Moss Landing Marine Laboratories

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RESULTS OF THE SEA GRANT FISHES SAMPLING PROGRAM FOR THE 1971-1972 SEASON

Annual Report, Part 6, 1973

by

Gary E. Kukowski
Sea Grant Research Assistant

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Robert E. Arnal, Sea Grant Project Coordinator

Moss Landing Marine Laboratories
of the
California State University and Colleges
at
Fresno, Hayward, Sacramento, San Francisco, San Jose, and Stanislaus

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Dr. Robert E. Arnal, Coordinator

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METHODS AND MATERIALS

Fishing Gear

Gill nets, as described by Kukowski (1971), were used in both the Pajaro River and Elkhorn Slough (These same nets were used in sampling Monterey Bay. Because the catches did not seem to warrant the manpower and boat time required in this area, this program was discontinued after the summer.) Soak time of the nets in the Pajaro River was reduced by 50 percent because it was felt that a representative sample could be obtained without a lengthy period.

Areas Sampled

In the Pajaro River, sampling was continued at only one of the original stations, station 1303, which was sampled five times during this sampling period.

Two of the stations in Elkhorn Slough, 1201 and 1204, were sampled six times during this sampling period. The Annual Report (Kukowski, 1971) includes a map showing the location of each station sampled in both the Pajaro River and Elkhorn Slough.

Manpower Resources

Because of changes made in the sampling procedure, it was not necessary to obtain the outside help required previously. The following students, enrolled in the research participation class at Moss Landing Marine Laboratories, are to be thanked for the time and effort they gave in assisting the author in the collection of data:

Summer - Evelyn Hansen, Jeff Keh, and Milos Radakovich; Fall - Fredrick Breitenbach, Jim Eastwood, George Monaco, and Edward Stark; Spring - Dennis Dickey, Tom Forgatsch, and Tim Mayes.

Data Obtained

The fishes collected from the two areas were processed for data on the same day. Techniques as discussed by Kukowski (1971) were used to obtain data, except that the determination of minimum and maximum weights was discontinued. After all data were obtained, the samples were either returned to the ecosystem, added to the Moss Landing Marine Laboratories reference and teaching collections or utilized as bait or food in various other studies underway at the Laboratories.

RESULTS

In the Annual Report, the results of the sampling program were presented by listing the percent of total individuals and percent of total biomass for the dominant species for each station, along with a species list of fishes collected for each station. The species list will be continued, but the numbers of each species collected and the total number and total biomass will be substituted for percent composition. Total numbers rather than percent illustrate more clearly the changes occurring during the seasons and the differences between stations in the same area. The soak time may differ for each sampling period, thus differences between catch size are to be expected.

Pajaro River

Two new species of fishes were found during this sampling period; thus a total of seven species have been found at station 1303. Table I lists the species and number of specimens for each species for each sampling date.

Even though the amount of soak time is less, it seems that the number of specimens declined during the fall of the year and did not return in the spring to the same level as the previous spring. A probable reason for this was the dumping of raw sewage into the Pajaro River which caused considerable fish mortality during the first part of January 1972. Evidently, most of the fishes in the saline part of the river were killed by the sewage discharge and those collected during the spring were migrants that had moved in from Monterey Bay.

Elkhorn Slough

Nine new species of fishes were found during this sampling period, bringing the total to twenty-two for the two stations sampled in Elkhorn Slough. Table II lists the species and number of specimens for each species for each sampling date and station.

The number of specimens captured at each station reached a low during the month of December, but returned in the spring to about the same level as the previous spring.

TABLE I

FISHES FOUND IN THE PAJARO RIVER

1.	*Clupea harengus pallasi*	Pacific herring
2.	*Salmo gairdneri*	Steelhead
3.	*Atherinops affinis*	Topsmelt
4.	*Morone saxatilis*	Striped bass
5.	*Cymatogaster aggregata*	Shiner perch
6.	*Leptocottus armatus*	Pacific staghorn sculpin
7.	*Platichthys stellatus*	Starry flounder

	Feb. 20, 1971 Large gill net 1.25 hrs. soak 5021	Mar. 27, 1971 Comb. gill net 3.5 hrs. 502	July 23, 1971 Comb. gill net 1.75 hrs. 502	Sept. 29, 1971 Comb. gill net 1.75 hrs. 502	Nov. 12, 1971 Comb. gill net 2.0 hrs. soak	Feb. 23, 1972 Comb. gill net 2.0 hrs. soak	April 26, 1972 Comb. gill net 2.0 hrs. soak
1	4				2	20	
2			1		1		1
3		73	66	57	18	4	6
4			27	1	2	1	
5	1	19	29	1	12	3	23
6	1	3	8				2
7	10	6	43	32	9	5	11
Total # of Specimens	16	101	174	91	44	33	43
Total Biomass (g)	1,480	11,490	18,140	9,640	4,860	3,150	3,180

Table II

FISHES FOUND IN ELKHORN SLOUGH

1.	*Mustelus californicus*	Gray smoothhound
2.	*Mustelus henlei*	Brown smoothhound
3.	*Triakis semifasciata*	Leopard shark
4.	*Urolophus halleri*	Round stingray
5.	*Myliobatis californica*	Bat ray
6.	*Clupea harengus pallasi*	Pacific herring
7.	*Atherinops affinis*	Topsmelt
8.	*Atherinopsis californiensis*	Jacksmelt
9.	*Morone saxatilis*	Striped bass
10.	*Cymatogaster arregata*	Shiner perch
11.	*Embiotoca jacksoni*	Black perch
12.	*Hyperprosopon argenteum*	Walleye surfperch
13.	*Micrometrus minimus*	Dwarf perch
14.	*Phanerodon furcatus*	White seaperch
15.	*Rhacochilus toxotes*	Rubberlip perch
16.	*Rhacochilus vacca*	Pile perch
17.	*Ophiodon clongatus*	Lingcod
18.	*Leptocottus armatus*	Pacific staghorn sculpin
19.	*Citharichthys sordidus*	Pacific sanddab
20.	*Citharichthys stigmaeus*	Speckled sanddab
21.	*Parophrys vetulus*	English sole
22.	*Platichthys stellatus*	Starry flounder

Station 1202	6, March 1971 Large gill net 3.25 hrs. soak	24, April 1971 Large gill net 6.5 hrs. soak	23, July 1971 Large gill net 3.75 hrs. soak	20, Aug. 1971 Large gill net 4.0 hrs. soak	27, Oct. 1971 Large gill net 4.0 hrs. soak	15, Dec. 1971 Large gill net 3.75 hrs. soak	16, Feb. 1972 Large gill net 4.0 hrs. 510	12 April 1972 Large gill net 4.0 hrs. 502
1			4					
3		8	2					
4			1	1				1
5		1						
6	87						6	
7								27
8	4	66					44	28
9		1					1	
10	2	32	5	1				6
11	2	2	6	2				2
12		5						
18	1	3	3	3	1	1	1	
22				1				
Total # of Specimens	96	118	21	8	1	1	52	64
Total Biomass (g)	6,970	5,1680	6,950	1,070	30	50	10,690	8,130

Station 1204	6 Mar. 1971 Comb. gill net 4.5 Hrs. 500	6 May 1971 Comb. gill net 2.5 hrs. soak	23 July 1971 Comb. gill net 3.5 hrs. soak	20, Aug. 1971 Comb. gill net 3.5 hrs. soak	27, Oct 1971 Comb. gill net 4.0 hrs. soak	15, Dec. 1971 Comb. gill net 3.75 hrs. 5021	16, Feb. 1972 Comb. gill net 4.0 hrs. soak	12, April 1972 Comb. gill net 4.0 hrs. soak
1	2	2		1	1			
2								3
3	1	4	2	8	2		1	
5			1					
8	13	1	1			1		2
10	1	23	57	5	24			
11		3	5	3	22	4	13	1
12			1	1			1	
13		1						
14	2	2		3	4	1	16	3
15		4			2		1	
16			4		5		1	3
17								1
18		7	3	9	13			1
19				1				
20			1		2			
21			1					
22					1	1		
Total # of Specimens	19	47	76	31	76	7	33	14
Total Biomass (g)	1,5640	1,2050	9,850	15,400	16,640	1,410	8,070	4,560

BENTHIC FISHES ASSOCIATIONS FROM TWO DEPTHS IN MONTEREY BAY, CALIFORNIA

INTRODUCTION

The fish fauna of the Monterey Bay area has been studied by both private and public agencies, and a recent extensive bibliography reviews publications presenting data from the area (Kukowski, 1972). Representative studies would include publications by Snyder (1913) on the fishes inhabiting the streams draining into the bay, by Johnston (1954) on intertidal fishes, by Heimann (1962) on fishes collected in trawls beyond the three mile limit, and by Barham (1957) on the deep water fishes. Many habitats have been examined but little attention has been given to the sandy bottom habitat between the littoral zone and the waters utilized by the commercial fishermen, beyond the three mile limit. This shallow, intermediate zone is probably an important nursery for some fish species. The present study, therefore, is concerned with the identification of the fish fauna in this relatively unstudied habitat.

Fish inhabiting the open waters of Monterey Bay may be affected by the changing hydrographic seasons of the area. Skogsberg (1936), Bolin and Abbott (1961) and Bolin (1964) have studied the annual cycles in Monterey Bay. These authors recognized three hydrographic periods in the upper 100 m: (1) an upwelling period, which is characterized by low surface temperatures, high salinities, and high nutrient concentrations; (2) an oceanic period, which is characterized by high surface temperatures, decreasing salinity, and low nutrient concentrations; and (3) the Davidson current period, characterized by decreasing temperatures, low salinities, and low nutrient conditions. The fish fauna can be expected to respond to these hydrographic seasons, but to date no study has indicated the importance of hydrographic events to the fish communities in the bay.

The purpose of the present study is to identify the fish species present over the sandy benthos of Monterey Bay, to recognize natural assemblages of these species, and to determine any differences in the faunal composition associated with depth, location, and season. Stations were established at 8 and 19 fathoms at three sectors in the bay (off Manresa Beach, the Pajaro River, and the Salinas River) and included samples taken during upwelling, oceanic, and Davidson current oceanographic periods. Data includes species lists, numerical abundance, frequency of occurrence and recurrent groupings of species in relationship to depth.

The present study presents data on numerical abundance of various species sampled in the shallow bay environment. However, the numerical abundance of a particular species in any sample is subject to a number of variables, including variables related to sampling techniques. Therefore, the author was concerned with methods other than simple abundance measurements to relate the fish fauna to the pelagic habitat in space and in time. Grouping of the fish into assemblages of species frequently found together seemed to provide such an alternative method, and these groupings hopefully may reveal relationships between the fauna and its environment more clearly than enumeration alone. A number of methods are available to delineate groups of organisms. Some groupings have been defined on subjective grounds alone, others defined more rigorously on the basis of vegetation or various physical or chemical parameters of the environment. Other methods are based on correlations between pairs of species or coefficients of association between species pairs. The above techniques, however, do not clearly establish groupings of species that form a nearly constant part of each others' biological environment. A method described by Fager (1957), however, does establish such recurrent assemblages, and this method has been used in the present study.

METHODS AND MATERIALS

Fishing Gear

The sampling gear consisted of a 20 foot (foot line measurement) otter trawl, bag and cod-end of 1.5 inch and 1.0 inch stretch mesh respectively, and a bag liner of .38 inch stretch mesh.

The 55 foot research vessel Amigo of Marine Research and Development was employed during the first three months of the sampling period. During this time the otter boards were attached to the net mouth with 33 foot mud lines and connected by 66 foot bridle lines to the single towing cable of the research vessel. The amount of cable and trawling speed were dependent on the depth of the sampling area with an average ratio of about 1:4 (depth of water to length of cable) and speed of 3 knots. Three trawls, each of 10 minutes duration, were made at each station sampled. The number of replicate trawls was reduced to two in August 1971 because this smaller number was found to be sufficient (Kukowski, 1971). All trawls for each station for each sampling date were combined for easier analysis of data.

The 26 foot research vessel Orca of Moss Landing Marine Laboratories was used for the remaining part of the year in order to lower operating costs. When using this smaller vessel the otter boards were attached directly to the net instead of having 33 foot mud lines between the otter boards and net. The same 66 foot bridle lines were used to connect the otter boards to the towing cable. The ratio of the cable was about 1:4 and the engine RPM was maintained at 1000 (about 2 or 3 knots).

Areas Sampled

Fish sampling stations were selected from the established hydrographic sampling stations used in the Sea Grant Study at Moss Landing Marine Laboratories (Figure 1). The three inshore stations had a depth of 8 fathoms, while the outer three stations were at the 19 fathom contour. The three pairs of stations were located off of the following landmarks: Manresa Beach (stations 1154 and 1156), the Pajaro River (stations 1105 and 1155), and the Salinas River (stations 1101 and 1110). Station 1110 does not coincide with the hydrographic station 1110 because of the desire to sample at the 19 fathom contour.

The four original stations (1154, 1156, 1105, and 1155) were sampled eight times during the 15 month period. The stations off the Salinas River (1101 and 1110) were sampled four times with the sampling commencing in October, 1971. All sampling was done between March 1971 and May 1972. Appendix A lists the sampling dates for each station.

Collection and Analysis of Data

All fishes were identified and the number of individuals, total weight, minimum and maximum lengths and length frequencies of each species were recorded. All data were taken in the laboratory rather than in the field.

Length measurements were the total length, or the length from tip of snout to tip of compressed tail when the fish was fully extended on its side on a flat surface. Lengths were recorded on a measuring board fitted with a strip of plastic calibrated with transverse lines at centimeter intervals. For convenience, measurements were recorded as

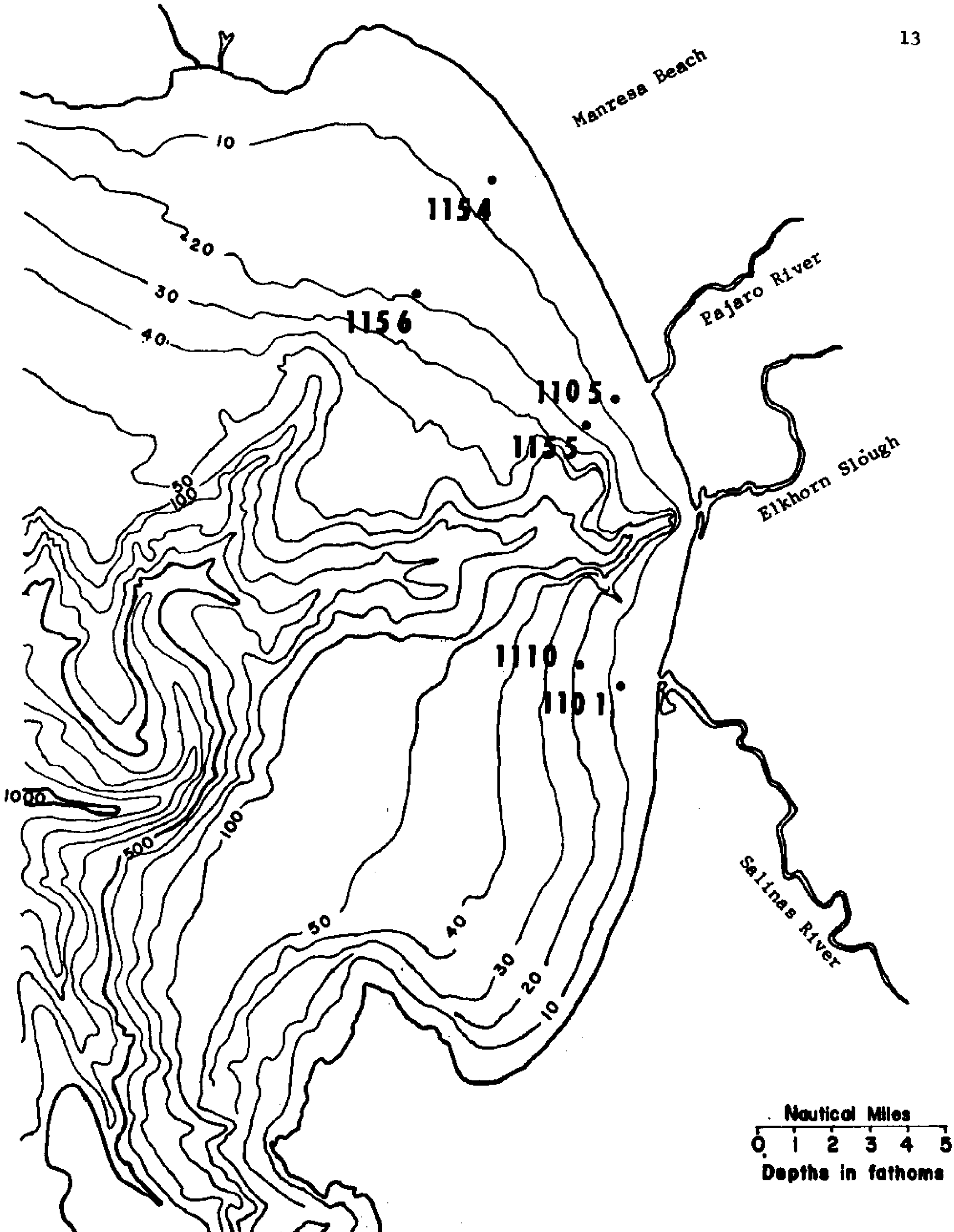

Figure 1. Fish sampling stations of Monterey Bay.

whole centimeters, whereas the actual length could be 0.5 centimeters less.

An autopsy balance was used to obtain weights to the nearest 10 grams. Thus, fish recorded as 50 grams included all whose weight ranged from 45 to 55 grams, or those within the range of 50 ± 5 grams. Fish that weighed less than 5 grams were not recorded.

A spring balance milk scale (capacity 9 kilograms) was used for fishes too large for the autopsy balance. Weights were measured to to the nearest one-tenth of a pound and then converted to grams. Length and weight data have not been analyzed in this report but are available from the Moss Landing Marine Laboratories Library.

References used to identify the fishes are listed in Kukowski (1971). All names are in accordance with the American Fisheries Society nomenclature (1970).

All data first were placed on laboratory work sheets and then transferred to special forms with spaces corresponding to computer punch cards. These are of two types, one with all the above data except length frequencies, and the other for length frequencies.

All fishes were either frozen or preserved in 10 percent formalin before processing. After all measurements were obtained, the specimens were discarded (see Kukowski, 1971).

To determine recurrent groups, it is, first of all, necessary to determine the index of affinity between the species. This was done according to Fager and McGowan (1963) except that the formula $\left[J/(N_A N_B)^{\frac{1}{2}}\right] - \frac{1}{2}(N_B)^{\frac{1}{2}}$ was corrected by Clark (1971) to $J/(N_A N_B)^{\frac{1}{2}} - \frac{1}{2}(N_B)^{\frac{1}{2}}$. The method of Fager (1957) was then used to determine recurrent groups.

The connections between the recurrent groups were calculated using techniques described by Fager and Longhurst (1968).

Since the index of affinity deals only with the presence or absence of a species in a sample, the index of similarity (Day and Pearcy, 1968) was used to determine the similarities in percent composition between samples. The percentage composition for all species in each sample was calculated and then all possible sample pairs were compared. For each species common to both samples, the lower of the two percentages were taken as a measure of species association between the two samples. The sum of these low values shows the index of similarity for the two samples. For example, if species A, B, and C occurred in the following samples with these percentages:

	Sample 1 (%)	Sample 2 (%)
Species A	14	20
Species B	60	40
Species C	85	10

then, the index of similarity is 64 percent for these two samples. Appendix B shows all the indices of similarity for each station. The letters in the bottom half of the "trellis diagram" indicate whether the index was used in the determination of location, depth, or seasonality similarities.

RESULTS

The total list of species, their frequency and percent occurrence for the sampling period are shown in Table III. Data are divided into three categories: those from 8 fathom stations (20 samples), from 19 fathom stations (20 samples), and from stations at both depths combined (40 samples).

Table IV lists the total number of specimens collected for each species and their percent composition of the total catch for the 8 fathom stations, 19 fathom stations, and both depths combined.

Table V lists all six stations and the number of species and specimens collected at each station for each sampling date. It also lists the mean, standard deviation, and variance of the number of species and specimens caught at each station and for each of the two depths.

The relations between recurrent groups for the 8 fathom stations are shown in Figure 2, for the 19 fathom stations in Figure 3, and for both depths combined in Figure 4. The fractions near the connecting lines of the groups indicate the relative affinity between each set of groups. The denominator indicates the number of possible affinities between the two groups, while the numerator indicates the number of affinities observed.

Tables VI, VII, VIII, and IX show the results of using the index of similarity. Table VI shows the similarity in percent composition of the catches that are attributable to different locations and depths. Table VII shows the seasonal changes in percent composition of the catches taking place at each station and for each of the two depths.

TABLE III

FISHES FOUND IN MONTEREY BAY - SPECIES

FREQUENCY AND PERCENT OCCURRENCE

1.	Eptatretus stouti	Pacific hagfish
2.	Squalus acanthias	Spiny dogfish
3.	Torpedo californica	Pacific electric ray
4.	Raja binoculata	Big skate
5.	Raja inornata	California skate
6.	Urolophus halleri	Round stingray
7.	Myliobatis californica	Bat ray
8.	Clupea harengus pallasi	Pacific herring
9.	Engraulis mordax	Northern anchovy
10.	Spirinchus starksi	Night smelt
11.	Porichthys notatus	Plainfin midshipman
12.	Microgadus proximus	Pacific tomcod
13.	Otophidium taylori	Spotted cusk-eel
14.	Syngnathus californiensis	Kelp pipefish
15.	Genyonemus lineatus	White croaker
16.	Cymatogaster aggregata	Shiner perch
17.	Hyperprosopon anale	Spotfin surfperch
18.	Micrometrus minimus	Dwarf perch
19.	Phanerodon furcatus	White seaperch
20.	Rhacochilus toxotes	Rubberlip seaperch
21.	Zalembius rosaceus	Pink seaperch
22.	Anarrhichthys ocellatus	Wolf-eel
23.	Lepidogobius lepidus	Bay goby
24.	Icichthys lockingtoni	Medusafish
25.	Peprilus simillimus	Pacific pompano
26.	Sebastes paucispinis	Bocaccio
27.	Sebastes spp.	Rockfish
28.	Ophiodon elongatus	Lingcod
29.	Zaniolepis latipinnis	Longspine combfish

TABLE III (CONTINUED)

30.	*Chitonotus pugetensis*	Roughback sculpin
31.	*Icelinus quadriseriatus*	Yellowchin sculpin
32.	*Leptocottus armatus*	Pacific staghorn sculpin
33.	*Odontopyxis trispinosa*	Pygmy poacher
34.	*Stellerina xyosterna*	Pricklebreast poacher
35.	*Citharichthys sordidus*	Pacific sanddab
36.	*Citharichthys stigmaeus*	Speckled sanddab
37.	*Paralichthys californicus*	California halibut
38.	*Eopsetta jordani*	Petrale sole
39.	*Glyptocephalus zachirus*	Rex sole
40.	*Lepidopsetta bilineata*	Rock sole
41.	*Microstomus pacificus*	Dover sole
42.	*Parophrys vetulus*	English sole
43.	*Platichthys stellatus*	Starry flounder
44.	*Pleuronichthys decurrens*	Curlfin sole
45.	*Pleuronichthys verticalis*	Hornyhead turbot
46.	*Psettichthys melanostictus*	Sand sole
47.	*Symphurus atricauda*	California tonguefish

TABLE III (CONTINUED)

Species No.	Frequency of Occurrence (Out of 20 Samples) 8 Fathom Stations	Percent Occurrence 8 Fathom Stations	Frequency of Occurrence (Out of 20 Samples) 19 Fathom Stations	Percent Occurrence 19 Fathom Stations	Frequency of Occurrence (Out of 40 Samples Both Depths Combined	Percent Occurrence Both Depths Combined
1.	0	0	4	20	4	10.0
2.	1	5	0	0	1	2.5
3.	2	10	5	25	7	17.5
4.	6	30	4	20	10	25.0
5.	0	0	3	15	3	7.5
6.	1	5	0	0	1	2.5
7.	2	10	0	0	2	5.0
8.	2	10	3	15	5	12.5
9.	3	15	3	15	6	15.0
10.	11	55	8	40	19	47.5
11.	0	0	12	60	12	30.0
12.	6	30	5	25	11	27.5
13.	1	5	6	30	7	17.5
14.	2	10	1	5	3	7.5
15.	5	25	6	30	11	27.5
16.	5	25	9	45	14	35.0
17.	9	45	13	65	22	55.0
18.	1	5	0	0	1	2.5
19.	4	20	6	30	10	25.0
20.	1	5	0	0	1	2.5
21.	1	5	13	65	14	35.0
22.	0	0	1	5	1	2.5
23.	1	5	0	0	1	2.5
24.	0	0	1	5	1	2.5
25.	1	5	6	30	7	17.5
26.	0	0	6	30	6	15.0
27.	2	10	10	50	12	30.0

TABLE III (CONTINUED)

Species No.	Frequency of Occurrence (Out of 20 Samples) 8 Fathom Stations	Percent Occurrence 8 Fathom Stations	Frequency of Occurrence (Out of 20 Samples) 19 Fathom Stations	Percent Occurrence 19 Fathom Stations	Frequency of Occurrence (Out of 40 Samples) Both Depths Combined	Percent Occurrence Both Depths Combined
28.	2	10	9	45	11	27.5
29.	0	0	6	30	6	15.0
30.	1	5	1	5	2	5.0
31.	0	0	1	5	1	2.5
32.	4	20	3	15	7	17.5
33.	0	0	4	20	4	10.0
34.	1	5	0	0	1	2.5
35.	7	35	20	100	27	67.5
36.	20	100	13	65	33	82.5
37.	0	0	1	5	1	2.5
38.	0	0	8	40	8	20.0
39.	0	0	2	10	2	5.0
40.	0	0	1	5	1	2.5
41.	0	0	11	55	11	27.5
42.	12	60	18	90	30	75.0
43.	11	55	7	35	18	45.0
44.	12	60	14	70	26	65.0
45.	1	5	10	50	11	27.5
46.	15	75	13	65	28	70.0
47.	1	5	8	40	9	22.5
Totals:	33 species		40 species		47 species	

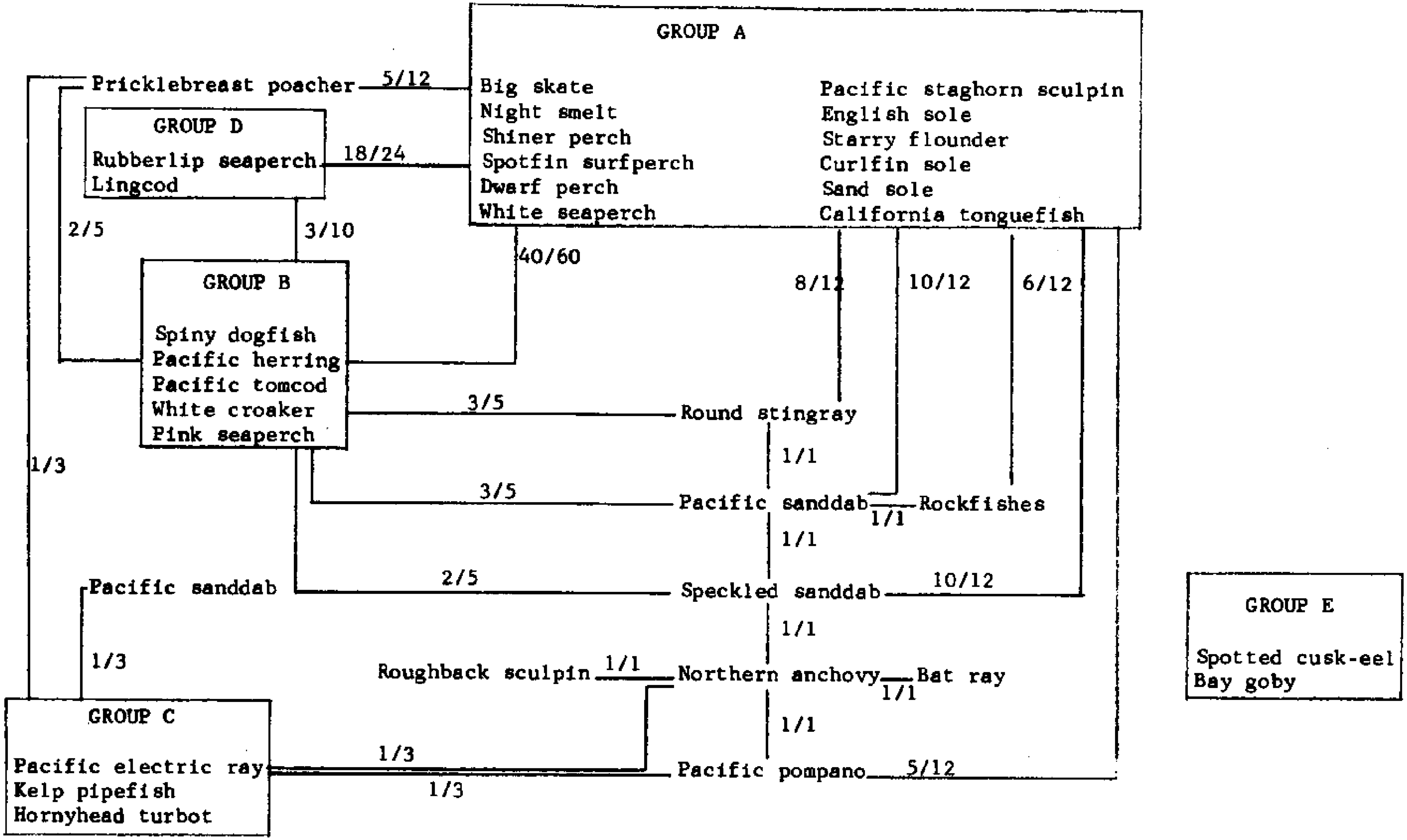

Figure 2. Relations between recurrent groups - 8 fathom stations

(Note: Pacific sanddab listed twice on this page.)

$$\text{Fractions} = \frac{\text{Number of observed affinities}}{\text{Number of possible affinities}}$$

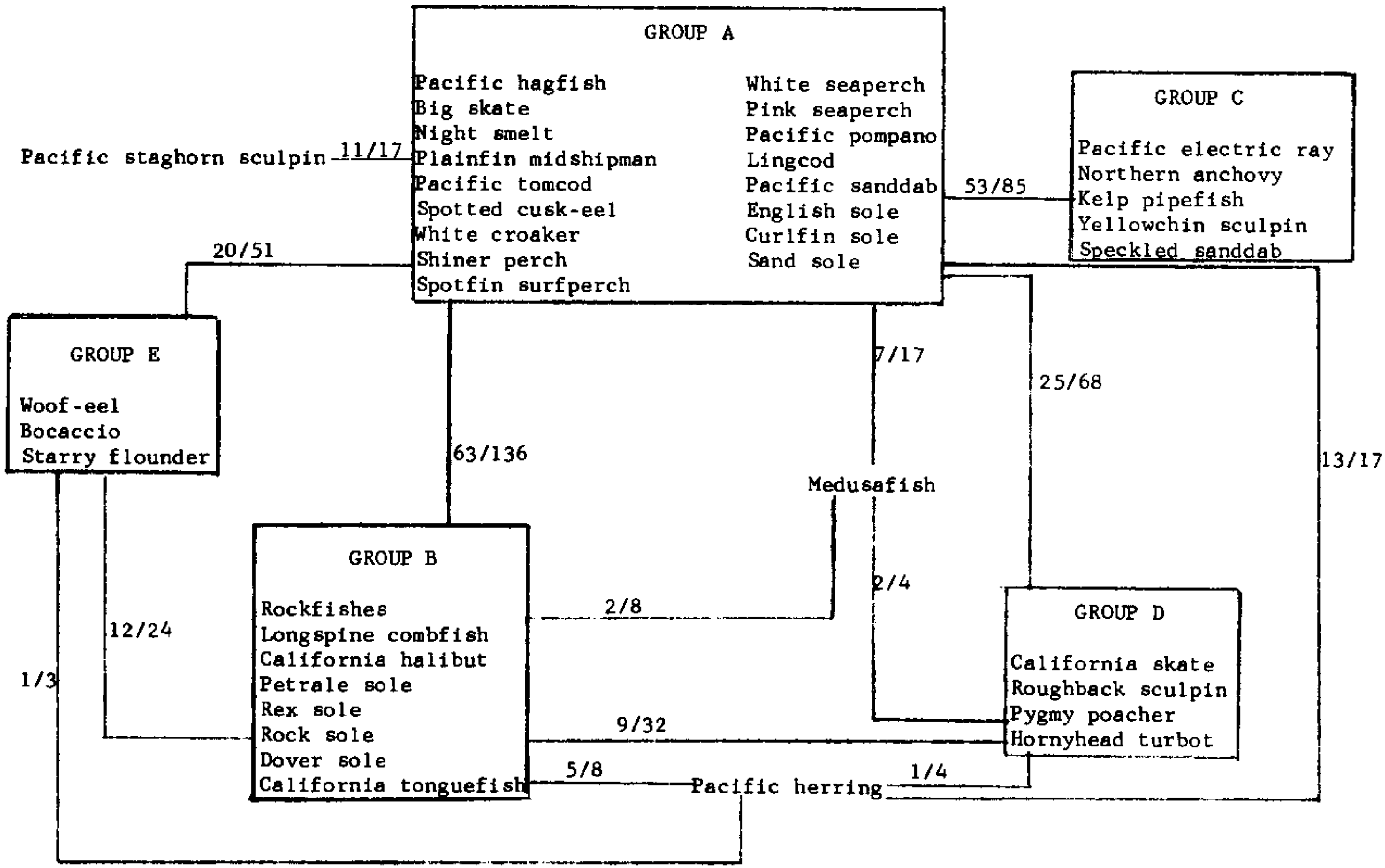

Figure 3. Relations between recurrent groups - 19 fathom stations

$$\text{Fractions} = \frac{\text{Number of observed affinities}}{\text{Number of possible affinities}}$$

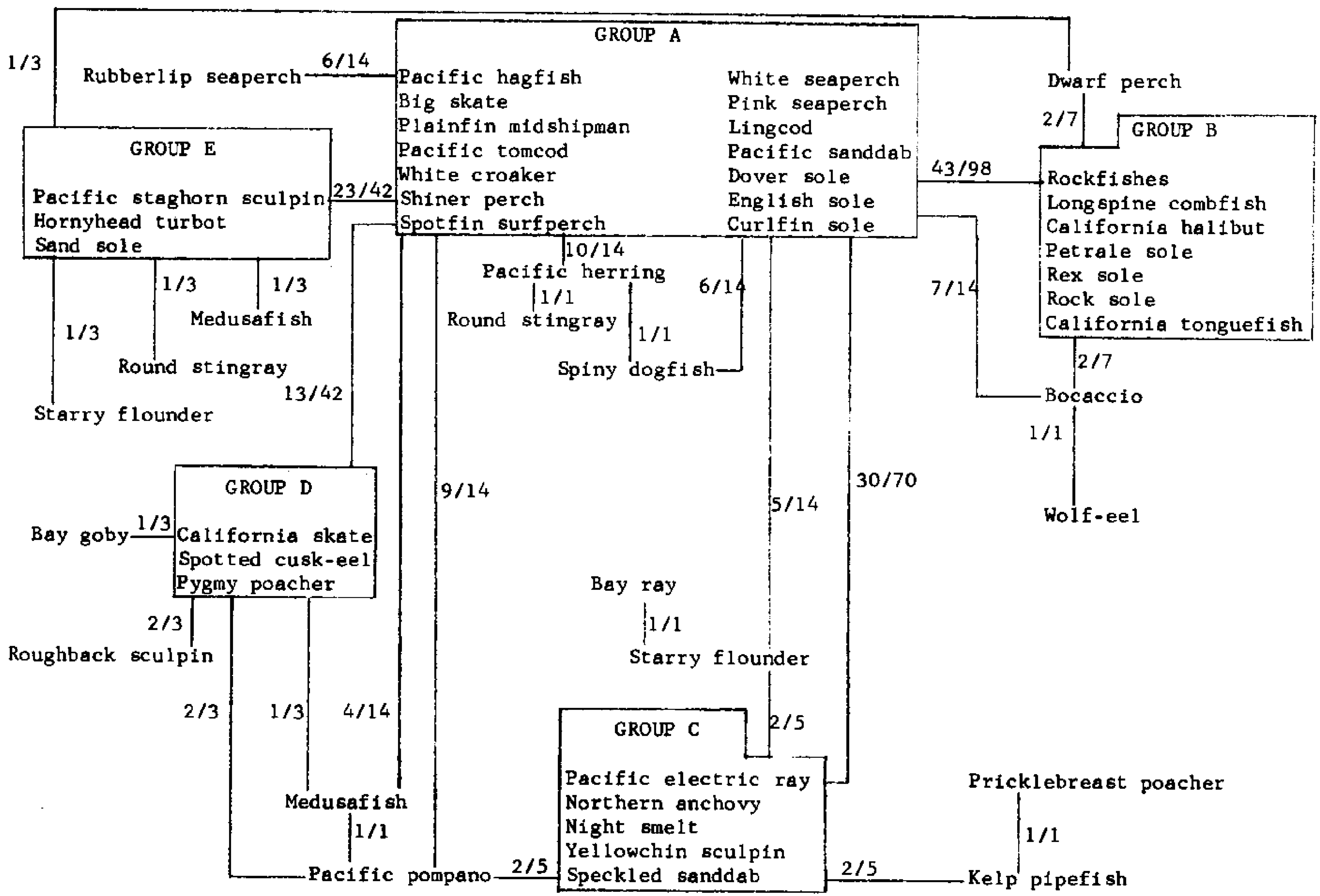

Figure 4. Relations between recurrent groups - 8 and 19 fathom stations combined
(Note: Round stingray, medusafish and starry flounder listed twice on this page.)

$$\text{Fractions} = \frac{\text{Number of observed affinities}}{\text{Number of possible affinities}}$$

TABLE IV

FISHES FOUND IN MONTEREY BAY -

TOTAL NUMBER OF SPECIMENS AND PERCENT COMPOSITION

Species Number	Total Number Collected From 8 Fathom Stations	Percent Composition of Total 8 Fathom Stations	Total Number Collected From 19 Fathom Stations	Percent Composition of Total 19 Fathom Catches	Total Number Collected From Both Depths Combined	Percent Composition of Total 8 and 19 Fathom Catches
1.	0	0	4	I	4	I
2.	1	I[1]	0	0	1	I
3.	2	I	9	.1	11	.1
4.	8	.2	7	.1	15	.1
5.	0	0	3	I	3	I
6.	1	I	0	0	1	I
7.	5	.1	0	0	5	I
8.	2	I	9	.1	11	.1
9.	228	4.8	95	1.3	323	2.7
10.	2,308	48.2	406	5.7	2,714	22.7
11.	0	0	218	3.0	218	1.8
12.	24	.5	145	2.0	169	1.4
13.	1	I	11	.2	12	.1
14.	3	.1	1	I	4	I
15.	485	10.1	296	4.1	781	6.5
16.	31	.6	170	2.4	201	1.7
17.	245	5.1	254	3.5	499	4.2
18.	1	I	0	0	1	I
19.	13	.3	30	.4	43	.4
20.	1	I	0	0	1	I
21.	29	.6	274	3.8	303	2.5
22.	0	0	2	I	2	I
23.	1	I	0	0	1	I
24.	0	0	1	I	1	I
25.	1	I	17	.2	18	.2
26.	0	0	18	.2	18	.2

TABLE IV (CONTINUED)

Species Number	Total Number Collected From 8 Fathom Stations	Percent Composition of Total 8 Fathom Stations	Total Number Collected From 19 Fathom Stations	Percent Composition of Total 19 Fathom Catches	Total Number Collected From Both Depths Combined	Percent Composition of Total 8 and 19 Fathom Catches
27.	36	.8	317	4.4	353	3.0
28.	12	.2	23	.3	35	.3
29.	0	0	57	.8	57	.5
30.	1	I	1	I	2	I
31.	0	0	3	I	3	I
32.	5	.1	7	.1	12	.1
33.	0	0	10	.1	10	.1
34.	7	.1	0	0	7	I
35.	268	5.6	3,381	47.1	3,649	30.5
36.	677	14.1	246	3.4	923	7.7
37.	0	0	1	I	1	I
38.	0	0	43	.6	43	.4
39.	0	0	2	I	2	I
40.	0	0	1	I	1	I
41.	0	0	154	2.1	154	1.3
42.	182	3.8	658	9.2	840	7.0
43.	48	1.0	8	.1	56	.5
44.	103	2.2	74	1.0	177	1.5
45.	1	I	14	.2	15	.1
46.	52	1.1	75	1.0	127	1.1
47.	3	.1	126	1.8	129	1.1
Totals:	4,785		7,171		11,956	

[1]Insignificant

TABLE V

NUMBER OF SPECIES AND SPECIMENS COLLECTED AT EACH STATION DURING THE SAMPLING PERIOD

	1971					Sampling Dates		1972						
8 Fathom Stations	Mar.	April	May	Aug.	Sept.	Oct.	Nov.	Dec.	Jan.	Mar.	May	N	$\bar{X}$	S	S^2
1154 No. of Species	10		12	15	14		7		6	5	10	8	9.9	3.7	13.6
1154 No. of Specimens	732		154	1,456	482		63		121	147	179	8	417	477	227,802
1105 No. of Species		6	6	15	14		5		5	1	5	8	7.1	4.8	23.3
1105 No. of Specimens		152	203	297	387		21		6	1	20	8	136	149	22,210
1101 No. of Species						6		4		3	5	4	4.5	1.3	1.7
1101 No. of Specimens						302		37		14	11	4	91	141	19,922
All Three Combined No. of Species												20	7.7	4.3	18.1
All Three Combined No. of Specimens												20	239	343	117,647
19 Fathom Stations															
1156 No. of Species	20		22	22	14		11		9	8	12	8	14.8	5.8	33.4
1156 No. of Specimens	575		587	843	549		289		131	24	83	8	385	295	86,974
1155 No. of Species	20		17	17	12		15		12	4	11	8	13.5	4.9	24.3
1155 No. of Specimens	839		365	457	560		566		125	22	115	8	381	280	78,176
1110 No. of Species						12		19		9	9	4	12.2	4.7	22.2
1110 No. of Specimens						414		415		142	70	4	260	180	32,588
All Three Combined No. of Species												20	13.8	5.1	25.7
All Three Combined No. of Specimens												20	359	262	68,537

TABLE VI

SIMILARITY INDICES AS A FUNCTION OF LOCATION AND DEPTH

Location: Combine indices of similarity for stations sampled at the same depth and within same month; different locations:

$N = 23$ $\bar{X} = 47.3$ $S = 25.6$ $S^2 = 658$

Combine indices of similarity for stations sampled at the same depth and within one month of each other; different locations:

$N = 23$ $\bar{X} = 51.7$ $S = 22.2$ $S^2 = 492$

t for above two means = .62 = not significant at 5 % level

Combine above two groups (no differences due to time):

$N = 46$ $\bar{X} = 49.5$ $S = 23.8$ $S^2 = 567$

Depth: Combine indices of similarity for stations sampled at the same location and within same month; different depths:

$N = 19$ $\bar{X} = 23.3$ $S = 18.2$ $S^2 = 333$

Combine indices of similarity for stations sampled at the same location and within one month of each other; different depths:

$N = 6$ $\bar{X} = 16.2$ $S = 10.0$ $S^2 = 100$

t for above two means = .90 = not significant at 5 % level

Combine above two groups (no differences due to time):

$N = 25$ $\bar{X} = 20.4$ $S = 17.2$ $S^2 = 295$

Combine indices of similarity for stations sampled at different locations but within same month; different depths:

$N = 23$ $\bar{X} = 16.3$ $S = 14.7$ $S^2 = 216$

Combine indices of similarity for stations sampled at different locations but within one month of each other; different depths:

$N = 22$ $\bar{X} = 21.2$ $S = 18.4$ $S^2 = 340$

t for above two means = .98 = not significant at 5 % level

TABLE VI (CONTINUED)

Combine above two groups (no differences due to time):

$N = 45$ $\bar{X} = 18.7$ $S = 16.6$ $S^2 = 276$

t for the means (20.4, 18.7) = .40 = not significant at 5 % level

Combine above four groups (no differences due to different locations):

$N = 70$ $\bar{X} = 19.7$ $S = 16.6$ $S^2 = 275$

TABLE VII

SIMILARITY INDICES BETWEEN DIFFERENT SAMPLING TIMES AT A STATION

8 Fathom Stations	No. of Samples	No. of Similarity Indices	$\bar{X}$ of Similarity Indices	S	S^2
1154	8	28	36.1	24.7	608
1105	8	28	37.9	18.8	355
1101	4	6	54.8	16.5	272
All three combined	20	62	38.7	21.9	478

19 Fathom Stations					
1156	8	28	46.5	19.3	374
1155	8	28	45.4	20.4	417
1110	4	6	49.2	17.2	294
All three combined	20	62	46.2	19.4	376

TABLE VIII

SIMILARITY INDICES AS A FUNCTION OF OCEANOGRAPHIC PERIODS AT THE 8 FATHOM STATIONS

8 Fathom Stations 1154 - 1105 - 1101 Total N = 190 $\overline{X}$ - 33.7 S = 23.3 S^2 = 541	Upwelling Period Mar. 1971 - July 1971	Oceanic Period Aug. 1971 - Nov. 1971	Davidson Current Period Dec. 1971 - Jan. 1972	Upwelling Period Feb. 1972 - May 1972
Upwelling Period Mar. 1971 - July 1971	N = 6 $\overline{X}$ = 62.8 S = 12.0 S^2 = 143	N = 28 $\overline{X}$ = 39.7 S = 21.0 S^2 = 443	N = 12 $\overline{X}$ = 16.2 S = 14.1 S^2 = 200	N = 24 $\overline{X}$ = 39.7 S = 22.3 S^2 = 498
Oceanic Period Aug. 1971 - Nov. 1971	N = 28 $\overline{X}$ = 39.7 S = 21.0 S^2 = 443	N = 21 $\overline{X}$ = 38.5 S = 22.4 S^2 = 500	N = 21 $\overline{X}$ = 24.1 S = 19.5 S^2 = 381	N = 42 $\overline{X}$ = 34.9 S = 23.8 S^2 = 568
Davidson Current Period Dec. 1971 - Jan. 1972	N = 12 $\overline{X}$ = 16.2 S = 14.1 S^2 = 200	N = 21 $\overline{X}$ = 24.1 S = 19.5 S^2 = 381	N = 3 $\overline{X}$ = 14.0 S = 3.6 S^2 = 13	N = 18 $\overline{X}$ = 28.2 S = 25.8 S^2 = 663
Upwelling Period Feb. 1972 - May 1972	N = 24 $\overline{X}$ = 39.7 S = 22.3 S^2 = 498	N = 42 $\overline{X}$ = 34.9 S = 23.8 S^2 = 568	N = 18 $\overline{X}$ = 28.2 S = 25.8 S^2 = 663	N = 15 $\overline{X}$ = 28.7 S = 24.7 S^2 = 608

TABLE IX

SIMILARITY INDICES AS A FUNCTION OF OCEANOGRAPHIC PERIODS AT THE 19 FATHOM STATIONS

19 Fathom Stations 1156 - 1155 - 1110 Total $\underline{N}$ = 190 $\bar{X}$ = 46.6 S_2= 19.1 S^2 = 365	Upwelling Period Mar. 1971 - July 1971	Oceanic Period Aug. 1971 - Nov. 1971	Davidson Current Period Dec. 1971 - Jan. 1972	Upwelling Period Feb. 1972 - May 1972
Upwelling Period Mar. 1971 - July 1971	$\underline{N}$ = 6 $\bar{X}$ = 42.5 S = 14.0 S^2 = 197	$\underline{N}$ = 28 $\bar{X}$ = 43.8 S_2= 17.1 S^2 = 292	$\underline{N}$ = 12 $\bar{X}$ = 37.1 S_2= 13.3 S^2 = 176	$\underline{N}$ = 24 $\bar{X}$ = 42.2 S_2= 15.6 S^2 = 242
Oceanic Period Aug. 1971 - Nov. 1971	$\underline{N}$ = 28 $\bar{X}$ = 43.8 S_2= 17.1 S^2 = 292	$\underline{N}$ = 21 $\bar{X}$ = 69.3 S_2= 14.9 S^2 = 222	$\underline{N}$ = 21 $\bar{X}$ = 27.7 S_2= 11.1 S^2 = 122	$\underline{N}$ = 42 $\bar{X}$ = 56.0 S_2= 14.6 S^2 = 213
Davidson Current Period Dec. 1971 - Jan. 1972	$\underline{N}$ = 12 $\bar{X}$ = 37.1 S_2= 13.3 S^2 = 176	$\underline{N}$ = 21 $\bar{X}$ = 27.7 S_2= 11.1 S^2 = 122	$\underline{N}$ = 3 $\bar{X}$ = 29.0 S_2= 13.5 S^2 = 183	$\underline{N}$ = 18 $\bar{X}$ = 32.2 S_2= 12.1 S^2 = 146
Upwelling Period Feb. 1972 - May 1972	$\underline{N}$ = 24 $\bar{X}$ = 42.2 S_2= 15.6 S^2 = 242	$\underline{N}$ = 42 $\bar{X}$ = 56.0 S_2= 14.6 S^2 = 213	$\underline{N}$ = 18 $\bar{X}$ = 32.2 S_2= 12.1 S^2 = 146	$\underline{N}$ = 15 $\bar{X}$ = 57.4 S_2= 16.3 S^2 = 265

Comparisons between stations at the same depth are used in Tables VIII and IX and these data illustrate the seasonal changes taking place in percent composition of the catches at the 8 and 19 fathom stations in regard to the three oceanographic periods of Monterey Bay during the period under study (Smethie, 1972). There is also a partial replication of the upwelling period, thus making four divisions in all.

Table X lists all the scores and their probabilities for the comparisons of mean indices of similarity used in Tables VI, VII, VIII, IX, and for comparisons of numbers of species and specimens from Table V.

TABLE X

STATISTICAL SIGNIFICANCES OF RESULTS

Source	Means	t	Significance
Table V			
8 Fathom Stations			
No. of Species	9.9, 7.1	1.30	N.S.[1]
	9.9, 4.5	2.78	S[2] at 2% level
	7.1, 4.5	1.03	N.S.
No. of Specimens	417, 136	1.58	N.S.
	417, 91	1.30	N.S.
	136, 91	.49	N.S.
19 Fathom Stations			
No. of Species	14.8, 13.5	.48	N.S.
	14.8, 12.2	.77	N.S.
	13.5, 12.2	.43	N.S.
No. of Specimens	385, 381	.02	N.S.
	385, 260	.76	N.S.
	381, 260	.77	N.S.
Both Depths			
No. of Species	13.8, 7.7	4.12	S. at .1% level
No. of Specimens	359, 239	1.23	N.S.
Table VI			
Depth	23.3, 16.2	.90	N.S.
	23.3, 16.3	1.37	N.S.
	23.3, 21.2	.36	N.S.
	16.3, 16.2	.01	N.S.
	21.2, 16.2	.63	N.S.
	21.2, 16.3	.98	N.S.
Table VII			
8 Fathom Stations	37.9, 36.1	.30	N.S.
	54.8, 36.1	1.76	N.S.
	54.8, 37.9	2.03	N.S.

TABLE X (CONTINUED)

Source	Means	t	Significance
19 Fathom Stations	46.5, 45.4	.20	N.S.
	49.2, 46.5	.31	N.S.
	49.2, 45.4	.42	N.S.
Both Depths	46.2, 38.7	2.02	S. at 5% level
Table VIII			
Between Oceanographic Periods			
Upwelling Period	62.8, 39.7	2.57	S. at 2% level
	62.8, 16.2	6.90	S. at .1% level
	62.8, 39.7	2.42	S. at 5% level
	39.7, 16.2	3.52	S. at 1% level
	39.7, 39.7	.00	N.S.
	39.7, 16.2	3.31	S. at 1% level
Oceanic Period	39.7, 38.5	.19	N.S.
	39.7, 24.1	2.64	S. at 2% level
	39.7, 34.9	.86	N.S.
	38.5, 24.1	2.22	S. at 5% level
	38.5, 34.9	.57	N.S.
	34.9, 24.1	1.79	N.S.
Davidson Current Period	24.1, 16.2	1.22	N.S.
	16.2, 14.0	.26	N.S.
	28.2, 16.2	1.46	N.S.
	24.1, 14.0	.87	N.S.
	28.2, 24.1	.56	N.S.
	28.2, 14.0	.93	N.S.
Upwelling Period	39.7, 34.9	.80	N.S.
	39.7, 28.2	1.54	N.S.
	39.7, 28.7	1.43	N.S.
	34.9, 28.2	.97	N.S.
	34.9, 28.7	.85	N.S.
	28.7, 28.2	.05	N.S.
Within Oceanographic Periods	62.8, 38.5	2.53	S. at 2% level
	62.8, 14.0	6.69	S. at .1% level
	62.8, 28.7	3.20	S. at 1% level
	38.5, 14.0	1.85	N.S.
	38.5, 28.7	1.24	N.S.
	28.7, 14.0	1.00	N.S.

TABLE X (CONTINUED)

Source	Means	t	Significance
Table IX			
Between Oceanographic Periods			
Upwelling Period	43.8, 42.5	.17	N.S.
	42.5, 37.1	.79	N.S.
	42.5, 42.2	.04	N.S.
	43.8, 37.1	1.20	N.S.
	43.8, 42.2	.35	N.S.
	42.2, 37.1	.97	N.S.
Oceanic Period	69.3, 43.8	5.45	S. at .1% level
	43.8, 27.7	3.76	S. at .1% level
	56.0, 43.8	3.19	S. at 1% level
	69.3, 27.7	10.26	S. at .1% level
	69.3, 56.0	3.38	S. at 1% level
	56.0, 27.7	7.82	S. at .1% level
Davidson Current Period	37.1, 27.7	2.18	S. at 5% level
	37.1, 29.0	.94	N.S.
	37.1, 32.2	1.04	N.S.
	29.0, 27.7	.18	N.S.
	32.2, 27.7	1.21	N.S.
	32.2, 29.0	.41	N.S.
Upwelling Period	56.0, 42.2	3.60	S. at .1% level
	42.2, 32.2	2.26	S. at 5% level
	57.4, 42.2	2.91	S. at 1% level
	56.0, 32.2	6.07	S. at .1% level
	57.4, 56.0	.30	N.S.
	57.4, 32.2	5.10	S. at .1% level
Within Oceanographic Periods	69.3, 42.5	3.92	S. at .1% level
	42.5, 29.0	1.37	N.S.
	57.4, 42.5	1.96	N.S.
	69.3, 29.0	4.41	S. at .1% level
	69.3, 57.4	2.27	S. at 5% level
	57.4, 29.0	2.81	S. at 2% level
Tables VIII and IX			
Total - 8 and 9 Fathom Stations	46.6, 33.7	5.91	S. at .1% level

TABLE X (CONTINUED)

Source	Means	t	Significance
Tables VII and VIII			
Total	38.7, 33.7	1.49	N.S.
Tables VII and IX			
Total	46.6, 46.2	.14	N.S.

[1] N.S. = Not Significant, $p > 5\%$
[2] S. = Significant, $p \leq 5\%$

DISCUSSION

A total of 11,956 specimens representing 25 families and 47 species was collected in the 40 samples (Tables III and IV). Thirty-three species were found in the 8 fathom stations and 40 species in the 19 fathom stations. Of the total 11,956 specimens collected, 4,785 were from the 8 fathom stations and 7,171 from the 19 fathom stations.

Six species (spotfin surfperch, Pacific sanddab, speckled sanddab, English sole, curlfin sole, and sand sole) were present in 50 percent or more of the 40 samples. Six species (night smelt, speckled sanddab, English sole, starry flounder, curlfin sole, and sand sole) were present in 50 percent or more of the 20 samples taken at the 8 fathom stations. The speckled sanddab occurred in all samples taken at this depth. Eleven species (plainfin midshipman, spotfin surfperch, pink seaperch, rockfish, Pacific sanddab, speckled sanddab, Dover sole, English sole, curlfin sole, hornyhead turbot, and sand sole) were present in 50 percent or more of the 20 samples taken at the 19 fathom stations. The Pacific sanddab occurred in all samples taken at this deeper depth.

Five species (night smelt, white croaker, Pacific sanddab, speckled sanddab, and English sole) comprised 74 percent of the total specimens collected in the 40 samples. The Pacific sanddab comprised 30.5 percent of the total, while the night smelt comprised 22.7 percent. Five species (night smelt, white croaker, spotfin surfperch, Pacific sanddab, and speckled sanddab) comprised 83 percent of the total specimens collected at the 8 fathom stations. Night smelt accounted for 48.2 percent of the total. Three species (night smelt, Pacific sanddab, and English sole) comprised 62 percent of the total specimens collected at the 19 fathom stations. The Pacific sanddab comprised 47.1 percent of the total.

Combining the above results, it is apparent that the night smelt and speckled sanddab are the dominant species at the 8 fathom stations, while the Pacific sanddab and English sole are the dominant species at the 19 fathom stations. The Pacific sanddab, speckled sanddab, and English sole are found to be the dominant species when the two depths are combined.

Comparing the species list from these Monterey Bay stations with the results of Day and Pearcy (1968) off the coast of Oregon, one finds that 11 families and 16 species are common to both places. Day and Pearcy collected a total of 7,689 fishes representing 21 families and 67 species in their 36 samples. These authors used similar collecting methods at stations with depths ranging from 40 to 1829 meters. Only the 40 meter depth is common to both studies and at this depth, there are 10 species common to both areas.

Heimann (1963) conducted a trawling study in Monterey Bay using much larger commercial gear; he worked with commercial fishermen who could not legally trawl within three miles of shore. From the 53 species representing 22 families he found, 20 species from 16 families are common to both studies.

Means of 7.7 species and 239 specimens per sampling date were found for the 8 fathom stations (Table V), whereas means of 13.8 species and 359 specimens per sampling date were noted for the 19 fathom stations. In comparing the means of number of species and specimens for the two depths, one finds that the difference between the mean number of species is statistically significant at the .1% level of confidence, while the difference between mean number of specimens is not statistically significant. The difference between the means of the number of species collected at stations 1154 and 1101 is significant at the 2% level of confidence (see Table X), which is probably due to the fact that sampling at station 1101 was started in the fall of 1971 and therefore no collecting was done during the summer when the number of species and specimens of fishes in Monterey Bay appears to be at its highest for both depths. The fact that the mean number of species at station 1110 (sampled at the same time as 1101) is not significantly different from those of the other two 19 fathom stations, may be due to the fact that the number of species and specimens may decline earlier in the fall in the inshore than the offshore area. The number of species and specimens is apparently highest in the spring and summer, decreasing during the fall to a minimum during the winter. There is also an indication that the mean number of species and specimens for both depths may also be highest in the northern part of the bay and decrease towards the south. The catches for the spring of 1972 are considerably lower than for the spring of 1971. Further data will be needed to substantiate these indications.

Groupings of species which very frequently form a part of each others biological environment were developed to give an insight into possible interspecific relationships (Figures 2, 3, and 4). Such groupings may be helpful to later investigators working on food studies, etc. These groupings, however, are derived from only a 15 month survey and it is possible that there are errors due to sampling, the "level of significance" required of the index of affinity, etc.

A mean percent composition of 49.5 was found when combining the indices of similarity for stations sampled at the same depth and the same time or within one month of each other (Table VI). This rather large value was derived by comparisons from different locations and thus location does not seem to be a factor that contributes to different percent composition of the catches.

A mean percent composition of 19.7 was found when combining the indices of similarity for stations sampled at the same or different locations at the same time or within one month of each other (Table VI). This fairly small value was derived by comparisons from different depths and thus depth seems to be an important factor in contributing to different percent compositions of the catches. Table X shows that none of the values from the comparisons of means of the four subdivisions of depth in Table VI are significant, so there are no significant differences between the mean indices of similarity due to different locations and time differences of one month.

Seasonal changes in percent composition of the catches within a depth range are not significant (Tables VII and X) but the mean composition of the combined 8 fathom stations are significantly different for that at the 19 fathom depth. Moreover, the 19 fathom stations have the higher mean indices of similarity indicating that the catches at the deeper stations are more similar to each other throughout the year than the catches at the 8 fathom stations.

The highest mean index of similarity (62.8%) is found when comparing the different stations sampled during the first upwelling period with each other (Table VIII). The lowest mean index of similarity (14.0%) is found when comparing the different stations sampled during the Davidson current period with each other. The four lowest mean indices of similarity (16.2, 24.1, 14.0, and 28.2%) occur when the samples from the Davidson current period are compared to the samples from the other three periods and themselves.

The subsection for Table VIII in Table X shows that there are 10 comparisons of mean pairs that are significantly different from each other. The statistically significant differences are as follows: 1. in comparing the samples obtained during the first upwelling period with the samples obtained during the other three periods, the mean index of similarity of this period is significantly different than the mean indices of the other three periods while the mean index for the Davidson current period is also significantly different from the mean indices of the other three periods; 2. in comparing the samples obtained during the oceanic period with the samples obtained during the other three periods, the mean index of the Davidson current period is significantly different from the mean indices of the first upwelling period and the oceanic period; 3. in comparing each index, that shows what the similarity was during that specific period and not what the similarity is compared to the other period, with each other, the mean index of similarity for the first upwelling period is significantly different than the mean indices of the other three periods. The catches at the 8 fathom stations are quite similar in composition during the upwelling period and dissimilar during the Davidson current period. The index of similarity for the second period of upwelling is not as high as for the first, but this is probably due to the fact that the months for the two sampling periods differ.

With regard to the 19 fathom stations, the highest mean index of similarity (69.3%) is found when comparing the different stations sampled during the oceanic period with each other (Table IX). The lowest mean index of similarity (29.0%) is found when comparing the different stations sampled during the Davidson current period with each other. The four lowest mean indices of similarity (37.1, 27.7, 29.0, and 32.2%) occur when the samples from the Davidson current period are compared to the samples from the other three periods and themselves.

The subsection for Table IX in Table X shows that there are 16 comparisons of mean pairs that are significantly different from each other. The statistically significant differences are as follows: 1. in comparing the samples obtained during the oceanic period with the samples obtained during the other three periods, each mean index of similarity of this period is significantly different than the mean index of each other period; 2. in comparing the samples obtained during the Davidson current period with the samples obtained during the other three periods, the mean index of similarity of the first upwelling period is significantly different from the mean index of similarity of the oceanic period; 3. in comparing the samples obtained during the second upwelling period with the samples obtained during the other three periods, the mean index of similarity of the first upwelling period is significantly different than the mean indices of the other three periods, while the mean index for the

Davidson current period is also significantly different from the mean indices of the other three periods; 4. in comparing each index, that shows what the similarity was during that specific period and not what the similarity is compared to the other period, with each other, the mean index of similarity for the oceanic period is significantly different than the mean indices of the other three periods and the mean index of similarity for the Davidson current period is significantly different than the mean indices of the oceanic and upwelling periods. The trends in this table are not as obvious as those in Table VIII, but seem to indicate that there is a high similarity of percent composition of the catches during the oceanic period and a low similarity of percent composition of the catches during the Davidson current period. There is also a fairly high similarity of percent composition of the catches during the second upwelling period.

Changes in catch composition over the year are more marked at the 8 fathom stations (33.7%) than at the 19 fathom stations (46.6%) (Tables VIII and IX). This difference is significant at the .1% level of confidence (Table X).

Since in Table VII the 8 fathom stations are compared only to themselves over the year and in Table VIII they are compared to each other over the year, any difference in the total mean indices of similarity for these two tables would be due to station location. The two means, 38.7 percent (Table VII) and 33.7 percent (Table VIII), are not significantly different (Table X), thus there is no significant difference in catch composition over the year in regard to station location at the 8 fathom stations. The same nonsignificant results are found for the 19 fathom station means of 46.2 percent (Table VII) and 46.6 percent (Table IX).

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APPENDIX A

SAMPLING DATES FOR EACH STATION

Stations:

1154	1105	1101
9 March 1971	2 April 1971	6 October 1971
4 May 1971	8 May 1971	1 December 1971
6 August 1971	6 August 1971	8 March 1972
10 September 1971	10 September 1971	2 May 1972
17 November 1971	17 November 1971	
5 January 1972	5 January 1972	
22 March 1972	22 March 1972	
3 May 1972	3 May 1972	

Stations:

1156	1155	1110
9 March 1971	13 March 1971	6 October 1971
4 May 1971	8 May 1971	1 December 1971
7 August 1971	6 August 1971	8 March 1972
10 September 1971	10 September 1971	2 May 1972
17 November 1971	17 November 1971	
5 January 1972	5 January 1972	
22 March 1972	22 March 1972	
3 May 1972	3 May 1972	

APPENDIX B

Station and Month	54-3	56-3	55-3	05-4	54-5	56-5	05-5	55-5	54-8	56-8	05-8	55-8	54-9	56-9	05-9	55-9	01-10	10-10	54-11	56-11	05-11	55-11	01-12	10-12	54-1	56-1	05-1	55-1	01-3	10-3	54-3	56-3	05-3	55-3	01-5	10-5	54-5	56-5	05-5	55-5
54-3	X	11	26	43	55		74		67		8		51		47		3		2		2		2		3		2		2		39		2		3		66		53	
56-3	D	X	25	10		57		51		45		57		60		55		54		53		57		52		20		39		55		60		42		46		81		59
55-3	D	L	X	22		37		22		31		15		11		9		20		10		44		44		25		54		21		24		18		19		25		24
05-4	L	D	D	X	20	26	60	2	49		4-		60		54		45		47		50		50		12		20		50		32		44		51		51		72	
54-5	T			L	X	30	60	5	57		44		64		63		36		34		33		34		12		20		33		32		32		37		61		75	
56-5		T	T	D	D	X	26	59		66		52		46		44		49		39		45		43		23		48		37		46		34		36		57		42
05-5	T			L	L	D	X	2	61		25		49		57		14		10		22		11		9		20		22		32		7		25		68		64	
55-5		T	T	D	D	L	D	X		54		58		54		52		60		51		52		39		14		44		49		54		37		44		52		52
54-8	T			T	T		T		X	22	17	7	67	6	55	4	8		4		4		3		4		8		3		39		3		14		69		58	
56-8		T	T			T		T	D	X	49	52	22	64	34	47		50		38		44		41		22		42		34		51		31		53		52		38
05-8	T			T	T		T		L	D	X	25	38	31	45	20	60		51		55		38		13		39		46		5		35		59		19		32	
55-8		T	T			T		T	D	L	D	X	8	7-	19	87		84		79		83		39		11		29		71		78		36		44		57		62
54-9	T			T	T		T		T	D	L	D	X	5	74	3	24	10	18		19		18		12		25		19		39		17		40		54		63	
56-9		T	T			T		T	D	T	D	L	D	X	18	76	53	68		64		65		36		11		27		62		70		36		60		51		61
05-9	T			T	T		T		L	D	T	D	L	D	X	18	36	24	31		22		18		13		18		18		33		14		37		54		64	
55-9		T	T			T		T	D	L	D	T	D	L	D	X	52	80		77		75		33		11		27		70		76		34		43		52		59
01-10	T			T	T		T		T		T		L	D	L	D	X	60	60	51	51	60	41		11		26		46		1		39		48		8		27	
10-10		T	T			T		T		T		T	D	L	D	L	D	X	23	75	12	85		41		14		32		77		83		44		49		50		68
54-11	T			T	T		T		T		T		T		T		L	D	X	19	70	26	73	33	11		17		73		1		70		45		5		23	
56-11		T	T			T		T		T		T		T		T	D	L	D	X	6	84	0	33		12		28		76		70		36		42		46		58
05-11	T			T	T		T		T		T		T		T		L	D	L	D	X	13	71	11	11		36		86		1		62		64		4		30	
55-11		T	T			T		T		T		T		T		T	D	L	D	L	D	X	6	39		17		36		77		82		44		49		52		67
01-12	T			T	T		T		T		T		T		T		T		L	D	L	D	X	4	15	4	17	14	86		1		78		48		5		33	
10-12		T	T			T		T		T		T		T		T		T	D	L	D	L	D	X	2	15	8	40		34		38		33		34		51		41
54-1	T			T	T		T		T		T		T		T		T		T		T		L	D	X	73	10	15	11		61		10		12		27		12	
56-1		T	T			T		T		T		T		T		T		T		T		T	D	L	D	X	4	30		16		18		15		16		20		15
05-1	T			T	T		T		T		T		T		T		T		T		T		L	D	L	D	X	18	31		1		17		44		9		22	
55-1		T	T			T		T		T		T		T		T		T		T		T	D	L	D	L	D	X		43		36		41		43		41		44
01-3	T			T	T		T		T		T		T		T		T		T		T		T		T		T		X	28	1	8	71	55	60		4		3	
10-3		T	T			T		T		T		T		T		T		T		T		T		T		T		T	D	X	1	74	22	64		62		49		84
54-3	T			T	T		T		T		T		T		T		T		T		T		T		T		T		L	D	X	5	1	1	1		54		32	
56-3		T	T			T		T		T		T		T		T		T		T		T		T		T		T	D	L	D	X	4	44		16		55		67
05-3	T			T	T		T		T		T		T		T		T		T		T		T		T		T		L	D	L	D	X	32	45		4		20	
55-3		T	T			T		T		T		T		T		T		T		T		T		T		T		T	D	L	D	L	D	X		65		42		71
01-5	T			T	T		T		T		T		T		T		T		T		T		T		T		T		T		T		T		X	33	14	12	34	36
10-5		T	T			T		T		T		T		T		T		T		T		T		T		T		T		T		T		T	D	X	8	49	12	64
54-5	T			T	T		T		T		T		T		T		T		T		T		T		T		T		T		T		T		L	D	X	15	60	9
56-5		T	T			T		T		T		T		T		T		T		T		T		T		T		T		T		T		T	D	L	D	X	17	55
05-5	T			T	T		T		T		T		T		T		T		T		T		T		T		T		T		T		T		L	D	L	D	X	29
55-5		T	T			T		T		T		T		T		T		T		T		T		T		T		T		T		T		T	D	L	D	L	D	X

"TRELLIS DIAGRAM" ILLUSTRATING THE DEGREE OF SIMILARITY OF THE FISHES COLLECTED

D = DEPTH

L = LOCATION

T = TIME OR SEASONALITY