Marjorie Sherwood

RECRUITMENT OF NEARSHORE DEMERSAL FISHES

The relatively shallow waters of estuaries and back bays are known to be nursery grounds for many species of fish. The scarcity of such areas in southern California and the current patterns of the Southern California Bight, which maintain pelagic larvae close to shore (Southern California Coastal Water Research Project 1973; Parrish 1979), tend to make the nearshore waters of the open coast relatively more important as a nursery ground in this region. In fact, much of the variation in trawl monitoring surveys of demersal fishes appears to be the result of seasonal influxes of postlarval juveniles settling out of the water column (Mearns 1979).

The goal of this study was to use available trawl data to determine the extent to which the nearshore waters of the open coast serve as a nursery ground for the demersal fishes of southern California. The main objectives were to (1) identify the species for which juveniles are abundant at depths of 20 to 150m, (2) examine first-year growth in postlarval juveniles of selected species from several collection sites, and (3) document fluctuations in recruitment of select species during the past decade.

In each area studied, less than ten species accounted for more than 95 percent of the trawl-caught juveniles. Juveniles were defined for simplicity as those specimens less than 60mm standard length (SL). Juveniles recruited into the region during all seasons of the year, and the size and time of the influx often varied from year to year. For several of the most abundant species, variations in first-year growth between sampling sites were of the same magnitude as those for one site in successive years. Some species grew more slowly in the winter months. Major fluctuations in recruitment of species such as the calico rockfish (*Sebastes dalli*) and the California lizardfish (*Synodus lucioceps*) appeared to occur over the region as a whole.

METHODS

The data analyzed in this study were collected primarily in four areas--Palos Verdes shelf, south San Pedro Bay, Dana Point, and Catalina Island. The most extensive set of trawl-monitoring data was that of the County Sanitation Districts of Orange County collected in south San Pedro Bay off Newport. Six to eight stations were sampled quarterly beginning in 1969. A single day-time tow was taken at each station with a net having a 7.6-m headrope and a 1.3-cm strech mesh cod-end liner. On-bottom sampling time was 10 minutes, and all tows were made aboard the MV Fury II (November 1969 to May 1970) and the RV Vantuna (August 1970 and subsequent surveys). Between November 1969 and May 1974, the eight stations sampled ranged in depth from about 18 to 150 m. In August 1974, the two deepest stations were deleted from the program and several other stations were relocated; the result was a grid of 7 stations ranging in depth from 18 to 64 m. However, a deep station (150 m) was sampled in January 1977 and October 1979.

On the Palos Verdes shelf, surveys were conducted by the County Sanitation Districts of Los Angeles County. A minimum of 12 stations at depths of 23, 61, and 137 m were consistently monitored in summer and winter beginning in 1972. Most surveys were conducted with a net having a headrope of 7.6-m and a cod-end stretch mesh liner of 1.3-cm. However, in the summer of 1972, a net with a 12.1-m headrope and 3.5-cm stretch mesh cod-end was used; and surveys in winter 1972 and summer 1973 were made with a net having a 7.6-m headrope and a 2.5-cm stretch mesh cod-end liner. Average on-bottom trawl time was 10 minutes and trawling speeds ranged from 2.8 to 5.0 km/hr.

The samples from Catalina Island analyzed in this study were from three stations at 23, 61, and 137 m on the windward side of the island near the southwest tip. The stations were sampled twice per year with the gear employed on the Palos Verdes shelf.

Off Dana Point, surveys were conducted quarterly in 1973 and 1974 at seven to nine stations. The nine-station grid ranged from 24 to 100 m in depth. The surveys were conducted aboard the MV Fury II using a net with a 7.6-m headrope and a 1.3-cm stretch mesh cod-end liner. At each station, the net was towed for 10 minutes (on-bottom time) at 1.3 m/sec (Mearns and Word 1975).

In each survey, fishes were identified, examined for external abnormalities, and measured to the nearest 0.5 cm SL. The size data were placed in a computer format, and a program was written to summarize size class frequencies by species and survey. Growth curves were determined by identifying the 10-mm size class with the greatest number of individuals from a single recruitment in successive seasons.

This method is most useful in examining growth in the most abundant species during the early years before the age classes become indistinguishable (Ricker 1979). However, this method has a number of limitations. It may not be sensitive enough to detect small differences in growth between areas or to account for differential mortality; it is difficult to apply to species that do not recruit in large numbers; and it is difficult to use with larger specimens in which year classes cannot be easily distinguished on the basis of size.

RESULTS

Catch Compostion

Less than 10 species accounted for more than 95 percent of the juveniles (defined as specimens less than 60 mm SL) collected at a given site by bottom trawls at depths of 20 to 150 m. The stripetail rockfish (*Sebastes saxicola*), Pacific sanddab (*Citharichthys sordidus*), and speckled sanddab (*C. stigmaeus*) were among the most abundant species in each area sampled. Catches of juveniles taken in 1973-74 are presented in Tables 1-4. Reproductive strategies of these species differed. The sanddabs are oviparous with

Table 1. Abundance and depth distribution of juvenile fishes (defined as those less than 60 mm standard length) collected at 12 stations* on the Palos Verdes shelf, 1973-74.

		Depth Distribution (No./sample)		
	Total No.	23m	61m	137m
Stripetail rockfish	2463	66	54	12
Speckled sanddab	1637	85	0.79	–
Splitnose rockfish	667	–	–	42
Pacific sanddab	270	0.47	14	0.25
Yellowchin sculpin	119	0.79	5.1	0.44
Vermilion rockfish	38	1.9	0.053	–
White croaker	37	1.9	0.053	–
Slender sole	34	–	–	2.1
Dover sole	25	–	0.79	0.62
	5290**			
No. of samples	54	19	19	16

*The 12 stations were on 4 transects (T0, T1, T4, T5) at 23, 61, and 137 m sampled twice per year.
**Accounts for almost 98 percent of juveniles.

Table 2. Abundance and depth distribution of juvenile fishes (defined as those less than 60 mm standard length) collected at 9 stations* off Dana Point, 1973–4.

	Total No.	Depth Distribution (No./sample) 24-30m	48-57m	82-100m
Pacific sanddab	1373	0.045	34	25
Stripetail rockfish	1232	0.091	45	8.1
Bay goby	190	0.27	6.7	1.3
Pink seaperch	178	0.82	6.9	0.083
Yellowchin sculpin	90	0.14	3.2	0.54
Speckled sanddab	83	3.6	—	0.12
Dover sole	60	—	0.70	1.8
Plainfin midshipman	33	0.091	0.83	0.50
Longfin sanddab	21	0.045	0.87	—
	3260**			
No. of samples	69	22	23	24

*The 9 stations consisted of 3 transects sampled 4 times per year.
**Accounts for greater than 97 percent of juveniles.

Table 3. Abundance and depth distribution of juvenile fishes (defined as those less than 60 mm standard length) collected at 3 stations* off Catalina Island, 1973–74.

	Total No.	Depth Distribution (No./sample) 23-26m	55-63m	130-133m
Pacific sanddab	1288	17	58	240
Speckled sanddab	589	120	2.8	—
Stripetail rockfish	198	—	41	8.5
Pink seaperch	48	0.20	12	—
Shortbelly rockfish	22	4.4	—	—
Yellowchin sculpin	16	—	4.0	—
Greenstriped rockfish	7	—	—	1.8
Slender sole	4	—	—	1.0
Chilipepper	3	0.60	—	—
	2175**			
No. of samples	13	5	4	4

*The 3 stations made up one transect sampled twice per year.
**Accounts for almost 100 percent of juveniles.

planktonic eggs and larvae; the rockfishes are primarily ovoviviparous with planktonic larvae. Only one viviparous (live-bearing) species--the pink seaperch (*Zalembius rosaceous*)--was represented by large numbers of juveniles.

Off Palos Verdes, small stripetail rockfish were abundant at all three depths sampled--23, 61, and 137 m. It appeared that the smallest specimens were at the shallow depths and the larger specimens at the deeper depths (Figure 1). The large numbers of recently settled individuals at 23 m were collected near Redondo Canyon, and this suggests that canyons may function to concentrate settling juveniles. Small speckled sanddabs were most abundant at the shallowest depths; Pacific sanddab, at the intermediate depth; and splitnose rockfish (*Sebastes diploproa*), at the deepest stations.

In south San Pedro Bay, small speckled sanddabs and white croaker (*Genyonemus lineatus*) were abundant at the shallowest depths. Small yellowchin sculpin (*Icelinus quadriseriatus*), Pacific sanddab, speckled sanddab, and stripetail rockfish were abundant at intermediate depths. And small Pacific sanddab, splitnose rockfish, Dover sole

Table 4. Abundance and depth distribution of juvenile fishes (defined as those less than 60 mm standard length) collected at 7 to 8 stations* in south San Pedro Bay, 1973-74.

		Depth Distribution (No./sample)		
	Total No.	14-20m	32-65M	92-150m
Yellowchin sculpin	1258	0.36	35	0.25
Pacific sanddab	1123	0.071	29	5.2
Speckled sanddab	922	20	18	—
Stripetail rockfish	556	0.29	16	2.2
Splitnose rockfish	502	—	1.6	37
Dover sole	225	—	0.39	18
Pink seaperch	165	—	4.6	—
Slender sole	106	—	0.056	8.7
Plainfin midshipman	79	—	2.0	0.50
White croaker	79	5.6	—	—
	5015**			
No. of samples	62	14	36	12

*Stations were sampled quarterly. An eight station grid was sampled prior to fall 1974. At that time, the sampling pattern was changed — 2 stations were retained and 5 new stations were added. The deep stations were not sampled in fall and winter 1974.

**Accounts for greater than 98 percent of juveniles.

(*Microstomus pacificus*), and slender sole (*Lyopsetta exilis*) were abundant in deeper waters. These depth categories covered a wider range than those off Palos Verdes.

Off Dana Point and Catalina Island, at the deeper depths, small Pacific sanddab and stripetail rockfish were most abundant. The samples off Dana Point were probably too shallow to collect splitnose rockfish, and this species was not present in the samples taken off Catalina Island. At intermediate depths, small Pacific sanddab, stipetail rockfish, and pink seaperch were abundant in both areas. Off Dana Point, the bay goby (*Lepidogobius lepidus*) was also present. In the shallow samples taken off Catalina, small Pacific sanddab and speckled sanddab were very abundant; but off Dana Point, no small specimens were unusually abundant.

Growth

Postlarval juveniles recruited (or became available to the trawl sampling programs) during all seasons of the year (Figure 2). Among the most abundant, there appeared to be two primary influx periods--winter and spring. Plainfin midshipman (*Porichthys notatus*), rex sole (*Glyptocephalus zachirus*), bigmouth sole (*Hippoglossina stomata*), and pink seaperch appeared to recruit primarily in winter; stripetail rockfish, Dover sole, speckled sanddab, Pacific sanddab and blackbelly eelpout (*Lycodopsis pacifica*), primarily in spring; and calico rockfish, in summer. These observations are based on data collected off Orange County from 1971 to

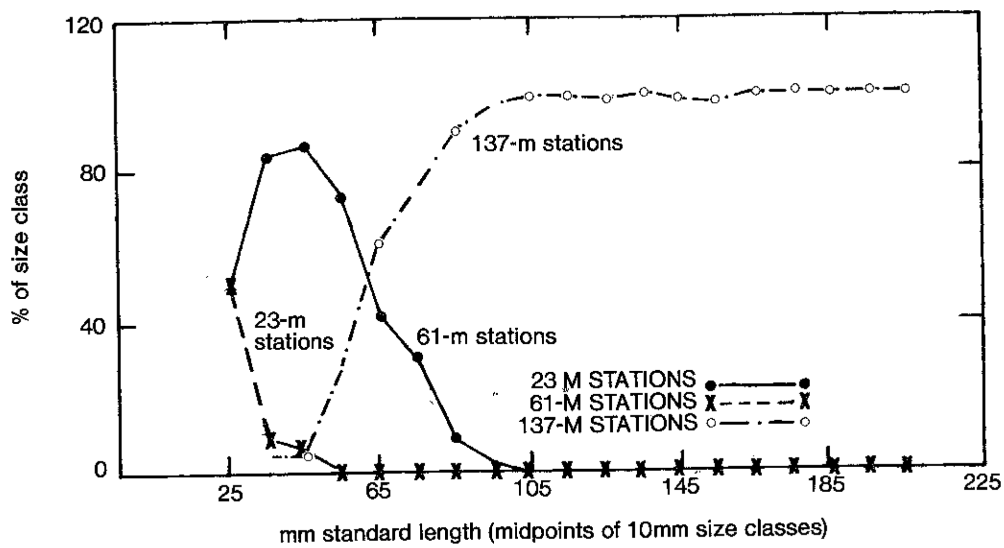

Figure 1. Depth distribution by size of stripetail rockfish on the Palos Verdes shelf (12 stations). 1972-75.

1977; however, exact time of recruitment can vary from year to year. For example, settling in Pacific sanddab was earlier in 1974 than in 1973, although the 1973 influx was larger (Figure 3). This pattern also occurred off Dana Point, suggesting that the effect was regional.

For several species collected in south San Pedro Bay, there was evidence of reduced growth during the winter. In Pacific sanddab, this could be seen in three different year classes (Figure 3). Other species for which reduced winter growth appeared to occur were rex sole, Dover sole, calico rockfish, and speckled sanddab (Figure 4). This pattern was not seen during the first years of growth of certain species (for example, the pink seaperch and plainfin midshipman).

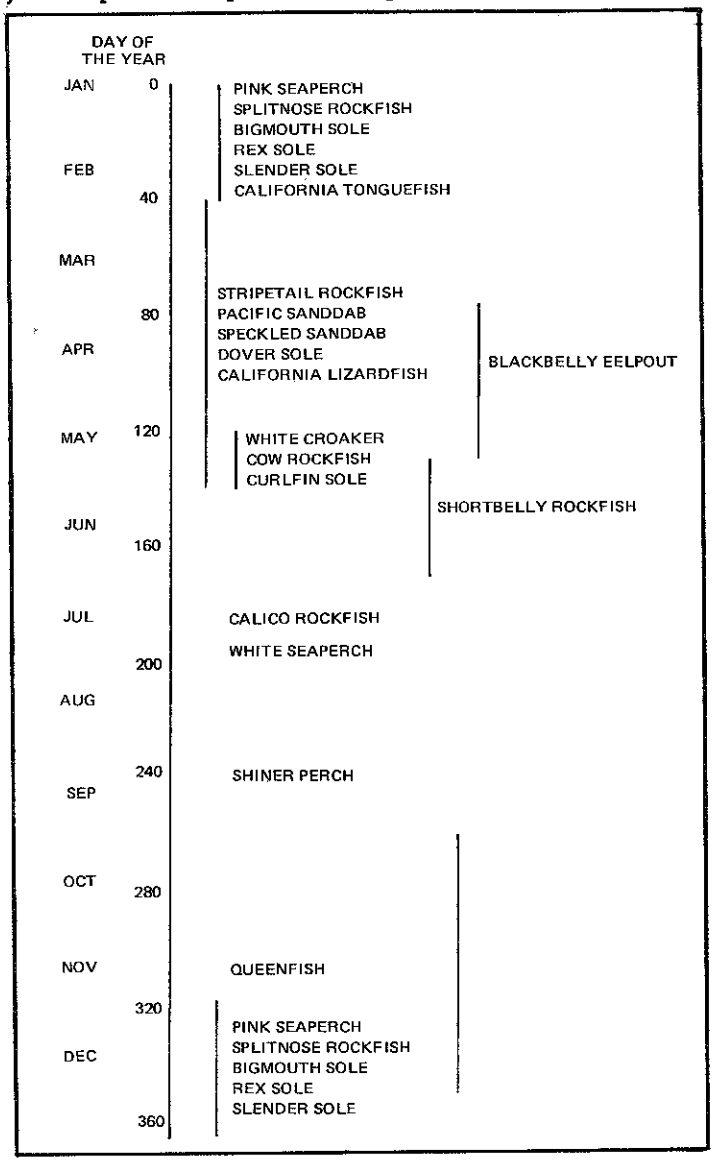

Figure 2. Approximate recruitment times for slected southern California demersal fishes estimated from trawl data taken in south San Pedro Bay, 1971-77.

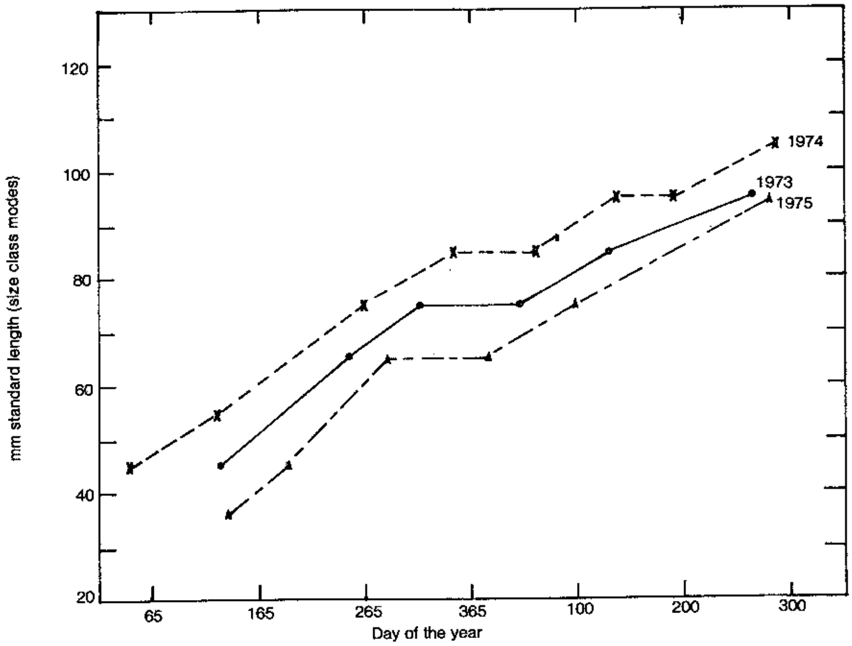

Figure 3. Estimated growth in three successive year classes of Pacific sanddab in south San Pedro Bay, 1973-76.

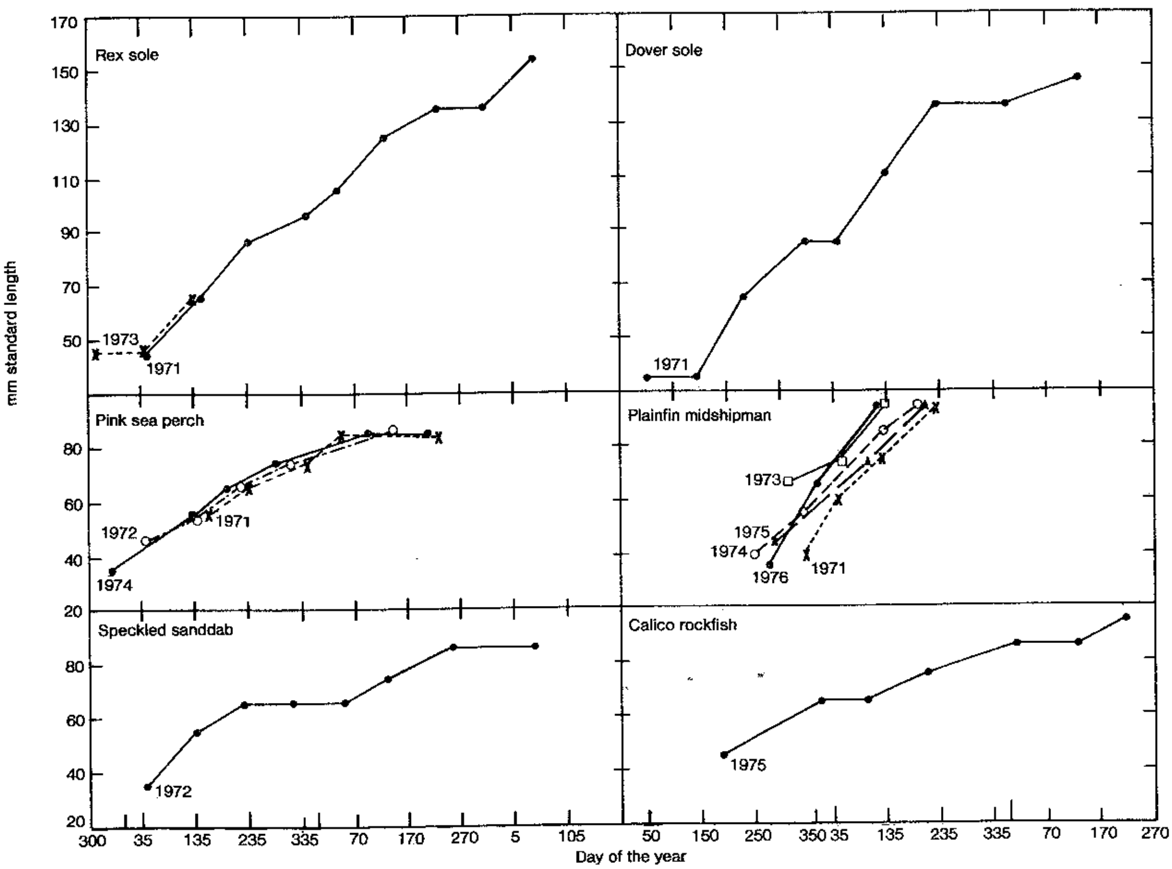

Figure 4. Estimated growth of six demersal fishes during the first years after initial collection in travel surveys, south San Pedro Bay, 1971-77.

For a few of the more abundant species, it was possible to compare first-year growth in individuals from different areas. The variations appeared to be of similar magnitude to those of a species in one area from year to year. In stripetail rockfish, early growth in 1973 appeared similar off Palos Verdes, Newport, and Dana Point (Figure 5A). In

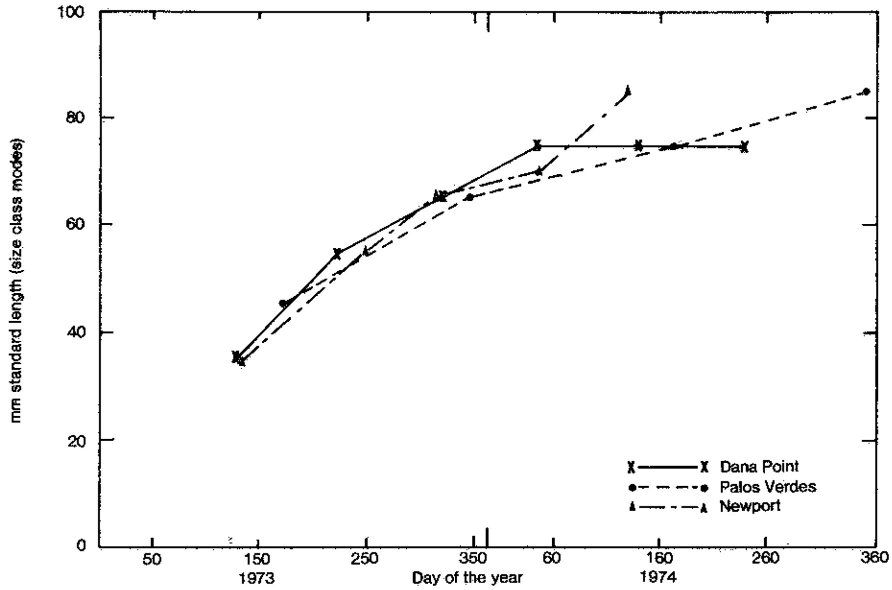

Figure 5A. Estimated growth of stripetail rockfish settling off Palos Verdes, Newport, and Dana Point in 1973.

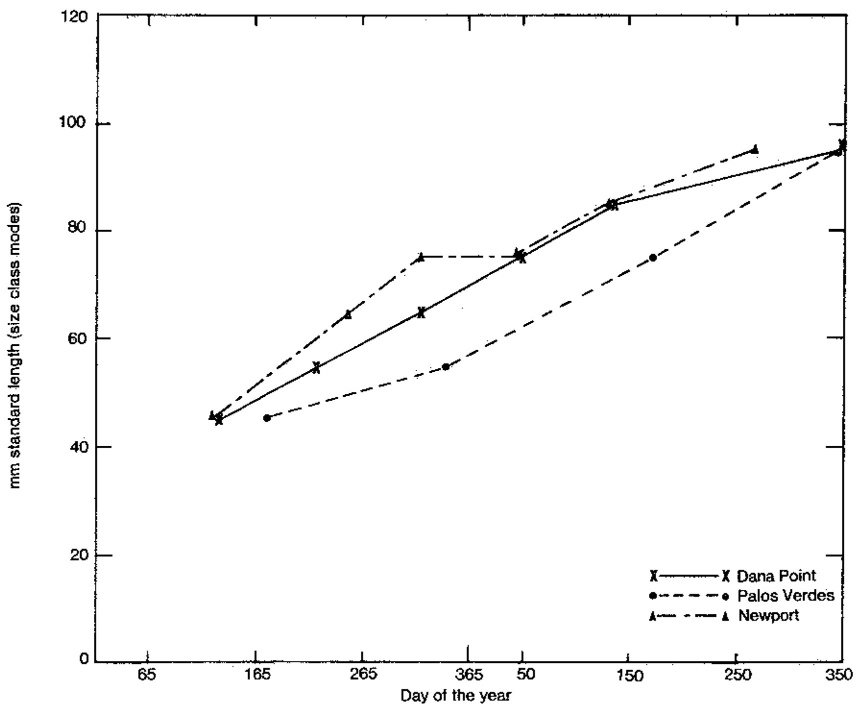

Figure 5B. Estimated growth of Pacific sanddab settling off Palos Verdes, Newport, and Dana Point, 1973.

Pacific sanddab, initial growth appeared slower at Palos Verdes, but by the end of the second year, the size class mode was similar to those in specimens collected off Newport and Dana Point (Figure 5B). In calico rockfish, size after approximately 2 years on the bottom appeared similar off Palos Verdes and Newport (Figure 5C). And in plainfin midshipman, early growth was similar off Dana Point and Newport (Figure 5D).

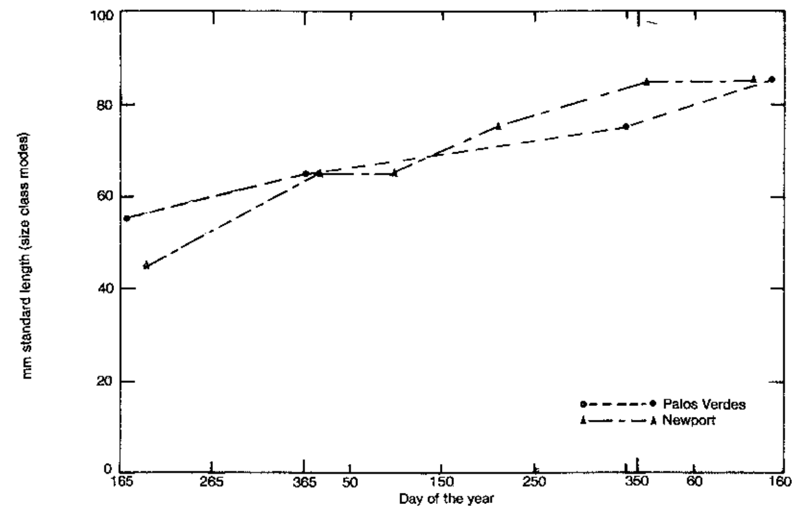

Figure 5C. Estimated growth of calico rockfish settling off Palos Verdes and Newport, 1975.

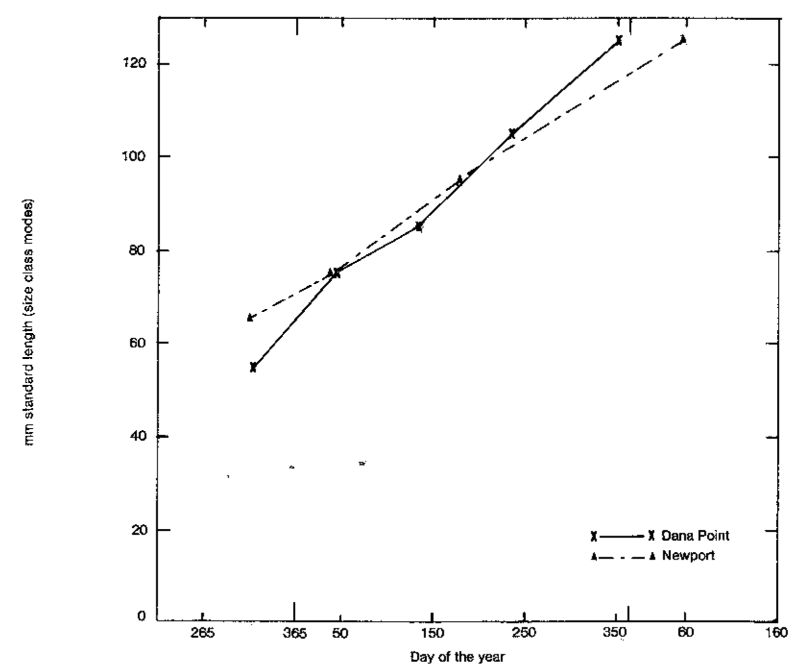

Figure 5D. Estimated growth of plainfin midshipman off Newport and Dana Point, 1973.

Fluctuations

Some demersal species recruit into the nearshore waters every year, though the time and size of the influx may vary from year to year. Examples are the Pacific and speckled sanddabs and the stripetail and splitnose rockfishes. Other species recruit into an area on an aperiodic basis. The best example of this is the recruitment of calico rockfish into southern California nearshore waters in summer 1975 (Mearns et al. 1980). The influx was substantial and was recorded in the surveys off Palos Verdes and Newport (Table 5). The presence of larger specimens in the catches prior to 1975 suggested that a similar influx may have occurred in the region in the early or mid-1960's. These data indicate that a strong recruitment can affect the population structure for a number of years.

A second example of aperiodic recruitment is that of the California lizardfish. This species was collected in relatively large numbers in 1973 and 1977 in south San Pedro Bay (Table 6). It was also present off Palos Verdes in those years, though in fewer numbers. Juvenile California tonguefish (*Symphurus atricauda*) were also abundant in 1973 and 1977 in south San Pedro Bay; off Palos Verdes, there was a recruitment in 1977. Both species may be considered warm-water species. The distribution of the California lizardfish is from Guayamas, Mexico, to San Francisco and that of the California tonguefish is from Cabo San Lucas, Baja California, to Big Lagoon in Humboldt County (Miller and Lea 1972). The recruitment patterns of these two species suggest that 1973 and 1977 may have been warm-water years. This is supported by the occurrence of mass strandings of pelagic red crabs (*Pleuroncodes planipes*) on southern Califdornia beaches in 1973 (Radovich 1961; Mearns et al. 1980). In addition, Santa Monica Bay surface water temperatures in January and February of 1973 and 1977 exceeded the average values for the years, 1969-77 (Figure 6).

SUMMARY AND CONCLUSIONS

The nearshore waters of the open coast in southern California serve as a nursery ground for many demersal fish species. Approximately 15 percent of the total trawl catch consists of specimens less than 60mm SL (Sherwood and Mearns, in press). Recruitment occurs during all seasons of the year but appears to be heaviest in winter and spring. Different species recruit at different depths within the depth range emphasized in this study (20 to 150 m). Fluctuations in the strength and time of recruitment appear to occur on a regional basis and may vary from year to year.

Table 5. Abundance of calico rockfish off Newport and Palos Verdes, 1971–77. (Note influx of small individuals in 1975).

Fish standard length (midpoints of 10 mm size classes)

Survey Date Year	Day	25	35	45	56	66	75	85	95	105	115	125	135	145	155	≥165
Palos Verdes Shelf																
72	167									1		1				
72	346															
73	174															
73	346													1	2	
74	172															
74	348															
75	171		1	33	500											
75	365				12	30	2									
76	138			1	3	4	3			2				1	1	1
76	349				2	54	394	349	80	9						
77	140					54	339	342	47	1						
South San Pedro Bay																
71	047					1		3	2	2	5	13	17	10	2	
71	146												1	1	1	
71	232									1	1	12	28	17	3	
71	345										3	12	7	3	1	
72	042										1	1	2	2	2	
72	133										2	2	3	1		1
72	224												3	2		
72	313											1		2	1	
73	045										1	2	1	1		
73	130											3	5	2		
73	249												1			
73	318											1	1			
74	045											1	1	1	1	
74	129											1	3	1	1	
74	262												1	3	1	
74	346												3	2	1	
75	057														1	
75	133												2			
75	191	2	801	230	656	13										
75	287		9	68	167	49	4						1			
76	014			1	207	234	33	1								
76	097		1		40	245	96	21								
76	210					13	197	155	7						2	
76	280															
77	005						1	2								
77	123	1				1	20	25	8							
77	188		22	474	39	2	20	59	64	5	1					

Table 6. Abundance of California lizardfish off Newport and Palos Verdes, 1971-77

Survey Date Year	Day	Fish standard length (midpoints of 10 mm size classes) 35	45	55	65	75	85	95	105	115	125	135	145	155	165	175	185	195	205	215	Total
Palos Verdes shelf																					
72	167																				0
72	346																				0
73	174																				0
73	346																1	1	1		6*
74	172																			1	5*
74	348																				0
75	171																				2*
75	365																				2*
76	138																				3*
76	349																				0
77	140				1	1			3												6*
South San Pedro Bay																					
71	047																		1		3*
71	146																				0
71	232																				0
71	345																				0
72	042																				0
72	133																				0
72	224																				0
72	313																				0
73	045				13																14*
73	130			2		3	13	7	6	13	2	2	2				1	1			52
73	249									2	7	4	5	12	9	11	6	3	1	1	62*
73	318													1		1	1	8	7	6	38*
74	045																1	2	1	1	13*
74	129												1								7*
74	262																	1			3*
74	346																				6*
75	057																				5*
75	133																				0
75	191																				2*
75	287																				0
76	014																				0
76	097																				0
76	210																				4*
76	280																				3*
77	005					1															7*
77	123	2			2	13	7	4	1	1											31*
77	188			1	8	38	64	38	14	4	5	7	4	5	3						191

A strong recruitment can influence the population structure for several years. Differences in reproductive strategy and length of the larval period should be considered in future studies of recruitment fluctuations. The data and information presented here re-emphasize the need to document variability in species recruitment to be able to identify "normal" conditions in an area and suggest that monitoring recruitment fluctuations at a single control site may be useful for understanding changes in the region as a whole.

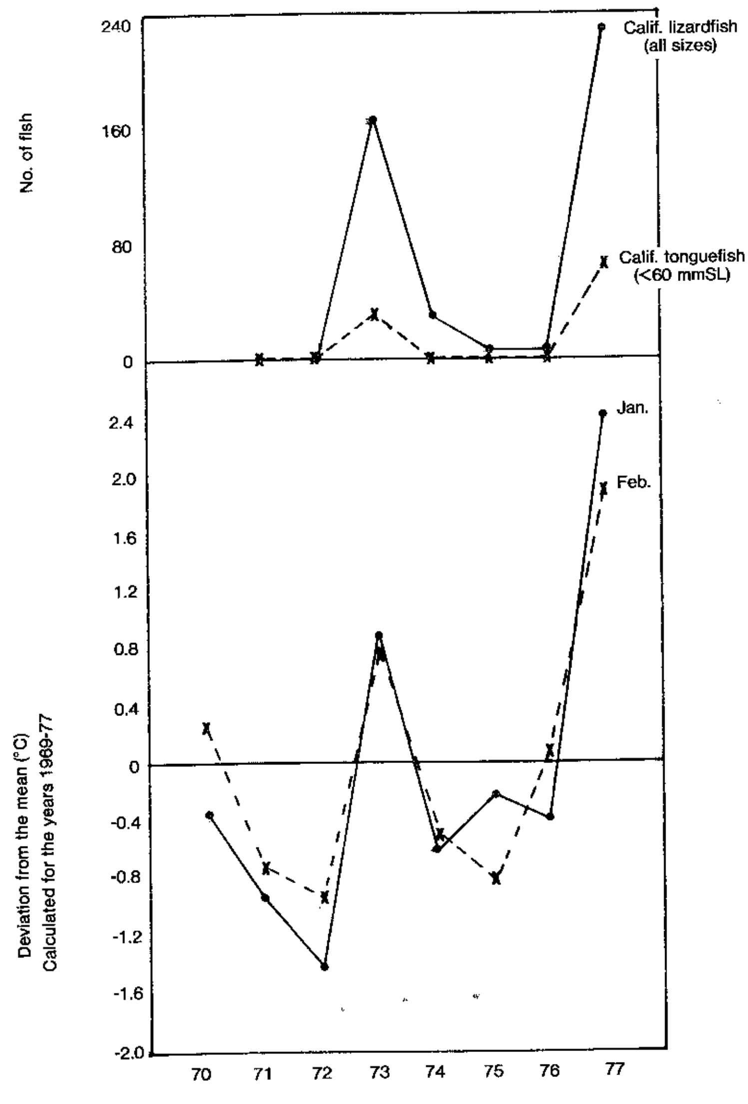

Figure 6. Average monthly surface water temperatures from 19 stations in Santa Monica Bay (monthly temperature data from A.J. Mearns) and fish abundance (February 1971 to July 1977).

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