

**CALIFORNIA DEPARTMENT OF FISH AND GAME**  
**Nearshore Sport Fish Habitat Enhancement Program**

**OBSERVATIONS OF THE  
BIOLOGICAL COMMUNITIES AT  
BOLSA CHICA ARTIFICIAL REEF**

Prepared by  
D. Bedford, J. Tarpley and M. Palmer-Zwahlen

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## Abstract

Bolsa Chica Artificial Reef (BCAR) was constructed in November 1986 with 10,400 tons of concrete rubble and eight concrete and steel barges. Prior to any additional augmentation of BCAR, the U.S. Army Corps of Engineers and the California Coastal Commission required the California Department of Fish and Game (CDFG) to survey the biological communities on and around BCAR.

In April 1992, qualitative surveys of the biological communities were conducted on one of the eight modules at BCAR and at a nearby sand-only site. One of the modules, Module D, located in 90 feet of water (MLLW), was surveyed for fish, macroinvertebrates, and turf community organisms (small plants and sessile animals). Twelve species of fish were observed, including kelp bass (*Paralabrax clathratus*) and barred sand bass (*P. nebulifer*). Eight macroinvertebrate species were observed, rock scallops (*Crassedoma giganteum*) being the most abundant. The turf community was comprised of thirteen invertebrate taxa, among which erect ectoprocts (*Bugula* spp.) were the most numerous. Two species of foliose red algae (*Rhodymenia pacifica* and *Anisocladella pacifica*) were also observed.

The reef has reached an advanced stage of successional development with fish and invertebrate communities diverse and well established. However, due to its depth and the turbidity of surrounding waters, this reef is not likely to ever support a diverse algal community.

The diversity and abundance of fish and macroinvertebrates were, as to be expected, much lower in the nearby sand-only site. Only two species of fish and seven macroinvertebrate species were observed. Of these, only the sea pen, *Stylatula elongata*, was common.

Overall, when compared to nearby sand-only habitats, Bolsa Chica Artificial Reef appears to contribute substantially to the local biological productivity. In addition, the concrete rubble used in BCAR's construction appears to be performing as well as the quarry rock used in all of CDFG's experimental reefs.

### Acknowledgements

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## Introduction

In November 1986, Bolsa Chica Artificial Reef (BCAR) was constructed in Orange County, approximately 4.5 NM south of the Anaheim Bay entrance (Figure 1) by the California Department of Fish and Game (CDFG). BCAR is a "fishing opportunity" reef, intended to enhance the production of living marine resources and increase fishing opportunities. Such a reef is generally built from "materials of opportunity" such as high quality concrete rubble or quarry rocks. BCAR consists of 10,400 tons of concrete rubble arranged in an eight module (rubble piles) complex placed on a gently sloping sand bottom (Figure 2). In addition, eight steel and concrete barges were scattered among the modules. Details of reef design and construction are contained in the Artificial Reef Plan for Sport Fish Enhancement (Wilson et al. 1990).

BCAR was initially planned to be intermittently augmented with materials of opportunity after the initial construction. However, prior to any such augmentation activities, fulfillment of permit conditions as established by the U.S. Army Corps of Engineers and the California Coastal Commission, required CDFG biologists of the Nearshore Sport Fish Habitat Enhancement Program (NSHEP) to conduct biological surveys of the reef.

In April 1992, 5½ years after construction, plant and animal communities on BCAR and a nearby sand-only site were



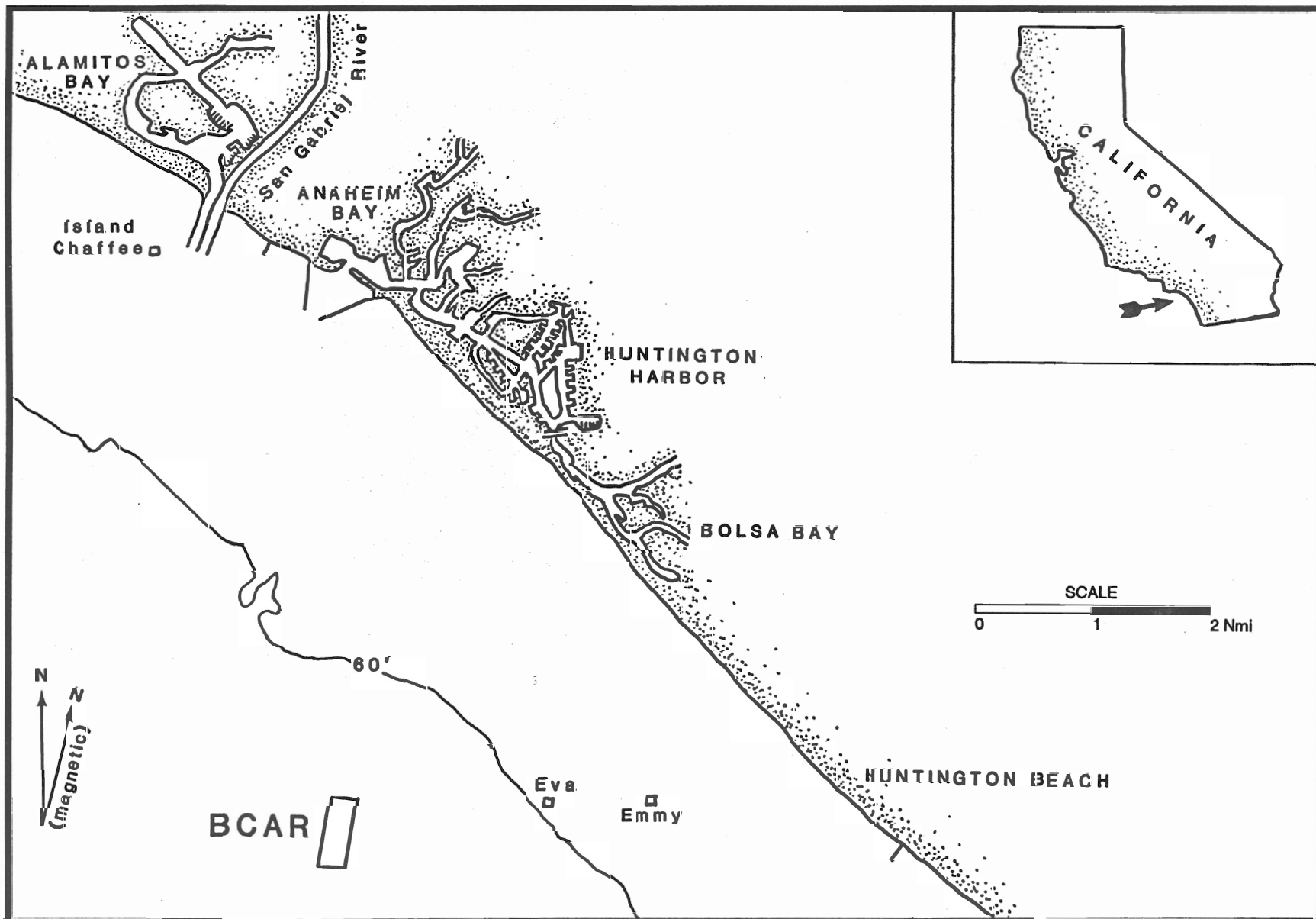


Figure 1. Location of Bolsa Chica Artificial Reef (BCAR).

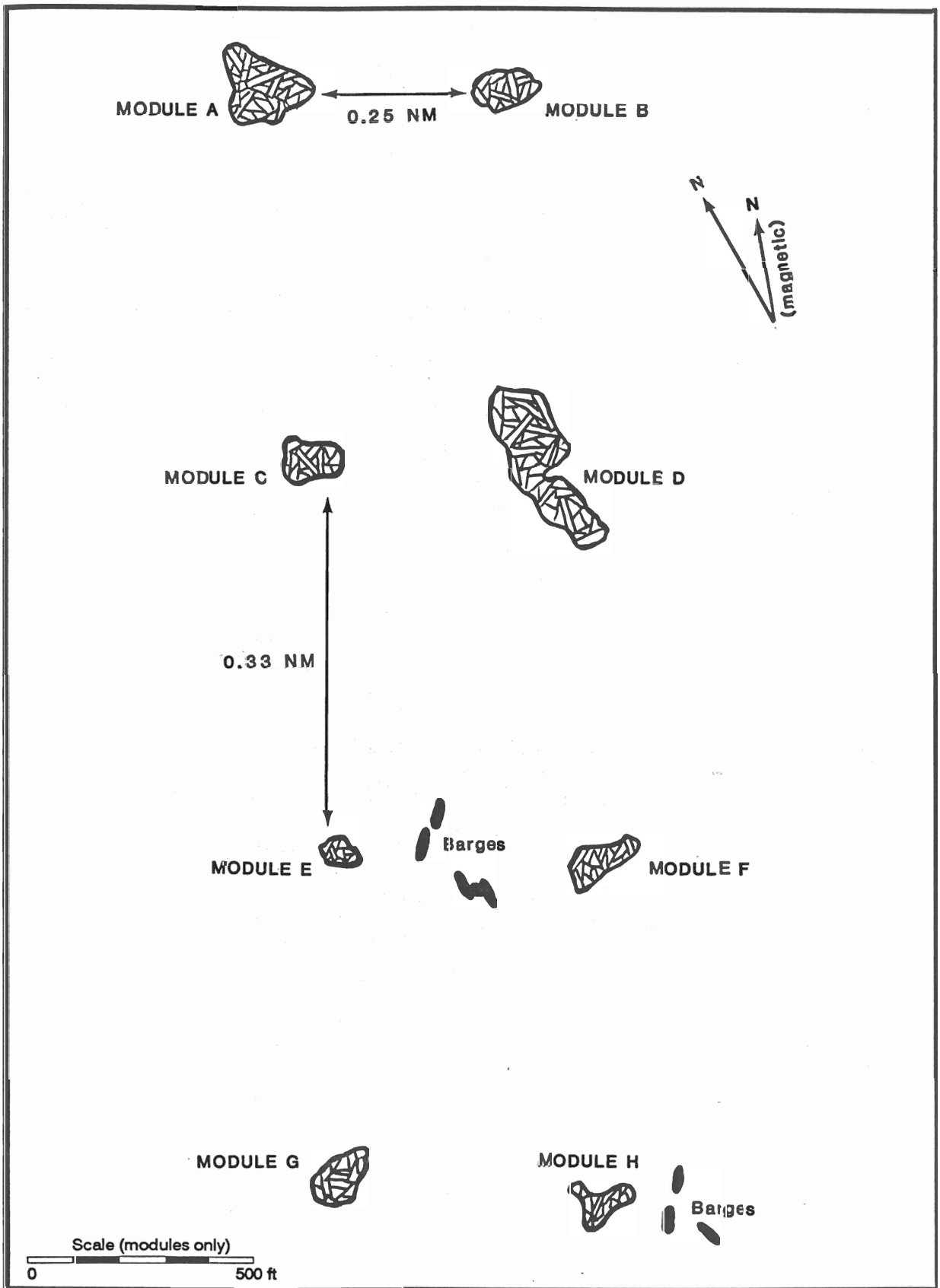


Figure 2. Structure of Bolsa Chica Artificial Reef (BCAR).

qualitatively assessed. In addition, since all of the "experimental" reefs previously built and monitored by CDFG had been constructed with quarry rock, this survey provided an opportunity to evaluate the appropriateness of the use of concrete rubble as reef material.

#### Methods

On April 20 - 23, 1992, fish and macroinvertebrate assemblages, and the low profile turf community (small plants and sessile invertebrates) on Module D and a nearby sand-only site were qualitatively surveyed by NSHEP biologists using SCUBA. Module D was selected because it is the largest and easiest of the modules to locate and because its depth (90 ft Mean Lower Low Water (MLLW)) was within the practical depth limitations at which divers could safely accomplish adequate biological surveys. Due to the deeper depth, individual dives were limited to 18 minutes bottom time. A total of 15 dives were made over four days. Altogether, 88 personnel hours were expended in locating the module and surveying the sites.

The module was located using side-scan sonar. This technique was superior to the standard chart recording fathometer because it was more sensitive to bathymetric changes and could detect the low profile (2-6 ft) modules easier.

The abundance of organisms on the reef was estimated by surveying an area within a 50 ft radius of a temporary buoy line placed on the reef. The total search area was approximately 7,800 ft<sup>2</sup>. All fish, macroinvertebrates, algae, and turf community organisms were identified and abundances were recorded.

Fish and macroinvertebrate abundances (total counts) were estimated using four categories: abundant (>50 individuals), common (11-50 individuals), occasional (2-11 individuals), and rare (1 individual). Fish were further categorized as adult (Ad) and subadult (SAd). Abundances (percent cover) of turf community organisms were estimated using four categories: abundant (>50% cover), common (11-50% cover), occasional (2-11% cover), and rare ( $\leq 1\%$  cover).

Data describing the physical characteristics of Module D and the sand-reef ecotone were recorded. Data included module depth and height (profile), water visibility, and sediment type. Module depth and height were determined by averaging numerous diver-held depth gauge readings along the module base and crest, respectively.

A second survey was conducted a few hundred feet away from the module to evaluate the biota at a sand-only site. This site was at a sufficient distance so as to be unaffected by potential influences from the reef complex. This survey was conducted at

approximately the same depth as the reef by three divers positioned at 33 ft intervals along a 100 ft line attached to a temporary buoy anchor. Divers swam a complete 360° circle around the anchor, covering a total area of more than 31,400 ft<sup>2</sup>. Organism abundance and physical characteristics of the site were recorded using the same categories as those used for the reef survey.

To show that BCAR does support species important to anglers (one of the purposes of constructing BCAR), results from the diver surveys were qualitatively compared with data from CDFG observer logs of commercial passenger fishing vessels (CPFV) at BCAR from 1987 to 1989.

## Results

### Physical Data

Module D of BCAR was in 90 ft of water (MLLW) at its base. Module height varied between 2 and 6 ft. The module was surrounded by black anoxic-like sediments composed of densely packed, fine gray sand and silt. There was no apparent scouring around the base of the reef which was littered with broken shells from blunt razor clams (*Solen sicarius*) and abalone jingles (*Pododesmus cepio*). Underwater visibility at BCAR was relatively low, ranging from 5 to 15 ft.

The depth of the sand-only site was 88 ft (MLLW). It consisted of fine gray sand and silt similar to that present around the module. There was little to no rippling of the sand surface due to the lack of significant water motion at that depth. In general, this area appeared to be a relatively featureless expanse of sand.

## Biological Data <sup>1/</sup>

### Fishes

Twelve species of fish were observed on or associated with Module D (Table 1). Adult and subadult blacksmith were the most abundant fish on the module (Plate 1). Adult barred sand bass and sargo were also commonly observed. In addition, both adult and subadult kelp bass were common as were subadult pile perch. Adult black surfperch, white surfperch, sculpin, blackeye gobies, and adult and subadult sheephead were all found occasionally on the module. One adult rubberlip perch and a subadult smooth ronquil (Plate 2) were also seen during the survey dives.

At the sand-only site, only two species of fishes were observed. Lizardfish were seen occasionally and an unidentified flatfish was observed once.

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<sup>1/</sup> Organisms observed at BCAR and the sand-only site are referred to by their common names. A complete list of common and scientific names is provided in Appendix 1.

**Table 1. Abundance and age estimates of organisms observed on Bolsa Chica Artificial Reef and the nearby sand-only site, April 1992.**

<u>BOLSA CHICA ARTIFICIAL REEF</u>			<u>SAND-ONLY SITE</u>		
FISHES	Abundance Estimate <sup>o</sup>	Age Estimate <sup>1</sup>	FISHES	Abundance Estimate <sup>o</sup>	Age Estimate <sup>1</sup>
Blacksmith	abundant	Ad/SAd	Lizardfish	occas.	Ad
Barred sand bass	common	Ad	Unid. flatfish	rare	Ad
Kelp bass	common	Ad/SAd			
Sargo	common	Ad			
Pile surfperch	common	Ad			
Sheephead	occas.	Ad/SAd			
White surfperch	occas.	Ad			
Black surfperch	occas.	Ad			
Sculpin	occas.	Ad			
Blackeye goby	occas.	Ad			
Rubberlip perch	rare	Ad			
Smooth ronquil	rare	SAd			
MACROINVERTEBRATES	Abundance Estimate <sup>o</sup>		MACROINVERTEBRATES	Abundance Estimate <sup>o</sup>	
Rock scallop	abundant		Sea pen	common	
Short-spined sea star	common		Tube anemone	occas.	
Kellet's whelk	occas.		Short-spined sea star	occas.	
Sea cucumber	occas.		Kellet's whelk	occas.	
Spanish shawl	occas.		Moon snail	occas.	
Sheep crab	rare		Unid. sea snail	occas.	
Spiny Lobster	rare		Sheep crab	rare	
Ochre sea star	rare				
TURF COMMUNITY	Abundance Estimate <sup>2</sup>		TURF COMMUNITY	Abundance Estimate <sup>2</sup>	
<u>Foliose Red Algae:</u>					
<i>Rhodymenia pacifica</i>	occas.				
<i>Anisocladella pacifica</i>	rare				
<u>Invertebrates:</u>					
Erect ectoprocts	common				
Encrusting ectoprocts	occas.				
Ornate jewel box	occas.				
Strawberry anemone	occas.				
Red gorgonian	occas.				
Abalone jingle	occas.				
Other hydroids	occas.				
Tunicates	occas.				
Barnacles	occas.				
Feather duster worms	occas.				
Urn sponge	occas.				
MACROALGAE	Abundance Estimate <sup>2</sup>	Size Estimate <sup>3</sup>	MACROALGAE	Abundance Estimate <sup>2</sup>	Size Estimate <sup>3</sup>
Giant kelp	"drift plants only"			None observed	

<sup>o</sup> - Categories for estimating fish and macroinvertebrate abundances are: abundant = >50; common = 11-50; occasional = 2-11; and rare = 1.

<sup>1</sup> - Age estimates for fishes are based upon adult (Ad)/subadult (SAd) categories used in CDFG fish studies at Pendleton Artificial Reef.

<sup>2</sup> - Abundance estimates for turf community and macroalgae are: abundant = >50% cover; common = 11-50% cover; occasional = 2-11% cover; and rare = <1%.

<sup>3</sup> - Categories for estimating algal size are: A1 = 1 in - 1ft; A2 = 1ft to subsurface; and A3 = surface canopy.



Plate 1. Schools of plankton-feeding blacksmith, *Chromis punctipinnis*, provide an important source of food for larger reef fishes.



Plate 2. Assorted sizes of concrete "chunks" create numerous micro-habitats and provide shelter for a large number of fishes, including this smooth ronquil, *Rathbunella hypoplecta*.



### Macroinvertebrates

Eight macroinvertebrate species were observed on Module D (Table 1). Only rock scallops were abundant. The short-spined sea star was common, while the Kellet's whelk, the California sea cucumber, and the spanish shawl nudibranch were classified as occasional. The sheep crab, the spiny lobster, and the ochre sea star were each observed only once.

At the sand-only site, seven macroinvertebrates were observed. Only the white sea pen was common. Species observed occasionally included the tube anemone, the short-spined sea star, Kellet's whelk, moon snail, and an unidentified gastropod. A sheep crab was also observed once during the survey.

The area surveyed at the sand-only site was approximately four times greater than the reef area surveyed. Since the term "common" was defined as 11 to 50 individuals observed over the entire area surveyed, an organism listed as "common" at the sand-only site is actually less dense or less prevalent than an organism considered "common" on the reef, because of the larger area sampled.

### Turf Community

Only two species of foliose red algae were observed on Module D (Table 1). *Rhodomenia pacifica* was seen occasionally and

*Anisocladella pacifica* was observed once. None of the plants were more than 3 inches in height.

Thirteen turf community invertebrate taxa were also observed on the module, although none were abundant. Erect ectoprocts, comprised of several species (Appendix 1), were common. Ten taxa were observed occasionally: the bivalves, ornate jewel box and abalone jingle; the cnidarians, strawberry anemones, red gorgonians (Plate 3), and hydroids; the stalked tunicate, barnacles, the feather duster worm, the urn sponge, and an unidentified encrusting ectoproct.

The sand-only site did not have a turf community. The lack of hard substrate and the dynamic nature of sand is not suitable habitat for turf or reef associated organisms. Therefore, the sandy habitat surrounding the reef remains relatively barren.

#### CPFV Observer Logbook Data

Species composition and abundance of fishes caught aboard CPFVs at BCAR from 1987 to 1989 are listed in Table 2. This list includes only those trips that had a CDFG observer on board for positive fish identification and proper data collection. During those trips a total of 4118 fish were caught representing 35 species.

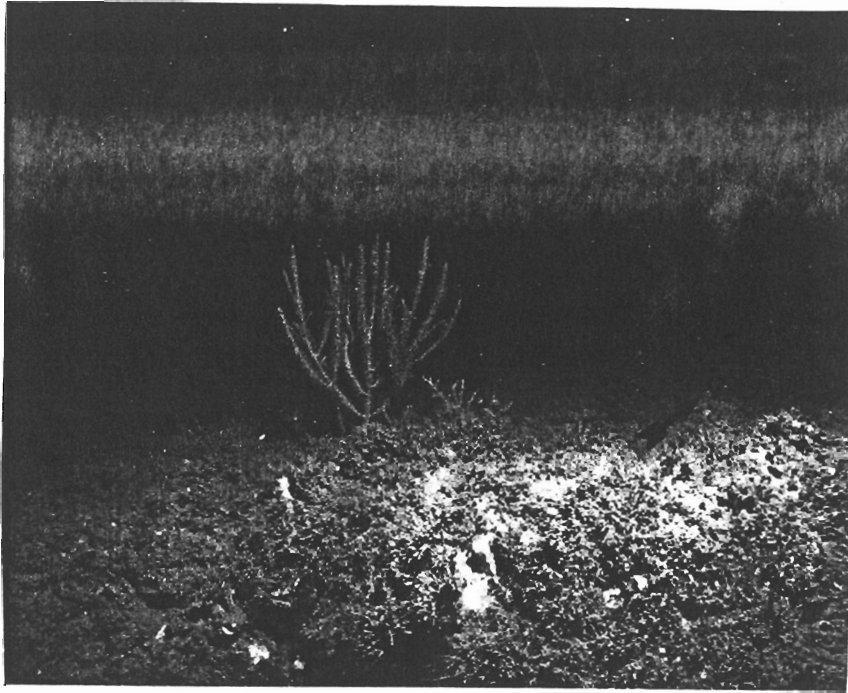


Plate 3. Despite BCARs depth and offshore location, many invertebrate species cover the reef surface. Shown here are ectoprocts, hydroids, a colony of red gorgonians, *Lophogorgia chilensis* (center), and a rock scallop, *Crassedoma giganteum* (arrow).

**Table 2. Species composition and numbers of fish caught aboard CPFVs with CDFG observers at BCAR from 1986 to 1989. Species ranked by total number caught over all years. n = number of trips.**

<u>Rank</u>	<u>Common Name</u>	<u>1987</u>	<u>1988</u>	<u>1989</u>	<u>Total</u>
1	Barred Sand Bass	409	1527	127	2063
2	Pacific Mackerel	206	367	198	771
3	California Barracuda	278	8	27	313
4	White Croaker	0	260	26	286
5	Kelp Bass	0	78	197	275
6	Sculpin	1	66	117	184
7	California Lizardfish	23	32	23	78
8	Pacific Bonito	47	3	0	50
9	California Halibut	6	10	11	27
10	Spiny Dogfish	0	11	5	16
11	Yellowtail	7	0	0	7
12	Rubberlip Surfperch	0	0	6	6
12	Thornback	0	6	0	6
13	Vermilion Rockfish	3	0	0	3
13	Flag Rockfish	3	0	0	3
13	Lingcod	3	0	0	3
13	Jack Mackerel	0	3	0	3
14	Kelp Rockfish	0	0	2	2
14	Gopher Rockfish	0	0	2	2
14	Copper Rockfish	2	0	0	2
14	Halfbanded Rockfish	0	0	2	2
14	Ocean Whitefish	0	0	2	2
14	Yellowfin Croaker	0	2	0	2
15	White Seabass	0	0	1	1
15	Treefish	0	0	1	1
15	Speckled Sanddab	0	1	0	1
15	Longfin Sanddab	0	0	1	1
15	Fantail Sole	0	1	0	1
15	Queenfish	0	1	0	1
15	Monkeyface Eel	0	1	0	1
15	Pacific Hake	0	1	0	1
15	California Skate	0	0	1	1
15	Longnose Skate	0	1	0	1
15	Starry Skate	0	1	0	1
15	Bat Ray	0	1	0	1
<b>TOTAL</b>		<b>988</b>	<b>2381</b>	<b>749</b>	<b>4118</b>
n		4	10	4	
Mean # Fish/Trip		247	238.1	187.3	
# species		12	21	18	

In 1986, before BCAR was constructed in November, no CPFV fishing occurred in the area. After construction, from 1987 to the present, BCAR has become a prime fishing location for local CPFVs. Data from observers indicate that many species desired by anglers are being caught on the reef (Table 2), including; reef-oriented species such as kelp bass, barred sand bass, and sculpin. Sand habitat species such as the California halibut; and pelagic species such as California barracuda, Pacific bonito, and Pacific mackerel are attracted to, and are also caught on and around the reef. These species' attraction to the reef may be simply attraction to the structure of to fulfill a biological need such as feeding, shelter, or reproduction.

The barred sand bass, an important sport fish, was the most frequently caught fish on BCAR from 1987 to 1989. Other important species such as the kelp bass and sculpin also ranked among the top six most caught species (Table 2).

Fish species observed during diving surveys and now established on the reef, but not sampled during the first three years of reef existence, were: sheephead; sargo; black, pile, and white surfperches; blacksmith; and demersal fishes such as gobies and the smooth ronquil.

Catch records show an increasing abundance of reef associated fishes in the BCAR area over the three year period sampled. The

kelp bass, sculpin, rockfish, and rubberlip surfperch catch has increased, despite the sampling effort in 1988 being 2.5 times greater than in the other years. Overall, not only have abundances increased, but also species diversity as the reef has matured.

After 1989, CDFG observers on CPFVs were discontinued, ending detailed data collection. However, anecdotal reports from local newspapers and CPFV skippers indicate that BCAR has continued to be heavily fished by CPFVs and private boaters to the present day.

#### Discussion

The fish community on BCAR is diverse and well established. Both the presence of blackeye goby and rubberlip perch are indicative of a mature reef (Lewis *et al.* in press). In addition, many of the fish species known to be common on nearshore reefs in southern California (Ambrose and Swarbrick 1989, Wilson *et al.* 1990) were also observed on Module D.

The large number of juvenile and adult blacksmith on Module D strongly suggest fish production is occurring. Blacksmith are especially important to the nearshore reef ecology. By feeding on plankton in the water column and defecating on the reef where they aggregate, blacksmith provide an important source of nutrients for other reef organisms to utilize (Quast 1968a). In

addition, juvenile blacksmith are an important source of food for some larger reef-associated fish species (Quast 1968b).

Two of the most important reef-associated sport fishes, the kelp bass and barred sand bass, were common as adults in our surveys. In addition, juvenile kelp bass were also present. The abundance of these species on BCAR provide evidence for the popularity of this reef with local CPFV operators. These two species rank second and third, respectively, in importance to the southern California CPFV industry (National Marine Fisheries Service 1987 in press). CPFV logbooks also showed that these species and others such as sculpin, are frequently sought after and caught sport fish at BCAR.

The macroinvertebrate and turf communities are also fairly diverse and well-developed for a reef at this depth. The presence of gorgonians, erect ectoprocts, and strawberry anemones are indicative of a mature stage of reef development (Palmer-Zwahlen and Aseltine in press). However, it does not appear likely that a well developed algal community will develop on Bolsa Chica Artificial Reef. The combination of depth and turbidity prevents the necessary light for dense algal growth from reaching the reef. The presence of only a few species of red foliose algae is typical of deep reefs.

There were few major differences found when the biological communities of this "fishing opportunity" reef constructed of surplus concrete rubble, were compared with CDFGs "experimental" reefs constructed of quarry rock. The fish community at BCAR is nearly identical to those at similar quarry rock reefs of approximately the same age and depth (Wilson and Togstad 1985, Grant 1991). Virtually all surfaces of Module D were covered by macroinvertebrate and turf community organisms (Plates 2 and 3), similar in species composition and abundance to those occurring on quarry rock reefs at Pacific Beach and Santa Monica Bay artificial reefs (Wilson and Togstad 1985, Grant 1991).

The composition and abundance of the fish and invertebrate biota at Module D is, as would be expected, considerably different than the nearby sand-only site. These surveys show that the reef habitat supports a much more diverse community than the sand habitat. Although difficult to accurately quantify because of the transient nature of some of the fish and invertebrate species and the low visibility conditions, the overall abundance of observed organisms on the reef was several times greater per unit of area than on the sand habitat area. Thus, BCAR appears to contribute substantially to local biological productivity. Observations from diver surveys and CPFV logbooks indicate that BCAR will continue to support a healthy reef ecosystem providing enhanced opportunities for the southern California angler.



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**Appendix 1. Common and scientific names of organisms observed on Bolsa Chica Artificial Reef and nearby sand-only site, April 1992.**

	<u>Common Name</u>	<u>Scientific Name</u>
<b>FISHES</b>		
	Blacksmith	<i>Chromis punctipinnis</i>
	Barred sand bass	<i>Paralabrax nebulifer</i>
	Kelp bass	<i>Paralabrax clathratus</i>
	Black surfperch	<i>Embiotoca jacksoni</i>
	Pile surfperch	<i>Damalichthys vacca</i>
	Rubberlip surfperch	<i>Rhacochilus toxotes</i>
	White surfperch	<i>Phanerodon furcatus</i>
	Sculpin	<i>Scorpaena gutta</i>
	Sheephead	<i>Semicossyphus pulcher</i>
	Sargo	<i>Anisotremus davidsonii</i>
	Lizardfish	<i>Synodus lucioceps</i>
	Blackeyed goby	<i>Coryphopterus nicholsii</i>
	Smooth ronquil	<i>Rathbunella hypoplecta</i>
<b>MACROINVERTEBRATES</b>		
	Rock scallop	<i>Crassedoma giganteum</i>
	Kellet's whelk	<i>Kelletia kelletii</i>
	Moon snail	<i>Polinices lewisii</i>
	Unid. sea snail	Volutacea
	Spanish shawl	<i>Flabellina iodinea</i>
	Short spined sea star	<i>Pisaster brevispinus</i>
	Ochre sea star	<i>Pisaster ochraceus</i>
	Calif. sea cucumber	<i>Parastichopus californicus</i>
	Sheep crab	<i>Loxorhynchus grandis</i>
	Spiny lobster	<i>Panulirus interruptus</i>
<b>TURF COMMUNITY</b>		
	Foliose red algae:	<i>Anisocladella pacifica</i> <i>Rhodomenia pacifica</i>
	Invertebrates:	
	Erect ectoprocts	<i>Bugula spp.</i> <i>Hippodiplosia insculpta</i> <i>Tricellaria occidentalis</i>
	Ornate jewel box	<i>Chama arcana</i>
	Abalone jingle	<i>Pododesmus cepio</i>
	Hydroids	<i>Obelia sp.</i>
	Strawberry anemone	<i>Corynactis californica</i>
	Tube anemone	<i>Pachycerianthus fimbriatus</i>
	Red gorgonian	<i>Lophogorgia chilensis</i>
	Sea pen	<i>Stylatula elongata</i>
	Urn sponge	<i>Leucilla sp.</i>
	Feather duster worms	<i>Eudistylia polymorpha</i>
	Barnacles	<i>Balanus spp.</i>
	Stalked tunicate	<i>Styela montereyensis</i>