519 - Silt with sand
1636		Lithothamnion and black sponge/algae coating on rocks; Rhodymenia and Opuntiella spp. type
		153602 - Rock with approximately 70% silty sand overlay. Documentation. Henricia (1); Encrusting coralline 5%; Polychaete (1)?; Reds approximately 2%; Ophiuroids (+); Br. bryozoans less than 1%; Paracyathus (5+); Mediaster (1); Orange ?sponge less than 1%
		D 153645 - Silt with sand and approximately 1% Rock and overlay +. Lytechinus (1); Paracyathus (2)
1637	261′	Large S. serranoides, 15" long (1); Higher relief, more broken; Rhodymenia, Opuntiella and 2 more species resembling Rhodymenia
		D 153728 - Approximately 85% Boulders. Balanophyllia many/+; Encrusting coralline approximately 70%; Mediaster (2); Sebastomus (1)? (cf. elongatus); Sebastomus (1); Patiria (1); ?Ophiuroid (1); Paracyathus (+); Solitary tunicate (1+); Red crust 2%+; Circular ?bryozoan (16)?; Reds 1%

Time	Depth	Comments
638		Mediaster 1/sqm; S. serranoides, 15" long
		153811 - Silty sand with ripples. Mediaster (1)
		153854 - Silty sand with ripples. Mediaster (1). (Fr. shift 153811
1639		Sandstone - smooth - rounded - tufts of Bugula; encrusting coralline and black encrusting rock; Mediaster 1/m^2, Linckia; S. levis (1)
		153937 - Silty sand with ripples. Gastropod (1)
1640		Mediaster 1/sqm; S. chlorostictus, Linckia (2)
		⁻D 154019 - Rock with 80% sand overlay. Encrusting coralline 15%; Solitary tunicate (6+); Reds less than 1%; Br. bryozoan less than 1%; Balanophyllia (2); Paracyathus (22+); Mediaster (1); Lytechinus (1); Sebastes eos group (1); ?Circular bryozoan (4)?; ?O (3+)
1641	261′	Moving over beach sandstone facies; S. elongatus
		⁻D 154102 - 50% boulder and rock. Encrusting coralline 40%; Balanophyllia (2); Green crust 20%; Red crust 10%; Solitary tunicates (3); Terebratalia (1); Paracyathus (2+); Orange bumps approximately (5); Reds; White ?Sponge (1)
		⁻D 154145 - 70% rock with approximately 90% silt/sand overlay. Sebastomus (1); Henricia (1); Fish (1); Paracyathus approximately (33); Ophiuroids (1+); Reds much less than 1%
1642		(25′ from pinger)
		⁻D 154228 - Rock with 90% sand overlay. Orange crust much less than 1%; Reds much less than 1%
1643	261′	(End of transect) (110 minutes total) (Reached pinger) (Released buoy); Sand; Mediaster; (Getting dark as night approaches)
		D 154311 - Silt with sand. Lytechinus (1); Mediaster (1)
		D 154354 - Silt with sand and 4% Boulder
		⁻D 154437 - Silt with sand and ripples and 4% pebble and gravel. Encrusting coralline (+); Mediaster (1); ?Coryphopterus (W) (1)

Time Depth Comments

D 154520 - 40% Boulder, cobble, pebble on silt with sand. Encrusting coralline (+); ?Balanophyllia (+)

D 154602 - Rock and boulder with approximately 80% sand overlay. Encrusting coralline 20%; Mediaster (2); Henricia (2); Sebastomus (1); Sebastes (3); Fish (1)

154645 - Rock with 50% sand overlay. Encrusting coralline 50%; Solitary tunicates (10+); ?Heterogorgia (1); ?Coryphopterus (W) (1); white branched sponge less than 1%; Reds less than 1%; Ophiuroids (3+)

D 154728 - Rock with 85% sand overlay. Encrusting coralline approximately 5%; Ophiuroids (+); Reds much less than 1%; Solitary tunicate (1); ?sponge less than 1%; ?Gastropod

D 154811 - Silt with sand (ripples)

D 154854 - Silt with sand, light debris. Lytechinus (4+)

D 154937 - Rock, approximately 95% sand overlay. Mediaster (5); Paracyathus (4+); Lytechinus (3+); Yellow sponge less than 1%

D 155020 - Rock, boulder, 35% sand overlay. Encrusting coralline 55%; Mediaster (1); Coryphopterus (Y) (1); Sebastomus (1); Green crust approximately 5%; Red crust 2%; Reds 2%; Balanophyllia (4); Paracyathus (7+); Solitary tunicates (1+)

D 155102 - Silty sand, ?Rock, overlay (+), less than 1% pebble. Paracyathus (2); Balanophyllia (2)

D 155145 - Approximately 30% Rock, 50% sand overlay. Encrusting coralline 10%; Mediaster (1); Unbranched Red (1); Ophiuroids (+); Lytechinus (1); Fish (2+); Gray object (1)

D 155228 - Approximately 60% Rock, cobble; 20% sand overlay; approximately 40% sand and gravel. Lytechinus (2+); Mediaster (1); Coryphopterus (approximately Y) (1); Gastropod (1)

D 155311 - Rock, 97% sand overlay (2 holes). Ophiuroids (4+); Paracyathus (23+); Encrusting coralline less than 1%; Crusts (+)

D 155354 - Rock, 98% sand overlay. Lytechinus (1); Ophiuroids (+); Paracyathus (4+)

Time	Depth	Comments

~D 155437 - Rock, 99% sand overlay. Lytechinus (1); Paracyathus (4+)

155520 - Rock, 99% sand overlay. Mediaster (1); Reds less than 1%; Paracyathus (6); ?Ophiuroids (+)

~D 155602 - Rock, 100% sand overlay. Lytechinus (4+); Reds less than 1%; Fish (1); Paracyathus (2+); ?cup coral (1)

~D 155645 - Rock, 98% sand overlay, heavy debris. Reds less than 1%; Yellow sponge 1%; Paracyathus (3+); ?Lytechinus (1); Hydroids (+)

155728 - Silt with 90% pebble, gravel, coarse sand. Lytechinus (4)

~D 155811 - Rock, 90% sand overlay. Coryphopterus (approximately W) (1); Gastropod (1)?; Paracyathus (4+); Encrusting coralline less than 1%; RC/reds less than 1%; Lytechinus (1)

~D 155854 - Rock, 90% sand overlay. Encrusting coralline approximately 1%; Red crust 8%; Lytechinus (1+); ?O (1); Mediaster (1); Br. reds (2); ?Paracyathus (1+)

155937 - 25% Boulder on Coarse sand with silt. Encrusting coralline 85%; Red crust 5%; Dark crust approximately 2%; Light Green crust 1%; Green crust 1%; Balanophyllia (17+); White bumps many/+; Reds 2%; Orange crust 1%+

160020 - Silt with sand 5% Boulder, cobble; overlay. Paracyathus (2); Encrusting coralline 10%; Sebastes eos group (1) (good shot)

160102 - Silt, coarse sand 8% cobble, pebble. Encrusting coralline 3%; ?Polychaete (1)

160145 - 40% Rock, boulder, cobble on silt and coarse sand. Encrusting coralline 15%; Red crust/Dark crust 70%; Orange crust 4%; Green crust approximately 1%; Mediaster (1); Reds 1%; Balanophyllia (40+); ?Paracyathus (1)

160228 - 35% Rock, boulder, cobble; 20% sand overlay. Encrusting coralline 70%; Orange crust 5%; Light Green crust 2%; Dark crust 2%+; Reds 3%; Gastropod (1)

~D 160311 - 35% Rock, boulder in coarse sand and silt. Frame shift. Encrusting coralline 75%; Balanophyllia (4); Red crust 6%; Green crust 5%; Dark crust (+); Orange crust 2%; Hydroids (+); Paracyathus (1+)

Time	Depth	Comments

160354 - Rock, 99% sand overlay; heavy debris. Encrusting coralline less than 1%; Reds less than 1%; Lytechinus (3+)

‾Turbid 160437 - Silty sand (ripples), debris. Mediaster (1); Lytechinus (1)

‾Turbid 160602 - Silty sand (ripples) debris. Mediaster (1)

‾D 160645 - 20% Boulder, cobble on silty sand; 95% sand overlay. Mediaster (2); Lytechinus (1); Reds 2%; Encrusting coralline approximately 2%; ?Coryphopterus (W) (1); Paracyathus (1+)

‾Turbid 160728 - Silty sand (ripples). Lytechinus (1)

160811 - Silty sand debris. ?Cup corals (+)

160854 - Silty sand (ripples). Mediaster (1); Reds much less than 1%; ?Lytechinus (1)

160937 - Silty sand (ripples), debris. Mediaster (2); Reds less than 1%; ?Ophiuroid (1)

‾Turbid 161020 - Silty sand, ripples

‾D 161103 - Approximately 25% Rock, boulder, cobble on fine sand, 60% sand overall; shells. Mediaster (1); (Pinger can). Encrusting coralline 5%; Red crust 10%

‾D 161145 - Rock, 97% fine sand overlay. Mediaster (2); Paracyathus (3+)

‾D 161228 - Silt with coarse sand (ripples); ?overlay. Mediaster (2); ?cup corals (2+)

‾D 161311 - Rock, boulder, 98% sand overlay by silty sand (ripple). Paracyathus (3)

Turbid 161354 - Sand (+). ?Lytechinus (1)

‾D ‾Turbid 161437 - Silt and sand (ripple) approximately 10% Rock, boulder with 95% overlay. Mediaster (1); Lytechinus (1); ?O (1)

‾B/‾D 161520 - Silt and sand (ret. rip.), debris. Lytechinus (1)

‾B/‾D 161602 - Silty sand (ripples) debris. Lytechinus (4)

Time	Depth	Comments
		¬B/¬D 161645 - Silty sand (ripples) debris. Lytechinus (2+)
1717		Half hour involved in trying to release line to anchor
		161728 - Silty sand (ripples) debris 5% rock with 95% overlay. Encrusting coralline 2%; Mediaster (1); Lytechinus (1)
		¬B/¬D 161811 - Silt and sand (ripples). Mediaster (2)
		¬B 161854 - Silt and sand (ripples) 5% rock, 90% sand overlay. Mediaster (1)
		¬D 161937 - Silty sand, debris. ?Paracyathus (1); ?Fish (1)
		¬B/¬D 162020 - Silty sand (ripples), debris. Lytechinus (1)
		¬D/Turbid 162102 - Silty sand with rock, cobble and avy debris. Encrusting coralline (+)
		¬D 162145 - Rock, 99% silty sand overlay, heavy debris. Mediaster (1); Reds much liss than 1%; ?Glass sponge (1); Paracyathus (2+)
1722		On the surface
		¬D 162228 - Silty sand (ripples), debris and 2% cobble. ?Cup corals (2)
		¬D 162311 - Silty sand, debris. Mediaster (+)
		¬B/¬D 162354 - Silty sand, heavy debris. Lytechinus (1); Reds approximately 1%
		¬D 162437 - Rock with 95% silty sand overlay and debris. Encrusting coralline 2%; Red% 2%
		¬D 162520 - Rock, 98% sand overlay, debris. Red 1%s Lytechinus (1); ?Cup corals (+); ?Gastropods (2+); Yellow ?spo;ge 1%
		162602 - Same as above
		¬B/¬LL 162645 - Rock, 99% silty sand overlay, debris. Reds less than 1%
		LL 162728 - Rock, approximately 99% sand overlay, debris. Algae (+)
		LL 162811 - Roc approximately 99% sand overlay, debris. Reds 1%
		D/LL 1,2854
		LL 162937

(Rick's time is 13 minutes behind sub time)

Communities based on Substrate, % of time of transect

Sand	5+15+7+5	= 32/110 = Rocky
high relief	15	15/110 =
Rocky low relief		39/110 =
Sandstone facies	24m	24/110 =

DOMINANT COMMUNITIES

1.	Sand	Mediaster; Lytechinus - Luidia; Sole (?sp); Straggler rockfish - primarily Sebastomus spp.
2.	Boulder/Sand	Sponges - Haliclona? 10-40 rockfish in view; Eugorgia sp; encrusting coralline; Mediaster; Paracyathus; Balanophyllia; Sebastomus spp.; Olive
3.	Sandstone	Mediaster; encrusting coralline; Rhodomenia; Sebastomus Olives; 10 rockfish in view
4.	High Relief	Dominant inverts: Allopora; Eugorgia sp.; Eugorgia rubens; Lophogorgia; Astrangia; Sponges (Haliclona?); Bugula; encrusting coralline; Rhodymenia spp.; Mediaster Dominant fish: S. paucispinis; Sebastomus; Olive juvenile rockfish. Approximately 200 rockfish in view. Sand: Rocky low relief. Rocky high relief

Appendix F

DENSITY - DEPTH PLOTS

Appendix F

DENSITY - DEPTH PLOTS

Density-depth plots for 30 species categories are presented. Data were combined for all survey areas (A, B, C, E, F, and G). Table F-1 lists the species categories selected for detailed analysis.

Density is expressed in terms of (1) percent cover for encrusting, colonial or aggregated organisms, (2) individuals per square meter for discrete sessile or sedentary organisms, or (3) individuals per observation, for all species of fish. In the last case, an observation represents a discrete observer notation, per one minute interval of video camera record, or a Benthos camera frame.

An asterisk represents one observation, while a number indicates the total number of observations of that frequency at that depth.

Qualitative (presence/absence) data are not included in these plots. Examples of complete dive (data) records are presented in Appendix E.

TABLE F-1. SPECIES CATEGORIES SELECTED FOR DETAILED ANALYSIS

Common Name or Descriptor	Scientific Name	Depth Range, m
Big-bladed kelp	*Agarum fimbriatum*	15-85
Hydrocoral	*Allopora californica*, 7 cm.	18-112
Hydrocoral	*Allopora californica*, 7 cm.	21-75
Orange cup coral	*Balanophyllia elegans*	16-131
Erect coralline alga	*Bossiella* sp.	23-76
Erect coralline alga	*Calliarthron cheilosporides*	14-90
Bath sponge	"*Clathrina*"	40-117
Palm kelp	*Eisenia arborea*	14-82
Encrusting coralline algae	(Encrusting corallines)	14-136
Purple Fan coral	*Eugorgia rubens*	28-98
Red alga	*Gelidium* spp.	14-61
Yellow gorgonian	*Heterogorgia papillosa*	43-87
Big-bladed kelp	*Laminaria farlowii*	14-85
White sea urchin	*Lytechinus anamesus*	25-146
Iridescent red alga	*Maripetta rotata*	52-116
Equal-armed starfish	*Mediaster aequalis*	20-134
Senorita	*Oxyjulis californica*	14-101
Cup Coral	*Paracyathus stearnsi*	15-112
Bat star	*Patiria miniata*	14-99
Sheephead	*Pimelometopon pulchrum*	14-88
White fan coral	*Plumarella longispina*	37-143
Greenspotted/greenblotched rockfish	*Sebastes chlorostictus/ rosenblatti*	87-123
Starry rockfish	*Sebastes constellatus*	28-146
Square spot rockfish	*Sebastes hopkinsi*, <18 cm	17-143
	Sebastes hopkinsi, ≥18 cm	18-115
	Sebastes hopkinsi (no length recorded)	27-112
Cowcod	*Sebastes levis*	30-143
Rosy rockfish	*Sebastes rosaceus*	18-143
Rockfish	*Sebastes*, other	14-144
Vase sponge	"*Staurocalyptus*"	40-136
Brown alga	**Zonaria farlowii*	23-68

* No density-depth plot generated

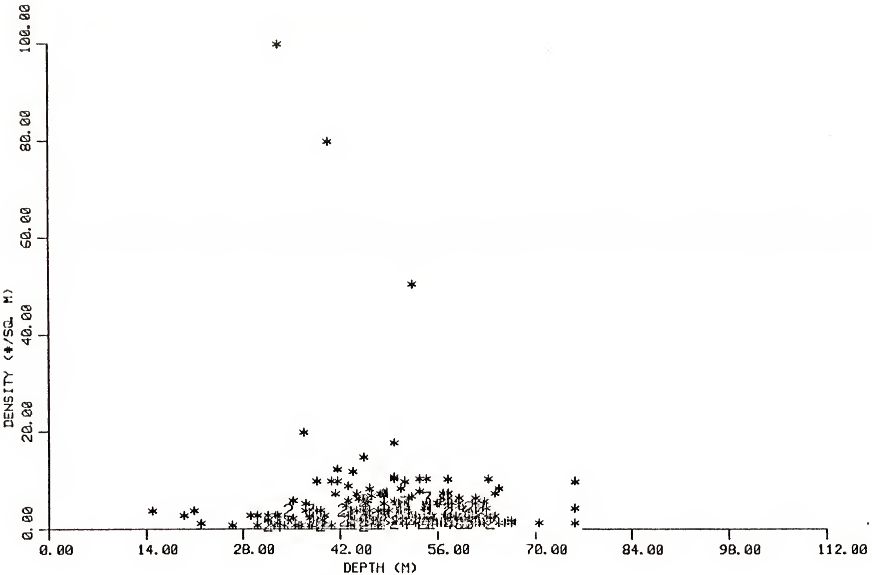


Figure F-1. Density/Depth Plot <u>Agarum</u> <u>fimbriatum</u>

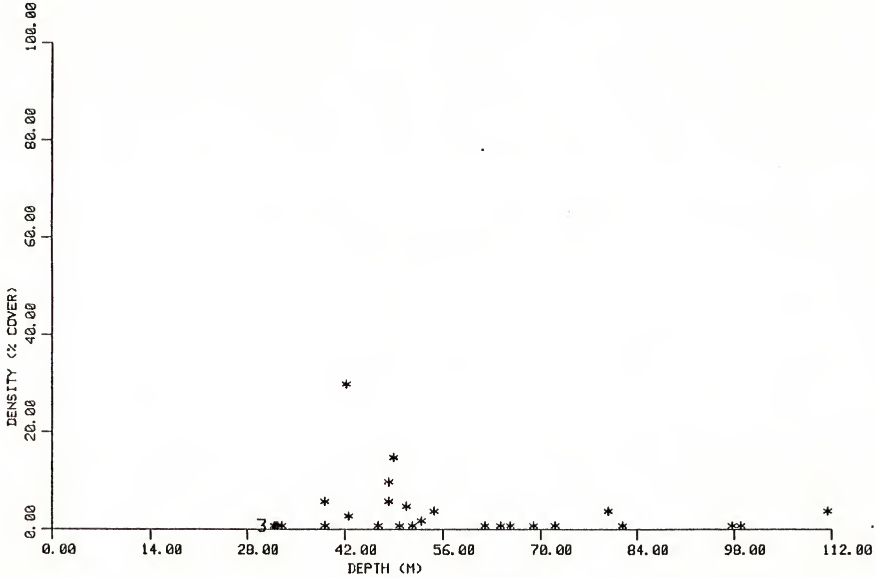


Figure F-2. Density/Depth Plot Allopora californica (< 3 in.)

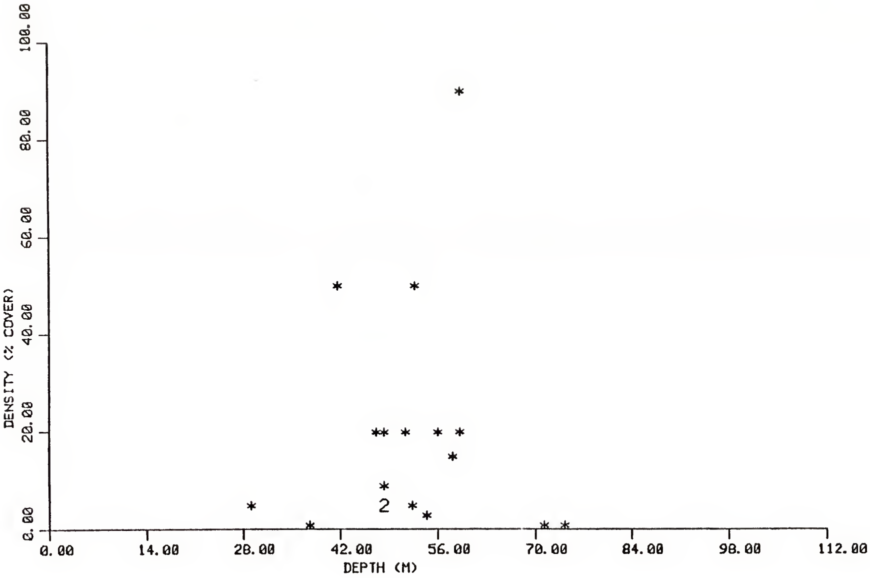


Figure F-3. Density/Depth Plot Allopora californica (> 3-in)

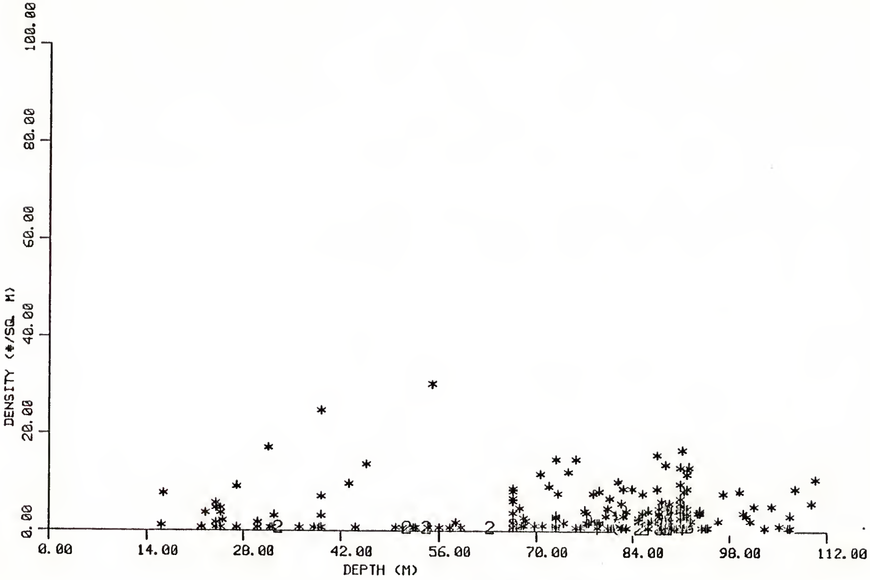


Figure F-4. Density/Depth Plot Balanophyllia elegans

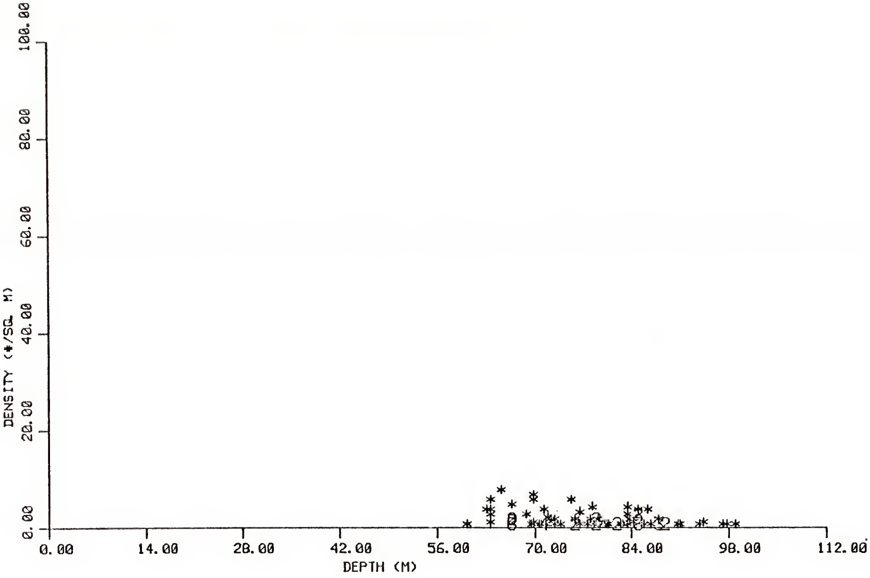


Figure F-5. Density/Depth Plot Bath Sponge ("Clathrina")

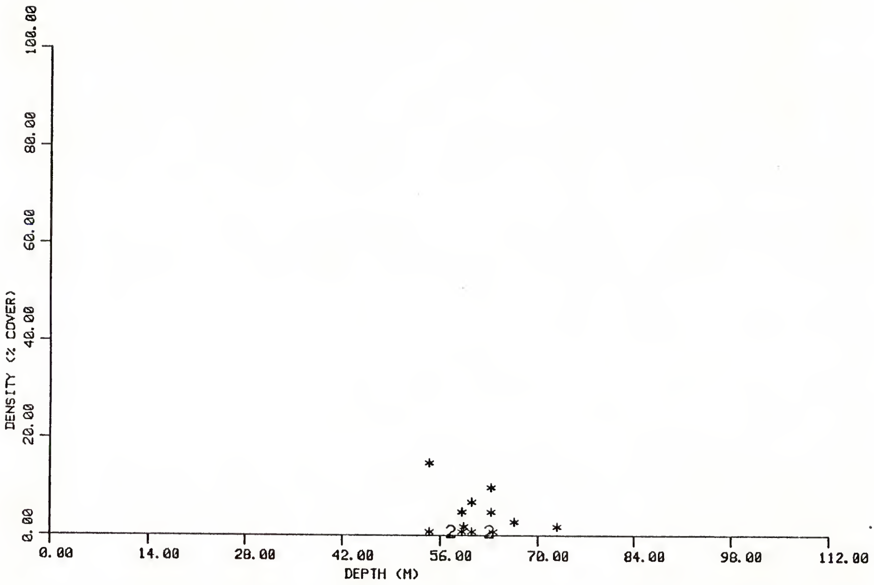


Figure F-6. Density/Depth Plot <u>Bossiella</u> sp.

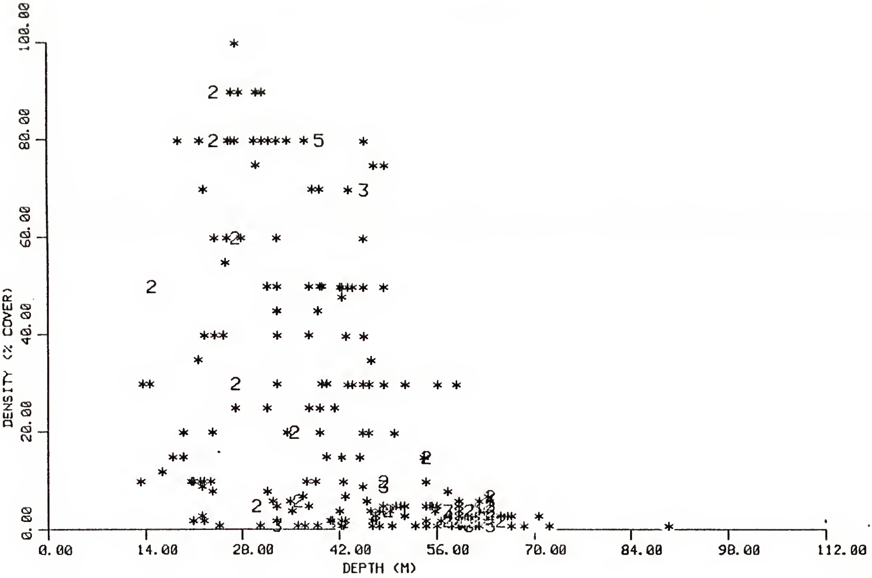


Figure F-7. Density/Depth Plot Calliarthron cheilosporides

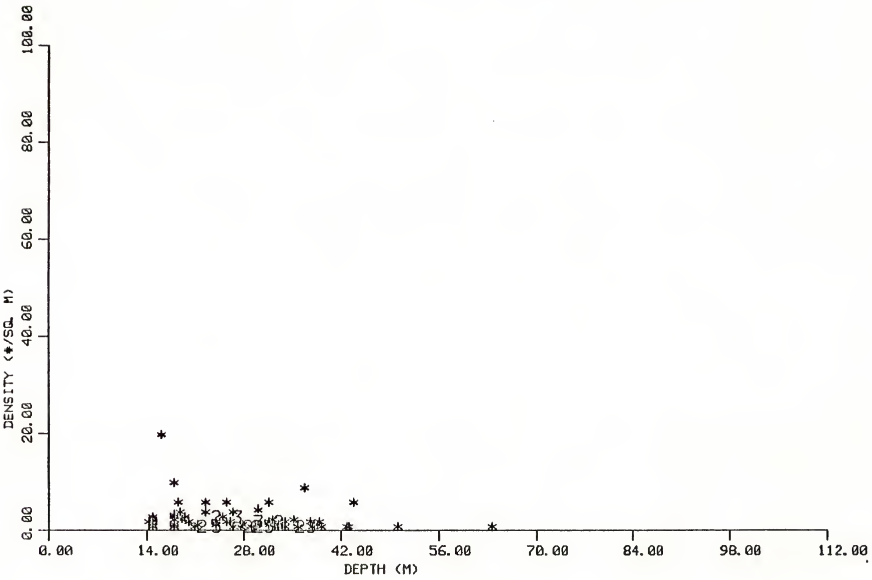


Figure F-8. Density/Depth Plot *Eisenia arborea*

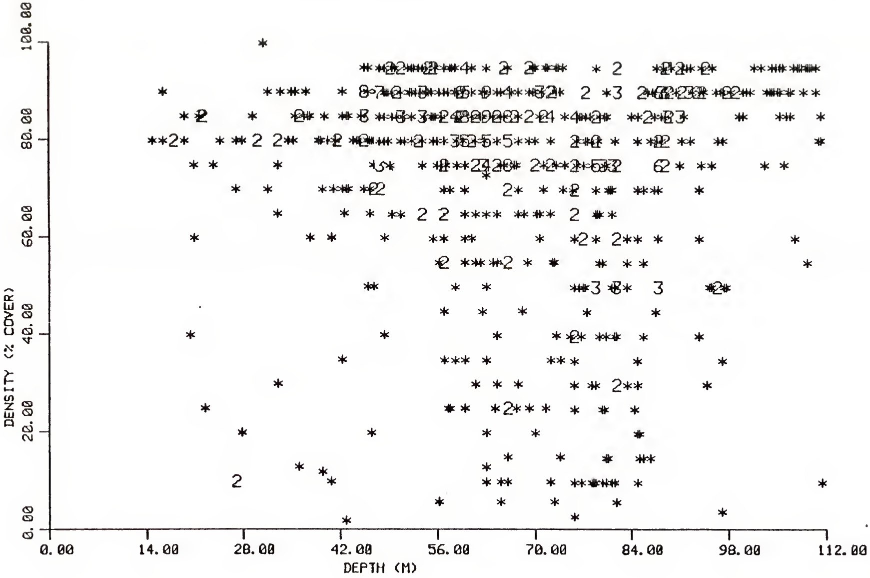


Figure F-9. Density/Depth Plot Encrusting Coralline

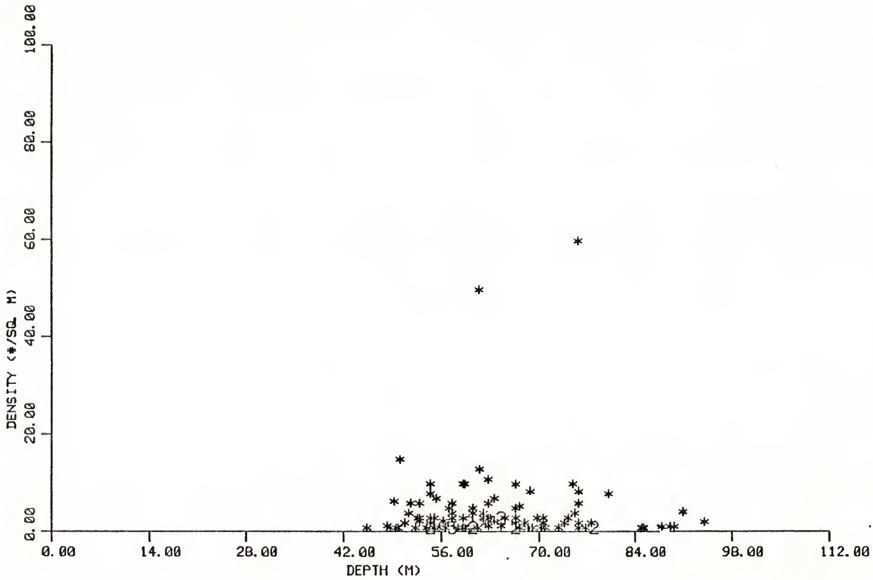


Figure F-10. Density/Depth Plot Eugorgia rubens

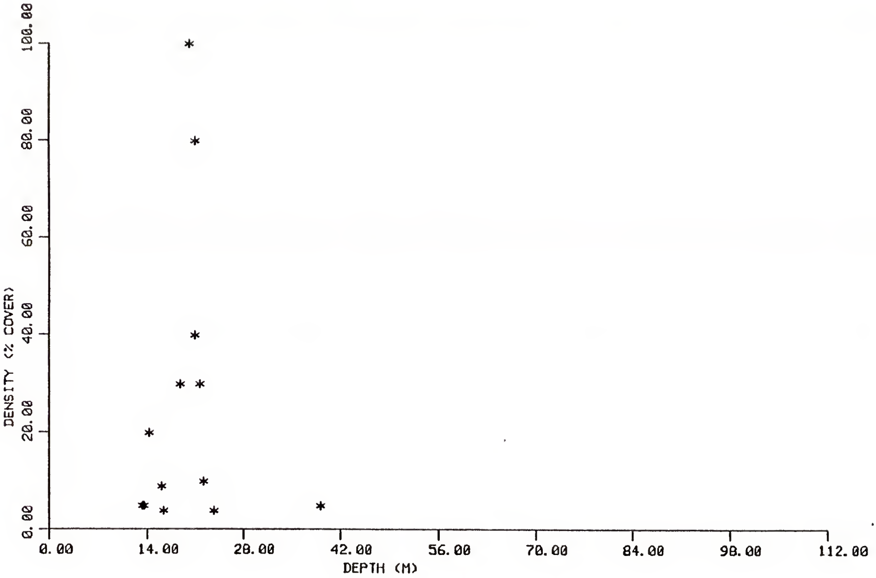


Figure F-11. Density/Depth Plot Gelidium sp.

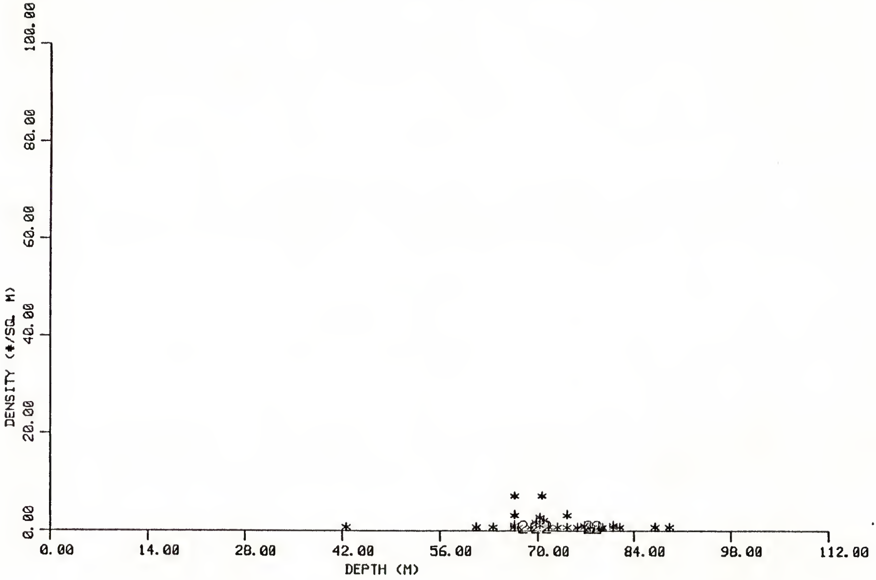


Figure F-12. Density/Depth Plot Heterogorgia papillosa

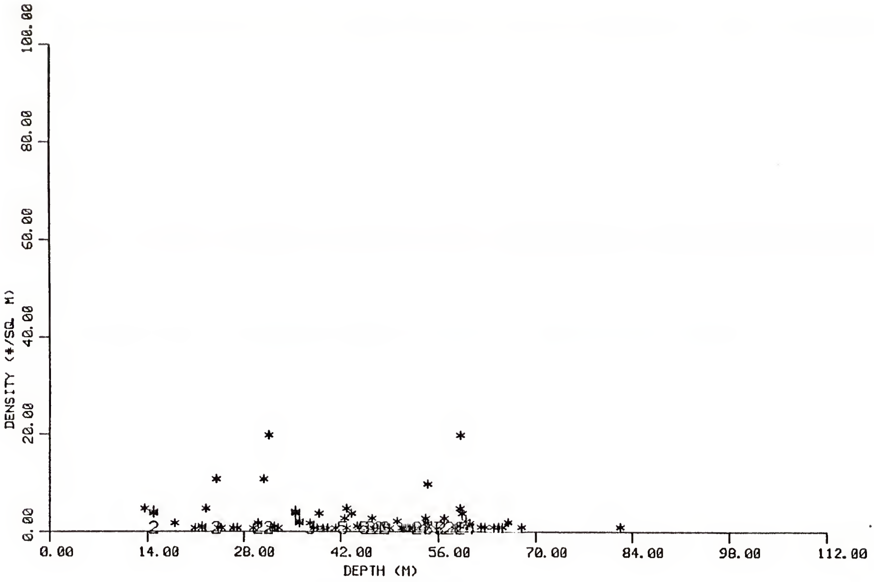


Figure F-13. Density/Depth Plot _Laminaria farlowii_

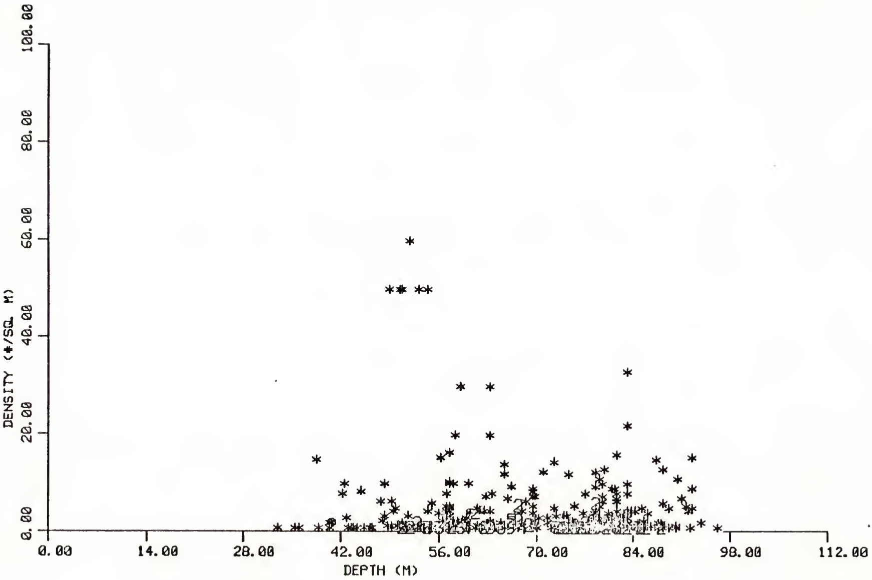


Figure F-14. Density/Depth Plot Lytechinus anamesus

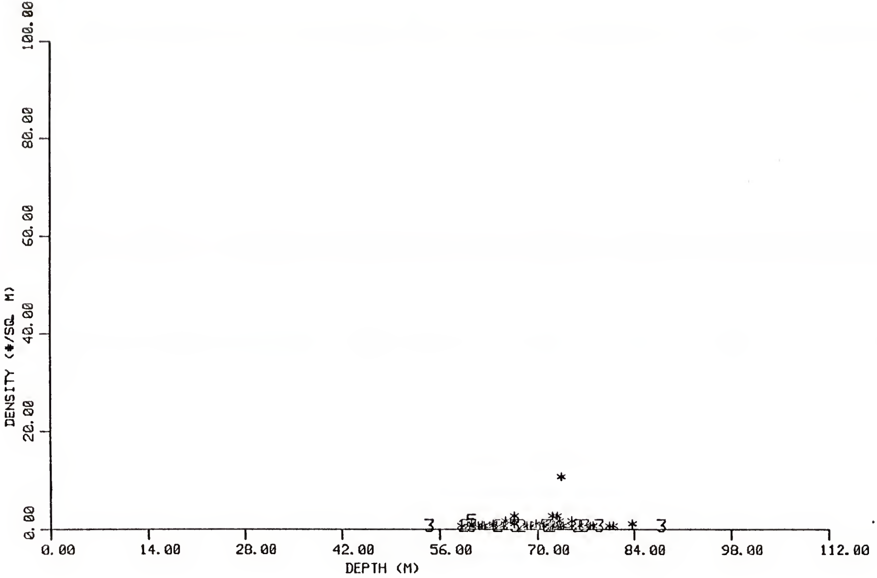


Figure F-15. Density/Depth Plot <u>Maripelia rotata</u>

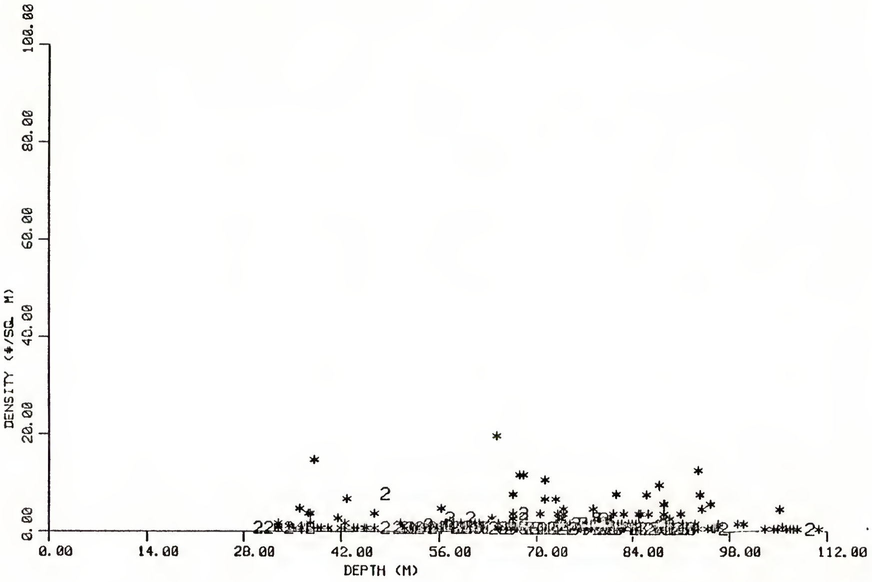


Figure F-16. Density/Depth Plot *Mediaster aequalis*

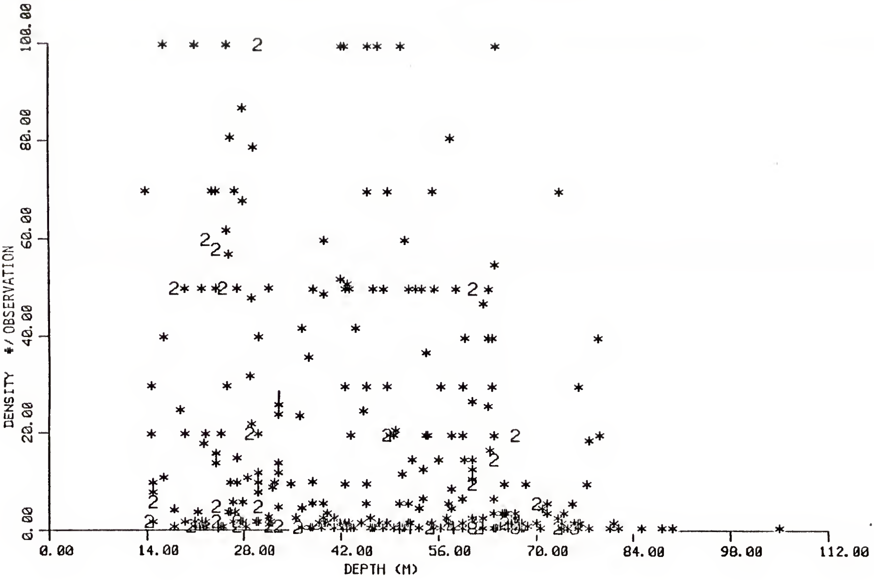


Figure F-17. Density/Depth Plot Oxyjulis californica

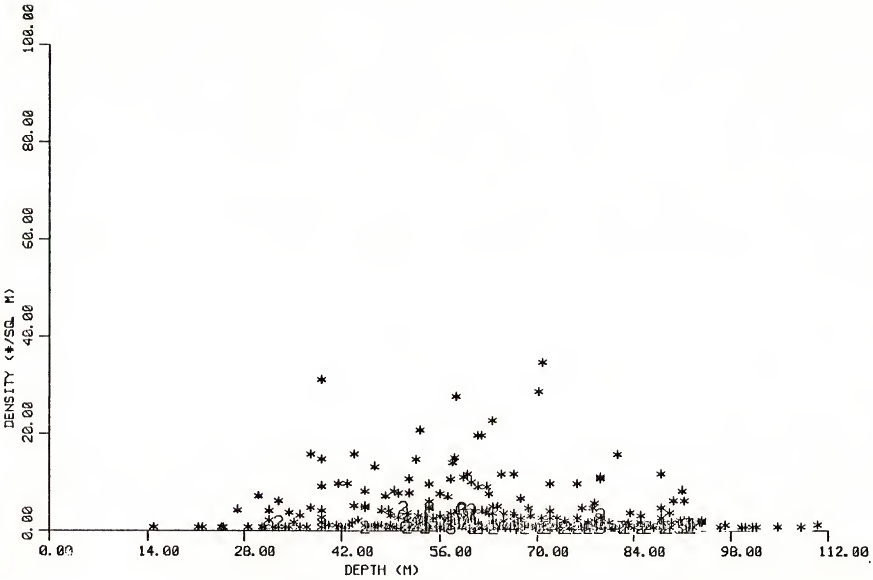


Figure F-18. Density/Depth Plot *Paracyathus stearnsi*

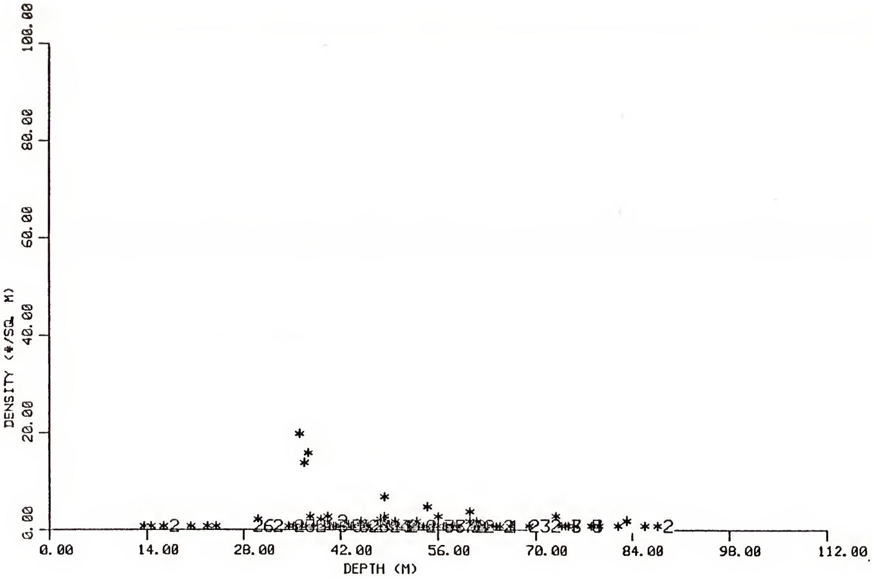


Figure F-19. Density/Depth Plot *Patiria miniata*

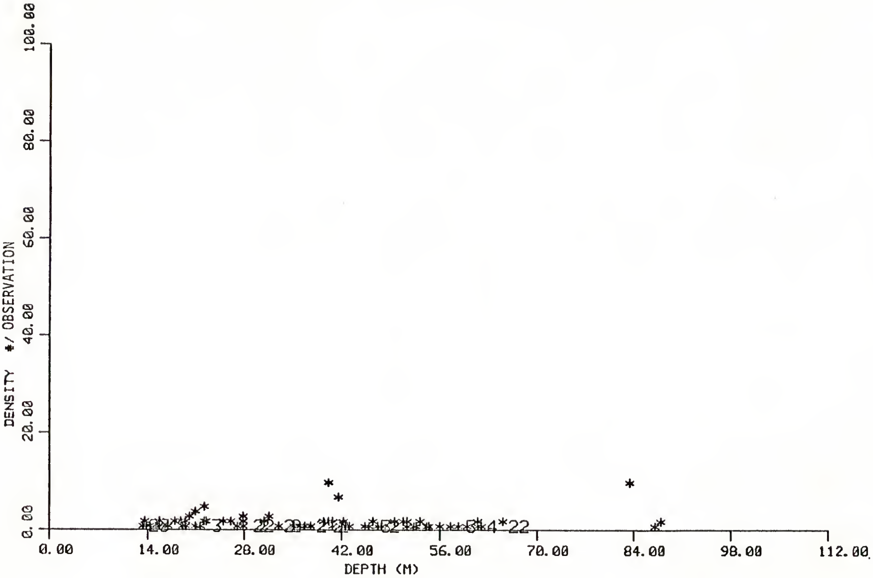


Figure F-20. Density/Depth Plot <u>Pimelometopon pulchrum</u>

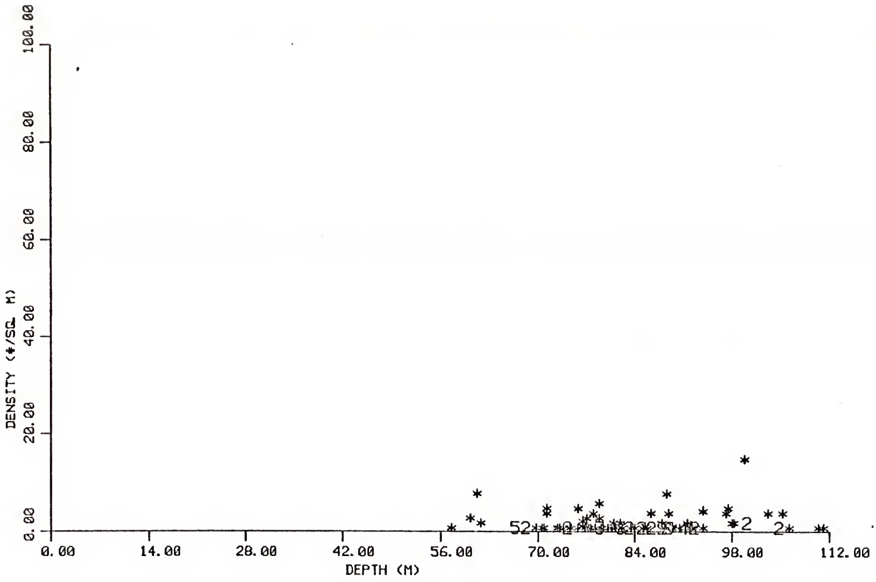


Figure F-21. Density/Depth Plot Plumarella longispina

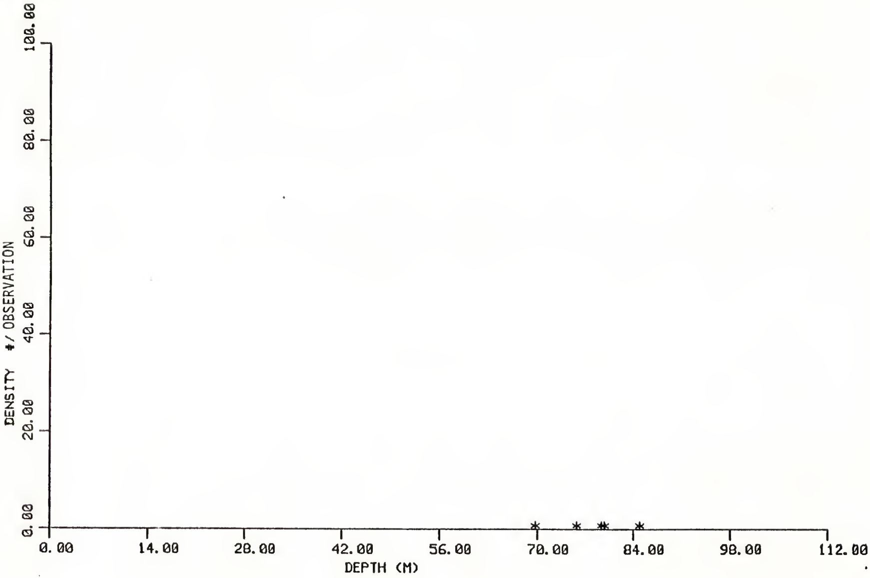


Figure F-22. Density/Depth Plot Sebastes chlorostichtus

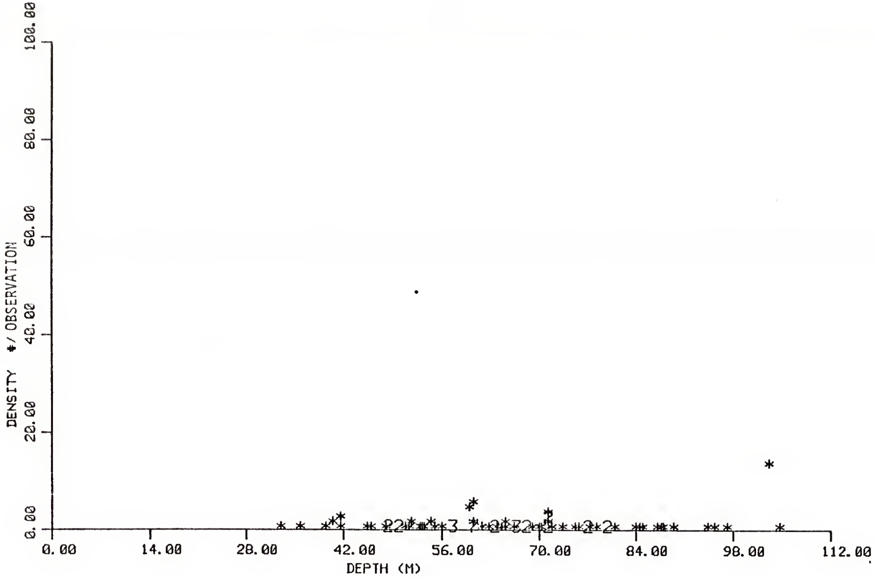


Figure F-23. Density/Depth Plot Sebastes constellatus

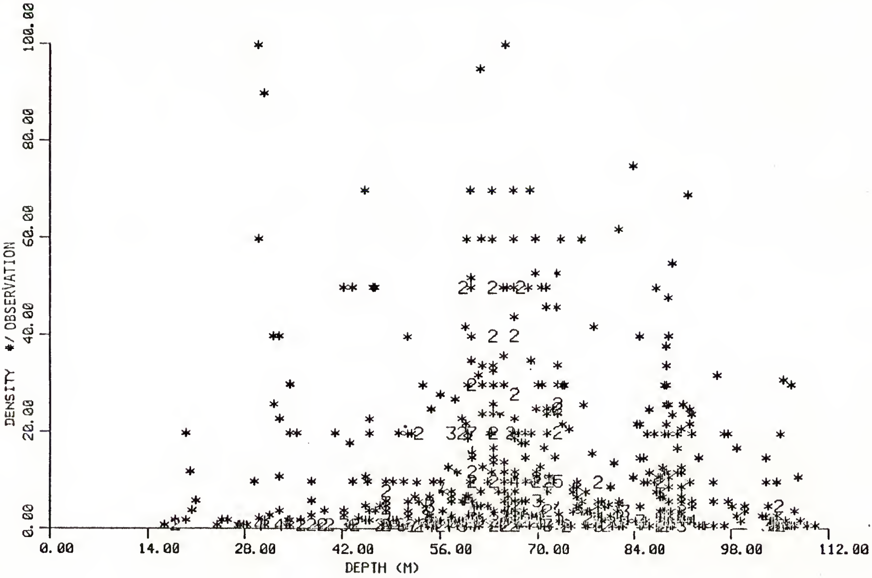


Figure F-24. Density/Depth Plot Sebastes hopkinsi

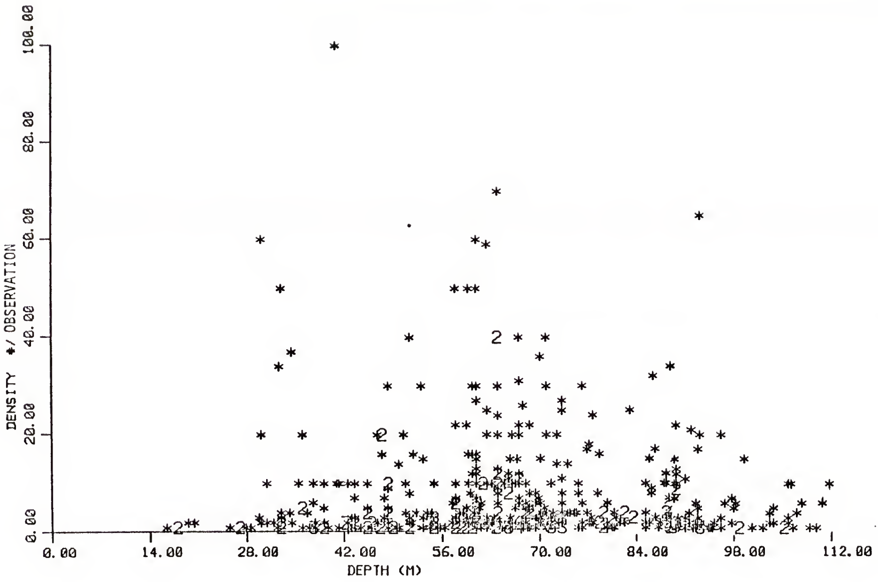


Figure F-25. Density/Depth Plot Sebastes hopkinsi (> 7 in)

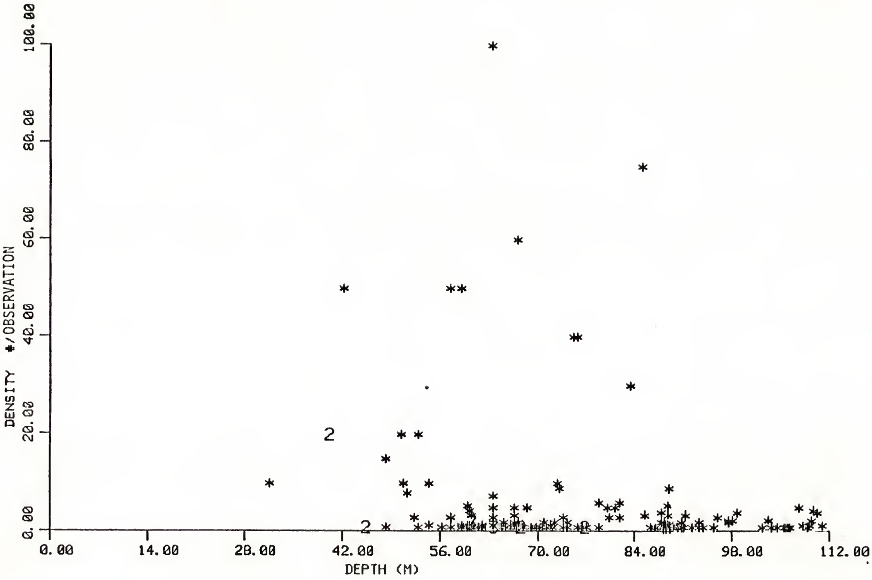


Figure F-26. Density/Depth Plot Sebastes hopkinsi (NLG)

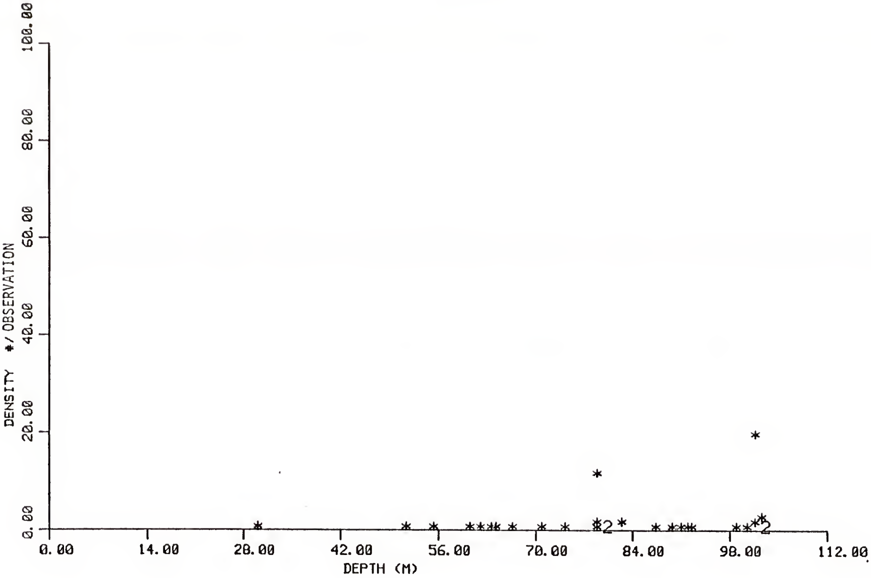


Figure F-27. Density/Depth Plot Sebastes levis

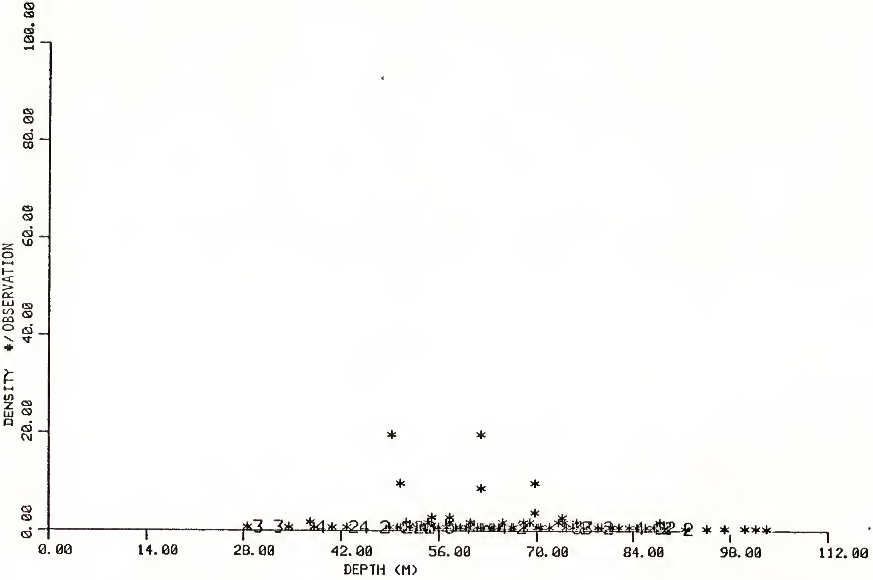


Figure F-28. Density/Depth Plot Sebastes rosaceus

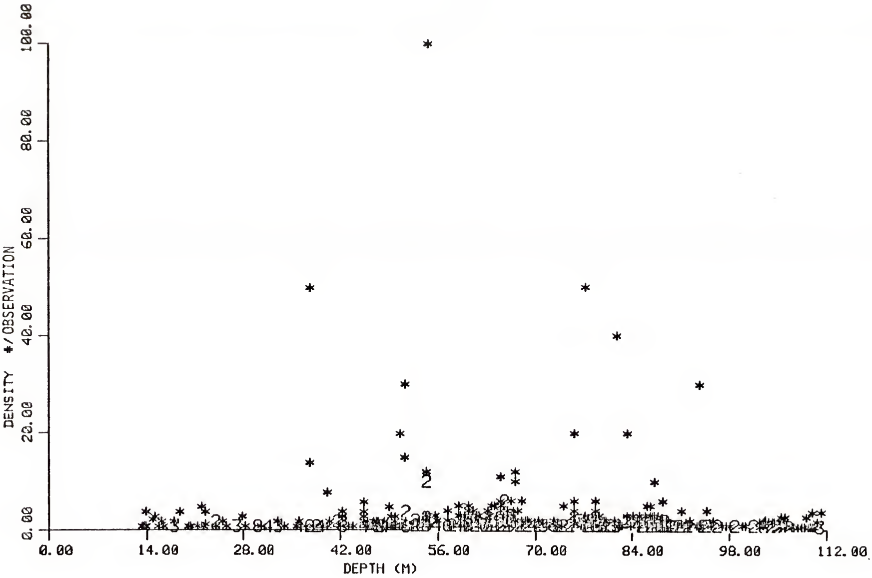


Figure F-29. Density/Depth Plot <u>Sebastes</u> spp (other)

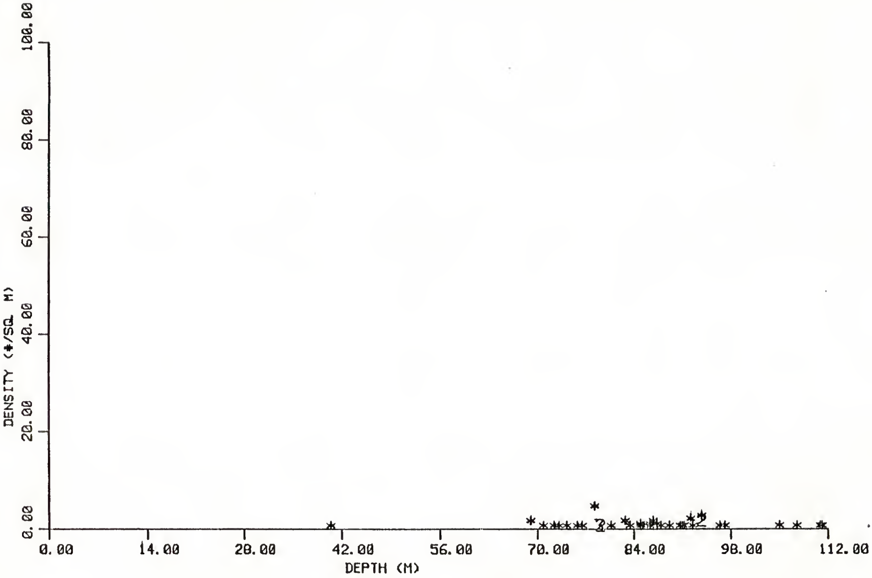


Figure F-30. Density/Depth Plot Vase Sponge ("Staurocalyptus")

Appendix G

CRUISE REPORTS #1 AND #2

INTERSTATE ELECTRONICS CORPORATION
SUBSIDIARY OF ATO
Oceanic Engineering

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Post Office Box 3117
Anaheim, California 92803

Telephone (714) 635-7210 or (714) 772-2811
TWX U.S.A. 910-591-1197 TELEX 655443

BIOLOGICAL AND GEOLOGICAL RECONNAISSANCE AND CHARACTERIZATION SURVEY OF TANNER AND CORTES BANK

CRUISE REPORT SUBMERSIBLE OPERATIONS #1

Prepared by:

Interstate Electronics Corporation

November 1978

Prepared for:

United States Department of Interior
Bureau of Land Management
Washington, D.C.

Under Contract No. AA 551-CT8-43

EXECUTIVE SUMMARY

Interstate Electronics Corporation commenced final mobilization October 18, 1978, aboard the RV SEAMARK at San Diego, California for submersible operations #1. The survey was designed to observe, photograph and record information about the biological communities on selected transects across regions of rock outcrops, of the Tanner-Cortes Banks Region.

During the ensuing 13 days, one day was spent in mobilization, one day set aside for testing and one full day and part of the last day were lost due to inoperable weather conditions, 10 operational days were achieved during which 21 transects were observed and photographed in priority areas A, B, E and F covering over 53,000 meters (29.4 miles) of sea floor.

Section 2

SURVEY OPERATIONS

2.1 INTRODUCTION

Mr. William B. Merselis the program manager was the party chief responsible for the biological and photography portion of the program including planning, field survey direction, data collection, and plotting. He was supported and backed up by Dr. Andy Lissner at sea and Mr. Ford McFarlane in the Interstate office.

The cruise was scheduled for ten days to include nine days of submersible operations. The purpose was to conduct a survey of the biological communities on rock outcrops in the four priority Tanner/Cortes Bank study areas, to make observations, T.V. and audio tape recorded records of required data, take color photographs of the bottom and to locate areas desirable for movie production. Survey operations covered priority areas A,B,E, and F with transects being layed out to maximize areal and depth diversity to be seen by the consultants.

The basic operations conducted were scientific observer/photography transect dives. The dives were organized in terms of priority, and three dives per day were planned. Sea conditions, swell height and period and water clarity were important criteria in deciding the order of survey. The number dives completed in a working day depended upon weather, maintenance, and the on-bottom time for prior dives that day. However, for most days, mechanical and electronic conditions proved to be the limiting factors that finally determined the number of dives and the transect distance covered across the sea floor. We normally worked at least a twelve-hour day and did obtain up to six hours of bottom time in a day. Although weather maps were monitored daily, a one day delay was encountered due to unexplained adverse weather on October 21, and caused operations to be terminated after one transect on October 30.

Interstate recognized the potential for equipment failure therefore spares and repair equipment were provided for nearly everything. Navigation, because of two systems, had its own backup as well as spares. In the event of an Argo navigation problem while on a dive the submersible could be positioned by the Mini Ranger, pinger, and detailed knowledge of the bathymetry.

The benthic camera system was backed up by ship board spares and a known source for a new system. Hand held 35 mm cameras and black and white video which were used to supplement the benthic camera record were also considered as backup so that failure of any one system would not result in loss of all data. Spare 35 mm cameras and video system were carried on board. Spare audio tape recorders were carried on board and rotated from dive to dive.

2.2 SUBMERSIBLE OPERATIONS

Five major activities were conducted prior to and during a submersible operation: dive preparation, observer preparation, submersible launch, transect activitiy, and submersible retrieval. In general these activities proceeded as follows:

- Dive Preparation. Positions were fixed and transect buoys placed at the predetermined ends of the transect. The submersible was serviced, batteries charged, air filter changed, oxygen and air tanks replaced. Minor maintenance was also completed at this time. Tapes, film, camera setting, strobe setting, timing apparatus, backup equipment and materials were checked and serviced and the ship positioned for the dive.

- Observer Preparation. Simultaneous with dive preparation, the scientific observer prepared for the next dive. Preparation consistéd of replaying tapes and discussing observations of prior dives. It further consisted of evaluating community structure along the transect based on the bathymetric chart prepared from prior survey work. During this period observers studied the chart for the next dive and discussed relevant features of the terrain and anticipated points of scientific interest which might be encountered.

- Submersible Launch. The submersible was launched near the buoy at the start of the transect and the pilot followed but buoy line to the bottom.

- Transect Activities. The submersible traversed along the transect line. All survey activity was carried out as carefully as posssible along the lines specified. Data collected included automated and observer triggered photographs and black and white video of the bottom and benthos, and a tape recorded commentary on the community structure and organisms sighted. In addition other observations as associated with community structure, size, density, topography and bottom type were noted.

- Submersible Retrieval. When the submersible returned to the side of the ship basic maintenance was performed, batteries connected for recharging and expendables replaced. Exposed film and tapes were changed, cased, labeled, and indexed for storage and buoys reset for the next transect.

2.3 ACCOMPLISHMENTS

Biological observer and photography transects planned for the first phase of the submersible operations were successfully accomplished even though everything did not go exactly as we had planned. During the operations we were unable to accomplish three dives every day as planned, but because we were able to extend the length of some dives, 53,400 meters (29.4 N. miles of seafloor transects were accomplished in 21 dives. Figures 2-1 thru 2-4 of priority areas A,B,E and F show the location of the individual transects. Table 2-1 contains the details of each dive such as date, location, observer, depth and information gathered. Appendix B is a copy of the Engineering Notebook log sheet records of each days activity.

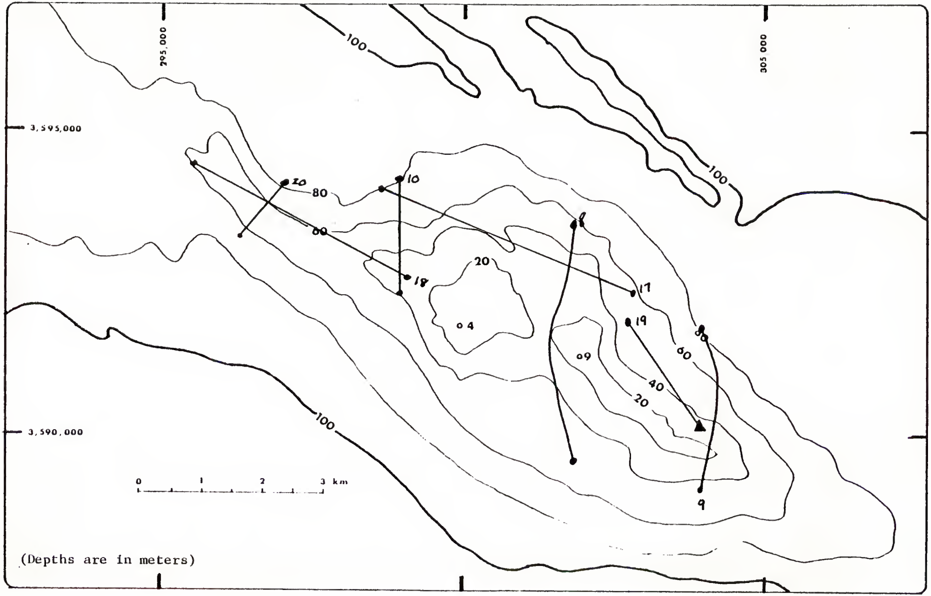

Figure 2-1 Submersible Transects Bishop Rock, Area "A"

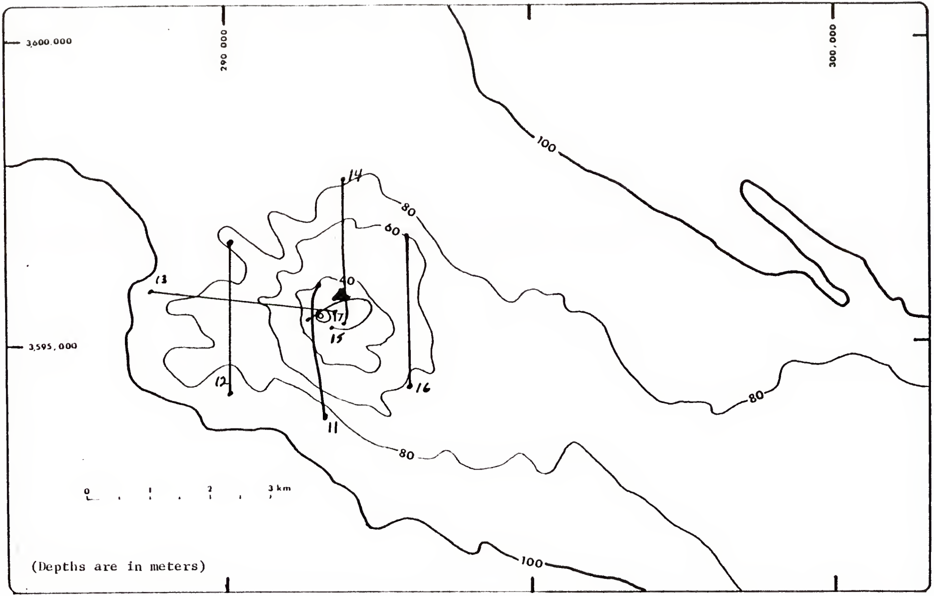

Figure 2-2. Submersible Transects Nine-Fathom Reef, Area "B"

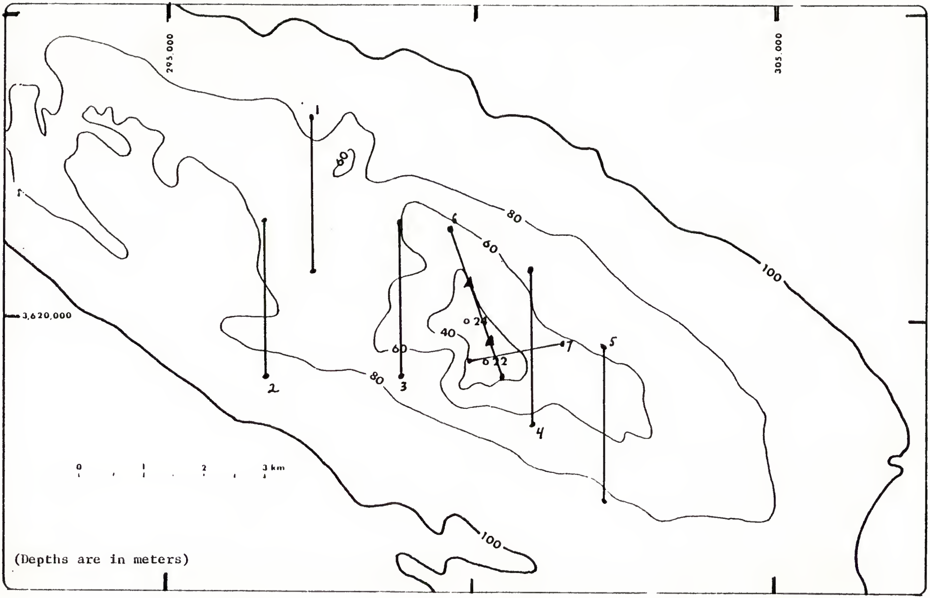

Figure 2-3. Submersible Transects Central Tanner Bank, Area "E"

TABLE 2-1. SURVEY ACCOMPLISHMENTS

Date	Dive Number	Location/ Observer	Length/ Meters	Depth Start	Meters Shallow	End	Audio Tapes Sides	Video Tapes	Benthos	Hand Held	Start Position X Y	End Position X Y
10/20	1	E Word	2600	84	64	79	3	0	1	8	297,326 - 3,623,187	297,430 - 3,620,582
	2	E Grigg	2600	94	68	81	2	0	1	48	296,625 - 3,618,929	296,689 - 3,621,463
10/21	Inoperable Weather Conditions. No dives											
10/22	3	E Lissner	2800	77	44	58	2	0	1	12	298,775 - 3,618,901	298,827 - 3,621,421
10/23	4	E Word	1900	60	40	58	2	1	1	0	301,000 - 3,618,200	301,000 - 3,620,000
10/24	5	E Grigg	1750	63	44	66	3	3	1	99	302,139 - 3,619,424	302,121 - 3,617,733
	6	E Lissner	2850	48	28	43	3	1	1	0	299,661 - 3,621,236	300,696 - 3,618,751
	7	E Word	1850	55	27	60	1	1	1	30	301,535 - 3,619,552	299,840 - 3,619,315
10/25	8	A Grigg	4300	67	18	50	2	3	1	84	301,806 - 3,594,188	301,811 - 3,590,031
	9	A Lissner	2550	55	19	70	2	2	1	0	303,880 - 3,589,211	303,927 - 3,591,691
	10	A Word	1800	77	33	33	2	2	1	20	298,983 - 3,594,178	299,004 - 3,592,578
10/26	11	B Grigg	2450	82	27	33	2	2	1	75	291,895 - 3,593,712	291,642 - 3,595,811
	12	B Word	2650	91	59	82	2	2	0	140	290,207 - 3,594,205	290,234 - 3,596,638
10/27	13	B Lissner	3300	84	21	30	3	2	1	0	288,964 - 3,595,810	291,947 - 3,595,727
	14	B Stoddard	1700	63	20	26	3	2	1	0	291,934 - 3,597,517	291,865 - 3,595,648
10/28	15	B Lissner	1300	19	15	47	1	1	1	5	291,907 - 3,595,618	291,916 - 3,596,024
	16	B Lissner	2400	67	50	64	3	2	1	16	293,024 - 3,594,221	293,021 - 2,596,684
	17	A Stoddard	4300	47	23	80	2	3	1	9	302,700 - 3,592,400	298,900 - 3,594,000
10/29	18	A Harden	4300	33	33	74	4	1	1	5	299,120 - 3,592,660	295,300 - 3,594,101
	19	A Lissner	2100	27	16	21	2	1	1	1	302,476 - 2,591,490	303,880 - 3,590,101
	20	A Stoddard	1100	81	47	80	2	2	1	4	297,080 - 3,594,127	296,314 - 3,593,357
10/30	21	F Lissner	2800	97	68	84	3	2	1	32	292,600 - 3,624,000	292,600 - 3,621,500
10/30	Inoperable weather caused the dives to be terminated early.											
Total	21		53,400 (29.4 N.M.)	97	15	84	49	33	20	588		

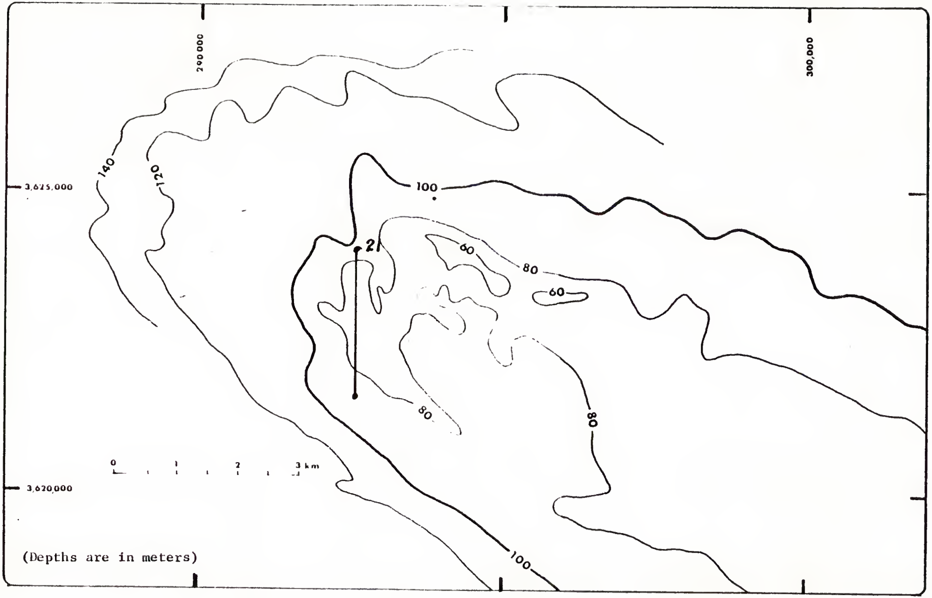

Figure 2-4. Submersible Transects Northwest Tanner Bank, Area "F"

2.4 SUMMARY OF THE DAILY LOG, PROBLEMS AND SOLUTIONS

10/19 During the test day one of Interstate's biological observers became ill and when the ship reached San Diego he left the ship with the intention of returning later at sea if possible. At that time Mr. Merselis, Program Manager, decided to remain onboard for the full cruise and Dr. A. Lissner, the second Interstate observer became his assistant and onsite advisor.

During discussions with the Sientific team, the Chief Submersible Pilot and the Interstate Chief Scientist the thought of calibrating each observer, photographs, and his notes against the other observers was discussed in depth. There were a number of good reasons to consider this approach but because of the additional time and expense that would be incurred and because the program had not been planned that way the party chief decided that the first days effort would be three separate dives on Tanner Bank area E. Consultants J. Word, Dr. R. Grigg and Interstate's Dr. A. Lissner would make dives on three different relatively simple (i.e. areas of low topographic change and where we anticipated relatively simple and uniform geologic condditions) transects in order to obtain good scientific observations and yet have a chance to work out any complications that might arise with the total system.

10/20 Initial confusion by team members in the operation to locate a position for end buoy required an extra hour.

Upon checkout the T.V. system was not working properly with either recording unit. So the recorders were removed and it was decided to make the dives without T.V.

Dive #1 accomplished and transect end marker released.

Dive #2 completed but end marked could not be released.

The wind began to pick up about 3 pm.

T.V. repaired that night.

10/21 Day lost due to weather.

0730 - Wind NW 24 knots, gusts to 30 knots.
Swell 7 feet at 8 seconds with a 2 foot wind chop.

0900 - Anchor chain broke. Some swell up to 10 feet.
Decided to go in behind San Clemente to wait for better weather.

10/22 The T.V. recording system failed and motor controller in submarine failed but transect 3 was completed satisfactorily.

After the submarine surfaced it was noted that the T.V. Camera had flooded so it was removed and the backup hand held T.V. system was loaded into the submarine and performed well for the rest of the cruise.

Dive 4 started but due to a short in the submarine motor and excessive smoke the dive was aborted.

Remainder of day unable to dive but submersible crew repaired motor for the next day.

10/23 Transect 4 was aborted early after 1900 meters due to short circuit and excessive smoke in submarine. Sub motor overhauled again and set to go at 1630 hours, however during Dive 5 there were power problems and the transect could not be run.

At this point GOI was called and arrangements made to send new parts to the ship for full repair or motor replacement.

NSI power system presenting some intermittent problems. New unit to be sent to ship.

10/24 0700 - NSI system operating fine and recalibrated.

0830 - Submersible motor system repaired and ready to go. All systems operating satisfactorily.

Transects 5, 6, and 7 completed.

10/25 Good day - two excellent transects 8, 9, completed, a third only 1850 meters long was also completed.

10/26 Late in the first dive, Transect #11 the strobe unit hit the bottom causing failure of flashtube, glass cover, and short in the power supply board. (Above components replaced in the field before first dive on October 27).

The spare flash unit was mounted for the second dive but would only fire in test mode. Attempted to trouble shoot without success. Lost three hours. Finally decided to make dive #12 without strobe and consequently no pictures from the benthos camera.

This afternoon the party chief decided to extend the survey duration as long as possible, based on the weather being excellent, observers and pilots working well as a team, submersible operations going well, video and audio systems working well, good coverage with the hand held camera and that spares for the benthos would arrive tomorrow morning.

10/27 0715 - Benthos strobe unit repaired operating successfully.

NSI calibration problem.

0810 - NSI calibrated

First dive Transect #13 completed.

Second dive aborted due to motor brushes failure and motor will not run. Repaired by 1700 hours so decided to try and make the next dive.

Transect #14 completed but could not find pinger buoy for release. In addition the surface buoy line had parted thus leaving pinger and marker on the bottom.

10/28 Because we could hear the Transect line #14 end pinger marker, and had only one spare and because the area was reported to be of scientific interest it was decided to make a short dive to recover the pinger. Dive 15 was conducted but pinger was not located, however the area covered was considered significant enough to call it Transect #15.

The spare benthos flash unit was repaired and operational this morning.

Transects 16 and 17 were also completed making it an excellent day.

10/29 Another excellent day. Three transects 18, 19 and 20 completed. Transect 19 moved into slightly deeper water (27 meters) because of conditions on top of the ridge.

10/30 0500 - Lost NSI Mini Ranger signal. Ran north for calibration.
0700 - No calibration. Turn east towards Area F.
0800 - NSI calibrated.
0853 - AROG system cutting in and out but start and end buoys were placed by 0921 - Swell quite large and increasing.
1218 - Transect #21 completed successfully but submersible could not locate end pinger and marker.
1240 - Pinger buoy line parted during recovery attempt due to large swell and marker being caught on the sea floor. Because submarine still had adequate battery power it was decided that a quick attempt would be made to recover the pinger. This also allowed the Program Manager/Party Chief, a geologist, an opportunity to observe the sea floor.

By early afternoon the swell had increased to 10 to 12 feet with an occasional swell of 14 feet. By 1330 hours the wind had come up to 15 knots with gusts to 20 knots and conditions began to become dangerous for operations. The weather report was for no improvement in the next day or two. By 1415 hours, with the wind above 15 knots and sea conditions dangerous, the chief pilot decided not to risk another dive. However the submarine was serviced and conditions observed until 1640 hours when the final decision to return to port was made because of the weather. Thus, one half of this day was lost due to weather.

INTERSTATE ELECTRONICS CORPORATION
Oceanic Engineering Division

Appendix A

SUBMERSIBLE OBSERVER'S MANUAL

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SUBMERSIBLE OBSERVER'S MANUAL

OBSERVER PREPARATION

Prior to the surveys each observer will familiarize himself with the species card file for the area. This pre-survey coordination will ensure that the maximum information is obtained during the survey operation.

Many species can be field identified by characteristics not normally used for identification in the laboratory. Good field identification depends on two critical factors: (1) the overall expertise of the observer in making taxonomically relevant observations and (2) the prior training of the observer in recognizing the known species of the area. For this reason the observers were chosen for their known expertise in recognizing organisms of the benthic community likely to be encountered in the study area. This expertise includes a familiarity with the intertidal community north of Point Conception, as many species of this community occur in the deeper water of the Tanner and Cortes Banks.

The observers will receive additional training in the identification of all resident species, regardless of prior knowledge, to assure that all conflicting opinions are resolved and all observations are homogenous among the various observers prior to the survey. Where necessary, type specimens and specialists in the classification of specific groups will be consulted to produce state-of-the-art identifications. Especially important to consider are many indirect aids to identification such as distinctive behavior patterns, prey types, species associations, depth ranges, and environmental factors which may well be the deciding factor in the identification of similar species. Where available, such indirect aids will be studied to enable observers to record a maximum amount of information to supplement the photographic record.

To accomplish the training and orientation goals of the presurvey preparation, Interstate will assemble a photographic library of organisms known to occur in or near the study area. This library of color slides, benthic photographs, and movie footage will be thoroughly studied by the observers. The benthic photographs presently available through the Allan Hancock Foundation and the shallow subtidal photographs available through BLM are part of this photo library. The color slides of corals (David Harden), fish (Dr. Richard Rosenblatt), anthropods (Mary Wicksten), nudibranches (L.A. County Museum) and barnacles (Dr. William Newman) will be supplemented by slides of museum specimens where slides of living specimens cannot be obtained.

A special effort will be made to define communities and species associations known or likely to be encountered in the study area. These features will also be studied to assure consistent use of terminology among the observers.

The special expertise of the consultants will be available on the cruises to assure high quality of the observations. If possible one dive will be performed in each of the primary sites with a consultant observer. This will help to assure sound evaluation of community structure. Consultants available to act as observers include Dr. Richard Grigg and Jack Word.

SURVEY PLAN

Operations

Interstate's proposal to conduct 12-hour work days for submersible operations is cost-effective, offers operational flexibility, and allows a synthesis of all scientific data collected during that day.

Although use of a 12-hour submersible operations day versus a 24-hour operations day adds to the relative cost of submersible operations, the operational flexibility afforded is significant. Delays of several hours due to inclement weather or technical difficulties will not handicap the operations. Refurbishment and complete checkout of photographic and submersible systems during the off hours will decrease the chance of malfunctions and subsequent "down time" during operating hours. Such down time can lead to high cost overruns on a 24-hour operation, if sufficient contingency time is not scheduled.

During the periods when the submersible is not diving, transect homing markers, (submersible navigation aids) will be precisely positioned at the beginning and end of each of the next days transects to better enable the submersible to maintain its track.

Use of a 12-hour operating day will allow Interstate, their consultants and the submersible crew to work in a more comfortable mode increasing the reliability of observations and the safety of operations. Twelve hour operating days are preferred to complete the preliminary mapping process. The "off" time will be used to prepare preliminary maps and plan the details for the traverses of the following day. Manipulation of the amount of data which would be derived from 12-hour survey operations is preferred by Interstate to insure high quality data interpretation and inventory while aboard ship.

SUBMERSIBLE OPERATIONS

Since the observers will be extremely busy during the dive, observer fatigue is a potential problem. General Oceanographics has indicated that four hours is the maximum effective observation time for this type of survey. After evaluating observer endurance and the cost of submersible operation, Interstate plans that each observer dive will be approximately two and one alf to three hours; then the submersible will surface and the observers will change. This time span will assure that the quality of observation will remain uniformly high throughout the project. In the event that one of the primary observers is unable to make a dive, a secondary observer will make the dive. Both observer teams will have undergone the same training so the quality of observations will not be lowered if a substitution is required.

All activities will be coordinated by clocks synchronized to National Bureau of Standards time transmissions. To ensure true known course and position along the transect line, pingers will be located on buoys at the ends of the transect for the sub to locate itself and the submersible will be positioned by the support vessel as it moves along the line. Course corrections will be relayed from the mother ship to the pilot of the submersible should it stray from the planned transect line. The submersible will automatically relay information as needed to the support vessel which will be recorded on the audio documentary system.

Description of all activities on the submersible will be entered into the taped record which will include a specific time code entry for later synchronization to the photographic record. The benthic cameras will have a clock readout for record on the film. Concrete blocks with buoys will be placed at the start and end position of each transect, and some may be left in position after the survey is completed to allow reoccupation of the transects. Before each dive the following items will be checked by the observer's support man:

(1) Syncronize video clock, observer's watch and ship's time to NBS time.

(2) The camera is loaded with film and ready to go.

(3) Video recorder is loaded with fresh tape and ready to go.

(4) Audio recorder is loaded with fresh tape and ready to go.

(5) Test video recorder and initialize with date, time, and transect number.

(6) Test audio recorder and initialize with date, time, and transect number.

(7) Check for 4 spare video and 4 spare audio tapes on board submersible.

(8) Activate benthic camera before transect.

OBSERVATIONS

The observer on each dive will be responsible for making the tape recording during the dive and operating the 35-mm movie/still camera. Continuous tape recordings will be made of observer's comments including community observations, coral distribution, and species identifications. The observers will record in as much detail as possible the species associations, distribution, community structure and geomorphology along the transect line.

Visual observations during transects will provide a semiquantitative data record. Sightings per unit travel and estimated numbers of individuals per square meter or separation distance and approximate size will be noted for the dominant species, including all larger epibenthic coral. This information will be used to plot densities on the debriefing maps and for community analysis. Estimates of faunal density will be determined by line transect methods. It is essential that consistent observational methods be incorporated within the field program. Each observer will record comments using standardized terminology on the following:

- Geology and Geomorphology
  - nature and areal extent of sediments or bedrock
  - features of exposed bedrock
  - structural trends and downslope movements
  - oil, tar, gas seeps and other objects
- Identifications of dominant species
  - algae
  - invertebrates (especially corals)
  - demersal and pelagic fish (especially residents)
- Distribution and density of the larger, more abundant species
- Associations of various species
- Community structure identification
  - horizontal differentiation
  - vertical differentiation

Transect Run

A transect may consist of several "runs" during which the submersible is in motion and observations are being recorded.

Be sure video and sound recorders are on before beginning a run.

Initialize the sound recording with date and time by voice. Also state your name, transect location and depth.

The observer will look only through the lateral-forward port on the camera side during a run.

During a transect run the observer will accomplish the following:

(1) Call out the names of every community entered in the following manner:

"Community of Allopora on bedrock."

"Community of Eisenia on bedrock."

"Community of Encrusting corallines and brittle stars on bedrock."

"Community of mud-flat."

"Community of cobbles."

"Community of sand-flat."

Or other, as observed: The name should identify the dominant feature or species.

If the community is new and the observer needs to record detailed observations, then the observer should call a brief "New Community Stop". If so we will obtain a new fix on the position at the submersible.

(2) Immediately follow community name with substrate type, if not already stated, adding specifics:

"Sand appears coarse, not silty."

"Rock appears rough, possible volcanic."

"Rock bedded 90° to run, bedding, plane nearly vertical."

"Small round cobbles interspersed with shell fragments."

Look into the area around the submersible and describe the lay of the land to answer such questions as: "Does the reef extend all around or just under the camera?"

(3) Follow with names and estimated density of dominant organisms visible at time of observation in running sequence as they are seen, giving priority to:

A Corals, all types.

B Larger plants.

C Rock Fish.

D Other large species.

E Smaller organisms.

Remember, smaller organisms should show up on photographic record, also larger fish will be seen on the video tape. The observer is particularly useful for identifying species and seeing the overall features not visible on either of these records. Therefore the observer is not responsible for providing a quantifiable record of sightings, nor any meaningful estimates of densities of smaller organisms. Rather, the observer should note all identifiable species he sees to supplement these other records. Also the observer should be aware of, and record, subtle differences in terrain and associated community structure that will not show up on the film or video, especially relating to the distribution of Allopora and other corals.

Phrases such as "large" or "many" should be avoided each observer should attempt to describe "it" as "about 10 centimeters", "about 2 meters", "over 10", "about 25", or whatever to such estimates.

Be explicit. Be exact.

Nevertheless, if you see an organism you do not recognize or cannot immediately name, identify it in common name terminology such as "large red urchin", or "canary yellow rock fish". Remember what you called each unknown and keep future references to it the same. Later many unknowns may become known.

The scientific observer will be trained in routine geologic observations. The observer will be briefed on features likely to be encountered along each submersible transect based upon interpretation of bathymetric, and sidescan sonar records. The observers will be provided with standard criteria to judge the areal extent of sediments over bed rock, the geomorphic expressions of terraced or emplaced bedrock, bedrock lithology, accumulations of detached rubble, and color, general nature and composition of surficial sediments. Also criteria for general structural trends, and features within surficial sediments such as wave forms, downslope movements (slump, creep, slide) and expressions of gas, oil or tar seeps will be used.

Further geologic information derived from tape-recorded observers field notes, will be used to describe, characterize and map rocky outcrops and areas of surficial sediment accumulation within each of the areas of interest. The taped records of trained scientific observers' descriptions of geological features will be coordinated with continuous televised documentation of the cruise track.

Stopping

The pilot will be responsible for telling the observer when a run begins and when a run terminates. A run may be terminated for one of the following four reasons:

o Transect is complete.

- o Video tape must be changed.
- o Technical or health problem arises which in the judgement of the pilot requires stopping of a run.
- o New community identification. (DO NOT ABUSE SUCH STOPS i.e. don't make them too often).

The observer may stop the run briefly when encountering a new community to familiarize himself with the organisms seen. This shall be termed a "new community stop". This may also be considered a new dominant species stop where the stop is necessary to photograph and describe it.

If an unknown is new and dominant, consider that it designates a new community. Call a stop. Try to photograph it. At least describe it thoroughly. Note such things as habitat, morphology, color, markings and habits. Make such stops as brief as possible. Advise surface ship of time of stop and start for positioning.

Activity During Stops

- o Special taxonomic photographs: Objects of interest will be photographed through the submersible port by the observer using the 35-mm camera.
- o Hand held camera will not be used during a transect run, but may be used during stops.
- o In general notes will not be hand recorded during transect runs, but may be made during stops if necessary.
- o Video tapes will be changed at 1 hour intervals. The submersible will be halted at this time. Observers will check the backup tape recorder, and change the tape when less than half an hour remains on that side of the tape.

Soft Substrate Transect:

At the discretion of the observer, when on soft substrates, the observer may request the pilot to increase speed. Such a change requires a new position by the ship. Such a change should be noted by voice. The observer will continue to record species and features seen.

If no change in topography is expected in the remainder of the transect a soft substrate transect may be terminated after ten minutes pending confirmation from the senior scientist in charge.

If a soft substrate termination is planned then the course will be changed and the pilot will navigate towards the second marker buoy. If a termination is not planned then additional submersible activity will be at the discretion of the senior scientist in charge.

TRANSECT CHECK LIST

Typical Transect Activities. Begin at bottom marker with the submersible stopped.

(1) Check benthic camera operation: Flash should be visible intermittently.

(2) Check video recorder: Video monitor should be operating.

(3) Check observer's watch against video monitor time.

(4) Initialize by stating:

- o Your Name.
- o Transect Number.
- o Date (State name of month, not number).
- o Time (Hours military with minutes).
- o Depth on Bottom.

(5) Describe start area: Remember this is a reconaissance survey not a research project. However, be aware of dive topography such as cliff faces and boulder areas.

(A) Community type (i.e. dominant species).

(B) Describe bottom geomorphology including:

- o Color and nature of rocks
- o Extent of outcrops
- o Strike of outcrops
- o Dip of outcrops
- o Other bottom features

(C) Describe community including:

- o Note top five species.
- o List visible species.
- o Note extent, distribution, and size of corals.

Check List (continued

(D) Take special photographs if required.

(6) Begin run:

- o Note major community features similar to item 5 above.
- o Note changes in dominant species and their distribution.
- o Note changes in geomorphology.
- o Be ready to stop run if a new community is encountered.

(7) End of hour run:

- o Maintenance stop.
- o Pilot changes video tape.
- o Observer changes audio tape.
- o Stow all gear not in use.

(8) Go to step (1) to start next run or terminate dive if transect finished. A given dive may have a maximum of three total hours of "run" time.

Coverage of Survey:

- o Tanner and Cortes Banks. Secondarily, the Trough and South Santa Rosa Ridge.
- o Above 150 meters depth to the shallowest safe depth for submersible operation.
- o Rocky habitats, including boulder and cobble patches.
- o Epibenthic organisms (not nekton, not plankton) and rock associated fish.

- o Resident species (not transients).
- o Dominant features (not rare species, not subtle geomorphological features).
- o Substrate type and extent for mapping.
- o Community type and extent for mapping.

Video Documentation

Considerable thought has been given to the question of using television cameras, either in black and white or color. The Nekton submarine is currently configured for the use of video television. Video enhances the capability to recover as much useful data as possible. The video record will be used during observer debriefing after each dive. Special tape recordings and notes may be made during the debriefing period to assure minimum information loss. This will also allow interaction between the members of the observer team to assure consistency of observations between team members. Such topics as locations for movie footage, special collections, and community structure will be discussed at this time. Video picture quality will not be as good as with transparencies, and so will be used primarily to supplement the cruise log.

Shipboard Debriefing and Initial Plotting.

After each dive, the observer will replay the taped record of the dive in the presence of the other scientists on board the support vessel. During the debriefing, notes will be made on topographic maps relating to the location of important species, community analysis, and other features observed. These notes will simplify the coordination of observations with topographic features during the analysis of the data and will provide an immediately available record of cruise results for use by Interstate for preliminary meetings and briefings with BLM.

The primary purpose of conducting a post-dive debriefing is to maximize the quantity and quality of usable data resulting from the surveys. Questions and problems can be resolved, and tentative identifications evaluated, while the details are still fresh in the observer's mind. Also, having just seen the entire transect, the observer has a better perspective on that specific area, and may now be more aware of indicators of community structure. Any logistical problems arising can be presented and discussed, especially those dealing with the quality of observations and photographs. This debriefing will also help in preparing the next observer so that his diving time can be optimally spent obtaining the best observations.

The use of several qualified scientific observers on alternate dives will allow complete debriefing of each observer aboard ship upon completion of a dive. Interstate considers the use of television of extreme benefit as the observer can, immediately after a dive, review the video tapes, and while observations are still fresh in his mind, expound upon the observations he made during the survey. Review of video tapes by subsequent submersible observers will acquaint them with the salient geoogical features in preparation for their dive. Preliminary field observational overlay maps can be prepared during playback of television and sound tapes under the supervision of the observer. The preparation of rough field maps from video tapes aboard ship may identify particularly interesting trends, outcrops or other geological features which might be investigated during subsequent dives.

In addition observers

Work up complete species list for the dive during debriefing noting all common names used and scientific name equivalents. Any errors should be noted and the correct name given. Remember some poor helpless secretary has to transcribe the tape with the help of these notes.

The species card file will be used as the standard reference for all names.

Textbooks will be used only where species cards and other observers cannot help.

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BIOLOGICAL AND GEOLOGICAL RECONNAISSANCE AND CHARACTERIZATION SURVEY OF TANNER AND CORTES BANK

CRUISE REPORT SUBMERSIBLE OPERATIONS #2

Prepared by:

Interstate Electronics Corporation

December 1978

Prepared for:

United States Department of Interior
Bureau of Land Management
Washington, D.C.

Under Contract No. AA 551-CT8-43

EXECUTIVE SUMMARY

Interstate Electronics Corporation completed mobilization aboard the RV SEAMARK at San Diego, California for cruise 1 and 2 of submersible operations #2 on November 3 and 15, 1978 respectively. The survey was designed to observe, photograph and record information about the biological communities on selected transects across regions of rock outcrops, of the Tanner-Cortes Banks Region.

During the ensuing 16 days, one day was set aside for testing, four full days were lost due to inoperable weather conditions, and 8 operational days were achieved during which 15 transects were observed and photographed in areas A, B, C, E, F, and G covering 41,850 meters (22.6 miles) of sea floor, and three and part of a fourth movie dive were completed in priority areas A, C, E, and F.

Section 1

INTRODUCTION

The goal of the second phase of the biological and geological reconnaissance program was to place scientific observers in a submersible, close to the sea floor, to obtain and record detailed information and photography for community structure interpretations, dominant species identification, and geology along selected transects over rocky outcrop areas. This information once analyzed is to be compiled on overlays, in tables, and in report form to present a Biological and Geological Characterization of Tanner and Cortes Bank.

The general survey area, Figure 1-1, is 90 nautical miles SSW of the Los Angeles Harbor Entrance, 35 miles SW of San Clemente Island, and 100 miles west of San Diego. The area examined was from 32°25' to 32°55'N and 119°05' to 119°30'W. The four sub-areas A, B, E, and F surveyed during this cruise (from October 18 through October 31, 1978) are shown in detail on Figures 2-1 through 2-4.

Interstate Electronics Corporation was the prime contractor. Participating groups had the area of basic responsibility as follows:

1. Interstate Electronics Corporation, Oceanic Engineering Division (Interstate) had the responsibility to provide overall program and logistics management, coordination and liaison, survey direction, support and documentation of operations, preparation and direction of biological observers, photographic equipment, integration and analysis of biological data, preparation of charts and operations report, and submittal of data to BLM.

2. General Oceanographics Inc. (GOI) was responsible for operation and maintenance of the survey vessel Seamark and Nekton submersible, Stowage of supplies, securing of equipment, fueling, provisioning, bunking and messing, communications, deck machinery operation, safety of ship and all personnel aboard, ultimate decision on operations plan, modifications at sea, and submittal of a copy of the cruise log to Interstate.

3. Navigation Services, Incorporated (NSI) provided equipment installation, operation and maintenance for precision onsite navigation with the Argo and Mini-ranger systems, and will provide post plots of submersible tracks, output of range data and submittal of logs to Interstate.

Table 1-1 is a listing, by affiliation of the personnel involved.

Table 1-1. PARTICIPANTS: PHASE II SUBMERSIBLE OBSERVATIONS CRUISE 1
18 OCTOBER 1978 THROUGH 31 OCTOBER 1978

Interstate Electronics Corporation

Oceanic Engineering Division
707 E. Vermont Ave. P.O. Box 3117
Anaheim, California 92803
(714) 772-2811 (213) 626-9422

Shipboard Party	Function	Participation
W. Merselis	Program Manager	Duration
D. Harden	Biological Observer	10-27 to 10-31
A. Lissner	Biological Observer	Duration
K. Stoddard	Biological Observer	Duration
J. Ambrosius	Technician Support	10-23 to 10-31
R. Kendall	Equipment Test	10-18 to 10-19
Consultants		
R. Grigg	Biological Observer	10-18 to 10-27
J. Word	Biological Observer	10-18 to 10-27
Shore Support		
F. McFarlane	Equipment Support	10-18 to 10-31

Navigation Services Inc.
1600 Callens Road P.O. Box 820
Ventura, California 93001
(805) 644-7405

J. Cooley	Navigator	Duration
F. Jerkovich	Navigator	Duration

General Oceanographics Inc.
11578 Sorrento Valley Rd. Suite 25
San Diego, California 92121
(714) 452-9540

R. Wyer et al.	Ships Captian/Crew	Duration
R. Olson	Chief Pilot	Duration
J. O'Donnell	Pilot	Duration
P. Traphagen	Pilot	Duration
R. Horton	Pilot	10-18 to 10-23

Department of the Interior
Bureau of Land Management
Outer Continental Shelf Office
300 N. Los Angeles St. Room 7127
Los Angeles, California 90053
(213) 688-7104

Shipboard Observer		
R. Wilhelmsen	Technical Program Manager	10-18 to 10-23

Section 1

INTRODUCTION

The goal of the second phase of the biological and geological reconnaissance program was to place scientific observers in a submersible close to the sea floor to observe, record and photograph detailed information for interpretations of community structure and identification of dominant species and geology along selected transects over rocky outcrop areas. This information once analyzed is to be compiled on overlays, in tables, in edited movies, and in report form to present a biological and geological characterization of Tanner and Cortes Bank.

The general survey area, Figure 1-1, is 90 nautical miles SSW of the Los Angeles Harbor Entrance, 35 nautical miles SW of San Clemente Island, and 100 nautical miles west of San Diego. The area examined was from 32°25' to 32°55'N Latitude and 119°05' to 119°30'W Longitude. The six sub-areas A, B, C, E, F, and G surveyed during submersible operations #2 (November 3 through 12 and November 15 through 20, 1978) are shown in detail on Figures 2-1 through 2-6.

Interstate Electronics Corporation was the prime contractor. Participating groups had the area of basic responsibility as follows:

1. Interstate Electronics Corporation, Oceanic Engineering Division (Interstate) had the responsibility to provide overall program and logistics management, coordination and liaison, survey direction, support and documentation of operations, preparation and direction of biological observers, photographic and movie equipment, integration and analysis of biological data, preparation of charts and operations report, and submittal of data to BLM.

2. General Oceanographics Inc. (GOI) was responsible for operation and maintenance of the survey vessel Seamark and Nekton submersible, stowage of supplies, securing of equipment, fueling, provisioning, bunking and messing, communications, deck machinery operation, safety of ship and all personnel aboard, ultimate decision on operations plan, modifications at sea, and submittal of a copy of the cruise log to Interstate.

3. Navigation Services, Incorporated (NSI) provided equipment installation, operation and maintenance for precision onsite navigation with the Argo and Mini-ranger systems, and will provide post plots of submersible tracks, output of range data and submittal of logs to Interstate.

Table 1-1 is a listing, by affiliation of the personnel involved.

Table 1-1. PARTICIPANTS: PHASE II SUBMERSIBLE OPERATIONS #2
3 NOVEMBER THROUGH 12 AND 15 NOVEMBER THROUGH 20,1978

Interstate Electronics Corporation

Oceanic Engineering Division
707 E. Vermont Ave. P.O. Box 3117
Anaheim, California 92803
(714) 772-2811 (213) 626-9422

Shipboard Party	Function	Participation
A. Lissner	Party Chief, Biological Observer	Duration
K. Stoddard	Biological Observer	Duration
J. Ambrosius	Technician Support	Duration
R. Kendall	Movie Operations	11-3 to 11-12
Consultant		
J. Engle	Biological Observer	Duration
Shore Support		
W. Merselis	Program Manager	Duration
F. McFarlane	Equipment Support	Duration
N. Plutchak	Chief Scientist	Duration

Navigation Services Inc.
1600 Callens Road P.O. Box 820
Ventura, California 93001
(805) 644-7405

J. Cooley	Navigator	Duration
F. Jerkovich	Navigator	11-3 to 11-12
T. Swann	Navigator	11-15 to 11-20

General Oceanographics Inc.
11578 Sorrento Valley Rd. Suite 25
San Diego, California 92121
(714) 452-9540

R. Worthington et al.	Ships Captain/Crew	11-15 to 11-20
R. Wyer et al.	Ships Captian/Crew	11-3 to 11-12
R. Olson	Chief Pilot	Duration
J. O'Donnell	Pilot	Duration
P. Traphagen	Pilot	Duration
M. Wilson	Pilot	11-3 to 11-7

Section 2

SURVEY OPERATIONS

2.1 INTRODUCTION

Dr. Andrew L. Lissner was the party chief responsible for the biological and photography portion of the program including planning, field survey direction, data collection, and plotting. He was supported and backed up by Mr. William B. Merselis, Mr. Ford McFarlane and Mr. Noel Plutchak in the Interstate Office.

The cruise was scheduled for ten days to include nine days of submersible operations. The purpose was to conduct a survey of the biological communities on rock outcrops in the six priority Tanner/Cortes Bank study areas, to make observations, T.V. and audio tape recorded records of required data, take color photographs of the bottom, to make movie dives in areas selected from submersible operations #1, and to select areas for additional movie dives based on information gathered during the present operation. Survey operations covered areas A,B,C,E,F, and G with transects layed out to maximize areal and depth diversity to be viewed by the observers.

The basic operations conducted were scientific observer/photography transect dives and movie dives. The dives were organized in terms of priority, and three dives per day were planned. Sea conditions, swell height and period and water clarity were important criteria in deciding the order of survey. The number of dives completed in a working day depended upon weather, maintenance, and the on-bottom time for prior dives that day, however, for most days, mechanical and electronic conditions proved to be the limiting factors that finally determined the number of dives and the transect distance covered. We normally worked at least a twelve-hour day and did obtain up to six hours of bottom time in a day. Although weather maps were monitored daily in an attempt to initiate submersible operations during a period of favorable weather and sea conditions, four days of delay were encountered due to adverse weather on November 4, 5, 10 and 11.

Interstate recognized the potential for equipment failure therefore spares and repair equipment were provided for nearly everything. Navigation, because of two systems, had its own backup as well as spares. In the event of an Argo navigation problem while on a dive the submersible could be positioned by the Mini Ranger, pinger, and detailed knowledge of the bathymetry.

The benthic camera system was backed up by a second complete system and spare parts carried on board the ship. Hand held 35 mm cameras and black and white video were used to supplement the benthic camera record and were also considered as backups so that failure of any one system would not result in loss of all data. Spare 35 mm cameras and video system were carried on board. Spare audio tape recorders were carried on board and rotated from dive to dive.

2.2 SUBMERSIBLE OPERATIONS

Five major activities were conducted prior to and during a submersible operation: dive preparation, observer preparation, submersible launch, transect activitiy, and submersible retrieval. In general these activities proceeded as follows:

- Dive Preparation. Positions were fixed and transect buoys placed at the predetermined end of the transect. The submersible was serviced, batteries charged, air filter changed, oxygen and air tanks replaced. Minor maintenance was also completed at this time. Tapes, film, camera setting, strobe setting, timing apparatus, backup equipment and materials were checked and serviced and the ship positioned for the dive.

- Observer Preparation. Simultaneous with dive preparation, the scientific observer prepared for the next dive. Preparation consisted of replaying tapes and discussing observations of prior dives. During this period observers studied the bathymetric chart for the next dive and discussed relevant features of the terrain and anticipated points of scientific interest which might be encountered.

- Submersible Launch. The SEAMARK was positioned at the predetermined start of the transect, the submersible was launched, and the pilot ballasted the submersible to the bottom. This procedure differed from submersible operations #1 since a start buoy was not placed, but resulted in the saving of one half hour per dive, one or two submersible navigation positions and did not decrease the accuracy of the survey.

- Transect Activities. The submersible traversed along the transect line. All survey activity was carried out as carefully as posssible along the lines specified. Data collected included automated and observer triggered photographs and black and white video of the benthos, and a tape recorded commentary on the community structure and organisms sighted. In addition other observations associated with community structure, size, density, topography and bottom type were noted.

- Movie Activities. Based on information obtained from earlier transect dives a marker buoy was placed at a predetermined position. The submersible traversed near the buoy and was positioned near features of biological and geological interest to enable Dr. Kendall to film characteristic areas using the movie camera. All filming was done through lateral-facing portholes with illumination provided by two 1,000 watt color-temperature controlled movie lights positioned on the submersible. The power source for the lights was a generator located on the surface in a Zodiac raft. During movie operations the submersible was tethered to the generator by the movie light cable. The movie lights were turned on or off at the request of the scientific cameraman. As a safety precaution the entire movie light and cable system could be released, freeing the submersible from any attachment. The entire operation was facilitated by three-way radio communications between the support vessel, Zodiac, and the submersible.

- Submersible Retrieval. When the submersible returned to the side of the ship basic maintenance was performed, batteries connected for recharging and expendables replaced. Exposed film and tapes were changed, cased, labeled, and indexed for storage and buoys reset for the next transect.

2.3 ACCOMPLISHMENTS

Biological observer and photography transects and movie dives planned for the second phase of the submersible operations were successfully accomplished although mechanical and weather problems prevented the completion of three movie dives and one transect in area F and area D. During the operations we were unable to accomplish three dives every day as planned, but because we were able to extend the length of some dives, 41,850 (22.6 N.M.) of seafloor transects were accomplished in 15 dives. Figures 2-1 thru 2-6 of areas A,B,C,E,F, and G show the location of the individual transects and movie dives. Table 2-1 contains the details of each dive such as date, location, observer, depth and information gathered. Appendix B is a copy of the Engineering Notebook log sheet records of each days activity.

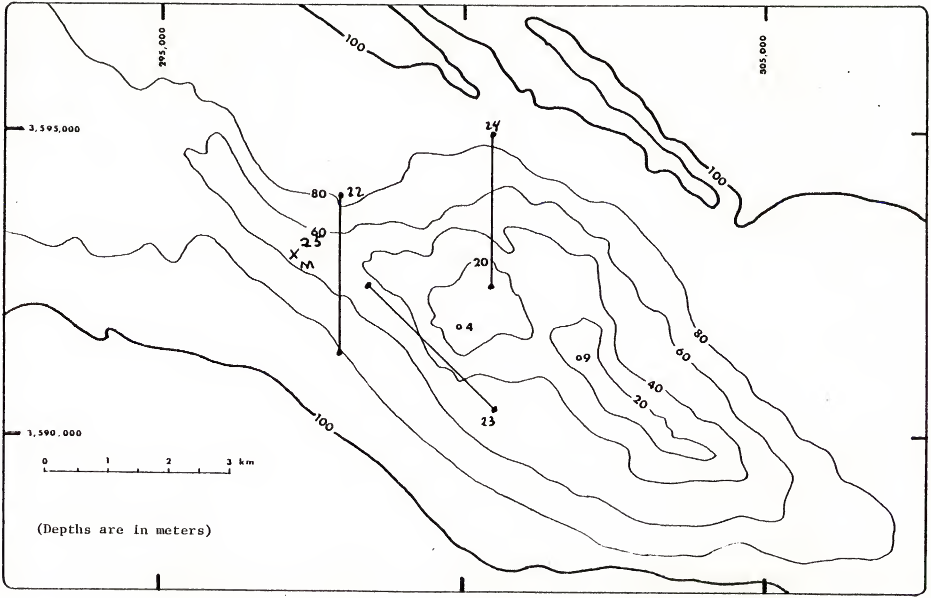

Figure 2-1 Submersible Transects Bishop Rock, Area "A"

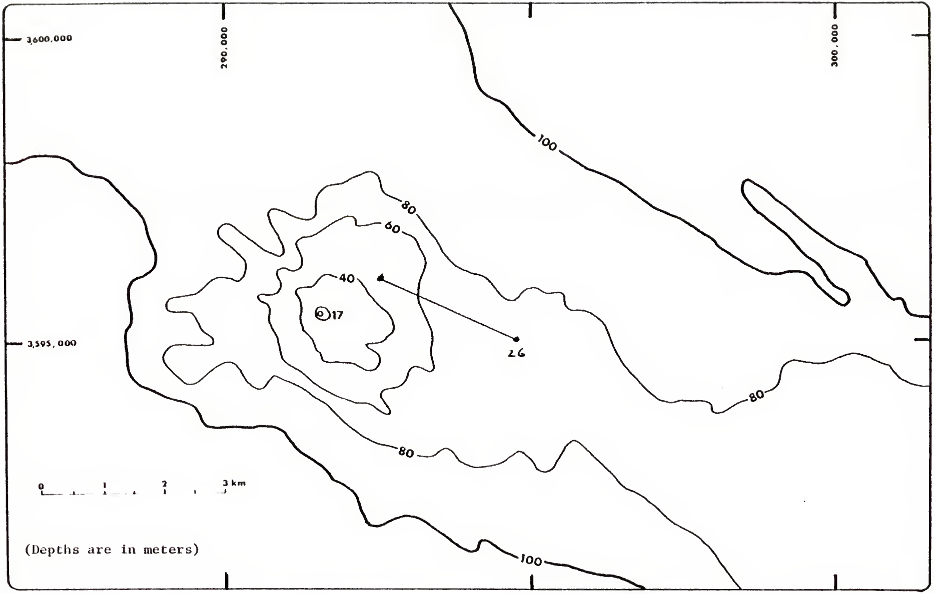

Figure 2-2 Submersible Transects Nine-Fathom Reef, Area "B"

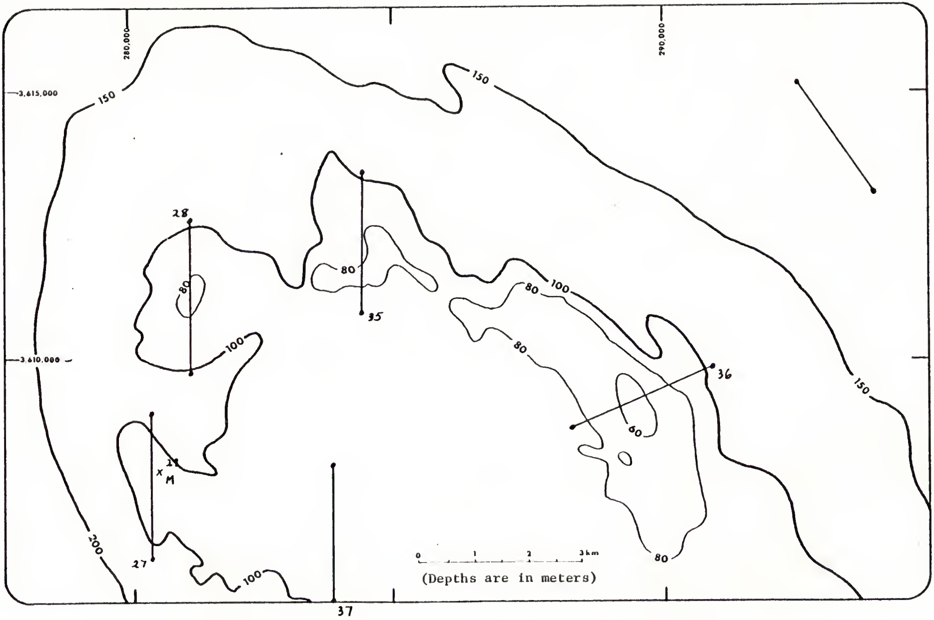

Figure 2-3 Submersible Transects Northwest Cortes Bank, Area "C"

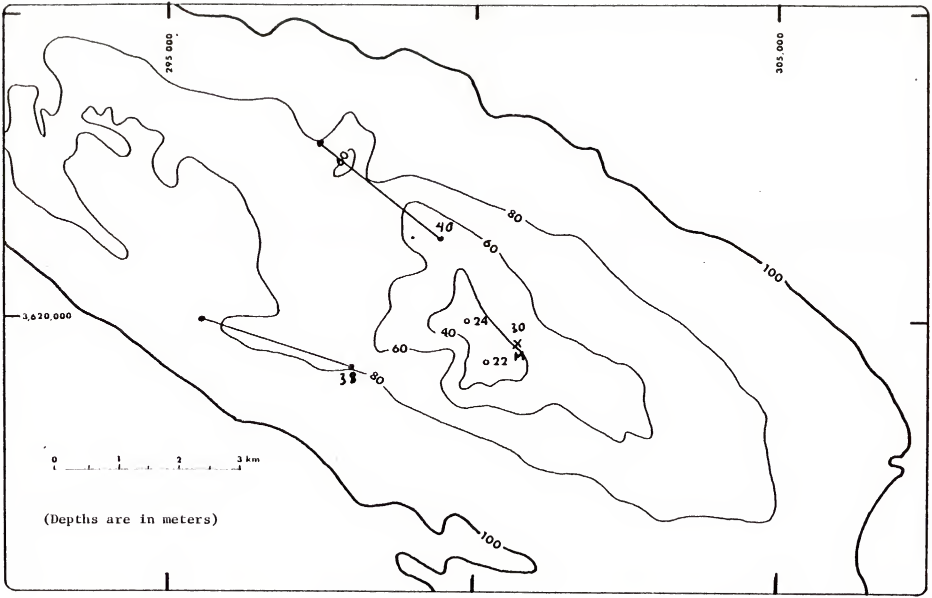

Figure 2-4 Submersible Transects Central Tanner Bank, Area "E"

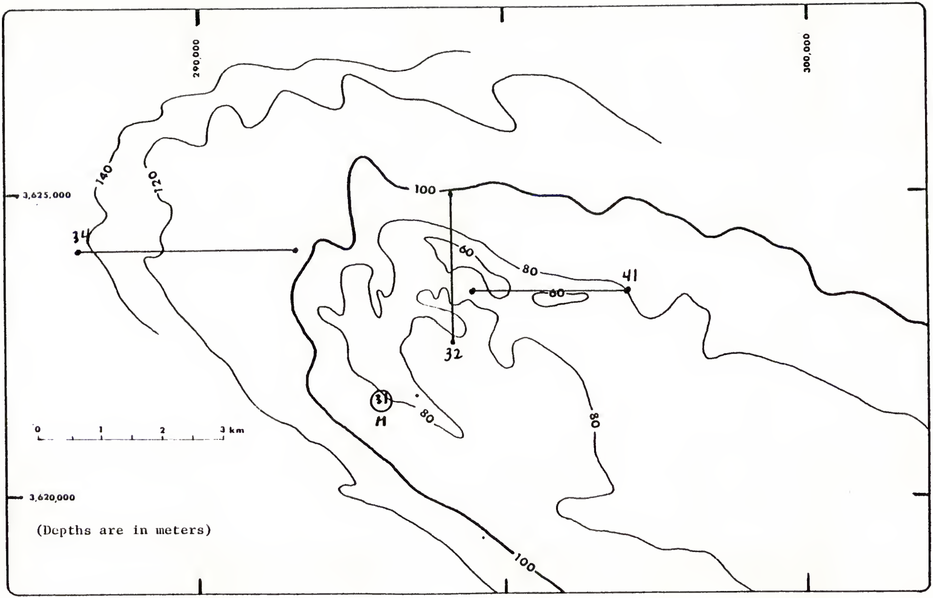

Figure 2-5 Submersible Transects Northwest Tanner Bank, Area "F"

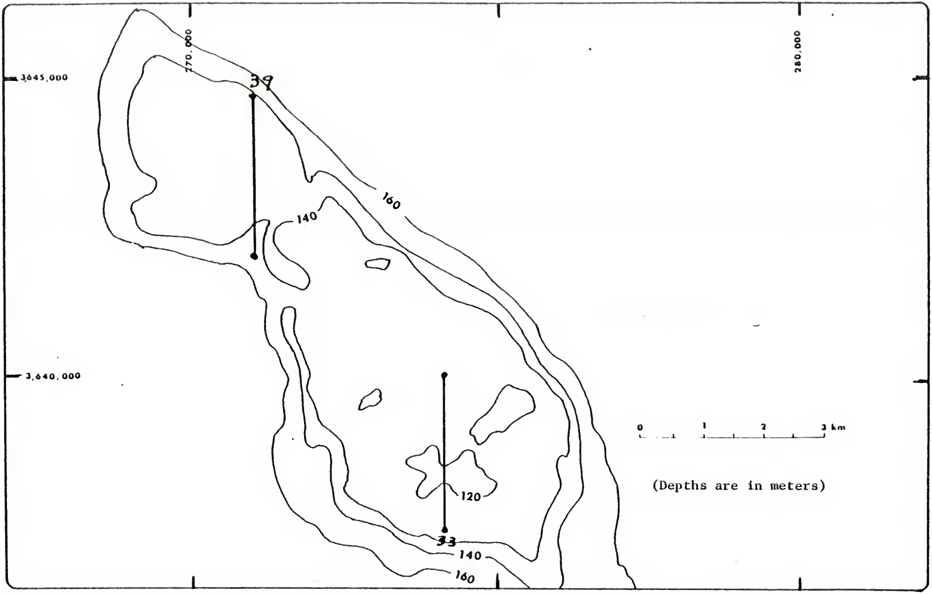

Figure 2-6 Submersible Transects Santa Rosa Ridge, Area "G"

TABLE 2-1. SURVEY ACCOMPLISHMENTS

Date	Dive Number	Location/ Observer	Length/ Meters	Depth Start	Meters Shallow	End	Audio Tapes (Sides)	Video Tapes	Benthos Camera Record	Hand-Held Photographs	UTM 11 Start Position X	UTM 11 Start Position Y	UTM 11 End Position X	UTM 11 End Position Y
Cruise 1														
11/4	Inoperable weather conditions. No dives.													
11/5	Inoperable weather conditions. No dives.													
11/6	22	A/ Stoddard	2500	78	49	80	2	2	1	10	298,000	3,594,000	298,000	3,591,500
	23	A/ Engle	2800	54	20	55	2	2	1	5	300,500	3,590,500	298,500	3,592,500
	24	A/ Lissner	2500	85	9	9	2	2	1	12	300,500	3,595,000	300,500	3,593,500
11/7	25	A/ Kendall	*	72	*	*	*	*	*	*	297,400	3,593,500	*	*
	26	B/ Stoddard	2700	79	46	46	2	2	1	2	295,000	3,595,000	292,500	3,596,000
11/8	27	C/ Engle	2700	122	79	112	3	2	1	26	280,500	3,601,300	280,500	3,604,000
	28	C/ Lissner	2900	118	76	94	2	2	1	5	281,300	3,607,600	281,300	3,604,700
	29	C/ Kendall	*	97	*	*	*	*	*	*	280,679	3,602,892	*	*
11/9	30	E/ Kendall	*	33	29	*	*	*	*	*	300,800	3,619,450	*	*
	31	F/ Kendall	*	83	83	90	*	*	*	*	293,123	3,621,247	*	*
	32	F/ Stoddard	2500	84	50	105	3	2	1	5	294,200	3,622,500	294,200	3,625,000
11/10	Inoperable weather conditions. No dives.													
11/11	Inoperable weather conditions. No dives.													
Cruise 2														
11/16	33	G/ Engle	2500	129	102	112	2	2	1	35	274,200	3,637,600	274,200	3,640,100
11/17	34	F/ Stoddard	2750	143	100	100	2	3	1	11	287,750	3,624,000	291,500	3,624,000
	35	C/ Lissner	2500	87	40	103	2	2	1	20	284,400	3,606,000	284,400	3,608,500
	36	C/ Engle	2800	101	59	84	2	2	1	17	290,900	4,604,800	288,300	3,603,750
11/18	37	C/ Stoddard	2500	100	82	85	2	2	1	14	283,800	3,600,500	238,800	3,603,000
	38	E/ Lissner	2700	69	61	70	2	2	1	7	298,000	3,619,100	295,500	3,619,900
11/19	39	G/ Engle	2500	121	94	136	2	2	1	10	271,200	3,642,100	271,200	3,644,600
	40	E/ Stoddard	2500	54	54	71	2	2	1	10	299,500	3,621,250	297,500	3,622,750
	41	F/ Lissner	2500	85	61	76	2	2	1	9	297,000	3,623,300	294,500	3,623,300
Total	16+4*		41,850 (22.6 N.M.)				34	33	16	198				

* Movie dive.

2.4 SUMMARY OF THE DAILY LOG, PROBLEMS AND SOLUTIONS

CRUISE 1

11/3/78 Two movie test dives performed by Dr. R. Kendall near Coronado Escarpment; observation and technical assistance by Interstate Chief Scientist N. Plutchak. During first dive one movie light detached requiring the submersible to surface for reattachment. Second movie dive was successful, all systems functioned properly. SEAMARK returned to San Diego to drop off N. Plutchak and load additional equipment and personnel.

Interstate personnel Dr. A. Lissner, Dr. R. Kendall, K. Stoddard, J. Ambrosius, consultant J. Engle, BLM representative Dr. R. Gillard, and GOI and NSI personnel mobilized and boarded SEAMARK for departure to Bishop Rock Area A.

Scientific observers confer during transit.

11/4/78 Day lost due to weather.

0900 - Wind to 20 knots, swell 5-8 feet at 6 second intervals.
1230 - Wind to 20 knots, maneuvering near transect site.
1400 - Weather unchanged, departed for San Clemente Island to weather.

11/5/78 Returned to Bishop Rock area. Day lost due to weather.

0530 - Wind NW to 15 knots, swell 6-8 feet, occasional to 10 feet.
0615 - Departed for NW Cortes (Area C) to determine if sea conditions were improved near deeper water.
0730 - Near Area C, weather unchanged, departed for San Clemente Island to anchor.

11/6/78 Video Sciences underwater T.V. system not operational and could not be repaired. The observer-held video camera was installed and was used during the submersible operations.

- Transect Dives 22 and 23 completed near Bishop Rock and end buoys released.

- Transect Dive 24 completed near Bishop Rock, end buoy could not be released because of shallow water and was retrieved by hand.

11/7/78 Shuttle boat Rio Rita arrived and departed with GOI Vice President M. Wilson, and BLM representative Dr. B. Gillard.

Movie dive (25) initiated near Bishop Rock (Area A). Movie light detached from submersible and was reattached by Zodiac crew at surface. Dive started again and was terminated after 5 minutes movie filming time due to electrical short in movie lights. End buoy was retrieved by hand.

B. Kendall repaired movie system during afternoon.

U.S.S. PIGEON anchored on dive 26 end position requiring re-positioning of transect.

- Transect Dive 26 completed near Nine Fathom Reef (Area B) and end buoy released.

11/8/78 0430 Inoperable weather conditions near Cortes Bank. Departed for NW Cortes (Area C) to attempt transects in deeper water.

- Transect Dive 29 completed at NW Cortes.

11/9/78 Movie Dives 30 and 31 completed at Tanner Bank (Areas E and F).

- Transect Dive 32 completed at Tanner Bank (Area F) and Buoy released.

11/10/78 Day lost due to weather.

0930 - Near Bishop Rock (Area A) wind 20 knots, swell to 10 feet. Departed for NW Cortes to determine if sea conditions were improved near deeper water.
1100 - Weather conditions unchanged.
1930 - Returned to Tanner Bank to wait for improved weather.

11/11/78 Day lost due to weather.

0830 - End buoy placed for transect dive 33. Wind to 25 knots, rain squall winds to 35 knots.
1019 - Wind to 20 knots, end buoy retrieved by hand.
1300 - Rain squalls to 35-40 knots. Consulted with B. Merselis and decided to head towards San Diego unless weather improved.
1330 - Weather not significantly improved.
1900 - Continued towards San Diego.

11/12/78 0140 - Arrived GOI dock, San Diego.
0600 - Began demobilization: All data and one benthos camera and strobe returned to Interstate for initial analysis and testing, respectively.

Cruise 2

11/15/78 Mobilization and departure from San Diego to Santa Rosa Ridge.

11/16/78 0600 - NSI mini-ranger system could not be calibrated.
0900 - Attempted repairs to mini-ranger.
System not repairable, helicopter dispatched with replacement unit.

Decided to initiate Transect Dive 33 in Area G using Loran and Argo navigation. No end buoy placed, submersible was positioned at start point and followed the predetermined compass heading.
1009 - Leak through Marsh marine penetrator caused submersible to resurface for repair.

1106 - Continued Dive 33.
1243 - Helicopter drop complete, installation of replacement mini-ranger initiated.
1328 - Transect Dive 33 completed at Santa Rosa Ridge.
1400 - Submersible fuse malfunction, later replaced.
1600 - Mini-ranger could not be calibrated causing termination of day's operations.

11/17/78 1645 - Mini-ranger calibrated.

- Transect Dives 34 and 35 completed at Tanner Bank (Area F) and NW Cortes, respectively, and end buoys released.

- Transect Dive 36 completed at NW Cortes, end buoy retrieved mannually due to difficulty of locating pinger in the dark.

- Interstate and GOI advised that submersible operations would be extended.

11/18/78 0624 - Initiated Transect Dive 37.
0625 - Leak in submersible tail seal made it necessary to surface and repair on deck.
0813 - Continued Dive 37.
1020 - Transect Dive 37 completed at NW Cortes and end buoy released.
- Completed Dive 38 at Tanner Bank (Area E) and end buoy released.

11/19/78 Transect Dive 39 completed at Santa Rosa Ridge (Area G), and dives 40 and 41 completed at Tanner Bank (Areas E and F).

1700 - Departed for San Diego.

11/20/78 0600 - Arrived GOI dock, San Diego.
0800 - Demobilization complete: offloaded all equipment, data, and personnel.

Department of the Interior

Bureau of Land Management
Outer Continental Shelf Office
300 N. Los Angeles St. Room 7127
Los Angeles, California 90053
(213) 688-7104

Shipboard Observer

B. Gillard	BLM Observer/ Representative	11-3 to 11-7

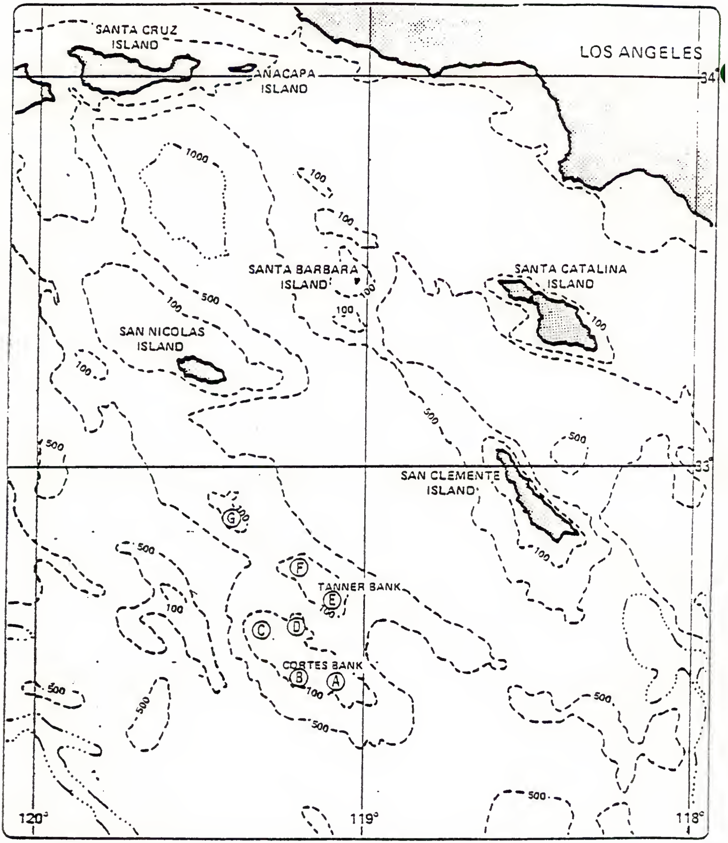

Figure 1-1. Location Map of Tanner-Cortes Study Area

TABLE 1-2. PHASE II EQUIPMENT LIST

Supplier	Equipment
Interstate Electronics Corp.	Benthos Underwater Camera System and Strobe Movie Camera, Lights, Cables and Generator Hand Held 35 mm Camera Video Tape Recording System and Backup System Tape Recorders for Data Logging Film, Tapes, Supplies
General Oceanographics	Seamark Nekton Submersible All Normal Spares and Supplies
Navigation Services, Inc.	Cubic Argo Navigation System Model DM-54 Motorola Mini Ranger III - Radio Positioning System
Ocean Contractors	200 Watt-Second Flash, Timer, Power Supply Battery Charger 2, 1,000 Watt Burns and Sow Movie Light System Color-Tran Light Transformer for Movies.

1.2.3 System Test

Even though all of the equipment was tested in the Electronics Laboratory and work shop at GOI, Interstate had planned for both a dockside test during mobilization and a day of test dives. During the dockside test the first Ocean Contractors 200-Watt-second flash tube failed when immersed in sea water. Other equipment checked out correctly. On October 19 Seamark departed San Diego for a test area near the Coronado Canyon where we anticipated clear water and adequate bottom conditions to test the equipment.

At the test site the NSI Navigation equipment was performing well. The Ocean Contractors spare 200 watt-second flash, benthos camera, Video Sciences underwater T.V. and Interstate audio tape recording systems were mounted for the first test dive. A pinger was mounted on a line marker stand and lowered to the sea floor and buoyed off. Dr. Kendall with submersible pilot Rick Olson made the dive to check out each system. Due to high internal motor noise, underwater sound transmission and an infrequent need for communication between the submarine and the ship it was deemed no necessary to tape record all communications to and from the submarine.

During the first test dive the 200 watt-second flash failed, but the camera, T.V. System, audio system and pinger tracking system all performed satisfactorily. The other components, camera timer, power supply, battery charger were functional and were left on board as a backup for the Benthos flash unit.

An order placed for a backup Benthos flash unit which was leased from Intersea Research Corporation and sent to the ship on October 23. Because the video recording system cut out intermittently, probably due to humidity in the submarine, we tested and planned to use the back up recording unit for future dives until the first unit could be serviced.

The second test dive was started to test the movie equipment. Lights were attached and all equipment loaded into the submarine and surface support zodiak. The cable was streamed into the water and support floats attached in preparation to make the test dive. Within minutes after personnel were in the submarine but before it was launched the wind suddenly changed from the light airs from the east to strong wind from the southeast; within five minutes it was blowing 22 knots steady with gusts over 30 knots and appeared to be building rapidly. As the sea began to build it became difficult and dangerous to handle the equipment and at 1510 hours it was decided to cancel the movie test dive and return to San Diego to off load Dr. Kendall and to order a back up Benthos strobe. During the few minutes at dock side final adjustments to the navigation antenna were made, a broken timer resistor wire in the Benthos strobe unit were repaired and the weather conditions checked. The fast storm was expected to move through the Tanner-Cortes area. The forecast was for good weather. Therefore at 1930 hours the ship departed for Tanner Bank.

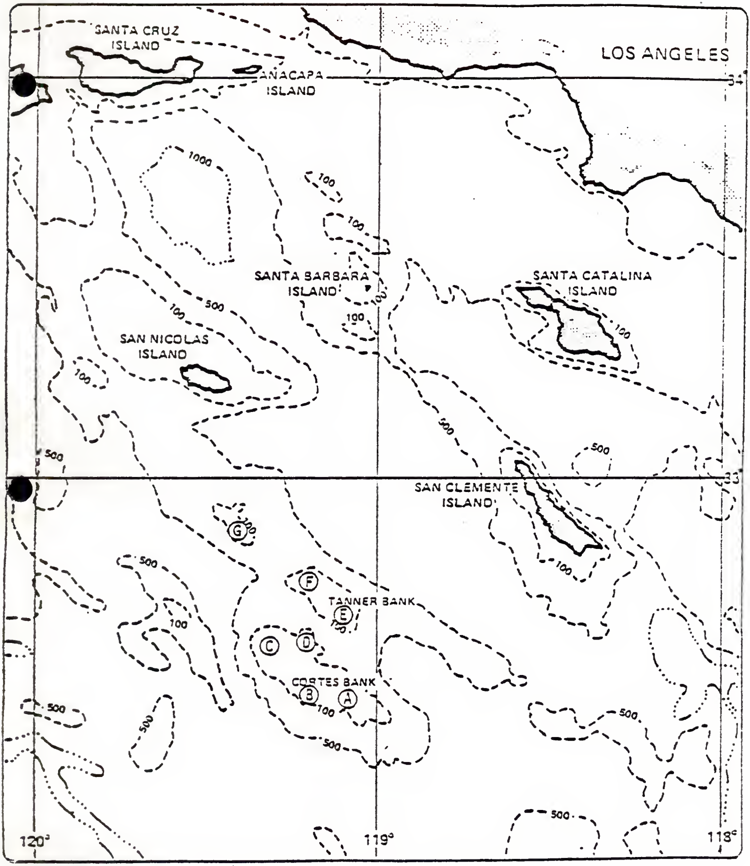

Figure 1-1. Location Map of Tanner Cortes Study Area

1.2 MOBILIZATION

In any survey all the initial planning comes together during mobilization. Our mobilization, October 17 and 18, included preparation of the scientific observers, testing of the equipment, designing and constructing mounting brackets penetrators and new port plates for equipment to be placed on or in the submersible and finally testing the total system.

1.2.1 Scientific Observer Preparation

Scientific observer preparation was accomplished by review and discussion of a species reference card file with photographs prepared by Interstate. The reference file was based on species lists available from earlier studies at Tanner Cortes, and information solicited from experts in industry and the academic community. Materials included in the file were photographs, species names, depth ranges, identifying characteristics, ecological relationships, community associations, and other information to aid observers in pre-dive preparation and post-dive debriefing. A submersible observers manual prepared by Interstate (Appendix A) was reviewed by all participants.

Ship-board preparation involved explanations, descriptions and continual updating of the reference file based on observer recommendations and observations made during the survey. The success of the operation can be attributed to the continual exchange of information between observers, and the utility of the species reference file during post-dive debriefings and transcriptions by the observers.

1.2.2 Equipment Preparation

Equipment was mobilized and bench tested and was delivered to the ship on October 17. Final mobilization, modifications and installations on the submersible were made on October 18.

Because the proper operation of each piece of equipment was important to obtain quality data, all systems were checked prior to loading and then again on board the ship at the pier. After successful checkout a short shakedown cruise was made October 19, off San Diego to insure that all systems were functioning properly while the submersible was underway.

Table 1-2 is a list of the equipment tested and section 1.2.3 covers the system testing.

1.2 MOBILIZATION

In any survey all the initial planning comes together during mobilization. Our mobilization, November 3 and 15, included preparation of the scientific observers, testing of the equipment including the movie system and finally testing the total system. Mobilization for submersible operations #2 was minimal since the majority of the equipment used during submersible operations #1 was stowed on board the SEAMARK between cruises, and systems and procedures for the two operations were nearly identical.

1.2.1 Scientific Observer Preparation

Scientific observer preparation was accomplished by review and discussion of a species reference card file with photographs prepared by Interstate. The reference file was based on species lists available from earlier studies at Tanner-Cortes Banks, and information solicited from experts in industry, government, and the academic community. Materials included in the file were photographs, species names, depth ranges, identifying characteristics, ecological relationships, community associations, and other information to aid observers in pre-dive preparation and post-dive debriefing. A submersible observers manual prepared by Interstate (Appendix A) was reviewed by all participants.

Ship-board preparation involved review of notes, observations, and maps from submersible operations #1; and explanations, descriptions and continual updating of the reference file based on observer recommendations and observations made during the survey. The success of the operation can be attributed to the continual exchange of information between observers, and the utility of the species reference file during post-dive debriefings and transcriptions by the observers.

1.2.2 Equipment Preparation

Additional equipment for submersible operations #2 was mobilized and bench tested and was delivered to the ship on November 3 and November 15.

Because the proper operation of each piece of equipment was important to obtain quality data, all systems were checked prior to loading and then again on board the ship at the pier. After successful checkout a short shakedown cruise for the movie dive procedures and equipment was made November 3, off San Diego to insure that all systems were functioning properly while the submersible was underway.

Table 1-2 is a list of the equipment tested and section 1.2.3 covers the system testing.

TABLE 1-2. PHASE II EQUIPMENT LIST

Supplier	Equipment
Interstate Electronics Corp.	Benthos Underwater Camera System and Strobe and Complete Backup Camera/Strobe System, Movie Camera, Lights, Cables, and Hand Held 35 mm Camera Video Tape Recording System and Backup System Tape Recorders for Data Logging Film, Tapes, Supplies
General Oceanographics	Seamark Nekton Submersible All Normal Spares and Supplies
Navigation Services, Inc.	Cubic Argo Navigation System Model DM-54 Motorola Mini Ranger III - Radio Positioning System
Ocean Contractors	2, 1,000 Watt Burns and Sawyer Movie Light System Color-Tran Light Transformer for Movies.

1.2.3 System Testing

Even though most of the systems and equipment had been previously tested and proved to be functioning correctly during submersible operations #1, Interstate decided to conduct one additional day of movie test dives to insure proper performance before submersible operations #2.

Dr. Kendall made two movie test dives on November 3 near the Coronado Escarpment. During the first test dive one of the movie lights detached from the submersible and it was necessary to return to the surface in order to reattach the light. During the second test dive all systems and equipment functioned properly and a test roll was filmed first with the movie lights on and finally with only the submersible lights for illumination.

After the SEAMARK returned to San Diego following the movie test dives, the benthos camera system and the video sciences underwater T.V. were mounted on the submersible and retested. All systems were functioning properly, the weather forecast was favorable and it was decided to depart for Cortes Bank at 2300 on November 3.

Appendix H

SPECIES OCCURRENCES AT TANNER AND CORTES BANK AND SANTA ROSA RIDGE AS RECORDED BY SUBMERSIBLE OBSERVERS (O), VIDEO CAMERA (V), AND BENTHOS CAMERA (B)

* RECORDS ARE IDENTIFICATIONS MADE BY TAXONOMIC CONSULTANTS

Appendix H

SPECIES OCCURRENCES AT TANNER AND CORTES BANK
AND SANTA ROSA RIDGE AS RECORDED BY SUBMERSIBLE
OBSERVERS (O), VIDEO CAMERA (V), AND BENTHOS CAMERA (B)
* RECORDS ARE IDENTIFICATIONS MADE BY TAXONOMIC CONSULTANTS

SPECIES	AREA					
	A	B	C	E	F	G
ALGAE						
CHLOROPHYTA						
Bryopsis sp.				O		
Codium cuneatum	O,B	B*				
Codium fragile	O					
Codium sp.(encrusting)	O,B	O,V,B	O,V,B	O,V,B	O,V	
Codium sp. (erect)		B				
PHAEOPHYTA						
Agarum fimbriatum	O,V,B	O,V,B		O,V,B	B	
Cystoseira sp.	O,V,B	O,V,B		V		
Desmarestia latifrons	B*					
Dictyopteris undulata	O,V,B	O,V,B		V		
Dictyota/Pachydictyon	O,B	O,B				
Eisenia arborea	O,V,B	O,V,B		O,B		
Laminaria dentigera	O	O		O		
Laminaria farlowii	O,V,B	O,V,B	O,V	O,V,B	O,B	
Macrocystis pyrifera	O					
Pterygophora californica	O,B*					
Zonaria farlowii	O,V,B	O,V,B	V,B	O,B	B	
RHODOPHYTA						
Amphiroa sp.		O				
Calliarthron cheilosporides	O,V,B	O,V,B	O	O,V,B	O,B	
"Bossiella"	O,V,B	O,V,B	B	B		
Botryocladia pseudodichotoma	O,B	O,B		O,B		
Corallina sp.	O,B	O,B				
Gelidium nudifrons	O,B*					
Gelidium sp.	O,V,B	O,V		O		
Gigartina sp.	O	O		O		
Maripelta rotata	O,V,B	O,V,B	O,B	O,B	O,B	
Microcladia sp.	O	O				
"Nienburgia"				B*		
"Opuntiella"	O	O		O	B	
Phycodrys sp.		B*				
Plocamium sp.	O,B	O,B				
Prionitis sp.	O	O				
Rhodymenia californica				B*		

SPECIES OCCURRENCES AT TANNER AND CORTES BANK
AND SANTA ROSA RIDGE AS RECORDED BY SUBMERSIBLE
OBSERVERS (O), VIDEO CAMERA (V), AND BENTHOS CAMERA (B)
* RECORDS ARE IDENTIFICATIONS MADE BY TAXONOMIC CONSULTANTS

	AREA					
SPECIES	A	B	C	E	F	G
Foliose reds (including "Iridaea")	O,V,B	O,V,B	O,B	O,B	O,B	
dicho-flabellate reds (including Rhodymenia, "Stenogramme", "Fryeella", "Callophyllis")	O,V,B	O,V,B	O,B	O,B	O,B	
Encrusting coralline algae	O,V,B	O,V,B	O,V,B	O,V,B	O,V,B	O,V,B
TRACHEOPHYTA (ANGIOSPERMAE)						
"Zostera marina"				O		
INVERTEBRATA						
ANNELIDA						
POLYCHAETA						
Nereidae	O					
Protula superba		O,B	O,B	O,B	O,B	O,V,B
Salmacina sp.	O	O		O		
Sabellidae	O	O		O		
Serpulidae			O,B	O,B	O,B	B
Epitokes			O			
ARTHROPODA						
CRUSTACEA						
Balanus nefrens (on Allopora)	O					
Balanus tintinnabulum				O		
Balanus sp.					B*	
Cancer sp.			O			
Chorilia longipes			B*			
"Herbstia"	B*					
Loxorhynchus crispatus		B*	O,V,B*		O,V	
Munida sp.					B*	
Mursia sp.			O			
Pandalus sp.	B*			O		
Pandalus danae		O	O			
Pandalus platyceras		O				
Panuliris interruptus		O				
Galatheidea	O		O		O,B	O
Paguridae					O,B	
BRACHIOPODA						
Laqueus californica	O	O,B	O,V,B		O,B	O
Terebratalia transversa	B	O	O,B	O,B	O,B	

SPECIES OCCURRENCES AT TANNER AND CORTES BANK
AND SANTA ROSA RIDGE AS RECORDED BY SUBMERSIBLE
OBSERVERS (O), VIDEO CAMERA (V), AND BENTHOS CAMERA (B)
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SPECIES	AREA					
	A	B	C	E	F	G
Hymenamphiastra cyanocrypta	O				O	
"*Leucetta*"		O		B*	O,B*	B*
Leucilla nuttingi				O		
"*Ophlitaspongia*"	O	O				
Plocamia sp.	O	O				
"*Spheciospongia*"		O	O	O		
"*Staurocalyptus*"		O	O,V,B	O,B*	O,V,B*	O,B*
Tethya aurantia	O,B	O,B		O,B		
Trikentrion sp.	O,B	O,B	O	O,B	O	
Calcareous sponges	O,B	O	B	O,B	O	B
Demospongia, red, orange, yellow, tan	O	O	O	O,B	O,B	B
Encrusting sponges	O,B	O,B	O,B	O	O,B	B
Hexactinellida	O	O,V,B	O	O,B	O,V,B	O,B
UROCHORDATA						
"*Aplidium/Archidostoma*"	B*					
Metandrocarpa taylori			B			
"*Pyura*"				B*		
"*Rhopalea*"	O,B	O,B	O,B*	O,B	O,B	
Trididemnum sp.	O			B*	B*	
Encrusting tunicates	O	O		O	O,B	O
PISCES						
AGNATHA						
Eptatretus stoutii			O			
CHONDRICHTHYES						
Cephaloscyllium ventriosum			O			
Hydrolagus colliei	O,V	O	O	O	O,V,B	O
Myliobatis californica	O			O		
Prionace glauca	O	O		O	O	
Raja stellulata					O	
Raja sp.				O		
Torpedo californica	O,V	O	O,V	O,V	O	
OSTEICHTHYES						
Agonidae					B*	
Agonopsis sp.	B*					
Alloclinus holderi	O,B	B*				
Heterostichus rostratus	B*					
Artedius sp.				B*		

SPECIES OCCURRENCES AT TANNER AND CORTES BANK
AND SANTA ROSA RIDGE AS RECORDED BY SUBMERSIBLE
OBSERVERS (O), VIDEO CAMERA (V), AND BENTHOS CAMERA (B)
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SPECIES	AREA					
	A	B	C	E	F	G
GASTROPODA						
Acmaea funiculata	B*	B*		B*		
Acmaea mitra				B*		
Acmaea sp.				B		
Acmaea sp.				B		
Anisodoris nobilis				O		
Antiplanes sp.						B*
Archidoris sp.	O					
Astraea gibberosa	O,B	O,B*	B*	O,B*	B*	
Astraea undosa	O			O		
Bursa sp.				O		
Cadlina sp.		O	O	O	O	
Calliostoma annulatum	O		O,B	B*	B*	
Calliostoma "gloriosum"	B*			B*		
Calliostoma variegatum/turbinum			B*			
Calliostoma sp.	O,B		O,B	O,B	O,B	O,B
Cidarina cidaris					B*	B*
Cypraea spadicea	O	O,B		O,B		
Epitonium sp.						B*
Flabellinopsis iodinea	O,B	O,B	O			
Fusitriton oregonensis						B*
Haliotis sp.	O			O		
Macrarene cookeana			B*	B*		
Megathura crenulata	O,B	O				
Muricidae			B*			
Muricidae/Cancellariidae						B*
Nassarius insculptus					B*	B*
Norrisia norrisii	O,B	O				
Puncturella cucullata			B*	B*	B*	
Tegula aureotincta	B*					
Tegula regina	O,B	O,B*		O,B*		
Tegula sp.				O,B	B	
Triopha carpenteri	O,B*	B			O	
Tritonia sp.				O,B	O,B	O
Trochidae		B*		B*		
Turridae			B*			B*
Dorid nudibranch	O			O	O	O
PORIFERA						
"Axocielita"	B*	B*	B*	B*		
"Clathrina"	O	B	O,V,B	O,V,B	O,V,B	
Haliclona sp.	O	O				

SPECIES OCCURRENCES AT TANNER AND CORTES BANK
AND SANTA ROSA RIDGE AS RECORDED BY SUBMERSIBLE
OBSERVERS (O), VIDEO CAMERA (V), AND BENTHOS CAMERA (B)
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SPECIES	AREA					
	A	B	C	E	F	G
Sebastes chlorostictus/rosenblatti	O	O	O	O,B	O,B	
Sebastes chrysomelas	B			O		
Sebastes constellatus	O,B	O,B	O,B	O,V,B	O,V,B	O
Sebastes dalli	O	O				
Sebastes elongatus			O	O	O,B	O,V,B
Sebastes "ensifer"					O	
Sebastes hopkinsi	O,V,B	O,V,B	O,V,B	O,V,B	O,V,B	O,V,B
Sebastes jordani				O		
Sebastes lentiginosus				O		
Sebastes levis	O	O,V	O,V	O,V	O,V	O
Sebastes macdonaldi	O	O,V	O,V	V	O,V	O,V
Sebastes miniatus	O		O,V		B*	
Sebastes mystinus	O,B	O,V,B	O,V	O,V,B	O,V	
Sebastes nigrocinctus						O
Sebastes ovalis	O	O,V	O,V	O	O,V	O
Sebastes paucispinis	O,V	O,V	O,V	O,V	O,V,B	O,V,B
Sebastes rosaceus	O,B	O,B	O,V,B	O,V,B	O,V,B	O,B
Sebastes ruberrimus				O	O	
Sebastes rubrivinctus	O	O	O,B	O,V	O,V	O
Sebastes saxicola	B*		B*			
Sebastes semicinctus						O
Sebastes serranoides	O,V,B	O,V	O,V,B	O,B	O,V,B	
Sebastes serriceps	O,B	O,V,B		O	O	
Sebastes umbrosus				O		
Sebastes sp.	O,B	O,B	O,B	V,B	O,B	B
Sebastomus spp.	O,V,B	O,V,B	O,V,B	O,V,B	O,V,B	O,V,B
Seriola dorsalis	O	O,B				
Stereolepis gigas	O	O		O		
Trachurus symmetricus	O	O		O	O	
Xeneretmus sp.			O			
Zalembius rosaceus		O		O		
Zaniolepis frenatus	B*		O,V	B*		B*
Zaniolepis sp.			O	O,B*	O,V	O,V,B
Flatfish, misc.	O	O	O	O,V	O,V	O
MAMMALIA						
Zalophus californianus	O	O		O	O	O

[redacted]

INTERSTATE ELECTRONICS CORPORATION

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