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The Reef Fish Assemblage of the Outer Los Angeles Federal Breakwater, 2002–2003

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Abstract.—The conspicuous and cryptic fish assemblage of the Los Angeles Federal Breakwater was assessed from 2002 to 2003. Thirty-five species were observed or collected during the study period. The assemblage of cryptic fishes was composed primarily of a mix of Oregonian and San Diegan, species including snubnose sculpin (*Orthonopias triacis*), coralline sculpin (*Artedius corallinus*) and blackeye goby (*Rhinogobiops nicholsii*). The species composition of conspicuous fishes was approximately equal between taxa from these two provinces. Blacksmith (*Chromis punctipinnis*), black perch (*Embiotoca jacksoni*) and kelp bass (*Paralabrax clathratus*) dominated the assemblage of conspicuous fishes. Species composition reflects the localized cool temperature regime of the area and the high relief kelp forest habitat.

Rocky reefs are among the most important but least abundant habitats within the Southern California Bight (Cross and Allen 1993). More than 125 species of fish have been documented in this habitat, more than 25% of the Californian marine total (Quast 1968b; Feder et al. 1974; Horn and Allen 1978). Artificial reefs have been constructed within the Bight to augment natural reefs and to mitigate lost natural reefs through development or habitat degradation (Ambrose 1994). Although not their primary purpose, breakwaters form artificial reefs and have been shown to be effective fish enhancement structures in urban areas (Stephens et al. 1994). Breakwaters provide high relief, complex habitats that are ideal for many reef-associated fishes. The Los Angeles Federal Breakwater is 13.8 km long (McQuat 1951) making it the largest artificial reef in the Southern California Bight, yet, prior to this study, a systematic characterization of the fish population on this breakwater has not been made. The breakwater at King Harbor, Redondo Beach, California has been extensively surveyed since 1974, and more than 100 species of fish have been observed with about half of those being resident (present year-round throughout the study) species (Stephens and Zerba 1981; Stephens et al. 1994). However, this breakwater is also characterized by a high degree of temperature stratification due to warm water input from a coastal generating station into King Harbor and its proximity to the Redondo submarine canyon. King Harbor, a small craft marina, is also probably less affected than Los Angeles Harbor, a major international port, by anthropogenic effects. Quantitatively evaluating the fish assemblage on Los Angeles Federal Breakwater will

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provide critical information on the potential of these structures to replace or supplement natural rocky reef habitat in an urban setting.

Artificial reefs have been shown to support high densities of fish due to either attraction or production of fishes, but generally have low standing stocks compared to natural reefs because artificial reefs are generally smaller than natural reefs (Ambrose and Swarbrick 1989; Demartini et al. 1989). Monitoring of reef fishes has become an important component of many fisheries management strategies to ensure maintenance of ''healthy'' ecosystems and sustainable fisheries (Stephens and Zerba 1981; Stephens et al. 1984; Paddack and Estes 2000). This task is especially important in areas that are near large population centers and/or are heavily influenced by anthropogenic activities.

Visual censuses along transects with defined widths and lengths can be used to make reasonably accurate estimates of the density of fishes, and their effectiveness has been well established for fishes on temperate reefs in southern California (e.g. Quast 1968a, b, c; Ebeling et al. 1980; Stephens and Zerba 1981; Larson and DeMartini 1984; Stephens et al. 1986; DeMartini et al. 1989; Allen et al. 1992). However, visual censuses tend to underestimate fish densities (Sale and Douglas 1981) especially those of small or cryptic species (Brock 1982; Bellwood and Alcala 1988). These limitations are generally well recognized and do not prevent reasonably precise density estimates for conspicuous fishes from being obtained.

Cryptic fishes are usually small, camouflaged fishes that live in or among rocks, crevices, or algae. These fish usually retreat into the reef in the presence of divers and thus cannot be accurately sampled using techniques for estimating densities of conspicuous fishes. Cryptic fishes are more precisely estimated with the use of ichthyocides or anesthetics (Allen et al. 1992). Previous studies in southern California have shown cryptic fishes to be important members of rock reef habitats in terms of density, species richness (Allen et al. 1992), and secondary productivity (Stephens and Zerba 1981; Stephens et al. 1984).

The primary goal of this study was to provide a description of the reef fish assemblage of the outer Los Angeles Federal breakwater using visual census and an anesthetic to survey both large mobile and small cryptic fishes effectively. The densities, depth distributions, biomass and seasonality of the fish assemblage were determined.

Methods

The Los Angeles Federal Breakwater forms the western border of the Los Angeles-Long Beach Harbor complex (Figure 1). The Breakwater was constructed in three parts. The northernmost section was completed in 1912 and the final two sections were completed in 1928 (McQuat 1951). It is constructed of quarry rock that forms a sloping high relief reef extending from the surface to 15 meters where it is bounded by a mud flat (J.T.F. personal observation). During this study purple urchins (*Strongylocentrotus purpuratus*) forming characteristic barrens dominated the shallow subtidal portion of the reef (< 4 m). Giant kelp (*Macrocystis pyrifera*) was abundant between 5–10 m throughout the study, while coralline algae and macroinvertebrates dominated the deeper portions of the reef.

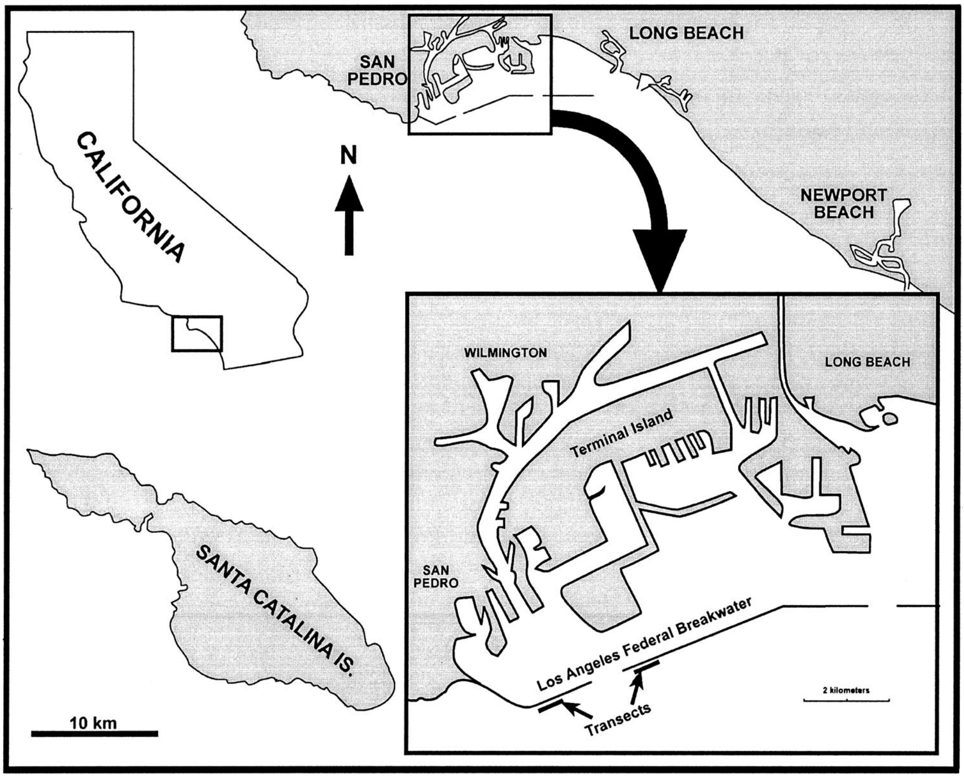

Fig. 1. Location of the study sites at the Los Angeles Federal Breakwater.

Sampling

Cryptic and conspicuous fishes were sampled quarterly from September 2002 to November 2003 at two sites along the outer Breakwater (Figure 1). Fishes were not sampled in Spring 2003 due to poor visibility and severe wave action at the study site. Conspicuous fishes were censused using visual transects on SCUBA at randomly selected 6 m and 12 m isobaths. All transects were conducted between 1000 and 1400 hrs. On each sampling date, divers swam a 2 m wide × 50 m long transect counting all conspicuous fishes within the 100 m^2 area. Counts made by two divers were averaged for each transect. All fishes that passed divers from behind were omitted to avoid counting the same fish multiple times or overestimating fishes that may be attracted to divers (Terry and Stephens 1976; Stephens and Zerba 1981; Stephens et al. 1984). Four replicate transects were conducted at each depth at two sites each sampling period, except January 2003 where two replicates per depth per site were completed due to poor visibility.

Cryptic fishes were sampled in 1 m^2 randomly selected quadrats using quinaldine diluted 1:9 in 2-propanol. All fish within the 1-m quadrat were anesthetized and collected in mesh bags, fixed in 10% formalin for seven days and preserved in 70% ethanol. A minimum of four replicates per depth per site was taken during each sampling period to assess abundance and species composition. Specimens were blotted dry and weighed to the nearest 0.1 gram (wet weight; WWT) and standard length (SL) was measured to the nearest 0.1 mm in the laboratory using digital calipers.

Biomass of conspicuous fishes was estimated by determining an average length of every species from each age class and then using established length-weight regressions for each species. Cryptic species that were observed on transects were estimated by taking the mean weight of that species from cryptic collections taken during this study.

The effects of depth and sampling date (season) on density and biomass were tested using two-way analysis of variance (ANOVA) with replication. Data were log (x + 1) transformed for conspicuous fishes, and log (x + 1/6 of the minimum non-zero value) transformed for cryptic fishes to restore normality and homoscedasticity to these data. However, it is important to note that this study occurred on a single continuous reef. Therefore, depth is also confounded with changes in habitat between depths and that seasonal effects may not have been adequately sampled. These factors should be considered when interpreting these data.

Results

Cryptic Fishes

A total of 107 individuals were collected in 62 1-m^2 samples. Thirteen species from eight families were collected over the study period. The assemblage of cryptic fishes consisted primarily (82.2%; Table 1) of three species, snubnose sculpin (*Orthonopias triacis*), coralline sculpin (*Artedius corallinus*) and blackeye goby (*Rhinogobiops nicholsii*). Snubnose sculpin was the most abundant species (37%) followed by coralline sculpin (23.4%) and blackeye goby (18.7%).

Density (individuals/m^2) of all cryptic fishes during the study period was 1.8 m^2 ± 0.16 (n = 62). The density of all species combined was highest in July 2003, (Figure 2) and lowest in January 2003 although differences in density among seasons were not statistically significant (ANOVA, $F_{3,58} = 0.59$; P = 0.62). The density within the individual depth strata did not closely follow the trend of the combined depth strata. The highest density was recorded in shallow stratum in July 2003, the lowest density in October 2002, and intermediate density in November 2003. Overall, mean density was higher in the shallow stratum but was not significant (ANOVA, $F_{1,46} = 0.8$; P = 0.37). The shallow stratum was not sampled in January 2003 due to strong surge, which prevented accurate surveys at shallow depths. The fish density peaked in the deep stratum in October 2002 and November 2003, with the lowest density encountered in January 2003. The number of species remained relatively constant over the sample period, ranging from a low of five in January of 2003 to a maximum of seven in October 2002 and July 2003.

Mean biomass (gWWT/m^2) of all cryptic fishes during the study period was 3.3 ± 0.82 (n = 62; Figure 3). Biomass closely paralleled the trend of density. It was highest in July and November of 2003 and lowest in January 2003 and there was no significant difference in biomass density between depths (ANOVA, $F_{1,46} = 1.7$; P = 0.20) or among seasons (ANOVA, $F_{2,46} = 0.1$; P = 0.94). Blackeye goby constituted the most biomass, comprising 18.7% of the total, although this species was ranked fourth in terms of numerical density (Table 1). Painted greenling (*Oxylebius pictus*) was ranked second in terms of biomass comprising

Table 1. Density and biomass of individuals collected in five quarterly surveys of cryptic fishes at the outer Los Angeles federal breakwater, from October 2002 to October 2003. Biomass (gWWT/m^2) indicated in parentheses.

Species	Common name	October 2002	January 2003	July 2003	November 2003	Total	%
Orthonopias triacis	Snubnose sculpin	14 (7.6)	5 (8.3)	16 (7.2)	8 (10.7)	43 (33.7)	40.7 (17.0)
Artedius corallinus	Corraline sculpin	4 (4.3)	3 (4.6)	9 (5.3)	9 (12.2)	25 (26.5)	23.4 (13.4)
Rhinogobiops nicholsii	Blackeye goby	11 (13.9)	1 (0.9)	1 (2.0)	7 (20.1)	20 (37.0)	18.7 (18.7)
Gibbonsia elegans	Spotted kelpfish	3 (10.3)		2 (4.7)		5 (15.1)	4.7 (7.6)
Alloclinus holderi	Island kelpfish		1 (1.0)		2 (5.7)	3 (6.8)	2.8 (3.4)
Gobiesox rhessodon	California clingfish			3 (4.7)		3	2.8 (2.4)
Oxylebius pictus	Painted greenling			2 (34.3)		2	1.9 (17.3)
Chromis punctipinnis	Blacksmith	1 (0.4)				1 (0.4)	0.9 (0.2)
Lythrypnus zebra	Zebra goby	1 (0.5)				1 (0.5)	0.9 (0.3)
Scorpaena guttata	California scorpionfish	1 (19.6)				1 (19.6)	0.9 (9.9)
Sebastes atrovirens	Kelp rockfish			1 (2.7)		1	0.9 (1.4)
Sebastes auriculatus	Brown rockfish				1 (7.3)	1 (7.3)	0.9 (3.7)
Sebastes carnatus	Gopher rockfish				1 (9.4)	1 (9.4)	0.9 (4.8)
	Total	35	10	34	28	107 (375.5)	
	Density no./m^2	1.8	1.2	2.1	1.8	1.7	
	Biomass (gWWT/m^2)	(2.8)	(1.5)	(3.8)	(4.1)	(3.1)	
	Number of species	7	4	7	6	13	

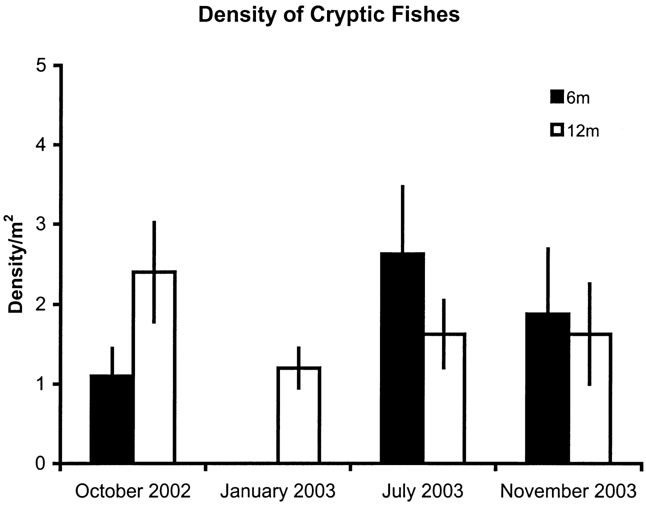

Fig. 2. Mean density of cryptic fishes at six and twelve meter depth strata at the Los Angeles Federal Breakwater. Density varied significantly by season in the six meter stratum (ANOVA $F_{3,23} = 17.45$, $P < 0.001$) although seasonal variation in the deep stratum was not significant (ANOVA $F_{3,32} = 1.11$; $P = 0.36$).

17.3% of the total (Table 1) although only two large individuals were collected during the study. Snubnose sculpin was numerically dominant but third most abundant in biomass (17.0%). Three species of juvenile rockfish, kelp rockfish, brown rockfish and gopher rockfish (*Sebastes atrovirens, S. auriculatus* and *S. carnatus* respectively) contributed disproportionately to the biomass total contributing 9.8% of the total biomass although only three large individuals were collected. Six families accounted for 97.4% of the total biomass and were dominated

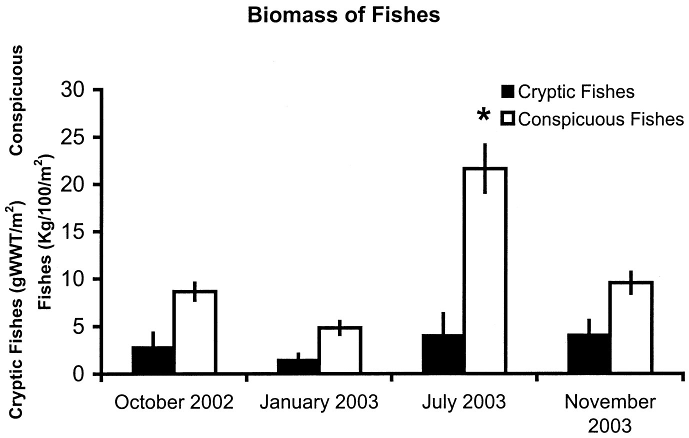

Fig. 3. Biomass density of cryptic and conspicuous fishes for two depth strata combined, by season, over the period of October 2002 to November 2003. There was no significant difference in biomass of cryptic fishes between depths (ANOVA $F_{1,46} = 1.4$; $P = 0.24$) or among seasons (ANOVA $F_{2,46} = 0.3$; $P = 0.76$). A significant peak in biomass density of conspicuous fishes occurred in July 2003 (ANOVA, $F_{3,52} = 18.8$; $P < 0.001$; Tukey post hoc test; $P < 0.001$). Results shown as mean ± SE.

by Cottidae (30.4%), Scorpaenidae (19.7%), Gobiidae (18.9%), Hexagrammidae (17.3%), Clinidae (7.6%) and Labrisomidae (3.4%).

Conspicuous Fishes

Twenty-eight species from 13 families were observed on 56 transects during the study period (Table 2). Five species accounted for 80.8% of all fishes counted on visual transects during the study. These included blacksmith (*Chromis punctipinnis*; 56%), black perch (*Embiotoca jacksoni*; 12%), pile perch (*Rhacochilus vacca*; 6%), kelp bass (*Paralabrax clathratus*; 3.5%) and señorita (*Oxyjulis californica*; 3.3%). Large schools of blacksmith juveniles were often observed. The density of the top five species remained relatively constant during the study.

The mean density of conspicuous fishes was 85.3 ± 7.1/100 m^2 ($n = 56$). Patterns of density were similar between the depth strata except in October 2002 when juvenile blacksmith recruited in large numbers (Figure 4). Fishes were significantly more abundant in shallow depths throughout the study period (ANOVA, $F_{1,48} = 21.4$; $P < 0.001$). Density also varied significantly by season in the shallow stratum (ANOVA, $F_{3,23} = 17.45$; $P < 0.001$) and was significantly higher in July 2003 (Tukey post hoc test; $P < 0.05$). The peak density in the shallow stratum during summer was primarily due to the abundance of juvenile blacksmith that recruited during that period. Variation in density at the deep strata over time was marginally significant (ANOVA, $F_{3,23} = 2.72$; $P = 0.07$; Figure 4). Abundance in the deep stratum showed a similar pattern of seasonal variation, despite the absence of the juvenile blacksmith.

Mean biomass (Kg/100 m^2) of all conspicuous fishes during the study period was 12.1 ± 1.16 ($n = 56$; Figure 3) and closely followed the pattern of density. Biomass was significantly higher in the shallow stratum (ANOVA, $F_{1,54} = 7.5$; $P = 0.008$), and a significant peak in biomass density occurred in July 2003 (ANOVA, $F_{3,52} = 18.8$; $P < 0.001$; Tukey post hoc test; $P < 0.001$).

The density (individuals/100 m^2) of cryptic fishes contributed substantially to the overall density of cryptic and conspicuous fishes. The mean density of cryptic fishes combined across depths was 174 ± 21.7 ($n = 62$) compared to 85 ± 7.1 ($n = 56$) for conspicuous fishes increasing the total density of fishes 300% and constituting 67% of the total density. Six species were observed both on visual transects and in cryptic collections (Table 3). Species richness was increased from 28 to 35 species (an increase of 25%) with the inclusion of cryptic fishes; however the increase in biomass was minimal (< 10%).

Discussion

Species richness of cryptic fishes from the Los Angeles Breakwater was comparable to that found in other studies of rocky reef habitats. In this study, 13 species of cryptic fishes were collected in 62 benthic samples. This is comparable to 12 species in 60 samples at King Harbor (Stephens and Zerba 1981), nine species in 20 samples at Palos Verdes (Stephens et al. 1984) and 14 species in 105 samples using rotenone enclosures at Santa Catalina, Island, California (Allen et al. 1992). In comparison, 28 species were observed during 56 visual transects at the Los Angeles Breakwater during the same period. A mean of 9.6 ± 0.31 ($n = 56$) species per transect were observed, similar to the 7–12 species per 100 m^2 transect reported by Stephens et al. (1994) at King Harbor, California.

Table 2. Density of conspicuous fishes (100 m^2) surveyed on 56 visual transects from October 2002 to November 2003. Results are presented as mean ± standard error.

Family	Species	Common name	October 2002	January 2003	July 2003	November 2003	Total
Pomacentridae	*Chromis punctipinnis*	Blacksmith	61.3 ± 7.8	27.6 ± 4.9	84.3 ± 15.7	9.1 ± 2.8	45.6 ± 2.8
Embiotocidae	*Embiotoca jacksoni*	Black perch	6.6 ± 1.4	7.4 ± 1.3	10.4 ± 1.4	14.9 ± 2.2	9.8 ± 0.2
Embiotocidae	*Rhacochilus vacca*	Pile perch	3.7 ± 0.5	5.0 ± 0.7	3.3 ± 0.4	6.8 ± 1.1	4.7 ± 0.1
Serranidae	*Paralabrax clathratus*	Kelp bass	1.2 ± 0.5	1.0 ± 0.3	4.4 ± 0.1	4.3 ± 0.8	2.7 ± 0.2
Labridae	*Oxyjulis californica*	Senorita	3.1 ± 1.0	2.3 ± 0.4	1.5 ± 0.6	3.9 ± 0.8	2.7 ± 0.1
Embiotocidae	*Brachyistius frenatus*	Kelp perch	1.1 ± 0.5	1.0 ± 0.7	2.0 ± 1.0	5.4 ± 1.6	2.4 ± 0.2
Kyphosidae	*Hermosilla azurea*	Zebraperch	0.1 ± 0.1		7.1 ± 3.3		1.8 ± 1.1
Labridae	*Semicossyphus pulcher*	California Sheephead	1.4 ± 0.6	0.8 ± 0.2	1.4 ± 0.6	1.6 ± 0.4	1.3 ± 0.1
Hexagrammidae	*Oxylebius pictus*	Painted greenling	1.8 ± 0.3	0.8 ± 0.3	1.6 ± 0.4	0.9 ± 0.2	1.3 ± 0.0
Kyphosidae	*Girella nigricans*	Opaleye	0.2 ± 0.1	0.1 ± 0.1	3.3 ± 1.4	0.8 ± 0.3	1.1 ± 0.3
Serranidae	*Paralabrax nebulifer*	Barred sand bass	1.4 ± 0.4	0.8 ± 0.6	2.1 ± 0.3	0.4 ± 0.2	1.2 ± 0.1
Pomacentridae	*Hypsopops rubicundus*	Garibaldi	0.6 ± 0.3		1.2 ± 0.4	1.6 ± 0.5	0.9 ± 0.1
Kyphosidae	*Medialuna californiensis*	Halfmoon	0.1 ± 0.1	0.3 ± 0.3	0.1 ± 0.1	2.9 ± 1.5	0.8 ± 0.3
Scorpaenidae	*Sebastes serranoides*	Olive rockfish	5.1 ± 3.4	0.8 ± 0.6		0.4 ± 0.2	1.5 ± 0.9
Labridae	*Halichoeres semicinctus*	Rock wrasse	0.7 ± 0.3		1.0 ± 0.3	0.9 ± 0.3	0.6 ± 0.0
Embiotocidae	*Rhacochilus toxotes*	Rubberlip seaperch	1.9 ± 0.7	0.3 ± 0.3	0.3 ± 0.1	0.4 ± 0.2	0.7 ± 0.1
Scorpaenidae	*Sebastes atrovirens*	Kelp rockfish	2.0 ± 0.7		0.4 ± 0.2		0.6 ± 0.2
Gobiidae	*Rhinogobiops nicholsii*	Blackeye goby	0.9 ± 0.3		0.3 ± 0.1	0.4 ± 0.2	0.4 ± 0.0
Embiotocidae	*Hypsurus caryi*	Rainbow seaperch	0.1 ± 0.1	1.9 ± 0.8	0.2 ± 0.2	0.3 ± 0.1	0.6 ± 0.2
Clinidae	*Heterostichus rostratus*	Giant kelpfish	0.1 ± 0.1			1.1 ± 0.4	0.3 ± 0.1
Haemulidae	*Anisotremus davidsonii*	Sargo			0.2 ± 0.1	0.3 ± 0.2	0.1 ± 0.0
Labrisomidae	*Alloclinus holderi*	Island kelpfish	0.1 ± 0.1		0.3 ± 0.2		0.1 ± 0.0
Embiotocidae	*Phanerodon furcatus*	White seaperch	0.3 ± 0.3				0.1 ± 0.1
Scorpaenidae	*Scorpaena gutata*	Spotted scorpionfish	0.1 ± 0.1				0.0 ± 0.0
Cottidae	*Scorpaenichthys marmoratus*	Cabezon		0.1 ± 0.1		0.1 ± 0.1	0.0 ± 0.0
Scorpaenidae	*Sebastes chrysomelas*	Black and yellow rockfish	0.1 ± 0.1			0.1 ± 0.1	0.0 ± 0.0
Heterodontidae	*Heterodontus francisci*	Horn shark		0.1 ± 0.1			0.0 ± 0.0
Scorpaenidae	*Sebastes serriceps*	Treefish			0.1 ± 0.1		0.0 ± 0.0

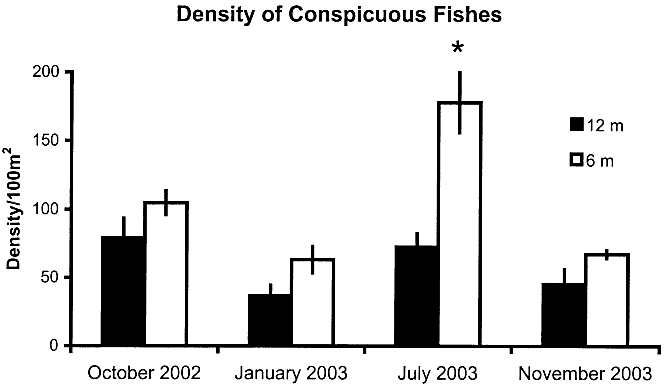

Fig. 4. Density of conspicuous fishes at six and twelve meter depth strata. Density varied significantly by season 6m ANOVA $F_{3,23} = 17.45$, $P < 0.001$. Variation in density at the deep strata was not significant. Results shown as mean ± SE.

Density varied seasonally in a similar manner with both the cryptic and conspicuous fishes at the Federal Breakwater. The density of both conspicuous and cryptic fishes peaked during the summer of 2003 corresponding to the warmest period of the study. The density of the five most abundant conspicuous species were relatively constant throughout the study suggesting that these species are all permanent residents of the reef. Blacksmith is a warm temperate species that has been the dominant planktivore in most southern rocky reef kelp bed environments since 1976–1977 when sea surface temperatures in southern California began to increase (Stephens and Zerba 1981). This species depends on high relief reef for shelter during nocturnal periods and is well suited to breakwaters because of the high availability of caves and crevices used at night.

Six species of surfperches (Embiotocidae) were observed during this study and comprised 21% of all fishes counted. After the blacksmith, the black and pile perch were the most abundant fishes. These surfperches are unique in that they are non-dispersing livebearers who are dependent upon the resources of the reef they inhabit making them excellent models for examining reef productivity (Ellison et al. 1979; Schmitt and Holbrook 1990; Pondella et al. 2002). As such, annual year-class strength of newborn surfperches was tightly coupled to habitat productivity in Santa Barbara, California (Holbrook et al. 1997). Abundance of black and pile perch were higher than reported at King Harbor and much higher than the density at Palos Verdes, Rancho Palos Verdes, California, the nearest rocky reef (Pondella et al. 2002). The relatively high density of these demersal surfperches was an indication of overall reef production and health.

Overall, few differences were apparent in the distribution of fishes between the shallow and deep strata. The shallow portions of the breakwater had higher densities of conspicuous fishes that were largely driven by the presence of juvenile blacksmith. No trend in densities of cryptic fishes with depth was observed. However, cryptic fishes were extremely rare in the urchin barrens that dominated the shallow regions of the reef (J.T.F, pers. observ.). Two species of sculpins (Cottidae) collected in the study were more abundant in areas with fleshy red algae or areas protected from physical disturbance. Exposed areas and areas dominated with coralline algae often had few or no cryptic fish present. It appears that wave action may prevent cryptic fishes from inhabiting the most exposed habitats when appropriate shelter is absent.

Fishes collected in cryptic samples consisted of both small camouflaged forms and juvenile benthic fishes including three species of rockfishes and the painted greenling. The small cryptic fishes consisted primarily of three species, which contributed 82% of the total individuals and 49% of the biomass. Overall, cryptic fishes increased the total numerical density estimate of the reef by 300% while their contributions to total biomass are less than ten percent. However, these fishes have a high turnover rate and may serve as important prey items to other fishes constituting an important component of energy transfer in reef ecosystems.

Many studies have attempted to discern the factors that influence fish assemblages in particular habitats. Artificial reefs in particular received a great deal of attention because they are often used as mitigation tools to replace lost habitat. In order to mitigate lost habitat effectively they must replace natural reefs in terms of species composition and biomass. Most studies comparing artificial and natural reefs have found general similarity in the fish assemblages (Russel 1975; Jones and Thompson 1978; Molles 1978; Matthews 1985). Studies have also reported higher densities of fish on artificial reefs than on natural reefs (Ambrose and Swarbrick 1989; Pondella et al. 2002). Some characteristics that influence temperate fish assemblages include temperature regime, recruitment success (Stephens et al. 1994) and algal cover (Holbrook et al. 1990). Stephens et al. (1984) suggested that temperature change is the most important factor controlling changes in the kelp-rock fish assemblage. Over the past three decades the Southern California Bight has warmed appreciably and Oregonian species have declined in this region. However, on a localized scale a persistent influence of cool water can support these species, a process that has been noted on the Pacific coast of Baja California (Horn and Allen 1978; Pondella et al. 2005).

The Los Angeles Federal Breakwater supports a diverse and abundant reef fish assemblage. Species richness and density were at or above comparable artificial and natural reefs. The persistent cool water of this area influences these factors. The largest artificial reef in Southern California, which borders the third busiest commercial port in the world, supports a healthy and robust ichthyofauna.

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