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1990 REFERENCE SITE SURVEY

SOUTHERN CALIFORNIA COASTAL WATER RESEARCH PROJECT AUTHORITY
7171 FENWICK LANE, WESTMINSTER, CALIFORNIA 92683

FINAL REPORT

1990 REFERENCE SITE SURVEY

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SUMMARY

In 1977 and 1985 SCCWRP conducted surveys of sediment characteristics and biological communities in southern California in order to provide reference information that could be used for comparison to data collected from areas affected by wastewater discharges. In the summer of 1990, seven areas previously sampled in 1977 and 1985 reference surveys were re-sampled. Three depths (30, 60, and 150 m) were sampled in each area. Since one station was abandoned due to kelp, a total of 20 stations were sampled. The 1990 survey was designed to update the information collected in the 1977 and 1985 surveys.

Sediment grain-size, organic carbon and nitrogen, nine trace metals, five DDT isomers, two PCB Aroclors, and 30 PAH compounds were measured in the surface sediment at each station.

The shelf sediments were predominantly sandy silt. Generally, the percent sand decreased and the percent clay increased as water depth increased. Off Imperial Beach there was an intrusion of coarse sand into deeper water. Since the concentrations of organic material, trace metals and organic contaminants were highly correlated with clay content, the concentration of these compounds increased with depth. The concentration of trace metals and organic contaminants in reference site sediments was generally very low. Contaminant concentrations were highest off Zuma Beach, the area nearest to Los Angeles. Except for silver, sediment contaminant concentrations measured in 1977, 1985 and 1990 were similar. The concentration of silver was an order of magnitude lower in 1985 than in 1977 or 1990.

Macrobenthos (> 1 mm), and trawl-caught megabenthic invertebrates and fish were collected at each site. Macrobenthic assemblages at 30 m were the most heterogeneous and were dominated by several species of amphipods. Sites at 60 m were usually dominated by the ophiuroid *Amphiodia urtica*, but large patches of the polychaete *Myriochele* sp M dominated a few sites. While the number of species, the number of individuals, and biomass were higher at 60 than at 30 or 150m, the difference was not significant. Sandy areas off Imperial Beach were inhabited by a very different macrobenthic assemblage.

Megabenthic assemblages at 30 m were dominated by the asteroid *Astropecten verilli*. At 60 m, the assemblages were dominated by the sea urchin *Lytechinus pictus* and by the prawn *Sicyonia ingentis*. Many species common on the basin slopes were collected at the 150 m sites. More megabenthic species were collected at 150 m than at the other depths.

Fish assemblages also changed over depth. The 30 m sites were dominated by

speckled and longfin sanddabs; the 60 m sites were dominated by Pacific and longfin sanddabs; and the 150 m sites were dominated by slender sole and plainfin midshipman. Numbers of fish species, individuals, and biomass increased with depth.

The reference assemblages sampled in 1977, 1985 and 1990 were similar. Only subtle differences in species composition and abundances were observed. However, numbers of species, individuals, and biomass per sample were usually lowest in 1985, which may reflect effects of the 1982-83 El Niño. Examination of data from the three Southern California Coastal Water Research Project (SCCWRP) surveys shows that the southern California mainland shelf is a stable habitat with little change over 13 years.

ACKNOWLEDGEMENTS

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Field collections were coordinated by Mr. Harold Stubbs, SCCWRP Marine Coordinator, with the assistance of Mr. Dario Diehl. Ship time was provided by the City of Los Angeles aboard the R/V *LA MER*, Captain Steve Kmeth; County Sanitation Districts of Los Angeles County aboard the R/V *OCEAN CENTINAL*, Captain Steve Gregson; and the City of San Diego aboard the R/V *MONITOR III*, Captain Jack Russell.

David Tsukada and Azra Khan (SCCWRP) analyzed sediment grain-size, TOC and TN. Marilyn Castillo and Azra Khan assisted in evaluation of sediment contaminant analysis. Trace metals and organic contaminants were analyzed at Global Geochemistry, Canoga Park, California.

The taxonomists who identified animals collected in grabs and trawl samples are listed in Appendix 3. Fred Stern from CSDLAC assisted with field sampling. Larry Cooper (SCCWRP) wrote computer programs for calculations of species diversity, evenness, and dominance. We are particularly grateful for the assistance and consultation of Dr. Bob Smith and his staff at EcoAnalysis, Ojai, California, for providing the ordination and classification analyses. Andrew Jirik, Valerie Raco, and Marilyn Castillo of SCCWRP assisted with preparation of this report. Elena Preston and Debbie Hallock produced the report.

I. INTRODUCTION

Fish and macroinvertebrate communities near major wastewater outfalls in southern California have been monitored for over twenty years. The objective of the monitoring is to determine the impact of the wastewater discharge on these communities. Since marine communities are variable both in space and time, the determination of impact is usually achieved by comparing conditions in the vicinity of the outfalls to conditions in "reference" areas, that is, areas believed to be free from impacts from human activities.

On three occasions SCCWRP has conducted surveys of sediment characteristics, contaminant levels, and biological conditions on the southern California mainland shelf in order to provide reference values for comparison to data collected from areas affected by wastewater discharge.

The first survey was conducted in 1977 (Word and Mearns 1979). Seventy benthic grab samples and 53 trawl samples were taken from 71 stations distributed at approximately 10-kilometer intervals between Point Conception and the Mexican Border. Samples were taken at a depth of approximately 60 meters because most of the major outfalls discharge at this depth. In 1985, 13 of the original 71 stations were reoccupied (Thompson *et al.* 1987). Samples were taken at 30, 60 and 150 meters in order to provide data for the range of depths sampled in the monitoring programs. The third SCCWRP reference survey was conducted in 1990.

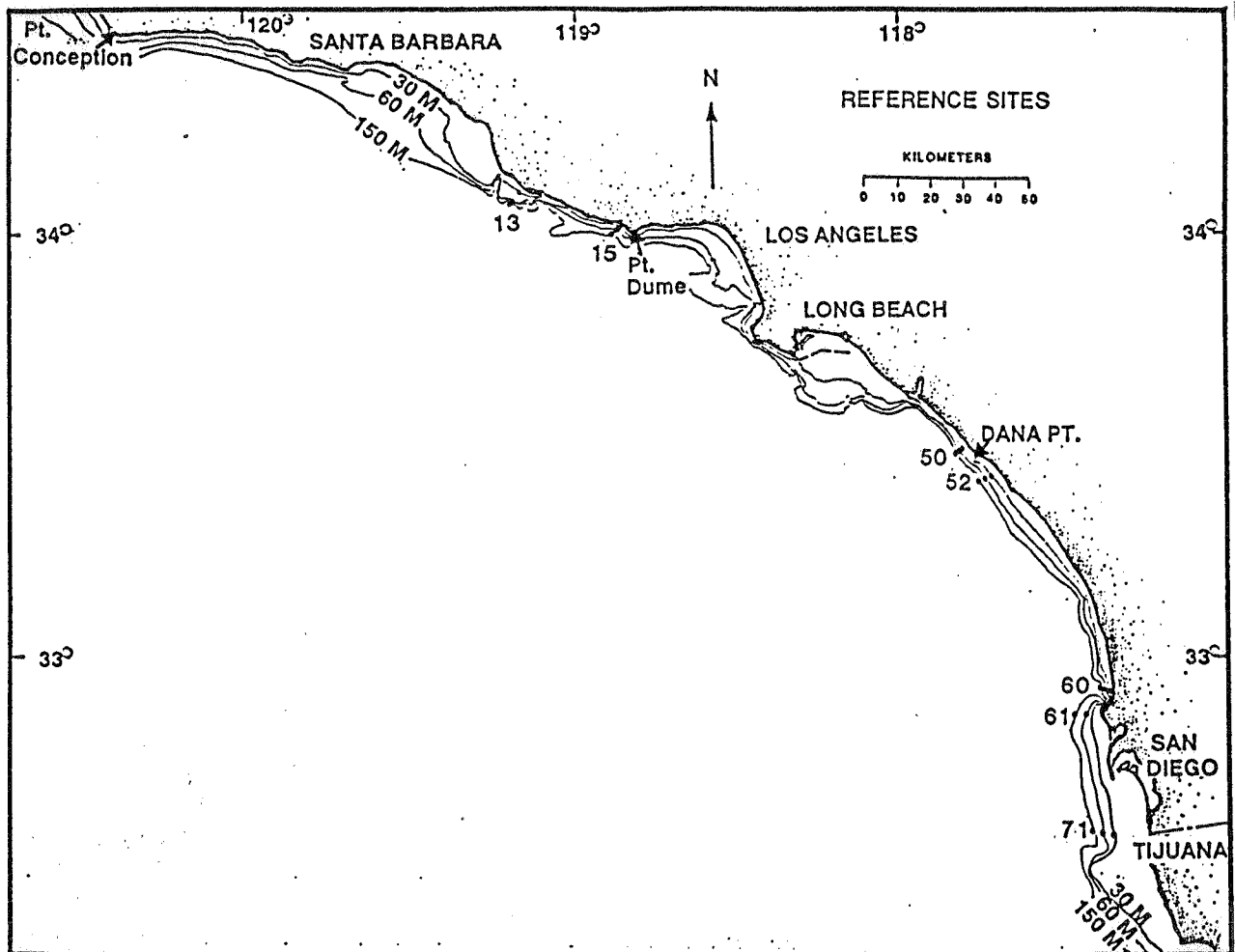
This report contains the results of the 1990 survey. It also updates the preceding reports, with several differences. New in the 1990 Reference Survey are estimates of reference values for near-bottom salinity; total nitrogen, iron, and manganese ; and nine polynuclear aromatic hydrocarbon (PAHs) compounds in sediments. Variables reported in previous surveys that are not included in this report are estimates for contaminants in tissues, concentrations of lindane, hexachlorobenzene, o,p' DDD, lipids, total volatile solids (TVS), and several PAH compounds in sediments. Comparisons between the three SCCWRP surveys are made in the Discussion and Conclusions.

II. METHODS

Seven of the original 71 60-m Survey areas were re-sampled during July and August 1990. This is a decrease from the 13 areas sampled in 1985. At each area, samples were taken at 30, 60, and 150 m for a total of 20 stations (Figure 1). The 30 meter station at area R61 off La Jolla was abandoned due to kelp. Station locations and sampling dates are listed in Appendix 1.

A SeaBird CTD was used to measure salinity, temperature, and dissolved oxygen at each station. Sediment samples were collected using a 0.10 m² chain-rigged Van

Figure 1. Chart of the southern California coastal shelf showing 1990 reference site sampling locations. Station locations are listed in Appendix 1. Station numbers are those used in the 1977 60 m Survey (Word and Mearns 1979) and 1985 Reference Site Survey (Thompson *et al.* 1987).



Veen grab sampler. For sediment characteristics and contaminants, two subsamples were taken from the grab sampler: one for grain-size, organic material, and trace metals, and the other for trace organic contaminants. The sub-samples were collected from the surface 2 cm of the grab sample with an open-barreled syringe, 26 mm in diameter. The samples were composited, and immediately frozen.

Sediment-grain size (% sand, % silt, % clay), total organic carbon (TOC), and total nitrogen (TN) were measured at each station. Details of analysis are included in Appendix 2. Total volatile solids (TVS) was not measured in this survey. Regressions presented in the 1985 survey report can be used to calculate total volatile solids values from the TOC values.

Nine trace metals were measured in each sample: silver (Ag), cadmium (Cd), chromium (Cr), copper (Cu), nickel (Ni), lead (Pb), zinc (Zn), iron (Fe), and manganese (Mn). Fe and Mn were not measured in previous surveys. Detection limits are listed on Table 1 and details of analysis are included in Appendix 2.

Seven chlorinated hydrocarbon contaminants were measured at each station, five DDT isomers (*o,p'*-DDE, *p,p'*-DDE, *p,p'*-DDD, *o,p'*-DDT, *p,p'*-DDT), and two PCB compounds (Aroclor 1242 and Aroclor 1254). Detection limits are listed in Table 1 and details of analysis are included in Appendix 2. The five DDT isomers analyzed in this survey are a reduction from the six isomers measured in the 1977 and 1985 surveys; *o,p'*-DDD was not measured in this survey.

Thirty polynuclear aromatic hydrocarbon (PAH) compounds were measured in sediments from each site. These compounds and their detection limits are listed in Table 1. The 30 compounds are somewhat different from the 28 compounds measured in the 1985 survey. However, some individual PAH compounds were measured in both surveys (Table 1). Polynuclear aromatic hydrocarbons were not measured in 1977. Given the differences in the number of DDT isomers and PAH compounds measured in the 1985 and 1990 surveys, total DDTs and total PAHs reported in each survey should not be directly compared.

Benthic macrofauna were collected from a separate Van Veen grab sample. The entire sample was sieved through a 1.0 mm screen. The animals and debris were fixed in 10% borax-buffered formalin in seawater. Upon return to the lab, the samples were transferred to 70% ethanol for preservation, sorted to major taxa, and identified to the lowest practicable taxon (see Appendix 3 for a list of taxonomists).

Megafaunal invertebrates and fish were collected at each site using a 7.6 m otter trawl. The same trawl gear and collection methods were used in the 1977, 1985, and 1990 surveys (Mearns and Stubbs 1974). Size-frequency measurements were made on all fish species, but are not reported here.

Table 1. Sediment contaminants measured and their detection limits.

Contaminants	Detection Limit (ng/dry g [ppb])
1. Chlorinated hydrocarbons	
p,p'-DDE	0.5
p,p'-DDD	" "
o,p'-DDE	" "
p,p'-DDT	" "
o,p'-DDT*	" "
Aroclor 1242	5.0
Aroclor 1254	" "
2. Polynuclear aromatic hydrocarbons (PAHs)	
Naphthalene* ²	0.09
2-Methylnaphthalene ²	" "
1-Methylnaphthalene ²	" "
1,3,5-Triisopropylbenzene*	" "
Biphenyl ²	" "
2,6-Dimethylnaphthalene ²	" "
Hexamethylbenzene*	" "
Acenaphthalene ²	" "
2,3,5-Trimethylnaphthalene* ²	" "
Fluorene* ²	" "
2-Methylfluorene*	" "
Dibenzothiophene* ²	" "
Phenanthrene ²	" "
Anthracene* ²	" "
Fluoranthrene ²	" "
Pyrene ²	" "
2,3-Benzofluorene* ²	" "
1,1'-Benzofluorene* ¹	" "
Benz(A)anthracene ²	" "
Chrysene/triphenylene ²	" "
Benzo(B + K)fluoranthene ²	" "
Benzo(E)pyrene	" "
Benzo(A)pyrene ²	" "
Perylene ²	" "
9,10-Diphenylanthracene* ²	" "
1,2,5,6-Dibenzanthracene* ²	" "
Benzo(G,H,I)perylene	" "
Anthanthrene ¹	" "
Coronene ¹	" "
1,2,4,5-Dibenzopyrene ¹	" "

Table 1 (continued)

<u>Trace Metals</u>	(mg/dry g [ppm])
Ag	0.1
Cd	0.1
Cr	0.2
Cu	0.8
Ni	0.1
Pb	0.5
Zn	0.2
Fe ¹	4.1
Mn ¹	0.8

* below given detection limits in all reference site samples

1 = indicates that measurements of these compounds/ions have not been previously reported for So. Calif. reference sites.

2 = PAH compounds also reported in 1985 Reference Survey.

Three commonly used indices of biological community structure were calculated for grab macrofauna, megabenthic invertebrates, and fish at each station: species diversity (H' , Shannon and Weaver 1949), evenness (J , Pielou 1966), and dominance (C , Simpson 1949). The latter two indices are scaled between 0 and 1, where values of 1 indicate perfect evenness and complete dominance, respectively.

Species abundance data from grab and trawl samples were analyzed using several multivariate methods. Ordination and classification analyses were used to show patterns in species composition and abundances at each station. Relationships between sediment and macrobenthic variables were evaluated using principal components analysis and multiple regressions. Details of these methods are included in Appendix 2. For contaminants with concentrations below detection limits, a value equal to 1/2 the detection limit value was substituted in the calculations of means.

Significance tests for differences in numbers of species, individuals, and indicator species abundances biomass, between site groups or over depth were conducted using Tukey's HSD multiple comparisons test (Tukey 1951); data were \log_{10} transformed.

The raw data from the survey are included in the Appendices. Complete listings of the 1990 data in IBM PC ASCII format is available from SCCWRP upon request.

III. RESULTS

A. Physical Parameters

1. Temperature, Salinity, and Dissolved Oxygen

Mean temperature, salinity, and dissolved oxygen concentrations near the seafloor (<1 m from bottom) at each station are listed in Table 2. Temperatures in the July - August sampling period ranged from 9.9° to 13.8°C. Temperatures were lower at the 150 m sites than at the 30 m sites; the warmest water was off Dana Pt. (Appendix 4.1). Salinity ranged from 33.2 ‰ to 33.8 ‰, and was highest at the 150 m sites. The lowest salinities were measured at the head of the La Jolla submarine canyon (Appendix 4.2). Dissolved oxygen (DO) concentrations also decreased with depth. The lowest values (3.1 mg/l) were measured at the southern 150 m sites and the highest values (9.0) were measured at 30 m sites off Dana Pt. (Appendix 4.3). Near-bottom salinity and temperature were significantly correlated with water depth (Table 3).

2. Sediment Grain-size and Chemistry

a. Grain-size and organic material

The sediments at the mainland shelf sites ranged from fine clayey-silt at some of the 150 m sites to coarse sand off Imperial Beach. Grain-size generally decreased over shelf depths (Table 2). The proportion of clay in the sediment was highest at the 150

Table 2. Mean values ($\pm 95\%$ confidence intervals) for near-bottom water and sediment parameters measured in the survey.

	<u>30 m</u>	<u>(n=6)</u>	<u>60 m</u>	<u>(n=7)</u>	<u>150 m</u>	<u>(n=7)</u>
1. <u>Near bottom water</u>						
Temperature (T°C)	13.2	(± 0.5)	11.8	(± 0.6)	10.1	(± 0.2)
Salinity (‰)	33.4	(± 0.1)	33.4	(± 0.1)	33.7	(± 0.1)
DO (mg/l)	7.4	(± 1.9)	6.2	(± 1.6)	4.4	(± 1.2)
2. <u>Sediment quality (percent dry wt.)</u>						
Sand	65.1	(± 30.3)	47.8	(± 32.4)	38.1	(± 23.4)
Silt	31.8	(± 28.9)	46.6	(± 30.2)	51.6	(± 18.8)
Clay	3.0	(± 1.8)	5.5	(± 2.3)	10.0	(± 5.2)
Dry wt.	68.5	(± 3.2)	65.3	(± 5.5)	60.4	(± 7.0)
TOC	0.47	(± 0.19)	0.57	(± 0.24)	0.82	(± 0.44)
TN	0.04	(± 0.01)	0.04	(± 0.02)	0.07	(± 0.04)
3. <u>Trace metals (ppm)</u>						
Ag	0.10	(± 0.10)	0.25	(± 0.43)	0.05	(± 0.00)
Cd	0.26	(± 0.23)	0.24	(± 0.27)	0.37	(± 0.23)
Cr	17.00	(± 4.2)	25.60	(± 13.8)	31.00	(± 10.4)
Cu	5.30	(± 2.3)	9.20	(± 5.5)	13.90	(± 5.6)
Ni	8.00	(± 4.0)	11.40	(± 8.2)	13.90	(± 5.9)
Pb	4.40	(± 1.4)	6.90	(± 3.3)	8.20	(± 3.6)
Zn	29.10	(± 11.1)	45.10	(± 21.2)	55.10	(± 18.2)
Fe	10997.50	(± 3666.7)	17963.50	(± 7746.0)	21311.00	(± 6036.8)
Mn	99.00	(± 43.8)	133.40	(± 62.9)	156.00	(± 57.6)
4. <u>Trace organics compounds (ppb)</u>						
PCBs (2 Aroclors)	7.1	(± 4.2)	11.9	(± 11.4)	12.3	(± 9.7)
DDTs (5 Isomers)	5.4	(± 4.8)	12.6	(± 13.4)	15.0	(± 14.0)
PAHs (30 cpds)	24.1	(± 19.9)	26.2	(± 14.1)	38.6	(± 20.2)

Table 3. Pearson product-moment correlation matrix for Reference Site Survey sediments. A. sediment types, and B. contaminant concentrations. * Indicates significant correlation, initial and =0.05 corrected for multiple comparisons to p < 0003.

A.															
	Depth	% Sand	% Silt	% Clay	% Dry/Wet	% TOC	% TN	Salinity	bottom Temp.	bottom D.O.					
Depth	-	-.341	.268	.657*	-.533*	.447*	.499*	.895*	-.925*	-.659*					
% Sand		-	-.995*	-.789*	.722*	-.574*	-.557*	-.362	.214	-.271					
% Silt			-	.721*	-.670*	.517*	.496*	.297	-.145	.334					
% Clay				-	-.862*	.786*	.803*	.636*	-.540*	-.137					
% Dry					-	-.793*	-.850*	-.403	.440	.197					
% TOC						-	.956*	.450*	-.332	-.181					
% TN							-	.468*	-.406	-.254					
Salinity								-	-.844*	-.419					
bottom Temp									-	.729*					
bottom D.O.										-					
B.															
	Trace Metals											Organic Hydrocarbons			
	Ag	Cd	Cr	Cu	Ni	Pb	Zn	Fe	Mn	PAHs	DDTs	PCBs			
Depth	-.176	.229	.461	.598	.345	.444	.495	.524	.374	-.370	.291	-.212			
% Sand	.378	-.405	-.658	-.834*	-.536	-.705	-.866*	-.818*	-.855*	-.283	-.283	.469			
% Silt	-.380	.382	.630	.789*	.518	.674	.835*	.785*	.834*	.235	.307	.468			
% Clay	-.280	.457	.680	.905*	.526	.739*	.852*	.819*	.788*	.521	.286	-.364			
% Dry/Wet	.391	-.412	-.743*	-.884*	-.564	-.800*	-.862*	-.861*	-.836*	-.569	-.295	-.394			
% TOC	-.281	.426	.676	.783*	.463	.705	.691	.697	.618	.353	.295	-.411			
% TN	-.329	.430	.706	.771*	.527	.756*	.705	.720	.642	.542	.302	-.349			
Salinity	-.170	.376	.532	.578	.499	.467	.494	.510	.336	-.311	.494	-.342			
Temp.	.060	-.134	-.447	-.488	-.372	-.407	-.432	-.503	-.308	.367	-.370	-.160			
D.O.	-.051	.247	.012	-.029	.148	.049	.085	-.008	.164	.311	.124	-.100			

m sites; at Station R50-150 off Dana Point, 17.3% of the sediment was clay. At Station R71-30, off Imperial Beach, 96.6% of the sediment was sand. The sediment at the deeper R71 sites was also sandy (Appendix 4.4 to 4.6). Gravel was present in only three of the deeper, southern samples: Station R61-150 (0.8%); R71-60 (0.6%); and R71-150 (1.2%).

Sand, silt, and clay were not significantly correlated with depth (Table 3), but clay was significantly correlated with percent dry weight.

Total organic carbon (TOC) and total nitrogen (TN) were measured at each site. Since TOC and TN are significantly inversely correlated with sediment clay content (Table 3), TOC and TN generally increase over shelf depths as grain-size decreases (Table 2). TOC and TN were highly significantly correlated; however, neither was significantly correlated with depth (Table 3). TOC ranged from 0.15% to 1.52%. The extreme values occurred at the 150 m sites. (Appendix 4.8). Total nitrogen ranged from 0.01% to 0.09% (Appendix 4.9).

b. Trace metals

Concentrations of most metals (except Ag) increased with depth (Table 2); however, the correlations between metal concentrations and depth were not significant (Table 3). Distributions of individual trace metals are shown in Appendix 4.10 to 4.18. Silver concentrations were particularly low; only three sites had Ag concentrations above the detection limits. Concentrations of all contaminant trace metals, except for Cu and Zn, were highest at the R15 stations closest to metropolitan Los Angeles. Cu was highest at Stations R52-150 and R60-150; Zn was highest at R50-150 and R52-60. Fe and Mn were not measured in previous surveys. Fe and Mn are components of normal sedimentary minerals, particularly silts and clays, and are not usually considered anthropogenic contaminants. The concentration of Fe and Mn were highest in areas with the highest proportions of silt and clay and lowest at the sandiest sites.

Only Cu, Pb, Zn, Fe, and Mn were significantly correlated with sediment grain-size and/or organic content (Table 3).

c. Chlorinated and petroleum hydrocarbons

Total DDTs (sum of 5 isomers) were highest at the northern 60 and 150 m reference sites (up to 39 ppb) and lowest at the southern sites (<0.5 ppb), particularly those with high sand content (Appendix 4.19). Average DDT concentrations increased with water depth, (Table 3), ranging from 5.4 ppb at the 30 m sites to 15.0 ppb at the 150 m sites (Table 2); however, the correlation between DDT concentration and depth was not significant. Of the 5 isomers measured, p,p'-DDE had the highest concentra-

tion at all sites, and p,p'-DDT was below detection limits at all sites (Appendix Table 4.1).

Total PCBs (sum of 2 Aroclor mixtures) were highest in 2 different areas: Sta. R15-150 north of Pt. Dume (29 ppb), and Sta. R52-60 off Dana Pt. (31 ppb; Appendix 4.20). PCBs were lowest at the sandy southern stations (<5.0 ppb). Average PCBs increased over water depth (Table 3), ranging from 7.1 ppb at 30 m, to 12.3 ppb at 150 m (Table 2); the trend, however, was not significant. Aroclor 1242 was below detection limits (5.0 ppb) at all sites except Sta. R15-150, and Aroclor 1254 was measurable at only half the sites (Appendix Table 4.1).

Total PCBs were not significantly correlated with any abiotic sediment parameters, including grain-size or organic carbon content (Table 3).

Total PAHs (sum of 30 compounds) were highest at the 150 m sites, ranging up to 69 ppb at Sta. R13-150 off Oxnard (Appendix 4.21). As with the other trace organic contaminants, PAHs were lowest at the southern 30 m sandy stations. Again the trend with depth was not significant (Table 2).

Of the 30 PAH compounds measured, 11 were below detection limits (0.09 ppb) at all sites (Table 1). Only 11 compounds were consistently measured at all sites (Appendix Table 4-1). Seven of the PAH compounds quantified during this survey have not been previously measured in marine sediments off southern California (Table 1).

B. Biological Communities

1. Macrofaunal invertebrate assemblages

Ordination and classification analyses of the species in benthic grab samples identified five groups of sites, each with similar species composition and abundances (Figure 2). Except for Site Group 3 (= Station R71-60), the sites groups are sub-assemblages, that is, they differ slightly in species composition and abundances from the large-scale *Amphiodia urtica* assemblage that inhabits the entire southern California mainland shelf (Jones 1969; Thompson *et al.* 1987a). The presence of *A. urtica* unifies the shelf assemblage and indicates reference mainland shelf conditions.

The 30 m sites classified into two sub-assemblages (Figure 3, Table 4). Group 5 represents typical 30 m assemblages. These sites were dominated by amphipods, *Amphideutopus oculatus* and *Ampelisca brevisimulata*. *A. oculatus* was most abundant at the two northern 30 m sites; 57 individuals were collected at station R15-30. The polychaete *Spiophanes missionensis* was also among the most abundant species (Table 4). Stations R50-30 and R52-30 were more similar to 60 m sites (Group 4) due to reduced abundances of these amphipods and the dominance of *A. urtica*.

Group 4 represents the typical southern California mainland shelf assemblage dominated by *A. urtica* and *S. missionensis*. The latter species was present at all sites

Figure 2. Dendrogram from classification analysis of macrobenthic grab samples. See Appendix 2 for details of analysis.

BENTHIC MACROFAUNA

ECOLOGICAL DISTANCE

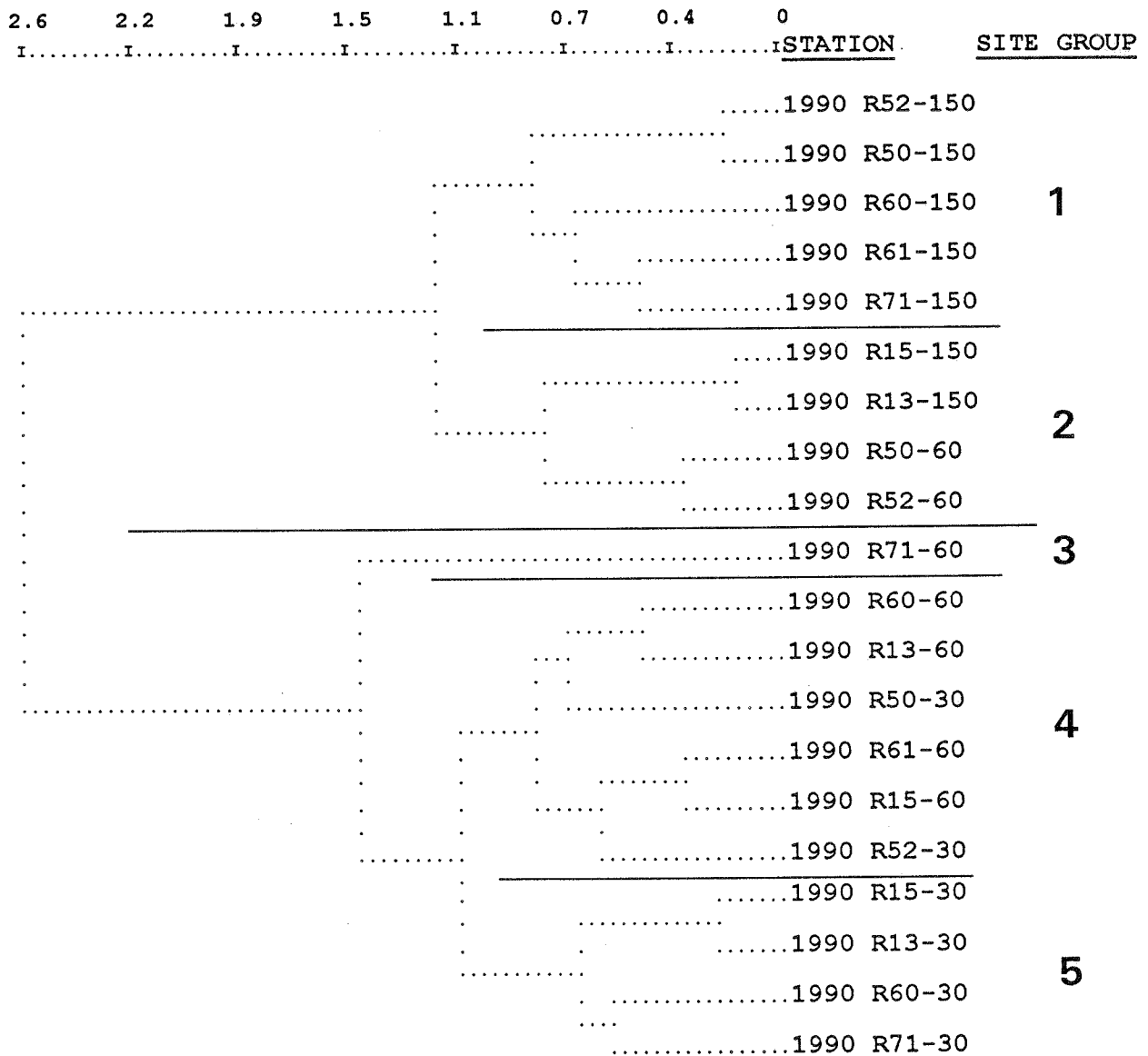
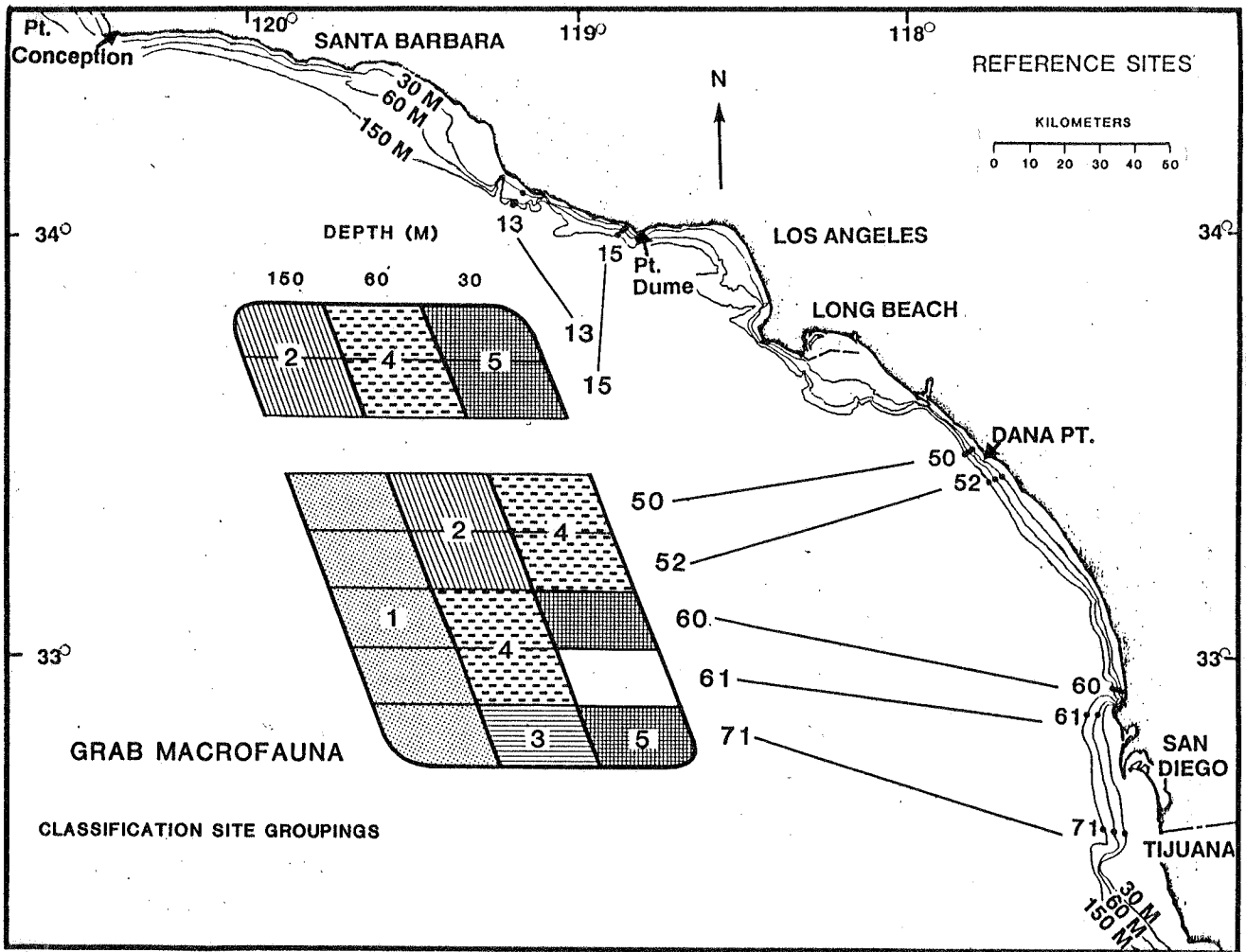


Figure 3. Distribution of benthic macrofaunal assemblages (= site groups) from classification analysis.



sampled, but was most abundant at the 60 m sites (Figure 4; Appendix 4.22). Stations R50-60 and R52-60 were more similar to the northern 150 m sites due to the presence of large numbers of the polychaete *Myriochele* sp. M. A total of 14,990 individual m² were collected at Station R50-60. Large patches of these polychaetes were collected at several sites in the region (Appendix 4.23). What factors cause such large numbers of these worms in patches are not known.

The benthic assemblage at Station R71-60 was different from that found at the other stations (Table 4). The gastropod *Micranellum* (= *Caecum*) *crebricinctum* and the ostracod *Euphilomedes carcharodonta* were the most abundant species; the brittlestar *Amphiodia urtica* was absent. The sediment at this station was over 94% sand.

The southern 150 m sites formed the most homogeneous site grouping. These sites were dominated by the polychaete *Spiophanes fimbriata* (Appendix 4.24) and *A. urtica*. The northern 150 m sites were different because of the presence of *Myriochele* sp. M.

The 30 and 60 m sites at R50 and R52 differed from adjacent sites at similar depths. At R50 and 52, the 30 m stations had affinities with the 60 m stations while the 60 m stations had affinities with the 150 m stations.

Trends in the numbers of species, individuals, and biomass per grab at each depth are shown in Figure 5 and Appendix 4.25 to 4.27. There was no significant difference in number of species or biomass among the three depths. Because of the high abundance of *Myriochele* sp. M at a few sites, the number of individuals was significantly higher at the 60 m sites than at the other sites. Although the species composition at station R71-60 differed, there was no significant difference in other assemblage parameters (numbers of species, individuals, and biomass) between the sandy-bottom assemblage and the *Amphiodia* assemblage.

Comparisons of the number of species and individuals and biomass among the classification site groups is shown at the bottom of Table 4. Group 2 had the fewest species, but the highest number of individuals. Group 4 had the highest number of species and biomass. The single sandy site, R71-60, had the lowest biomass. However, due to variation, there were no significant differences in numbers of individuals and biomass among any of the groups. Numbers of species were only significantly different between Group 2 and 4, the highest and lowest values.

Species diversity (H'), evenness (J) and dominance (C) indices were calculated at each site (Appendix 4.28 to 4.30). Values of these indices were similar at the 30 and 150 m sites. H' and J were highest at the 30 m sites (maximum = 4.05 and 0.9, respectively) and lowest at the 60 m sites (minimum = 1.12 and 0.27, respectively). C was highest at the 60 m sites (maximum = 0.62), and lowest at the 30 m sites

Table 4. Mean number of organisms per grab for common species in each classification site group. The five most abundant species in each site group and the ten most commonly collected species (frequency of occurrence = F.O.) were included. The order of the species in this table was produced by inverse classification analysis of the species. Letter species designations are SCAMIT provisional species. P=polychaete; Os=ostracod; Op=ophiuroid; Pe=pelecypod; G=gastropod; A=amphipod; Ph=phoronid.

			Macrofaunal Assemblages				
			Mean no. per grab in each classification site group				
			1	2	3	4	5
			150m	60-150m	R71-60	30-60m	30m
Species	Taxon	F.O.	n=5	n=4	n=1	n=6	n=4
<i>Euphilomedes producta</i>	Os	9	8.4	20.8	0	1.2	0
<i>Spiophanes fimbriata</i>	P	12	29.6	6.5	0	3	2.0
<i>Maldane sarsi</i>	P	15	11.8	1.0	1	1.3	1.5
<i>Pectinaria californiensis</i>	P	18	10.4	25	5	7.5	1.2
<i>Amphiodia urtica</i>	Op	16	19.4	120.2	0	77.3	4.2
<i>Spiophanes berkeleyorum</i>	P	16	6.8	2.5	0	6.0	1.8
<i>Tellina carpenteri</i>	Pe	17	2.0	2.2	0	5.7	2.0
<i>Myriochele sp. M</i>	P	6	0	386.5	1	6.8	0
<i>Mediomastus sp.</i>	P	19	9.2	5.2	4	7.0	2.8
<i>Parvilucina tenuisculpta</i>	Pe	19	13.2	1.2	8	5.2	2.8
<i>Spiophanes missionensis</i>	P	20	5.0	13.2	24	32.7	11.5
<i>Rhepoxynius bicuspidatus</i>	A	15	1.6	5.0	0	5.7	8.5
<i>Prionospio sp. A</i>	P	16	2.4	1.5	12	10.5	7.8
<i>Paraprionospio pinnata</i>	P	11	0.6	2.2	0	2.3	8.5
<i>Chloeia pinnata</i>	P	7	0.2	1.0	24	2.5	0
<i>Micranellum crebricinctum</i>	G	1	0	0	40	0	0
<i>Euclymeninae sp. A</i>	P	11	0.2	0.2	6.0	7.2	5.0
<i>Euphilomedes carcharodonta</i>	Os	13	0.2	2.8	40	4.8	5.2
<i>Phoronis sp.</i>	Ph	10	0	0.5	28	3.8	3.0
<i>Ampelisca brevisimulata</i>	A	11	0	1.5	0	3.8	12.5
<i>Amphideutopus oculatus</i>	A	7	0	0.2	0	0.3	16.8
<i>Spiophanes bombyx</i>	P	7	0	0	10	0.3	9.5
Mean no. species per grab			62.2	58.8	76.0	90.3	78.0
Mean no. Individ. per grab			247.0	691.5	356.0	375.0	273.0
Mean biomass (wet g) per grab			8.9	7.9	4.1	15.0	6.3

Figure 4. Depth-related trends in mean (\pm std. dev.) abundance of the most abundant macrobenthic species collected. Arrow indicates standard deviation is off scale.

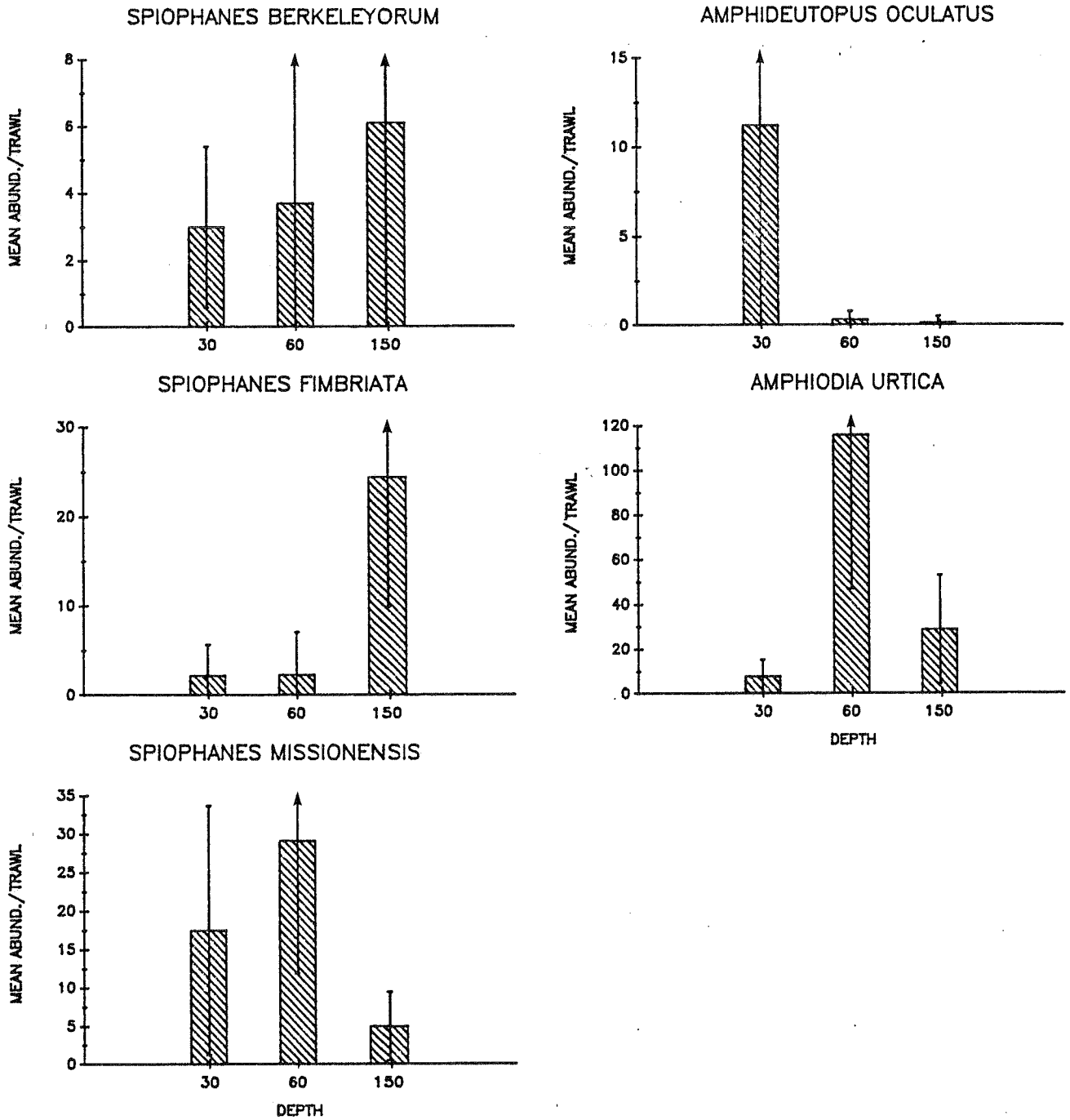
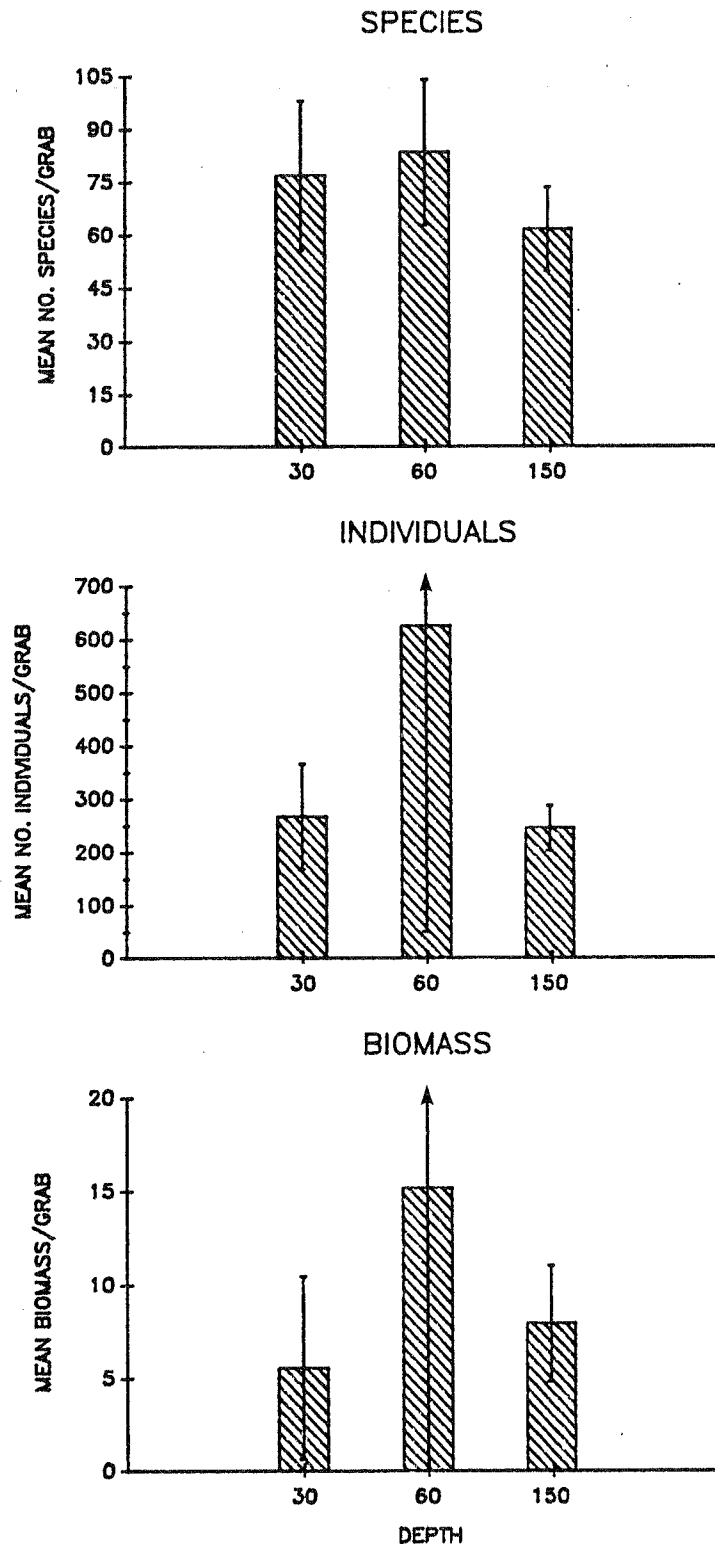


Figure 5. Depth-related trends in the mean (\pm std. dev.) number of macrofaunal species, individuals, and biomass per grab. Arrow indicates standard deviation is off scale.



(minimum = 0.03).

The 20 abiotic sediment variables analyzed formed 6 independent sediment factors. Each factor is composed of several sediment variables having similar patterns in their proportions or concentrations among the 20 sites sampled. For example, Factor 1 shows that sediment grain-size and 4 trace metals had trends among the sites and accounted for about 30% of the variation (Table 5). Similar patterns can be deduced from Table 3, but this analysis indicates the maximum level of separation of the variables statistically possible. In other words, given the intercorrelations among the sediment variables, only 6 independent patterns exist.

Using the factor scores as independent variables in multiple regression shows how much of the variation in the first two macrobenthic ordination axis scores is accounted for by each factor (Table 5). Ordination axis 1 scores were significantly associated with sediment factors 1 and 2, which represent trends in sediment grain-size, Mn, Zn, Fe, Cu, and trends in bottom water TOC, S%, and DO. Together these two factors accounted for almost 77% of the variation in ordination axis 1 scores (Table 5). These factors are, therefore, a significant predictor of ordination axis 1. Ordination axis 2 scores were most significantly associated with sediment factors 2 and 6 which represent trends in bottom water and trends in Ag. Factor 3 contributed to improving both axis 1 and 2 regressions.

Factor 3 (chlorinated hydrocarbons and trace metals) was the only factor significantly associated with abundances of *Amphiodia urtica*; however, this factor only accounted for about 38% of the variation in abundance of *Amphiodia*.

This analysis showed that bottom water, sediment-grain size, trace metals, and chlorinated hydrocarbon contaminants accounted for most of the variation in the macrobenthos in reference areas. PAHs and organic material in sediments were not strongly associated with the biological variables.

2. Megabenthic Invertebrate Assemblages

The large, motile invertebrates collected in otter trawl samples formed four site groupings or assemblages (Figure 6). Two of the groupings included sub-groups or sub-assemblages. These groupings were related to depth (Figure 7).

The 30 m sites (Group 4) were dominated by the sea star *Astropecten verrilli*; more than 110 sea stars per trawl were collected at these sites (Table 6). The abundance of *Astropecten verrilli* was highest at 30 m and decreased with depth (Figure 8; Appendix 4.31). This species is a predator that feeds on small crustaceans and clams (Striplin 1987). Group 4a represents a 'light' (abnormally small catch) trawl at Station R52-30. Although more similar to Group 3 in the classification dendrogram (Figure 6),

Table 5. A) Common sediment factors for six principal components axes using all 20 reference sites. Only sediment variables significantly correlated to the principal component ($p < 0.05$) are listed. B) Results of multiple regression analysis. R^2 is the amount of variation in the biological variable accounted for by each factor(s). P is the probability that the ANOVA for the regression is significant.

A.

<u>PCA FACTORS</u>						
	1	2	3	4	5	6
	Sand	TOC	DDTs	PAHs	TOC	Ag
	Silt	D.O.	PCBs		TN	
	Clay	S0/00	Ni			
	Mn	Ca				
	Zn	Cr				
	Fe	Pb				
	Cu					
% Variation	30.1	13.4	25.6	6.7	12.2	5.3

B.

Ordination Score Axis 1			Ordination Score Axis 2			Amphiodia urtica (no. grab)		
Factor	R2	P	Factor	R2	P	Factor	R2	P
1	.336	.007	1	.121	.134	1	.017	.548
2	.432	.002	2	.233	.031	2	.003	.810
3	.063	.285	3	.147	.095	3	.376	.004
1,2	.768	<.001	6	.358	.005	5	.005	.768
1,2,3	.831	<.001	2,6	.591	.001	1,3	.393	.014
			2,3,6	.738	<.001	1,3,5	.398	.039
			1,2,3,6	.859	<.001	1,2,3,5	.401	.086

Figure 6. Dendrogram from classification analysis of trawl-caught megabenthos. See Appendix 2 for details of analysis.

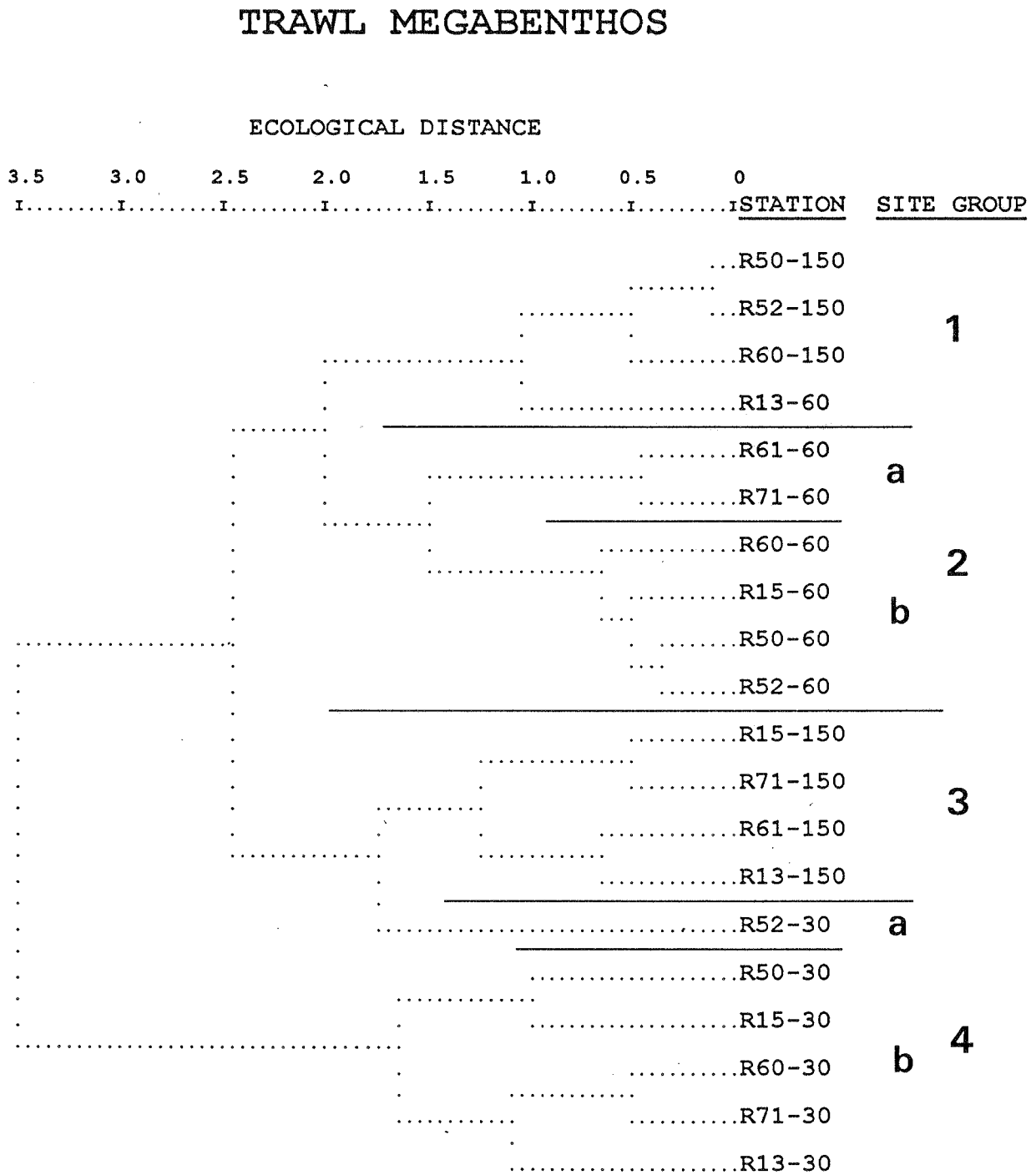


Figure 7. Distribution of megabenthic assemblages (= site groups) from classification analysis.

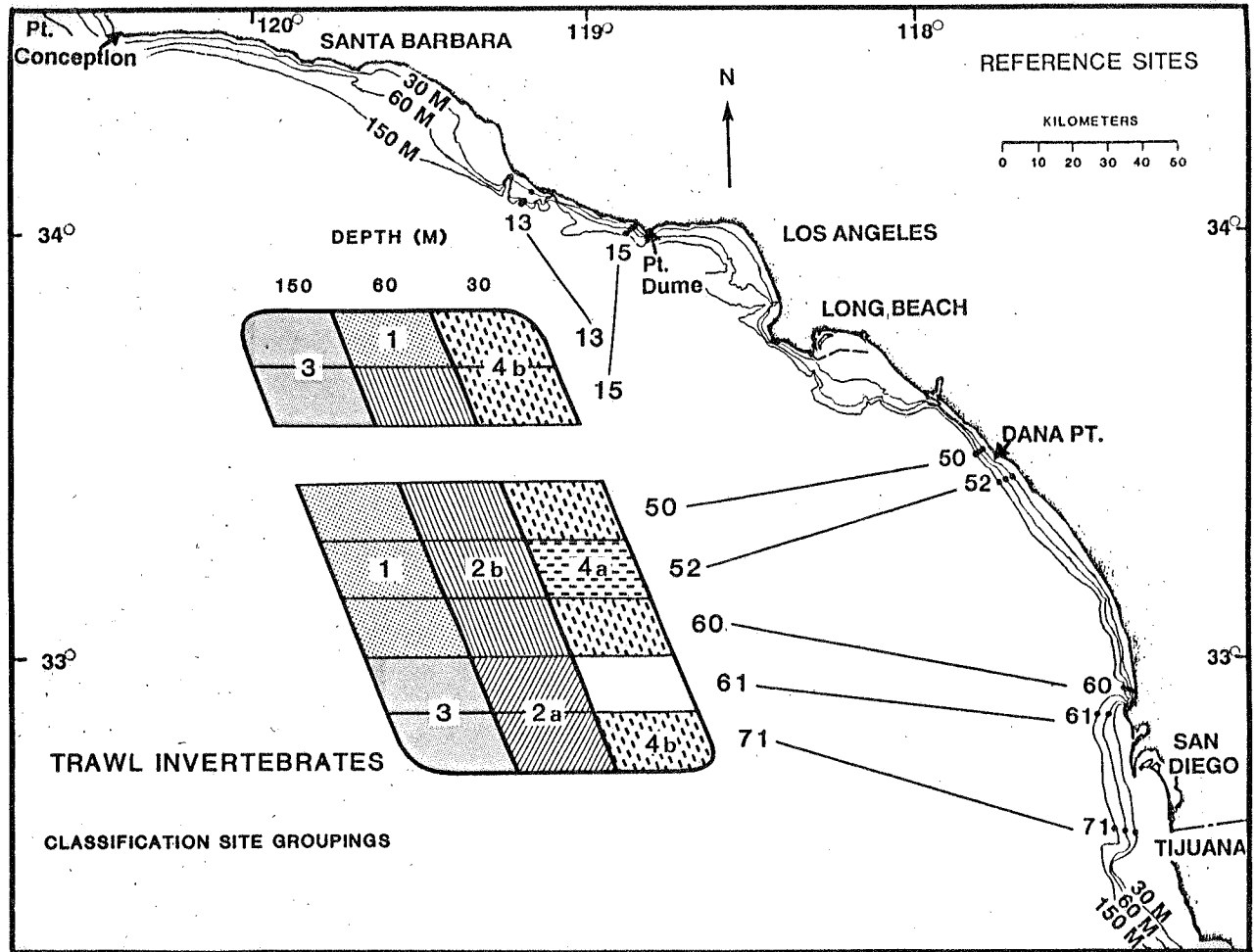


Figure 8. Depth-related trends in mean abundance (\pm std. dev.) of the three most abundant megabenthic species collected. Arrow indicates the standard deviation is off scale.

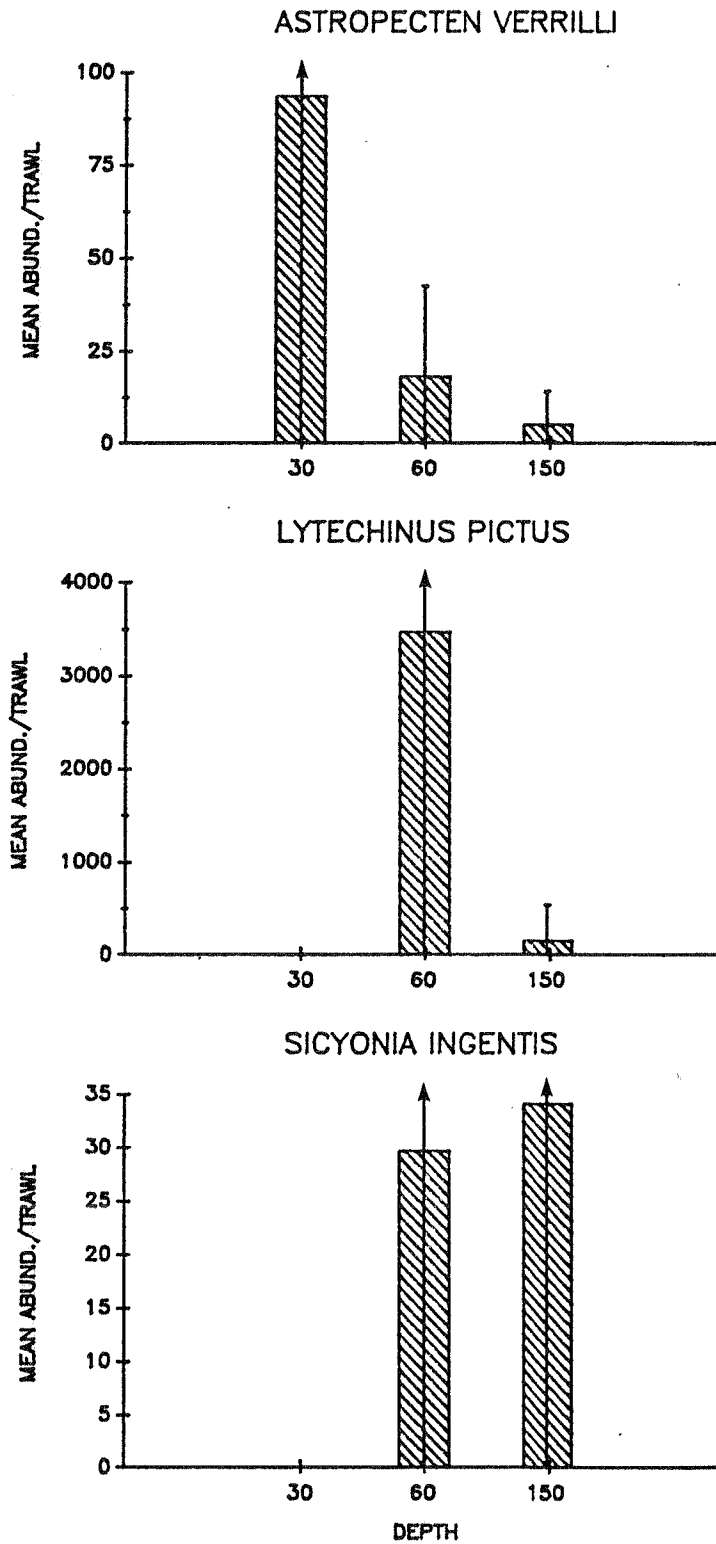


Table 6. Mean number of individuals per trawl for megabenthic species in each classification site group. The five most abundant species in each site group and the ten most commonly collected species (frequency of occurrence = F.O.) were included. The order of the species in this table was produced by inverse classification analysis of the species. C = crustacean; E = echinoderm; M = molluscan.

Megabenthic Assemblages								
			Mean no. per trawl in each classification site group					
			1	2a	2b	3	4a	4b
			60-150m	60m	60m	150m	R52-30	
30m Species	Taxon	F.O.	n=4	n=2	n=4	n=4	n=1	n=5
<i>Pandalus platyceros</i>	C	3	29.8	0	0	0	0	0
<i>Pleurobranchaea californica</i>	M	7	2.8	0	0.2	1.4	0	0
<i>Parastichopus californicus</i>	E	11	25.8	13	12.8	0.6	0	0.4
<i>Sicyonia ingentis</i>	C	12	64	1.5	45	1.6	0	0
<i>Luidia foliolata</i>	E	15	29.8	4	2.2	13.4	0	2.8
<i>Brissopsis pacifica</i>	E	4	0.5	0	0	41	0	0
<i>Allocentrotus fragilis</i>	E	6	29.8	0	0	303.6	0	0
<i>Octopus rubescens</i>	M	6	0.2	3	0.5	1.2	0	0
<i>Lytechinus pictus</i>	E	13	23.2	11391.5	350.2	212.2	8	1
<i>Luidia asthenosoma</i>	E	1	0	6	0	0	0	0
<i>Ophiothrix spiculata</i>	E	7	0	6	3	0	0	0.2
<i>Crangon alaskensis</i>	C	3	0	0	6.5	0	0	0
<i>Loxorhynchus grandis</i>	C	8	0.5	0	2.2	0	0	0.2
<i>Astropecten verrilli</i>	E	17	0.8	40	11.2	8.8	9	110.4
<i>Lovenia cordiformis</i>	E	4	0	0	0	0.6	2	3.0
<i>Heterocrypta occidentalis</i>	C	3	0	0	0.2	0	0	1.0
Mean no. species per trawl		16.8	14.5	10.8	11.0	5.0	7.2	
Mean no. Individ. per trawl			249.5	11478.0	440.0	739.3	21.0	
122.0								
Mean biomass (wet kg) per trawl			17.4	21.1	8.4	17.0	0.2	1.2

this station contained most of the same species as Group 4b, but in reduced abundances.

The 60 m sites (Group 2) were inhabited by typical southern California mainland shelf megabenthos. The white urchin *Lytechinus pictus* was the most abundant species, especially at the Group 2a sites. This species was more abundant at 60 m than at 30 or 150 m (Figure 8). *Lytechinus pictus* forms large scale (100s m) herds on the mainland shelf. These herds were apparently sampled at Station R61- and R71-60 where up to 13,933 individuals were collected (Appendix 4.33). Station R13-60 was more similar to some of the 150 m sites because of the increased abundance of the ridge-back prawn *Sicyonia ingentis*.

The 150 m sites divided into 2 sub-assemblages. At the Group 1 sites, *S. ingentis* was the most abundant species (Table 6; Appendix 4.34). At the Group 3 sites, *S. ingentis* was less abundant and the pink urchin *Allocentrotus fragilis* was most abundant. *A. fragilis* is an upper slope species commonly collected deeper on the basin slopes (Thompson *et al.* 1987b).

The number of species, individuals, and biomass per trawl at each depth are shown on Figure 9 and Appendix 4.35 to 4.37. These parameters were significantly lower at the 30 m sites than at the deeper sites. The number of species was similar at 60 and 150 m. The number of individuals was significantly higher at 60 m than at 150 m. Biomass was higher at 150 than at 60 m, but the difference was not significant.

Comparison of these parameters among the classification site groups is shown in Table 6. The number of species per trawl was significantly lower at the Group 4 sites than at the group one sites, but was similar among the other sites. The number of individuals was significantly higher at the Group 2a sites due to the large number of *L. pictus* sampled at some of the 60 m sites. Biomass at the Group 4 sites was significantly lower than the other sites.

Megafaunal species diversity (H') increased with water depth, from 0.79 at 30 m to 1.17 at 150 m. The highest value occurred at Station R50-150. However, there was considerable variability in these values within each depth (Appendix 4.38). Evenness (J) also increased with depth, but the highest value of 0.52 occurred at Station 13-60. Dominance (C) was highest at the 30 and 60 m stations and decreased at the 150 m sites (Appendix 4.39, 4.40).

3. Epibenthic and Demersal Fish Assemblages

Trawl-caught epibenthic and demersal fish classified into three main site groupings; Group 3 formed two sub-groups (Figure 10). The three main groups reflected depth differences.

Figure 9. Depth-related trends in mean (\pm std. dev.) number of megabenthic species, individuals, and biomass per trawl. Arrow indicates standard deviation is off scale.

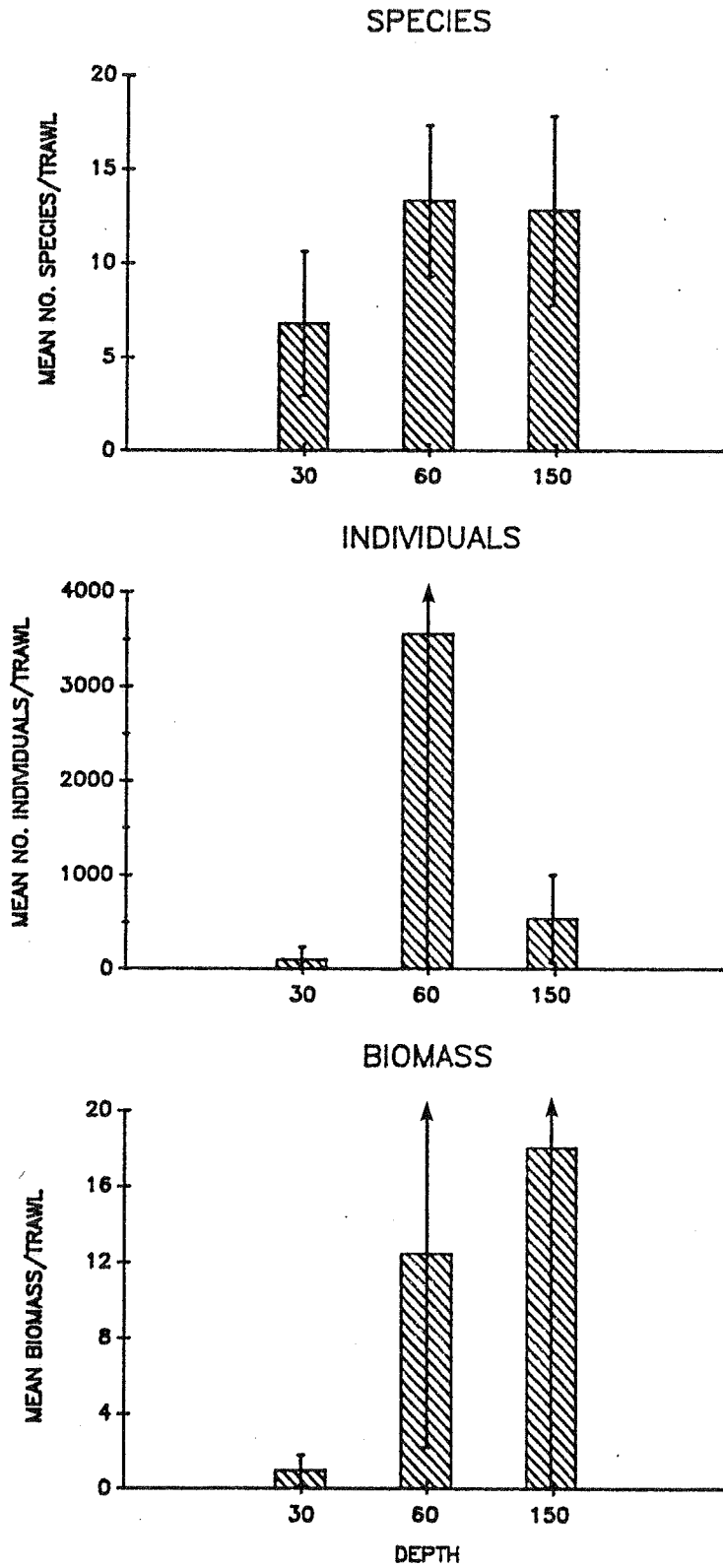
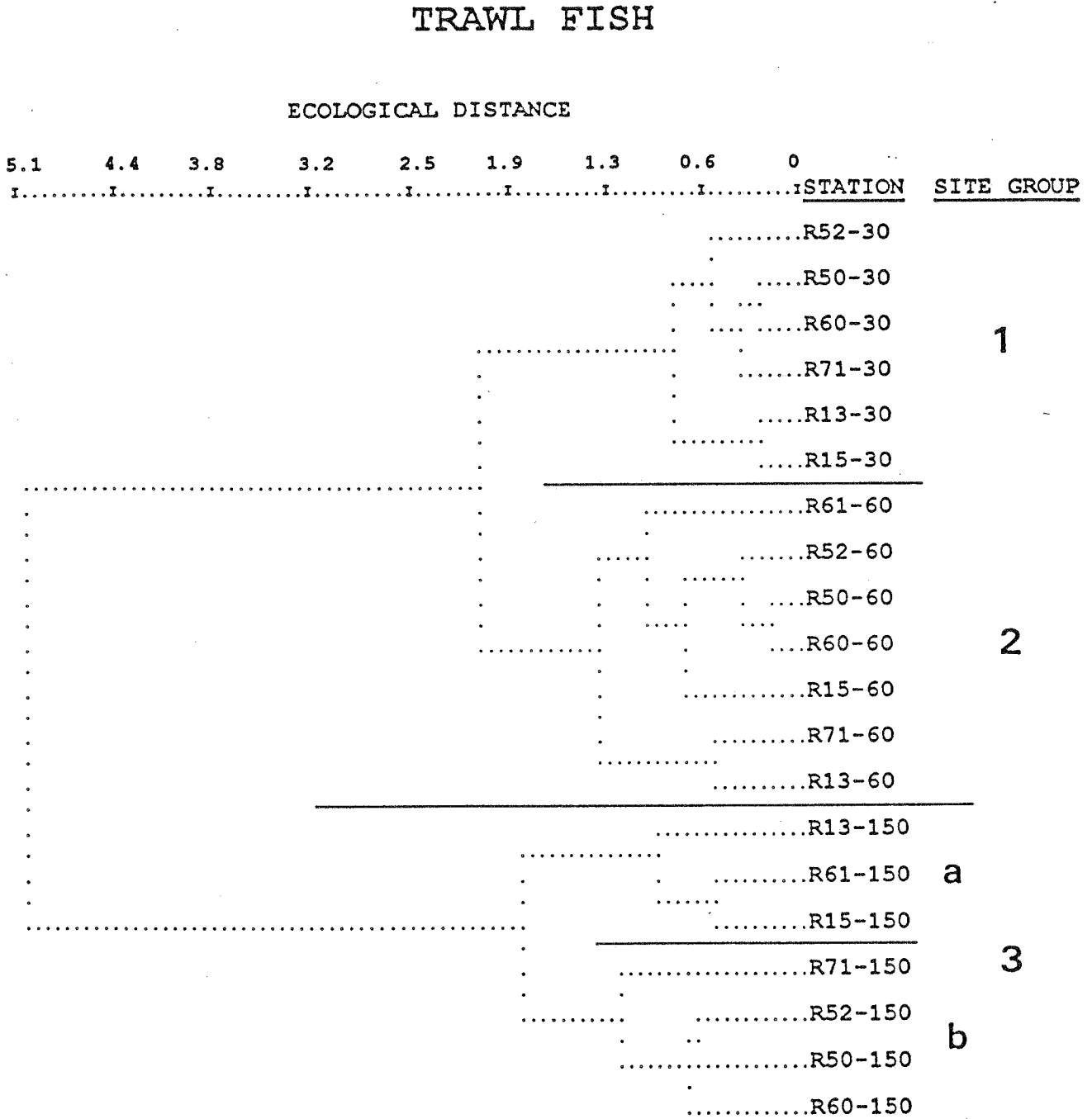


Figure 10. Dendrogram from classification analysis of trawl-caught fish. See Appendix 2 for details of analysis.



The 30 m sites all classified together (Figure 11). These sites were dominated by speckled sanddabs and longfin sanddabs (Table 7). Speckled sanddabs were significantly more abundant at 30 m than at 60 m, and were not collected at 150 m (Figure 12; Appendix 4.42).

The 60 m sites also classified together. Many of the same species of fish occurred at 30 and 60 m, but there were differences in dominance between the two depths. At 60 m, Pacific sanddabs were the dominant species, but longfin sanddabs were also abundant (Table 7). Although Pacific sanddabs were more abundant at 60 m, the difference in abundance among depths was not statistically significant (Figure 12; Appendix 4.41).

The fish assemblage at the 150 m sites was considerably different than the assemblages at 30 and 60 m. Although classification analysis showed two sub-groups in the 150 m sites, the species composition in the sub-groups was similar; the sub-groups differed mainly in the relative abundance of the species. Pacific and Gulf sanddabs were more abundant in Group 3a. Slender sole, Plainfin midshipman, and Dover sole were more abundant in Group 3b. Stripetail rockfish were equally abundant in both groups (Table 7). Slender sole were only collected at the 150 m sites (Figure 12; Appendix 4.43).

The number of fish species, individuals, and biomass per trawl increased over depth (Appendix 4.44 to 4.46). However, due to the variability among the sites within each depth, there were no significant differences in species or biomass among the depths (Figure 13). The number of individuals at the 150 m sites was significantly greater than at the 30 m sites.

Comparison of numbers of species, individuals, and biomass among the classification site groups showed that Group 3b had significantly higher numbers of species than Group 1 and Group 3a sites, and significantly higher numbers of individuals than the Group 1 sites. There was no significant difference in biomass among the site groups (Table 7).

Mean fish species diversity (H') was similar at the 30 and 60 m sites (1.48-1.49) but was higher at the 150 m sites (Appendix 4.47). The highest value occurred at Station R50-150. Megafaunal diversity was also highest at this site. The pattern for mean evenness (J) and dominance (C) was similar to the pattern in diversity; J was higher and C lower at the 150 m sites than at the 60 and 30 m sites (Appendix 4.48, 4.49).

Figure 11. Distribution of fish site groups from classification analysis.

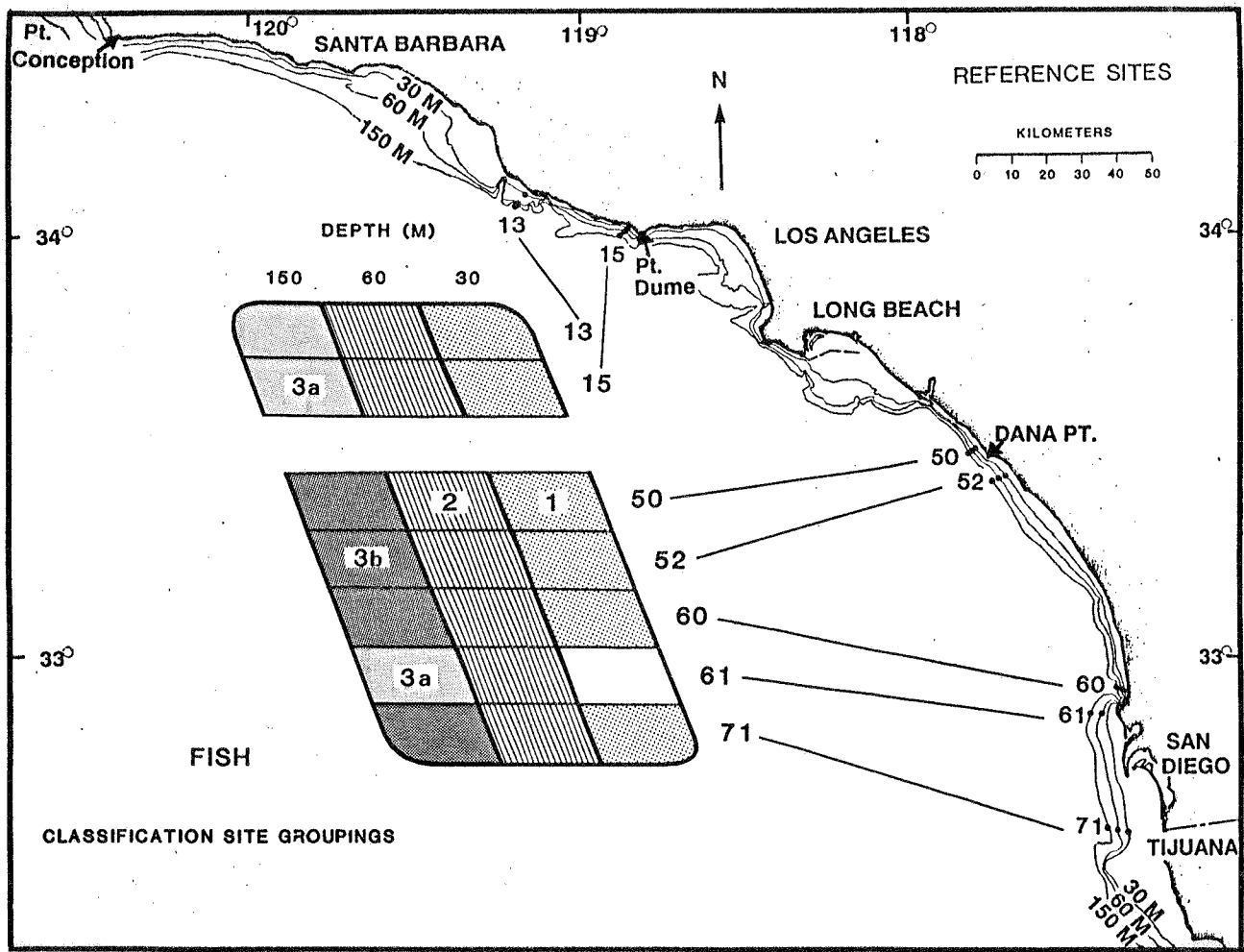


Table 7. Mean number of fish per trawl for species in each classification site group. The five most abundant species in each site group and the ten most commonly collected species (frequency of occurrence = F.O.) were included. The order of the species in this table was produced by inverse classification analysis of the species.

Fish Assemblages					
Mean no. per trawl in each <u>classification site group</u>					
		1	2	3a	3b
Species	F.O.	30m n=6	60m n=7	150m n=3	150m n=4
Speckled sanddab	6	52.2	1.7	0	0
Hornyhead turbot	13	9.7	6.1	0	0
California lizard fish	14	4.7	2.4	0.3	0.8
Longfin sanddab	13	32.7	73.0	0	0.2
California tonguefish	10	0.7	12.6	0	0.2
Yellowchin sculpin	10	0.3	46.6	0.3	0.2
Longspine combfish	6	0.3	19.7	0.3	0
Bigmouth sole	16	6.0	3.3	0.3	4.2
Pink surfperch	9	0	4.0	0	4.8
Pacific sanddab	16	10.2	91.0	99.3	40.5
Slender sole	7	0	0	18.7	188.2
Dover sole	9	0	1.1	8.7	57.0
Stripetail rockfish	9	0	1.7	41.7	38.2
Plainfin midshipman	10	0	1.0	40.7	115.8
Gulf sanddab	7	0	0.4	81.0	16.5
Mean no. species per trawl		11.2	14.1	10.7	18.8
Mean no. Individ. per trawl		129.7	278.9	296.7	553.8
Mean biomass (wet kg) per trawl		8.0	8.2	10.9	18.7

Figure 12. Depth-related trends in mean abundance (\pm std. dev.) of three of the most abundant fishes collected. Arrow indicates standard deviation is off scale.

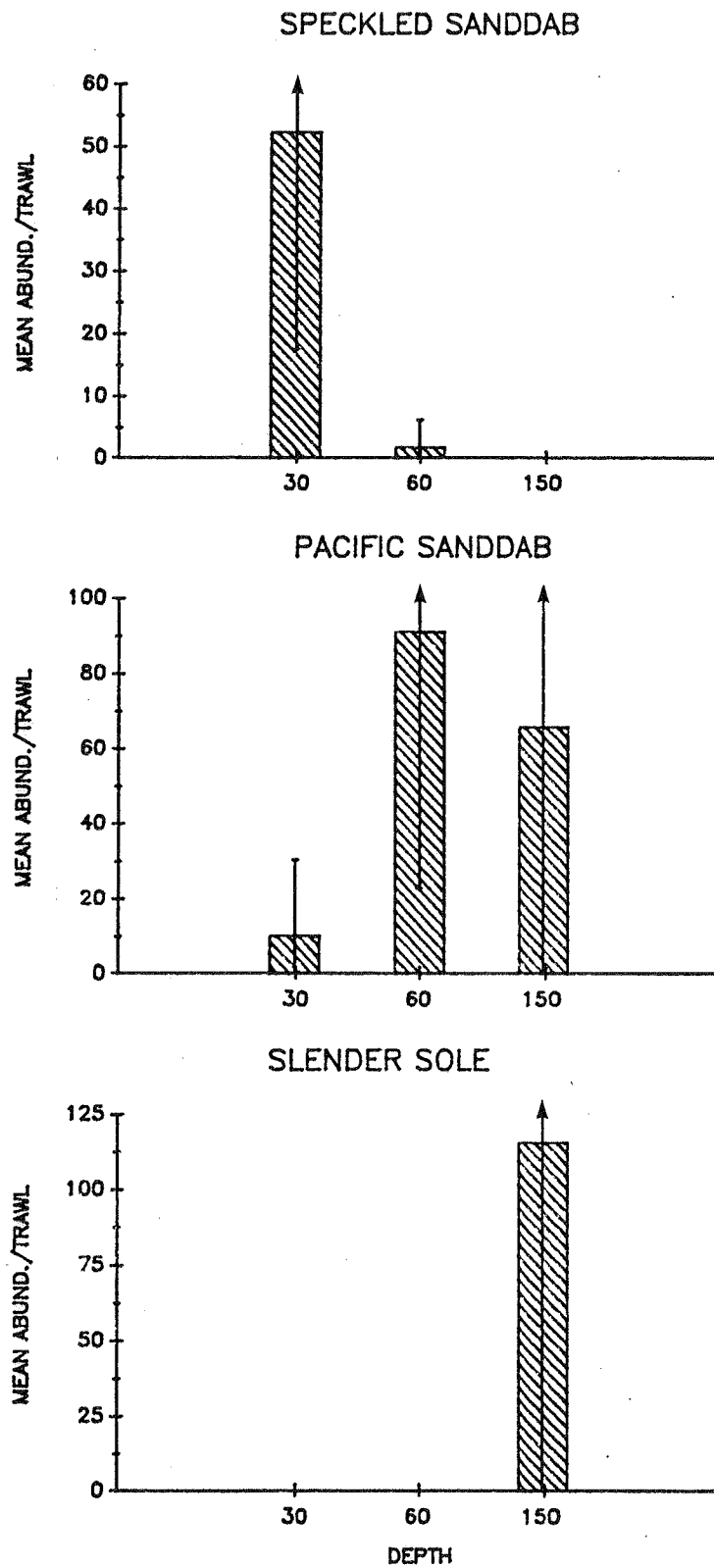
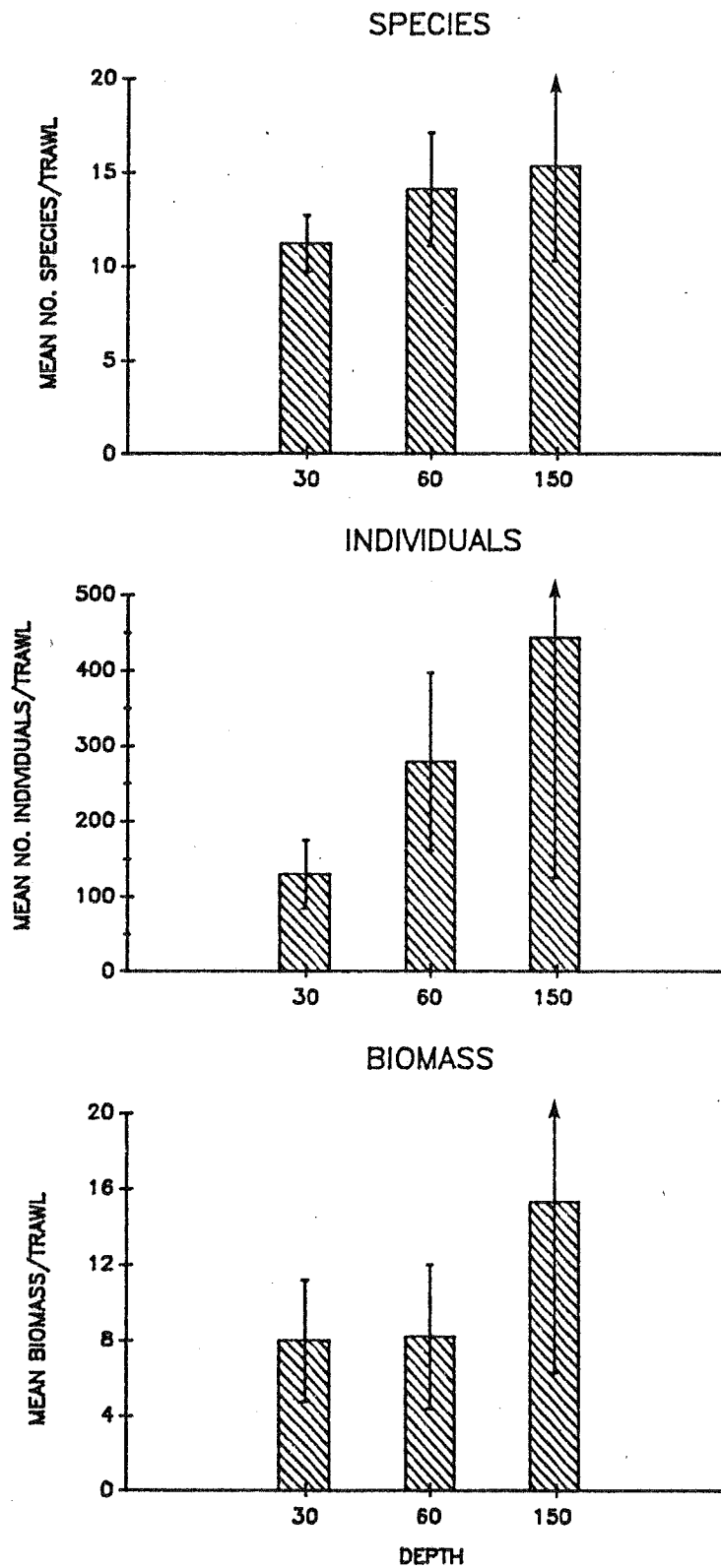


Figure 13. Depth-related trends in mean number of fish species, individuals, and biomass. Arrow indicates standard deviation is off scale.



IV. DISCUSSION AND CONCLUSIONS

The data from this survey serve to update the information from the 1977 and 1985 Reference Surveys, and to provide additional information about long-term temporal variation at reference sites. As in previous surveys by SCCWRP and others (Emery 1960, Anderholt and Reed 1978), the sediment of the southern California mainland shelf between 30 and 150 m was mostly soft, sandy silt. The benthic invertebrates and fish collected were typical southern California reference area organisms as recently summarized by Thompson et al., (In Press), and Cross and Allen (In Press). The distribution of some of the sub-assemblages may be related to water depth; however aggregations of a few species and shifts in dominance may also modify sub-assemblage distributions.

In order to provide estimates of long-term variation at reference sites and to evaluate trends in the data over time, it is necessary to compare the data from the three SCCWRP surveys. However, there are many problems in making those comparisons. All of the methods of analysis for sediment chemistry have changed. Different laboratories used differing methods of extraction and instrumental analysis in each survey. It is assumed that each time these measurements were made, proper QA/QC was conducted and the values reported within each survey are independent and accurate. Since four DDT isomers and 16 PAH compounds were quantified in 1990, six DDT isomers were quantified in 1977 and 1985, and 28 PAH compounds were quantified in 1985, the data for total DDTs and PAHs are not comparable among the surveys

Of equal importance, are the taxonomic differences among the surveys. Taxonomic changes may occur due to refinements in understanding variation in species characteristics. Additionally, different taxonomists working in each survey had different levels of expertise. To facilitate comparisons among the three SCCWRP surveys, the benthic macrofaunal species names were standardized *post hoc*. Names used in each survey were examined and changed, merged or degraded, as necessary. Name degradation occurred when several names within a taxon were combined to a higher taxon to obtain a comparable level of nomenclature among the surveys. Macrobenthic names were standardized only for this comparison, not in the material presented in the preceding text. Standardization was not done for megabenthic invertebrate or fish names. Those groups have generally lower numbers of species and are better known than the macrobenthos.

Notwithstanding the differences in analyses among the surveys, it is desirable to evaluate changes in a given parameter over time. Therefore, values from the three surveys were compared statistically using a one-way ANOVA (Table 8).

Table 8. Comparison of the 1977 60-m Survey, 1985 Reference Survey and 1990 Reference Survey data. Means and confidence limits were calculated using only the same seven 60 m sites sampled in each survey (DDTs and PCBs were only measured at 3 common sites in the 1977 survey). For statistical comparison among years, data values were log₁₀ transformed, or for percentages, arcsine transformed.

Parameter	60 M Survey <u>1977</u>		Ref. Survey <u>1985</u>		Ref. Survey <u>1990</u>		1-Way <u>ANOVA</u> probability
	<u>mean</u>	<u>95%CI</u>	<u>mean</u>	<u>95%CI</u>	<u>mean</u>	<u>95%CI</u>	
<u>Sediment</u>							
% TOC	0.53 ³	(0.15)	0.57	(0.36)	0.57	(0.24)	.982
% TVS	2.7	(0.8)	3.3	(1.8)	2.9 ³	(1.3)	.888
% Sand	46.4	(26.1)	49.7	(38.2)	47.8	(32.4)	.984
Ag (ppm)	0.30	(0.25)	0.04	(0.05)	0.25	(0.43)	.001**
Cd (ppm)	0.30	(0.21)	0.13	(0.11)	0.24	(0.27)	.165
Cr (ppm)	19.8	(9.4)	21.8	(11.1)	25.6	(13.8)	.753
Cu (ppm)	6.3	(2.9)	11.0	(6.4)	9.2	(5.5)	.538
Ni (ppm)	10.1	(8.4)	11.6	(8.7)	11.4	(8.2)	.870
Pb (ppm)	6.3	(1.9)	5.4	(3.4)	6.9	(3.3)	.412
Zn (ppm)	36.1	(12.2)	44.5	(25.7)	45.1	(21.2)	.913
PCBs (ppb)	9.7	(13.6)	18.9	(11.3)	10.6	(11.0)	.235
DDTs (ppb)	28.0	(63.2)	23.5	(35.5)	12.6	(12.7)	NT
PAHs (ppb)	Not measured		26.3	(44.7)	25.9	(14.0)	NT
<u>Biological</u>							
Infaunal sp.	67.8	(22.6)	55.7	(19.4)	82.8	(20.5)	.070
Infaunal indiv.	418.0	(88.0)	331.8	(138.2)	625.8	(573.4)	.136
Infaunal biom.	6.7	(3.1)	10.0	(6.4)	15.2	(15.4)	.354
Megafaunal sp.1	10.7	(5.0)	11.8	(6.0)	13.3	(4.0)	.495
Megafaun. indiv.	1043.4	(1490.2)	85.4	(44.8)	3555.6	(5627.3)	.078 ²
Megafaun. biom.	7.0	(6.1)	3.5	(4.4)	12.4	(10.2)	.075 ²
Fish species ¹	15.6	(3.2)	11.4	(3.8)	14.1	(3.0)	.087
Fish indiv.	375.0	(245.6)	145.8	(73.1)	278.8	(117.9)	.026*
Fish biom.	8.4	(7.1)	3.9	(1.5)	8.2	(3.9)	.029*

* = significant difference between years $\hat{A}=0.05$

** = significant difference between years $\hat{A}=0.01$

1. Names of organisms not standardized between surveys

2. Variances heterogeneous

3. Value calculated from regression

NT = Not tested as different years measured different component DDT isomers and part compounds, see text.

The values for percent TOC, TVS and sand, as well as the concentrations of Cr, Cu, Ni and Zn were lowest in 1977. However, only Cr and Zn consistently increased over time. Given the variability in the data, there was no significant differences among the years for any of the sediment parameters, except for Ag; the concentration of Ag in 1985 was an order of magnitude lower than in 1977 or 1990. The reasons for this difference is not known. There were no consistent decreases in sediment contaminants.

PCBs in sediments were not significantly different among the 3 surveys (Table 8). Trends in DDTs and PAHs were not tested statistically due to differences in the number of DDT isomers and PAH compounds quantified in each survey. Using the 95% confidence intervals as a guide, there does not appear to be any real differences in DDTs or PAHs among the surveys.

All the macrobenthic grab and megabenthic invertebrate trawl parameters were highest in 1990. Although macrobenthic biomass and megabenthic species showed consistent increasing trends over time, there was no significant difference between the years. Megabenthic individuals were two orders of magnitude lower in 1985 than in other years. However, due to the large amount of variation within years, there were no significant differences in any of these grab or trawl parameters over time.

In contrast to the invertebrate data, fish parameters were highest in 1977 and lowest in 1985. Fish individuals and biomass were significantly lower in 1985 at $\hat{\alpha} = 0.05$, but not at $\hat{\alpha} = 0.01$, a more conservative test considering the number of tests conducted.

Most of the biological parameters were lowest in 1985. The reason for this trend is not known. The trend could be related to the 1982-83 El Niño and storms, but it is not possible to determine if this is the case with the data presented herein.

Each time a control or reference survey has been made the number of stations decreased. This is mainly because our concept and knowledge of reference sites is refined from each survey. The current set of seven areas (20 sites) are representative of most shelf habitats off southern California and bracket the major ocean dischargers. These sites probably represent the minimum number of sites that should be used to describe reference conditions on the southern California shelf. Following publication of the NRC study (National Research Council 1990) and renewed interest in regional monitoring, eventually this set of reference sites could be incorporated into a southern California regional monitoring program.

How to use reference site information in monitoring programs remains to be demonstrated. Recommendations on how to use biological information in such a program are discussed in a draft report to the U.S. EPA (Tetra Tech. Draft Report).

V. REFERENCES

- Anderholt, R. and W.E. Reed. 1978. Sedimentary and Organic Characterization. Southern California baseline study, benthic year 2, Vol. III, report 150.0 SAI 77-917-LT. Science Applications, Inc. La Jolla, CA.
- Ballschmiter, K. and M. Zell. 1980. Analysis of Polychlorinated Biphenyls (PCB) by Glass Capillary Chromatography. *Fresen. Z. Anal. Chem.* 302:20-31.
- Boesch, D.F. 1977. Application of numerical classification in ecological investigations of water pollution. U.S.E.P.A., Ecological Research Series. EPA-600/3-77-033.
- Bradfield, G.E. and N.C. Kenkel. 1987. Nonlinear ordination using shortest path adjustment of ecological distances. *Ecology* 68(3): 750-753.
- Clifford, H.T. and W. Stephenson. 1975. An Introduction to Numerical Classification. Academic Press, New York. 229 p.
- Cross, J.N. and L.G. Allen. Fishes of the Southern California Bight. *In: Ecology of the Southern California Bight: A Synthesis and Interpretation.* In Press. Chapter 9.
- Eganhouse, R., R.W. Gossett, and G.P. Hershelman. 1990. Congener-specific Characterization and Source Identification of PCB Input to Los Angeles Harbor. *Final report: California Regional Water Quality Control Board - Los Angeles Region.* September 1990. 34p.
- Eganhouse, R. and R.W. Gossett. 1991. Sources and Magnitude of Bias Associated with Determination of Polychlorinated Biphenyls in environmental Samples. *Anal. Chem.* (In Press).
- Emery, K.O. 1960. The sea off southern California, a modern habitat of petroleum. J. Wiley and Sons, New York, NY. 366 p.
- Hedges, J.I. and J.H. Stern. 1984. Carbon and nitrogen determinations of carbonate-containing solids. *Limnol. Oceanogr.* 29:657-663.
- Kruskal, J.B. and M. Wish. 1978. Multidimensional Scaling. Sage University Papers on Quantitative Applications in the Social Sciences, series no. 07-011. Beverly Hills and London: Sage Publications. 93 p.
- Mearns, A.J. and H.H. Stubbs. 1974. Comparison of Otter Trawls Used in Southern California Coastal Surveys. SCCWRP Tech. Report #213. 14 p.
- National Research Council (NRC). 1990. Monitoring Southern California's Coastal Waters; a Cast Study. *Nat'l Acad. Press.* Washington, D.C.
- Pielou, E.C. 1966. The Measurement of Diversity in Different Types of Biological Collections. *J. Theor. Biol.* 13:131-144.

Plumb, R. 1981. Procedures for Handling and Chemical Analysis of Sediment and Water Samples. *Technical report: EPA/CE-81-1*, U.S. Army Corps of Engineers. Vicksburg.

Shannon, C.E. and W. Weaver. 1949. The Mathematical Theory of Communication. Univ. of Illinois. Urbana, Illinois. 117 p.

Simpson, E.H. 1949. Measurement of Diversity. *Nature*. 163:688.

Smith, R.W., B.B. Bernstein, and R.L. Cimberg. 1988. Community-Environmental Relationships in the Benthos: Applications of Multivariate Analytical Techniques. Chapter 11 *In: Marine Organisms as Indicators*. Springer-Verlag. New York. p. 247-326.

Striplin, P.L. 1987. Resource Utilization by *Astropecten verrilli* along gradients of organic enrichment. MS Thesis. C.S.U.L.B. 158 p.

Tetra Tech, Draft report. Analysis of Ambient Monitoring. Tetra Tech, Inc. Lafayette, ca. 104 pp.

Thompson, B.E., J. Laughlin, and D. Tsukada. 1987. 1985 Reference site survey. *Technical report: #221*, Southern California Coastal Water Research Project. Long Beach, CA. 50 p.

Thompson, B.E., G.F. Jones, J.D. Laughlin, D.T. Tsukada. 1987b. Distribution Structure of Echinoids from Basin Slopes off Southern California. *Bull. So. Cal. Acad. Sci.* 86:113-125.

Thompson, B.E., J. Dixon, S.C. Schroeter, and D.J. Reish. Benthic Invertebrates. *In: Ecology of the Southern California Bight: A Synthesis and Interpretation*. In Press. Chap. 8.

Tukey, J.W. 1951. Quick and Dirty Methods in Statistics, Part II. Simple analysis for standard designs. *Proc. 5th Ann. Conv. Amer. Soc. Qty. Ctrl.* p. 189-197.

Word, J. and A. Mearns. 1979. 60-meter Control Survey off Southern California. *Technical report: #229*, Southern California Coastal Water Research Project 58 p.

APPENDIX 1.

STATION LOCATIONS, SAMPLING DATES AND VESSELS USED

STATION	<u>Loran C</u>		DATE	VESSEL
	LI	L2		
R13-30	28073.2	41345.0	2 AUG 90	MARINE SURVEYOR
R13-60	28071.0	41342.9	"	"
R13-150	28068.4	41344.0	"	"
R15-30	28118.0	41246.2	3 AUG 90	"
R15-60	28117.0	41246.2	"	"
R15-150	28113.5	41245.8	"	"
R50-30	28246.2	40834.9	7 AUG 90	OCEAN SENTINAL
R50-60	28244.2	40835.5	"	"
R50-150	28243.5	40836.0	"	"
R52-30	28254.8	40788.2	6 AUG 90	"
R52-60	28252.8	40790.0	"	"
R52-150	28250.3	40794.6	"	"
R60-30	28272.3	40631.7	31 JULY 90	MONITOR III
R60-60	28270.9	40633.5	"	"
R60-150	28271.5	40636.9	"	"
R61-60	28262.0	40639.0	1 AUG 90	"
R61-150	28257.2	40649.8	"	"
R71-30	28261.8	40588.0	30 JULY 90	"
R71-60	28253.8	40606.0	"	"
R71-150	28248.0	40621.2	"	"

APPENDIX 2. ANALYTICAL METHODS

A. Total Organic Carbon and Nitrogen

Elemental analyses (total organic carbon-TOC, total nitrogen-TN) were carried out on sediments by high temperature (flash) combustion using a Carlo Erba EA1108 elemental analyzer. The sediments were ground with a mortar and pestle, weighed into silver combustion boats, treated for carbonate removal by a modification of the vapor acidification technique of Hedges and Stern (1984), and heated to drive off excess HCl and water. The carbonate-free sediments were then wrapped in tin combustion boats and analyzed on the Carlo Erba elemental analyzer.

Data were acquired with a Carlo Erba EAGER 100 data system which utilizes an IBM-compatible microcomputer. The instrument was calibrated daily with acetanilide. The precision of the sediment analyses for TOC and TN are estimated at < 2% and < 5%, respectively, based on replicate determinations of carbonate-free sediments and sludges.

Analysis of acetanilide showed that the instrument yields results within 0.5, 0.05, and 3.3% of the actual amounts of carbon, nitrogen and hydrogen, respectively. Analysis of National Research Council of Canada standard reference sediments, PACS-1, for total carbon yielded results that agreed with the certified value to within 5.7%. All concentrations presented here are relative to total sediment weight (i.e. including carbonate carbon).

B. Sediment Grain Size Analysis

The sample was thoroughly homogenized by stirring or shaking. Approximately 20-40 g was sub-sampled and placed in a 1000 ml beaker or flask. For sandy sediments, more was used (~40 g): for finer sediments less was used (~20 g). Twenty-five ml 10% hydrogen peroxide was added to digest organic material. When frothing ceased, an additional 10 ml hydrogen peroxide was added and the sample was boiled to remove any excess hydrogen peroxide. Care was taken to avoid boiling over the sample.

The sample was separated into sand and silt/clay fractions by wet sieving through a 63 um stainless steel sieve. The silt/clay fraction that passed through the sieve was collected and the sand fraction was retained on the sieve. The bottom of the sieve was wrapped with foil to prevent loss of sample, and the sample was dried at 40-50°C.

The silt/clay fraction was transferred to a 1000 ml graduated cylinder and allowed to stand until most of the particles had settled (over night). The water was decanted into 500 ml polypropylene bottles and centrifuged for 20 minutes at 1000 RPM. The clear water from the centrifuged bottles was siphoned off and the remaining fine residue was

washed back into the graduated cylinder. Twenty-five ml of 1% Calgon solution was added to the silt/clay fraction to prevent flocculation of the sediment particles.

The sample was then adjusted to 1000 ml with distilled H₂O and observed for flocculation. The sample was vigorously mixed and a 25 ml sample was withdrawn from a depth of 20 cm, 20 seconds after the stirring was stopped (silt fraction). The sample and pipette were rinsed with distilled water into the aluminum weighing dish. A 25 ml sample was taken from a depth of 5 cm at the times tabulated by Plumb (1981) and transferred to a pre-weighed aluminum dish (clay fraction). Twenty-five mls of 1% Calgon solution was also dried in a pre-weighed dish to act as a correction factor in the pipette analysis calculations.

After the sand fraction was dried, a sieve was placed over a smooth sheet of paper. A 2.5 cm soft bristle paint brush was used to brush the particles across the screen until no fine particles continued to pass through the sieve. The fine particles that passed through the 63 um sieve were dried in a pre-weighed aluminum dish and the dried weight added to the silt fraction. The sieve was inverted and the screen brushed to remove additional sand particles caught in the sieve. The particles were added to the sand dish.

Aluminum dishes containing the samples were dried at 50°C and weighed to the nearest 0.0001 g. Calculations were as follows:

$$\text{Silt weight} = ([\text{net wt. sample} - \text{Calgon correction factor}] \times 40) + \text{Additional silt}$$

$$\text{Clay weight} = (\text{net wt. sample} - \text{Calgon correction factor}) \times 40$$

$$\text{Calgon correction factor} = (\text{net weight of 25 ml Calgon}) \times .025 \text{ (ml of Calgon in sample)}$$

C. Trace Metals

After intercalibration studies using standard reference materials were done, trace metal analyses were subcontracted to Global Geochemistry Corporation, Canoga Park, California. Sediments were analyzed for silver, cadmium, chromium, copper, nickel, lead, zinc, iron and manganese.

Sample digestion was done using EPA SW 846 3050 procedure. Wet sediment was digested in nitric acid and hydrogen peroxide. The digestate was then refluxed with either nitric acid or hydrochloric acid and then diluted to a volume of 50 ml. A separate sample was also taken for determination of moisture. An analytical blank was prepared and treated as a sample throughout the digestion procedure.

Samples were analyzed on an inductively coupled plasma emission spectrometer, a

Baird simultaneous PST installed with 27 element channels. The concentrations of the metals were determined by comparison with known standards. Where interelement interference was observed, corrections were made accordingly, i.e., iron on cadmium, copper, chromium and lead; and aluminum on cadmium and lead.

Post digestion spikes of each sample were done and the recoveries were used to correct all data affected by the sample matrix, including pre-digestion spikes.

D. Trace Organics

Analysis of polynuclear aromatic hydrocarbons (PAHs) and chlorinated hydrocarbons (CHCs) was also subcontracted to Global Geochemistry Corporation. Extraction and clean up of the sediments were carried out according to modified SCCRWP methods (Eganhouse *et al.* 1990).

The frozen samples were thawed and homogenized. Wet sediment was extracted three times with methylene chloride by sonication for 30 minutes. The combined extracts were then concentrated to a small volume. Clean up was done using a silica gel column. A fraction corresponding to PAHs and CHCs was isolated and taken up in hexane.

The PAHs were analyzed on an Incos 50 GC-MS using a modified EPA 8270 method. The CHCs were analyzed on a Varian 3700 gas chromatograph equipped with an electron capture detector. The DDT compounds (*o,p'*-DDE, *p,p'*-DDE, *o,p'*-DDT and *p,p'*-DDT) and the Arochlors (1242 and 1254) were quantified by the internal standard method using PCB congener 207 (Ballschmiter and Zell 1980). One peak was used for quantitation of 1242 and two peaks for 1254 as described in Eganhouse *et al.* (1991).

E. Numerical analysis of biological data

Ordination is a technique which simultaneously uses abundances of all species to summarize the patterns of overall community change. With this technique, samples are represented as points positioned in a multidimensional space. The positions of the sample points in the space depend on the relative community composition of the corresponding samples. Samples with similar community composition will be relatively close in the space, and those with very different communities will be relatively far apart. Thus, the distance between a pair of samples in the ordination space is a relative measure of how different the communities are in the two samples.

General discussions of ordination techniques are found in Smith *et al.* (1988). The specific ordination method used in the present study is called local nonmetric multidimensional scaling (Kruskal and Wish 1978).

The data input to the ordination technique is a matrix of intersample dissimilarity index

values contrasting the communities found at all pairs of samples. A pair of samples with similar species composition and abundances will have a relatively low dissimilarity value, and vice versa for sample pairs with very different communities. The particular index used is called the Bray-Curtis, Czekanowski, or percent (dis)similarity index (Clifford and Stephenson 1975, Boesch 1977).

Dissimilarity values were re-estimated using the step-across method (Williamson 1978; Smith 1984; Bradfield and Kenkel 1987). Here, the longer dissimilarity values are re-estimated from the shorter dissimilarity values. If one thinks of dissimilarity values as distances, the manner in which a dissimilarity value is re-estimated is analogous to computing the shortest distance between two cities on a road map by adding the distances between the cities which must be passed through on the way from one city to the other. With the present application, all dissimilarity values above .8 are re-estimated by the step-across procedure. This value (.8) is the point where the Bray-Curtis dissimilarities begin to lose sensitivity.

Before use in the dissimilarity index computations, the species abundance data for each separate impact and control area were pooled (averaged) for each survey. The data were then transformed by a square root and standardized by the species mean (of values > 0).

To evaluate the relationships between abiotic sediment and macrobenthic variables, the data were analyzed using several multivariate methods. First, the 20 sediment variables measured (those listed on Table 3 except for depth and % dry wt.) were analyzed using principal components analysis to derive common sediment factors. Then, those factor scores were used as independent variables in multiple regression analysis to evaluate the contribution of each factor, or variable of interest. Separate analyses were conducted using *Amphiodia* abundance and macrobenthic principal coordinates analysis (ordination) scores. Principal components and multiple regression analyses were conducted using SYSTAT 4.0 software.

APPENDIX 3

LIST OF TAXONOMISTS

SORTERS

Andrew Jirik*
David Tsukada*

TAXONOMISTS

Polychaetes

Diane O'Donohue*
Larry Lovell (Consultant - Vista, Ca).

Crustaceans

Jim Laughlin (Seattle METRO)
Jim Roney (Hyperion Treatment Plant, City of L.A.)

Molluscs

David Tsukada

Echinoderms

David Tsukada

Nemertea

David Tsukada

TRAWL ORGANISMS

Fish

Dario Diehl*
Pat Hershelman* - trawls
Jim Roney - trawls
Karen Smith (Hyperion Treatment Plan, City of L.A.) - trawls
Larry Cooper*
Tim Rothans (City of San Diego (S.D.))
Mike Kelly (City of S.D.)
Steve Lagos (City of S.D.)

TRAWL INVERTEBRATES

Ron Velarde (City of S.D.)
Dorothy Norris (City of S.D.)

* = S.C.C.W.R.P.

APPENDIX 4

STATION: R13 DEPTH: 30

SPECIES	NUMBER/GRAB
AMPELISCA BREVISIMULATA	21
RHEPOXYNIUS VARIATUS	19
PARAPRIONOSPIO PINNATA	11
FOXIPHALUS OBTUSIDENS	11
PRIONOSPIO SP. A	11
EUCLYMENINAE	10
LEPTOCHELIA SP.	9
SPIOPHANES MISSIONENSIS	8
AMPHIDEUTOPUS OCULATUS	8
PRAXILLELLA SP.	8
SPIOPHANES FIMBRIATA	8
GLOTTIDIA ALBIDA	8
MOOREONUPHIS NEBULOSA	7
CHONE VELERONIS	7
MEDIOMASTUS SP.	7
AMPELISCIPHOTIS PODOPHTHALMA	6
ONUPHIDAE	5
SPIOPHANES BOMBYX	5
ASTEROIDEA	4
AMPHIURIDAE	4
EUCLYMENINAE SP. A	4
BALCIS RUTILA	4
MELINNA OCULATA	3
AMPHARETE ARCTICA	3
AMPELISCA CRISTATA	3
RHEPOXYNIUS BICUSPIDATUS	3
OWENIA COLLARIS	3
ASYCHIS DISPARIDENTATA	3
CAPITELLA CAPITATA	2
AMPELISCA PUGETICA	2
ANEMONE #83	2
ASTROPECTEN VERRILLI	2
AMPELISCA HANCOCKI	2
VOLVULELLA CYLINDRICA	2
COMPSOMYAX SUBDIAPHANA	2
AMPHIODIA SP.	2
AMPELISCA CAREYI	2
MALDANE SARSI	2
PECTINARIA CALIFORNIENSIS	2
SPIOPHANES BERKELEYORUM	2
TELLINA CARPENTERI	2
NEPHTYS FERRUGINEA	2
ANOPLODACTYLUS SP.	1
BATHYLEBERIS SP.	1
ANOTOMASTUS GORDIODES	1
GLYCIDAE ARMIGERA	1

AMPHIOPLUS SP.	1
EXOGONE LOUREI	1
EHLERSIA HETEROCHAETA	1
EUSYLLIS SP.	1
CADULUS FUSIFORMIS	1
TEREBELLIDAE	1
POLYCIRRUS CALIFORNICUS	1
TELLINA MODESTA	1
CYLICHNA DIEGENSIS	1
LEPTOPECTEN LATIAURATUS	1
LINEUS FLAVESCENS	1
CYLICHNELLA INTERMEDIA	1
LEVINSENIA GRACILIS	1
PHYLLODOCE HARTMANAE	1
PHOTIS SP.	1
PHORONIS SP.	1
LEPTOGNATHIA SP. B	1
EUPHILOMEDES CARCHARODONTA	1
CEREBRATULUS SP.	1
CHONE MOLLIS	1
HEMILAMPROPS CALIFORNICA	1
TUBULANUS PELLUCIDUS	1
TUBULANUS SP.	1
WESTWOODILLA CAECULA	1
SOLENIIDAE	1
PARANEMERTES SP. A	1
LINEUS SP.	1
TUBULANUS POLYMORPHUS	1
NEBALIA SP.	1
LANICE CONCHILEGA	1
STERNASPIS FOSSOR	1
PODARKEOPSIS SP. A	1
NEPHTYS CAECOIDES	1
DIASTYLIS CALIFORNICA	1

SPECIES/GRAB: 80

IND./GRAB: 269

STATION: R13 DEPTH: 60

SPECIES	NUMBER/GRAB
AMPHIODIA URTICA	37
AMPHIODIA SP.	31
EXOGONE LOUREI	28
PHOTIS BREVIPES	18
PRIONOSPIO SP. A	17
RHEPOXYNIUS BICUSPIDATUS	16
SPIOPHANES MISSIONENSIS	15
AORA SP.	15
NEMATODA	14
PECTINARIA CALIFORNIENSIS	12
PHYLLOCHAETOPTERUS PROLIFICA	12

NEASTACILLA CALIFORNICA	8
CAPRELLA SP.	8
EUPHILOMEDES CARCHARODONTA	8
CHLOEIA PINNATA	8
MEDIOMASTUS SP.	8
GAMMAROPSIS MAMOLA	7
PHOTIS SP.	7
PLEUSYMTES SUBGLABER	7
EUPHILOMEDES PRODUCTA	5
AMPHISSA BICOLOR	5
STHENELANELLA UNIFORMIS	5
PHORONIS SP.	5
AMPHIURIDAE	4
STERNASPIS FOSSOR	4
LEPTOCHELIA SP.	4
GLYCERA CAPITATA	4
FOXIPHALUS OBTUSIDENS	4
AMPHIPHOLIS SP.	3
ASTROPECTEN VERRILLI	3
NEPHASOMA SP.	3
NEMOCARDIUM CENTIFILOSUM	3
PHYLLODOCE MEDIPAPILLATA	3
LEUCON SP.	2
AMPELISCA PUGETICA	2
PARAPRIONOSPIO PINNATA	2
HIPPOMEDON DENTICULATUS	2
JAEROPSIS DUBIA	2
PHOLOE GLABRA	2
TEREBELLIDES REISHI	2
KURTZIELLA BETA	2
LYTECHINUS PICTUS	2
AMPELISCA BREVISIMULATA	2
TEREBELLIDES SP.	2
MAERA SIMILE	2
EXOgone SP. B	2
SPIOPHANES BERKELEYORUM	2
HAVELOCKIA BENTI VAR ZACAE	2
LEPTOGNATHIA SP. B	2
GLYCERA AMERICANA	1
PHERUSA NEOPAPILLATA	1
PIROMIS SP. A	1
LEPTOSYNAPTA SP.	1
PARVILUCINA TENUISCUPTA	1
PHYLLODOCE HARTMANAE	1
SCHMITTIUS POLITUS	1
PODOCERUS CRISTATUS	1
PODOCHELA SP.	1
LUMBRINERIS JAPONICA	1
SABELLARIA CEMENTARIUM	1
BATHYLEBERIS SP.	1
ARCOSCALPELLUM CALIFORNICUM	1
KURTZIA ARTEAGA	1
ANTHOMEDUSAE COL	1
TELLINA CARPENTERI	1

ASTEROIDEA	1
SPIOCHAETOPTERUS COSTARUM	1
NEREIS SP.	1
MALDANE SARSI	1
ANEMONE #83	1
PENTAMERA PSEUDOPULIFERA	1
LANICE CONCHILEGA	1
NEPHTYS FERRUGINEA	1
AMPHIUURA ARCYSTATA	1
PALEANOTUS BELLIS	1
CALYPTRAEA FASTIGIATA	1
CADULUS QUADRIFISSATUS	1
GONIADA MACULATA	1
CAMPANULARIIDAE COL	1
THARYX SP.	1
CAPITELLA CAPITATA	1
CARINOMA MUTABILIS	1
MYRIOWENIA CALIFORNIENSIS	1
OPHIUROCONIS BISPINOSA	1
AMPELISCA PACIFICA	1
BITTIUM SP.	1
HIATELLA ARCTICA	1
PAGURIDAE	1
AMPELISCA CAREYI	1
WESTWOODILLA CAECULA	1
CLYMENURA GRACILIS	1
COOPERELLA SUBDIAPHANA	1
TUBULANUS SP.	1
DIASTYLIS CALIFORNICA	1
AMPELISCA CRISTATA	1
ACANTHOPTILUM SP.	1
EUCLYMENINAE	1
EUCHONE INCOLOR	1
ODOSTOMIA SP.	1
CYLICHNELLA EXIMIA	1
HETEROCRYPTA OCCIDENTALIS	1
AMPELISCA HANCOCKI	1
TENONIA PRIOPS	1
HARMOTHOE CF. LUNULATA	1

SPECIES/GRAB: 104

IND./GRAB: 418

STATION: R13 DEPTH: 150

SPECIES	NUMBER/GRAB
EUPHILOMEDES PRODUCTA	59
AMPHIODIA URTICA	19
MYRIOCHELE SP.	18
SPIOPHANES FIMBRIATA	11
PECTINARIA CALIFORNIENSIS	10
AMPHIODIA SP.	9

SPIOPHANES MISSIONENSIS	7
HETEROPHOXUS OCULATUS	7
THARYX MONILARIS	6
AMPELISCA CAREYI	5
LUMBRINERIS CF. TETRAURA	5
SPIOPHANES BERKELEYORUM	4
PISTA DISJUNCTA	4
TELLINA CARPENTERI	3
HIPPOMEDON DENTICULATUS	3
NICIPPE TUMIDA	3
EUDORELLA PACIFICA	3
AMPHIURIDAE	3
STERNASPIS FOSSOR	3
MYSELLA SP.	3
AMPHARETE ARCTICA	2
CHLOEIA PINNATA	2
THARYX TESSELATA	2
MALDANE SARSI	2
MEDIOMASTUS SP.	2
GLYCIDAE ARMIGERA	2
AXINOPSIDA SERRICATA	2
GLYCERA CAPITATA	2
MONOCULODES SP.	2
PARAPRIONOSPIO PINNATA	2
RHEPOXYNIUS BICUSPIDATUS	2
PARVILUCINA TENUISCULPTA	2
POLYDORA SOCIALIS	1
PRAXILLELLA GRACILIS	1
PRAXILLELLA SP.	1
AMPHIPLUS STRONGYLOPLAX	1
PISTA SP. B	1
AMPHARETE SP.	1
HYDRACTINIA SP. COL	1
PHYLLODOCE LONGIPES	1
GENETYLLIS CASTANEA	1
PHYLLOCHAETOPTERUS LIMICOLUS	1
AMPELISCA PUGETICA	1
LUMBRINERIS CRUZENSIS	1
PHOLOE GLABRA	1
TUBULANUS NOTHUS	1
LAMPROMYS CARINATA	1
THARYX SP. C	1
GONIADA BRUNNEA	1
PRIONOSPIO SP. B	1
THARYX SP. A	1
EUCLYMENINAE SP. A	1
BATHYLEBERIS SP.	1
NEPHTYS FERRUGINEA	1
AORA SP.	1
PARAMYA SP. A	1

NUCULA TENUIS	
AMPELISCA HANCOCKI	1
NEMOCARDIUM CENTIFILOSUM	1
WESTWOODILLA CAECULA	1
EUCLYMENINAE	1
HESPERONOE LAEVIS	1

SPECIES/GRAB: 62

IND./GRAB: 239

STATION: R15 DEPTH: 30

SPECIES	NUMBER/GRAB
AMPHIDEUTOPUS OCULATUS	57
PARAPRIONOSPIO PINNATA	18
AMPELISCA BREVISIMULATA	18
SPIOPHANES MISSIONENSIS	17
PRIONOSPIO SP. A	16
FOXIPHALUS OBTUSIDENS	15
GLOTTIDIA ALBIDA	14
ONUPHIDAE	11
AMPELISCIPHOTIS PODOPHTHALMA	11
RHEPOXYNIUS BICUSPIDATUS	11
EUCLYMENINAE SP. A	10
EUPHILOMEDES CARCHARODONTA	10
LUMBRINERIS CALIFORNIENSIS	9
AMPHIODIA SP.	9
PARVILUCINA TENUISCUPTA	9
AMPELISCA AGASSIZI	9
LEPTOCHELIA SP.	9
MONOCULODES HARTMANAE	7
MACOMA YOLDIFORMIS	7
PHORONIS SP.	6
STHENELANELLA UNIFORMIS	6
EHLERSIA HETEROCHAETA	6
AMPHIURIDAE	5
PHOTIS BREVIPES	4
OWENIA COLLARIS	4
EDOTEA SP. A	4
GNATHIA CRENULATIFRONS	4
MALDANE SARSI	4
AMPHIODIA URTICA	4
CALLIANASSA SP.	4
PODOCERUS CRISTATUS	4
EDWARDSIIDAE	3
LISTRIELLA GOLETA	3
NEPHTYS CAECOIDES	3
PISTA SP. B	3
NEREIS SP.	3
TELLINA CARPENTERI	3
THARYX SP. A	3
NUCULANA TAPHRIA	3

PECTINARIA CALIFORNIENSIS	3
PENTAMERA PSEUDOPOPULIFERA	3
SPIOPHANES BOMBYX	3
MOOREONUPHIS NEBULOSA	3
GLYCERA CAPITATA	3
TUBULANUS SP.	2
BALCIS SP.	2
ENTEROPNEUSTA	2
CIRRIFORMIA SPIRABRANCHA	2
COMPSOMYAX SUBDIAPHANA	2
ASTROPECTEN VERRILLI	2
CHONE ALBOCINCTA	2
KURTZIA ARTEAGA	2
LEPTOSYNAPTA SP.	2
NEPHTYS FERRUGINEA	2
ASTEROPELLA SP.	2
MICRURA SP.	2
MYSELLA SP.	2
RANDALLIA ORNATA	2
SPIOCHAETOPTERUS COSTARUM	2
AMPELISCA PUGETICA	2
LINEIDAE	2
SOLENSICARIUS	1
SPIOPHANES BERKELEYORUM	1
ANEMONE #83	1
SCRUPOCELLARIA DIEGENSIS	COL 1
CADULUS SP.	1
CARINOMA MUTABILIS	1
AMPHISSA UNDATA	1
GLYCIDINDE ARMIGERA	1
HETEROCRYPTA OCCIDENTALIS	1
SYNIDOTEA MAGNIFICA	1
AMPHIURA ARCYSTATA	1
MELINNA OCVLATA	1
CERIANTHARIA	1
LOIMIA MEDUSA	1
LOVENIA CORDIFORMIS	1
AMPHIOPUS SP.	1
VOLVULELLA CYLINDRICA	1
POECILOCHAETUS JOHNSONI	1
GONIADA MACULATA	1
AMPELISCA PACIFICA	1
AMPELISCA HANCOCKI	1
TURBONILLA SP.	1
LUMBRINERIS CRUZENSIS	1
TUBULANUS NOTHUS	1
POLYCIRRUS CALIFORNICUS	1
POLYDORA SOCIALIS	1
AMPHIPORUS SP.	1
LEUCON SUBNASICA	1
MEDIOMASTUS SP.	1
NEBALIA SP.	1
CAPRELLA SP.	1
THARYX MONILARIS	1

NEVERITA RECLUZIANA	1
DIOPATRA SP.	1
AMPHIOPLUS HEXACANTHUS	1
ACMIRA CATHERINAE	1
VOLVULELLA CALIFORNICA	1
PHYLLODOCE LONGIPES	1
PINNIXA OCCIDENTALIS	1
OPHIODERMELLA CANCELLATA	1
PHYLLODOCE SP.	1
PARANEMERTES SP. A	1
TUBULANUS POLYMORPHUS	1
PHERUSA NEOPAPILLATA	1
CYLICHNA DIEGENSIS	1
CHONE SP. B	1
AXINOPSIDA SERRICATA	1
CHONE VELERONIS	1
WESTWOODILLA CAECULA	1

SPECIES/GRAB: 110

IND./GRAB: 444

STATION: R15 DEPTH: 60

SPECIES	NUMBER/GRAB
AMPHIODIA URTICA	158
SPIOPHANES MISSIONENSIS	15
HETEROPHOXUS OCULATUS	12
PARAMYA SP. A	8
LISTRIOLOBUS PELODES	8
CHLOEIA PINNATA	6
AMPELISCA BREVISIMULATA	6
EUPHILOMEDES CARCHARODONTA	5
PECTINARIA CALIFORNIENSIS	5
AXINOPSIDA SERRICATA	5
PHOLOE GLABRA	4
PENTAMERA POPULIFERA	4
NINOE SP. A	4
PRIONOSPIO SP. A	4
PRIONOSPIO (MINUSPIO) LIGHTI	4
TELLINA CARPENTERI	4
PHOTIS BREVIPES	4
HESPERONOE LAEVIS	4
SPIOPHANES BERKELEYORUM	4
LUMBRINERIS CRUZENSIS	3
LEPTOSYNAPTA SP.	3
PINNIXA OCCIDENTALIS	3
MOLPADIA INTERMEDIA	3
CALLIANASSA SP.	3
BYBLIS VELERONIS	3
MEDIOMASTUS SP.	3
CARAZZIELLA CITRONA	3
VOLVULELLA PANAMICA	2

AMPELISCA HANCOCKI		2
MOOREONUPHIS NEBULOSA		2
EUDORELLA PACIFICA		2
CERIANTHARIA		2
EXOGONE LOUREI		2
HARMOTHOE NIGRALBA		2
LUMBRINERIS SP.		2
GONIADA MACULATA		2
SCALIBREGMA INFLATUM		2
GNATHIA CRENULATIFRONS		2
BATHYLEBERIS SP.		2
POECILOCHAETUS JOHNSONI		1
STYLATULA ELONGATA		1
AMPELISCA CAREYI		1
GLYCINDE ARMIGERA		1
ASTEROIDEA		1
LUMBRINERIS CF. TETRAURA		1
LEPTOCHELIA SP.		1
CAMPANULARIIDAE	COL	1
THARYX SP. A		1
KURTZIELLA BETA		1
AMPHIDEUTOPUS OCULATUS		1
MARPHYSA SP. A		1
AORA SP.		1
TURBONILLA SP.		1
SINUM SCOPULOSUM		1
GLYCERA CAPITATA		1
LUMBRINERIS JAPONICA		1
TUBULANUS NOTHUS		1
SARSIELLA SP.		1
ACMIRA CATHERINAE		1
DIASTYLIS SP. A		1
EDWARDSIIDAE		1
NICIPPE TUMIDA		1
ENTEROPNEUSTA		1
EUCLYMENINAE		1
NUCULANA TAPHRIA		1
OWENIA COLLARIS		1
PARAMERMERTES SP. A		1
NASSARIUS PERPINGUIS		1
PARAMERMERTES SP.		1
RHEPOXYNIUS BICUSPIDATUS		1
PARVILUCINA TENUISCUPTA		1
MYRIOCHELE GRACILIS		1
PHORONIS SP.		1
ACTINIARIA		1
PERIPLOMA DISCUS		1
COSSURA CANDIDA		1
BUGULA SP.	COL	1
CYLICHNA DIEGENSIS		1

EUCLYMENINAE SP. A	
DACTYLOPLEUSTES SP. A	1
EUNICE AMERICANA	1
LISTRIELLA GOLETA	1
EUPHILOMEDES PRODUCTA	1
LINEIDAE	1

SPECIES/GRAB: 84
IND./GRAB: 357

STATION: R15 DEPTH: 150

SPECIES	NUMBER/GRAB
AMPHIODIA URTICA	76
EUPHILOMEDES PRODUCTA	19
SPIOPHANES FIMBRIATA	12
PECTINARIA CALIFORNIENSIS	11
EUCLYMENINAE	10
LUMBRINERIS CF. TETRAURA	9
RHEPOXYNIUS BICUSPIDATUS	8
HETEROPHOXUS OCULATUS	8
PISTA DISJUNCTA	7
PHOLOE GLABRA	5
PARAPRIONOSPIO PINNATA	5
SPIOPHANES BERKELEYORUM	5
TELLINA CARPENTERI	5
THARYX SP. C	4
GLYCERA CAPITATA	4
MEDIOMASTUS SP.	4
MONOCULODES SP.	3
SPIOPHANES MISSIONENSIS	3
COSSURA CANDIDA	3
CADULUS QUADRIFISSATUS	3
PARADIOPATRA PARVA	2
CHLOEIA PINNATA	2
EULALIA LEVICORNUTA	2
THARYX MONILARIS	2
AMPELISCA HANCOCKI	2
CHAETODERMA SP.	2
TEREBELLIDES SP.	1
BITTIUM SP.	1
HARMOTHOE SP.	1
STHENELAIS TERTIAGLABRA	1
TUBULANUS NOTHUS	1
AXINOPSIDA SERRICATA	1
SILOPHASMA GEMINATUM	1
DECAMASTUS GRACILIS	1
ORCHOMENE DECIPIENS	1
PARVILUCINA TENUISCUPTA	1

LAONICE APPELOFI	1
OPHIURA LUTKENI	1
TEREBELLIDES REISHI	1
KURTZIELLA BETA	1
EUDORELLA PACIFICA	1
LUMBRINERIS SP.	1
MALDANE SARSI	1
AMPELISCA CAREYI	1
PISTA SP. B	1
LAONICE CIRRATA	1
CLYMENURA GRACILIS	1
PRAXILLELLA SP.	1
PRAXILLELLA GRACILIS	1
CYLICHNELLA INTERMEDIA	1
AMPELISCA BREVISIMULATA	1
MICRURA SP.	1
LISTRIOLOBUS PELODES	1
AMPHIDEUTOPUS OCULATUS	1
PARANAITIS POLYNOIDES	1

SPECIES/GRAB: 55
IND./GRAB: 245

STATION: R50 DEPTH: 30

SPECIES	NUMBER/GRAB
CAPRELLA SP.	23
MEDIOMASTUS SP.	20
THARYX SP. A	17
GLOTTIDIA ALBIDA	11
PARVILUCINA TENUISCUPTA	10
SPIOPHANES MISSIONENSIS	9
HETEROPHOXUS OCULATUS	8
AMPHIODIA URTICA	8
CADULUS FUSIFORMIS	7
PINNIXA OCCIDENTALIS	7
PARAPRIONOSPIO PINNATA	7
SPIOPHANES BERKELEYORUM	6
PISTA SP.	6
MOOREONUPHIS NEBULOSA	6
NEREIS SP.	5
TUBULANUS NOTHUS	5
PRIONOSPIO SP. A	5
LUMBRINERIS CF. TETRAURA	5
OWENIA COLLARIS	5
TELLINA CARPENTERI	4
AMPELISCA BREVISIMULATA	4
TUBULANUS SP.	4
AMPHIODIA SP.	4
SCOLOPLOS ARMIGER	4
SPIOCHAETOPTERUS COSTARUM	4
PENTAMERA PSEUDOPOPULIFERA	3

POLYDORA CONVEXA	3
ENTEROPNEUSTA	3
AMPHIURIDAE	3
CERIANTHARIA	3
EDOTEA SUBLITTORALIS	3
MELINNA OCVLATA	3
MACOMA YOLDIFORMIS	3
POECILOCHAETUS JOHNSONI	3
LINEIDAE	3
SOLENI SICARIUS	2
PRIONOSPION (MINUSPION) LIGHTI	2
GLYCERA AMERICANA	2
CYLICHTNA DIEGENSIS	2
STERNASPIS FOSSOR	2
PECTINARIA CALIFORNIENSIS	2
AMPELISCA CAREYI	2
MYRIOCHELE SP.	2
TUBULANUS PELLUCIDUS	2
LANICE CONCHILEGA	2
OLIGOCHAETA	2
LAONICE CIRRTATA	1
LEITOSCOLOPLOS PUGETTENSIS	1
EHLERSIA HETEROCHAETA	1
EUCLYMENINAE	1
EPITONIUM SP.	1
HIPPOMEDON DENTICULATUS	1
GONIADA BRUNNEA	1
EHLERSIA HYPERIONI	1
PRAXILLELLA SP.	1
LUMBRINERIS CALIFORNIENSIS	1
RHEPOXYNIUS BICUSPIDATUS	1
AMPHARETE LABROPS	1
LYSIPPE SP. A	1
AMPELISCA PUGETICA	1
ACMIRA CATHERINAE	1
HESPERONOE LAEVIS	1
EDWARDSIIDAE	1
PODARKEOPSIS GLABRUS	1
COOPERELLA SUBDIAPHANA	1
NEASTACILLA CALIFORNICA	1
MYSELLA SP.	1
VOLVULELLA CYLINDRICA	1
CHAETODERMA SP.	1
LUCINOMA ANNULATA	1
PHERUSA NEOPAPILLATA	1
TUBULANUS POLYMORPHUS	1
MYTILIDAE	1
MALDANE SARSI	1
AMPELISCA PACIFICA	1
DIASTYLOPSIS TENUIS	1
DRILONEREIS SP.	1
ECLYSIPPE TRILOBATUS	1
NEPHTYS CORNUTA FRANCISCANA	1
SCALIBREGMA INFLATUM	1

PODOCHELA SP.	1
SPIOPHANES BOMBYX	1
ASYCHIS DISPARIDENTATA	1
NEVERITA RECLUZIANA	1
EDOTEA SP. A	1
AMPHIUURA ARCYSTATA	1
MITRELLA AURANTIACA	1

SPECIES/GRAB: 87
IND./GRAB: 287

STATION: R50 DEPTH: 60

SPECIES	NUMBER/GRAB
MYRIOCHELE SP.	1499
AMPHIODIA SP.	122
AMPHIODIA URTICA	67
PECTINARIA CALIFORNIENSIS	64
SPIOPHANES MISSIONENSIS	25
PRIONOSPPIO (MINUSPIO) LIGHTI	19
HETEROPHOXUS OCULATUS	9
EUPHILOMEDES CARCHARODONTA	8
AMPHIURIDAE	8
MEDIOMASTUS SP.	8
RHEPOXYNIUS BICUSPIDATUS	7
GYMNONEREIS CROSSLANDI	6
GLYCERA CAPITATA	4
LEVINSENIA GRACILIS	4
EUPHILOMEDES PRODUCTA	3
STERNASPIS FOSSOR	3
KURTZIELLA BETA	3
AMPELISCA CAREYI	3
PINNIXA OCCIDENTALIS	2
PHORONIS SP.	2
PARAPRIONOSPPIO PINNATA	2
VOLVULELLA PANAMICA	2
PHOLOE GLABRA	2
RUTIDERMA LOMAE	2
ENTEROPNEUSTA	2
LUMBRINERIS SP.	2
PRIONOSPPIO SP. B	2
AMPELISCA PACIFICA	2
GLYCIDINDE ARMIGERA	2
AMPELISCA HANCOCKI	2
PRIONOSPPIO SP. A	2
CYLICHNA DIEGENSIS	2
SPIOPHANES FIMBRIATA	2
DRILONEREIS SP.	1
STHENELANELLA UNIFORMIS	1
ACOETES PACIFICA	1

THARYX SP. A	1
THARYX SP. C	1
LEPIDASTHENIA BERKELEYAE	1
STYLATULA ELONGATA	1
ASYCHIS DISPARIDENTATA	1
SILOPHASMA GEMINATUM	1
TELLINA CARPENTERI	1
AXINOPSIDA SERRICATA	1
CARINOMELLA LACTEA	1
TEREBELLIDES SP.	1
COSSURA SP.	1
PARVILUCINA TENUISCUPTA	1
TRAVISIA BREVIS	1
BYBLIS VELERONIS	1
EUDORELLA PACIFICA	1
PRAXILLELLA GRACILIS	1
PLEHNIA CAECA VAR. OCULIFERA	1
AMPHIPHOLIS SP.	1
AMPHIURA ARCYSTATA	1
NEPHTYS FERRUGINEA	1
ODOSTOMIA SP.	1
MYSELLA SP. B	1
CAPITELLA CAPITATA	1
NEMATODA	1
NEMOCARDIUM CENTIFILOSUM	1
MYTILIDAE	1

SPECIES/GRAB: 62

IND./GRAB: 1921

STATION: R50 DEPTH: 150

SPECIES	NUMBER/GRAB
SPIOPHANES FIMBRIATA	29
LUMBRINERIS CF. TETRAURA	20
AMPHIODIA SP.	19
PECTINARIA CALIFORNIENSIS	16
EUCLYMENINAE	15
THARYX SP. C	13
LEVINSENIA GRACILIS	12
HETEROPHOXUS OCULATUS	10
AMPHIURIDAE	9
GNATHIA CRENULATIFRONS	7
AMPHIODIA URTICA	6
PARADIOPATRA PARVA	6
SPIOPHANES MISSIONENSIS	5
PRIONOSPPIO (MINUSPIO) LIGHTI	5
THARYX MONILARIS	5
PARVILUCINA TENUISCUPTA	5
RHODINE BITORQUATA	4
AMPELISCA CAREYI	4
PISTA DISJUNCTA	4

MALDANE SARSI	4
PRIONOSPIO SP. A	3
PRAXILLELLA GRACILIS	3
TELLINA CARPENTERI	3
STERNASPIS FOSSOR	3
AGLAOPHAMUS DICIRRIS	3
MEDIOMASTUS SP.	2
ONUPHIS IRIDESCENS	2
SPIOCHAETOPTERUS COSTARUM	2
LEPTOGNATHIA SP. B	2
MYRIOCHELE GRACILIS	2
ASYCHIS DISPARIDENTATA	2
AXINOPSIDA SERRICATA	2
COSSURA CANDIDA	2
GONIADA BRUNNEA	1
ALLIA RAMOSA	1
GLYCERA CAPITATA	1
THARYX SP. A	1
EUDORELLA PACIFICA	1
HYPERIIDAE	1
WESTWOODILLA CAECULA	1
TUBULANUS PELLUCIDUS	1
HARMOTHOE SP. B	1
CHAETODERMA SP.	1
SUBADYTE SP. A	1
CARDIOMYA PLANETICA	1
DECAMASTUS GRACILIS	1
DOUGALOPLUS AMPHACANTHA	1
DIASTYLIS PELLUCIDA	1
MOLPADIA INTERMEDIA	1
DIASTYLIS SP. B	1
AMPELISCA SP.	1
LINEUS BILINEATUS	1
MELINNA HETERODONTA	1
SPIOPHANES BERKELEYORUM	1
LIMIFOSSOR FRATULA	1
BRISSOPSIS PACIFICA	1
AMPHIOPLUS SP.	1

SPECIES/GRAB: 57

IND./GRAB: 253

STATION: R52 DEPTH: 30

SPECIES	NUMBER/GRAB
SPIOPHANES MISSIONENSIS	50
AMPHIODIA URTICA	18
GLOTTIDIA ALBIDA	16
TELLINA CARPENTERI	12
PECTINARIA CALIFORNIENSIS	8
AMPELISCA CRISTATA	8
AMPELISCA BREVISIMULATA	8

MOOREONUPHIS NEBULOSA	7
FOXIPHALUS OBTUSIDENS	5
SPIOPHANES BERKELEYORUM	5
SPIOPHANES FIMBRIATA	5
BYBLIS VELERONIS	5
CREPIDULA SP.	4
PHORONIS SP.	4
STERNASPIS FOSSOR	4
COMPSOMYAX SUBDIAPHANA	3
AMPELISCA PUGETICA	3
DIOPATRA SP.	3
AMPELISCA HANCOCKI	3
GNATHIA CRENULATIFRONS	3
MACOMA YOLDIFORMIS	3
POLYCIRRUS SP.	2
HETEROCRYPTA OCCIDENTALIS	2
AMPELISCA CAREYI	2
RHEPOXYNIUS BICUSPIDATUS	2
PENTAMERA PSEUDOPOPULIFERA	2
PARVILUCINA TENUISCUPTA	2
BALCIS OLDROYDI	2
EUCLYMENINAE SP. A	2
PRAXILLELLA SP.	2
EUPHILOMEDES CARCHARODONTA	1
CAMPANULARIIDAE COL	1
CALLIANASSA SP.	1
EHLERSIA HYPERIONI	1
HOLOTHUROIDEA	1
CYLICHNELLA INTERMEDIA	1
CYLICHNA DIEGENSIS	1
HARMOTHOE SP.	1
NOTOCIRRUS CALIFORNIENSIS	1
LUMBRINERIS CF. TETRAURA	1
TUBULANUS NOTHUS	1
TUBULANUS PELLUCIDUS	1
STREBLOSOMA CRASSIBRANCHIA	1
DIASTYLIS CALIFORNICA	1
STHENELAIS TERTIAGLABRA	1
STHENELANELLA UNIFORMIS	1
LEPTOCHELIA SP.	1
GLYCERA CAPITATA	1
COOPERELLA SUBDIAPHANA	1
SCLEROCONCHA TRITUBERCULATA	1
SPIOCHAETOPTERUS COSTARUM	1
SILOPHASMA GEMINATUM	1
AMPELISCA SP.	1
SPIOPHANES BOMBYX	1
EPITONIUM SP.	1
EUDORELLA PACIFICA	1

NEPHTYS FERRUGINEA	
KURTZIA ARTEAGA	1
PHYLLODOCE SP. A	1
PODARKEOPSIS SP. A	1

SPECIES/GRAB: 60

IND./GRAB: 225

STATION: R52 DEPTH: 60

SPECIES	NUMBER/GRAB
AMPHIODIA SP.	101
AMPHIODIA URTICA	87
MYRIOCHELE SP.	29
SPIOPHANES MISSIONENSIS	18
AMPHIURIDAE	15
PECTINARIA CALIFORNIENSIS	15
HETEROPHOXUS OCVLATUS	9
MEDIOMASTUS SP.	7
AMPELISCA BREVISIMULATA	5
MYSELLA SP. B	4
PRIONOSPPIO SP. A	4
PRIONOSPPIO (MINUSPIO) LIGHTI	4
PINNIXA OCCIDENTALIS	4
LUMBRINERIS CF. TETRAURA	4
AMPELISCA CAREYI	3
EUPHILOMEDES CARCHARODONTA	3
RHEPOXYNIUS BICUSPIDATUS	3
EDWARDSIIDAE	3
STHENELANELLA UNIFORMIS	3
STERNASPIS FOSSOR	2
AMPELISCA HANCOCKI	2
NEMOCARDIUM CENTIFILOSUM	2
TUBULANUS PELLUCIDUS	2
COSSURA CANDIDA	2
EUPHILOMEDES PRODUCTA	2
GYMNONEREIS CROSSLANDI	2
CADULUS QUADRIFISSATUS	1
SPIOPHANES BERKELEYORUM	1
AXINOPSIDA SERRICATA	1
SPIOPHANES FIMBRIATA	1
PARADIOPATRA PARVA	1
MYSELLA SP.	1
AORA SP.	1
AMPHIURA SP.	1
AMPELISCA PUGETICA	1
ARUGA OCVLATA	1
OLIGOCHAETA	1
HARMOTHOE SP.	1
AMPHICTEIS SCAPHOBRANCHIATA	1
KURTZIELLA BETA	1
LEVINSENIA GRACILIS	1

AMPELISCA PACIFICA	1
LUMBRINERIS CALIFORNIENSIS	1
VOLVULELLA PANAMICA	1
MALDANE SARSI	1
ENTEROPNEUSTA	1
DENTALIUM SP.	1
BYBLIS VELERONIS	1
PHOLOE GLABRA	1
PODARKEOPSIS GLABRUS	1
PENTAMERA POPULIFERA	1
PARVILUCINA TENUISCUPTA	1
ACOETES PACIFICA	1

SPECIES/GRAB: 53

IND./GRAB: 362

STATION: R52 DEPTH: 150

SPECIES	NUMBER/GRAB
SPIOPHANES FIMBRIATA	25
PECTINARIA CALIFORNIENSIS	21
STERNASPIS FOSSOR	10
AMPHIURIDAE	10
LUMBRINERIS CF. TETRAURA	7
AMPHIODIA SP.	6
THARYX SP. C	5
PRAXILLELLA SP.	5
AMPHIODIA URTICA	4
PISTA DISJUNCTA	4
PARADIOPATRA PARVA	4
CEREBRATULUS SP.	3
LEVINSENIA GRACILIS	3
PRAXILLELLA GRACILIS	3
MALDANE SARSI	3
AMPHIPLUS STRONGYLOPLAX	3
EXOgone LOUREI	2
HETEROPHOXUS OCULATUS	2
MYSELLA SP. B	2
HARMOTHOE SP. B	2
LAONICE APPELLOFI	2
MEDIOMASTUS SP.	2
SPIOPHANES BERKELEYORUM	2
AMPELISCA CAREYI	2
TELLINA CARPENTERI	2
AMAGE ANOPS	1
NEREIS SP.	1
AMPELISCA PACIFICA	1
CIRROPHORUS BRANCHIATUS	1
TUBULANUS NOTHUS	1
TRAVISIA BREVIS	1
CHAETODERMA SP.	1
EHLERSIA HETEROCHAETA	1

SPIOPHANES MISSIONENSIS	1
VOLVULELLA PANAMICA	1
THARYX MONILARIS	1
PARVILUCINA TENUISCUPTA	1
THARYX SP. A	1
THYSANOCARDIA NIGRA	1
RHODINE BITORQUATA	1
PARAMERMERTES SP.	1
PRIONOSPIO SP. A	1
AMPHARETE SP.	1
MYRIOCHELE GRACILIS	1
PARAMAGE SCUTATA	1
PINNIXA OCCIDENTALIS	1
POLYNOIDAE	1
CADULUS QUADRIFISSATUS	1

SPECIES/GRAB: 48

IND./GRAB: 157

STATION: R60 DEPTH: 30

SPECIES	NUMBER/GRAB
RHEPOXYNIUS BICUSPIDATUS	20
TELLINA MODESTA	13
SPIOPHANES MISSIONENSIS	11
HIPPOMEDON DENTICULATUS	8
AMPELISCA BREVISIMULATA	5
NEREIS SP.	5
CHONE VELERONIS	4
AMPHIODIA URTICA	4
EUCLYMENINAE SP. A	4
EUPHILOMEDES CARCHARODONTA	4
SPIOPHANES BOMBYX	4
CLYMENURA GRACILIS	4
GLYCIDINDE ARMIGERA	4
NASSARIUS PERPINGUIS	4
EHLERSIA HETEROCHAETA	3
GLOTTIDIA ALBIDA	3
PRIONOSPIO SP. A	3
THALENESSA SPINOSA	3
PRAXILLELLA SP.	2
LAONICE CIRRATA	2
MOOREONUPHIS NEBULOSA	2
MEDIOMASTUS SP.	2
BALCIS RUTILA	2
AMPELISCA CAREYI	2
LEPTOCHELIA SP.	2
LUMBRINERIS CALIFORNIENSIS	2
PARVILUCINA TENUISCUPTA	1
CAMPYLASPIS SP. C	1
CARINOMA MUTABILIS	1
OLIVELLA BAETICA	1

STHENELANELLA UNIFORMIS	1
ASTEROIDEA	1
PHOLOE GLABRA	1
TURBONILLA SP.	1
RANDALLIA ORNATA	1
AMPHIDEUTOPUS OCULATUS	1
AMPELISCA PUGETICA	1
ENTEROPNEUSTA	1
CHONE MOLLIS	1
ARTACAMELLA HANCOCKI	1
EULIMA CALIFORNICA	1
CADULUS FUSIFORMIS	1
COMPSOMYAX SUBDIAPHANA	1
LINEIDAE	1
LINEUS BILINEATUS	1
GNATHIA CRENULATIFRONS	1
NEBALIA SP.	1
MYSELLA SP.	1
MYRIOCHELE GRACILIS	1
HETEROCRYPTA OCCIDENTALIS	1
LUCINOMA ANNULATA	1

SPECIES/GRAB: 51

IND./GRAB: 147

STATION: R60 DEPTH: 60

SPECIES	NUMBER/GRAB
AMPHIODIA SP.	64
SPIOPHANES MISSIONENSIS	57
AMPHIODIA URTICA	47
PRIONOSPIO SP. A	33
EUCLYMENINAE SP. A	32
SPIOPHANES FIMBRIATA	13
PHOLOE GLABRA	12
PINNIXA OCCIDENTALIS	11
LUMBRINERIS CRUZENSIS	9
HIPPOMEDON DENTICULATUS	8
AMPHIURIDAE	8
ENTEROPNEUSTA	8
GONIADA BRUNNEA	8
RHEPOXYNIUS BICUSPIDATUS	7
MEDIOMASTUS SP.	7
EUCLYMENINAE	7
EUPHILOMEDES CARCHARODONTA	7
PHORONIS SP.	6
LINEUS BILINEATUS	5
LEPTOGNATHIA SP. B	5
LEPTOCHELIA SP.	5
MALDANE SARSI	5
PODARKEOPSIS GLABRUS	4
GNATHIA CRENULATIFRONS	4

LUMBRINERIS CALIFORNIENSIS	4
PHOTIS SP.	4
TEREBELLIDES SP.	4
KURTZIELLA BETA	3
PECTINARIA CALIFORNIENSIS	3
TELLINA CARPENTERI	3
GLYCERA CAPITATA	3
LEPTOSYNAPTA SP.	3
PRIONOSPIO (MINUSPIO) LIGHTI	3
SPIOPHANES BERKELEYORUM	3
CIRRATULUS SP.	3
STERNASPIS FOSSOR	3
TUBULANUS SP.	3
AMPELISCA BREVISIMULATA	3
NEMATODA	2
LYSIPPE SP. B	2
AMPELISCA HANCOCKI	2
EDWARDSIIDAE	2
HARMOTHOE NIGRALBA	2
MOOREONUPHIS NEBULOSA	2
CYLICHNA DIEGENSIS	2
PARAPRIONOSPIO PINNATA	2
EUDORELLA PACIFICA	2
ANONYX CARINATUS	2
EUNICE AMERICANA	2
GLYCERA AMERICANA	2
PARVILUCINA TENUISCUPTA	2
RHODINE BITORQUATA	2
CEREBRATULUS SP.	2
RHEPOXYNIUS VARIATUS	2
STHENELANELLA UNIFORMIS	2
ANOBOTHRUS GRACILIS	1
AMPELISCA SP.	1
SOLEN SP.	1
ARGISSA HAMATIPES	1
CUSPIDARIA PARAPODEMA	1
EHLERSIA HETEROCHAETA	1
SCALIBREGMA INFLATUM	1
BATHYLEBERIS SP.	1
AMPHIDEUTOPUS OCULATUS	1
VOLVULELLA PANAMICA	1
THARYX SP. A	1
THARYX SP. C	1
AMPHIURA ARCYSTATA	1
CADULUS FUSIFORMIS	1
CADULUS QUADRIFISSATUS	1
SYNCHELIDIUM SHOEMAKERI	1
TUBULANUS FRENATUS	1
WESTWOODILLA CAECULA	1
TUBULANUS PELLUCIDUS	1
TUBULARIA SP.	1
ECLYSIPPE TRILOBATUS	1
PARADIOPATRA PARVA	1
MEGALOMMA PIGMENTUM	1

MICROSPPIO PIGMENTATA	1
ODOSTOMIA SP.	1
AMPHIOPLUS SP.	1
JASMINEIRA SP. B	1
MONOSTYLIFERA	1
LEITOSCOLOPLOS PUGETTENSIS	1
PENTAMERA PSEUDOPOPULIFERA	1
LOPHOPANOPEUS BELLUS BELLUS	1
EUCHONE INCOLOR	1
LOVENIA CORDIFORMIS	1
LINEIDAE	1
AMPHIOPLUS HEXACANTHUS	1
MYXICOLA INFUNDIBULUM	1
NASSARIUS PERPINGUIS	1
NEREIS SP.	1
EUNOE CF. DEPRESSA	1
MYRIOCHELE GRACILIS	1
GLOTTIDIA ALBIDA	1
DRILONEREIS SP.	1
PIROMIS SP. A	1
HARMOTHOE SP. B	1
PHYLLODOCE SP. A	1
PISTA DISJUNCTA	1
PLATYNEREIS BICANALICULATA	1
PARANEMERTES SP.	1
HEMILAMPROPS CALIFORNICA	1
PHERUSA NEOPAPILLATA	1

SPECIES/GRAB: 105

IND./GRAB: 501

STATION: R60 DEPTH: 150

SPECIES	NUMBER/GRAB
SPIOPHANES FIMBRIATA	51
PARVILUCINA TENUISCUPTA	50
MALDANE SARSI	45
EUCLYMENINAE	13
THARYX SP. C	12
AXINOPSIDA SERRICATA	9
MEDIOMASTUS SP.	8
PRIONOSPIO (MINUSPIO) LIGHTI	7
THARYX MONILARIS	6
ONUPHIS IRIDESCENS	3
PECTINARIA CALIFORNIENSIS	3
GNATHIA CRENULATIFRONS	3
PARAPRIONOSPIO PINNATA	3
MYRIOCHELE GRACILIS	3
TELLINA CARPENTERI	3
LAONICE APPELLOFI	3
GONIADA BRUNNEA	2
GLYCERA CAPITATA	2

GYMNONEREIS CROSSLANDI	2
RHODINE BITORQUATA	2
CADULUS QUADRIFISSATUS	2
VOLVULELLA PANAMICA	2
CHAETODERMA SP.	2
MELINNA HETERODONTA	2
GLYCERA AMERICANA	2
LIMIFOSSOR FRATULA	2
LUMBRINERIS CF. TETRAURA	2
CEREBRATULUS SP.	1
AXIOPSIS SPINULICAUDA	1
SPIOPHANES MISSIONENSIS	1
CYLICHNA DIEGENSIS	1
NICOMACHE LUMBRICALIS	1
ASYCHIS DISPARIDENTATA	1
NOTOMASTUS TENUIS	1
SPIOCHAETOPTERUS COSTARUM	1
KURTZIELLA BETA	1
SPIOPHANES BERKELEYORUM	1
EUNOE CF. DEPRESSA	1
PARADIOPATRA PARVA	1
AGLAOPHAMUS DICIRRIS	1
MONOCULODES SP.	1
LYSIPPE SP. A	1
ADONTORHINA CYCLIA	1
LUMBRINERIS CRUZENSIS	1
AMPELISCA PACIFICA	1
LINEUS BILINEATUS	1
THARYX SP. A	1
LUMBRINERIS SP.	1
DENTALIUM WATSONI	1
GLYCIDAE ARMIGERA	1
NEPHTYS FERRUGINEA	1
AMPHARETE SP.	1
LINEIDAE	1
EUCLYMENINAE SP. A	1
HESPERONOE LAEVIS	1

SPECIES/GRAB: 55

IND./GRAB: 272

STATION: R61 DEPTH: 60

SPECIES	NUMBER/GRAB
AMPHIODIA URTICA	78
SPIOPHANES MISSIONENSIS	50
MYRIOCHELE SP.	39
AMPHIODIA SP.	19
SPIOPHANES BERKELEYORUM	16
PARVILUCINA TENUISCUPTA	15
PECTINARIA CALIFORNIENSIS	15
MYSELLA SP. B	12

HETEROPHOXUS OCULATUS	10
TELLINA CARPENTERI	10
PRIONOSPIO (MINUSPIO) LIGHTI	9
EUCLYMENINAE SP. A	8
EUPHILOMEDES CARCHARODONTA	8
RHEPOXYNIUS BICUSPIDATUS	7
PHORONIS SP.	7
AMPELISCA PUGETICA	6
GLYCERA CAPITATA	6
STHENELANELLA UNIFORMIS	6
THARYX SP. A	6
STERNASPIS FOSSOR	5
PRIONOSPIO SP. A	4
CADULUS QUADRIFISSATUS	4
PHOLOE GLABRA	4
AXINOPSIDA SERRICATA	4
PINNIXA OCCIDENTALIS	4
BYBLIS VELERONIS	4
LEPTOCHELIA SP.	4
AMPELISCA PACIFICA	4
MEDIOMASTUS SP.	4
AMPHIPHOLIS SP.	4
MYSELLA SP.	3
OWENIA COLLARIS	3
PARAPRIONOSPIO PINNATA	3
ENTEROPNEUSTA	3
NICIPPE TUMIDA	3
LEVINSENIA GRACILIS	3
GYMNONEREIS CROSSLANDI	3
ASTEROIDEA	2
AMPELISCA AGASSIZI	2
LUMBRINERIS CALIFORNIENSIS	2
KURTZIELLA BETA	2
GONIADA MACULATA	2
CYLICHNA DIEGENSIS	2
THARYX SP. C	2
CLYMENURA GRACILIS	2
WESTWOODILLA CAECULA	2
TUBULANUS PELLUCIDUS	2
PHLEBOBRANCHIA	2
TUBULANUS SP.	2
SPIOCHAETOPTERUS COSTARUM	2
CAPITELLA CAPITATA	2
MOOREONUPHIS NEBULOSA	1
EYAKIA ROBUSTA	1
GAMMAROPSIS MAMOLA	1
NEMOCARDIUM CENTIFILOSUM	1
GASTROPTERON PACIFICUM	1
ANOBOTHRUS GRACILIS	1
OPHIUROCONIS BISPINOSA	1
ARUGA OCVLATA	1
ASABELLIDES LINEATA	1
EUNICE AMERICANA	1
CYLICHNELLA INTERMEDIA	1

STENOTHOE FRECANDA	1
ACMIRA SIMPLEX	1
MALDANE SARSI	1
EUCLYMENINAE	1
AMPELISCA HANCOCKI	1
PYCNOGONIDA	1
LOIMIA MEDUSA	1
SYNCHELIDIUM SHOEMAKERI	1
PRIONOSPIO SP. B	1
LUCINOMA ANNULATA	1
LAONICE APPELOFI	1
SARSIELLA SP.	1
SCOLOPLOS ARMIGER	1
SILOPHASMA GEMINATUM	1
KURTZIA ARTEAGA	1
ECHINOIDEA	1
EUPHILOMEDES PRODUCTA	1
VOLVULELLA PANAMICA	1
CAULLERIELLA GRACILIS	1
TUBULANUS POLYMORPHUS	1
PHERUSA NEOPAPILLATA	1
LINEIDAE	1
CALLIANASSA SP.	1
GNATHIA CRENLATIFRONS	1
CAMPANULARIIDAE COL	1
GLYCIDAE ARMIGERA	1
CAPRELLA SP.	1
LEITOSCOLOPLOS PUGETTENSIS	1
LEPTOSYNAPTA SP.	1
TUBULANUS NOTHUS	1
CHLOEIA PINNATA	1
CHONE MINUTA	1
THARYX MONILARIS	1
COSSURA CANDIDA	1
ORCHOMENE DECIPIENS	1

SPECIES/GRAB: 97

IND./GRAB: 467

STATION: R61 DEPTH: 150

SPECIES	NUMBER/GRAB
SPIOPHANES FIMBRIATA	31
SPIOPHANES BERKELEYORUM	30
AMPHIODIA URTICA	25
SPIOPHANES MISSIONENSIS	14
AMPHIODIA SP.	13
EUPHILOMEDES PRODUCTA	12
EUCLYMENINAE	10
MEDIOMASTUS SP.	9
PARVILUCINA TENUISCUPTA	8
RHEPOXYNIUS BICUSPIDATUS	7

AMPHIURIDAE	7
MALDANE SARSI	6
LEPTOGNATHIA SP. B	5
STERNASPIS FOSSOR	5
NOTOMASTUS TENUIS	5
PARADIOPATRA PARVA	5
PHOLOE GLABRA	5
PRAXILLELLA SP.	4
LYSIPPE SP. B	4
CADULUS QUADRIFISSATUS	3
CLYMENURA GRACILIS	3
TRAVISIA BREVIS	3
THARYX SP. C	3
PECTINARIA CALIFORNIENSIS	2
LYSIPPE SP. A	2
PRIONOSPIO SP. A	2
DOUGALOPLUS AMPHACANTHA	2
AMPELISCA CAREYI	2
HETEROPHOXUS OCULATUS	2
GLYCERA CAPITATA	2
ADONTORHINA CYCLIA	2
AGLAOPHAMUS DICIRRIS	2
ALLIA ANTENNATA	2
MAGELONA CF. BERKELEYI	1
PISTA SP. B	1
SPIOCHAETOPTERUS COSTARUM	1
ORCHOMENE SP.	1
BATHYMEDON SP.	1
PRAXILLELLA GRACILIS	1
AMAGE ANOPS	1
AMPHARETIDAE	1
ALLIA CF. NOLANI	1
TELLINA CARPENTERI	1
TUBULANUS NOTHUS	1
ASTEROIDEA	1
MICROSPPIO PIGMENTATA	1
THYSANOCARDIA NIGRA	1
ANOBOTHRUS GRACILIS	1
CHLOEIA PINNATA	1
PHYLLODOCE HARTMANAE	1
THARYX SP. A	1
CYLICHNA DIEGENSIS	1
CYCLOCARDIA VENTRICOSA	1
EUPHILOMEDES CARCHARODONTA	1
ACMIRA CATHERINAE	1
DECAMASTUS GRACILIS	1
GLYCERA AMERICANA	1
DIASTYLIS SP. A	1
LEITOSCOLOPLOS PUGETTENSIS	1
LUMBRINERIS CRUZENSIS	1
	1

JASMINEIRA SP. B	
GONIADA BRUNNEA	1
AMPHICTEIS SCAPHOBRANCHIATA	1
PRIONOSPIO SP. B	1
LEPTOSYNAPTA SP.	1

SPECIES/GRAB: 65
IND./GRAB: 269

STATION: R71 DEPTH: 30

SPECIES	NUMBER/GRAB
SPIOPHANES BOMBYX	26
THARYX SP. C	15
NEREIS SP.	14
SPIOPHANES MISSIONENSIS	10
OWENIA COLLARIS	9
PINNIXA OCCIDENTALIS	9
SCALIBREGMA INFLATUM	9
ARUGA OCVLATA	9
MAGELONA SACCULATA	7
EUPHILOMEDES CARCHARODONTA	6
AMPELISCA BREVISIMULATA	6
AMPELISCA CRISTATA	6
MYSELLA SP.	6
PHORONIS SP.	5
ONUPHIS IRIDESCENS	5
PARAPRIONOSPIO PINNATA	5
SPIOPHANES BERKELEYORUM	4
MAGELONA HARTMANAE	4
FOXIPHALUS OBTUSIDENS	4
CHONE VELERONIS	4
HETEROMASTUS FILIFORMIS	4
CARINOMA MUTABILIS	3
AMPELISCA HANCOCKI	3
RICTAXIS PUNCTOCAELATUS	3
TELLINA CARPENTERI	3
LISTRIELLA GOLETA	3
GLOTTIDIA ALBIDA	2
CADULUS SP.	2
CADULUS FUSIFORMIS	2
MEGALOMMA PIGMENTUM	2
PRAXILLELLA SP.	2
EUCLYMENINAE SP. A	2
CYLICHTNA DIEGENSIS	2
PISTA DISJUNCTA	2
PISTA SP. B	2
APOPRIONOSPIO PYGMAEA	1
BALCIS RUTILA	1
ASTEROIDEA	1
AMPHARETE LABROPS	1
MEGALOMMA SP.	1

CALLIANASSA SP.	1
NASSARIUS SP.	1
MICRURA SP.	1
KURTZIA ARTEAGA	1
PRIONOSPIO SP. A	1
PHOTIS SP.	1
MEDIOMASTUS SP.	1
LEUROLEBERIS SHARPEI	1
GLYCERA OXYCEPHALA	1
PINNIXA FRANCISCANA	1
PHYLLODOCE HARTMANAE	1
OLIVELLA BAETICA	1
SPIOCHAETOPTERUS COSTARUM	1
AMPHIDEUTOPUS OCULATUS	1
CREPIDULA SP.	1
LYONSIA CALIFORNICA	1
CHAETOZONE CF. SETOSA	1
AMAEANA OCCIDENTALIS	1
PRIONOSPIO (MINUSPIO) LIGHTI	1
PARVILUCINA TENUISCUPTA	1
TUBULANUS PELLUCIDUS	1
STHENELANELLA UNIFORMIS	1
CHONE MOLLIS	1
NEPHTYS CALIFORNIENSIS	1
SYNCHELIDIUM SHOEMAKERI	1
LEPTOCHELIA SP.	1
NEPHTYS CAECOIDES	1

SPECIES/GRAB: 67

IND./GRAB: 232

STATION: R71 DEPTH: 60

SPECIES	NUMBER/GRAB
MICRANELLUM CREBRICINCTUM	40
EUPHILOMEDES CARCHARODONTA	40
PHORONIS SP.	28
CHLOEIA PINNATA	24
SPIOPHANES MISSIONENSIS	24
PISTA SP. B	14
FOXIPHALUS OBTUSIDENS	12
PRIONOSPIO SP. A	12
SPIOPHANES BOMBYX	10
PARVILUCINA TENUISCUPTA	8
PARADIOPATRA PARVA	7
EUCHONE INCOLOR	7
LEPTOCHELIA SP.	7
EUCLYMENINAE SP. A	6
ASABELLIDES LINEATA	6
JASMINEIRA SP. B	6
EUCLYMENINAE	5
PECTINARIA CALIFORNIENSIS	5

STHENELANELLA UNIFORMIS	4
MEDIOMASTUS SP.	4
NEMOCARDIUM CENTIFILOSUM	4
ONUPHIS IRIDESCENS	4
SPIOCHAETOPTERUS COSTARUM	4
POLYDORA CONVEXA	3
MYRIOCHELE OCULATA	3
LYONSIA CALIFORNICA	3
GLYCERA CAPITATA	3
MEGALUROPIDAE SP. A	3
ANEMONE #83	3
CIRROPHORUS LYRA	3
PHLEBOBRANCHIA	3
THARYX TESSELATA	2
CHONE MOLLIS	2
CHONE SP. C	2
ACMIRA SIMPLEX	2
ANOBOTHRUS GRACILIS	2
MEGALOMMA PIGMENTUM	2
OWENIA COLLARIS	1
CEREBRATULUS SP.	1
PARANEMERTES SP.	1
ASTROPECTEN VERRILLI	1
BRISSOPSIS PACIFICA	1
PROCAMPYLASPIS SP. A	1
CAMPYLASPIS CANALICULATA	1
CARINOMA MUTABILIS	1
NOTOMASTUS MAGNUS	1
THYSANOCARDIA NIGRA	1
MELINNA OCULATA	1
PANDORA BILIRATA	1
AMPHARETE ARCTICA	1
ONUPHIDAE	1
AMPHICTEIS SCAPHOBRANCHIATA	1
MALDANE SARSI	1
LYSIPPE SP. A	1
LIMNORIA SP.	1
ETEONE SP.	1
GLYCINDE ARMIGERA	1
RHODINE BITORQUATA	1
SOLARIELLA SP.	1
LANASSA SP. D	1
NUCULANA HAMATA	1
LANICE CONCHILEGA	1
GONIADA MACULATA	1
LAONICE APPELLOFI	1
TUBULANUS SP.	1
LINEUS BILINEATUS	1
ENTEROPNEUSTA	1
GNATHIA CRENULATIFRONS	1

CHAETOZONE NR. CORONA	
LUMBRINERIS SP.	1
EUNICE AMERICANA	1
LUMBRINERIS CALIFORNIENSIS	1
SILOPHASMA GEMINATUM	1
PHOTIS SP.	1
MYRIOCHELE SP.	1

SPECIES/GRAB: 75
IND./GRAB: 355

STATION: R71 DEPTH: 150

SPECIES	NUMBER/GRAB
EUPHILOMEDES PRODUCTA	30
MEDIOMASTUS SP.	25
PARADIOPATRA PARVA	20
AMPHIODIA URTICA	18
AMPHICHONDRIUS GRANULOSUS	15
SPIOPHANES FIMBRIATA	12
EUCLYMENINAE	10
PONTOGENIA SP.	10
PECTINARIA CALIFORNIENSIS	10
AMPHIODIA SP.	6
PRAXILLELLA SP.	6
PRIONOSPIO SP. A	6
LYTECHINUS PICTUS	5
HETEROPHOXUS OCULATUS	5
PRIONOSPIO SP. B	5
DOUGALOPLUS AMPHACANTHA	4
SPIOPHANES MISSIONENSIS	4
GLYCERA CAPITATA	4
MYRIOCHELE GRACILIS	4
DECAMASTUS GRACILIS	3
MONOCULODES SP.	3
SILOPHASMA GEMINATUM	2
HIPPOMEDON DENTICULATUS	2
LYSIPPE SP. B	2
LEPTOGNATHIA SP. B	2
AMPHARETE ARCTICA	2
PARVILUCINA TENUISCUPTA	2
LUMBRINERIS SP.	2
NOTHRIA OCCIDENTALIS	2
GNATHIA CRENULATIFRONS	2
THARYX MONILARIS	2
BRISSOPSIS PACIFICA	2
AMPHIURIDAE	2
THARYX SP. C	2
EXOGONE LOUREI	2
PARAONIDAE	2
THARYX SP. A	2
CAPRELLA SP.	1

LINEIDAE	1
BYBLIS VELERONIS	1
SPIOCHAETOPTERUS COSTARUM	1
SARSIELLA SP.	1
CAMPYLASPIS SP.	1
RHAMPHOBRACHIUM LONGISETOSUM	1
CARINOMA MUTABILIS	1
ARGULUS SP.	1
AMYGDALUM PALLIDULUM	1
GYMNONEREIS CROSSLANDI	1
PISTA ALATA	1
AORA SP.	1
GLYCINDE ARMIGERA	1
LEVINSENIA GRACILIS	1
AMPHIURA SP.	1
EUNOE CF. DEPRESSA	1
LAONICE APPELOFI	1
POLYCIRRUS CALIFORNICUS	1
AMPHICTEIS SCAPHOBRANCHIATA	1
PISTA SP. B	1
PRIONOSPIO (MINUSPIO) LIGHTI	1
THARYX TESSELATA	1
AMPELISCA HANCOCKI	1
TUBULANUS POLYMORPHUS	1
AMPELISCA SP.	1
MALDANE SARSI	1
ORBINIIDAE	1
NOTOMASTUS TENUIS	1
DENTALIUM SP.	1
DIASTYLIS SP. A	1
GONIADA MACULATA	1
HETEROMASTUS FILOBRANCHUS	1
ACMIRA CATHERINAE	1
RUTIDERMA LOMAE	1
CLYMENURA GRACILIS	1
ACMIRA SIMPLEX	1
ACMIRA LOPEZI	1
AMPELISCA CAREYI	1
ADONTORHINA CYCLIA	1
LEITOSCOLOPLOS PUGETTENSIS	1
NEPHTYS FERRUGINEA	1
RHEPOXYNIUS MENZIESI	1
NICIPPE TUMIDA	1
EUCHONE INCOLOR	1
RHEPOXYNIUS BICUSPIDATUS	1
TELLINA CARPENTERI	1

SPECIES/GRAB: 84

IND./GRAB: 284

APPENDIX 5

STATION: R13 DEPTH(M): 30

SPECIES	NO./TRAWL	KG. WET WT/TRAWL
CITHARICHTHYS STIGMAEUS	99	1.0
CITHARICHTHYS XANTHOSTIGMA	44	3.0
PLEURONICHTHYS VERTICALIS	16	2.7
CITHARICHTHYS SORDIDUS	9	0.5
HIPPOGLOSSINA STOMATA	8	0.5
PAROPHRYS VETULUS	6	1.0
SYNODUS LUCIOCEPS	3	0.0
ICELINUS QUADRISERIATUS	2	0.0
RAJA INORNATA	2	1.5
SYMPHURUS ATRICAUDA	1	0.0
XYSTREURYS LIOLEPIS	1	0.2
SCORPAENA GUTTATA	1	0.2
MISC. WT. *	0	0.1

NO. SPECIES: 13.00
IND./TRAWL: 192.00
KG./TRAWL: 10.70

STATION: R15 DEPTH(M): 30

SPECIES	NO./TRAWL	KG. WET WT/TRAWL
CITHARICHTHYS STIGMAEUS	46	0.3
PLEURONICHTHYS VERTICALIS	19	3.1
HIPPOGLOSSINA STOMATA	16	1.4
XYSTREURYS LIOLEPIS	6	1.1
PAROPHRYS VETULUS	5	0.9
SYNODUS LUCIOCEPS	3	0.1
ZANIOLEPIS LATIPINNIS	2	0.0
CITHARICHTHYS XANTHOSTIGMA	2	0.1
SCORPAENA GUTTATA	2	0.4
CITHARICHTHYS SORDIDUS	1	0.0
RAJA INORNATA	1	1.0
MISC. WT. *	0	0.1

NO. SPECIES: 12.00
IND./TRAWL: 103.00
KG./TRAWL: 8.45

STATION: R50 DEPTH(M): 30

SPECIES	NO./TRAWL	KG. WET WT/TRAWL
CITHARICHTHYS STIGMAEUS	30	0.2

CITHARICHTHYS XANTHOSTIGMA	22	2.9
SYNODUS LUCIOCEPS	12	2.0
PLEURONICHTHYS VERTICALIS	7	1.8
HIPPOGLOSSINA STOMATA	4	0.4
PHANERODON FURCATUS	3	0.4
HETEROSTICHUS ROSTRATUS	2	0.01
XYSTREURYS LIOLEPIS	2	0.3
SCORPAENA GUTTATA	1	0.3
PLEURONICHTHYS DECURRENS	1	0.2
PARALICHTHYS CALIFORNICUS	1	0.3
SYMPHURUS ATRICAUDA	1	0.02
RAJA BINOCULATA	1	0.3

NO. SPECIES: 13.00
IND./TRAWL: 87.00
KG./TRAWL: 9.13

STATION: R52 DEPTH(M): 30

SPECIES	NO./TRAWL	KG. WET WT/TRAWL
CITHARICHTHYS XANTHOSTIGMA	57	4.7
CITHARICHTHYS SORDIDUS	51	0.3
SCORPAENA GUTTATA	7	2.3
SYNODUS LUCIOCEPS	6	0.4
PLEURONICHTHYS VERTICALIS	3	0.7
HIPPOGLOSSINA STOMATA	2	0.3
RHINOBATOS PRODUCTUS	1	1.7
RAJA BINOCULATA	1	0.3
SYMPHURUS ATRICAUDA	1	0.1
XYSTREURYS LIOLEPIS	1	0.3

NO. SPECIES: 10.00
IND./TRAWL: 130.00
KG./TRAWL: 11.05

STATION: R60 DEPTH(M): 30

SPECIES	NO./TRAWL	KG. WET WT/TRAWL
CITHARICHTHYS STIGMAEUS	71	0.1
CITHARICHTHYS XANTHOSTIGMA	69	0.1
CITHARICHTHYS SP.	20	0.0
PLEURONICHTHYS VERTICALIS	9	1.2
HIPPOGLOSSINA STOMATA	3	0.4
SYNODUS LUCIOCEPS	2	0.0
PLATYRHINOIDIS TRISERIATA	1	0.4
SCORPAENA GUTTATA	1	0.3
XYSTREURYS LIOLEPIS	1	0.3
MISC. WT.*	0	0.1

NO. SPECIES: 10.00

IND./TRAWL: 177.00
KG./ TRAWL: 2.90

STATION: R71 DEPTH(M): 30

SPECIES	NO./TRAWL	KG. WET WT/TRAWL
CITHARICHTHYS STIGMAEUS	67	0.6
PLEURONICHTHYS VERTICALIS	4	0.9
HIPPOGLOSSINA STOMATA	3	0.5
PAROPHRYS VETULUS	3	0.4
PARALICHTHYS CALIFORNICUS	2	1.0
SCORPAENA GUTTATA	2	0.8
SYNODUS LUCIOCEPS	2	0.3
CITHARICHTHYS XANTHOSTIGMA	2	0.4
XYSTREURYS LIOLEPIS	1	0.3
PLEURONICHTHYS RITTERI	1	0.1
SEBASTES AURICULATUS	1	0.2
SYMPHURUS ATRICAUDA	1	0.1

NO. SPECIES: 12.00
IND./TRAWL: 89.00
KG./TRAWL: 5.55

STATION: R13 DEPTH(M): 60

SPECIES	NO./TRAWL	KG. WET WT/TRAWL
CITHARICHTHYS SORDIDUS	205	5.8
ICELINUS QUADRISERIATUS	27	0.2
PLEURONICHTHYS VERTICALIS	13	1.3
ZANIOLEPIS LATIPINNIS	8	0.2
SEBASTES SAXICOLA	6	0.0
MICROSTOMUS PACIFICUS	3	0.3
ODONTOPYXIS TRISPINOSA	2	0.0
ZANIOLEPIS FRENATA	2	0.0
HIPPOGLOSSINA STOMATA	2	0.0
OPHIODON ELONGATUS	1	0.2
CITHARICHTHYS FRAGILIS	1	0.0
PARALICHTHYS CALIFORNICUS	1	1.6
SYNODUS LUCIOCEPS	1	0.1
ZALEMBIUS ROSACEUS	1	0.0
PORICHTHYS NOTATUS	1	0.0
EOPSETTA JORDANI	1	0.7
MISC. WT. *	0	0.1

NO. SPECIES: 17.00
IND./TRAWL: 275.00
KG./TRAWL: 10.50

STATION: R15 DEPTH(M): 60

SPECIES	NO./TRAWL	KG. WET WT/TRAWL
ZANIOLEPIS LATIPINNIS	105	2.2
CITHARICHTHYS SORDIDUS	53	0.8
ICELINUS QUADRISERIATUS	29	0.2
ARGENTINA SIALIS	15	0.0
ZALEMBIUS ROSACEUS	11	0.1
CITHARICHTHYS XANTHOSTIGMA	7	0.5
SEBASTES SAXICOLA	6	0.0
SYMPHURUS ATRICAUDA	6	0.2
MICROSTOMUS PACIFICUS	5	0.6
HIPPOGLOSSINA STOMATA	2	0.2
PLEURONICHTHYS VERTICALIS	2	0.0
SEBASTES (SEBASTOMUS) SP.	2	0.0
PARALABRAX NEBULIFER	1	0.6
SEBASTES VEXILLARIS	1	0.0
SYNODUS LUCIOCEPS	1	0.0
ODONTOPYXIS TRISPINOSA	1	0.0
MISC. WT. *	0	0.1

NO. SPECIES: 17.00
IND./TRAWL: 247.00
KG./TRAWL: 5.50

STATION: R50 DEPTH(M): 60

SPECIES	NO./TRAWL	KG. WET WT/TRAWL
CITHARICHTHYS XANTHOSTIGMA	51	2.7
CITHARICHTHYS SORDIDUS	46	0.3
ICELINUS QUADRISERIATUS	35	0.2
SYMPHURUS ATRICAUDA	27	0.7
SYNODUS LUCIOCEPS	11	2.5
HIPPOGLOSSINA STOMATA	6	0.7
ZALEMBIUS ROSACEUS	5	0.1
CORYPHOPTERUS NICHOLSII	4	0.0
PLEURONICHTHYS VERTICALIS	3	0.4
XENERETMUS LATIFRONS	1	0.0
PORICHTHYS NOTATUS	1	0.0
MISC. WT. *	0	0.1

NO. SPECIES: 12.00
IND./TRAWL: 190.00
KG./TRAWL: 7.70

STATION: R52 DEPTH(M): 60

SPECIES	NO./TRAWL	KG. WET WT/TRAWL
ICELINUS QUADRISERIATUS	98	0.2
CITHARICHTHYS XANTHOSTIGMA	65	1.3
SYMPHURUS ATRICAUDA	34	1.7
CORYPHOPTERUS NICHOLSII	8	0.0
PLEURONICHTHYS VERTICALIS	3	0.3
SYNODUS LUCIOCEPS	2	0.0
HIPPOGLOSSINA STOMATA	2	0.3
ZALEMBIUS ROSACEUS	2	0.0
SEBASTES MINIATUS	1	0.2
SEBASTES ROSACEUS	1	0.3
PORICHTHYS NOTATUS	1	0.0
MISC. WT.*	0	0.2

NO. SPECIES: 12.00
IND./TRAWL: 217.00
KG./TRAWL: 4.45

STATION: R60 DEPTH(M): 60

SPECIES	NO./TRAWL	KG. WET WT/TRAWL
CITHARICHTHYS XANTHOSTIGMA	246	10.7
ICELINUS QUADRISERIATUS	132	0.5
CITHARICHTHYS SORDIDUS	77	1.3
ZANIOLEPIS LATIPINNIS	23	0.3
SYMPHURUS ATRICAUDA	8	0.2
CHITONOTUS PUGETENSIS	7	0.1
PLEURONICHTHYS VERTICALIS	6	0.6
HIPPOGLOSSINA STOMATA	5	0.7
ZALEMBIUS ROSACEUS	4	0.0
CITHARICHTHYS SP.	3	0.0
CITHARICHTHYS FRAGILIS	2	0.0
ARGENTINA SIALIS	2	0.0
PORICHTHYS NOTATUS	2	0.1
SEBASTES MINIATUS	1	0.0
ODONTOPYXIS TRISPINOSA	1	0.0
PAROPHRYUS VETULUS	1	0.1
MERLUCCIUS PRODUCTUS	1	0.3
MISC. WT.*	0	0.2

NO. SPECIES: 18.00
IND./TRAWL: 521.00
KG./TRAWL: 15.10

STATION: R61 DEPTH(M): 60

SPECIES	NO./TRAWL	KG. WET WT/TRAWL
CITHARICHTHYS SORDIDUS	133	1.5
CITHARICHTHYS XANTHOSTIGMA	127	5.6
SYMPHURUS ATRICAUDA	13	0.3
PLEURONICHTHYS VERTICALIS	10	0.6
CORYPHOPTERUS NICHOLSII	7	0.0
CHITONOTUS PUGETENSIS	5	0.0
CHILARA TAYLORI	5	0.0
ODONTOPYXIS TRISPINOSA	5	0.0
LEPIDOGOBIUS LEPIDUS	4	0.0
ZALEMBIUS ROSACEUS	4	0.1
HIPPOGLOSSINA STOMATA	2	0.1
SEBASTES DALLII	2	0.0
RATHBUNELLA HYPOPLECTA	2	0.0
PORICHTHYS NOTATUS	2	0.1
SEBASTES SP.	1	0.0
RAJA INORNATA	1	1.0
ICELINUS QUADRISERIATUS	1	0.0
MISC. WT. *	0	0.4

NO. SPECIES: 18.00
IND./TRAWL: 324.00
KG./TRAWL: 9.70

STATION: R71 DEPTH(M): 60

SPECIES	NO./TRAWL	KG. WET WT/TRAWL
CITHARICHTHYS SORDIDUS	123	1.6
CITHARICHTHYS XANTHOSTIGMA	15	0.8
CITHARICHTHYS STIGMAEUS	12	0.2
CHITONOTUS PUGETENSIS	8	0.1
PLEURONICHTHYS VERTICALIS	6	0.4
ICELINUS QUADRISERIATUS	4	0.1
HIPPOGLOSSINA STOMATA	4	0.2
ZANIOLEPIS LATIPINNIS	2	0.1
SYNODUS LUCIOCEPS	2	0.8
PAROPHRYS VETULUS	1	0.3
ZALEMBIUS ROSACEUS	1	0.1

NO. SPECIES: 11.00
IND./TRAWL: 178.00
KG./TRAWL: 4.65

STATION: R13 DEPTH(M): 150

SPECIES	NO./TRAWL	KG. WET WT/TRAWL
CITHARICHTHYS SORDIDUS	43	1.5
LYOPSETTA EXILIS	28	0.6
MICROSTOMUS PACIFICUS	8	0.9
SEBASTES SAXICOLA	3	0.1
ZANIOLEPIS FRENATA	2	0.1
GLYPTOCEPHALUS ZACHIRUS	2	0.2
PAROPHRYS VETULUS	1	0.4
CITHARICHTHYS FRAGILIS	1	0.1
NO. SPECIES:	8.00	
IND./TRAWL:	88.00	
KG./TRAWL:	3.85	

STATION: R15 DEPTH(M): 150

SPECIES	NO./TRAWL	KG. WET WT/TRAWL
CITHARICHTHYS SORDIDUS	50	1.3
PORICHTHYS NOTATUS	49	2.5
SEBASTES SAXICOLA	15	0.3
CITHARICHTHYS FRAGILIS	15	0.4
LYOPSETTA EXILIS	10	0.3
MICROSTOMUS PACIFICUS	9	0.4
XENERETMUS TRIACANTHUS	2	0.0
ZANIOLEPIS FRENATA	1	0.0
ICELINUS QUADRISERIATUS	1	0.0
ICELINUS TENUIS	1	0.0
ZANIOLEPIS LATIPINNIS	1	0.0
XENERETMUS LATIFRONS	1	0.0
MISC. WT.*	0	0.1
NO. SPECIES:	13.00	
IND./TRAWL:	155.00	
KG./TRAWL:	5.30	

STATION: R50 DEPTH(M): 150

SPECIES	NO./TRAWL	KG. WET WT/TRAWL
LYOPSETTA EXILIS	89	2.0
PORICHTHYS NOTATUS	81	3.6
SEBASTES SAXICOLA	50	2.5
MICROSTOMUS PACIFICUS	46	2.5
CITHARICHTHYS FRAGILIS	18	0.5
XENERETMUS LATIFRONS	14	0.1

ZANIOLEPIS FRENATA	13	0.4
CITHARICHTHYS SORDIDUS	11	0.2
LYCODES PACIFICUS	11	0.5
ARGENTINA SIALIS	4	0.0
SEBASTES ROSENBLATTI	2	0.0
PLECTOBRANCHUS EVIDES	2	0.0
HYDROLAGUS COLLIEI	1	0.3
CHILARA TAYLORI	1	0.0
MISC. WT.*	0	0.1

NO. SPECIES: 15.00
IND./TRAWL: 343.00
KG./TRAWL: 12.70

STATION: R52 DEPTH(M): 150

SPECIES	NO./TRAWL	KG. WET WT/TRAWL
CITHARICHTHYS SORDIDUS	75	2.1
MICROSTOMUS PACIFICUS	47	1.4
LYOPSETTA EXILIS	46	1.1
SEBASTES SAXICOLA	26	1.0
LYCODES PACIFICUS	18	0.8
ZANIOLEPIS FRENATA	11	0.8
ZALEMBIUS ROSACEUS	9	0.3
PORICHTHYS NOTATUS	8	0.3
SEBASTES CHLOROSTICTUS	5	0.3
XENERETMUS LATIFRONS	5	0.0
SEBASTES DIPLOPROA	4	0.0
GLYPTOCEPHALUS ZACHIRUS	4	0.1
RAJA BINOCULATA	2	1.8
PARALICHTHYS CALIFORNICUS	2	1.5
SEBASTES ELONGATUS	2	0.2
SEBASTES LEVIS	1	0.3
SEBASTES SEMICINCTUS	1	0.2
SYMPHURUS ATRICAUDA	1	0.1
ARGENTINA SIALIS	1	0.0
SYNODUS LUCIOCEPS	1	0.3
MISC. WT.*	0	0.2

NO. SPECIES: 21.00
IND./TRAWL: 269.00
KG./TRAWL: 12.80

STATION: R60 DEPTH(M): 150

SPECIES	NO./TRAWL	KG. WET WT/TRAWL
PORICHTHYS NOTATUS	374	10.5
LYOPSETTA EXILIS	373	7.4
SEBASTES SAXICOLA	65	1.4
LYCODES PACIFICUS	47	1.2

MICROSTOMUS PACIFICUS	29	0.7
GLYPTOCEPHALUS ZACHIRUS	24	0.5
ZANIOLEPIS FRENATA	21	0.6
SEBASTES ROSENBLATTI	11	0.7
SEBASTES DIPLOPROA	8	0.2
MERLUCCIIUS PRODUCTUS	6	0.3
SEBASTOLOBUS ALASCANUS	3	0.1
CITHARICHTHYS SORDIDUS	2	0.0
CHILARA TAYLORI	2	0.5
HIPPOGLOSSINA STOMATA	2	0.3
RAJA INORNATA	1	0.9
ARGENTINA SIALIS	1	0.0
CITHARICHTHYS XANTHOSTIGMA	1	0.0
SEBASTES LEVIS	1	0.2
PHYSICULUS RASTRELLIGER	1	0.0
XENERETMUS LATIFRONS	1	0.0
ICELINUS QUADRISERIATUS	1	0.0
MISC. WT. *	0	0.2

NO. SPECIES: 22.00
IND./TRAWL: 974.00
KG./TRAWL: 25.70

STATION: R61 DEPTH(M): 150

SPECIES	NO./TRAWL	KG. WET WT/TRAWL
CITHARICHTHYS FRAGILIS	227	6.0
CITHARICHTHYS SORDIDUS	205	5.7
SEBASTES SAXICOLA	107	2.5
PORICHTHYS NOTATUS	73	2.4
LYOPSETTA EXILIS	18	0.1
MICROSTOMUS PACIFICUS	9	0.4
ZANIOLEPIS FRENATA	2	0.0
SQUALUS ACANTHIAS	2	5.7
ARGENTINA SIALIS	1	0.0
HIPPOGLOSSINA STOMATA	1	0.2
SYNODUS LUCIOCEPS	1	0.2
PAROPHRYUS VETULUS	1	0.1
MISC. WT. *	0	0.1

NO. SPECIES: 13.00
IND./TRAWL: 647.00
KG./TRAWL: 23.40

STATION: R71 DEPTH(M): 150

SPECIES	NO./TRAWL	KG. WET WT/TRAWL
LYOPSETTA EXILIS	245	4.4
MICROSTOMUS PACIFICUS	106	5.0
CITHARICHTHYS SORDIDUS	74	1.2

ZANIOLEPIS FRENATA	61	2.1
CITHARICHTHYS FRAGILIS	48	1.2
SEBASTES ROSENBLATTI	16	1.0
HIPPOGLOSSINA STOMATA	15	1.7
SEBASTES ELONGATUS	13	2.4
SEBASTES SAXICOLA	12	0.2
ZALEMBIUS ROSACEUS	10	0.3
SEBASTES JORDANI	9	0.4
SEBASTES SEMICINCTUS	6	0.3
XENERETMUS TRIACANTHUS	3	0.1
SYNODUS LUCIOCEPS	2	1.3
HYDROLAGUS COLLIEI	2	0.4
ARGENTINA SIALIS	2	0.1
CHILARA TAYLORI	2	0.1
GLYPTOCEPHALUS ZACHIRUS	1	0.2
PAROPHRYS VETULUS	1	0.2
RAJA INORNATA	1	1.0

NO. SPECIES: 20.00
IND./TRAWL: 629.00
KG./TRAWL: 23.60

APPENDIX 6

STATION: R13 DEPTH(M): 30

SPECIES	NO./TRAWL	KG. WET WT/TRAWL
ASTROPECTEN VERRILLI	112	0.0
NASSARIUS PERPINGUIS	1	0.0
LUIDIA FOLIOLATA	1	0.0
TAGELUS CALIFORNIANUS	1	0.0
MEGASURCULA CARPENTERIANA	1	0.0
STYELA SP.	1	0.0
MISC. WT. *	0	0.1

NO. SPECIES: 7.00
IND./TRAWL: 117.00
KG./TRAWL: 0.10

STATION: R15 DEPTH(M): 30

SPECIES	NO./TRAWL	KG. WET WT/TRAWL
ASTROPECTEN VERRILLI	359	1.0
LUIDIA FOLIOLATA	12	0.1
LYTECHINUS PICTUS	3	0.0
HETEROCRYPTA OCCIDENTALIS	2	0.0
LOVENIA CORDIFORMIS	1	0.0
MISC. WT. *	0	0.1
PUGETTIA SP.	0	0.0
ERILEPTUS SP.	0	0.0
ORTHOPAGURUS MINIMUS	0	0.0
CANCER PRODUCTUS	0	0.0
LOXORHYNCHUS GRANDIS	0	0.0

NO. SPECIES: 11.00
IND./TRAWL: 377.00
KG./TRAWL: 1.20

STATION: R50 DEPTH(M): 30

SPECIES	NO./TRAWL	KG. WET WT/TRAWL
ASTROPECTEN VERRILLI	27	0.1
LOVENIA CORDIFORMIS	14	0.0
CANCER SP.	3	0.4
PATIRIA MINIATA	2	0.3
PISASTER BREVISPINUS	2	1.4
LYTECHINUS PICTUS	2	0.0
LISTRIOLOBUS PELODES	1	0.0
LOXORHYNCHUS GRANDIS	1	0.0

LUIDIA FOLIOLATA	1	0.0
NORRISIA NORRISI	1	0.0
PILUMNUS SPINOHIRSUTUS	1	0.0
MISC. WT.*	0	0.2
DEMOSPONGIAE	0	0.0
STYLATULA ELONGATA	0	0.0
SCRUPOCELLARIA SP.	0	0.0

NO. SPECIES: 15.00
IND./TRAWL: 55.00
KG./TRAWL: 2.40

STATION: R52 DEPTH(M): 30

SPECIES	NO./TRAWL	KG. WET WT/TRAWL
ASTROPECTEN VERRILLI	9	0.1
LYTECHINUS PICTUS	8	0.0
LOVENIA CORDIFORMIS	2	0.0
OPHIURA LUTKENI	1	0.0
LUIDIA LUDWIGI	1	0.0
MISC. WT.*	0	0.1

NO. SPECIES: 6.00
IND./TRAWL: 21.00
KG./TRAWL: 0.20

STATION: R60 DEPTH(M): 30

SPECIES	NO./TRAWL	KG. WET WT/TRAWL
ASTROPECTEN VERRILLI	26	0.0
PARASTICHOPUS CALIFORNICUS	2	1.0
OPHIOTHRIX SPICULATA	1	0.0
PARAPAGURODES SP.	1	0.0
LEPTOPECTEN LATIAURATUS	1	0.0
MISC. WT.*	0	0.1

NO. SPECIES: 6.00
IND./TRAWL: 31.00
KG./TRAWL: 1.10

STATION: R71 DEPTH(M): 30

SPECIES	NO./TRAWL	KG. WET WT/TRAWL
ASTROPECTEN VERRILLI	28	0.5
LIRONECA VULGARIS	4	0.0
HETEROCRYPTA OCCIDENTALIS	3	0.0
PAGURISTES TURGIDUS	1	0.0
PYCNOPODIA HELIANTHOIDES	1	0.4

PARAPAGURODES SP.	1	0.0
BALCIS RUTILA	0	0.0
MISC. WT.*	0	0.1

NO. SPECIES: 8.00
IND./TRAWL: 38.00
KG./TRAWL: 1.00

STATION: R13 DEPTH(M): 60

SPECIES	NO./TRAWL	KG. WET WT/TRAWL
LYTECHINUS PICTUS	86	0.3
LUIDIA FOLIOLATA	29	3.1
SICYONIA INGENTIS	25	0.2
PARASTICHOPUS CALIFORNICUS	17	6.0
PODOCHELA LOBIFRONS	4	0.0
PLEUROBRANCHAEA CALIFORNICA	2	0.0
FUSINUS BARBARENSIS	2	0.0
ASTROPECTEN VERRILLI	2	0.0
SIMNIA AEQUALIS VIDLERI	1	0.0
ALLOCENTROTUS FRAGILIS	1	0.0
LOXORHYNCHUS GRANDIS	1	1.5
STRONGYLOCENTROTUS PURPURATUS	1	0.0
PTEROPURPURA MACROPTERA	1	0.0
PLUMULARIIDAE	1	0.0
MISC. WT.*	0	0.2
BUGULA SP.	0	0.0
HIATELLA ARCTICA	0	0.0
AGLAOPHENIA SP.	0	0.0
POECILOSCLERIDA	0	0.0
CELLARIA SP.	0	0.0
CRISIA SP.	0	0.0
DORIDOIDEA	0	0.0

NO. SPECIES: 22.00
IND./TRAWL: 173.00
KG./TRAWL: 11.30

STATION: R15 DEPTH(M): 60

SPECIES	NO./TRAWL	KG. WET WT/TRAWL
SICYONIA INGENTIS	99	0.4
OPHIOTHRIX SPICULATA	4	0.0
ASTROPECTEN VERRILLI	3	0.1
LUIDIA FOLIOLATA	3	0.1
CRANGON SP.	2	0.0
OCTOPUS RUBESCENS	2	0.0
LISTRIOLOBUS PELODES	2	0.0
PARASTICHOPUS CALIFORNICUS	2	0.5
LOXORHYNCHUS GRANDIS	1	0.9

MODIOLUS SP.	1	0.0
PLEUROBRANCHAEA CALIFORNICA	1	0.0
MEGASURCULA CARPENTERIANA	1	0.0
LYTECHINUS PICTUS	1	0.0
MISC. WT.*	0	0.1
POECILOSCLERIDA	0	0.0

NO. SPECIES: 15.00
IND./TRAWL: 122.00
KG./TRAWL: 2.00

STATION: R50 DEPTH(M): 60

SPECIES	NO./TRAWL	KG. WET WT/TRAWL
LYTECHINUS PICTUS	1400	4.2
SICYONIA INGENTIS	35	0.2
CRANGON ALASKENSIS	9	0.0
ASTROPECTEN VERRILLI	5	0.0
LISTRIOLOBUS PELODES	5	0.0
LUIDIA FOLIOLATA	4	0.0
LOXORHYNCHUS GRANDIS	2	1.9
PARASTICHOPUS CALIFORNICUS	2	0.5
CHAMA ARCANA	1	0.0
MOLPADIA INTERMEDIA	1	0.0
NEMOCARDIUM CENTIFILOSUM	1	0.0
LUIDIA LUDWIGI	1	0.0
STYLATULA ELONGATA	0	0.0
OPHIOTHRIX SPICULATA	0	0.0
MISC. WT.*	0	0.1

NO. SPECIES: 15.00
IND./TRAWL: 1466.00
KG./TRAWL: 6.90

STATION: R52 DEPTH(M): 60

SPECIES	NO./TRAWL	KG. WET WT/TRAWL
SICYONIA INGENTIS	40	0.4
ASTROPECTEN VERRILLI	36	0.7
CRANGON ALASKENSIS	16	0.0
OPHIURA LUTKENI	6	0.0
OPHIOTHRIX SPICULATA	5	0.0
OCTOPUS SP.	5	0.0
LOXORHYNCHUS GRANDIS	2	0.0
LUIDIA FOLIOLATA	2	0.2
	1	0.0

ERILEPTUS SPINOSUS		
HETEROCRYPTA OCCIDENTALIS	1	0.0
NEOCRANGON RESIMA	1	0.0
MISC. WT. *	0	0.2

NO. SPECIES: 12.00
IND./TRAWL: 115.00
KG./TRAWL: 1.50

STATION: R60 DEPTH(M): 60

SPECIES	NO./TRAWL	KG. WET WT/TRAWL
PARASTICHOPUS CALIFORNICUS	47	19.8
SICYONIA INGENTIS	6	0.0
LOXORHYNCHUS GRANDIS	4	3.0
OPHIURA LUTKENI	3	0.0
OPHIOTHRIX SPICULATA	3	0.0
MURSIA GAUDICHAUDII	1	0.3
ASTROPECTEN VERRILLI	1	0.0
CRANGON ALASKENSIS	1	0.0
PENNATULACEA	1	0.0
MEGASURCULA CARPENTERIANA	1	0.0
MISC. WT. *	0	0.1

NO. SPECIES: 11.00
IND./TRAWL: 68.00
KG./TRAWL: 23.20

STATION: R61 DEPTH(M): 60

SPECIES	NO./TRAWL	KG. WET WT/TRAWL
LYTECHINUS PICTUS	8850	11.8
ASTROPECTEN VERRILLI	14	0.0
PARASTICHOPUS CALIFORNICUS	9	1.5
LUIDIA FOLIOLATA	8	0.0
CRANGON NIGRICAUDA	8	0.0
OPHIOTHRIX SPICULATA	7	0.0
OCTOPUS RUBESCENS	5	0.2
SICYONIA INGENTIS	3	0.0
KELLETIA KELLETII	1	0.0
PAGURISTES SP.	1	0.2
HEPTACARPUS TENUISSIMUS	1	0.0
SCHMITTIUS POLITUS	1	0.0
STYLASTERIAS FORRERI	1	0.0
MISC. WT. *	0	0.2

NO. SPECIES: 14.00
IND./TRAWL: 8909.00
KG./TRAWL: 13.90

STATION: R71 DEPTH(M): 60

SPECIES	NO./TRAWL	KG. WET WT/TRAWL
LYTECHINUS PICTUS	13933	20.9
ASTROPECTEN VERRILLI	66	0.2
PARASTICHOPUS CALIFORNICUS	17	6.6
LUIDIA ASTHENOSOMA	12	0.0
OPHIOTHRIX SPICULATA	5	0.0
OPHIURA LUTKENI	3	0.0
PENNATULACEA	3	0.0
PODOCHELA HEMPHILLI	1	0.0
OCTOPUS RUBESCENS	1	0.0
FUSINUS SP.	1	0.0
LOLIGO OPALESCENS	1	0.0
STYLASTERIAS FORRERI	1	0.0
ROSSIA PACIFICA	1	0.0
PAGURISTES TURGIDUS	1	0.0
DEMOSPONGIAE	1	0.0
TELESTO SP.	0	0.0
MISC. WT.*	0	0.5

NO. SPECIES: 17.00
IND./TRAWL: 14047.00
KG./TRAWL: 28.20

STATION: R13 DEPTH(M): 150

SPECIES	NO./TRAWL	KG. WET WT/TRAWL
ALLOCENTROTUS FRAGILIS	73	3.7
ACANTHOPTILUM SP.	5	0.1
LUIDIA FOLIOLATA	5	0.2
ASTROPECTEN VERRILLI	4	0.2
PARASTICHOPUS CALIFORNICUS	1	0.8

NO. SPECIES: 5.00
IND./TRAWL: 88.00
KG./TRAWL: 4.85

STATION: R15 DEPTH(M): 150

SPECIES	NO./TRAWL	KG. WET WT/TRAWL
LYTECHINUS PICTUS	1040	2.6
BRISSOPSIS PACIFICA	86	1.8
LUIDIA FOLIOLATA	56	3.2
ALLOCENTROTUS FRAGILIS	48	2.1
NEOCRANGON ZACAE	12	0.0
PLEUROBRANCHAEA CALIFORNICA	6	0.0
OCTOPUS RUBESCENS	3	0.0

SICYONIA INGENTIS	2	0.0
CRINOIDEA	2	0.0
STYLASTERIAS FORRERI	1	0.1
METACRANGON SPINOSISSIMA	1	0.0
NEOCRANGON RESIMA	1	0.0
METRIDIUM SENILE	1	1.8
MISC. WT.*	0	0.4

NO. SPECIES: 14.00
IND./TRAWL: 1259.00
KG./TRAWL: 12.00

STATION: R50 DEPTH(M): 150

SPECIES	NO./TRAWL	KG. WET WT/TRAWL
NEOCRANGON ZACAE	31	0.0
LUIDIA FOLIOLATA	18	2.6
SICYONIA INGENTIS	12	0.3
METACRANGON SPINOSISSIMA	10	0.0
LYTECHINUS PICTUS	4	0.0
PLEUROBRANCHAEA CALIFORNICA	4	0.6
NEOCRANGON RESIMA	4	0.0
SPIRONTOCARIS HOLMESI	3	0.0
PANDALUS PLATYCEROS	1	0.1
LIRONECA VULGARIS	1	0.0
ROSSIA PACIFICA	1	0.0
CARDIOMYA PLANETICA	1	0.0
OCTOPUS SP.	1	0.0
BRISSOPSIS PACIFICA	1	0.0
ANTHOZOA	1	0.0
CANCELLARIA CRAWFORDIANA	1	0.0
MISC. WT.*	0	0.2

NO. SPECIES: 17.00
IND./TRAWL: 94.00
KG./TRAWL: 3.80

STATION: R52 DEPTH(M): 150

SPECIES	NO./TRAWL	KG. WET WT/TRAWL
SICYONIA INGENTIS	59	0.2
LUIDIA FOLIOLATA	56	4.5
PANDALUS PLATYCEROS	37	1.4
NEOCRANGON ZACAE	27	0.0
PLEUROBRANCHAEA CALIFORNICA	4	0.0
LYTECHINUS PICTUS	3	0.0
METACRANGON SPINOSISSIMA	3	0.0
NEOCRANGON RESIMA	2	0.0
OCTOPUS SP.	2	0.0
ROSSIA PACIFICA	2	0.0

ALPHEOPSIS EQUIDACTYLUS	1	0.0
SCHMITTIUS POLITUS	1	0.0
BRISSOPSIS PACIFICA	1	0.0
MISC. WT.*	0	1.0

NO. SPECIES: 14.00
IND./TRAWL: 198.00
KG./TRAWL: 7.10

STATION: R60 DEPTH(M): 150

SPECIES	NO./TRAWL	KG. WET WT/TRAWL
SICYONIA INGENTIS	160	3.0
ALLOCENTROTUS FRAGILIS	118	7.5
PARASTICHOPUS CALIFORNICUS	86	28.7
PANDALUS PLATYCEROS	81	3.0
NEOCRANGON COMMUNIS	20	0.0
SPIRINTOCARIS HOLMESI	17	0.0
LUIDIA FOLIOLATA	16	0.2
NEOCRANGON ZACAE	12	0.0
ROSSIA PACIFICA	7	0.0
METRIDIUM GIGANTEUM	6	1.5
METACRANGON SPINOSISSIMA	4	0.0
PLEUROBRANCHAEA CALIFORNICA	1	0.0
PARALITHODES RATHBUNI	1	0.0
NEOCRANGON RESIMA	1	0.0
OCTOPUS RUBESCENS	1	0.5
ASTROPECTEN VERRILLI	1	0.0
LOXORHYNCHUS GRANDIS	1	2.2
MURSIA GAUDICHAUDII	1	0.4
STRONGYLOCENTROTUS PURPURATUS	1	0.0
MISC. WT.*	0	0.2

NO. SPECIES: 20.00
IND./TRAWL: 535.00
KG./TRAWL: 47.20

STATION: R61 DEPTH(M): 150

SPECIES	NO./TRAWL	KG. WET WT/TRAWL
ALLOCENTROTUS FRAGILIS	914	40.2
BRISSOPSIS PACIFICA	119	4.2
LYTECHINUS PICTUS	9	0.0
ASTROPECTEN VERRILLI	6	0.0
SICYONIA INGENTIS	5	0.0
	3	0.0

LUIDIA FOLIOLATA		
LOVENIA CORDIFORMIS	1	0.0
PARASTICHOPUS CALIFORNICUS	1	0.5
LIRONECA VULGARIS	1	0.0
MISC. WT. *	0	0.8

NO. SPECIES: 10.00
IND./TRAWL: 1059.00
KG./TRAWL: 45.70

STATION: R71 DEPTH(M): 150

SPECIES	NO./TRAWL	KG. WET WT/TRAWL
ALLOCENTROTUS FRAGILIS	483	2.0
ASTROPECTEN VERRILLI	25	0.0
NEOCRANGON ZACAE	11	0.0
OPHIOPHOLIS BAKERI	6	0.0
PENNATULACEA	4	0.0
LYTECHINUS PICTUS	4	0.5
LUIDIA FOLIOLATA	3	0.0
OCTOPUS RUBESCENS	3	0.0
OPHIACANTHA DIPLASIA	2	0.0
FLOROMETRA SERRATISSIMA	2	0.0
GORGONOCEPHALUS CARYI	2	0.3
PARASTICHOPUS CALIFORNICUS	1	0.0
PHILINE ALBA	1	0.0
STYLASTERIAS FORRERI	1	0.0
OPHIONEREIS EURYBRACHIPLAX	1	0.0
MEDIASTER AEQUALIS	1	0.0
PLEUROBRANCHAEA CALIFORNICA	1	0.0
SICYONIA INGENTIS	1	0.0
MISC. WT. *	0	2.7

NO. SPECIES: 19.00
IND./TRAWL: 552.00
KG./TRAWL: 5.50

