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PHOTOGRAPHIC SURVEY OF BENTHIC FISH AND INVERTEBRATE COMMUNITIES IN SANTA MONICA BAY

Many techniques are available for determining what organisms live on the sea floor beyond diver depths. Trawls, grabs, and dredges are useful for determining what species are present and learning something about their relative abundances. However, the use of these devices does not provide scientists with a complete picture of where animals live relative to one another or what their habitats really look like. Moreover, such devices cannot be used in rocky areas. Even when they are used in softbottom areas, some animals, such as large fast-swimming fishes or attached sea pens, are able to avoid capture. Finally, moderately expensive vessels rigged with winches and staffed by a busy group of technicians are required to collect and process samples, and it is often many weeks or months before data is in a useful form. We think photography can increase our understanding of the abundance and distribution of marine life.

During the past several years, Project staff members have used a baited camera to survey marine life at depths ranging from 10 to 700 m throughout the Los Angeles-Orange County coastal area. The principal objective of the work reported here was to determine whether or not benthic habitats and the abundance and distribution of conspicuous benthic fishes and invertebrates can be sufficiently described using photography. Our specific objectives were to (1) use underwater photgraphy to describe the macrofauna at a number of stations in Santa Monica Bay; (2) compare these data to data collected by other methods (trawl and hook and line fishing); and (3) determine the abundance and diversity of conspicuous marine organisms at rocky locations that we are not able to sample by trawls or grabs.

During 1978 and 1979, we used a baited camera to survey 61 stations throughout Santa Monica Bay. From the resulting slides, we were able to describe the distribution of 68 conspicuous species of fishes and invertebrates and found that although all species had previously been captured by trawls, larger organisms were more abundant than previously thought. The number of species recorded and abundance estimates were definitely a function of bottom visibility, which increased with depth. Despite this, we found a considerable amount of marine life in rocky habits that have not been sampled by trawls or grabs. Our data suggests that, in deep water (100 m), there are twice as many species and four times as many individuals of fish over rocky-bottom areas than on soft-bottom sediments.

METHODS

Our system is built around a 35-mm Minolta SRT 101 camera. We use a 21-mm (wide-angle) lens with an aperture setting of f8 and Ektachrome ASA 200 film. The housing and strobe lights are designed to withstand pressures of 100 atmospheres, which might be encountered at a depth of 1,000 m. The system is explained in detail in the 1976 SCCWRP Annual Report (Bascom 1976).

The positioning of the strobe lights with respect to the camera is critical. Heezen and Hollister (1971) found that low-angle oblique photographs are easiest to interpret and give the best resolution of subtle sea floor features. The camera lens is pointed out and slightly downward with the strobe lights completely illuminating the field of view. Because of the effective focal length of the strobe lights under water, a picture of the bottom approximately 6 to 8 m away could be taken depending on visibility.

For the Santa Monica Bay survey, the camera in its weighted frame was baited with a small amount of squid to attract mobile animals from nearby waters. The camera was then activated and lowered to the bottom, taking a single picture approximately every 2 minutes for a period of 1 hour. Every 15 minutes, the camera frame was pulled off the bottom and immediately allowed to settle so that four positions at the same station could be obtained.

After processing, the individual 35-mm slides were examined for all of the parameters listed in Table 1. Sampling was conducted during the period 13 March 1978 to 15 June 1979.

The survey area was divided into twelve transects running perpendicular to shore and spaced approximately 3 to 7 km along shore with individual stations set a depths of 10, 30, 60, 100, and 300 m (Figure 1 and Bascom 1979). Nine additional stations were included in a tight grid around the Hyperion Treatment Plants's 5- and 7-mile outfall pipes at depths ranging from 65 to 217 meters. Transect 10 was

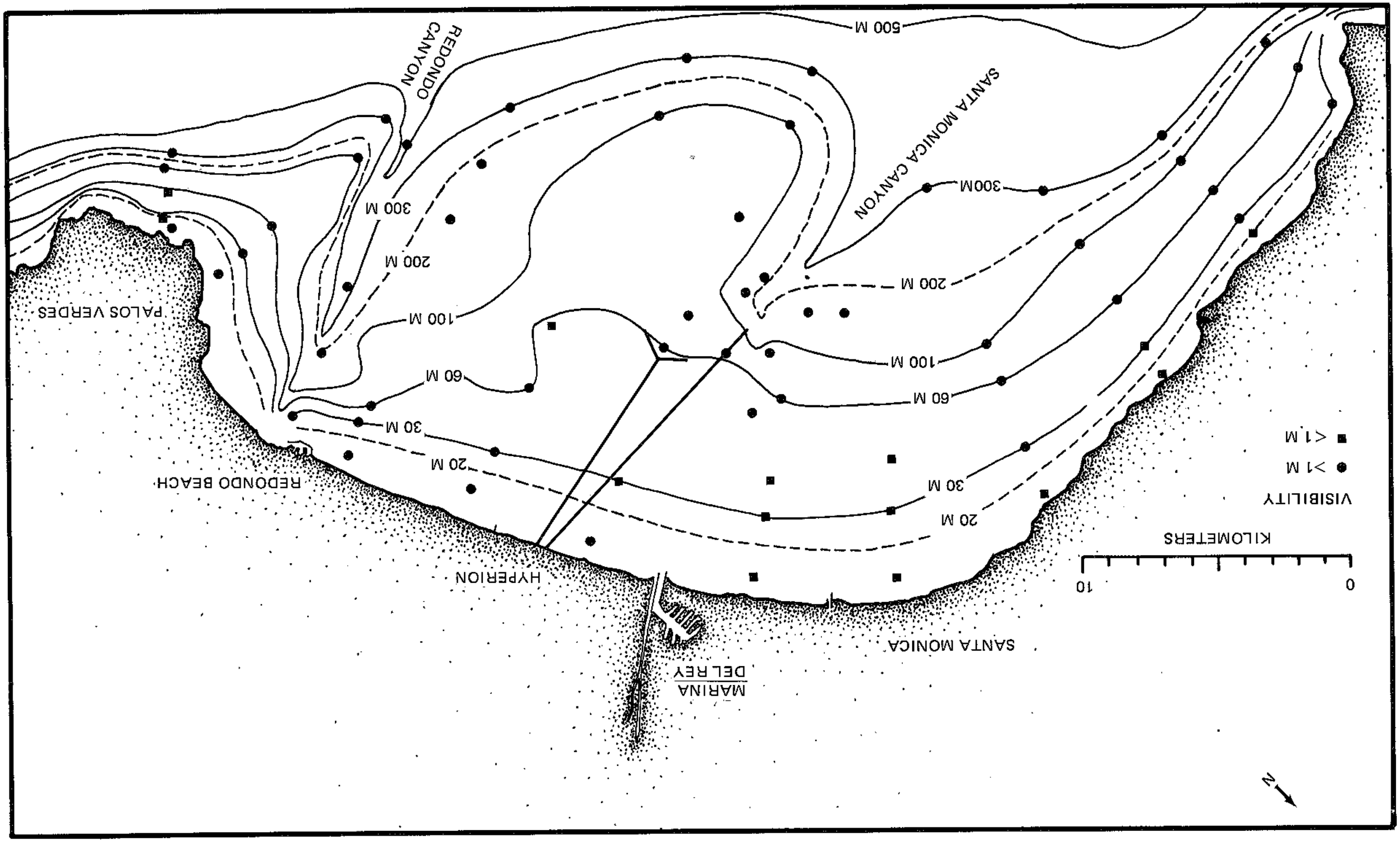

Figure 1. Santa Monica Bay survey grid showing estimated bottom visibility.

located perpendicular to shore through the center of Redondo Canyon with stations at 50, 186, 368, and 552 meters.

RESULTS

Our camera system was successfully deployed at 61 stations in Santa Monica Bay, but at only 53 of the stations was visibility sufficient to adequately describe the bottom. We obtained 539 positive frames (a positive bottom frame is one in which there is visible and recognizable biota). Overall, we recorded 34 species of fish representing 21 families and 34 species of invertebrates (Table 2). The three most abundant and frequently observed fishes were the sablefish *Anoplopoma fimbria* (present at 32.1 percent of the stations), Pacific sanddab *Citharichthys sordidus* (24.5 percent), and spiny dogfish *Squalus acanthias* (24.5 percent). Of the three, the sablefish and spiny dogfish probably would have been judged absent or rare by standard methods of assessment (otter trawl).

Probably the single most important factor in determining the number of species and number of individuals observed was the water clarity, which ranged from 0 to 6 m. The mean visibility on the bottom increased with depth from 10 to 100 m. The mean number of species and individuals observed also followed this trend.

All species photographed had been previously taken in Santa Monica Bay by otter trawl. A comparison of the "catch" by three methods of fish assessment (camera, hook and line, and otter trawl) was made using existing data (Table 3). It is clear from these data that the otter trawl captures a greater number of individuals and, in the case of Station 5-60 a greater number of species, than the other two methods. This would be expected since the otter trawl covers about 3,800 sq m of bottom compared to some 20 sq m for the camera. Results from a towed 35-mm camera covering the same area would be more comparable, however, this table illustrates that these three methods do complement each other.

Table 1. Parameters examined in the Santa Monica Bay Survey.

A. Water column
(color, visibility, density and shape of particulates)

B. Bottom
(motility, relief, tracks and tubes, coarseness, debris)

C. Water near bottom
(particulates, turbidity and color, motion)

D. Biota
(species, numbers, anomalies, sizes)

E. Behavior of Organisms
(proximity to bottom, posture, spacing, coloration)

Rocky hard bottom areas of low relief appeared to be much more productive for fish than did adjacent soft bottom areas at the same depths. For example, on soft bottoms along the 100-m isobath, we recorded an average visibility of 3.5 m, with the area occupied by an average of 5.2 fish of 3.2 species and 8.4 invertebrates of 2.0 species (Table 4). The bottom community was dominated by sea urchins (*Allocentrotus fragilis*, 5.8 per station), and sea pens (including *Acanthoptillum* sp., 1.8 specimens per station).

Table 2. Species "captured" by use of 35-mm camera during 1978 and 1979 in Santa Monica Bay at depths ranging from 10 to 552 meters.

Fish		Invertebrates	
Scientific name	**Common name**	**Scientific name**	**Common name**
Eptatretus sp.	Hagfish	Porifera UI	Sponge
Squalus acanthias	Spiny dogfish	Medusa UI	
? *Raja inornata*	California skate	Gorgoniacea UI	Gorgonian coral
Hydrolagus colliei	Ratfish	Penatulacea UI	Sea pen
Agonidae UI	Poacher	*Acanthoptilum* sp.	Sea pen
Anoplopoma fimbria	Sablefish	*Umbellula* sp.	Sea pen
Caulolatilus princeps	Ocean whitefish	*Metridium senile*	Anemone
Chromis punctipinnis	Blacksmith	*Paracyathus stearnsii*	Solitary coral
Citharichthys sordidus	Pacific sanddab	*Kelletia kelletii*	Kellet's welk
Cottidae UI	Sculpin	? *Murex* sp.	Murex
Embiotocidae UI	Surfperch	? *Nassarius* sp.	Dog welk
? *Engraulis mordax*	Northern anchovy	? Scaphopoda	Tusk shell
Genyonemus lineatus	White croaker	*Octopus* sp.	Octopus
Gobiidae UI	Goby	? Euphausiacea UI	Euphausiid
Hypsopops rubicundus	Garibaldi	*Pandalus platyceros*	Spot prawn
? *Lyopsetta exilis*	Slender sole	*Paralithodes* sp.	Crab
Oxyjulis californica	Senorita	*Cancer anthonyi*	Yellow crab
Paralabrax clathratus	Kelp bass	? *Loxorhynchus* sp.	Spider crab
Phaenerodon furcatus	White seaperch	*Mursia gaudichaudii*	Red pointer crab
Pisces UI	Fish	*Randalia ornata*	Crab
Sebastes chlorostictus	Greenspotted rockfish	Asteroidea UI	Asteroid star
Sebastes dalli	Calico rockfish	*Astropecten verrilli*	Asteroid star
Sebastes elongatus	Greenstripe rockfish	*Astropecten braziliensis*	Asteroid star
Sebastes mystinus	Blue rockfish	*Mediaster aegualis*	Asteroid star
Sebastes (sebastomus) UI	Rockfish	*Patiria miniata*	Bat star
Sebastes semicinctus	Halfbanded rockfish	*Pisaster giganteus*	Asteroid star
Sebastes serranoides	Olive rockfish	*Allocentrotus fragilis*	Fragile sea urchin
Sebastes paucispinis	Bocaccio	Echinoidea (irregular) UI	Irregular sea urchin
Sebastes UI	Rockfish	*Lytechinus anamesus*	White sea urchin
Symphurus atricauda	California tonguefish	*Strongylocentrotus franciscanus*	Red sea urchin
? *Xeneretmus latifrons*	Blackedge poacher	*Ophiomusium jolliensis*	Brittle star
Zalembius rosaceus	Pink seaperch	*Ophionereis eurybrachiplax*	Brittle star
Zaniolepis frenata	Shortspine combfish	*Parastichopus californicus*	Sea cucumber
Zaniolepis latipinnis	Longspine combfish	*Sicyonia ingentis*	Ridgeback prawn

The most abundant fish were Pacific sanddabs (*Citharichthys sordidus*, 2.1 per station), pink sea perch (*Zalembius rosaceus*, 0.6 per station), and spiny dogfish (*Squalus acanthias*). There were only occasional individuals of other small fish, crabs, octopus, and starfish (Table 4).

Table 3. Comparison of "catch" by three methods of fish assessment used in Santa Monica Bay. Camera stations show mean number of individuals/positive frame.*

Species		60-m Depth Camera	60-m Depth Hook and Line	60-m Depth Otter Trawl	185-m Depth Camera	185-m Depth Hook and Line	185-m Depth Otter Trawl
Pacific hagfish	*Eptatretus stouti*		1		1.5	1	
Blue shark	*Prionace glauca*		1				
Spiny dogfish	*Squalus acanthias*		1		1		
Ratfish	*Hydrolagus colliei*						12
Sablefish	*Anoplopoma fimbria*	1.25	7		4	4	1
Spotted cuskeel	*Chilara taylori*			2			
Roughback sculpin	*Chitonotus pugetensis*			3			
Gulf sanddab	*Citharichthys fragilis*			5			
Pacific sanddab	*Citharichthys sordidus*	1		36			
Speckled sanddab	*Citharichthys stigmaeus*			53			
White croaker	*Genyonemus lineatus*		6				
Rex sole	*Glyptocephalus zachirus*						40
Bigmouth sole	*Hippoglossina stomata*			3			
Blackbelly eelpout	*Lycodopsis pacifica*						20
Slender sole	*Lyopsetta exilis*						568
Pacific hake	*Merluccius productus*						1
Dover sole	*Microstomus pacificus*			7			64
English sole	*Parophrys vetulus*			8			6
Slim sculpin	*Radulinus asprellus*						2
Redbanded rockfish	*Sebastes babcocki*						1
Calico rockfish	*Sebastes dalli*	2.67					
Splitnose rockfish	*Sebastes diploproa*						46
Greenstriped rockfish	*Sebastes elongatus*		1				3
Cow Rockfish	*Sebastes levi*						1
Vermilion rockfish	*Sebastes miniatus*		4				
Bocaccio	*Sebastes paucispinis*					5	
Greenblotched rockfish	*Sebastes rosenblatti*					8	1
Stripetail rockfish	*Sebastes saxicola*		2			1	13
Blackedge poacher	*Xeneretmus lutifrons*						120
Pink seaperch	*Zalenbius rosaceus*						4

*Sampling dates and locations were as follows. 60-m depths: Camera, Station 4-3, Mar 78; hook and line, Station D-20, May 75; trawl, Station 20, (date). 185-m depths: Camera, Station F-1, May 78; hook and line, Station S-60, Apr 75 (182 m); trawl, Station S-60, Apr 77 (183 m).

Table 4. A comparison of soft bottom and hard bottom communities observed at depths of around 100m using 35-mm camera. Numbers indicate mean number of individuals occurring.

Station and Depth (m)	Soft Bottom 3–100	4–100	9–100	11–100	12–100	Hard Bottom A–1 80	1–100	2–100	7–100	8–100	Soft (Mean)	%	Hard (Mean)	%
Hagfish sp.								1.6			0	40	0.32	20
Spiny dogfish	1	1.5						1		2.25	0.5	0	0.65	40
Sablefish							1		1		0	80	0.4	40
Pacific sandab	1	1.71	1.5	6.4			1		20.8	1	2.12	20	4.56	60
Poacher UI				1							0.2	20	0	0
Sculpin UI				1							0.2	20	0	0
Seaperch UI					1						0.2	20	0	0
Goby UI				1.2							0.24	20	0	0
Fish UI		1				1	3.7	2.4	1		0.2	20	1.62	80
Greenspotted rockfish	1					3.7	6.5	4.4	3.4	2.6	0.2	20	4.12	100
Greenstriped rockfish	1						1.9	3.0		2.3	0.2	20	1.44	60
Rockfish UI		1				2		1.8		1.25	0.2	20	1.01	60
Pink seaperch		3					1.5				0.6	20	0.3	20
Shortspine combfish				1.5			2.5	1.4	4.4	1	0.3	20	1.86	80
Calico rockfish							1.8				0	0	0.36	20
Halfbanded rockfish							4.6	1.0		1.0	0	0	1.32	60
Bocaccio							1.1	3.3			0	0	0.88	40
Longspine combfish										1.7	0	0	0.34	20
Ratfish							1			1	0	0	0.4	40
Sea pen UI		1	1					1.5			0.4	40	0.3	20
Acanthoptilum sp.				7.1							1.42	20	0	0
Metridium senile	1										0.2	20	0	0
Gorgonian UI						2		1		6	0	0	1.8	60
Mediaster aequalis								1.5			0	0	0.3	20
Astropecten verrilli		1									0.2	20	0	0
Nassarius sp.			P								P	—	0	—
Octopus sp.	1										0.2	20	0	0
Cancer anthonyi		1									0.2	20	0	0
Mursia gaudichaudii									2	1.67	0	0	0.73	40
Allocentrotus fragilis				14.1	14.9						5.8	40	0	0
Ophiuran UI						13	8		3.4	4.3	0	0	5.74	80
Species	6	8	3	7	2	5	12	12	6	13	5.2		9.6	
Fish	4	5	1	5	1	3	11	9	4	10	3.2		7.4	
Inv.	2	3	2	2	1	2	1	3	2	3	2.0		2.2	
No. Indiv.														
Fish	4	8.21	1.5	11.1	1	6.7	26.6	19.9	24.6	15.1	5.2		18.6	
Inv.	2	3	1	21.2	14.9	15.0	8.0	4.0	5.4	11.97	8.4		8.9	
Bottom Visibility (m)	3.5	4.0	2.5	5.0	2.5	2.5	5.0	5.0	5.5	6.0	3.5		4.8	

In contrast, rocky areas of low relief along the 100-m isobath had a higher average visibility (4.8 meters), and the survey sites contained an average of 19.6 fish of 9.6 species and 8.9 invertebrates of 2.2 species (Table 4). The conspicuous benthic community was dominated by bright red gogonians (1.8 per site), large brittle stars (ophiuroids, 5.7 per site), and pointer crabs (*Mursia gaudichaudii*, 0.73 per site). Overlying this "gorgonian-ophiuroid garden" was a diverse assemblage of fishes including Pacific sanddab (4.56 per site), greenspotted rockfish (*Sebastes chlorostichtus*, 4.12 per site), shortspine combfish (*Zaniolepis frenata*, 1.86 per site), greenstripe rockfish (*Sebastes elongatus*, 1.44 per site), halfbanded rockfish (*Sebastes semicinctus*, 1.32 per site), other unidentified fish including rockfish (1.63 per site), bocaccio (*Sebastes paucispinis*, 0.88 per site) and spiny dogfish (0.65 per site). Poachers, sculpins, perch, and gobies, which were frequently seen in soft bottom areas, were either very rare or not observable on rocky bottoms.

It is possible that the greater average visibility at the rocky bottom sites (4.8 meters vs. 3.5 meters) was partly responsible for the increased abundance and number of fish species observed at these sites. However, we do not believe this difference in visibility could have accounted for the overall doubling of species and nearly five-fold increase in abundance observed and certainly not for the obvious difference in invertebrate and fish community structure. Overall we conclude the camera was very effective in providing us with a comparative as well as semiquantitative assessment of these low-relief rocky bottom areas that appear to occupy much of the Santa Monica Bay Shelf.

A major finding following this survey was the discovery of a uniquely organized assemblage of animals living in and above broken rock and cobble at one station (4C). As at the other deep sites described above, the coarse gravel in these areas was occupied by a community of large ophiuroids (possibly *Ophionereis* sp.) and sea fans (gorgonians). At another station (7.5-110), ophiurans were well organized into symmetrical quilt-like patterns (Figure Within a meter of the bottom were small schools of bocaccio and greenstriped rockfish. We think the factors contributing to this organization and community structure deserve further study.

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