AN ABSTRACT OF THE THESIS OF

Jose Sepulveda-Vidal for the degree of Master of Science

in Oceanography presented on August 5, 1977

Title: ROCKFISHES AND ASSOCIATED ICHTHYOFAUNA CAUGHT OFF MONTEREY, CALIFORNIA, SUMMER 1976

Abstract Approved: Redacted for privacy

William G. Pearcy

The distribution, species composition, and species associations of rockfishes off Monterey Bay were studied from bottom trawl catches at two locations (Leg I) and from a larger area (Leg II) during a rockfish survey covering four depth strata between 90 and 500 m.

Sixty eight species representing 24 families were found on or near the bottom of the continental shelf and upper continental slope. Scorpaenids and pleuronectids were the most abundant families in samples from Leg I. Numerically dominant species within these families were *Sebastes saxicola* and *Microstomus pacificus*. The two sites surveyed during Leg I, at depths of ca. 100 m and 200 m, differed primarily in abundance of species present rather than occurrence of different groups of species.

Diel changes observed in the catches of *Glyptocephalus zachirus*, *M. pacificus* and *Parophrys vetulus* were probably due to visual avoidance of the gear during daylight. Diel changes in the abundance of *S. saxicola*, *S. goodei*, *S. jordani*, *S. paucispinis*, and *Citharichthys*

sordidus were probably associated with feeding habits.

Based on recurrent group analysis, the demersal fish community off Monterey was characterized by three major species assemblages which seemed to be stratified by depth: a shallow water assemblage (<100 m) formed by the *Genyonemus lineatus* group; an intermediate depth assemblage (100-180 m) characterized by flatfishes and four rockfishes (*S. goodei*, *S. jordani*, *S. saxicola* and *S. elongatus*); and a deep-water assemblage (>180 m) formed by the *Merluccius productus* group. The species composition of these assemblages agreed with species composition of commercial landings of the Monterey trawl fishery and with species groups found in other studies off California, which were also segregated by depth.

ROCKFISHES AND ASSOCIATED ICHTHYOFAUNA CAUGHT OFF MONTEREY, CALIFORNIA, SUMMER 1976

by

Jose Sepulveda-Vidal

A THESIS

submitted to

Oregon State University

in partial fulfillment of
the requirements for the
degree of

Master of Science

June 1978

APPROVED:

Redacted for privacy

Professor of Oceanography
in Charge of Major

Redacted for privacy

Acting Dean of School of Oceanography

Redacted for privacy

Dean of Graduate School

Date thesis is presented August 5, 1977

Typed by Cheryl Schurg for Jose Sepulveda-Vidal

ACKNOWLEDGMENTS

I wish to thank Dr. W.T. Pereyra, formerly Director of Resource Assessment and Conservation Engineering Division (NOAA, NMFS, Northwest and Alaska Fisheries Center, Seattle) for providing the sampling gear and shiptime for this study and Dr. Suzumo Kato (NMFS Tiburon Laboratory, California) and W. Laroche (O.S.U. School of Oceanography) for their contribution to the success of the sampling program during Leg I and also for their help in identifying the species caught in that survey. I am also indebted to Mr. D. Gunderson for allowing me to use data from Leg II of the rockfish survey off Monterey.

Dr. Al Tyler (O.S.U. Fisheries and Wildlife) provided the computer programs for Fager's recurrent group analysis used in the analysis of Leg II samples, and Donna Worden (O.S.U. marine Science Center) technically assisted me in running these programs.

I am grateful to Dr. William G. Pearcy for his encouragement and suggestions, and to Dr. Sarah L. Richardson for her assistance and helpful criticism of the manuscript.

This research was supported by Contract No. 03-7-208-35070 from the National Oceanic and Atmospheric Administration.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF APPENDICES

ROCKFISHES AND ASSOCIATED ICHTHYOFAUNA CAUGHT OFF MONTEREY, CALIFORNIA, SUMMER 1976

INTRODUCTION

Rockfishes are important constituents of the benthic fish communities from the Bering Sea to California (Phillips, 1958; Alverson et al., 1964). A substantial portion of these fishes are found in midwater where they are unavailable to bottom trawls (Alverson et al., op. cit.; Beamish, 1966; Miller and Geibel, 1973). At least 54 different species of rockfishes are known to inhabit the waters off Central California (Miller and Lea, 1972) many of which are commercially important.

Prior to 1950, rockfishes were of only minor importance in the trawl catch off Monterey. Since then the fishery has expanded rapidly and now rockfishes dominate commercial landings from this area (Heimann, 1963; Kramer and Smith, 1971). However, no more than eight species are individually reported in the catch records and a large number of the species are simply classifed as "rockfish".

The Monterey area trawl fishery is characterized by three subfisheries based on fishing depths occupied by Monterey trawlers (Kramer and Smith, 1971): a shallow-water one in 30 to 60 fathoms (ca. 55 to 100 m), an intermediate-depth one in 60 to 130 fathoms (ca. 100 to 240 m), and a deep water one in 130 to 200 fathoms (ca. 240 to 370 m). Rockfishes are reported to be most abundant in the intermediate-depth fishery.

Relative abundance and stock size of commercially important rockfishes have shown some indications of overutilization in the recent

years (Miller and Geibel, 1973). The problem has become acute due to the lack of adequate data for management of the multispecies complexes of the rockfish of the Pacific Coast (Gunderson, 1976).

The need for a detailed survey of offshore rockfishes to determine the size and condition of stocks and the problems of implementing such a survey were the subject of discussion in a three day workshop convened by the Northwest Fisheries Center (NOAA, National Marine Fisheries Service) in January 1976. As a result, "pilot scale" surveys were conducted in Queen Charlotte Sound, B.C., and off Monterey Bay, California, two important areas of rockfish production.

The present paper reports the results of a subproject to study the diel changes and species associations of rockfishes and associated ichthyofauna in the Monterey area. Estimates of the mean biomass per unit area for each fish species taken in bottom trawls, the mean pelagic fish biomass per unit area, species and size composition for selected rockfish and non-rockfish species in bottom and midwater trawl catches have already been reported by Gunderson and Nelson (1977).

MATERIAL AND METHODS

The experimental rockfish survey off Monterey covered the area from 36°15'N to 37°15'N latitude, between the 50 fm (ca. 90 m) and 250 fm (ca. 450 m) isobaths. Diel observations were obtained during a preliminary survey (Leg I) conducted by the RV John N. Cobb on July 27-29, 1976. Additional information on species associations and community structure was obtained during Leg II, a combined demersal and pelagic survey, conducted simultaneously by three vessels from August 3 to August 25, 1976.

Sampling Gear and Procedure

Since time was a limiting factor for Leg I and little was known about suitable trawling areas, sampling sites between 110 m (60 fm) and 200 m (100 fm) were selected based on known distribution of some rockfish species. After a short echosounder survey for trawlable bottom, two locations were selected: site A at a depth between 90 and 110 m; and site B between 190 and 210 m and about 12 miles to the northwest of site A (Figure 1).

Benthic fishes were sampled with a standard 400 mesh Eastern trawl with a 28.7 m footrope and a 21.6 m headrope. Mesh sizes (stretched measure) were 10.2 cm in the wings and body, and 8.9 cm in the codend which had a 3.2 cm mesh liner. For midwater hauls a 9.1 m headrope midwater trawl was used. The net was designed to spread 6 m horizontally. Mesh sizes (stretched measure) were 6.4 cm in the belly, 5.1 cm in the body, 3.8 cm in the funnel, and 3.2 cm in the codend. Both the bottom and midwater trawls were operated with 5 x 7 ft steel V doors.

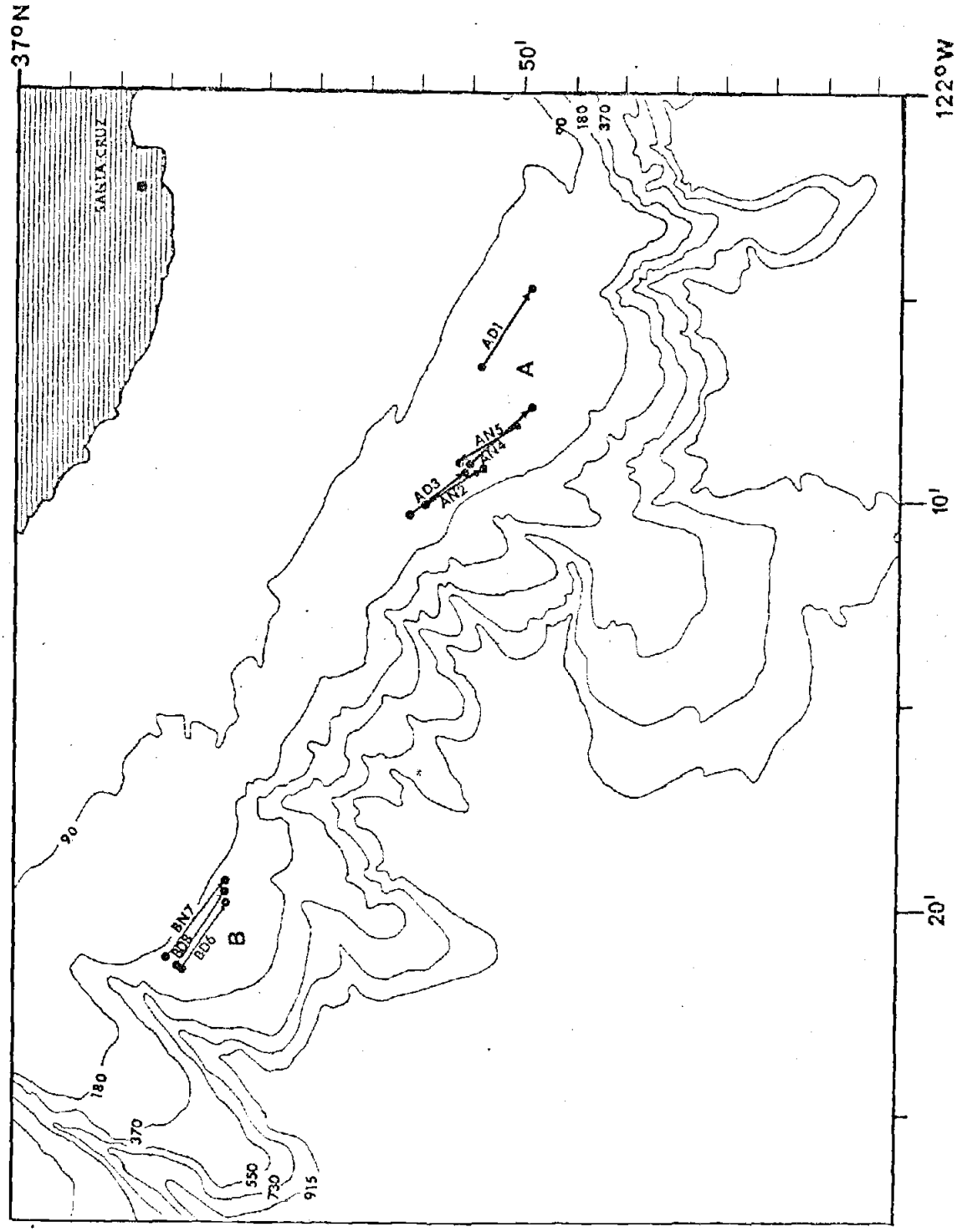


Figure 1. Location of demersal trawls off Monterey, CA. Rockfish survey Leg I: Sites A and B.

The trawls were set and retrieved while the ship was underway at low speeds and were towed at speeds of approximately three knots. The midwater trawl was positioned with an acoustic-link netsounder with a headrope transmitter unit with upward and downward looking transducers.

Daytime hauls were performed between 0900 and 1700 PDT (U.S. Pacific Daylight Time), nighttime hauls were performed between 2100 and 0300 PDT. Each bottom haul was followed by one or two midwater hauls on the same site. In all, eight bottom hauls and 15 midwater hauls were completed during Leg I of the experimental rockfish survey. The entire fish catch was sorted into taxonomic groups and species were identified. The total weight and number of specimens caught was determined for each species.

The demersal survey of Leg II was also completed by the RV John N. Cobb. The same Eastern trawl was used as in Leg I but with a 36.6 m bridles and roller gear on the footrope. This general survey was stratified by depth into four strata: 50-99, 100-149, 150-199, and 200-250 fms (i.e., 90-182, 183-274, 275-364, and 365-457 m, respectively).

After a pre-survey of the area for trawlable regions, all four strata were sampled so that the number of stations within each depth stratum was proportional to the area occupied by that depth stratum in the sampling area. Forty-six successful hauls were obtained. Starting points for these trawls are indicated in Figure 2.

As in the preliminary survey, all hauls were 1/2 hour duration and the total weight caught per species was determined, usually by sorting and weighing the entire catch. In the case of large catches a subsam-

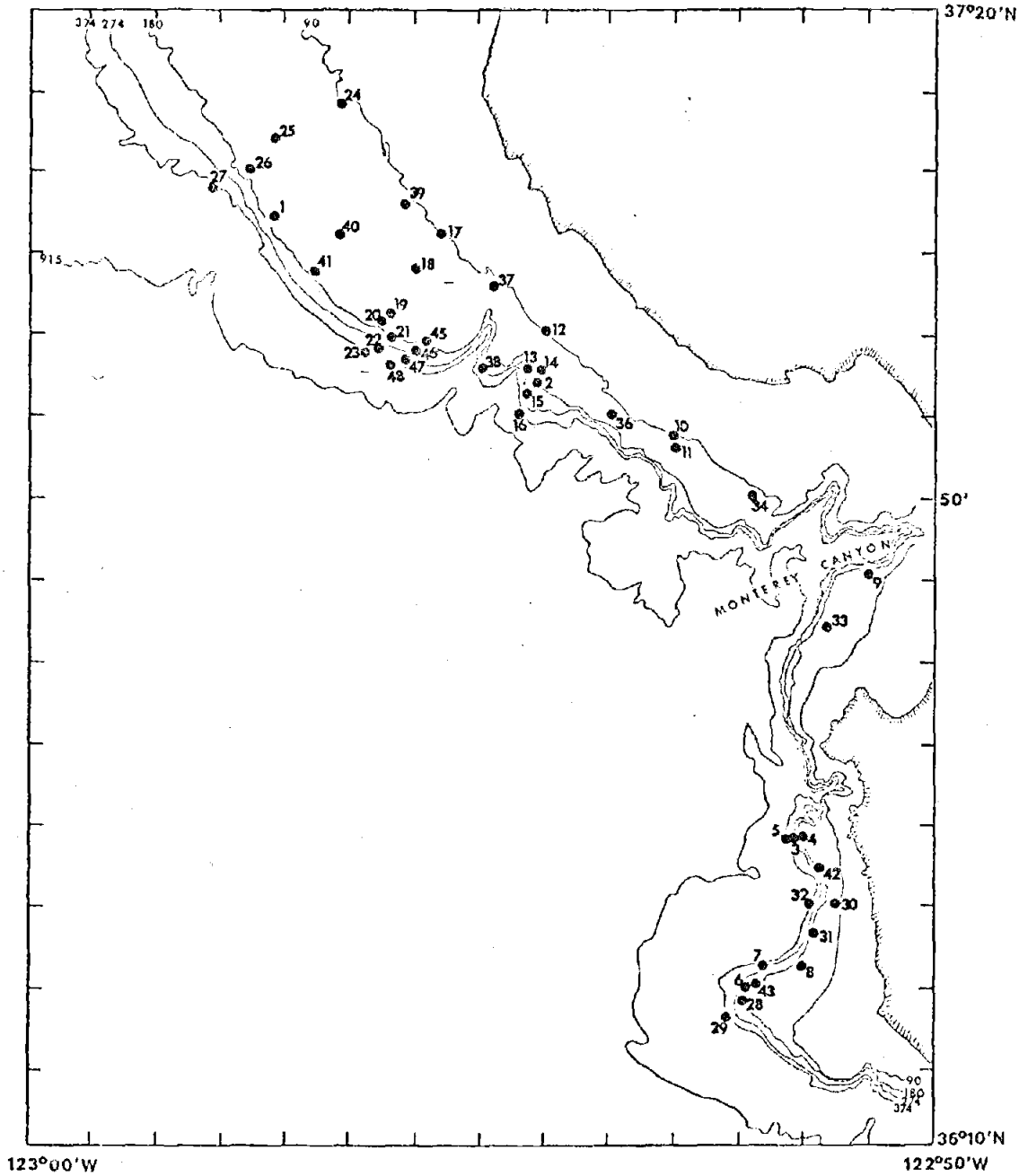


Figure 2. Starting points for trawl stations occupied by the John N. Cobb in the Monterey Area during Leg II of the Rockfish survey.

ple of the catch was taken and the results extrapolated to the total catch. Unfortunately the number of specimens for each species was not consistently recorded for all species in all tows of Leg II.

Analyses

Faunal similarity among hauls was described using Sanders' (1960) similarity index and Sørenson's (1948) similarity coefficient. The former compares the relative abundance of each speices, expressed as a percentage of the total catch per tow, for each species in all possible pairs of samples. The smaller percentage of the two is taken as the 'common abundance value'. These are added and the sum represents a measure of the percentage of the fauna common to a pair of samples.

Sørenson's similarity coefficient, S, based on the presence and absence of species in each sample, is defined as:

$$S_{ij} = \frac{2a}{(2a + b + c)} \qquad (1)$$

where a is the number of species found in common in samples i and j; b is the number of species found only in sample i, and c is the number of species found only in sample j. The similarity coefficient ranges from 0 (no affinity) to 1 (maximum affinity).

The relative importance of the dominant species was determined by ranking procedures (Fager, 1957). Species are ranked from 1 to 10 by abundance within each sample. The most abundant is then given a value of 10, the next 9, . . . and a rank of 10 is given a value of 1. The ranks are summed over the hauls considered and divided by the total number of hauls. The resultant 'biological index' includes both frequency of occurrence and abundance in determining dominant species.

Because of the small number of samples available and the high variability of species numbers among hauls, nonparametric tests were used to compare numerical abundance within groups of associated species.

Affinities between species were determined according to Fager and McGowan's (1963) recurrent group analysis:

$$\frac{J}{(N_a N_b)^{1/2}} - \frac{1}{2(N_b)^{1/2}} \qquad (2)$$

where J is the number of joint occurrences; N_a is the total number of occurrences of species a; N_b is the total number of occurrences of species b, and the species are assigned to the letters so that $N_a \leq N_b$. Species are considered to show affinity when values of expression (2) are equal to or greater than 0.50. The degree of association between recurrent groups was estimated as the ratio of the number of observed species-pair affinities above the 0.50 level to the maximum number of possible affinities (Fager, 1957).

RESULTS

ROCKFISH SURVEY LEG I

Details of demersal and midwater hauls at two locations are given in Appendix I. Midwater hauls from Leg I of the rockfish survey were not successful, in part because the netsounder and echo sounder malfunctioned or simply because no fishes were caught. They will not be included in subsequent analysis.

Catch Composition

A total of 11,663 fishes representing 17 families and 39 species were found in the eight demersal trawls. Scorpaenidae contributed the largest number of species (11), followed by Pleuronectidae (6), Rajiidae (4) and Cottidae (3). The ten most abundant species (by number) accounted for 92% of the catch (Table I). The abundant families were Scorpaenidae and Pleuronectidae. They comprised about 79% of the total catch. Bothidae and Gadidae, represented by one species each, were the next most important families. Scorpaenidae, Pleuronectidae, Bothidae, and Gadidae, together comprised 91% of the total catch in numbers.

Numerically abundant species of Scorpaenidae and Pleuronectidae, accounting for at least 90% of total catch, were:

	% of catch within family
Scorpaenidae	
Sebastes saxicola	65
Sebastes elongatus	12
Sebastes goodei	8
Sebastes jordani	8
Total	93

Table I. Rank Order of Abundance of Fishes Collected in Eight Demersal Trawls off Monterey.

Species Name	Percent of Total Catch	Total Number Collected
Sebastes saxicola	33	3814
Microstomus pacificus	19	2166
Glyptocephalus zachirus	8	913
Sebastes elongatus	6	693
Merluccius productus	6	640
Citharichthys sordidus	5	554
Sebastes goodei	4	488
Sebastes jordani	4	476
Lyopsetta exilis	4	449
Aprodon cortezianus	3	317
Anoplopoma fimbria	2	217
Hydrolagus colliei	1	168
Sebastes diploproa	1	137
Sebastes paucispinis	1	120
Trachurus symmetricus	0.7	87
Parophrys vetulus	0.7	86
Porichthys notatus	0.5	57
Sebastes chlorostictus	0.4	52
Sebastolobus alascanus	0.3	38
Zalembius rosaceus	0.3	33
Eopsetta jordani	0.2	29
Raja binoculata	0.2	28
Clupea harengus pallasi	0.2	18
Parmaturus xaniurus	0.1	15
Ophiodon elongatus	0.1	11
Sebastes crameri	0.1	9
Zeniolepis sp.	0.1	8
Sebastes entomelas	0.1	8

Table 1. (Continued)

Species Name	Percent of Total Catch	Total Number Collected
Xeneretmus latifrons	0.1	7
Icelinus tenuis	0.1	6
Squalus acanthias	0.1	6
Raja kinkaidii	0.05	4
Pleuronichthys verticalis	0.05	2
Agonopsis emmelane	0.05	2
Sebastes ovalis	0.05	1
Radulinus asprellus	0.05	1
Raja rhina	0.05	1
Raja sp.	0.05	1
Icelinus filamentosis	0.05	1

Pleuronectidae	
Microstomus pacificus	59
Glyptocephalus zachirus	25
Lyopsetta exilis	12
Total	96

Site Comparison

Samples from site A (ca. 100 m depth) accounted for 43% of the total catch, and samples from site B (ca. 200 m depth) for the remaining 57%. At each site the percent contribution of the numerically abundant families was:

	% of total catch	
	Site A	Site B
Scorpaenidae	31	57
Pleuronectidae	28	27
Bothidae	8	0
Gadidae	2	8
Anoplopomatidae	0	3
Zoarcidae	3	1
Total	72	97

Thus rockfishes and flatfishes were the most abundant groups at both sites.

The percent contribution of the abundant species within the first two families was:

	% of catch within family	
	Site A	Site B
Scorpaenidae		
Sebastes saxicola	50	74
Sebastes elongatus	34	0
Sebastes jordani	7	9
Sebastes goodei	5	10
Sebastes diploproa	0	4
Total	96	93
Pleuronectidae		
Microstomus pacificus	48	72
Glyptocephalus zachirus	33	16
Lyopsetta exilis	16	9
Total	97	97

Within each site, two daytime bottom trawls were obtained (AD1, AD3, and BD6, BD8); three nighttime hauls were taken at site A (AN2, AN4, and AN5) and one at site B (BN7). Relative abundance of each species, expressed as a percentage of the total catch per tow is given in Table II. The similarity among samples based on Sanders' (1960) similarity values is shown as a trellis diagram in Figure 3.

From Figure 3 it is evident that sample AD1 differs markedly in faunal composition from the other seven samples. This sample has a mean similarity value of 16.3 with the rest of site A samples, and a mean similarity value of 21.3 with site B samples. The mean similarity of all other site A samples (AD3, AN2, AN4 and AN5) is 61.0, and all site B samples is 58.7. The overall mean similarity is 42.9.

The mean similarity values of AD1, AD3, AN2, AN4 and AN5 with site B samples were 21.3, 47.4, 45.6, 38.5, and 45.7, respectively; and the

Table II. Species Percent Composition in Day and Night Demersal Trawls at Sites A and B.

Haul Number	AD1	AN2	AD3	AN4	AN5	BD6	BN7	BD8
Individuals	213	2632	1911	121	122	2965	2352	1347
Squalus acanthias	0.47	0.04				0.03	0.09	0.07
Raja binoculata	0.47	0.30	0.05		0.82	0.20	0.17	0.52
Citharichthys sordidus	3.29	9.65	13.92	17.36	4.92			
Eopsetta jordani	0.47	0.34	0.21			0.07	0.38	0.30
Lyopsetta exilis	0.47	6.38	5.76	6.61	4.92	1.11	2.47	4.83
Microstomus pacificus	0.94	26.56	7.69	20.66	17.21	5.46	30.61	28.95
Glyptocephalus zachirus	4.69	14.17	10.97	18.18	11.48	3.74	7.40	
Porichthys notatus	0.47	0.08	2.77			0.03		
Ophiodon elongatus	1.41	0.11	0.21					0.07
Merluccius productus	1.88	2.20	0.10	22.31	31.97	7.86	2.25	16.63
Sebastes chlorostictus	0.47	1.10	1.10					0.07
Sebastes crameri	1.41					0.13		0.15
Sebastes elongatus	0.47	13.56	16.54	3.31	4.10	0.13	0.26	
Sebastes goodei	44.60	0.11	0.37		0.82	7.18	5.95	2.15
Sebastes jordani	32.86	0.46	2.72			8.50	0.77	5.35
Sebastes saxicola	2.82	12.08	34.80	5.79	12.30	57.88	32.70	23.61
Sebastes paucispinis	2.35	0.15			0.82	1.85	0.38	3.41
Sebastes ovalis	0.47							
Hydrolagus colliei		2.89	0.47	0.83	0.82	0.03	3.23	0.30

Table 11. (Continued)

	AD1	AN2	AD3	AN4	AN5	BD6	BN7	BD8
Raja sp.		0.04						
Parmaturus xaniurus		0.08					0.55	
Parophrys velutus		1.41	0.26		2.46	0.03	1.53	0.30
Zalembius rosaceus		0.84	0.37	1.65	0.82	0.03		
Aprodon cortezianus		5.89	0.10	3.31	4.92	0.07	6.16	0.22
Sebastes entomelas		0.23			1.64			
Sebastolobus alascanus		1.14					0.34	
Agonopsis emmelane		0.08						
Zaniolepis sp.		0.11	0.26					
Pleuronichthys verticalis			0.10					
Clupea harengus pallasi			0.78					0.22
Anoplopoma fimbria			0.05			4.49	1.19	4.08
Radulinus asprellus			0.05					
Icelinus tenuis			0.31					
Icelinus filamentosus			0.05					
Trachurus symmetricus						0.57		5.20
Sebastes diploproa						0.51	3.44	3.04
Xeneretmus latifrons						0.07	0.09	0.22
Raja kincaidii							0.04	0.22
Raja rhina								0.07

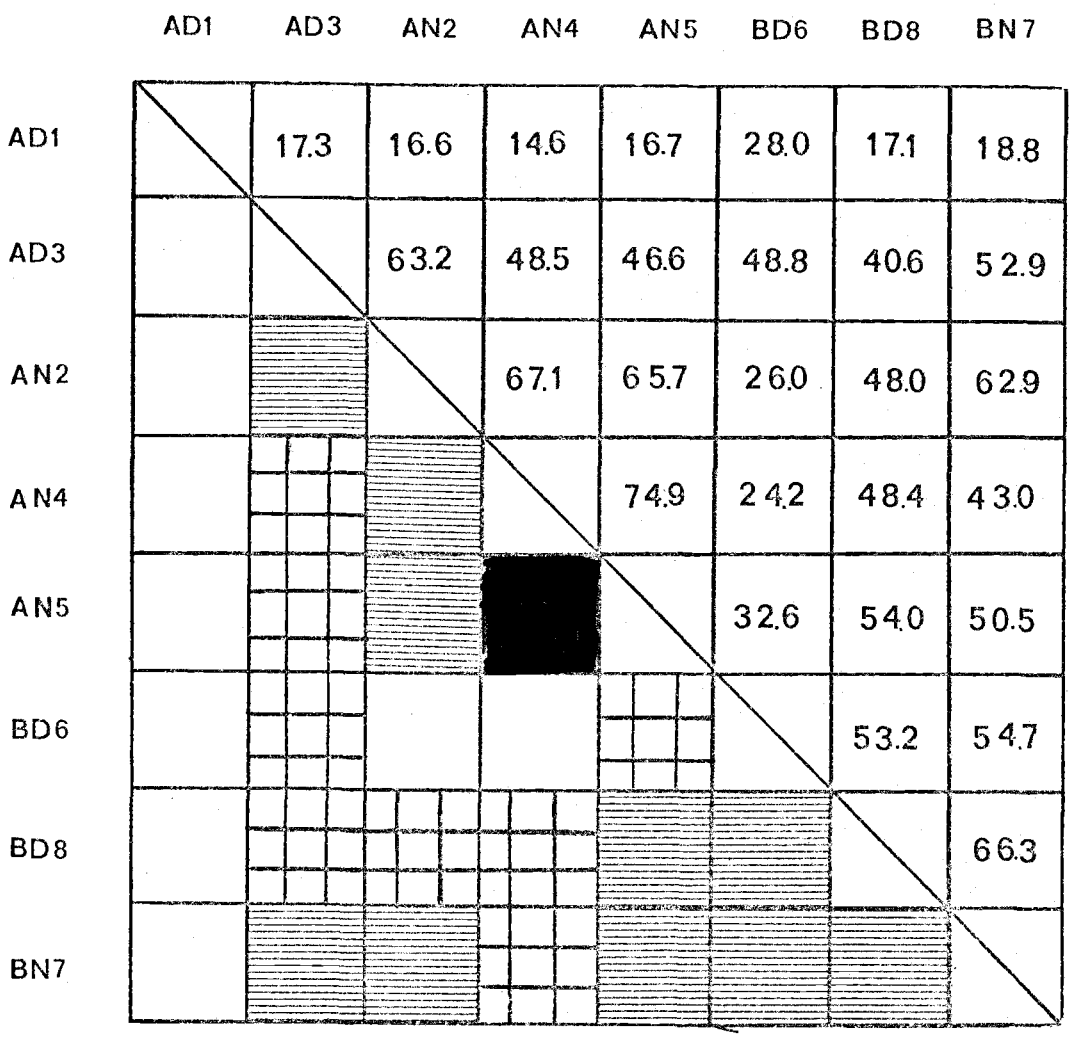


Figure 3. "Trellis diagram" illustrating the degree of similarity (based on Sanders'(1960) similarity index) of the demersal fish fauna in eight samples taken off Monterey, CA. Rockfish survey Leg I.

■ ≧ 70.0 ▤ 50.0 - 69.9 ▦ 30.0 - 49.9 □ < 30.0

mean similarity values of BD6, BD8 and BN7 with site A samples were 31.9, 41.6, and 45.6. Using Kruskal-Wallis H test statistic (Gibbons, 1976) no statistically significant differences were found between the median for each of these groups. Observed H values were 6.50 ($P < .10$) for the first set and 2.22 ($P < .50$) for the second set.

Dominant species at each site were determined by biological index values. At site A the dominant species were:

	Biological Index
Glyptocephalus zachirus	7.8
Sebastes saxicola	7.2
Microstomus pacificus	7.0
Citharichthys sordidus	6.8
Merluccius productus	5.2
Sebastes elongatus	4.6
Lyopsetta exilis	4.4
Aprodon cortezianus	2.8
Sebastes jordani	2.4
Sebastes goodei	2.0

while at site B the dominant species were:

	Biological Index
Sebastes saxicola	9.7
Microstomus pacificus	8.3
Merluccius productus	6.0
Sebastes jordani	5.3
Sebastes goodei	4.7
Glyptocephalus zachirus	4.0
Lyopsetta exilis	3.3
Anoplopoma fimbria	3.0
Aprodon cortezianus	2.3
Sebastes diploproa	2.3

Eight of the ten dominant species at site B were also dominant at site A. However, S. elongatus and Citharichthys sordidus were not dominant at site B.

Concordance of biological index values of these species common to both sites was tested using Kendall's coefficient of concordance, W (Gibbons, 1976). The observed value of W ($W = .678$, $Q = 9.5$; $P < .30$) was not large enough to reject the null hypothesis of independence between species ranks. Therefore, sites were different. Glyptocephalus zachirus, C. sordidus and S. elongatus were more dominant at site A than B. Sebastes goodei, S. diploproa and Anoplopoma fimbria were more dominant at site B than A.

In addition, five species were found only in site B samples (Raja rhina, R. kindaidii, S. diploproa, Xeneretmus latifrons, and Trachurus symmetricus) and ten species only in site A samples (Raja sp., C. sordidus, Pleuronichthys verticalis, S. entomelas, Sebastes ovalis, Radulinus asprellus, Icelinus tenuis, Icelinus filamentosus, Zaniolepis sp. and Agonopsis emmelane) (Table II). Many of the species found only at site B are deep water forms and many of those at site A frequent shallow to mid-depth waters. Twenty four species were common to both sites. Site A hauls contained 70 to 80% of these species. Site B hauls contained only 60 to 68%. Four species were common to all hauls (Lyopsetta exilis, Microstomus pacificus, Merluccius productus, and Sebastes saxicola).

Observed similarity coefficients (Sørensen's) based on the presence and absence of the species in each haul are shown in Figure 4. All but AN4 compared to BD8 had relatively high similarity coefficient

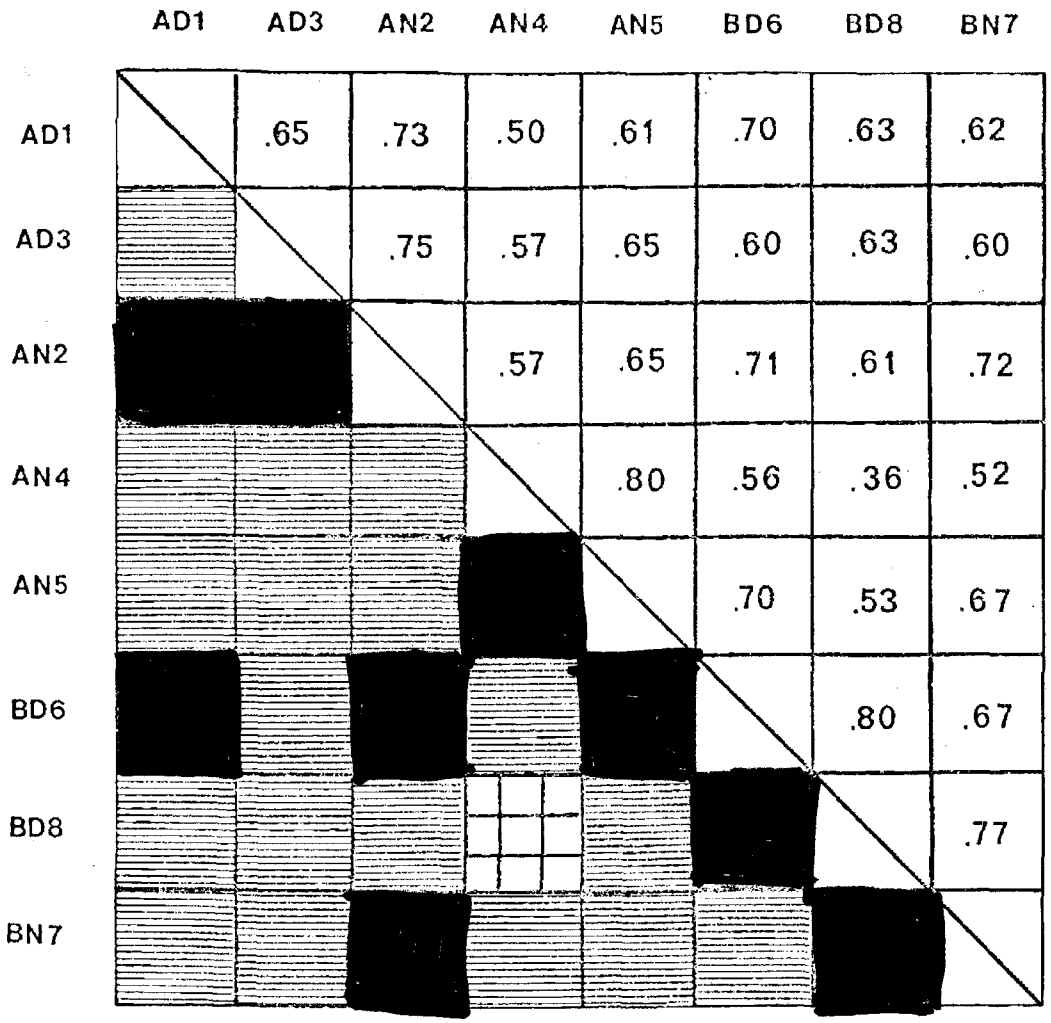


Figure 4. "Trellis diagram" illustrating the degree of similarity (based on Sørensen's (1948) similarity coefficient) of the demersal fish fauna in eig t samples taken off Monterey, CA. Rockfish survey Leg I.

■ ≧.70 ▤ .50 – .69 ▦ .30 – .49

values (> .50). The pattern was almost uniform over the sites, indicating that species present at the two sites were not markedly different. The apparent differences shown in Figure 3 thus reflected the variations in relative abundance. In fact, the abundant species in ADI were Sebastes goodei and Sebastes jordani, contributing 77% by number of the total catch per tow, while in all other samples the overall pattern was dominated by the abundance of Sebastes saxicola or Microstomus pacificus.

Diel Comparisons

Species composition of day and night tows for each site is given in Table III. Diel changes in the abundant species were apparent in each site. Using Sanders' (1960) index, higher similarity values (> 50) were observed within the nightime than the daytime samples (Figures 5a and 5b). This relative difference between day and night similarity values among samples was statistically significant ($H = 5.769$, $P < .02$). Thus the species composition of night samples was more uniform than day samples. However, Sørensen's similarity coefficients showed high similarity values (> .50) within daytime and nighttime hauls (Figure 6), indicating that the species present were not markedly different.

At both sites G. zachirus, M. pacificus, Aprodon cortezianus, Hydrolagus colliei, and Parophrys velutus were more abundant at night than day. By contrast S. saxicola was more abundant by day at site A, Merluccius productus was more abundant at night, and at site B it was more abundant at day. Catches of S. jordani, S. goodei, and S. paucispinis were also larger by day than by night at both sites. These rock-

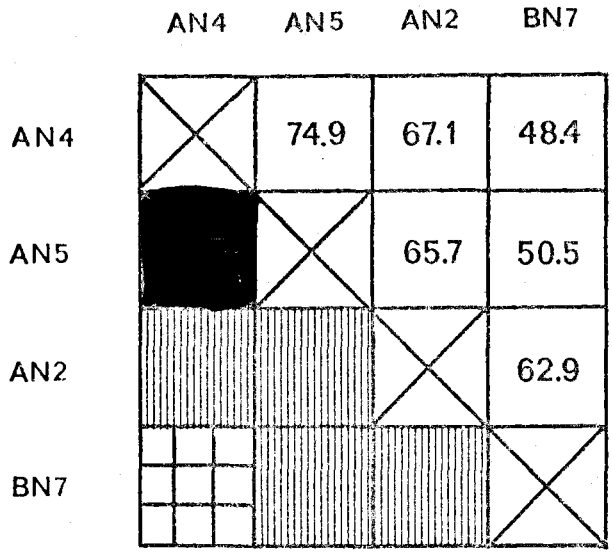
Table III. Species Percent Composition in Combined Day and Combined Night Demersal Trawls at Sites A and B.

Species Name	Percent Composition				Average Numbers Per Tow			
	Site A		Site B		Site A		Site B	
	Day	Night	Day	Night	Day	Night	Day	Night
Sebastes saxicola	18.81	10.05	40.74	32.70	336	113	1017	769
Microstomus pacificus	4.32	21.48	17.21	30.61	75	248	276	720
Glyptocephalus zachirus	7.82	14.61	1.87	7.40	110	136	56	174
Sebastes elongatus	8.50	6.99	.07	.26	159	122	2	6
Merluccius productus	.99	18.83	12.24	2.25	3	41	229	53
Lyopsetta exilis	3.11	5.97	2.97	2.47	56	61	49	58
Sebastes goodei	22.48	.31	4.67	5.95	51	1	121	140
Sebastes jordani	17.79	.15	6.92	.77	61	4	162	18
Aprodon cortezianus	.05	4.70	.15	6.16	1	55	3	145
Hydrolagus colliei	.24	1.51	.17	3.23	5	26	3	76
Sebastes paucispinis	1.17	.32	2.63	.38	3	2	51	9
Parophrys velutus	.13	1.29	.17	1.53	3	13	3	36
Eopsetta jordani	.34	.11	.18	.38	3	3	3	9
Raja binoculata	.26	.37	.36	.37	1	3	7	4
Squalus acanthias	.23	.01	.05	.09	1	0	1	2
Porichthys notatus	1.62	.03	.02		27	1	1	
Ophiodon elongatus	.81	.04	.04		4	1	1	
Sebastes chlorostictus	.78	.37	.04		11	10	1	
Zalembius rosaceus	.18	1.10	.02		4	8	1	
Citharichthys sordidus	8.60	10.64			137	94		

Table III. (Continued)

Species Name	Percent Composition				Average Numbers Per Tow			
	Site A		Site B		Site A		Site B	
	Day	Night	Day	Night	Day	Night	Day	Night
Zaniolepis sp.	.13	.04			3	1		
Sebastes ovalis	.23				1			
Pleuronichthys verticalis	.05				1			
Radulinus asprellus	.03				1			
Icelinus tenuis	.16				3			
Icelinus filamentosus	.03				1			
Parmaturus xaniurus		.03		.55		1		13
Sebastolobus alascanus		.38		.34		10		8
Raja sp.		.01						
Sebastes entomelas		.62				3		
Agonopsis emmelane		.03				1		
Trachurus symmetricus			2.89				44	
Raja rhina			.04				1	
Sebastes crameri	.70		.14		2		3	
Clupea harengus pallasi	.39		.11		8		2	
Anoplopoma fimbria	.03		4.28	1.19	1		94	28
Sebastes diploproa			.15	.09			3	2
Xeneretmus latifrons			.11	.04			2	1
Raja kinkaidii			1.77	.44			28	81

a)



b)

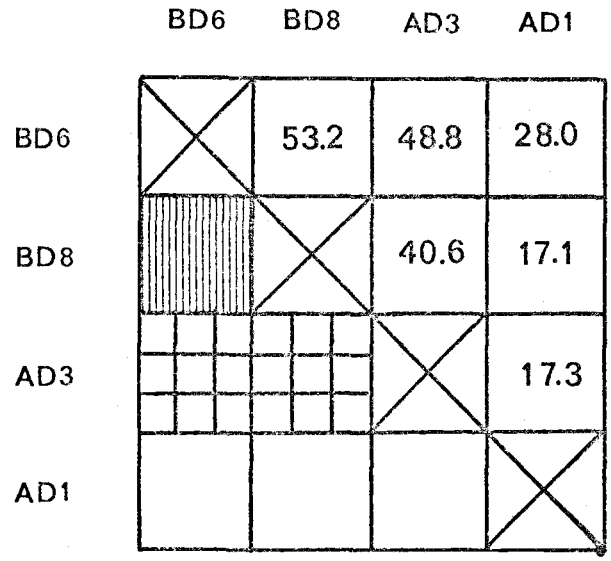
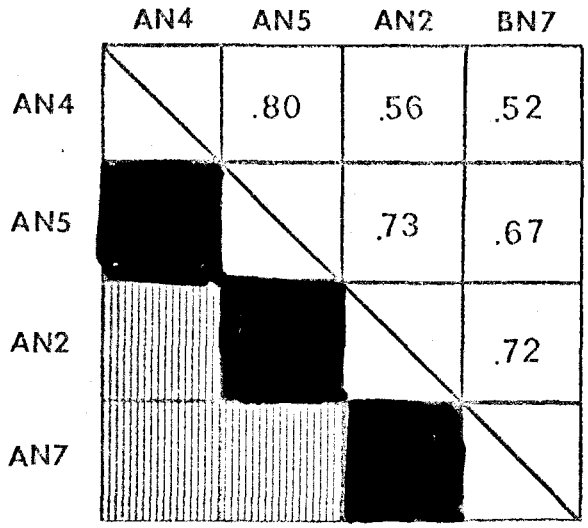


Figure 5. "Trellis diagram" illustrating similarity within diel period (based on Sanders' (1960) similarity index) in demersal trawls taken off Monterey. Rockfish survey Leg I. (a) nighttime samples, (b) daytime samples.

■ ≧ 70.0 ▥ 50.0 – 69.9 ▦ 30.0 – 49.9 □ < 30.



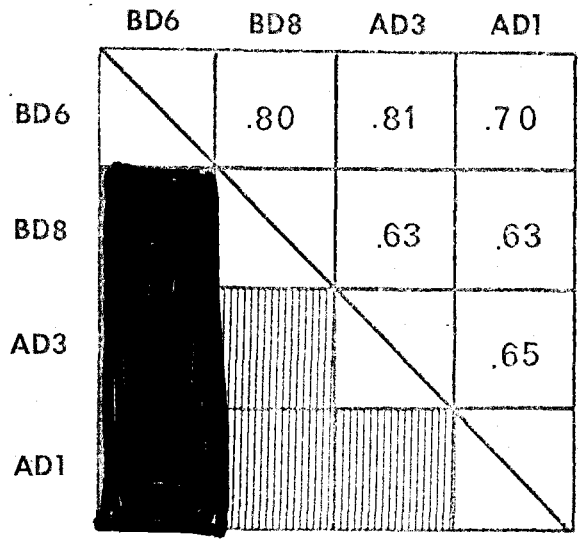


Figure 6. "Trellis diagrams" illustrating similarity within diel period (base on Sorensen's (1948) similarity coefficient) in demersal trawls taken off Monterey. Rockfish survey Leg I. (a) nighttime samples (b) daytime samples.

■ ≧.70 ▥ .50 – .69

fishes contributed 41.4% of the total catch by day but only 7.5% by night. C. sordidus, caught only at site A, was also more abundant by day than by night.

Species Affinities and Recurrent Groups

Of the 39 species found in Leg 1 survey, 26 could be arranged in five recurrent groups (Table IV); three others had affinities with some, but not all, of the members of one or the other of the groups; and ten species had no affinities with any of the others.

Group I consisted of 14 species of which five were flatfishes and five were rockfishes. One additional species, a shark (Squalus acanthias), showed affinity with some but not all of the species of this group, namely with hake (Merluccius productus), the rockfishes (except S. elongatus) and the flatfishes (with the exception of Glyptocephalus zachirus).

Groups II and III consisted of three species each. They both had interspecific connections with Group I but the degree of association between Group II and I is greater than between Group III and I. Two other species (Trachurus symmetricus and Raja kinkaidii) showed affinity only with species of Group III.

Group IV is a very special group consisting of one flatfish (Pleuronichthys verticalis) and three sculpins (Icelinus tenuis, I. filamentosus and Radulinus asprellus), with no connections with any of the other groups.

Group V consists of two species, Citharichthys sordidus and Zalembius rosaceus, showing affinities with eight and seven of the 14 species of Group I, respectively.

Table IV. Species Composition of Recurrent Groups. Rockfish Survey Leg I.

Species	Species
GROUP I	GROUP III
Raja binoculata	*Sebastes diploproa*
Hydrolagus colliei	*Anoplopoma fimbria*
Sebastes saxicola	*Xeneretmus latifrons*
Sebastes goodei	Associated:
Sebastes jordani	*Raja kinkaidii*
Sebastes elongatus	*Trachurus symmetricus*
Sebastes paucispinis	
Microstomus pacificus	GROUP IV
Lyopsetta exilis	*Radulinus asprellus*
Eopsetta jordani	*Icelinus tenuis*
Glyptocephalus zachirus	*Icelinus filamentosus*
Parophrys vetulus	*Pleuronichthys verticalis*
Merluccius productus	
Aprodon cortezianus	GROUP V
Associated:	*Zalembius rosaceus*
Squalus acanthias	*Citharichthys sordidus*
GROUP II	
Porichthys notatus	
Ophiodon elongatus	
Sebastes chlorostictus	

These recurrent groups were combined into major assemblages on the basis of the species connections with values of at least 0.25 (Figure 7). Only one major assemblage occurred. Basically it was dominated by rockfish and flatfish components of Group I. Group III had the lowest intergroup affinity value (0.26) and it was only present in site B samples. Possibly two assemblages, an intermediate depth assemblage (dominated by Sebastes saxicola and Microstomus pacificus) and a deep-water assemblage (dominated by Anoplopoma fimbria), might have been obscured by having mixed day and night samples. The rank order of abundance of species in recurrent Group I was determined from samples containing at least 80% of the species components of this group. Concordance among the rankings was statistically significant ($W = .467$, $Q = 42.473$, $P < .001$) indicating that the order of abundance between the species tended to be constant. The species, ordered by their sum of ranks, are as follows:

S. saxicola, M. pacifucus
G. zachirus
M. productus
S. jordani, S. goodei, L. exilis
S. elongatus
A. cortezianus, S. paucispinis, H. colliei
E. jordani, R. binoculata, P. vetulus

Therefore, S. saxicola and M. pacificus were consistently more abundant than all other species in the Group I. The relative abundance (by number) of S. saxicola was not significantly different from that of M. pacificus (Mann-Whitney-Wilcoxon test statistic, $T_x = 48$, $P = .310$).

Although five groups were defined for both day and night hauls,

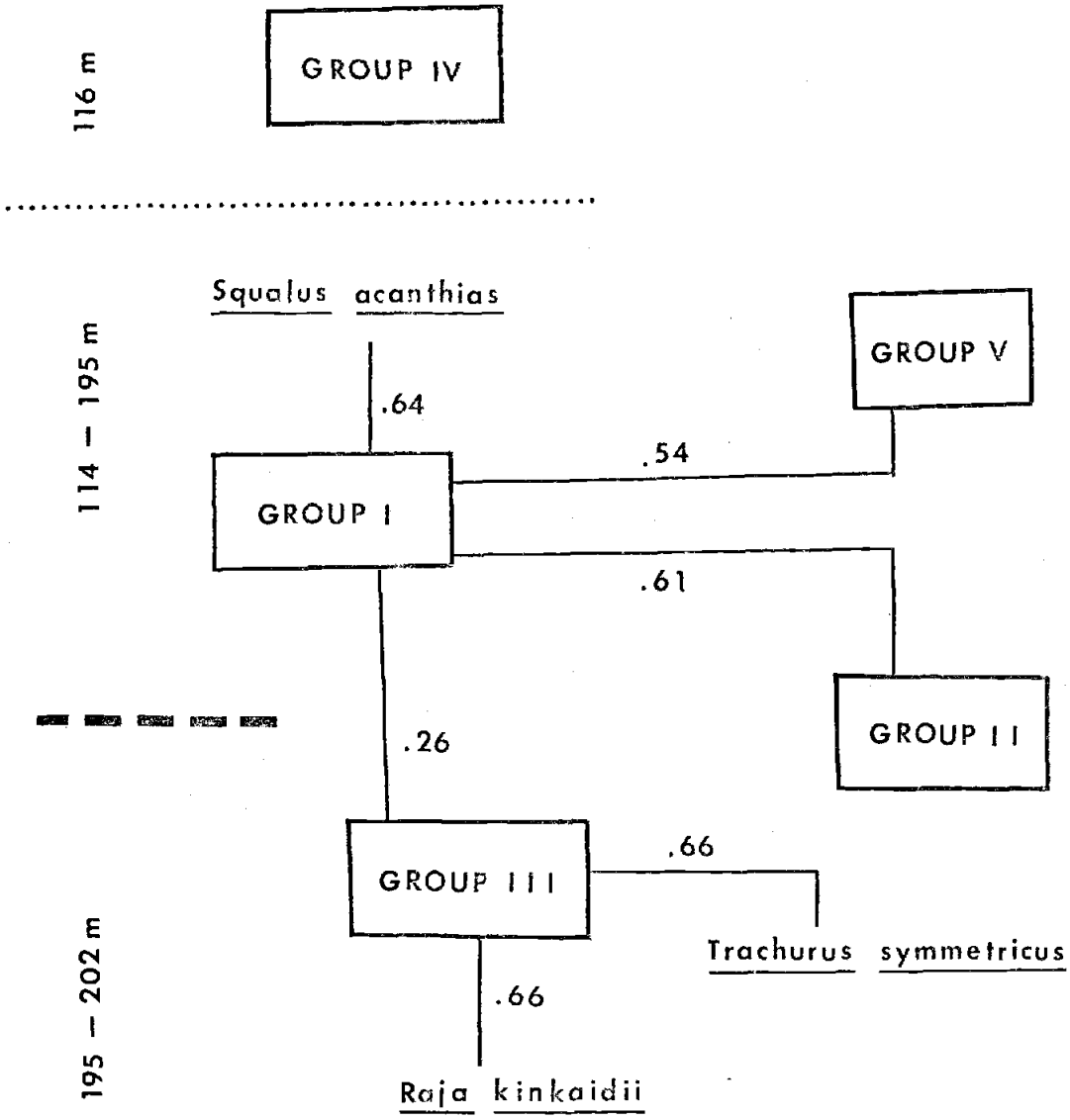


Figure 7. Intergroup affinities of recurrent species groups from Leg I and their combination into one major assemblage.

major differences in species affinities were detected between the daytime and nighttime hauls of Leg I (Table V). Differences were due to shifts of species from one group to another. Different daytime groups were all interrelated and the degree of association was relatively high (> .60). Nighttime groups showed fewer interrelations and two groups (2 and 5) showed no association with any of the others. The pattern was, however, difficult to interpret.

At night, three species from day Group I (Squalus acanthias, Sebastes jordani and Eopsetta jordani) became associated with Sebastolobus alascanus and Parmaturus xaniurus, originating a new group (Group 2) with low affinity (0.26) to its original group. Citharichthys sordidus showed high affinity with Zalembius rosaceus but in daytime it became associated with Ophiodon elongatus while the reverse occurred with Porichthys notatus. Aprodon cortezianus, Hydrolagus colliei and Parophrys vetulus were associated with deep-water forms such as Anoplopoma fimbria and Sebastes diploproa by day but at night they only showed affinity with species components of Group I.

ROCKFISH SURVEY LEG II

The surveyed area off Monterey covered by Leg II of the rockfish survey was between 36°15'N and 37°15'N latitude (Figure 2). Forty-six demersal trawls taken by the RV John N. Cobb were used as additional information on the demersal fish community between 90 and 450 m depth. Details on location and catch composition of these trawls are given in Appendix II.

Table V. Composition of the Recurrent Species Groups, Indicating Differences Between Day and Night. The Numbers After the Broken Lines in the List Indicates the Position of that Species in the Other Diel Period.

Group No.	Day	Night
1	Raja binoculata	Raja binoculata
	------ 3	Hydrolagus colliei
	Squalus acanthias	------ 2
	Sebastes saxicola	Sebastes saxicola
	Sebastes goodei	Sebastes goodei
	Sebastes elongatus	Sebastes elongatus
	Sebastes jordani	------ 2
	Sebastes crameri	------
	------ 1 associated	Sebastes paucispinis
	Lyopsetta exilis	Lyopsetta exilis
	Eopsetta jordani	------ 2
	------ 3	Parophrys vetulus
	Microstomus pacificus	Microstomus pacificus
	Glyptocephalus zachirus	Glyptocephalus zachirus
	Merluccius productus	Merluccius productus
	------ 3	Aprodon cortezianus
2	------ 1	Squalus acanthias
	------	Parmaturus xaniurus
	------	Sebastolobus alascanus
	------ 1	Sebastes jordani
	------ 1	Eopsetta jordani
3	------	Raja kinkaidii
	Hydrolagus colliei	------ 1
	Sebastes diploproa	Sebastes diploproa
	Aprodon cortezianus	------ 1
	Anoplopoma fimbria	Anoplopoma fimbria

Table V. (Continued)

Group No.	Day	Night
	Xeneretmus latifrons	*Xeneretmus latifrons*
	Parophrys velutus	------ 1
	Trachurus symmetricus	------
4	*Zalembius rosaceus*	*Zalembius rosaceus*
	Porichthys notatus	------ 5
	------	*Sebastes entomelas*
	------ 5	*Citharichthys sordidus*
5	------ 4	*Porichthys notatus*
	Citharichthys sordidus	------ 4
	Ophiodon elongatus	*Ophiodon elongatus*
	Sebastes chlorostictus	*Sebastes chlorostictus*
	------	*Agonopsis emmelane*
	------	*Zaniolepis* sp.
	------	*Raja* sp.

Catch Composition

A total of 60 species were found in the 46 demersal trawls. Unfortunately not all the sharks, skates and rays, and some other uncommon species were identified to species. In all, at least 21 families were represented. Twenty-eight species were added to those already found in Leg I hauls. These additions included, among others, 16 rockfishes and three flatfishes. The largest number of species was again contributed by Scorpaenidae (25) and Pleuronectidae (9).

Species Affinities and Recurrent Groups

Because of differences in the sampling design, recurrent groups were determined separately for Leg I and Leg II. However, groups were labeled so that they could be later compared to those found in Leg I (Table VI).

Of the 60 species found in Leg II, 22 could be arranged in seven groups (Table V). Four had affinities with some of the members of one or the other groups and 34 showed no affinity with any of the other species.

Group I consisted of five flatfishes and two rockfishes. Two additional rockfishes, *Sebastes saxicola* and *S. elongatus*, were associated with some but not all of the species of this group. A third species, *Ophiodon elongatus*, also showed affinity with some of the Group I species, but to a lesser extent than the former (see Figure 10).

Group III consisted of three species and one associated rockfish (*Sebastes aurora*). This group was only associated to Group VIII which contained two rockfish species: *Sebastes diploproa* and *Sebastolobus alascanus*.

Table VI. Species Composition of Recurrent Groups. Rockfish Survey Leg II. (Groups Were Labeled, for Convenience, so That They Could be Compared to Those of Leg I.)

Species	Species
GROUP I	GROUP VI
Sebastes goodei	*Sebastes brevispinis*
Sebastes jordani	*Sebastes rosaceus*
Microstomus pacificus	*Sebastes ruberrimus*
Lyopsetta exilis	
Eopsetta jordani	GROUP VII
Glyptocephalus zachirus	*Clupea harengus pallasi*
Parophrys vetulus	*Genyonemus lineatus*
Associated:	
Sebastes saxicola	GROUP VIII
Sebastes elongatus	*Sebastes diploproa*
Ophiodon elongatus	*Selastolobus alascanus*
GROUP III	GROUP IX
Anoplopoma fimbria	*Sebastes caurinus*
Merluccius productus	*Sebastes hopkinsi*
Aprodon cortezianus	
Associated:	
Sebastes aurora	
GROUP V	
Zalembius rosaceus	
Citharichthys sordidus	
Porichthys notatus	
Associated:	
Sebastes elongatus	
Ophiodon elongatus	

Group V also consisted of three species but it was only associated to Group I. Sebastes saxicola and O. elongatus were also associated with some but not all of the species of Group V.

Groups VI, VII and IX, showed no affinity with any other group. Groups VI and IX consisted of rockfishes only. These three groups contained species not found in Leg I, probably due to the different and larger area surveyed by Leg II.

The bathymetric distribution of recurrent groups of species derived from Leg II trawls is illustrated in Figures 8 and 9. Two depth contours, 90 and 180 m, seemed to delimit the distribution of the demersal fish communities. Group VII was found along the 90 m contour in six out of seven trawl stations in the northwest area off Monterey. This group was not found as a unit in the three trawl stations south of Carmel Canyon. Groups I and V were distributed between the 90 and 180 m contours. Beyond the 180 m contour Groups III and VIII were found, but Group VIII was not found to the South of Carmel Canyon.

Based on species connections among groups and the bathymetric distribution of recurrent groups, three major assemblages were formed: an inshore, an intermediate depth and a deep-water assemblage (Figure 10). Abundant species which characterized the inshore assemblage were Genyonemus lineatus and C. harengus pallasi; the flatfishes and four rockfishes (S. goodei, S. jordani, S. saxicola and S. elongatus) characterized the intermediate depth assemblage; and M. productus, A. fimbria, and A. cortezianus formed the deep-water assemblage.

Figure 8. Recurrent species groups bathymetric distribution off Monterey. Rockfish survey Leg II, northwest off Monterey and Monterey Bay area.

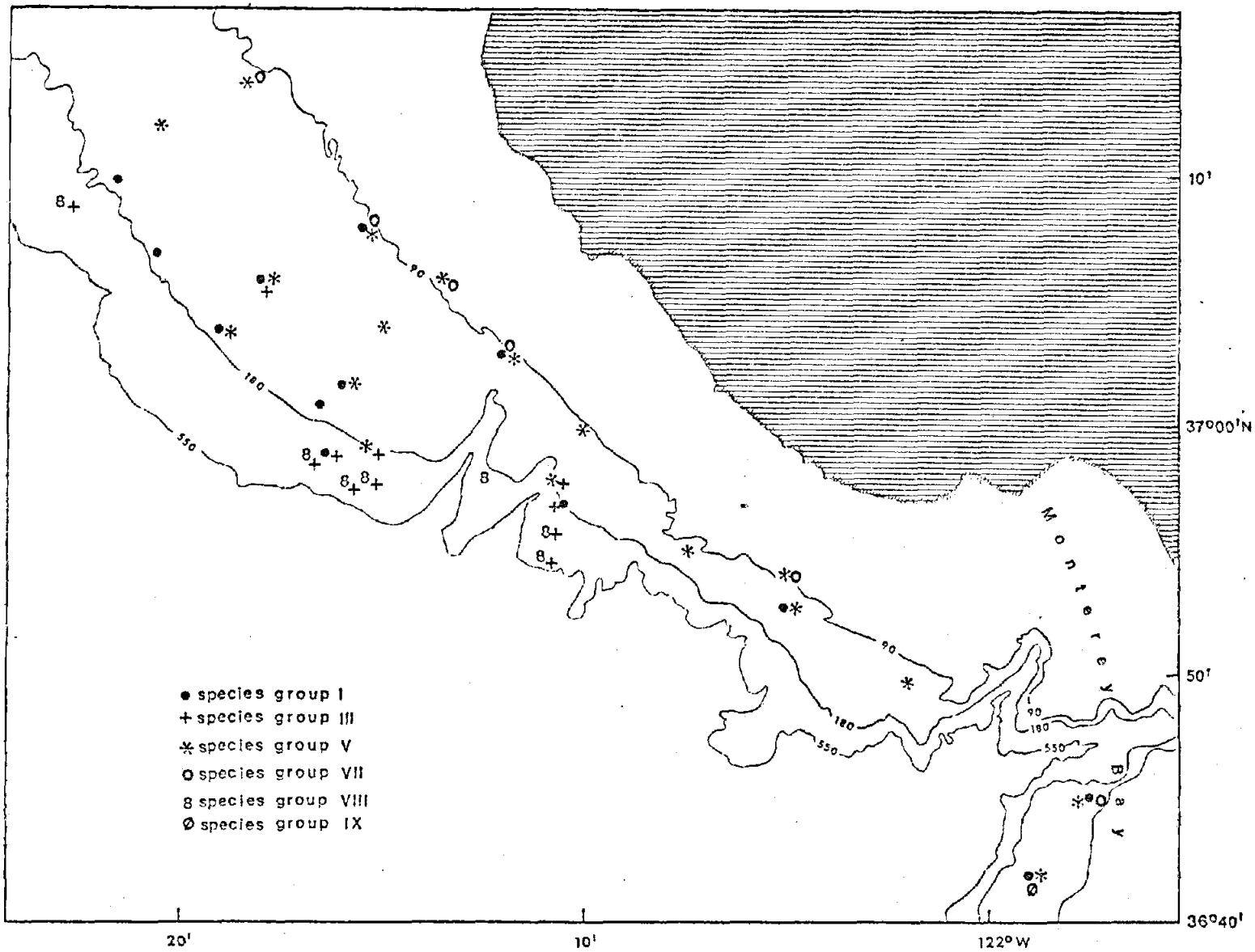
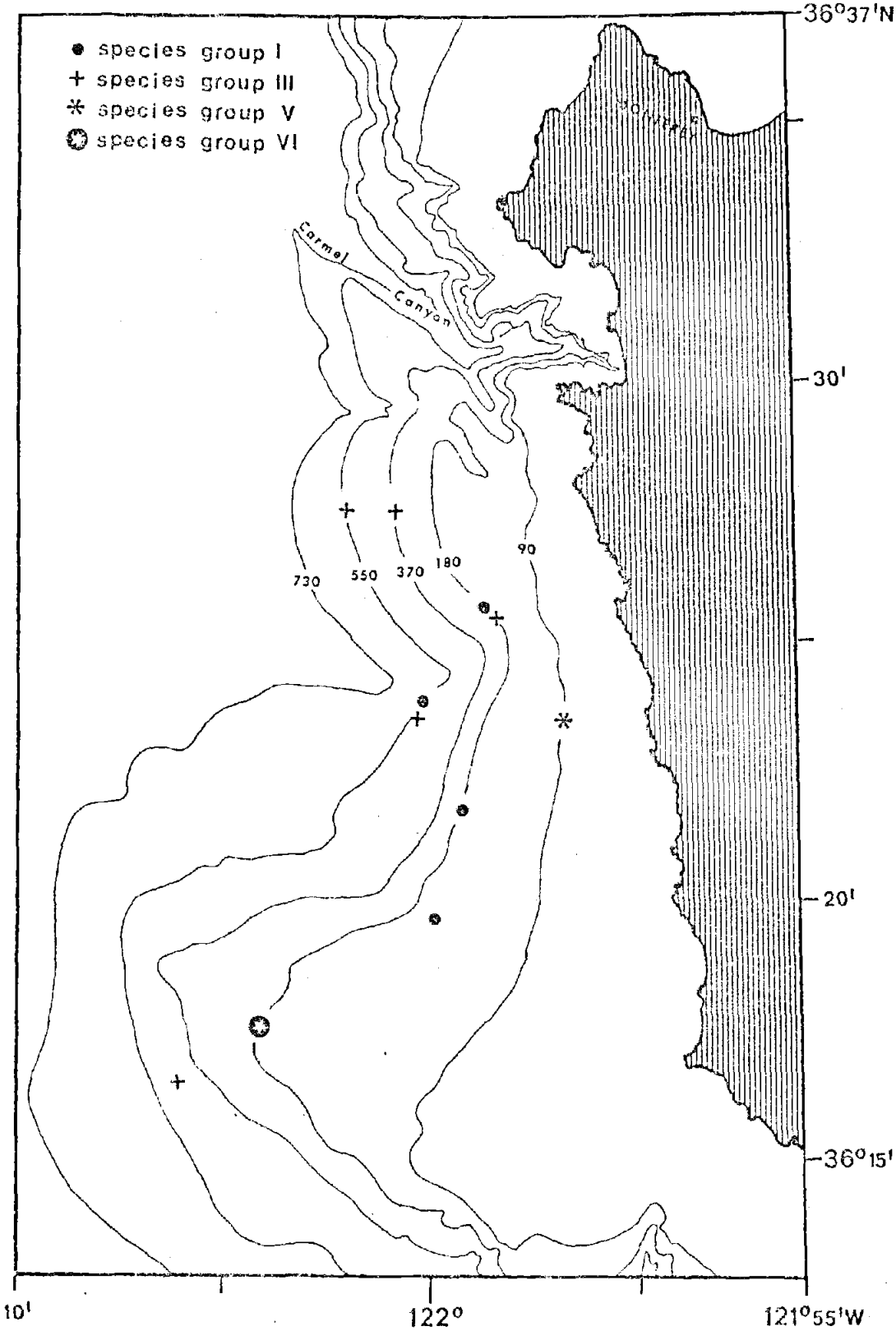

species group I
species group III
species group V
species group VII
species group VIII
species group IX
90
180
550
Monterey Bay
10'
37°00'N
50'
36°40'
20'
10'
122° W

Figure 9. Recurrent species groups bathymetric distribution. Rockfish survey Leg II, Monterey area south of Carmel Canyon.


species group I
species group III
species group V
species group VI
Carmel
Canyon
730
550
370
180
90
36°37'N
30'
20'
36°15'
10'
122°
121°55'W

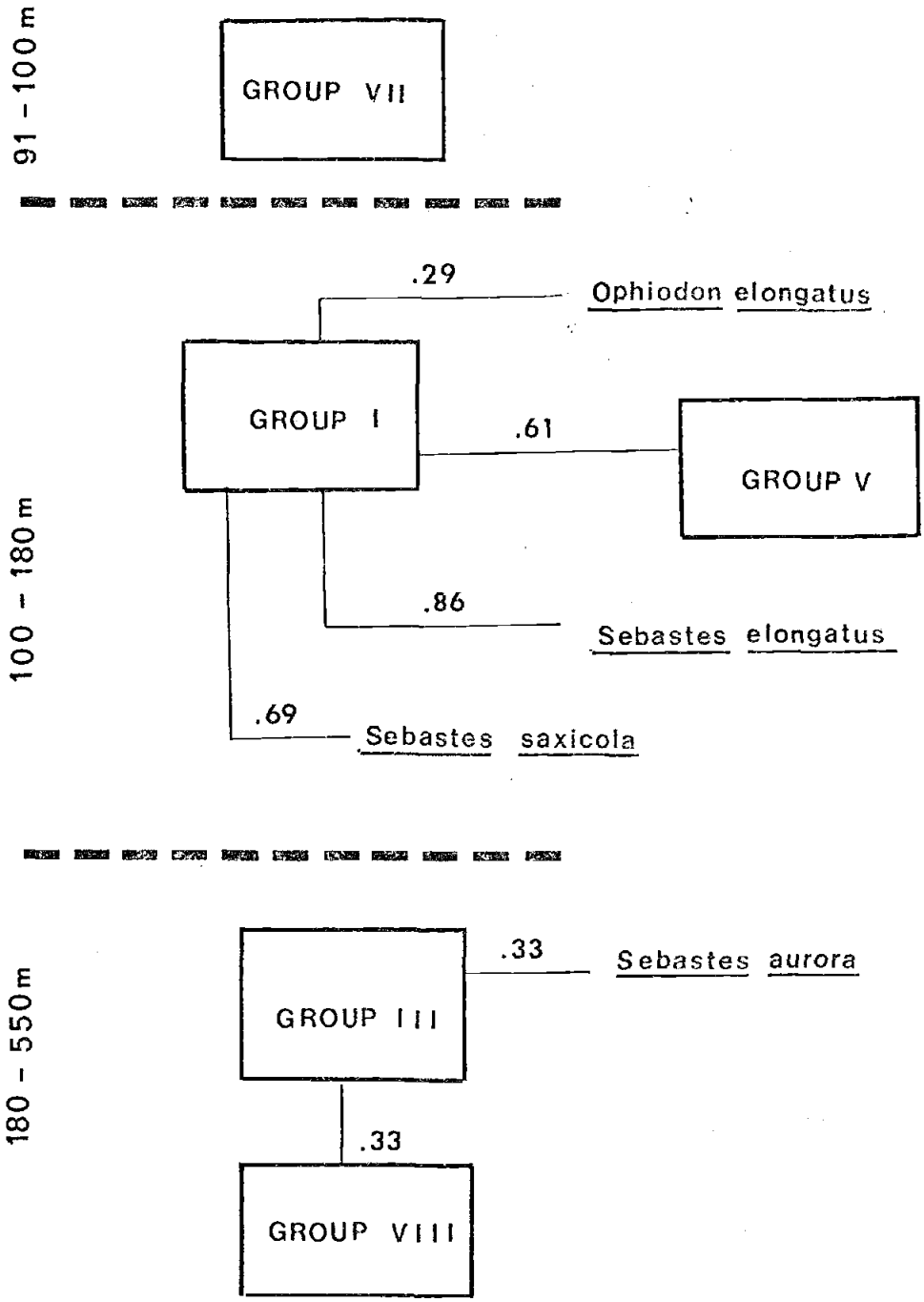


Figure 10. Intergroup affinities of recurrent species groups from Leg II and their combination into major assemblages.

DISCUSSION

The demersal trawls from Leg I and Leg II showed that at least 68 species, representing 24 families were present on or near the bottom of the continental shelf and upper continental slope areas surveyed off Monterey. Two families of fishes were found to be numerically abundant at the two sites sampled during Leg I survey. Rockfishes (Scorpaenidae) and flatfishes (Pleuronectidae) comprised 67% of the total catch at site A, and 84% at site B. Abundant species among the pleuronectids were *Microstomus pacificus* and *Glyptocephalus zachirus* at both sites. They comprised about 81 to 88% of the total catch within their family. Among the scorpaenids, *S. saxicola* and *S. elongatus* were abundant at site A (84% of total catch within family), while at site B *S. saxicola* alone comprised 74% of the total catch within family, followed by *S. goodei* which contributed 10% of the total scorpaenid catch.

The two sites differed mainly in the abundance patterns of species present. *Glyptocephalus zachirus*, *S. elongatus* and *C. sordidus* were more numerous at site A than at site B; *S. paucispinis*, *S. diploproa*, and *A. fimbria* were more numerous at site B. Such differences probably reflect the depth distributions of species. For example, *C. sordidus* was found only in site A samples. It has also been reported as an important component of a species association of fishes in shallow waters (42-73 m) off the Oregon coast (Day and Pearcy, 1968). *Sebastes diploproa* is a well known deep-water form (Heimann, 1963; Alverson et al., 1964).

Similarity based on the presence and absence of species in the samples was indicative that species present at both sites were not

markedly different. In general, most of the site differences were reflected in the catch composition of the rockfishes. As an example, sample AD1, taken close to the 90 m depth contour, showed a high degree of similarity (Sørensen's coefficient of 0.50 to 0.73) with all other samples which were taken closer to the 180 m depth contour than to the 90 m depth contour, while its similarity values based on numerical abundance (Sanders' index) were all below 28.0. This result explained by the fact that two rockfishes, S. goodei and S. jordani, numerically dominated the catch of the tow, while S. saxicola was the numerically abundant rockfish in most other tows.

Diel changes in the abundant species at sites A and B were observed among the flatfishes G. zachirus, M. pacificus and P. vetulus. They were taken in larger numbers by night than by day. Factors which could account for these differences are several. Small changes in vertical distribution could affect availability if species become less buried in the sea-bed and are more active in the water layers immediately above it at night, thus reducing the loss of fish under the trawl (Parrish et al., 1964). Visual avoidance of the net during the day could also explain such differences and this could be the major factor in the present study. Two other species, H. colliei and A. cortezianus, were also more numerous at both sites by night than by day. By contrast, C. sordidus was more abundant by day than by night. This species is known to feed on pelagic prey (Kravitz et al., 1976) which migrate vertically and presumably would be close to the bottom during daylight. Thus, C. sordidus would become more vulnerable to the trawl in the daytime.

Most of the rockfishes were more abundant by day than by night

(e.g., S. saxicola, S. goodei, S. jordani, and S. paucispinis). The larger catches by day of these species might well be associated with feeding habits. Pereyra et al. (1969) reported a shelf rockfish (S. flavidus) feeding on mesopelagic fauna during daytime hours. During the pelagic survey off Monterey (Leg II), I also observed that most of the rockfishes caught in daytime midwater hauls had stomachs full of crustaceans (probably euphausiid or shrimp-like prey) which were relatively undigested. Thus some rockfishes may be concentrated in feeding schools by day making them more available to the trawl. By night, it is possible that these fishes become more dispersed and seek shelter in rocky areas, reefs kelp beds with which they are often associated (Hobson, 1968; Miller and Geibel, 1973).

The Pacific hake, Merluccius productus, was more abundant at site B (deeper station) by day and at site A (shallow station) by night. Grinols and Tillman (1970) reported that hake undertake diel vertical migrations, coming off the bottom at night to feed and return to the bottom near dawn. Nelson and Larkins (1970) also indicated that hake feed during twilight hours. Hake are known to feed on shrimp, squid, anchovies and smelt (Paul, 1960) and on euphausiids (Alton and Nelson, 1970). The vertical movements of hake schools are probably in response to the vertical movements of their prey. These vertical movements could explain the increased abundance of hake at site B in daytime, but not the increase at site A at night. In a study off southern California, Mearns (1974) found that M. productus, S. jordani, and A. fimbria were present in shallow areas only at night, probably attracted by wastewater discharges and concentrations of prey. Perhaps the increased

abundance of hake at site A by night could be related to feeding and an inshore movement. Cooney (1967) reported shifts in abundance of Parophrys vetulus from deep waters during the day to shallow water at night in a narrow extension of Central Puget Sound. In the present study, however, higher numbers of P. vetulus were caught by night at both sites, suggesting that horizontal movements were not as pronounced as they were for M. productus.

These results from Leg I of this study indicate day-night differences in bottom trawl catches of both rockfishes and flatfishes. Hence data from daytime sampling alone may underestimate biomass of most flatfishes, while data from night samples may underestimate biomass of rockfishes. Such diel effects should be a consideration in future surveys.

The two Legs of the rockfish survey produced similar results with respect to the catch composition even though Leg II covered a much larger area. Numerically abundant species in Leg I were S. saxicola, S. elongatus, S. goodei, S. jordani, M. pacificus, G. zachirus, and L. exilis. These species were also reported among the 20 most abundant species (by weight) in Leg II of the rockfish survey (Gunderson and Nelson, 1977).

A comparison of the composition of recurrent groups derived from the separate analysis of Leg I and Leg II demersal trawls is made in Table VII. Although no two groups were completely identical in both surveys, most could be recognized on the basis of having at least some taxa in common. Most of the differences between the two surveys involved changes in the apportionment of species among groups. Differ-

Table VII. Composition of the Recurrent Groups Indicating Differences Between Leg I and Leg II Surveys. The Number After the Broken Line Indicates the Position of that Species in the Other Survey.

Group No.	Leg I	Leg II
1	*Raja binoculata*	------
	Hydrolagus colliei	------
	Sebastes saxicola	------ 1 associated
	Sebastes goodei	*Sebastes goodei*
	Sebastes jordani	*Sebastes jordani*
	Sebastes elongatus	------ 5 associated
	Sebastes paucispinis	------
	Microstomus pacificus	*Microstomus pacificus*
	Lyopsetta exilis	*Lyopsetta exilis*
	Eopsetta jordani	*Eopsetta jordani*
	Glyptocephalus zachirus	*Glyptocephalus zachirus*
	Parophrys vetulus	*Parophrys vetulus*
	Merluccius productus	------ 3
	Aprodon cortezianus	------ 3
2	*Porichthys notatus*	------ 5
	Ophiodon elongatus	------ 5 associated
	Sebastes chlorostictus	------
3	*Sebastes diploproa*	------ 8
	Anoplopoma fimbria	*Anoplopoma fimbria*
	Xeneretmus latifrons	------
	------ 1	*Merluccius productus*
	------ 1	*Aprodon cortezianus*

Table VII. (Continued)

Group No.	Leg I	Leg II
4	Radulinus asprellus	------ No
	Icelinus tenuis	------ similar
	Icelinus filamentosus	------ group
	Pleuronichthys verticalis	------
5	Zalembius rosaceus	Zalembius rosaceus
	Citharichthys sordidus	Citharichthys sordidus
	------ 2	Porichthys notatus
6	------ No	Sebastes brevispinis
	------ similar	Sebastes rosaceus
	------ group	Sebastes ruberrimus
7	------ No similar	Clupea harengus pallasi
	------ group	Genyonemus lineatus
8	------ 3	Sebastes diploproa
	------	Sebastolobus alascanus
9	------ No similar	Sebastes hopkinsi
	------ group	Sebastes caurinus

due to unmatched groups can be attributed to the restricted area surveyed during Leg I. In fact, three of the groups are based on one haul each and their components usually were not found in any other sample taken at the same depth, but then no other sample was taken in the near vicinity. Group IV was found in sample AD3 of Leg I at 116 m depth; Group VI was found in haul number 28, south of Carmel Canyon at 210 m depth; and Group IX, also taken in Leg II, was found in haul number 33 in the Monterey Bay area in 101 m depth.

The demersal fish community off Monterey (from about 90 to 500 m depth) consists of three major species assemblages which are segregated by depth: < 100 m, 100 to 180 m, and > 180 m. The shallow water assemblage (< 100 m) is characterized by the Genionemus lineatus group; the intermediate depth assemblage (100 to 180 m) is characterized by the S. jordani/M. pacificus group; and the deep-water assemblages (> 180 m) is characterized by the M. productus and S. diploproa groups. The assemblage found in Leg I, dominated by a rockfish and a flatfish, probably represents a combination of two transitional assemblages: the transition between a shallow-water assemblage and an intermediate depth assemblage (Groups I, II and V) and the transition between the intermediate depth assemblage and the deep-water assemblage (Group III).

The depth strata with which these three assemblages were associated closely approximated the boundaries of the three sub-fisheries of the Monterey trawl fishery. Moreover, the species composition of the three assemblages compared well with species composition of the commercial landings reported by Heimann (1963). He reported that S. diplopra, A. fimbria and M. productus ranked first, sixth, and eighth,

respectively, among the ten most important species (by weight) in the deep-water fishery; S. goodei, S. jordani, O. elongatus, and G. zachirus ranked first, third, fourth and fifth, respectively, among the ten most important species in the intermediate depth fishery. However, the shallow water fishery (ca. 50 to 100 m) was different, probably because samples in this study were only taken along its deeper depth boundary, ca. 90 m (Leg II survey). Flatfishes were the most abundant species (by weight) in the shallow water fishery.

A similar trend of depth related species groups was found off southern California by Mearns (1974). He described three flatfish groups within the nearshore demersal fish community (20-400 m depth). His shallow-water speckled sanddab group was not found off Monterey. However, he indicated the existence of another inshore group, dominated by Genyonemus lineatus and associated with Engraulis mordax, which resembles the shallow-water assemblage found off Monterey in this study. His mid-depth group, characterized by M. pacificus, C. sordidus, Z. rosaceus and P. notatus, is similar to the intermediate depth assemblage described for the Monterey Bay area. The deep-water group he described contained only two flatfishes, G. zachirus and L. exilis; these species were included in the intermediate depth assemblage off Monterey.

Depth related differences in faunal composition of fishes have also been reported off central and northern California, between Pt. Arguello to the Oregon border (Miller and Geibel, 1973). Inside the 73 m depth contour (not sampled in the present study) the principal rockfishes taken by hook-and-line were S. mystinus and S. serranoides,

while at greater depths the principal rockfishes were S. flavidus, S. entomelas, S. goodei, S. chlorostictus, S. rosaceus and the principal demersal species were Anoplopoma fimbria, Eopsetta jordani and Parophrys vetulus. These species that were abundant in depths greater than 73 m, were also included in the intermediate depth assemblage of Leg II. Most of them ranked among the 20 most abundant species (by weight) in the 100-149 and 150-199 depth strata (Gunderson and Nelson, 1977).

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APPENDICES

Appendix I. Rockfish Survey Leg I. Sites (A) and (B), Demersal Daytime (D) and Nighttime (N) Trawls, and Corresponding Midwater Trawls (MW). Fish Catch Composition in Midwater Hauls is Indicated.

Haul No.	Date 1976	Start Position / End Position Latitude	Longitude	Time (PST)	Depth (m)	Observations
AD1	7/26	36°50.8'	122°06.6'	1422	95	
		36°49.8'	122°06.6'	1452	97	
AMW1	7/26	36°50.8'	122°06.6'	1603	-	Net sounder not working
AN2	7/26	36°52.0'	122°10.2'	2235	115	
		36°50.7'	122°09.3'	2305	119	
AMW2	7/27	36°52.1'	122°10.2'	0010	113	20 m below surface
		36°50.4'	122°08.8'	0040	121	1 *Prionace glauca*
						11 *Porichthys notatus*
AMW3	7/27	36°52.2'	122°10.6'	0132	115	15-25 m off bottom
		36°51.1'	122°09.7'	0202	126	15 *Porichthys notatus*
						11 *Merluccius productus*
AD3	7/27	36°52.1'	122°10.5'	1221	113	
		36°51.0	122°09.5'	1251	119	
AM@4	7/27	36°51.1'	122°09.6'	1315	-	Net wounder not working
AMW5	7/27	36°50.0'	122°10.5'	1444	113	25 m off bottom
		36°50.8'	122°09.0'	1514	115	No fish caught

Appendix I. (Continued)

Haul No.	Date 1976	Start Position / End Position Latitude	Longitude	Time (PST)	Depth (m)	Observations
AMW6	7/27	36°52.2'	122°10.5'	1552	112	30 m off bottom
		36°20.1'	122°08.6'	1637	110	No fish caught
AN4	7/27	36°50.9'	122°08.9'	2215	113	
		36°49.8'	122°07.8'	2245	115	
AN5	7/27	36°50.1'	122°08.2'	2308	113	
		36°51.1'	122°09.4'	2338	121	
AMW7	7/28	36°51.2'	122°09.2'	0010	112	10-20 m below surface
		36°50.7'	122°08.6'	0040	112	No fish caught
AMW8	7/28	36°52.0'	122°10.5'	0122	113	37-40 m off bottom
		36°50.7'	122°08.9'	0152	117	3 *Merluccius productus*
						1 *Sebastes saxicola*
BD6	7/28	36°56.6'	122°21.0'	1305	196	
		36°55.7'	122°19.6'	1335	207	
BMW9	7/28	36°56.6'	122°20.8'	1434	198	Net hit bottom
				1442		Net sounder malfunction
						1 *Sebastes goodei*
						1 *Merluccius productus*
						1 *Glyptocephalus zachirus*
						24 *Sebastes jordani*

Appendix I. (Continued)

Haul No.	Date 1976	Start Position / End Position Latitude	Longitude	Time (PST)	Depth (m)	Observations
BMW10	7/28	36°56.9'	122°21.3'	1526	183	25 m below surface
		36°56.0'	122°19.6'	1556	214	3 *Sebastes jordani*
BMW11	7/28	36°56.5'	122°20.8'	1630	196	15-20 m off bottom
		36°55.7'	122°19.2'	1700	216	30 *Merluccius productus*

Appendix II. Rockfish Survey Leg II. Demersal Trawl Stations List and Their Fish Catch Composition.

Haul No.	Date 1976	Latitude North	Longitude West	Depth (m)	Species Content
1	8/3	37°07'	122°41'	135	Unidentified shark *Citharichthys sordidus* *Lyopsetta exilis* *Eopsetta jordani* *Parophrys vetulus* *Microstomus pacificus* *Glyptocephalus zachirus* *Clupea harengus pallasi* *Zalembius rosaceus* *Sebastes crameri* *Sebastes elongatus* *Sebastes elongatus* *Sebastes goodei* *Sebastes jordani* *Sebastes paucispinis* *Sebastes saxicola*
2	8/5	36°57'	122°21'	192	*Squalus acanthias* *Lyopsetta exilis* *Eopsetta jordani* *Parophrys vetulus* *Microstomus pacificus* *Glyptocephalus zachirus* *Anoplopoma fimbria* *Icelinus filamentosus* *Ophiodon elongatus* *Merluccius productus* *Sebastes crameri* *Sebastes entomelas* *Sebastes goodei* *Sebastes jordani* *Sebastes paucispinis* *Sebastes pinniger* *Sebastes saxicola*
3	8/7	36°29'	122°01'	366	*Microstomus pacificus* *Glyptocephalus zachirus* *Anopoma fimbria* *Merluccius productus* *Sebastes aleutianus* *Sebastes aurora* *Sebastes melanostomus*

Appendix II. (Continued)

Haul No.	Date 1976	Latitude North	Longitude West	Depth (m)	Species Content
4	8/7	36°29'	122°00'	210	*Hydrolagus colliei* *Lyopsetta exilis* *Parophrys vetulus* *Microstomus pacificus* *Glyptocephalus zachirus* *Merluccius productus* *Sebastes* sp. *Sebastes saxicola*
5	8/7	36°29'	122°02'	465	Unidentified shark *Microstomus pacificus* *Glyptocephalus zachirus* *Anoplopoma fimbria* *Merluccius productus* *Sebastolobus alascanus* *Sebastes aurora* *Sebastes diploproa* *Sebastes jordani* *Sebastes melanostomus* *Sebastes saxicola*
6	8/8	36°20'	122°04'	196	*Squalus acanthias* *Anoplopoma fimbria* *Ophiodon elongatus* *Sebastolobus alascanus* *Sebastes elongatus* *Sebastes goodei* *Sebastes jordani* *Sebastes paucispinis* *Sebastes saxicola*
7	8/8	36°21'	122°03'	320	*Merluccius productus* *Sebastes diploproa* *Sebastes melanostomus* *Sebastes paucispinis* *Sebastes rufus*
8	8/8	36°21'	122°00'	119	*Torpedo californica* *Hydrolagus colliei* *Citharichthys sordidus* *Lyopsetta exilis* *Eopsetta exilis* *Eopsetta jordani* *Parophrys vetulus* *Microstomus pacificus*

Appendix II. (Continued)

Haul No.	Date 1976	Latitude North	Longitude West	Depth (m)	Species Content
					Lepidopsetta bilineata Ophiodon elongatus Sebastes elongatus Sebastes flavidus Sebastes goodei Sebastes jordani Sebastes paucispinis
9	8/9	36°45'	121°55'	93	Squalus acanthias Raja binoculata Citharichthys sordidus Lyopsetta exilis Eopsetta jordani Parophrys vetulus Microstomus pacificus Glyptocephalus zachirus Porichthys notatus Clupea harengus pallasi Genyonemus lineatus Engraulis mordax Ophiodon elongatus Merluccius productus Sebastes elongatus Sebastes goodei Sebastes jordani Sebastes paucispinis Sebastes saxicola
10	8/9	36°54'	122°10'	91	Citharichthys sordidus Parophrys vetulus Microstomus pacificus Porichthys notatus Clupea harengus pallasi Genyonemus lineatus Sebastes goodei Sebastes jordani
11	8/9	36°53'	122°10'	101	Raja binoculata Hydrolagus colliei Citharichthys sordidus Eopsetta jordani Parophrys vetulus Microstomus pacificus Glyptocephalus zachirus Porichthys notatus

Appendix II. (Continued)

Haul No.	Date 1976	Latitude North	Longitude West	Depth (m)	Species Content
					Zalembius rosaceus Ophiodon elongatus Merluccius productus Sebastes chlorostictus Sebastes diploproa Sebastes elongatus Sebastes goodei Sebastes jordani Sebastes saxicola Sebastes wilsoni
12	8/9	37°00'	122°20'	97	Citharichthys sordidus Lyopsetta exilis Eopsetta exilis Eopsetta jordani Parophrys vetulus Porichthys notatus Zalembius rosaceus Sebastes chlorostictus Sebastes jordani
13	8/10	36°58'	122°21'	128	Citharichthys sordidus Lyopsetta exilis Eopsetta jordani Parophrys vetulus Microstomus pacificus Glyptocephalus zachirus Porichthys notatus Zalembius rosaceus Sebastes chlorostictus Sebastes elongatus Sebastes paucispinis
14	8/10	36°58'	122°21'	201	Lyopsetta exilis Eopsetta jordani Parophrys vetulus Microstomus pacificus Glyptocephalus zachirus Anoplopoma fimbria Merluccius productus Sebastes elongatus Sebastes jordani Sebastes paucispinis Sebastes saxicola

Appendix II. (Continued)

Haul No.	Date 1976	Latitude North	Longitude West	Depth (m)	Species Content
15	8/10	36°56'	122°22'	313	Raja trachura Hydrolagus colliei Lyopsetta exilis Eopsetta jordani Parophrys vetulus Microstomus pacificus Glyptocephalus zachirus Anoplopoma fimbria Merluccius productus Aprodon cortezianus Sebastolobus alascanus Sebastes crameri Sebastes diploproa Sebastes melanostomus Sebastes saxicola
16	8/10	36°55'	122°22'	421	Squalus acanthias Atheresthes stomias Microstomus pacificus Glyptocephalus zachirus Anoplopoma fimbria Merluccius productos Aprodon cortezianus Sebastolobus alascanus Sebastes aurora Sebastes diploproa Sebastes melanostomus Sebastes rufus
17	8/10	37°06'	122°27'	91	Citharichthys sordidus Eopsetta jordani Parophrys vetulus Glyptocephalus zachirus Porichthys notatus Clupea harengus pallasi Genyonemus lineatus Cymatogaster aggregata Zalembius rosaceus Sebastes diploproa Sebastes elongatus Sebastes goodei Sebastes jordani

Appendix II. (Continued)

Haul No.	Date 1976	Latitude North	Longitude West	Depth (m)	Species Content
18	8/10	37°04'	122°30'	110	Citharichthys sordidus Lyopsetta exilis Eopsetta jordani Parophrys vetulus Microstomus pacificus Glyptocephalus zachirus Porichthys notatus Clupea harengus pallasi Zalembius rosaceus Engraulis mordax Argentina sialis Sebastes elongatus Sebastes goodei Sebastes jordani
19	8/11	37°02'	122°32'	128	Citharichthys sordidus Lyopsetta exilis Eopsetta jordani Parophrys vetulus Microstomus pacificus Glyptocephalus zachirus Porichthys notatus Zalembius rosaceus Sebastes elongatus Sebastes goodei Sebastes pinniger Sebastes saxicola
20	8/11	37°01'	122°33'	174	Citharichthys sordidus Lyopsetta exilis Eopsetta jordani Parophrys vetulus Microstomus pacificus Glyptocephalus zachirus Sebastes chlorostictus Sebastes crameri Sebastes elongatus Sebastes goodei Sebastes jordani Sebastes melanostomus Sebastes saxicola
21	8/11	37°00'	122°32'	229	Citharichthys sordidus Lyopsetta exilis Microstomus pacificus

Appendix II. (Continued)

Haul No.	Date 1976	Latitude North	Longitude West	Depth (m)	Species Content
					Glyptocephalus zachirus Argentina sialis Sebastes elongatus Sebastes goodei Sebastes jordani Sebastes saxicola
22	8/11	36°59'	122°33'	305	Squalus acanthias Hidrolagus colliei Lyopsetta exilis Eopsetta jordani Parophrys vetulus Microstomus pacificus Glyptocephalus zachirus Anoplopoma fimbria Merluccius productus Aprodon cortezianus Sebastes crameri Sebastes diploproa Sebastes goodei Sebastes jordani Sebastes paucispinis Sebastes saxicola
23	8/12	36°59'	122°34'	399	Unidentified shark Squalus acanthias Raja binoculata Raja trachura Atheresthes stomias Eopsetta jordani Microstomus pacificus Glyptocephalus zachirus Anoplopoma fimbria Merluccius productus Sebastolobus alascanus Sebastes aurora Sebastes diploproa
24	8/12	37°14'	122°36'	91	Citharichthys sordidus Parophrys vetulus Microstomus pacifucus Glyptocephalus zachirus Porichthys notatus Clupea harengus pallasi Genyonemus lineatus

Appendix II. (Continued)

Haul No.	Date 1976	Latitude North	Longitude West	Depth (m)	Species Content
					Engraulis mordax Merluccius productus Sebastes goodei Sebastes jordani
25	8/12	37°12'	122°41'	110	Squalus acanthias Citharichthys sordidus Lyopsetta exilis Eopsetta jordani Parophrys vetulus Microstomus pacificus Glyptocephalus zachirus Zalembius rosaceus Sebastes crameri
26	8/12	37°10'	122°43'	137	Citharichthys sordidus Lyopsetta exilis Eopsetta jordani Microstomus pacificus Glyptocephalus zachirus Zalembius rosaceus Ophiodon elongatus Merluccius productus Sebastes chlorostictus Sebastes crameri Sebastes elongatus Sebastes entomelas Sebastes goodei Sebastes jordani Sebastes levis Sebastes paucispinis Sebastes saxicola
27	8/13	36°09'	122°46'	402	Squalus acanthias Raja trachura Hydrolagus colliei Microstomus pacificus Glyptocephalus zachirus Anoplopoma fimbria Merluccius producctus Sebastolobus alascanus Sebastes aurora Sebastes diploproa Sebastes paucispinis

Appendix II. (Continued)

Haul No.	Date 1976	Latitude North	Longitude West	Depth (m)	Species Content
28	8/14	36°19'	122°04'	210	Hydrolagus colliei Eopsetta jordani Ophiodon elongatus Sebastes brevispinis Sebastes chlorostictus Sebastes entomelas Sebastes goodei Sebastes levis Sebastes paucispinis Sebastes pinniger Sebastes rosaceus Sebastes ruberrimus Sebastes saxicola Sebastes zacentrus Sebastes rufus
29	8/14	36°18'	122°06'	463	Unidentified shark Raja rhina Microstomus pacificus Glyptocephalus zachirus Anoplopoma fimbria Merluccius productus Aprodon cortezianus Sebastes aurora Sebastes melanostomus
30	8/14	36°25'	121°57'	93	Hydrolagus colliei Citharichthys sordidus Eopsetta jordani Parophrys vetulus Lepidopsetta bilineata Porichthys notatus Ophiodon elongatus Sebastes rufus
31	8/14	36°23'	121°59'	119	Raja binoculata Torpedo californica Citharichthys sordidus Eopsetta jordani Parophrys vetulus Microstomus pacificus Glyptocephalus zachirus Ophiodon elongatus Sebastes goodei Sebastes jordani

Appendix II. (Continued)

Haul No.	Date 1976	Latitude North	Longitude West	Depth (m)	Species Content
32	8/15	36°25'	122°00'	395	Unidentified hagfish *Raja* sp. *Hydrolagus colliei* *Eopsetta jordani* *Microstomus pacificus* *Glyptocephalus zachirus* *Anoplopoma fimbria* *Merluccius productus* *Aprodon cortezianus* *Sebastolobus alascanus* *Sebastes aurora* *Sebastes jordani*
33	8/15	36°42'	121°58'	101	*Squalus acanthias* *Hydrolagus colliei* *Citharichthys sordidus* *Eopsetta jordani* *Parophrys vetulus* *Glyptocephalus zachirus* *Lepidopsetta bilineata* *Porichthys notatus* *Zalembius rosaceus* *Ophiodon elongatus* *Sebastes caurinus* *Sebastes chlorostictus* *Sebastes goodei* *Sebastes jordani* *Sebastes levis* *Sebastes wilsoni*
34	8/15	36°50'	122°04'	97	*Squalus acanthias* *Hydrolagus colliei* *Citharichthys sordidus* *Eopsetta jordani* *Parophrys vetulus* *Microstomus pacificus* *Glyptocephalus zachirus* *Pleuronichthys decurrens* *Porichthys notatus* *Zalembius rosaceus* *Ophiodon elongatus* *Sebastes chlorostictus* *Sebastes entomelas* *Sebastes flavidus* *Sebastes paucispinis*

Appendix II. (Continued)

Haul No.	Date 1976	Latitude North	Longitude West	Depth (m)	Species Content
					Sebastes pinniger
					Sebastes zacentrus
36	8/16	36°55'	122°15'	102	Citharichthys sordidus
					Eopsetta jordani
					Parophrys vetulus
					Microstomus pacificus
					Lepidopsetta bilineata
					Porichthys notatus
					Ophiodon elongatus
					Sebastes chlorostictus
					Sebastes elongatus
					Sebastes flavidus
					Sebastes goodei
					Sebastes jordani
					Sebastes levis
					Sebastes paucispinis
					Sebastes pinniger
					Sebastes wilsoni
37	8/16	37°03'	122°24'	99	Citharichthys sordidus
					Eopsetta jordani
					Parophrys vetulus
					Microstomus pacificus
					Glyptocephalus zachirus
					Porichthys notatus
					Clupea harengus pallasi
					Alosa sapidissimi
					Genyonemus lineatus
					Zalembius rosaceus
					Ophiodon elongatus
					Merluccius productus
					Thaleichthys pacificus
					Sebastes goodei
					Sebastes jordani
					Sebastes saxicola
38	8/16	36°58'	122°25'	208	Hydrolagus colliei
					Lyopsetta exilis
					Microstomus pacificus
					Glyptocephalus zachirus
					Porichthys notatus
					Sebastolobus alascanus
					Sebastes diploproa
					Sebastes goodei

Appendix II. (Continued)

Haul No.	Date 1976	Latitude North	Longitude West	Depth (m)	Species Content
					Sebastes paucispinis Sebastes saxicola
39	8/17	37°08'	122°31'	92	Squalus acanthias Citharichthys sordidus Lyopsetta exilis Eopsetta jordani Parophrys vetulus Microstomus pacificus Glyptocephalus zachirus Porichthys notatus Clupea harengus pallasi Genyonemus lineatus Zalembius rosaceus Engraulis mordax Thaleichthys pacificus Sebastes elongatus Sebastes goodei Sebastes jordani Sebastes saxicola
40	8/17	37°06'	122°36'	110	Unidentified shark Squalus acanthias Citharichthys sordidus Lyopsetta exilis Eopsetta jordani Parophrys vetulus Microstomus pacificus Glyptocephalus zachirus Anoplopoma fimbria Porichthys notatus Clupea harengus pallasi Zalembius rosaceus Ophiodon elongatus Merluccius productus Sebastes elongatus Sebastes goodei Sebastes jordani
41	8/17	37°04'	122°38'	132	Citharichthys sordidus Lyopsetta exilis Parophrys vetulus Microstomus pacificus Glyptocephalus zachirus Anoplopoma fimbria

Appendix II. (Continued)

Haul No.	Date 1976	Latitude North	Longitude West	Depth (m)	Species Content
					Porichthys notatus
					Zalembius rosaceus
					Sebastes elongatus
					Sebastes goodei
					Sebastes jordani
42	8/19	36°27'	121°59'	262	*Raja* sp.
					Hydrolagus colliei
					Lyopsetta exilis
					Lopsetta jordani
					Parophrys vetulus
					Microstomus pacificus
					Glyptocephalus zachirus
					Anoplopoma fimbria
					Merluccius productus
					Aprodon cortezianus
					Sebastolobus alascanus
					Sebastes alutus
					Sebastes diploproa
					Sebastes entomelas
					Sebastes goodei
					Sebastes paucispinis
					Sebastes saxicola
					Sebastes rufus
43	8/19	36°20'	122°03'	212	*Torpedo californica*
					Lyopsetta exilis
					Parophrys vetulus
					Microstomus pacificus
					Glyptocephalus zachirus
					Trachurus symmetricus
					Sebastes goodei
					Sebastes jordani
					Sebastes paucisprinis
					Sebastes saxicola
45	8/20	36°59'	122°30'	137	*Torpedo californica*
					Citharichtys sordidus
					Lyopsetta exilis
					Parophrys vetulus
					Glyptocephalus zachirus
					Porichthys notatus
					Sebastes goodei
					Sebastes jordani

Appendix II. (Continued)

Haul No.	Date 1976	Latitude North	Longitude West	Depth (m)	Species Content
46	8/20	36°59'	122°30'	238	Lyopsetta exilis Microstomus pacificus Glyptocaphalus zachirus Merluccius productus Aprodon cortezianus Sebastes diploproa Sebastes jordani Sebastes saxicola
47	8/20	36°58'	122°31'	305	Hydrolagus colliei Lyopsetta exilis Eopsetta jordani Parophrys vetulus Microstomus pacificus Glyptocephalus zachirus Anoplopoma fimbria Merluccius productus Aprodon cortezianus Sebastolobus alascanus Sebastes crameri Sebastes diploproa Sebastes saxicola Sebastes rufus
48	8/20	36°58'	122°32'	402	Raja trachura Raja rhina Microstomus pacificus Glyptocephalus zachirus Anoplopoma fimbria Merluccius productus Aprodon cortezianus Sebastolobus alascanus Sebastes aurora Sebastes diploproa Sebastes melanostomus