BEAM-TRAWL SURVEY OF BAY AND NEARSHORE FISHES OF THE SOFT-BOTTOM HABITAT OF SOUTHERN CALIFORNIA IN 1989

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ABSTRACT

Small-meshed (2.5-mm) beam trawls have been used in several recent surveys to examine the distribution of newly settled California halibut (*Paralichthys californicus*). However, information on the entire fish assemblage collected in these surveys has not previously been reported. The objective of this study was to describe the bay and shallow coastal ichthyofauna of southern California as sampled by small-meshed beam trawls. Areas off Los Angeles, Orange, and San Diego counties were surveyed from April to September 1989. Three stations were sampled at each of four coastal sites (Hermosa Beach, Long Beach, San Onofre, and Carlsbad) and two bay sites (Anaheim Bay and Agua Hedionda Lagoon). A 1.0-m beam trawl was used in bays and a 1.6-m beam trawl along the coast. A total of 288 samples was collected at depths of 0–3 m in bays and 6–13 m along the coast. The total collection of 48,994 fish comprised 72 species of 31 families. The catch was dominated by newly transformed (10–15-mm-long) fish.

Fish density decreased from bays to the exposed coast. However, standing crop was highest on the semiprotected coast and lowest in bays. Density decreased with increasing depth, but standing crop increased with depth. Fish density was much higher in May than in the other months. Standing crop was much lower in April than in the other months. The fish fauna included some species characteristic of either bay or coastal habitats, but other species occurred in both; some coastal species preferred either semiprotected or exposed habitats.

RESUMEN

Las redes de arrastre de fondo de malla fina (2.5 mm) han sido utilizadas en varios estudios por examinar la distribución de los individuos del lenguado de California (*Paralichthys californicus*) recientemente establecidos. Sin embargo, información sobre el conjunto de peces no ha reportada previamente. El objetivo del este estudio fue describir la ictiofauna de las bahías y las áreas costeras de poca profundidad del sur de California muestradas por las redes de arrastre de fondo de malla fina. Siendo así, se estudiaron algunas áreas costeras de los condados de Los Angeles, Orange, y San Diego, entre abril y septiembre de 1989. Se tomaron muestras en cuatro localidades costeras (Hermosa Beach, Long Beach, San Onofre, y Carlsbad) y en dos lagunas costeras (Anaheim Bay y Agua Hedionda Lagoon). Se muestrearon tres estaciones en cada localidad utilizando una red de arrastre de fondo de 1.0 m en las lagunas y una red de 1.6 m en las áreas costeras. Se colectaron 288 muestras en total, a profundidades de 0–3 m en las lagunas y de 6–13 m a lo largo de la costa. En este estudio se colectaron un total de 48,994 peces, representando 72 especies de 31 familias. La captura total fue dominada por individuos recientemente transformados (con longitudes de 10–15 mm).

La densidad de individuos decreció desde las bahías hacia la costa expuesta. Sin embargo, la densidad de biomasa fue más elevada en la costa semiprotegida y más baja en las bahías. La densidad de individuos decreció con la profundidad, pero la biomasa aumentó con la profundidad. La densidad de individuos fue más elevada en mayo que en las otros meses. La densidad de biomasa fue más baja en abril que en los otros meses. La ictiofauna incluyó algunas especies típicas de las bahías o de los habitats costeros, pero otras especies occurrierron en ambas áreas. Algunos especies de costa preferieron áreas semiprotegidas o áreas expuestas.

INTRODUCTION

The earliest surveyors of the soft-bottom ichthyofauna of southern California (Gilbert 1890, 1892, 1896, 1915; Ulrey and Greeley 1928) used beam trawls as a sampling device. However, since the 1950s small otter trawls have been preferred (Mearns and Allen 1978) because they capture more species of fish and are less cumbersome to use. The soft-bottom ichthyofauna of the southern California shelf has been extensively sampled during the past thirty-five years by otter trawls with 4.9–7.6-m headrope and 12-mm cod-end mesh (Carlisle 1969; M. J. Allen and Voglin 1976; M. J. Allen 1982; Moore et al. 1982; L. G. Allen 1985; Love et al. 1986).

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For most shelf species, 12-mm mesh in the cod end was sufficient to collect fish as short as 20–25 mm (Sherwood 1980; M. J. Allen 1982), and thus newly transformed juveniles of many species were captured (Moser et al. 1984). However, many near-shore and bay species transform at a smaller size (Ahlstrom et al. 1984; Kramer 1990). Thus newly transformed individuals of these species may pass through the mesh openings of the nets used in otter trawls.

Among the species that transform at a small size is California halibut (*Paralichthys californicus*), which undergoes metamorphosis and settles at 7–9 mm in length (Ahlstrom et al. 1984; L. G. Allen 1988). A number of surveys conducted since 1983 have examined settlement patterns of California halibut because of its importance to fisheries (Kramer and Hunter 1987, 1988; L. G. Allen 1988; M. J. Allen and Herbinson 1990; Kramer 1990; MBC 1990, 1991; L. G. Allen et al., in press). Some of these surveys (Kramer and Hunter 1988; M. J. Allen and Herbinson 1990; Kramer 1990; MBC 1990; L. G. Allen et al., in press) found extensive coastal settlement of halibut in some years. Previous studies (Haaker 1975; M. J. Allen 1982; Plummer et al. 1983) had suggested that settlement probably occurred only in bays. Thus the use of fine-meshed nets revealed a previously unknown distribution pattern of the smallest juveniles of this species.

Because the emphasis of most of the studies was on settlement patterns of California halibut, the catch of other fish species was either ignored or not reported. Although the distribution of larval fishes in nearshore waters of southern California is relatively well known (Barnett et al. 1984; Walker et al. 1987), little is known about this benthic microichthyofauna. This fauna consists largely of newly transformed juveniles of larger fishes but also includes many fishes with small adult sizes. Many species use bay and nearshore areas temporarily as nurseries before moving to deeper habitats as larger juveniles and adults. But the relative use of bays and shallow coastal areas for nurseries is not known for many species.

The main objective of this survey was to determine settlement patterns of California halibut. The results of the halibut portion of this survey are given in M. J. Allen and Herbinson 1990 and MBC 1990. The objective of this portion of the study was to describe the distribution and abundance of the ichthyofauna of the shallow soft-bottom habitat of bay and nearshore coastal areas of southern California from fine-meshed beam-trawl collections.

METHODS

Study Area

The study area was the same as that of M. J. Allen and Herbinson (1990) and MBC (1990). It extended about 130 km north to south from Hermosa Beach (Los Angeles County) to Carlsbad (San Diego County), California. Within this area, surveys were conducted at Hermosa Beach, Long Beach, Anaheim Bay, San Onofre, Carlsbad, and Agua Hedionda Lagoon (figure 1).

Anaheim Bay and Agua Hedionda Lagoon are bays; Hermosa Beach and Long Beach are semiprotected coastal sites; and San Onofre and Carlsbad are exposed coastal sites (M. J. Allen and Herbinson 1990). The bay sites are fully protected from offshore swells. The Hermosa Beach site is protected from swells from the south or southwest by the Palos Verdes Peninsula and offshore islands but is exposed to western swells. Southern swells occur most frequently during the summer, and western swells primarily during the winter (Maloney and Chan 1974). Thus exposure is variable but semiprotected during the period of this survey (April–September). The Long Beach site is protected from swells from the northwest, west, and southwest by the Palos Verdes Peninsula, breakwaters, and offshore islands. The San Onofre site is fully exposed to swells from the south and southwest; the Carlsbad site is exposed to swells from the west and south.

Stations at all sites were randomly sampled within blocks stratified by depth. The water depth of the blocks ranged from 0.0 to 0.8 m, 1.0 to 1.5 m, and

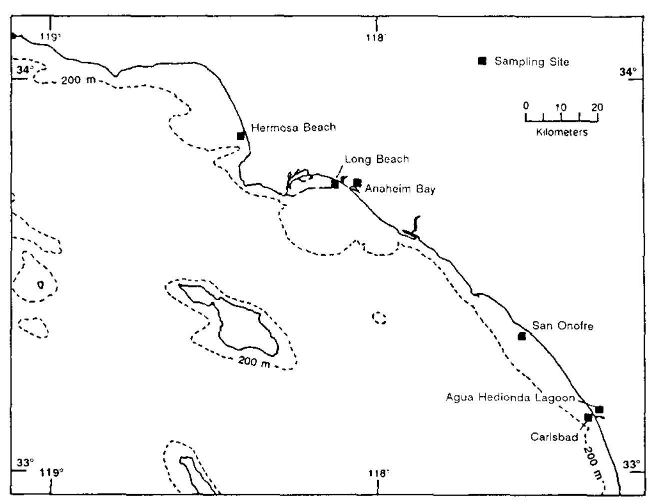

Figure 1. Locations of beam-trawl surveys in southern California, April–September 1989.

3.0 to 3.5 m in bays, and from 6 to 8 m, 8 to 11 m, and 11 to 15 m along the coast. Maps of the station locations are given in M. J. Allen and Herbinson 1990 and MBC 1990. Station coordinates are given in MBC 1990.

Sampling Methods

The fish were collected with the same nets used by Kramer (1990) and M. J. Allen and Herbinson (1990). Along the coast, samples were collected with a 1.6-m-by-0.4-m beam trawl, but in bays, a 1.0-m-by-0.3-m beam trawl was used. Both trawls were lined with 2.5-mm mesh netting. The beam trawls were equipped with a wheel and revolution counter (meter wheel), which recorded the distance trawled along the bottom. At coastal stations loran C coordinates (longitude and latitude) were recorded at the beginning and end of each haul. In the bays, 200-m trawl paths were measured and marked with buoys to separately indicate towing distance, in case the meter wheel fouled. Depth was measured with sonar at coastal sites and with a sounding line at bay sites.

Coastal trawling was done from the *Westwind*, a 14.6-m research vessel. Bay trawling at 1.0- and 3.0-m stations was done from a 5.2-m Boston whaler. At 0.5-m stations the beam trawl was pulled by two field technicians on foot.

The sites were sampled from April to September. Three 10-min (coast) or 200-m (bay) replicate hauls were attempted during daylight hours at each site's three stations, for a total of nine samples per site. Physical characteristics of each tow are given in MBC 1990.

All fish captured were retained for identification and measurement. Most were returned to the laboratory for processing, but large specimens were identified to species, measured, weighed, and released in the field. Only large debris was discarded in the field; the remaining debris and invertebrates were returned to the laboratory for closer examination. Specimens and debris samples were fixed in 10% buffered Formalin-seawater.

In the laboratory the samples were rinsed of Formalin after about a week and transferred to 70% isopropyl alcohol. Samples were then sorted to separate fish from invertebrates and debris. Fish were identified to species, measured, and weighed. The standard length (SL) of each bony fish or total length (TL) of each cartilaginous fish was measured to the nearest millimeter. For abundant species, subsamples of up to 200 fish were measured. Each species in a sample was weighed on a Mettler balance to the nearest 0.01 g.

After the last haul at each station, near-bottom water samples were collected with Van Dorn bottles. Temperature and hydrogen ion concentration (pH) of these samples were measured in the field with a Horiba analyzer. Station values are given in MBC 1990.

Data Analysis

The bottom area actually sampled in each tow was calculated from meter wheel readings or distances measured in the field. When fouling had occurred or the meter wheel reading was obviously too low, the distance traveled was estimated. This estimate was 200 m in bays and 315 m along the coast. The coastal estimate was based on the average distance attained by all "good" tows. The area sampled was computed as the product of the distance towed and the width of the trawl — 1.0 m for bays and 1.6 m for the coast. Estimated areas for replicates with extremely low readings were 200 m^2 for bays and 504 m^2 for the coast.

Fish catch parameters were summarized for number of individuals, density (number of individuals per hectare), biomass, standing crop (biomass per hectare), numbers of species, and Shannon-Wiener diversity (H'). The equation for H' is

$$H' = -\sum_{j=1}^{S} \frac{n_j}{N} \ln \frac{n_j}{N}$$

where n_j = number of individuals in the j^{th} species; S = total number of species; and N = number of individuals. H' is an index of the relative distribution of individuals among species but is also influenced by the number of species.

Catch parameters were summarized by habitat (bay, semiprotected coast, exposed coast), site, depth, and month. Frequency of occurrence, abundance, density, biomass, and standing crop were summarized for all species by habitat. Mean lengths and length ranges were summarized for each species. A complete summary is given in MBC 1990.

RESULTS

Sampling Effort

From April to September 1989, 36 to 52 trawl samples were taken each month, for a total of 288 samples. All stations were sampled, but fewer than three replicates were obtained at some stations because of fouling by algae or sand. Totals of 190 samples were collected along the coast and 98 in the bays;

of the coastal samples, 95 were collected at semiprotected and 95 at exposed stations. From 47 to 50 samples were collected at each site, 29 to 35 at each depth in the bays, and 60 to 64 at each depth along the coast.

Physical Oceanography

Means and ranges of temperatures and pH by month for bay and coastal habitats are given in M. J. Allen and Herbinson (1990). Temperatures ranged from 13.8° to 24.7°C and were always greater in bays than on the coast. Temperatures and pH by station and survey are given in MBC 1990.

Spatial and Temporal Variation of Catch Parameters

Entire survey. A total of 48,994 fish, weighing 243.3 kg and representing 72 species was collected. On average, 170 fish (SD = 464), 0.8 kg (SD = 1.2 kg), and 7 species (SD = 3) were taken per replicate; mean H' per replicate was 1.05 (SD = 0.49). Mean fish density for the entire survey was 6,289 individuals/ha (SD = 22,850 individuals/ha); mean standing crop was 19 kg/ha (SD = 24 kg/ha).

Habitat. Fish density was about five times greater in the bays than along the coast. In bays, the mean density was 13,346 fish/ha (SD = 37,453 fish/ha), whereas along the coast it was 2,649 fish/ha (SD = 5,309 fish/ha). Mean density in the bays was about four times greater than along the semiprotected coast (3,310 fish/ha; SD = 7,067 fish/ha) and seven times greater than along the exposed coast (1,988 fish/ha; SD = 2,355 fish/ha) (figure 2). Along the coast, the mean density was about 1.5 times greater in the semiprotected habitat than in the exposed habitat.

The mean standing crop of fish along the coast (23 kg/ha; SD = 26) was about twice as great as in the bays (11 kg/ha; SD = 16 kg/ha). The mean standing crop on the semiprotected coast (27 kg/ha; SD = 25 kg/ha) was about 1.4 times that of the exposed coast (19 kg/ha; SD = 27 kg/ha) and 2.5 times that of the bays (figure 2).

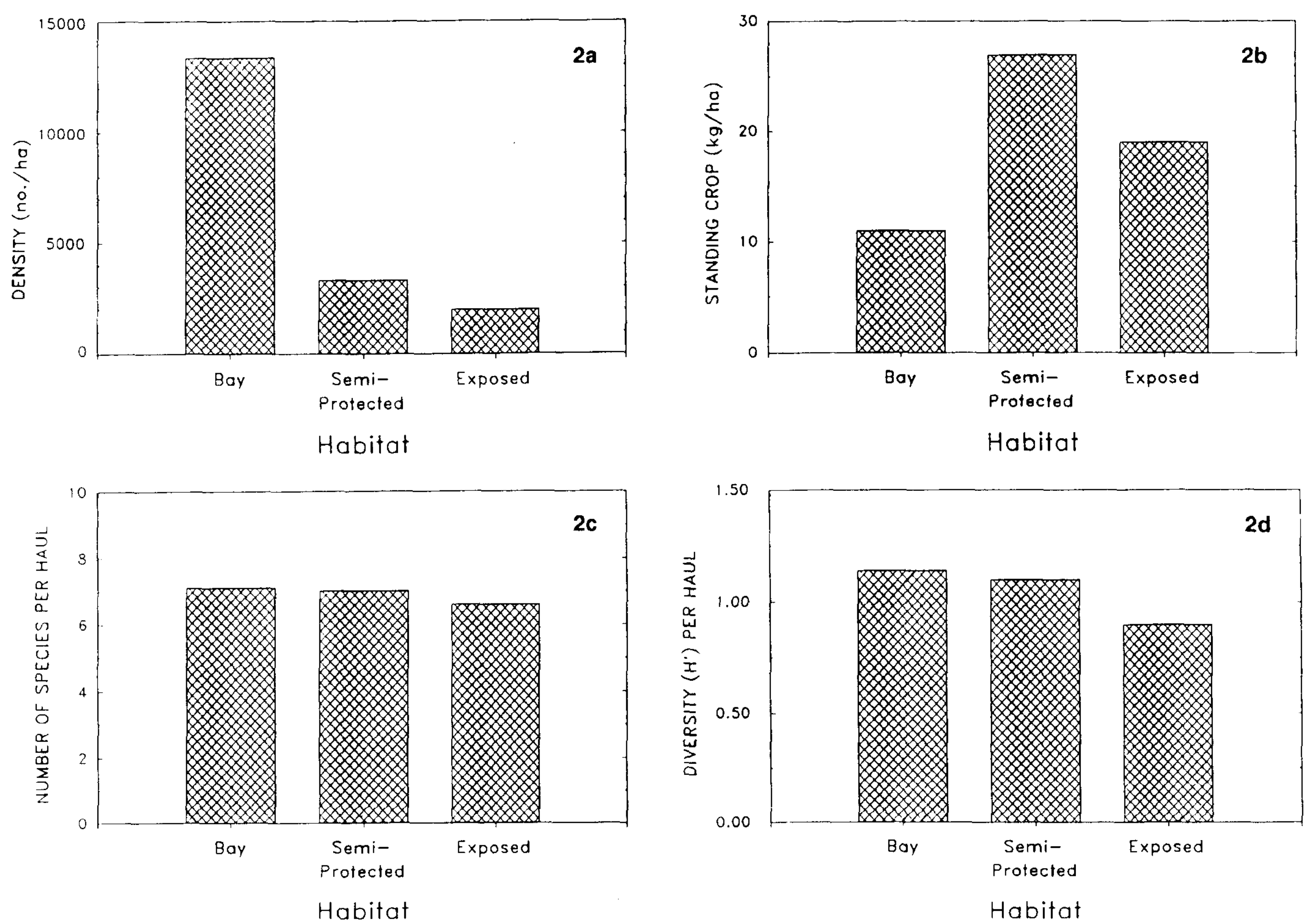

Figure 2. Variation in catch parameters from beam-trawl surveys of the southern California coast, April–September 1989, by habitat: *a*, density; *b*, standing crop; *c*, species richness; *d*, Shannon diversity.

Sixty species were taken along the coast and 43 in the bays; 48 were collected on the exposed coast and 44 on the semiprotected coast. However, the mean number of species per haul ranged from 6.6 (SD = 3.2) on the exposed coast to 7.1 (SD = 2.8) in bays (figure 2). Mean H' per haul for bays was 1.14 (SD = 0.54), and that for the coast was 1.00 (SD = 0.46). The mean H' for the semiprotected coast (1.10/haul; SD = 0.47/haul) was similar to that of bays (figure 2); both were somewhat higher than that of the exposed coast (0.90/haul; SD = 0.42/haul).

In summary, fish density decreased from bays to exposed coast. Standing crop was highest on the semiprotected coast and lowest in bays. Mean numbers of species and diversity were similarly high in bays and semiprotected coasts and were slightly lower on exposed coasts.

Site. Fish density was about twelve times greater in Anaheim Bay than at San Onofre, the site with the lowest density (figure 3); at Anaheim Bay the mean density was 23,121 fish/ha (SD = 51,436), whereas at San Onofre the density was 1,913 fish/ha (SD = 2,834). Densities were moderately low at Long Beach and Agua Hedionda Lagoon, and were very low at Carlsbad and Hermosa Beach.

Fish standing crop was about three times greater at Hermosa Beach than at Agua Hedionda Lagoon (figure 3); at Hermosa Beach, mean standing crop was 32 kg/ha (SD = 26 kg/ha), whereas at Agua Hedionda Lagoon it was 10 kg/ha (SD = 13 kg/ha). Standing crop was moderate at Carlsbad and Long Beach, but low at San Onofre and Anaheim Bay.

The number of species taken per site ranged from 28 at Long Beach to 40 at San Onofre. The mean number of species per haul ranged from 4.6 (SD = 3.4) at San Onofre to 7.0 at Carlsbad (SD = 3.6) and Hermosa Beach (SD = 2.2) (figure 3). Numbers of species were also high at Anaheim Bay and Agua Hedionda Lagoon, but were moderate at Long Beach. Mean H' per haul ranged from 0.79 (SD = 0.41) at San Onofre to 1.36 (SD = 0.46) at Agua Hedionda Lagoon (figure 3). H' was relatively low

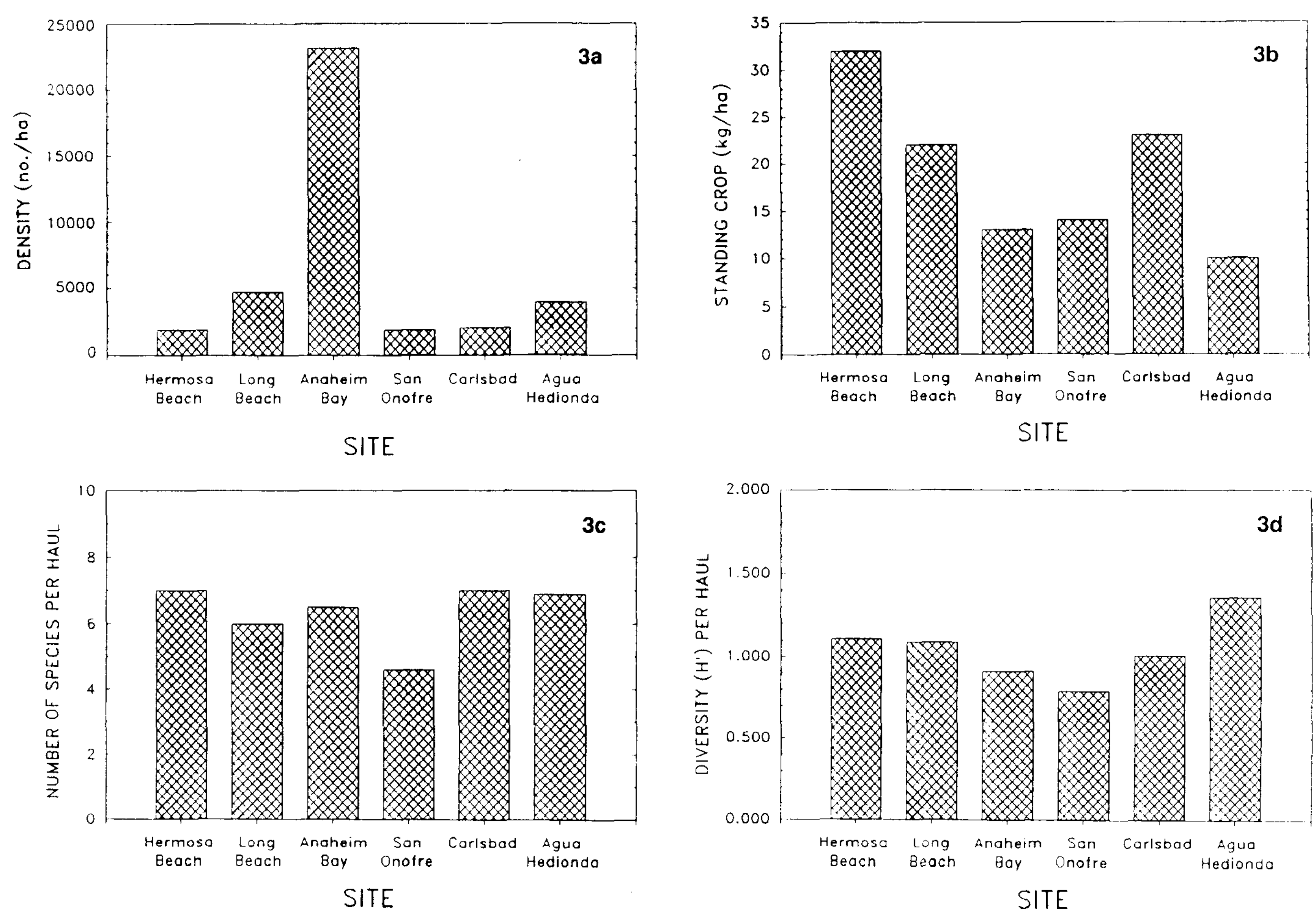

Figure 3. Variation in catch parameters from beam-trawl surveys of the southern California coast, April–September 1989, by survey site: *a*, density; *b*, standing crop; *c*, species richness; *d*, Shannon diversity.

at Anaheim Bay and moderate at the other coastal sites.

In summary, fish density was much greater at Anaheim Bay than at the other sites, which had similar low densities. Standing crop was highest at Hermosa Beach and other coastal sites, but was low in the two bays. Number of species and diversity were low at San Onofre but high at Agua Hedionda Lagoon. Carlsbad and Hermosa Beach had the highest mean number of species.

Depth. Fish density generally decreased with increasing depth (figure 4). The mean density at 0.5 m (29,265 fish/ha; SD = 59,800 fish/ha) was about 26 times greater than at 13.0 m (1,139 fish/ha; SD = 1,000) and 3.5 times greater than at 1.0 m (8,258 fish/ha; SD = 9,851), the depth with the next highest density. In turn, the mean density at 1.0 m was about seven times greater than that at 13.0 m. The density at 3.0 m was lower than that at 6.0 and 10.0 m.

Standing crop generally increased with depth (figure 4). Mean standing crop at 13.0 m (25.9 kg/ha; SD = 28.0 kg/ha) was about five times greater than at 0.5 m (4.9 kg/ha; SD = 3.9). The standing crop at 10.0 m was less than that at 6.0 m.

The mean number of species per haul ranged from 8.2 (SD = 2.8) at 1.0 m, to 5.6 (SD = 2.6) at 13.0 m (figure 4). Mean H' per haul ranged from 0.83 (SD = 0.51) at 0.5 m to 1.44 (SD = 0.33) at 3.0 m. No obvious depth-related trend was apparent for number of species or for diversity.

In summary, fish density decreased with increasing depth, and standing crop increased with depth. Number of species and diversity per haul showed no depth-related trends.

Month. Mean fish density in May (18,206 fish/ha; SD = 52,887) was about 6.5 times higher than in September (2,811 fish/ha; SD = 3,542 fish/ha). Densities in June and July were only slightly higher than in the other months, including September (figure 5).

The mean standing crop in August (23 kg/ha; SD = 37) was about three times greater than in April (8

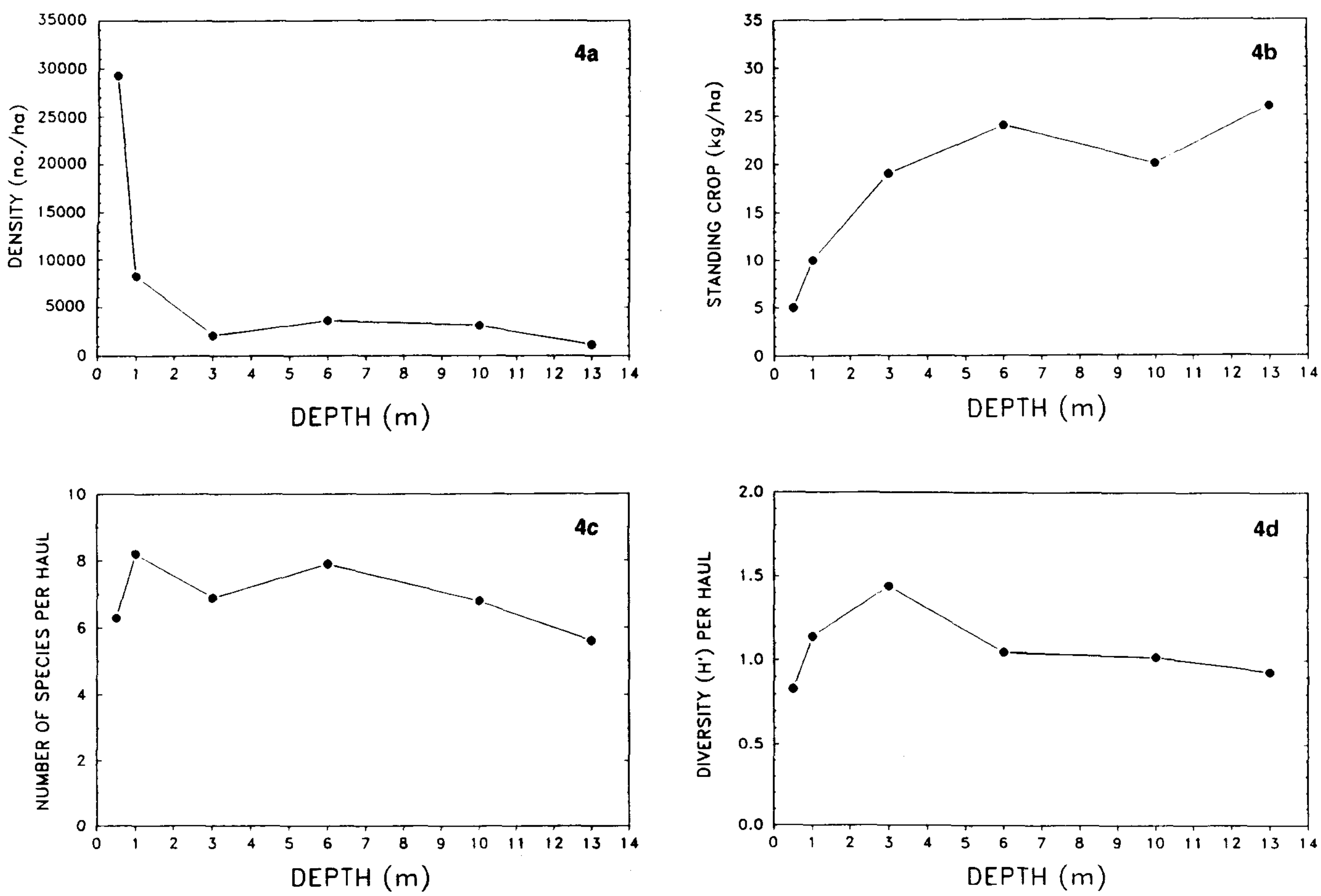

Figure 4. Variation in catch parameters from beam-trawl surveys of the southern California coast, April–September 1989, by water depth: *a*, density; *b*, standing crop; *c*, species richness; *d*, Shannon diversity.

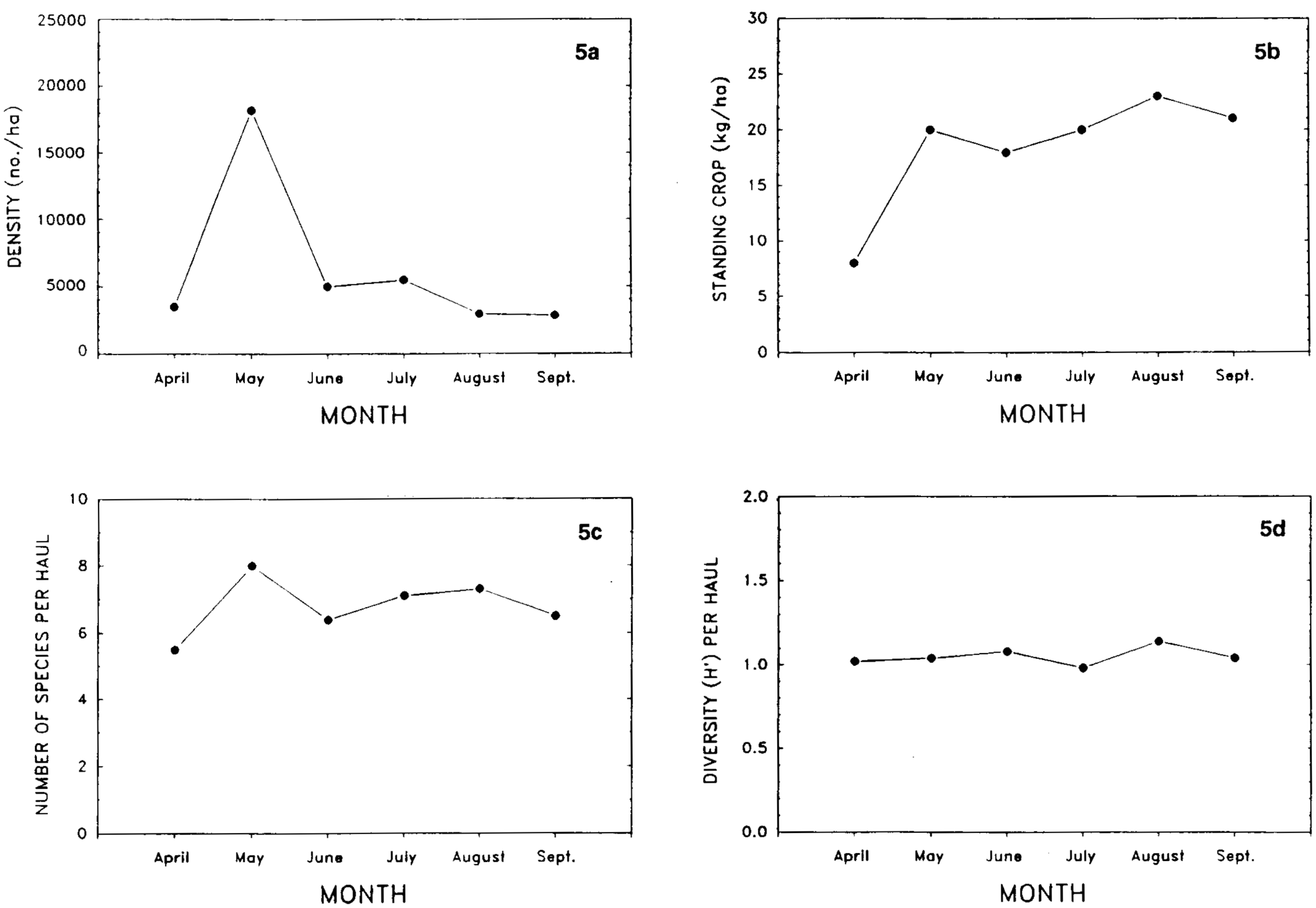

Figure 5. Variation in catch parameters from beam-trawl surveys of the southern California coast, April–September 1989, by month: *a*, density; *b*, standing crop; *c*, species richness; *d*, Shannon diversity.

kg/ha; SD = 10). The standing crop was high from May to September (figure 5).

The mean number of species per haul ranged from 5.5 (SD = 2.4) in April to 8.1 (SD = 2.9) in May. Numbers of species per haul were moderate from June to September. The mean diversity per replicate showed little monthly variation, ranging from 0.98 (SD = 0.42) in July to 1.14 (SD = 0.47) in August (figure 5).

In summary, fish densities were much higher in May than in other months. Standing crop was much lower in April than in other months. Number of species showed no obvious monthly trend, and diversity showed little monthly variation.

Composition of Catch

Taxonomic composition. The 72 species of fish collected represented two classes and 30 families (table 1). Bony fishes (Osteichthyes) were represented by 24 families and 65 species; cartilaginous fishes (Elasmobranchiomorphi) were represented by 6 families and 7 species. The most diverse families were the Syngnathidae (pipefishes), Embiotocidae (surfperches), Gobiidae (gobies), and Pleuronectidae (righteye flounders), with 6 species each.

Frequency of occurrence. Eleven species occurred in 20% or more of the 288 samples (table 2). Overall, speckled sanddab (*Citharichthys stigmaeus*) and California halibut were the only species that were found in more than 50% of the samples; speckled sanddab occurred in 60% of the samples and California halibut in 55%. However, species occurrence differed between bay and coastal habitats (table 2). Four species occurred in 50% or more of the bay samples: cheekspot goby (*Ilypnus gilberti*), bay pipefish (*Syngnathus leptorhynchus*), giant kelpfish (*Heterostichus rostratus*), and California halibut. Three species occurred in 50% or more of the coast samples: speckled sanddab, spotted turbot (*Pleuronichthys ritteri*), and California halibut.

TABLE 1
Common and Scientific Names of Fishes Captured during Beam-Trawl Surveys off Southern California at Depths of 0.5 to 13.0 m, April–September 1989

Taxon	Common name
Elasmobranchiomorphi	
Carcharhinidae	
Mustelus californicus	gray smoothhound
Torpedinidae	
Torpedo californica	Pacific electric ray
Rhinobatidae	
Platyrhinoidis triseriata	thornback
Rhinobatos productus	shovelnose guitarfish
Rajidae	
Raja inornata	California skate
Dasyatidae	
Gymnura marmorata	California butterfly ray
Urolophidae	
Urolophus halleri	round stingray
Osteichthyes	
Engraulidae	
Engraulis mordax	northern anchovy
Synodontidae	
Synodus lucioceps	California lizardfish
Ophidiidae	
Ophidion scrippsae	basketweave cusk-eel
Batrachoididae	
Porichthys myriaster	specklefin midshipman
Porichthys notatus	plainfin midshipman
Gobiesocidae	
Gobiesox rhessodon	California clingfish
Rimicola eigenmanni	slender clingfish
Rimicola muscarum	kelp clingfish
Cyprinodontidae	
Fundulus parvipinnis	California killifish
Atherinidae	
Atherinops affinis	topsmelt
Syngnathidae	
Cosmocampus (= Bryx) arctus	snubnose pipefish
Syngnathus auliscus	barred pipefish
Syngnathus californiensis	kelp pipefish
Syngnathus euchrous	chocolate pipefish
Syngnathus exilis	barcheek pipefish
Syngnathus leptorhynchus	bay pipefish
Scorpaenidae	
Scorpaena guttata	California scorpionfish
Cottidae	
Icelinus quadriseriatus	yellowchin sculpin
Leptocottus armatus	Pacific staghorn sculpin
Orthonopias triacis	snubnose sculpin
Scorpaenichthys marmoratus	cabezon
Agonidae	
Agonopsis sterletus	southern spearnose poacher
Cyclopteridae	
Liparis mucosus	slimy snailfish
Serranidae	
Paralabrax clathratus	kelp bass
Paralabrax maculatofasciatus	spotted sand bass
Paralabrax nebulifer	barred sand bass
Haemulidae	
Anisotremus davidsonii	sargo
Xenistius californiensis	salema
Sciaenidae	
Atractoscion nobilis	white seabass
Cheilotrema saturnum	black croaker
Genyonemus lineatus	white croaker
Menticirrhus undulatus	California corbina
Seriphus politus	queenfish
Kyphosidae	
Girella nigricans	opaleye
Embiotocidae	
Brachyistius frenatus	kelp perch
Cymatogaster aggregata	shiner perch
Embiotoca jacksoni	black perch
Hyperprosopon argenteum	walleye surfperch
Micrometrus minimus	dwarf perch
Phanerodon furcatus	white seaperch
Labridae	
Oxyjulis californica	senorita
Clinidae	
Gibbonsia elegans	spotted kelpfish
Gibbonsia metzi	striped kelpfish
Heterostichus rostratus	giant kelpfish
Blenniidae	
Hypsoblennius gentilis	bay blenny
Hypsoblennius gilberti	rockpool blenny
Hypsoblennius jenkinsi	mussel blenny
Gobiidae	
Acanthogobius flavimanus	yellowfin goby
Clevelandia ios	arrow goby
Gillichthys mirabilis	longjaw mudsucker
Ilypnus gilberti	cheekspot goby
Lepidogobius lepidus	bay goby
Quietula y-cauda	shadow goby
Bothidae	
Citharichthys stigmaeus	speckled sanddab
Citharichthys xanthostigma	longfin sanddab
Hippoglossina stomata	bigmouth sole
Paralichthys californicus	California halibut
Xystreurys liolepis	fantail sole
Pleuronectidae	
Hypsopsetta guttulata	diamond turbot
Pleuronectes (= Parophrys) vetulus	English sole
Pleuronichthys coenosus	C-O sole
Pleuronichthys decurrens	curlfin sole
Pleuronichthys ritteri	spotted turbot
Pleuronichthys verticalis	hornyhead turbot
Soleidae (= Cynoglossidae)	
Symphurus atricauda	California tonguefish

Common and scientific names follow Robins et al. 1991.

Thirty species were found in both bay and coastal habitats. The most common of these were California halibut, spotted turbot, and cheekspot goby. Thirty species occurred only along the coast: the three most common were speckled sanddab, hornyhead turbot (*Pleuronichthys verticalis*), and thornback (*Platyrhinoidis triseriata*). Twelve species occurred only in the bays. The three most common of these were bay pipefish, topsmelt (*Atherinops affinis*), and bay blenny (*Hypsoblennius gentilis*).

Species abundance and density. Twelve species accounted for 95% of the total catch (table 3). Topsmelt, queenfish (*Seriphus politus*), cheekspot goby, and white croaker (*Genyonemus lineatus*) together accounted for 76% of the catch. Topsmelt constituted 56% of the bay catch, whereas queenfish and white

TABLE 2
Species Occurring in 20% or More of Beam-Trawl Samples Taken off Southern California, April–September 1989

		Frequency of occurrence (%)		
		Bay	Coast	Total
Species	Common name	(n = 98)	(n = 190)	(n = 288)
Citharichthys stigmaeus	speckled sanddab	0	91	60
Paralichthys californicus	California halibut	53	56	55
Pleuronichthys ritteri	spotted turbot	16	66	49
Ilypnus gilberti	cheekspot goby	67	33	45
Seriphus politus	queenfish	11	44	33
Heterostichus rostratus	giant kelpfish	58	17	31
Pleuronichthys verticalis	hornyhead turbot	0	42	28
Leptocottus armatus	Pacific staghorn sculpin	46	17	27
Genyonemus lineatus	white croaker	4	36	25
Syngnathus leptorhynchus	bay pipefish	65	0	22
Engraulis mordax	northern anchovy	2	29	20

n = number of samples
See MBC 1990 for complete listing of species.

TABLE 3
Fish Species Accounting for 95% of the Total Fish Taken by Beam Trawl in Bay and Coastal Habitats of Southern California, April–September 1989

		Number of fish					(%)	
			Coast					
Species	Common name	Bay	Semiprotected	Exposed	Total	Study total	Total	Cum.*
Atherinops affinis	topsmelt	13,759	0	0	0	13,759	28	28
Seriphus politus	queenfish	84	4,142	4,771	8,913	8,997	18	46
Ilypnus gilberti	cheekspot goby	6,959	285	65	350	7,309	15	61
Genyonemus lineatus	white croaker	17	6,666	517	7,183	7,200	15	76
Citharichthys stigmaeus	speckled sanddab	0	1,640	2,599	4,239	4,239	9	85
Engraulis mordax	northern anchovy	2	928	843	1,771	1,773	4	88
Paralichthys californicus	California halibut	305	348	109	457	762	2	90
Syngnathus leptorhynchus	bay pipefish	747	0	0	0	747	2	91
Leptocottus armatus	Pacific staghorn sculpin	604	6	59	65	669	1	93
Pleuronichthys ritteri	spotted turbot	25	409	68	477	502	1	94
Heterostichus rostratus	giant kelpfish	338	20	30	50	388	1	95
Clevelandia ios	arrow goby	372	1	0	1	373	1	95

*Cumulative
See MBC 1990 for complete listing of species abundances.

croaker together made up 65% of the coastal catch. White croaker and queenfish constituted 72% of the catch from the semiprotected coast; queenfish were 50% of the catch from the exposed coast.

The species with the greatest overall densities were topsmelt, cheekspot goby, and queenfish, with means of 2,575, 1,243, and 701 fish/ha. However, topsmelt did not occur on the coast. In bays, the species with the greatest densities were topsmelt, cheekspot goby, and bay pipefish (table 4). On the semiprotected coast, the three dominant species were white croaker, queenfish, and speckled sanddab. On the exposed coast, the three dominant species were queenfish, speckled sanddab, and northern anchovy (*Engraulis mordax*).

Among the 11 species with mean densities of 50 fish/ha or greater, topsmelt and bay pipefish were found only in bays, and speckled sanddab only along the coast. Speckled sanddab were more abundant on the exposed coast than on the semiprotected coast. Of species found in both bay and coastal habitats, 5 were most abundant in bays. These were cheekspot goby, Pacific staghorn sculpin (*Leptocottus armatus*), California halibut, arrow goby (*Clevelandia ios*), and giant kelpfish. Of these, cheekspot goby, California halibut, and arrow goby were next most abundant on the semiprotected coast, whereas Pacific staghorn sculpin and giant kelpfish were next most abundant on the exposed coast. Three species (queenfish, white croaker, and northern anchovy) were most abundant along the coast. All had highest densities on the semiprotected coast, followed by the exposed coast, and then bays.

Species biomass and standing crop. Twenty species accounted for 95% of the total fish biomass catch in the study (table 5). Spotted turbot, California halibut, hornyhead turbot, and thornback together accounted for 56% of the biomass. Spotted sand bass

TABLE 4
Top Ten Species by Density in Habitats Sampled by Beam Trawl off Southern California, April–September 1989

			Density (no./ha)	
Rank	Species	Common name	Mean	SD
Bay			(n = 98)	
1	*Atherinops affinis*	topsmelt	7,726	35,150
2	*Ilypnus gilberti*	cheekspot goby	3,653	6,629
3	*Syngnathus leptorhynchus*	bay pipefish	408	744
4	*Leptocottus armatus*	Pacific staghorn sculpin	333	873
5	*Clevelandia ios*	arrow goby	211	813
6	*Heterostichus rostratus*	giant kelpfish	187	262
7	*Paralichthys californicus*	California halibut	158	275
8	*Paralabrax clathratus*	kelp bass	120	365
9	*Paralabrax nebulifer*	barred sand bass	114	226
10	*Paralabrax maculatofasciatus*	spotted sand bass	61	116
Semiprotected coast			(n = 95)	
1	*Genyonemus lineatus*	white croaker	1,354	6,111
2	*Seriphus politus*	queenfish	1,050	3,324
3	*Citharichthys stigmaeus*	speckled sanddab	320	399
4	*Engraulis mordax*	northern anchovy	209	941
5	*Paralichthys californicus*	California halibut	94	184
6	*Pleuronichthys ritteri*	spotted turbot	81	82
7	*Ilypnus gilberti*	cheekspot goby	61	113
8	*Symphurus atricauda*	California tonguefish	24	41
9	*Pleuronichthys verticalis*	hornyhead turbot	22	25
10	*Syngnathus exilis*	barcheek pipefish	11	34
Exposed coast			(n = 95)	
1	*Seriphus politus*	queenfish	1,008	2,120
2	*Citharichthys stigmaeus*	speckled sanddab	555	646
3	*Engraulis mordax*	northern anchovy	136	441
4	*Genyonemus lineatus*	white croaker	104	284
5	*Paralichthys californicus*	California halibut	25	44
6	*Syngnathus exilis*	barcheek pipefish	25	46
7	*Pleuronichthys ritteri*	spotted turbot	15	22
8	*Pleuronectes vetulus*	English sole	14	37
9	*Ilypnus gilberti*	cheekspot goby	14	32
10	*Pleuronichthys verticalis*	hornyhead turbot	13	27

n = number of samples
See MBC 1990 for complete listing of fish densities by habitat.

TABLE 5
Fish Species Constituting 95% of the Fish Biomass Taken by Beam Trawl off Southern California, April–September 1989

		Biomass (kg)					(%)	
			Coast					
Species	Common name	Bay	Semiprotected	Exposed	Total	Study total	Total	Cum.*
Pleuronichthys ritteri	spotted turbot	0.5	49.8	10.2	60.0	60.5	25	25
Paralichthys californicus	California halibut	0.9	20.8	15.9	36.7	37.7	15	40
Pleuronichthys verticalis	hornyhead turbot	0.0	14.3	5.7	20.1	20.1	8	49
Platyrhinoidis triseriata	thornback	0.0	5.7	12.9	18.6	18.6	8	56
Citharichthys stigmaeus	speckled sanddab	0.0	3.5	11.8	15.3	15.3	6	63
Gymnura marmorata	California butterfly ray	0.0	0.0	11.4	11.4	11.4	5	67
Hypsopsetta guttulata	diamond turbot	1.5	6.1	1.5	7.6	9.2	4	71
Torpedo californica	Pacific electric ray	0.0	6.8	0.0	6.8	6.8	3	74
Xystreurys liolepis	fantail sole	0.0	4.1	2.3	6.4	6.4	3	76
Porichthys myriaster	specklefin midshipman	0.0	6.2	0.0	6.3	6.3	3	79
Heterostichus rostratus	giant kelpfish	4.5	0.5	0.3	0.8	5.4	2	81
Paralabrax maculatofasciatus	spotted sand bass	5.2	0.0	0.0	0.0	5.2	2	83
Urolophus halleri	round stingray	1.4	1.8	1.8	3.6	5.0	2	85
Genyonemus lineatus	white croaker	0.0	4.5	0.2	4.7	4.7	2	87
Citharichthys xanthostigma	longfin sanddab	0.0	0.0	4.0	4.0	4.0	2	89
Scorpaena guttata	California scorpionfish	0.0	1.5	2.2	3.7	3.7	2	90
Leptocottus armatus	Pacific staghorn sculpin	1.5	0.1	1.7	1.8	3.3	1	92
Symphurus atricauda	California tonguefish	0.0	2.8	0.5	3.2	3.2	1	93
Rhinobatos productus	shovelnose guitarfish	0.0	0.5	2.7	3.2	3.2	1	94
Synodus lucioceps	California lizardfish	0.0	0.8	0.9	1.7	1.7	1	95

*Cum. = cumulative
See MBC 1990 for complete list of species.

(*Paralabrax maculatofasciatus*), giant kelpfish, and diamond turbot (*Hypsopsetta guttulata*) constituted 54% of the bay biomass. Spotted turbot, California halibut, and hornyhead turbot as a group accounted for 53% of the coastal biomass. Spotted turbot and California halibut accounted for 53% of the biomass on the semiprotected coast, whereas California halibut, thornback, speckled sanddab, and California butterfly ray (*Gymnura marmorata*) constituted 58% of the exposed-coast biomass.

Spotted turbot, California halibut, and thornback had the greatest overall standing crops, with means of 4.1, 2.9, and 1.4 kg/ha. In bays, the species with the greatest standing crops were the spotted sand bass, giant kelpfish, and Pacific staghorn sculpin (table 6). On the semiprotected coast, the three dominant species were spotted turbot, California halibut, and hornyhead turbot. On the exposed coast, the three dominant species were the California halibut, thornback, and speckled sanddab.

Among the 10 species with mean standing crops of 0.5 kg/ha or greater overall, spotted sand bass was found only in the bays, whereas thornback, hornyhead turbot, speckled sanddab, and California butterfly ray were found only along the coast; thornback, speckled sanddab, and California butterfly ray had highest standing crops on the exposed coast, and hornyhead turbot on the semiprotected coast. Of species collected in both bay and coastal habitats, three (spotted turbot, California halibut, and diamond turbot) had highest standing crops on the semiprotected coast. Spotted turbot and California halibut had next highest standing crops on the exposed coast, whereas diamond turbot had its next highest standing crop in bays. Giant kelpfish and round stingray (*Urolophus halleri*) had highest standing crops in bays; giant kelpfish was next highest on the semiprotected coast; and round stingray was next highest on the exposed coast.

Length. Fish collected in the study ranged in

TABLE 6
Top Ten Fish Species by Standing Crop in Habitats Sampled by Beam Trawl off Southern California, April–September 1989

Rank	Species	Common name	Standing crop (kg/ha) Mean	SD
Bay			(n = 98)	
1	*Paralabrax maculatofasciatus*	spotted sand bass	2.8	8.8
2	*Heterostichus rostratus*	giant kelpfish	2.5	6.0
3	*Leptocottus armatus*	Pacific staghorn sculpin	0.8	1.6
4	*Hypsopsetta guttulata*	diamond turbot	0.8	2.1
5	*Urolophus halleri*	round stingray	0.7	3.8
6	*Embiotoca jacksoni*	black perch	0.6	3.4
7	*Paralabrax clathratus*	kelp bass	0.6	1.7
8	*Paralichthys californicus*	California halibut	0.5	1.3
9	*Paralabrax nebulifer*	barred sand bass	0.4	0.9
10	*Atherinops affinis*	topsmelt	0.2	1.0
Semiprotected coast			(n = 95)	
1	*Pleuronichthys ritteri*	spotted turbot	9.8	11.2
2	*Paralichthys californicus*	California halibut	4.8	9.0
3	*Pleuronichthys verticalis*	hornyhead turbot	2.5	4.2
4	*Platyrhinoidis triseriata*	thornback	1.4	5.2
5	*Porichthys myriaster*	specklefin midshipman	1.4	4.2
6	*Torpedo californica*	Pacific electric ray	1.3	12.2
7	*Hypsopsetta guttulata*	diamond turbot	1.2	2.7
8	*Genyonemus lineatus*	white croaker	1.0	4.2
9	*Xystreurys liolepis*	fantail sole	0.8	3.1
10	*Citharichthys stigmaeus*	speckled sanddab	0.7	0.8
Exposed coast			(n = 95)	
1	*Paralichthys californicus*	California halibut	3.3	6.1
2	*Platyrhinoidis triseriata*	thornback	2.6	5.7
3	*Citharichthys stigmaeus*	speckled sanddab	2.6	2.5
4	*Gymnura marmorata*	California butterfly ray	2.4	22.4
5	*Pleuronichthys ritteri*	spotted turbot	2.3	4.2
6	*Pleuronichthys verticalis*	hornyhead turbot	1.3	3.1
7	*Citharichthys xanthostigma*	longfin sanddab	0.8	2.6
8	*Rhinobatos productus*	shovelnose guitarfish	0.5	2.0
9	*Scorpaena guttata*	California scorpionfish	0.5	2.2
10	*Xystreurys liolepis*	fantail sole	0.4	1.3

n = number of samples
See MBC 1990 for complete listing of standing crops by habitat.

length from 3 to 810 mm. The species with the longest mean lengths were Pacific electric ray, *Torpedo californica* (one specimen only); California skate, *Raja inornata* (one specimen only); and shovelnose guitarfish, *Rhinobatos productus* (table 7). The longest individual fish in the study were a Pacific electric ray (810 mm TL); California skate (539 mm TL); and California halibut (503 mm SL). The species with the shortest mean lengths were queenfish, black croaker (*Cheilotrema saturnum*), and kelp clingfish (*Rimicola muscarum*). The smallest individual fish were larval queenfish, white croaker, and cheekspot goby, which were 3 mm long.

The three most abundant species (topsmelt, queenfish, and cheekspot goby) were dominated by 10–15-mm fish. About 21% (2,931 of 13,759) of the topsmelt were measured: they ranged from 5 to 72 mm SL, with a mean length of 15 mm (table 7) and a mode of 10 mm. Topsmelt was collected only in bays, and most of the fish measured were 10–20 mm SL. About 64% (5,761 of 8,997) of the queenfish were measured; they ranged from 3 to 64 mm SL with a mean of 11 mm. Queenfish were found in all three habitats, but more than 60% of those measured were from the exposed coast. The length-frequency distribution was similar in all three habitats, with a mode of 10 mm in each. About 72% (5,259 of 7,309) of the cheekspot goby were measured; they ranged from 3 to 50 mm SL, with a mean of 16 mm. Cheekspot goby was found in all three habitats, but about 93% of those measured were from the bays. The length-frequency distribution had a mode of 15 mm in all three habitats, but the 10-mm length-class was almost as abundant on the exposed coast.

DISCUSSION

Small otter trawls have been used for extensive studies of demersal fish assemblages along the nearshore coast and bays (L. G. Allen 1985). In general, studies were restricted to either bays or the nearshore coast. Only limited comparisons have been made between habitats. Although beam trawls were used for deeper surveys along the shelf and slope in the past (Gilbert 1896; Ulrey and Greeley 1928), they have not been used recently until the late 1980s (Kramer and Hunter 1987, 1988; L. G. Allen 1988; M. J. Allen and Herbinson 1990; Kramer 1990; MBC 1991; L. G. Allen et al., in press).

These studies have emphasized California halibut; the entire fish catch of these studies has not yet been described. However, Kramer (1990) described the flatfish catch of beam-trawl surveys along the San Diego County coast during 1987–88. Of the studies mentioned, all surveyed both bays and coast except L. G. Allen et al. (in press), which covered only the nearshore coast. Thus this study (which is a summary of the gray report, MBC 1990) is the first to examine the entire ichthyofauna of the bays and the

TABLE 7
Lengths of the Ten Largest and Smallest Fish Species Collected in Beam-Trawl Surveys off Southern California, April–September 1989

Rank	Species	Common name	Length (mm) Min.	Max.	Mean	SD	Number of fish Measured	Total
	Largest species							
1	*Torpedo californica*	Pacific electric ray	—	—	810.0	—	1	1
2	*Raja inornata*	California skate	—	—	539.0	—	1	1
3	*Rhinobatos productus*	shovelnose guitarfish	217	501	334.8	97.6	13	13
4	*Platyrhinoidis triseriata*	thornback	83	450	291.9	82.4	77	77
5	*Urolophus halleri*	round stingray	195	396	287.9	61.2	15	15
6	*Mustelus californicus*	gray smoothhound	—	—	275.0	—	1	1
7	*Menticirrhus undulatus*	California corbina	—	—	267.0	—	1	1
8	*Gymnura marmorata*	California butterfly ray	166	337	238.0	88.6	3	3
9	*Ophidion scrippsae*	basketweave cusk-eel	192	241	225.5	18.3	6	6
10	*Pleuronichthys decurrens*	curlfin sole	—	—	214.0	—	1	1
	Smallest species							
1	*Seriphus politus*	queenfish	3	64	11.3	5.5	5,761	8,997
2	*Cheilotrema saturnum*	black croaker	—	—	12.0	—	1	1
3	*Rimicola muscarum*	kelp clingfish	6.5	16	12.4	4.3	4	4
4	*Icelinus quadriseriatus*	yellowchin sculpin	11	18	13.3	4.0	3	3
5	*Liparis mucosus*	slimy snailfish	9	18	13.5	6.4	2	2
6	*Rimicola eigenmanni*	slender clingfish	—	—	14.0	—	1	1
7	*Genyonemus lineatus*	white croaker	3	208	14.7	20.8	2,411	7,200
8	*Atherinops affinis*	topsmelt	5	72	14.7	8.8	2,931	13,759
9	*Ilypnus gilberti*	cheekspot goby	3	50	15.9	3.6	5,259	7,309
10	*Atractoscion nobilis*	white seabass	5	65	16.0	15.7	22	22

Min. = minimum; Max. = maximum
See MBC 1990 for complete list of species.

nearshore coast off southern California using a beam-trawl survey.

Like any other net, a beam trawl is better suited for sampling some species and sizes of fish than others. Because of the small net mouth, beam trawls probably underestimate the density of large fish and of fast-swimming fishes. Thus actual fish densities are probably higher than the values presented here. Kramer (1990) examined the selectivity of the beam trawls used in this survey for different size classes of California halibut. The 1.0- and 1.6-m beam trawls were equally effective at capturing halibut <80 mm SL, but the 1.6-m beam trawl was better at capturing larger halibut. However, the 1.6-m beam trawl captured more halibut <200 mm SL than did a 7.6-m otter trawl. Both the 1.0- and 1.6-m beam trawls probably have collection efficiencies of near 100% for 10-mm halibut (S. H. Kramer, MBC Applied Environmental Sciences, Costa Mesa, Calif, pers. comm.). The nets are probably similarly efficient for the small fish (10–15 mm) of other species that numerically dominate the catch for this study. However, efficiencies are likely to vary by size class and mobility of each species, and net-specific selectivities have not been established.

Estuaries and bays are important nursery grounds for some species of marine fishes (Moyle and Cech 1982), with juveniles of noncommercial species dominating southern California bays (L. G. Allen 1982). Fish density in the present study was about four times greater in the bays than on the semiprotected coast, and seven times greater than on the exposed coast; however, standard deviations were large. Density also varied greatly between the two bays examined. Fish density at Anaheim Bay was about six times greater than at Agua Hedionda Lagoon, where density was only slightly lower than that at the highest coastal site (Hermosa Beach).

In contrast, fish standing crop on the semiprotected coast was about 2.5 times greater than in the bays, and 1.4 times greater than on the exposed coast. Some of this difference may be due to the inclusion of more large fish in the catch of the 1.6-m net (as indicated by Kramer 1990). But it may be that most of the difference is due to a real reduction in the standing crop of larger fish in bays. Although standing crops were generally higher at semiprotected coastal sites than at exposed sites, the standing crop at Carlsbad (an exposed site) was slightly higher than that at Long Beach (a semiprotected site). It should be noted that a single large ray or flatfish can greatly influence the standing crop estimate for an area. For instance, the single Pacific electric ray taken in this survey weighed 6.8 kg (table 5) whereas the 13,759 topsmelt collected weighed 0.4 kg (MBC 1990). Because the beam trawl is less effective at capturing large fish (Kramer 1990), the standing crop of an area is probably greatly underestimated.

Thus the bay assemblage consisted of many small fish (mostly juveniles of larger species), whereas the nearshore coastal assemblage included more large fish. Although bays are apparently the best habitat for many small fish, and the coast the best place for larger fish, the semiprotected coast had the highest combined values of density and standing crop. Protection from swells is apparently important for small and juvenile fish, whereas many larger fish or species prefer (or at least are more abundant in) exposed habitats. The coast in general and the semiprotected habitat in particular had the highest number of species; however, the number of species and diversity per haul was similar in all habitats. In general, the exposed habitat appears to be a harsher environment that is suitable primarily for larger fishes.

Fish density was much greater at 0.5-m and 1.0-m stations than at deeper stations. This was due largely to the presence of topsmelt and cheekspot goby at these depths (MBC 1990). Topsmelt were found almost exclusively at 0.5 m, and cheekspot goby were most abundant at 0.5 and 1.0 m. Because topsmelt occur primarily in the upper few centimeters of the water column, the 0.5-m stations were the only ones that consistently included this portion of the water column in the sample (the 1.0-m beam trawl had a mouth opening that was 0.3 m high). Removal of these two species from the catch would reduce the fish density in shallow water to levels found at greater depths. The low standing crops at these shallow depths suggest that depths less than 1.0 m are unsuitable for larger fish.

Fish density was much greater in May than in the other months surveyed. This was primarily because there were large densities of topsmelt and white croaker in that month. Walker et al. (1987) noted a high abundance of atherinid larvae in coastal waters off San Onofre in spring 1978–80, with lower abundances in summer. In Anaheim Bay, peak spawning of topsmelt occurs in April and May (Klingbeil et al. 1975). Thus the high abundance of newly transformed topsmelt at this time is expected. However, Walker et al. (1987) noted highest abundances of white croaker larvae in winter or early spring, before the period sampled in this study.

The ichthyofauna of this study included species that appear only in bays and only along the coast, in addition to those that occupy both habitats. The primary bay assemblage (based on frequency of occurrence) consisted of cheekspot goby, bay pipefish, giant kelpfish, and California halibut. Topsmelt had the highest density, and spotted sand bass had the highest standing crop. The primary coastal assemblage consisted of speckled sanddab, spotted turbot, and California halibut. Dominant species in the semiprotected habitat were white croaker by density and spotted turbot by standing crop. Dominant species in the exposed habitat were queenfish by density and California halibut by standing crop.

In the bays, California halibut populations consisted primarily of juveniles, whereas cheekspot goby, bay pipefish, and giant kelpfish populations included the entire size range of the species. Giant kelpfish and bay pipefish are ambushing species that are probably associated primarily with eelgrass (*Zostera marina*) beds; bay pipefish has a syringelike feeding mechanism and eats amphipods and copepods (Hart 1973), whereas giant kelpfish can eat crustaceans and fish (Feder et al. 1974). Cheekspot goby and California halibut live primarily on the bottom. Cheekspot goby prefers sandy bottoms (Brothers 1975) and feeds on small crustaceans. California halibut generally has a larger mouth and probably eats larger prey. Small halibut feed on amphipods and cumaceans (L. G. Allen 1988).

Although occurring less frequently than some species in this study, juvenile topsmelt constituted most of the fish in bays. Topsmelt are generally the most abundant bay species in southern California (L. G. Allen 1982). All topsmelt captured in this survey were age-0 fish, the largest being 72 mm SL; topsmelt measure 65–100 mm SL by the end of the first year (L. G. Allen 1980). Age-0 topsmelt feed primarily on detritus and planktonic crustaceans (Klingbeil et al. 1975).

The high standing crop of spotted sand bass indicates that the bay is an important habitat for larger juveniles and adults of this species. It is a permanent resident of bays (Dixon and Eckmayer 1975; Klingbeil et al. 1975) and a cruising generalist that eats fish and crustaceans (Feder et al. 1974).

Along the coast, the most common species were flatfishes, represented by both juveniles and adults. Speckled sanddab, the most common species, is a generalist that feeds on benthic and nektonic prey (Ford 1965; M. J. Allen 1982); spotted turbot feeds on sessile anemones and polychaetes (Luckinbill 1969); and California halibut ambushes nektonic prey (Haaker 1975; M. J. Allen 1982). Both spotted turbot (a benthic feeder) and California halibut (an ambusher) had high standing crops on the coast.

Although not common, larval and small juvenile queenfish and white croaker were the most abundant fishes captured along the coast. Larvae of both species are most abundant near the bottom in the depth range sampled in this survey (Barnett et al. 1984). The beam trawl probably underestimated the density of white croaker and queenfish because it only samples to 0.4 m above the bottom. The number caught might have been much greater if the net sampled to 1.0 m above the bottom. Larvae and juveniles of these species probably eat copepods.

The cheekspot goby and California halibut were relatively abundant in both bay and coastal habitats; along the coast they were most abundant in semiprotected coastal areas. The cheekspot goby apparently does not occur widely in Anaheim Bay, being found primarily near the entrance (Klingbeil et al. 1975). In this study it was most abundant in enclosed bays but was moderately abundant in southeastern Santa Monica Bay at Hermosa Beach, a semiprotected coastal habitat (MBC 1990). Larvae of this species are known to be abundant along the nearshore coast (Barnett et al. 1984), but benthic juveniles have not been previously reported from the coast.

Although small juvenile California halibut are generally most abundant in bays (Haaker 1975; L. G. Allen 1988; M. J. Allen and Herbinson 1990; Kramer 1990), relatively high densities are sometimes found in southeastern Santa Monica Bay (M. J. Allen and Herbinson 1990; L. G. Allen et al., in press). Cheekspot gobies are considered to be an important food for juvenile halibut in bays (Drawbridge 1990). The absence of these gobies along the coast has been suggested as a possible reason for poor survival of juvenile California halibut on the coast (Kramer 1990). The relatively high coastal densities of these typical bay forms in southeastern Santa Monica Bay suggest that this semiprotected region shares some characteristics of the enclosed embayments of southern California. Because natural semiprotected coasts are rare along the mainland of southern California, the physical environment and microichthyofauna of southeastern Santa Monica Bay should be studied further. As bay and lagoon habitats of southern California become depleted, semiprotected coastal habitats may become increasingly important as alternative nursery grounds for some species.

Soft-bottom habitats along the coast generally do not have attached algae or seagrasses. However, eelgrass is often abundant in bays. As noted above, some bay species (e.g., giant kelpfish, bay pipefish) were probably associated with eelgrass beds. Along the coast, the dominant vegetation on soft bottoms is drift algae, consisting largely of red algae and kelp. Beds of drift algae are often extensive along the bottom of the nearshore coast, but they are only temporary. Along the coast, barcheek pipefish (*Syngnathus exilis*) was the primary species associated with drift-algae beds. But these beds probably provide cover for many transforming juveniles of other species, including white seabass, *Atractoscion nobilis* (L. G. Allen and Franklin 1988; Donoho 1990). Thus coastal drift-algae beds are a potentially important nearshore habitat on soft bottoms, and warrant further examination.

CONCLUSIONS

A beam-trawl survey of the southern California coast indicated that bay and nearshore coastal soft-bottom habitats differ in fish densities, standing crops, and species composition; semiprotected coastal habitats share some biological and physical attributes of bay and exposed coastal habitats.

Fish density decreased from bays to the exposed coast; however, standing crops were highest in semiprotected coastal areas and lowest in bays.

Fish density decreased with increasing depth, whereas standing crops increased with increasing depth; high densities at 0.5 and 1.0 m were primarily due to high densities of topsmelt and cheekspot goby.

Although standing crops increased from May to September, density was much higher in May than in any other month, because of large numbers of juvenile topsmelt and white croaker.

The ichthyofauna generally consisted of species that were characteristic of either bay or coastal habitats, but some species occurred in both areas; some coastal species were substantially more abundant in semiprotected habitats, whereas others were more abundant in exposed habitats.

In constrast to coastal fishes, bay fishes were typically small. Several species were probably associated with eelgrass beds. Drift-algae beds along the coast probably provide cover for newly transformed juveniles of some species.

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