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SPATIAL AND SEASONAL VARIATION IN THE BIOMASS AND SIZE DISTRIBUTION OF JUVENILE FISHES ASSOCIATED WITH A PETROLEUM PLATFORM OFF THE CALIFORNIA COAST, 2008-2010

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Spatial and Seasonal Variation in the Biomass and Size Distribution of Juvenile Fishes Associated with a Petroleum Platform off the California Coast, 2008-2010

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TECHNICAL SUMMARY

Study Title: Spatial and Seasonal Variation in the Biomass and Size Distribution of Juvenile Fishes Associated with a Petroleum Platform off the California Coast, 2008-2010

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Background and Objectives

The BOEMRE defines decommissioning as the process of ending oil, gas, or sulfur operations and returning the lease or pipeline right-of-way to a condition that meets the requirements of the regulations. The BOEMRE will conduct detailed environmental reviews of any proposed decommissioning projects to evaluate the impacts from platform removal on regional fish populations. When a platform is disassembled, habitat is removed, and numerous fishes and invertebrates are killed. However, yet unknown are the impacts of platform removal on regional populations of coastal organisms, particularly the economically important rockfish species, on the Pacific Outer Continental Shelf (OCS). The assessment of the effects of platform activities and of the habitat created by the structure of platforms on marine populations greatly bears upon decommissioning issues, as questions about essential fish habitat and the ecological role of Pacific OCS platforms are still unresolved.

Platform decommissioning alternatives fall into four general categories: complete removal (the default option), toppling, partial removal, and leave-in-place. The suite of decommissioning alternatives that proposes to leave part or all of the abandoned platform structure in the marine environment is often collectively referred to as "rigs-to-reefs." At this time there are several key issues in the Pacific OCS platform decommissioning and reefing debate. Because fish populations are usually limited by available habitat, energy, or recruitment, it is important to determine if platforms provide critical habitat for early life history stages.

Previous BOEMRE-supported research has established that there can be extremely large numbers of young-of-the-year (YOY) rockfishes (of several species) inhabiting the midwater portions of oil platforms. This research documents that 1) Some rockfish species (such as bocaccio, *Sebastes paucispinis*) recruit at far higher densities to some platforms compared to most natural reefs, at densities that are large enough to later positively impact the abundance of the adult stock; 2) These juvenile rockfishes may be at least as healthy (as measured by growth rates) as similar fishes on natural reefs; 3) Subsurface currents likely deliver juvenile rockfishes to the platforms at 25 m or deeper; 4) The timing of settlement pulses is related to variability in current patterns, suggesting that the offshore location and the vertical structure of platforms serve an important function for recruitment (i.e., settlement) of juvenile rockfishes; 5) In the absence of a platform, many of the young-of-year rockfishes would not have been transported by currents to natural reefs and would have perished before finding settlement habitat.

However, in order to understand the environmental consequences of the various decommissioning alternatives on local and regional fish populations, there is a need to know the importance of the platform as depth-stratified fish habitat when compared to adjacent natural reefs of comparable depths. Platforms are structurally similar to pinnacles that steeply rise from the deep to shallow waters. Such natural features, which have been shown to harbor high densities of juvenile fishes, are uncommon along the California coast. This study was designed to evaluate the importance of the vertical structure of the platform as settlement (i.e., recruitment) habitat for juvenile rockfishes, particularly in regard to a decommissioning alternative of cutting off the top of a platform and leaving a subsurface, vertical structure in place.

The primary goal of the present study is to fill gaps in information about the spatial and depth variability in recruitment of juvenile fishes to POCS platforms and natural reefs off of the California coast, particularly in order to analyze the environmental consequences of partial platform removal on local and regional fish populations.

Description

The purpose of this study is to provide BOEMRE with information that can be used to determine the potential importance of platforms to the recruitment and survival of depleted fish stocks. In the decommissioning process, it will be important to understand the role that platforms play as rockfish nursery grounds. BOEMRE defined the following questions:

1) What is the effect of depth on juvenile fish density, size distribution, and species composition along the vertical structure of platforms?
2) Do platforms provide critical habitat for early life history stages? What is the recruitment value of a platform?

To address these information needs of BOEMRE, we conducted scuba surveys of the fish assemblages around seven platforms that represent all of the various environmental parameters these structures encounter. California platforms are sited in a variety of water masses, bottom depths, and distances from shore. We also conducted scuba surveys on seven representative reefs and three shipwrecks that are in 25 to 30 m of water and that occupy the same water masses as surveyed platforms. Previous studies show that most rockfish recruitment at platforms occurs below 25 m; however, reefs of comparable depth had yet to be surveyed before our study commenced.

This study addresses the first question in three ways: (a) the platform scuba surveys were conducted at three different depths to give some indication of what depth young fishes recruit from the plankton; (b) fish recruitment to natural reefs whose crests are at depths of 20-35 m (the possible platform topping depths) were surveyed using scuba to characterize the recruiting fish assemblage that might be expected to settle on a topped platform.; and (c) a novel experiment employing fish aggregation devices (FADs) was designed to evaluate the importance of the shallow portion of platforms (<25 m) for recruitment.

Our specific tasks in regard to the second question were to identify (a) what species recruit to platforms and natural reefs, and (b) the differences and similarities of species composition, density, and recruitment timing among platforms and natural reefs. Our findings provide useful information for comparing platforms (and natural reefs) as habitat for young rockfishes.

Significant Results

Visual surveys of fishes were conducted by scuba at seven oil platforms, seven natural reefs, and three shipwrecks from Avila Beach, central California, to Long Beach, southern California, during summer of 2008 and 2009 as scheduled for this project. Sites were surveyed between one and five times in each year. After numerous reports of relatively high abundances of recruiting YOY rockfishes in the Santa Barbara Channel region in spring 2010, we revisited most of the platforms, reefs, and wrecks at least once through the summer. This study provides two lines of evidence that indicate that rockfishes likely will recruit to platforms topped to subsurface depths between 25 and 30 m (the partial removal decommissioning option). The evidence is that: (1) young-of-the-year (YOY) rockfishes are uncommon in shallow waters at platforms; and (2) YOY rockfishes recruit to natural reefs and artificial structures (wrecks) that crest at depths comparable to where decommissioned platforms would be topped. The implication from this study that rockfishes would recruit to a number of the topped platforms is in agreement with surveys of deeper-water reefs that note high, although localized, densities of YOY rockfishes.

Overall, 67 taxa were observed during the two scheduled survey seasons (2008 and 2009) and the supplemental survey season (2010) combined: 45 taxa were seen at platforms, 53 taxa at reefs, and 50 taxa at wrecks. At the platforms, 21 rockfish species were observed; the most abundant were bocaccio, shortbelly rockfish, squarespot rockfish, and widow rockfish. With only two exceptions, all rockfish species with juvenile or adult representatives on platforms occurred as recently settled YOY in that habitat. Only five rockfish species did not occur at the platforms and were found at either or both reefs and wrecks. Among the 10 most abundant fish taxa at platforms in the two scheduled surveys combined, six were non-rockfishes: blacksmith, jack mackerel, jacksmelt (or topsmelt), Pacific sardine, sharpnose seaperch, and halfmoon. The shell mound at the Platform Hazel site was surveyed in November 2008 and only a few fish of four species (YOY calico rockfish, YOY vermillion rockfish, blackeye goby, and YOY sheephead) were observed. Species-specific summaries of habitat use by rockfishes and non-rockfishes that are numerically important at the platforms and their size distributions are reported.

A consistent pattern among the two scheduled survey seasons and the supplemental survey season was the rarity of YOY rockfishes at the shallowest level of the platforms. In 2008, only one YOY rockfish was observed at the shallowest level among all platforms; in 2009, only 89 YOY rockfishes were observed at the shallowest level of platforms. Moreover, YOY rockfishes predominated the assemblage at the deepest level of the platforms with bocaccio, shortbelly rockfish, squarespot rockfish, and widow rockfish as the most abundant of 21 rockfish taxa observed. YOY rockfish recruitment at the platforms generally was greater in 2009 than in 2008, and higher densities at the deepest level of the platforms accounted for the increase.

Other than the concentration of YOY rockfishes at the deeper levels of the structures, there was no consistent pattern in overall YOY rockfish densities among the platforms between years. In 2008, the average YOY rockfish density was two orders of magnitude higher at Platform Irene than at the other platforms due to a single observation of a very large school of widow rockfish at the middle and deep levels. Rockfish recruitment was weak among the other platforms in 2008 except for squarespot rockfish at Platform Ellen recruiting to the deepest level. In contrast, in 2009, YOY rockfish densities were highest at Platform Gilda. Average densities increased at least two orders of magnitude at this platform and at B, Grace, and Eureka from the previous year. In 2010, YOY rockfish densities at Gilda, Grace, and Gina, three platforms clustered with Gail near the eastern entrance of the Channel, far exceeded densities at all platforms in the two previous years. The increase in each year was primarily due to bocaccio recruitment to the deepest level of the platforms.

Non-rockfishes, in contrast with rockfishes, generally were most abundant at the two shallower levels of the platforms during the two scheduled survey seasons and the supplemental survey season. Jack mackerel, a schooling pelagic species, and blacksmith, a schooling nearshore reef species, were the predominant non-rockfish taxa. Also numerous on occasion were other schooling species: jacksmelt (or topsmelt) and halfmoon. All of these schooling species have warm water affinities. Rockfishes and cabezon, species with cold water affinities, tended to be found at the deep 30-m level of platforms. Non-rockfishes 12 cm TL and less were more abundant by an order of magnitude at platforms off San Pedro than platforms in the Santa Barbara Channel during the two scheduled survey years; in contrast in 2010, the smaller size class of non-rockfishes was uncommon at Ellen and Eureka. Conspicuously rare were non-rockfishes at the northernmost platform, Irene; and like rockfishes, non-rockfishes were absent from the shallowest level. Irene is located off Point Conception, where wind-induced upwelling occurs through much of the year with strong currents directed offshore and turbulent wave surges in surface waters.

The relative abundance of total YOY rockfishes among platforms reefs and wrecks differed between the two scheduled survey seasons. In 2008 the density of YOY rockfishes at reefs and wrecks was no greater than the density at the middle and deep levels of the platforms. In contrast, in 2009, rockfish densities at the deepest level of platforms exceeded the densities at reefs and wrecks. YOY rockfish assemblages at platforms changed between years due to the recruitment of different YOY species; whereas, in contrast, the composition of the YOY rockfish assemblage at reefs and wrecks were more consistent between years and similar among sites. The assemblages from the two deeper levels of the platforms, reefs and wrecks were more similar in 2008 than in 2009. In 2009, the assemblages of the two deeper platform habitats differed from reef habitat; the relatively high density of YOY bocaccio at the two deeper platform level habitats and squarespot rockfish at reef habitat primarily accounted for the dissimilarity.

The supplemental surveys in 2010 documented a strong recruitment year for rockfishes. Clearly, YOY rockfish densities increased at platforms, reefs, and wrecks in 2010 from the previous years. Moreover, YOY rockfish densities at reefs in 2010 increased by an order of magnitude from the previous year to exceed YOY densities at platforms in 2010. In the two previous years combined, jackmackerel and blacksmith dominated the reef assemblage by total count. In contrast, in 2010, YOY shortbelly rockfish and bocaccio each outnumbered all non-rockfishes counted in the two previous years. YOY squarespot rockfish also were far more abundant in 2010. Similarly at the wrecks in 2010, rockfishes, namely YOY bocaccio, squarespot rockfish, and blue rockfish, were more abundant than all non-rockfishes combined. Strong recruitment of YOY rockfishes in 2010 clearly contributed to the decline in the importance of non-rockfishes from the previous two years and changes in the relative importance of species in the rockfish assemblage at all habitats.

In summary, the findings from this study show that YOY rockfish densities typically are concentrated below the shallow portion of the platform that would be removed should a platform be partially left in place when decommissioned. Additionally, YOY rockfish recruit to reefs and wrecks and these assemblages do not necessarily differ from the assemblage found between 25 and 30 m at platforms. Thus, it is plausible that the environmental consequences on local and regional rockfish populations from the partial removal of any of the platforms in this study will not be significant. However, to complicate the matter, the YOY rockfish assemblage and the abundance of YOY vary spatially and temporally among platforms. If the consequences of full removal of platforms, on a rig-by-rig basis, must be evaluated, then it is particularly important to determine the contribution of each platform to the fish stock in the region.

STUDY PRODUCTS

Report

Love, M. S. and M. M. Nishimoto. 2009. Spatial and seasonal variation in the biomass and size distribution of juvenile fishes associated with a petroleum platform off the California coast, 2008 Annual Report. (U. S. Department of the Interior, Minerals Management Service, Camarillo, CA, 93010, OCS Study MMS)

Poster

Nishimoto, M. M. and M. S. Love. The vertical distribution of young-of-year rockfishes at platforms: the lowdown on partial removal for rig-to-reef conversion. 16th Western Groundfish Conference, April 26 – 30, 2010, Juneau, AK.

Spatial and Seasonal Variation in the Biomass and Size Distribution of Juvenile Fishes Associated with a Petroleum Platform Off The California Coast, 2008-2010

ABSTRACT

The assessment of the effects of platform activities and of the habitat created by the structure of petroleum platforms on marine populations greatly bears upon decommissioning issues. The suite of decommissioning alternatives that proposes to leave part or all of the abandoned platform structure in the marine environment is often collectively referred to as "rigs-to-reefs." The primary goal of this study was to evaluate the importance of the vertical structure of the platform as settlement (i.e., recruitment) habitat for juvenile rockfishes, particularly in regard to the decommissioning alternative of cutting off the top of a platform and leaving a subsurface, vertical structure in place. We conducted visual surveys of fishes by scuba at seven oil platforms, seven natural reefs, and three shipwrecks from Avila Beach, central California, to Long Beach, southern California, during the summers of 2008 and 2009. Overall, 65 fish taxa were observed during the two survey seasons combined: 44 taxa were seen at platforms, 49 taxa at reefs, and 49 taxa at wrecks. At the platforms, 17 rockfish species were observed; the most abundant were bocaccio, widow rockfish, squarespot rockfish, and shortbelly rockfish. With only two exceptions, all rockfish species with juvenile or adult representatives on platforms occurred as recently settled young-of-the-year (YOY) in that habitat. Among the 10 most abundant fish taxa at platforms, six were non-rockfishes: blacksmith, jack mackerel, jacksmelt/topsmelt, Pacific sardine, sharpnose seaperch, and halfmoon which are all schooling species with warm-water affinities. This study provides two lines of evidence that indicate that rockfishes likely will recruit to platforms topped to subsurface depths between 25 and 30 m (the partial removal decommissioning option). The evidence is that: (1) YOY rockfishes are uncommon in shallow waters at platforms; and (2) YOY rockfishes recruit to reefs and wrecks and these assemblages do not necessarily differ from the assemblage found between 25 and 30 m at platforms. A consistent pattern between the two years of scuba surveys was the rarity of YOY rockfishes at the shallowest level (5-11 m) of the platforms. Moreover, YOY rockfishes predominated the assemblage at the deepest level (26-35 m) of the platforms with bocaccio, widow rockfish, and squarespot rockfish as the most abundant of 17 rockfish taxa observed. YOY rockfish recruitment at the platforms generally was greater in 2009 than in 2008, and higher densities at the deepest level of the platforms accounted for the increase. Supplementary data for this study from additional scuba surveys in 2010 are summarized. We revisited most of the platforms, reefs, and wrecks in 2010 at least once during summer 2010 after numerous reports of relatively high abundances of recruiting YOY rockfishes in the Santa Barbara Channel region. YOY rockfish densities in all habitats (platforms, reefs, and wrecks) increased markedly in 2010 above levels in the two previous years with the effect most pronounced at reefs. As in 2008 and 2009, the densities of rockfishes in 2010 were highest at the deepest level of platforms. The additional surveys in 2010 suggest that in years of relatively poor recruitment (e.g., 2008 and 2009), platforms play a more significant role as nursery habitat for regional populations of juvenile rockfishes.

INTRODUCTION

Although hundreds of thousands of juvenile rockfishes sometimes inhabit the midwaters of Pacific Outer Continental Shelf platforms (e.g., Love et al. 2003, 2010), the role that platforms play as nursery grounds for a number of commercially and recreationally exploited species is not well understood. Understanding this role is of critical importance to the Bureau of Ocean Energy Management, Regulation, and Enforcement (BOEMRE) and the State of California in assessing the ramifications of different platform decommissioning options (Holbrook et al. 2000; Bernstein et al. 2010).

Platform decommissioning alternatives fall into four general categories: complete removal (the default option), toppling, partial removal, and leave-in-place. The suite of decommissioning alternatives that proposes to leave part or all of the abandoned platform structure in the marine environment is often collectively referred to as "rigs-to-reefs." In a technical analysis to inform State policy on platform decommissioning, Bernstein et al. (2010) assessed that there will be much less biological production under the complete removal option compared to the partial removal option. The potential impacts of partial removal on the nursery function of platforms concern Federal and State marine resource managers charged with ensuring marine population sustainability and stakeholders that include but are not limited to recreational and commercial fishers, scuba divers, and conservationists. The newly enacted California Marine Resources Legacy Act authorizes the California Department of Fish and Game to approve the conversion of a decommissioned rig in State or Federal waters into an artificial reef if beneficial to the environment compared to the alternative of complete removal. BOEMRE is the lead agency for permitting the decommissioning of individual platforms in Federal waters (Schroeder and Love 2004).

Previous scuba and submersible studies show that different fish and invertebrate species tend to occur at different depths on the platforms. The depths at which fish recruit and the depths that adults inhabit vary markedly among species. Young-of-year (YOY) of a variety of shallow-dwelling and deep-dwelling benthic reef fish species recruit from the plankton primarily to the upper depths of the platform structure (e.g., Carr et al. 2003, Love et al. 2003). Furthermore, the relative densities of the YOY of many common rockfish species can be far greater on platforms than on reefs. Some of these species remain on the platforms for only part of their lives while others reside at the manmade habitats through much of adult life as documented by annual submersible surveys that have been conducted since 1995 (Love et al. 2003). These findings collectively generated what is now a long-standing concern that partial removal of the shallow portion of a platform (above ~ 25 m depth), may decrease the number of YOY rockfishes that recruit to the converted structure (Carr et al. 2003).

Twenty-seven active offshore production platforms are distributed in State and Federal waters from just north of Point Arguello to south off Orange County. The oil platforms extend throughout the water column from the ocean bottom to the surface. The platforms are located between 1.9 and 16.9 km from shore and at depths ranging from 11-363 m (Love et al. 2010). Details regarding platform dimensions and placement are found in Love et al. (2003).

The diversity in the species assemblage of YOY fishes around platforms is not only related to the vertical structure of the platform, geographic location, and bottom depth of the platform, but also coastal oceanography (Love et al. 2003, 2010; Nishimoto et al. 2008). The early life stages of most coastal reef fishes are subject to dispersal by ocean currents while in the plankton for days to months depending on species. Thus, local and regional current patterns will influence the composition of species that recruit from the plankton to an individual platform or reef, and affect the distribution of these YOY populations across habitats in the region.

The distribution of the platforms spans a biogeographic transition zone between the cold Oregonian and warm San Diegan marine provinces of the California Current System where a great diversity of marine organisms of both warm- and cold-water affinities occur (Hickey et al. 2003; Pondella et al. 2005). To the north and at the western entrance of the Santa Barbara Channel, cool waters of the California Current flow southward along the outer shelf, and colder, nutrient-rich water upwells nearshore and flows offshore over the shelf. Through much of the spring and summer when the YOY of rockfishes and many other reef fishes recruit to coastal habitat, upwelling occurs off Point Arguello and Point Conception where four northernmost platforms (including Platform Irene) are situated. In contrast, seven southernmost platforms (including Platforms Ellen and Eureka) are bathed in warmer currents that flow northward from Mexico. Within the Santa Barbara Channel, platforms are distributed along a gradient between these two extremes. The generalized circulation pattern in the Channel is cyclonic (counterclockwise in direction) during the spring and summer when the YOY of rockfishes and many other reef fishes recruit (Harms and Winant 1998). Relatively warm currents from the Southern California Bight flow westward along the mainland shelf and slope while cooler currents flow eastward along the Channel Islands. During this period, waters in the western half of the Channel generally are cooler than waters in the eastern Channel. Regional and local oceanographic conditions, such as current flow patterns, temperature and salinity, and nutrient concentrations, are variable seasonally and interannually (Lynn and Simpson 1987; Bjorkstedt et al. 2010). Changes in fish species abundance and distribution, reproduction, YOY recruitment, and survivorship have been associated with the phenomena of El Nino/La Nina and Pacific Decadal Oscillations (Lenarz et al. 1995; McGowan et al. 1998).

The primary goal of this study is to fill gaps in information about the spatial and vertical depth variability in recruitment of rockfishes to POCS platforms and natural reefs off of the California coast, particularly to provide data that can be used in future analyses of the environmental consequences of partial platform removal on local and regional fish populations. For example, at the time of this study, Bernstein et al. (2010) identified the lack of recruitment data from platforms and reefs for species other than bocaccio which limited the modeling of local biological production at platforms and the estimation of impacts of partial platform removal. Particularly lacking in previous studies has been information on fish recruitment at natural reefs at intermediate depths between 20 and 40 m. Rocky outcrops between 50 and 100 m in the Southern California Bight are habitat for several species of YOY rockfish that commonly occur in either nearshore kelp beds or deeper-water reefs (Love and Schroeder 2007; Love et al. 2009). We conducted SCUBA surveys at platforms and at natural reefs and shipwrecks that are at depths of at least 25 m to collect comparative data on what rockfish species settle (i.e., recruit), their densities, and size distributions in these habitats, as well as the depth at which rockfishes recruit at platforms. In addition, a novel experiment employing fish aggregation devices (FADs), was designed to evaluate the importance of the shallow portion of platforms (<25 m) for recruitment.

METHODS

SURVEYS AT PLATFORMS, REEFS, AND SHIPWRECKS

Visual surveys of fishes were conducted by scuba at oil platforms, natural reefs, and shipwrecks from Avila Beach, central California, to Long Beach, southern California, during Summer of 2008 and 2009 (Fig. 1). Sampling months at each site are given in Table 1. Sites were surveyed between one and five times in each year. Seven oil platforms, seven natural reefs, and three shipwrecks were surveyed. In addition, the shell mound at the site where Platform Hazel was removed was surveyed once in 2008. Divers recorded both the abundance and total length of each fish encountered. All divers engaged in visual surveys were first thoroughly trained in fish species identification and size estimation.

During each oil platform survey divers recorded observations within a 2 m wide x 2 m high window while swimming a pattern that covered the four corners and major horizontal support beams of the platform at three different depths (Fig. 2). The depths of these levels differ somewhat between platforms as the design of each platform may vary. Level 1 ranged from 5-11 m, level 2 11-22 m, and level 3 26-35 m.

Two slightly different sampling methodologies were employed when conducting fish surveys on natural reefs and shipwrecks. First, using a retractable transect tape one diver would count and estimate sizes of all fishes encountered along belt transects 30 m in length x 2 m wide x 2 m high. In addition, another observer would perform a series of five-minute fish counts. During these timed transects the diver would search for and count only young-of-the-year (YOY) rockfishes. These divers would look for rockfish YOY in places where they are known to occur such as boulder fields, crevices, and overhangs. Whenever possible at least three transects of each sampling method were conducted during each survey (i.e., site visit).

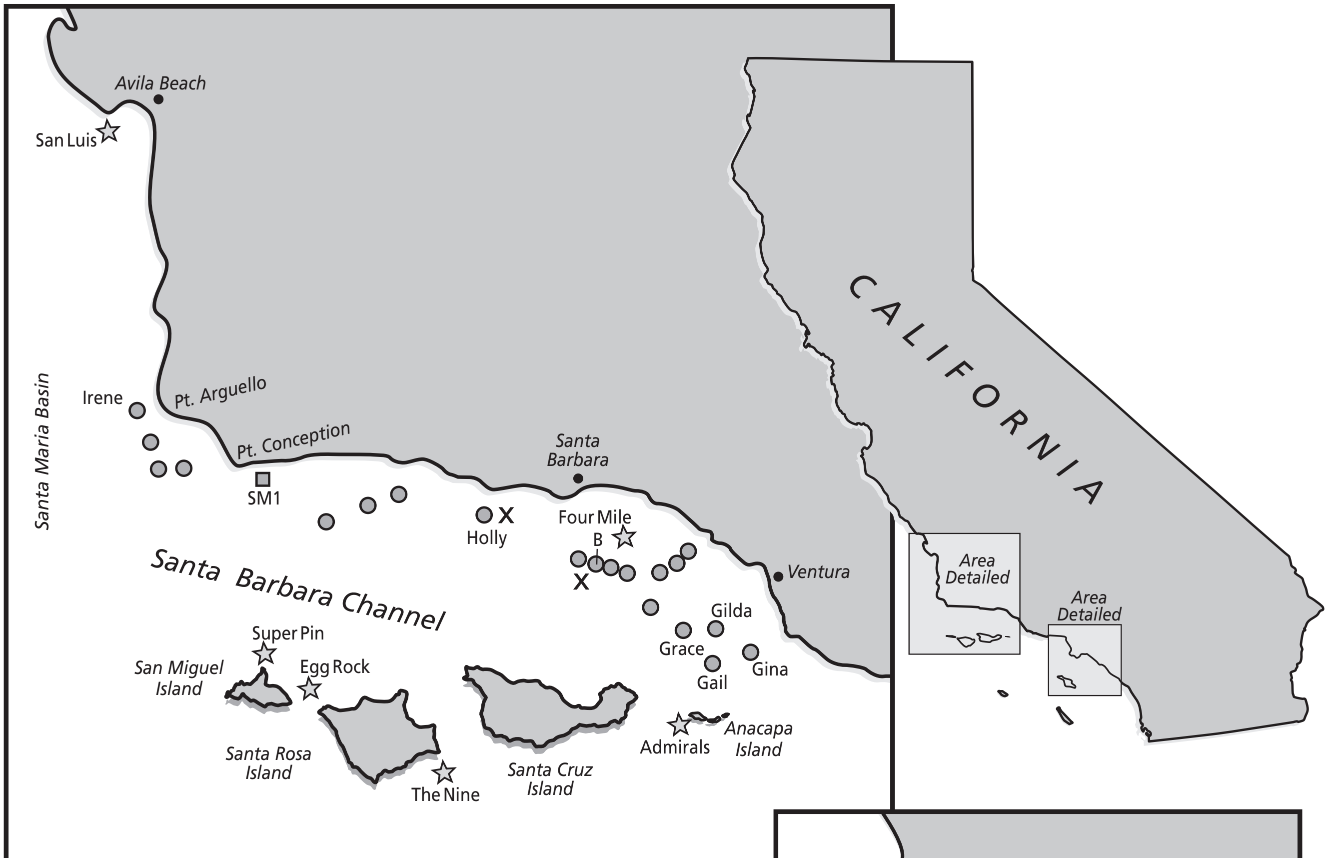
Fish counts from each oil platform survey were converted to density estimates (fish/100 m^2). The lengths of the survey transects at the platforms were measured by the divers. Fish density per platform was based on the total distance surveyed at each structure. Although the observer's swim pattern was consistent among platforms (Fig. 2), the lengths of the survey transects varied among the structures of different sizes. We also estimated fish density per level per platform. The areal coverage differed among the three levels at each platform.

Fish densities (fish/100 m^2) at the natural reefs, shipwrecks, and the Hazel shell mound were estimated from belt transect surveys. For each survey, the average number of fish per 30 m transect was calculated and then standardized to number of fish/100 m^2. In 2008, density estimates were based on three to eleven transects per survey. In 2009, three transects were conducted during each survey.

The timed fish surveys provided relative abundances of young-of-year rockfish species by rank. Four Mile Reef was sufficiently deep (restricting bottom time) and steep to preclude belt transect sampling.

Fish densities were estimated for two size classes: 1) less than or equal to 12 cm TL; 2) greater than 12 cm TL. We defined the smaller size class to include all YOY rockfishes, and refer to this size class as such. We compared YOY rockfish assemblages at levels of the platforms, reefs, and wrecks using methods of multidimensional scaling, cluster analysis, and analysis of similarity (PRIMER). Species densities were square root transformed for the assemblage analyses.

Supplementary data from additional scuba surveys in 2010 are summarized in this report (Ap-



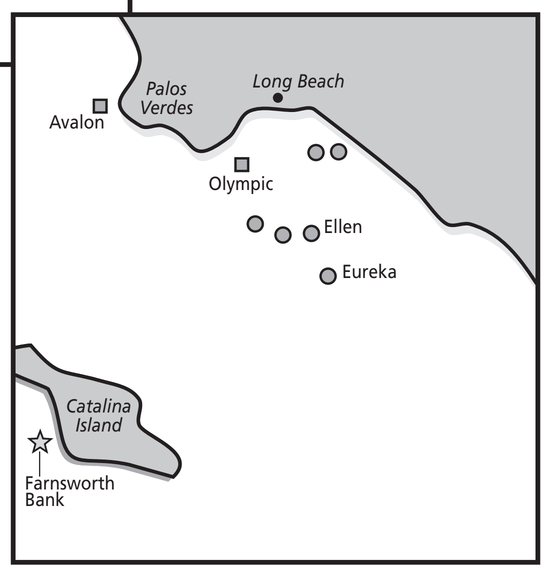


Figure 1. Map of the study area. Scuba surveys were conducted at sites from Avila Beach, central California to Long Beach, southern California, during Summer of 2008–2010. Circles demarcate platforms in the Santa Maria Basin and Santa Barbara Channel (large map) and on the San Pedro shelf and slope (small map). The platforms surveyed in this study are designated by name. Surveyed reefs and wrecks are labeled by name and demarcated by stars and squares, respectively. The two sites where the Fish Aggregating Device (FAD) experiment was conducted, near Platform Holly and Platform B, are labeled X.

pendix 4). We revisited most of the platforms, reefs, and wrecks in 2010 at least once during summer 2010 after numerous reports of relatively high abundances of recruiting YOY rockfishes in the Santa Barbara Channel region. Two platforms, Gina and Gail, which were not surveyed in 2008 or 2009, were surveyed in 2010 (Fig. 1). The same visual survey methodology was used in 2010 as in the two previous years.

Appendix 5 provides the locations and descriptions of platforms, reefs, and wrecks surveyed, June to September, 2008–2010.

FISH AGGREGATING DEVICE (FAD) EXPERIMENT

During Spring 2009, Fish Aggregating Devices (FADs) were deployed as platform analogs to evaluate the importance of the shallow water habitat (<25 m) for recruitment at platforms. The experiment was conducted at two sites, one within the area of Platform Holly, the other near Platforms A and B (Fig. 1, Table 2).

A set of three experimental moorings and three control moorings were deployed at each site (Fig. 3). Each experimental mooring served as an analog of a

Table 1. Schedule of 3-level surveys at platforms and belt transect and timed transect surveys at reefs, wrecks, and shell mound in 2008 and 2009; n is number of 30-m belt transects completed during a survey visit to a reef, wreck, or shell mound with exception of Four Mile Reef where 5-minute transects were conducted.

	2008					2009			
	Round 1	Round 2	Round 3	Round 4	Round 5	Round 1	Round 2	Round 3	Round 4
PLATFORMS									
HOLLY	6/3	6/24*	7/24*	8/21	9/26	6/9	7/7	8/4	9/9
GILDA	6/10		7/18	8/22	9/18	6/5	7/10	8/13	9/10
GRACE	6/10		7/18	8/19	9/18	6/5	7/10	8/13	9/10
B	6/17		7/17	8/26	9/16	5/19	6/23	8/6	9/8
ELLEN			7/9		9/13		7/17	8/21	
EUREKA			7/9*		9/13		7/17*	8/21	
IRENE			7/11	8/28*	9/23	5/29		8/19	
REEFS									
Admirals	5/13	6/12	7/15	8/15	9/19	5/26	6/26	7/31	9/1
n	5	4	8	6	5	3	3	3	3
Egg Rock	5/16	6/27		9/4	9/25	5/22		8/11	9/2
n	3	3		3	3	3		3	3
Farnsworth							7/16		
n							3		
Nine	5/15	6/20		8/7	9/9	5/28		8/11	9/2
n	4	11		10	8	3		3	3
San Luis				9/5	9/24				8/28
n				5	6				3
Super Pin	5/16	6/27		9/4	9/25	5/22		8/11	9/2
n	3	3		3	3	3		3	3
Four Mile		6/26	7/29	7/31	9/8	6/11	7/20		9/3
n		2	2	2	3	3	3		3
WRECKS									
Avalon			7/8		9/12		7/15	8/20	
n			3		3		3	3	
Olympic			7/8		9/12		7/15	8/20	
n			3		3		3	3	
SM1		6/24	7/25	8/28	9/23	5/29	7/9	8/19	
n		3	3	3	3	3	3	3	
SHELL MOUND									
Hazel					11/21				
n					4				

*partial survey at platform

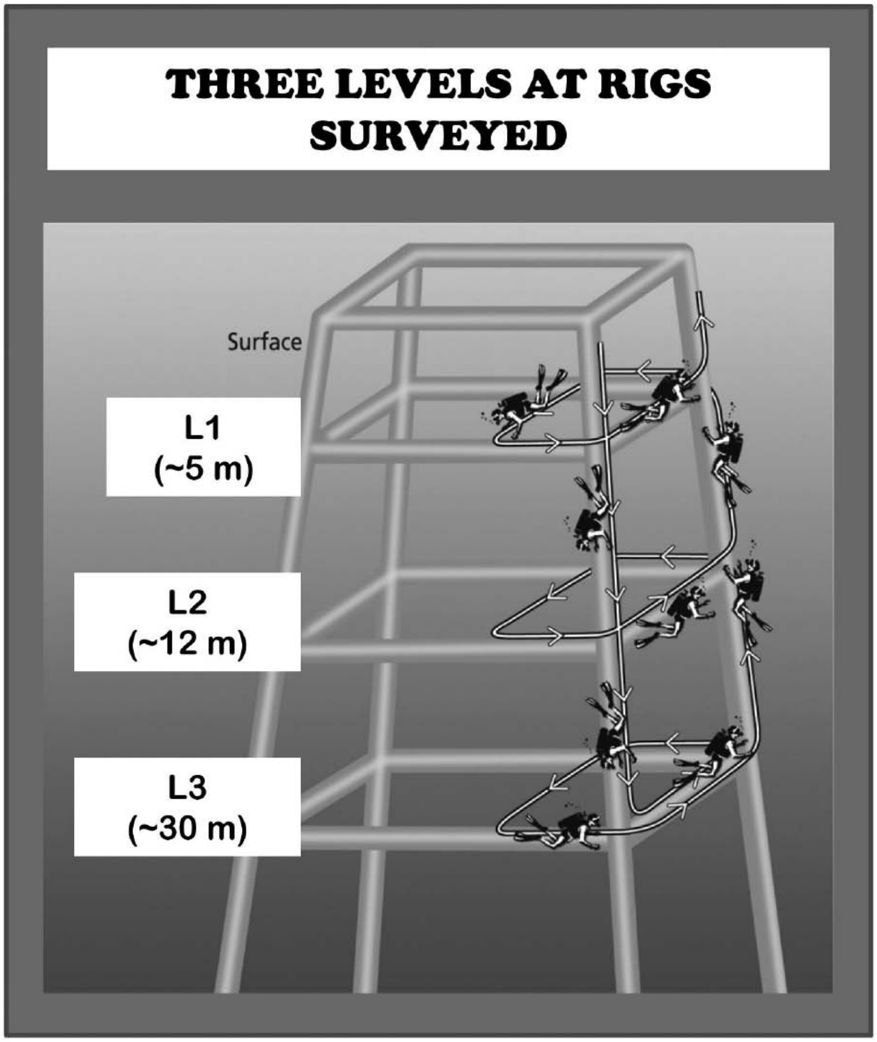


Figure 2. Schematic diagram of the sampling transect pattern swum by scuba divers surveying three levels of a typical oil platform structure. The transect pattern was repeated on the opposite side of the platform to complete the survey.

platform dismantled down to 25 m below the surface and consisted of one FAD unit acting as juvenile fish settlement habitat at that depth. As would be the case at a "topped" platform, no structure was available for fishes to settle upon above this FAD. Only a thin line, which we presumed would have a negligible effect as structure for fish settlement in the water column, ascended from the FAD unit at 25 m to a small surface marker buoy. In contrast, each control mooring consisted of one FAD unit about 25 m below the surface as on the experimental mooring and another FAD unit at 6-9 m providing shallow settlement habitat as on an intact platform.

Our hypothesis was that if shallow water habitat is important for juvenile rockfish recruitment to offshore structures, the recruits would be more abundant at the upper FAD units than lower FAD units on the control moorings. Additionally, if recruits vertically migrated to deeper water after initially settling on shallow water habitat, the abundance of recruits would be greater on the deep FAD units on the control mooring than on the FAD units at comparable depth on the experimental mooring.

Each FAD unit was comprised of two structures: 1) a SMURF (Standard Monitoring Units For the Recruitment of temperate reef Fishes), a 1 m x 0.25 m diameter plastic wide-mesh tube loosely stuffed with strips of plastic sheeting (Ammann 2004); and a Porcupine Fish Attractor© (2009 Patent pending, Cedars Ltd.), a spherical structure about 1.5 m diameter made of PVC rods radiating from a central orb. Scuba divers monitored the FAD moorings using two methods. First, the divers censused all fishes around the two types of FAD structures. Next, the divers encased the SMURF with a small-mesh net to retrieve, identify, innumerate, and measure the cryptic individuals that had settled within the SMURF.

RESULTS

SPECIES COMPOSITION IN THE THREE HABITATS: PLATFORMS, REEFS, AND WRECKS

Overall, 65 fish taxa were observed during the two scheduled survey seasons, 2008 and 2009 (Tables 3-8). Forty-four taxa were seen at platforms, 49 taxa at reefs from the 30-m transect surveys and the 5-min transect surveys, and 49 taxa at wrecks from the two survey methods.

Among the three habitats, twenty-two species of rockfishes and three rockfish species complexes (KGB, OYT, ROSY) were observed (Tables 4-7). The complexes are designations for groups of rockfish species that are indistinguishable from one another as small YOY in visual surveys. Fish identified as "KGB"

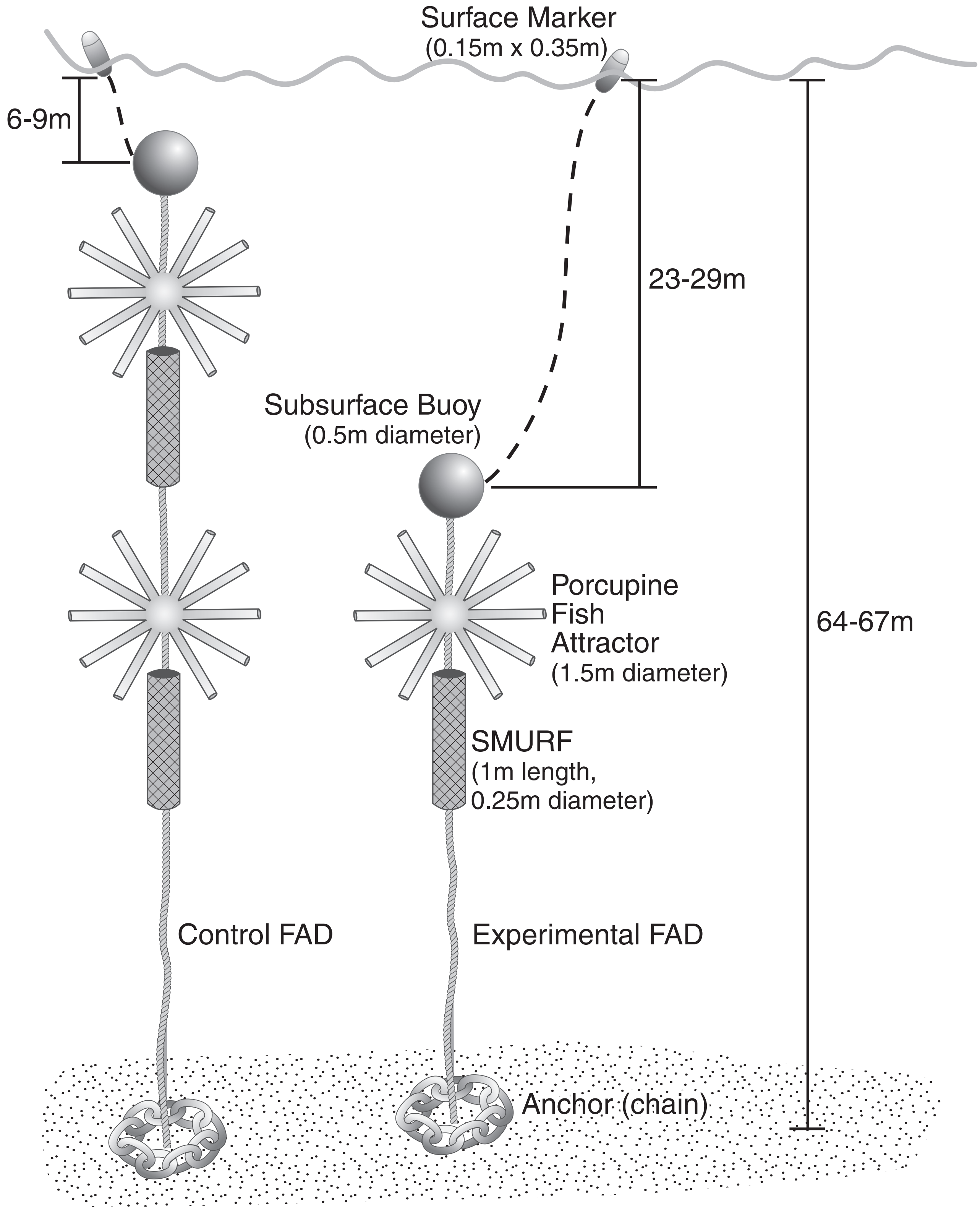


Figure 3. Schematic diagram of the experimental (right) and control (left) moorings deployed in the Fish Aggregating Device (FAD) experiment.

Table 2. Survey schedule of the fish attraction device (FAD) experiment in 2009. Moorings 1-6 were deployed off Goleta near Platform Holly, moorings 7-12 off Santa Barbara off Platforms A and B on the initial date during round 1 or 2. Each mooring was revisited on subsequent dates. "NS", no survey conducted.

Mooring	Top	Bottom	Round 1	Round 2	Round 3	Round 4	Round 5	Round 6	Round 7	Round 8
1		x	2-Jun	16-Jun	30-Jun	13-Jul	28-Jul	NS	NS	NS
2	x	x	2-Jun	*	30-Jun	13-Jul	28-Jul	14-Aug	27-Aug	NS
3		x	2-Jun	16-Jun	30-Jun	13-Jul	28-Jul	14-Aug	27-Aug	11-Sep
4	x	x	NS	16-Jun	30-Jun	13-Jul	28-Jul	14-Aug	27-Aug	11-Sep
5		x	2-Jun	16-Jun	30-Jun	13-Jul	28-Jul	14-Aug	27-Aug	11-Sep
6	x	x	2-Jun	*	30-Jun	13-Jul	28-Jul	14-Aug	27-Aug	11-Sep
7		x	4-Jun	18-Jun	2-Jul	14-Jul	30-Jul	14-Aug	27-Aug	11-Sep
8	x	x	NS	18-Jun	2-Jul	14-Jul	30-Jul	14-Aug	27-Aug	11-Sep
9		x	4-Jun	18-Jun	2-Jul	14-Jul	30-Jul	14-Aug	27-Aug	11-Sep
10	x	x	4-Jun	18-Jun	2-Jul	14-Jul	30-Jul	14-Aug	27-Aug	11-Sep
11		x	4-Jun	18-Jun	2-Jul	14-Jul	30-Jul	14-Aug	27-Aug	11-Sep
12	x	x	4-Jun	18-Jun	2-Jul	14-Jul	30-Jul	14-Aug	27-Aug	11-Sep

* Original mooring could not be located, and a replacement mooring was deployed

complex are kelp rockfish, gopher rockfish, or black-and-yellow rockfish. Fish identified as OYT are either olive rockfish or yellowtail rockfish. Fish designated ROSY are likely rosy rockfish or swordspine rockfish, but may also be other members of the rockfish subgenus *Sebastomus*. Species-specific summaries of habitat use by rockfishes that were numerically important at the platforms in 2008 and 2009 are in Appendix 1. All rockfish species, except for brown rockfish and black-and-yellow rockfish, occurred as recently settled YOY (12 cm TL and less) at one or more of the habitats. Black-and-yellow rockfish less than 12 cm TL may have been counted but identified as KGB during the surveys at any of the three habitats.

At the platforms, seventeen rockfish species, three species complexes (KGB, OYT, ROSY), and a few unidentified rockfishes were observed (Table 4). All rockfish species with juvenile or adult representatives on the platform, with exception of brown rockfish and black-and-yellow rockfish, occurred as recently settled YOY in that habitat.

Only five rockfish species did not occur at the platforms and were found at either or both reefs and wrecks (Tables 4-6). YOY black rockfish and stripetail rockfish were observed only at the reefs (Table 5). YOY and older juvenile starry rockfish and YOY china rockfish were found exclusively at the wrecks in the timed surveys. Vermillion rockfish were identified as YOY, juveniles, and adults at the reefs and wrecks.

Among the 10 most abundant fish taxa at platforms, six were non-rockfishes: blacksmith, jack mackerel, jacksmelt (or topsmelt), Pacific sardine, sharpnose seaperch, and halfmoon (Table 4). These non-rockfishes comprised 41% of the total fishes counted at platforms. Blacksmith (27% of all fishes counted) was second to bocaccio (45%) at platforms. At reefs, jack mackerel (45%) and blacksmith (29%) outnumbered all rockfishes (16%) (Table 5). At wrecks, blacksmith (41%), the most common non-rockfish, was equally abundant as all rockfishes combined (41%) (Table 6). Species-specific summaries of habitat use by non-rockfishes that are numerically important at the platforms are in Appendix 2.

Five non-rockfish taxa, atherinids, zebra perch, ocean sunfish, YOY and adult sharpnose seaperch, and pipefish, were observed only at the platforms (Tables 4-8). Fifteen non-rockfish taxa occurring at the reefs or wrecks were not seen on platforms. Kelp perch, black perch, unidentified kelpfish, spotfin surfperch, rainbow seaperch, bluebanded goby, lingcod, and rubberlip seaperch occurred on both reefs and wrecks. Wolf-eel, giant kelpfish, California scorpionfish, tubesnout, barred sandbass, stripedfin ronquil, and giant seabass were exclusively observed at wrecks.

At Four-Mile Reef, we used only the 5-minute transect method to estimate the relative abundance

Table 3. List of taxa observed in surveys, 2008–2009, at platforms, reefs, wrecks, and shell mounds with stage of development at 12 cm TL (YOY = Young-Of-the Year).

Family	Scientific name	Common name	Stage at 12 cm TL
Anarhichadidae	*Anarrhichthys ocellatus*	wolf-eel	immature
Atherinidae	*Atherinops affinis or Atherinopsis californiensis*	topsmelt or jacksmelt	immature
Aulorhynchidae	*Aulorhynchus flavidus*	tube-snout	mature
Bathymasteridae	*Rathbunella hypoplecta*	stripedfin ronquil	immature
	Rathbunella spp.	ronquil spp.	immature
Carangidae	*Trachurus symmetricus*	jack mackerel	YOY
Clinidae	*Gibbonsia spp.*	kelpfish spp.	immature
Clinidae	*Heterostichus rostratus*	giant kelpfish	immature
Clupeidae	*Sardinops sagax*	Pacific sardine	YOY
Cottidae	*Cottidae*	sculpin spp.	mature
Cottidae	*Scorpaenichthys marmoratus*	cabezon	YOY
Embiotocidae	*Brachyistius frenatus*	kelp perch	mature
	Embiotoca jacksoni	black perch	mature
	Embiotoca lateralis	striped seaperch	immature
	Hyperprosopon anale	spotfin surfperch	mature
	Hypsurus caryi	rainbow seaperch	immature
	Phanerodon atripes	sharpnose seaperch	immature
	Phanerodon furcatus	white seaperch	mature
	Rhacochilus toxotes	rubberlip seaperch	immature
	Rhacochilus vacca	pile perch	immature
Gobiidae	*Lythrypnus dalli*	bluebanded goby	mature
	Rhinogobiops nicholsii	blackeye goby	mature
Hexagrammidae	*Hexagrammos decagrammus*	kelp greenling	YOY
	Ophiodon elongatus	lingcod	YOY
	Oxylebius pictus	painted greenling	mature
Kyphosidae	*Girella nigricans*	opaleye	immature
	Hermosilla azurea	zebra perch	immature
	Medialuna californiensis	halfmoon	immature
Labridae	*Oxyjulis californica*	senorita	mature
	Semicossyphus pulcher	California sheephead	YOY
Molidae	*Mola mola*	ocean sunfish	YOY
Polyprionidae	*Stereolepis gigas*	giant seabass	YOY
Pomacentridae	*Chromis punctipinnis*	blacksmith	immature
	Hypsypops rubicundus	garibaldi	immature
Scorpaenidae	*Scorpaena guttata*	California scorpionfish	immature
	Sebastes atrovirens	kelp rockfish	YOY
	Sebastes atrovirens, S. carnatus, or *S. chrysomelas*	kelp rockfish, gopher rockfish, or black-and-yellow rockfish (KGB)	YOY
	Sebastes auriculatus	brown rockfish	YOY
	Sebastes carnatus	gopher rockfish	YOY
	Sebastes caurinus	copper rockfish	YOY
	Sebastes chrysomelas	black-and-yellow rockfish	YOY
	Sebastes constellatus	starry rockfish	YOY
	Sebastes dalli	calico rockfish	mature
	Sebastes entomelas	widow rockfish	YOY
	Sebastes flavidus or *S. serranoides*	yellowtail rockfish or olive rockfish (OYT)	YOY
	Sebastes hopkinsi	squarespot rockfish	YOY
	Sebastes jordani	shortbelly rockfish	YOY
	Sebastes melanops	black rockfish	YOY
	Sebastes miniatus	vermillion rockfish	YOY
	Sebastes mystinus	blue rockfish	YOY
	Sebastes nebulosus	china rockfish	YOY
	Sebastes paucispinis	bocaccio	YOY
	Sebastes pinniger	canary rockfish	YOY
	Sebastes rastrelliger	grass rockfish	YOY
	Sebastes rosaceus	rosy rockfish (ROSY)*	mature
	Sebastes rubrivinctus	flag rockfish	immature
	Sebastes saxicola	stripetail rockfish	mature
	Sebastes semicinctus	halfbanded rockfish	mature
	Sebastes serranoides	olive rockfish	YOY
	Sebastes serriceps	treefish	YOY
	Sebastes spp yoy	unidentified young-of-year rockfish	YOY
	Sebastes umbrosus	honeycomb rockfish	mature
Serranidae	*Paralabrax clathratus*	kelp bass	YOY
	Paralabrax nebulifer	barred sandbass	YOY
Syngnathidae	*Syngnathus californiensis*	kelp pipefish	mature

*Likely primarily *Sebastes rosaceus,* but also possibly swordspine rockfish, *Sebastes ensifer,* or other species of subgenus *Sebastomus*.

of fishes less than 12 cm TL (Table 8). Squarespot rockfish was relatively common and the ROSY complex and blue rockfish occurred in both survey years. The assemblage of newly recruited fishes changed somewhat between 2008 and 2009. In 2008, the species assemblage was dominated by squarespot rockfish followed by ROSY complex and blacksmith. In 2009, halfbanded rockfish numerically dominated the species assemblage although it occurred on only one of the survey dates, 3 September; also common were squarespot rockfish and ROSY complex as in 2008. We observed treefish, gopher rockfish, and stripetail rockfish only in 2008, and bocaccio, copper rockfish, and vermillion rockfish only in 2009.

More taxa measuring less than 12 cm TL were observed at the reefs and wrecks using the standard transects (53 taxa) than timed transects (45 taxa) (data not shown). However, some rare taxa were observed only during 5-min transects. At reefs, 2 rainbow seaperch, 1 stripetail rockfish, and 6 unidentified rockfish(es) occurred in the 5-min transect surveys, but were not observed in any 30-m transect surveys. At the wrecks, 1 striped seaperch, 2 starry rockfish, 1 china rockfish, 2 grass rockfish, and 5 ROSY complex and 1 unidentified rockfish were observed exclusively in the 5-min transects. Taxa that were not observed in the 30-m transect surveys were excluded in our comparative analysis of the three habitats.

The shell mound at the Platform Hazel site was surveyed using the 30 m-transect method on one date, 21 November 2008, and only a few fish of four species were observed (Table 7). They were YOY calico rockfish, YOY vermillion rockfish, blackeye goby, and YOY sheephead.

The supplemental surveys in 2010 documented a strong recruitment year for rockfishes. Although fewer surveys were conducted in 2010 than in the two previous years, increases in the total number of fishes were pronounced at platforms and reefs, and YOY accounted for the increase in counts (Tables 4, 5 and 6; Appendices 4.1a, 4.1b, and 4.1c). Clearly, YOY rockfish densities increased at platforms, reefs and wrecks in 2010 from the two previous years (Fig. 13a, Appendix 4.2). Moreover, YOY rockfish density at the reefs in 2010 increased by an order of magnitude from the previous year to exceed densities at platforms in 2010.

Fewer fish taxa were observed in 2010 than in the previous two years combined. In 2010, 21 rockfish taxa and 28 nonrockfish taxa were observed, and these were fewer than in the two previous years combined (Tables 4, 5, and 6; Appendices 4.1a, 4.1b, and 4.1c). Although some consistencies among years were observed in the rockfish assemblage, the relative importance of several abundant species (% of total count) in each of the three habitats (platforms, reefs, and wrecks) varied between years. For example at the platforms, bocaccio, widow rockfish, squarespot rockfish, and shortbelly rockfish were the most abundant rockfish taxa during the three years; however, their relative importance changed from year to year as recruitment strength varied.

Strong recruitment of YOY rockfishes in 2010 clearly contributed to the decline in the importance of non-rockfishes from the previous two years and changes in the relative abundance of species in the rockfish assemblage at all habitats. Blacksmith were the most abundant non-rockfish YOY and the second most abundant taxa at the platforms during 2008 and 2009 comprising 27% of the total count. However, in 2010, although by number blacksmith just edged out jack mackerel as the most abundant non-rockfish species, YOY blacksmith declined to 1.3% of the total count and were superseded by YOY shortbelly rockfish, squarespot rockfish and widow rockfish in importance. As in the two previous years, YOY squarespot were abundant in 2010 at reefs; however, their numbers were overtaken by shortbelly and bocaccio which together comprised 89% of all fishes counted. In contrast, only one bocaccio was seen and no shortbelly rockfish were observed in the two previous years at reefs. The importance gained by rockfishes over nonrockfishes at reefs in 2010 is seen in their relative numbers. In the two previous years combined, jackmackerel and blacksmith were each more abundant than all rockfishes combined by total count. In contrast, in 2010, shortbelly rockfish and bocaccio each outnumbered all non-rockfishes counted in the two previous years. Squarespot rockfish were four times more abundant than all non-rockfishes combined by count in 2010. Similarly at the wrecks in 2010, rockfishes, namely YOY bocaccio, squarespot rockfish, and blue rockfish, each outnumbered all non-rockfishes combined. Densities of species of rockfishes and non-rockfishes in 2010 at all habitats are reported in Appendices 4.4a and 4.4b.

Table 4. Rockfishes and non-rockfishes observed at platforms during the survey years , 2008 and 2008, combined . Included are number of fish in each taxon, proportion of total count, size range, count and proportion of fish 12 cm TL or less and greater than 12 cm TL.

					<= 12cmTL		> 12cmTL	
Common name	Total Count	% of total count	Min cm TL	Max cm TL	Count	% of Total Count	Count	% of Total Count
ROCKFISHES								
bocaccio	161991	44.6%	5	15	161923	100.0%	68	0.0%
widow rockfish	27013	7.4%	4	8	27013	100.0%		
squarespot rockfish	12993	3.6%	3	25	11039	85.0%	1954	15.0%
shortbelly rockfish	10000	2.8%	8	12	10000	100.0%		
kelp rockfish, gopher rockfish, or black and yellow rockfish (KGB)	386	0.1%	2	12	386	100.0%		
yellowtail rockfish or olive rockfish (OYT)	318	0.1%	2	16	313	98.4%	5	1.6%
kelp rockfish	259	0.1%	8	40	11	4.2%	248	95.8%
blue rockfish	242	0.1%	6	35	148	61.2%	94	38.8%
copper rockfish	84	0.0%	5	40	41	48.8%	43	51.2%
grass rockfish	55	0.0%	3	45	6	10.9%	49	89.1%
treefish	37	0.0%	4	17	35	94.6%	2	5.4%
rosy rockfish	25	0.0%	3	12	25	100.0%		
halfbanded rockfish	21	0.0%	6	10	21	100.0%		
gopher rockfish	12	0.0%	13	35			12	100.0%
calico rockfish	8	0.0%	8	15	2	25.0%	6	75.0%
flag rockfish	6	0.0%	10	16	1	16.7%	5	83.3%
honeycomb rockfish	4	0.0%	6	6	4	100.0%		
canary rockfish	3	0.0%	8	11	3	100.0%		
black and yellow rockfish	2	0.0%	25	28			2	100.0%
unidentified rockfish spp.	2	0.0%	4	5	2	100.0%		
brown rockfish	1	0.0%	35	35			1	100.0%
NON-ROCKFISHES								
blacksmith	98174	27.0%	2	34	88417	90.1%	9757	9.9%
jack mackerel	21680	6.0%	7	25	8610	39.7%	13070	60.3%
jacksmelt or topsmelt	20700	5.7%	10	15	10200	49.3%	10500	50.7%
Pacific sardine	5740	1.6%	4	16	5200	90.6%	540	9.4%
sharpnose seaperch	1122	0.3%	10	24	100	8.9%	1022	91.1%
halfmoon	786	0.2%	8	30	109	13.9%	677	86.1%
painted greenling	495	0.1%	4	22	281	56.8%	214	43.2%
California sheephead	357	0.1%	8	70	10	2.8%	347	97.2%
garibaldi	201	0.1%	4	28	30	14.9%	171	85.1%
kelp bass	197	0.1%	15	52			197	100.0%
white seaperch	119	0.0%	15	25			119	100.0%
pile perch	119	0.0%	14	40			119	100.0%
cabezon	93	0.0%	7	75	6	6.5%	87	93.5%
opaleye	78	0.0%	18	36			78	100.0%
kelp greenling	39	0.0%	4	18	30	76.9%	9	23.1%
senorita	9	0.0%	12	20	6	66.7%	3	33.3%
sculpin spp.	8	0.0%	6	14	6	75.0%	2	25.0%
blackeye goby	5	0.0%	8	13	3	60.0%	2	40.0%
ocean sunfish	3	0.0%	42	90			3	100.0%
pipefish	2	0.0%	20	22			2	100.0%
striped seaperch	1	0.0%	18	18			1	100.0%
zebra perch	1	0.0%	25	25			1	100.0%
ronquil spp.	1	0.0%	10	10	1	100.0%		
Rockfishes	213462	58.7%			210973	98.8%	2489	1.2%
Non-rockfishes	149930	41.3%			113009	75.4%	36921	24.6%
Total	363392	100.0%			323982	89.2%	39410	10.8%

Table 5. Rockfishes and non-rockfishes observed at reefs during 30 m transect surveys in two years combined, 2008 and 2009. Included are number of fish in each taxon, proportion of total count, size range, count and proportion of fish 12 cm TL or less and greater than 12 cm TL.

					Fish <= 12cmTL		Fish > 12cmTL	
Common name	Total Count	% of total count	Min cm TL	Max cm TL	Count	% of Total Count	Count	% of Total Count
ROCKFISHES								
squarespot rockfish	4609	12.5%	4	18	4608	100.0%	1	0.0%
blue rockfish	1078	2.9%	5	40	283	26.3%	795	73.7%
gopher rockfish	115	0.3%	7	38	12	10.4%	103	89.6%
kelp rockfish, gopher rockfish, or black and yellow rockfish (KGB)	114	0.3%	5	16	109	95.6%	5	4.4%
treefish	45	0.1%	4	38	23	51.1%	22	48.9%
copper rockfish	33	0.1%	24	45			33	100.0%
kelp rockfish	30	0.1%	8	30	13	43.3%	17	56.7%
vermillion rockfish	18	0.0%	30	40			18	100.0%
rosy rockfish	18	0.0%	5	28	17	94.4%	1	5.6%
black and yellow rockfish	16	0.0%	24	40			16	100.0%
yellowtail rockfish or olive rockfish (OYT)	13	0.0%	4	9	13	100.0%		
olive rockfish	12	0.0%	20	35			12	100.0%
black rockfish	3	0.0%	5	6	3	100.0%		
canary rockfish	3	0.0%	12	15	2	66.7%	1	33.3%
brown rockfish	1	0.0%	35	35			1	100.0%
bocaccio	1	0.0%	8	8	1	100.0%		
NON-ROCKFISHES								
jack mackerel	16380	44.5%	12	12	16380	100.0%		
blacksmith	10559	28.7%	6	30	1895	17.9%	8664	82.1%
senorita	1205	3.3%	3	20	159	13.2%	1046	86.8%
Pacific sardine	1000	2.7%	10	10	1000	100.0%		
blackeye goby	375	1.0%	5	15	331	88.3%	44	11.7%
painted greenling	365	1.0%	5	22	134	36.7%	231	63.3%
California sheephead	201	0.5%	8	60	13	6.5%	188	93.5%
spotfin surfperch	129	0.4%	5	7	129	100.0%		
pile perch	122	0.3%	10	40	3	2.5%	119	97.5%
white seaperch	76	0.2%	14	24			76	100.0%
black perch	63	0.2%	6	32	13	20.6%	50	79.4%
rubberlip seaperch	53	0.1%	25	45			53	100.0%
bluebanded goby	46	0.1%	5	6	46	100.0%		
kelp perch	25	0.1%	8	15	23	92.0%	2	8.0%
lingcod	20	0.1%	40	75			20	100.0%
kelp bass	11	0.0%	20	45			11	100.0%
opaleye	9	0.0%	28	45			9	100.0%
kelp greenling	8	0.0%	13	42			8	100.0%
halfmoon	6	0.0%	35	40			6	100.0%
California scorpionfish	6	0.0%	20	35			6	100.0%
sculpin spp.	5	0.0%	8	13	4	80.0%	1	20.0%
striped seaperch	3	0.0%	25	28			3	100.0%
garibaldi	3	0.0%	22	24			3	100.0%
wolf-eel	2	0.0%	15	15			2	100.0%
giant kelpfish	2	0.0%	25	30			2	100.0%
ronquil spp.	2	0.0%	16	18			2	100.0%
cabezon	2	0.0%	45	45			2	100.0%
kelpfish spp.	1	0.0%	12	12	1	100.0%		
Rockfishes	6109	16.6%			5084	83.2%	1025	16.8%
Non-rockfishes	30679	83.4%			20131	65.6%	10548	34.4%
Total	36788	100.0%			25215	68.5%	11573	31.5%

Table 6. Rockfishes and non-rockfishes observed at wrecks during 30 m transect surveys in two years combined, 2008 and 2009. Included are number of fish in each taxon, proportion of total count, size range, count and proportion of fish 12 cm TL or less and greater than 12 cm TL.

					Fish <= 12cmTL		Fish > 12cmTL	
Common name	Total Count	% of total count	Min cm TL	Max cm TL	Count	% of Total Count	Count	% of Total Count
ROCKFISHES								
squarespot rockfish	2075	28.9%	4	9	2075	100.0%		
blue rockfish	372	5.2%	5	25	262	70.4%	110	29.6%
yellowtail rockfish or olive rockfish (OYT)	261	3.6%	5	15	254	97.3%	7	2.7%
brown rockfish	75	1.0%	20	45			75	100.0%
kelp rockfish	42	0.6%	10	40	1	2.4%	41	97.6%
olive rockfish	38	0.5%	12	40	4	10.5%	34	89.5%
calico rockfish	17	0.2%	10	16	10	58.8%	7	41.2%
vermillion rockfish	17	0.2%	12	15	9	52.9%	8	47.1%
black and yellow rockfish	12	0.2%	20	28			12	100.0%
copper rockfish	11	0.2%	9	30	7	63.6%	4	36.4%
kelp rockfish, gopher rockfish, or black and yellow rockfish (KGB)	8	0.1%	4	8	8	100.0%		
gopher rockfish	8	0.1%	13	30			8	100.0%
honeycomb rockfish	8	0.1%	7	24	3	37.5%	5	62.5%
treefish	3	0.0%	16	30			3	100.0%
widow rockfish	1	0.0%	4	4	1	100.0%		
bocaccio	1	0.0%	8	8	1	100.0%		
canary rockfish	1	0.0%	6	6	1	100.0%		
NON-ROCKFISHES								
blacksmith	2961	41.2%	5	22	885	29.9%	2076	70.1%
senorita	367	5.1%	12	18	306	83.4%	61	16.6%
rubberlip seaperch	180	2.5%	20	40			180	100.0%
pile perch	177	2.5%	7	40	5	2.8%	172	97.2%
blackeye goby	145	2.0%	5	15	111	76.6%	34	23.4%
painted greenling	108	1.5%	3	18	38	35.2%	70	64.8%
black perch	101	1.4%	10	30	39	38.6%	62	61.4%
California sheephead	82	1.1%	8	100	6	7.3%	76	92.7%
ronquil spp.	26	0.4%	8	16	9	34.6%	17	65.4%
lingcod	16	0.2%	50	80			16	100.0%
stripedfin ronquil	13	0.2%	8	20	7	53.8%	6	46.2%
white seaperch	12	0.2%	6	20	9	75.0%	3	25.0%
kelp bass	9	0.1%	28	45			9	100.0%
kelp perch	7	0.1%	12	15			7	100.0%
opaleye	6	0.1%	30	35			6	100.0%
garibaldi	6	0.1%	22	29			6	100.0%
cabezon	6	0.1%	35	45			6	100.0%
kelp greenling	5	0.1%	30	40			5	100.0%
rainbow seaperch	4	0.1%	12	20	3	75.0%	1	25.0%
sculpin spp.	3	0.0%	8	12	3	100.0%		
tube-snout	1	0.0%	10	10	1	100.0%		
kelpfish spp.	1	0.0%	14	14			1	100.0%
spotfin surfperch	1	0.0%	9	9	1	100.0%		
bluebanded goby	1	0.0%	6	6	1	100.0%		
barred sandbass	1	0.0%	40	40			1	100.0%
giant seabass	1	0.0%	100	100			1	100.0%
Rockfishes	2950	41.0%			2636	89.4%	314	10.6%
Non-Rockfishes	4240	59.0%			1424	33.6%	2816	66.4%
Total	7190	100.0%			4060	56.5%	3130	43.5%

Table 7. Rockfishes and non-rockfishes observed at shell mound at at the Platform Hazel removal site. Included are number of fish in each taxon, proportion of total count, and size range.

Common name	Total Count	% of total count	Min cm TL	Max cm TL
Shell mound				
ROCKFISHES				
calico rockfish	6	35.3%	3	10
vermillion rockfish	3	17.6%	12	12
NON-ROCKFISHES				
blackeye goby	6	35.3%	8	12
California sheephead	2	11.8%	2	2
Rockfishes	9	52.9%		
Non-rockfishes	8	47.1%		
Total	17	100.0%		

Table 8. Rockfishes and non-rockfish, 12 cm TL and less, observed at Four-Mile Reef during 5-minute transect surveys in 2008 and 2009; total number of fish observed in two years combined, and total count and number of fish per survey observed in each year (mean, s.d., N=number of surveys).

2008 and 2009 (N=7)		2008 (N=4)			2009 (N=3)		
Common name	Total count	Total count	Mean fish/ survey	s.d.	Total count	Mean fish/ survey	s.d.
squarespot rockfish	1578	1031	116.0	135.6	547	60.8	31.0
halfbanded rockfish	1385				1385	153.9	266.5
rosy rockfish	109	68	6.4	7.3	41	4.6	3.7
blacksmith	25	25	3.1	6.3			
treefish	4	2	0.3	0.5	2	0.2	0.4
blue rockfish	4	4	0.3	0.7			
bocaccio	3				3	0.3	0.6
copper rockfish	2				2	0.2	0.4
vermillion rockfish	2				2	0.2	0.4
blackeye goby	1	1	0.1	0.3			
gopher rockfish	1	1	0.1	0.2			
stripetail rockfish	1	1	0.1	0.2			

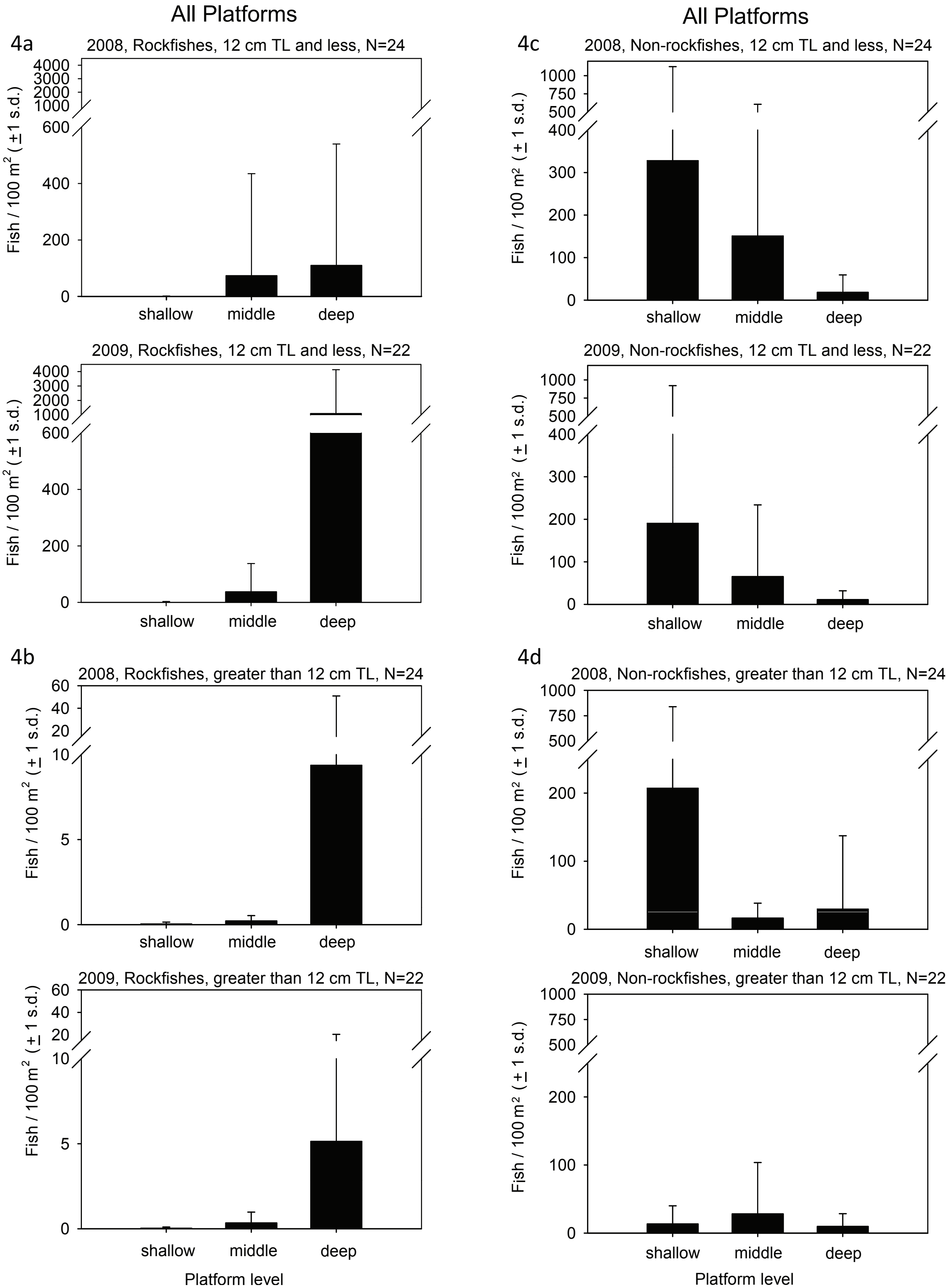


Figure 4. Annual average density (fish/100 m² ± 1 s.d., N=total number of visits) of: (a) rockfishes 12 cm TL or less; (b) rockfishes greater than 12 cm TL; (c) non-rockfishes 12 cm TL or less; and (d) non-rockfishes greater than 12 cm TL at the three platform levels. Shallow level ranged from 5-11 m, middle level 11-22 m, and deep level 26-35 m.

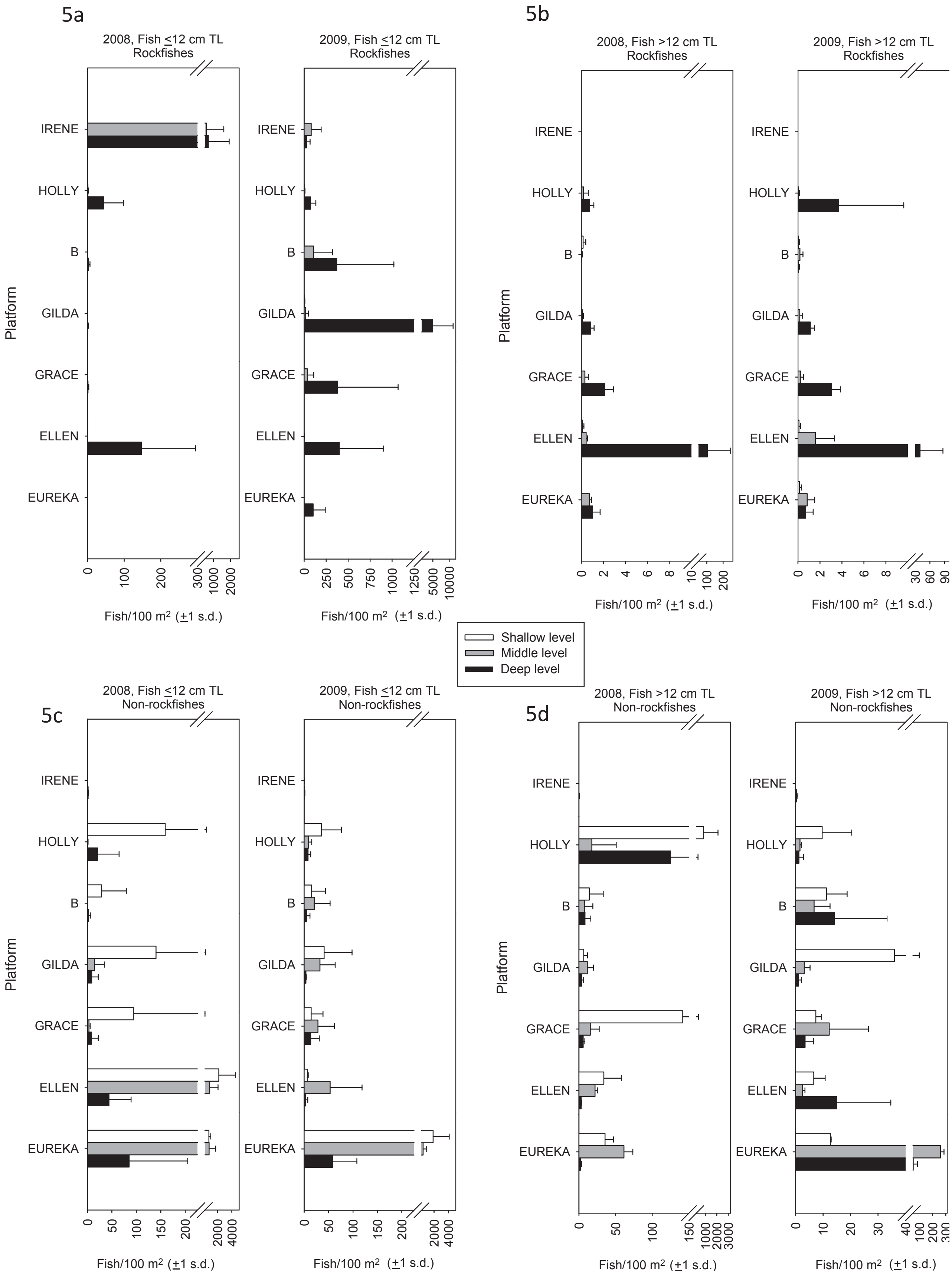


Figure 5. Annual average density (fish/100 m² ± 1 s.d.) of (a) rockfishes 12 cm TL or less; (b) rockfishes greater than 12 cm TL; (c) non-rockfishes 12 cm TL or less; and (d) non-rockfishes greater than 12 cm TL at the three levels surveyed at individual platforms. Shallow level ranged from 5-11 m, middle level 11-22 m, and deep level 26-35 m. See Table 1 for the number of visits to each platform annually.

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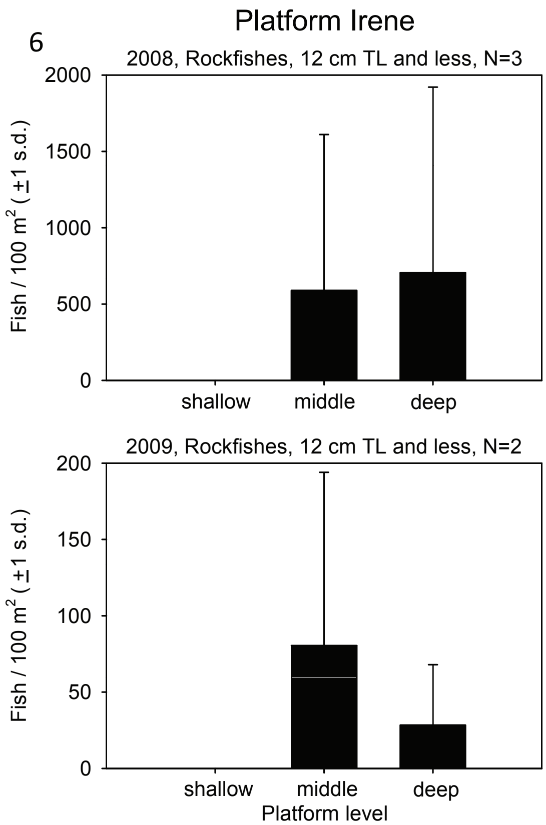

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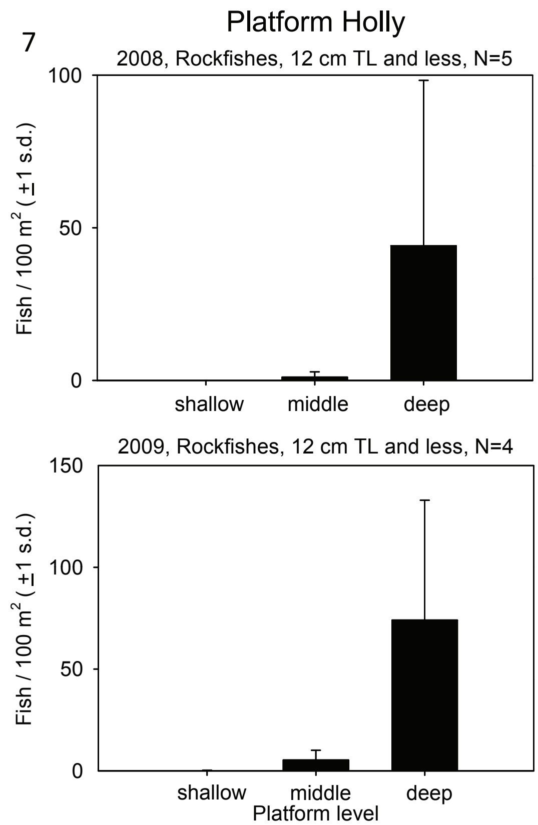

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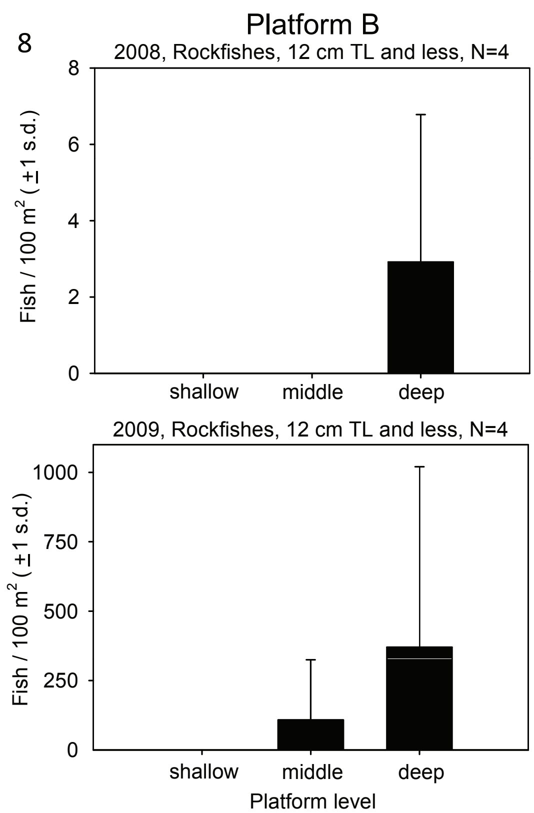

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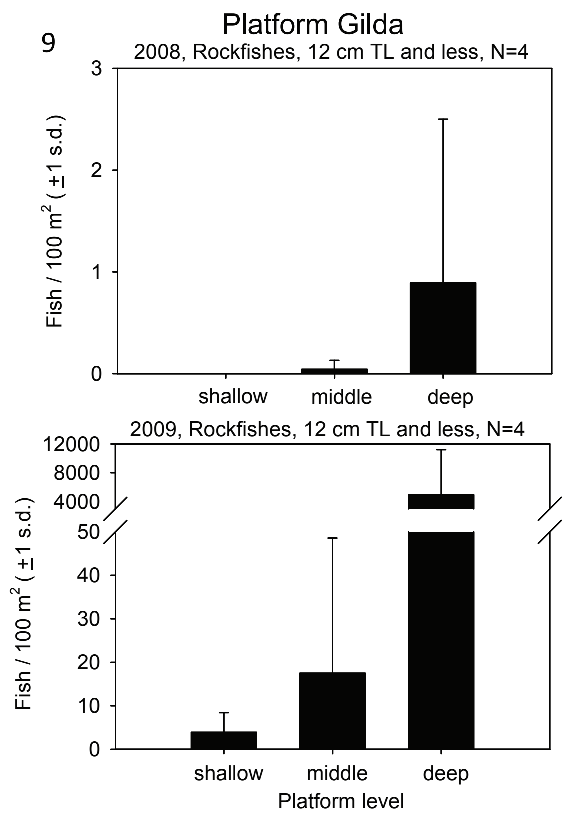
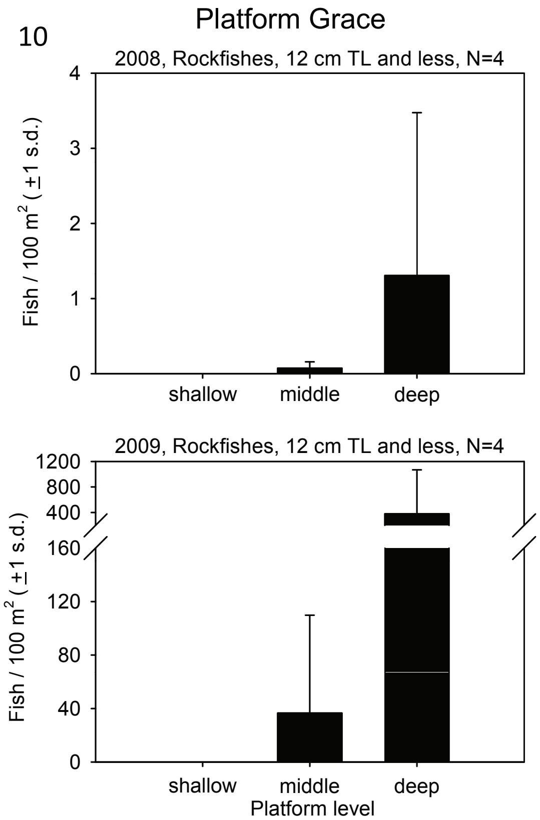


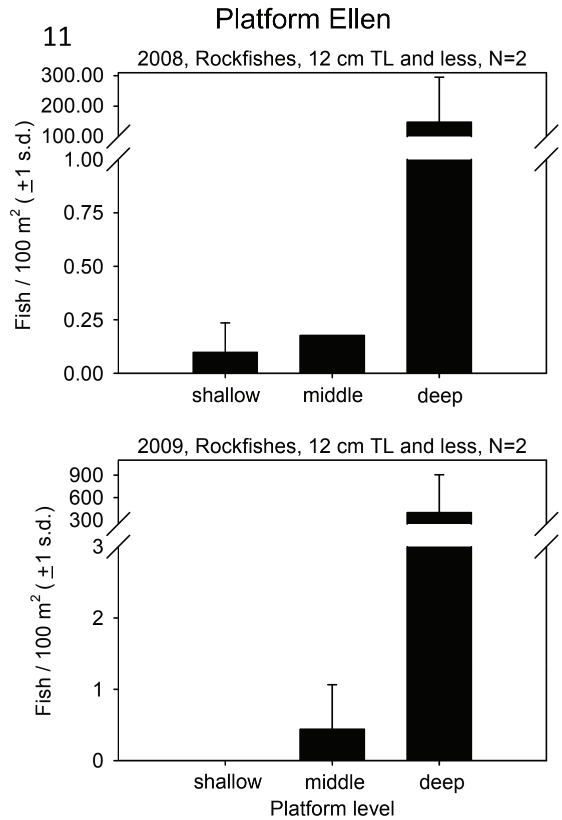
Figure 6. Platform Irene: Annual average density (fish/100 m² ± 1 s. d., N=total number of visits) of rockfishes 12 cm TL or less, and rockfishes greater than 12 cm TL at the three levels surveyed.

Figure 7. Platform Holly: Annual average density (fish/100 m² ± 1 s. d., N=total number of visits) of rockfishes 12 cm TL or less, and rockfishes greater than 12 cm TL at the three levels surveyed.

Figure 8. Platform B: Annual average density (fish/100 m² ± 1 s. d., N=total number of visits) of rockfishes 12 cm TL or less, and rockfishes greater than 12 cm TL at the three levels surveyed.

Figure 9. Platform Gilda: Annual average density (fish/100 m² ± 1 s. d., N=total number of visits) of rockfishes 12 cm TL or less, and rockfishes greater than 12 cm TL at the three levels surveyed.





VERTICAL DISTRIBUTION OF YOY ROCKFISHES AT THE PLATFORMS

Recruiting YOY rockfishes were rare at the shallowest level of the platforms (Figs. 4a, 5a, 6-12; annual averages of species density in Appendix 1). During the 2008 survey season, only one YOY rockfish was observed in the uppermost level, a KGB at Platform Ellen (0.2 fish/100 m^2) in July (Figs. 5a, 11; Appendix 1). In 2009, few YOY rockfishes were observed at the shallowest level, and these occurred at only two platforms: 1 OYT (0.2 fish/100 m^2) at Holly and 47 KGB (8.4 fish/100 m^2) at Gilda in June; and 1 KGB (0.2 fish/100 m^2) at Holly and 40 bocaccio (7.2 fish/100 m^2) at platform Gilda in July.

In contrast, YOY rockfishes were consistently more abundant at the two deeper levels surveyed and occurred on more platforms (Figs. 4a, 5a, 6-12). In 2008, YOY rockfishes were observed at the middle level on 5 of the 7 platforms and at the deepest level of all platforms. Survey abundances ranged from 1 to 11,000 rockfishes (0.1 – 1486 fish/100 m^2) at the middle level, and 3 to 15,000 rockfishes (0.4 – 2109 fish/100 m^2) at

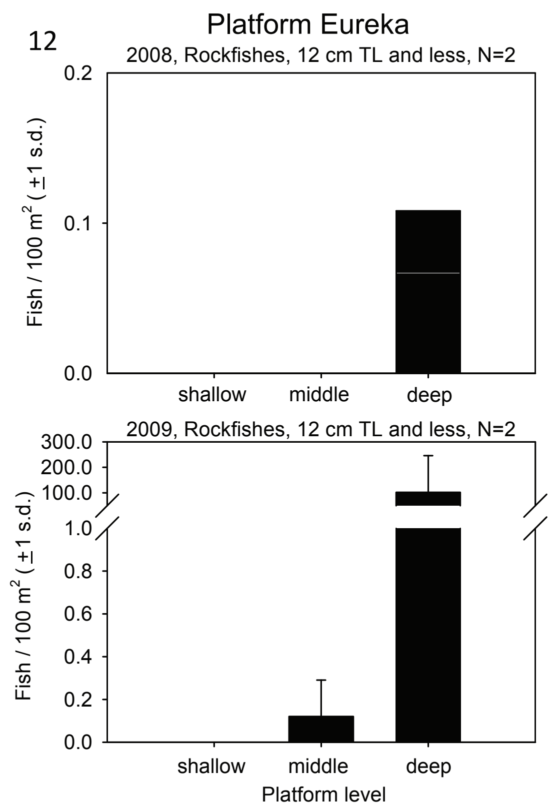


Figure 10. Platform Grace: Annual average density (fish/100 m^2 ± 1 s. d., N=total number of visits) of rockfishes 12 cm TL or less, and rockfishes greater than 12 cm TL at the three levels surveyed.

Figure 11. Platform Ellen: Annual average density (fish/100 m^2 ± 1 s. d., N=total number of visits) of rockfishes 12 cm TL or less, and rockfishes greater than 12 cm TL at the three levels surveyed.

Figure 12. Platform Eureka: Annual average density (fish/100 m^2 ± 1 s. d., N=total number of visits) of rockfishes 12 cm TL or less, and rockfishes greater than 12 cm TL. at the three levels surveyed.

the deep level. YOY rockfishes were absent from the deep level during only 5 of 25 surveys, and on only 2 of these 5 occasions were YOY rockfishes present on the upper portion of the platforms: 1 rockfish on Gilda and 3 rockfish on Irene on the middle level.

YOY rockfish recruitment at the platforms generally was greater in 2009 than in 2008, and higher densities at the deep level of the platforms accounted for the increase (Figs. 4a and 5a). In 2009, YOY rockfishes were present at the deep level of all platforms during every survey with numbers ranging from 3-100,400 rockfish (0.4 – 13,792 fish/100 m^2). In contrast, YOY rockfishes were observed at the shallow level on only 4 of 22 surveys.

The distribution of YOY rockfishes among platforms differed between years. In 2008, YOY rockfishes occurred at relatively high abundances at platforms, Irene, Holly, and Ellen where concentrations were centered at the deep level of the platforms (Fig. 5a). The highest density of YOY rockfishes in 2008 was observed in September at platform Irene where widow rockfish numbered 15,000 at the deep level (2109 fish/100m^2) and 11,000 at the middle level (1767 fish/100 m^2). In contrast on that date, no fish, other than 1 cabezon, a non-rockfish, were seen at the shallow level on Irene. At the four other platforms where YOY rockfish occurred in relatively low numbers, densities also were centered at the deep level.

In 2009, YOY rockfishes occurred at relatively high abundances at Gilda, B, Grace, and Ellen (Fig. 5a). The highest density of rockfishes occurred at Gilda in August, when bocaccio numbered 100,400 (13,790 fish/100 m^2) at the deep level, far exceeding the highest density of rockfishes observed in 2008 (widow rockfish at Irene) by nearly 10 fold. In contrast, only one rockfish was observed at the middle level and none at the shallow level during the same survey at Gilda. Highest densities of several other rockfish species were centered at the deep level of platforms: for example, shortbelly rockfish at Grace in July (1375 fish/100 m^2 at the deep level, 0 fish at the middle and shallow levels); bocaccio at Irene, Gilda, B, and Eureka; and squarespot rockfish at Ellen and Holly.

Several findings from the 2010 supplemental surveys were consistent with the two previous years in regard to the vertical distribution of YOY rockfishes at the platforms. First, densities of YOY rockfishes were lowest at the shallowest level of the platforms (Appendix 4.2). Second, YOY rockfishes were observed more frequently at the deep level (all 18 surveys) than at the shallow level (9 of 18 surveys). And third, the density of YOY rockfishes at the deep level of platforms disproportionately accounted for the increase in total rockfish abundance at the platforms (Appendix 4.2).

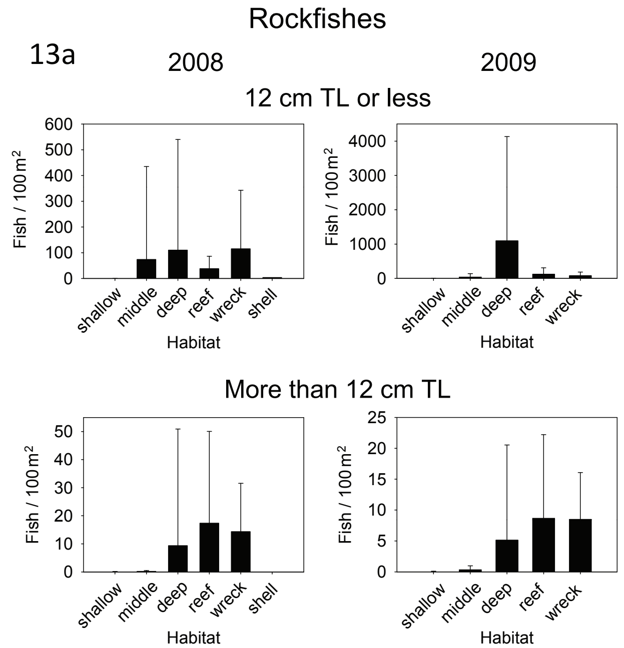
In 2010, YOY rockfish densities at Gilda, Grace, and Gina, three platforms clustered near the eastern entrance of the Channel, far exceeded densities at all platforms in the two previous years (Appendix 4.3a). YOY rockfish densities increased at Holly, but the recruitment effect was less pronounced than at the eastern Channel platforms. Highest densities of YOY rockfishes had occurred in the eastern Channel the previous year, and north and south of the Channel in 2008. Species-specific summaries of the distribution of YOY rockfishes among platforms in 2010 by density are in Appendices 4.4a.

YOY ROCKFISH ASSEMBLAGES AT PLATFORM LEVELS, REEFS, AND WRECKS

The relative abundance of total YOY rockfishes among platforms, reefs, and wrecks differed between years. In 2008, the density of YOY rockfishes at the reefs and wrecks were no greater than the density at the middle and deep levels of the platforms (Fig. 13a). In contrast, in 2009, rockfish densities at the deepest level of platforms exceeded the densities at the reefs and wrecks (Fig. 13a). Within each survey year, densities of total YOY rockfishes were highly variable (note large standard deviation:mean in figures) within the habitat types (e.g., levels of platforms, reefs, wrecks).

Cluster analysis and multidimensional scaling shows that the YOY rockfish assemblages at the two deeper levels of platforms tended to be more similar to each other than to the shallow level of platforms, reefs, or wrecks (the proximity of individual sites is directly related to their similarity to one another in Figs. 14 and 15). Figures 16-21 show the annual density of every YOY rockfish taxon in each habitat averaged from site mean densities.

In 2008, the assemblages from the two deeper levels of the platforms, reefs, and wrecks were not strikingly dissimilar (Fig. 14); differences among the YOY rockfish assemblages in the four habitats were only marginally significant based on an analysis of similarity (Global R=0.166, n=20, p=0.046). Pairwise tests showed that only the YOY rockfish assemblages at the middle level of platforms and reefs were not similar to each other statistically (R=0.256, p=0.04; average dissimilarity 92.31). Dissimilarity between these two habitats was accounted for by squarespot



rockfish, blue rockfish, and KGB which were consistently more abundant at reef sites than at the middle level of platforms; and by widow rockfish observed at the middle level exclusively at Platform Irene.

In 2009, the assemblages among the three levels of the platforms, reefs and wrecks were more dissimilar than the previous year (Fig. 15). Differences among the YOY rockfish assemblages among the five habitats were significant based on analysis of similarity (Global R=0.218, n=25, p=0.008). As in the previous year, pairwise tests showed that the assemblages at the middle and deep levels of platforms did not differ from each other (R=0.01, p=0.38). However, both platform habitats differed significantly from reefs (R=0.296, p=0.045; average dissimilarity=95.05 for middle level v reef; R=0.258, p=0.023; average dissimilarity=81.23 for deep level v reef). The relatively high density of YOY bocaccio at the two deeper platform level habitats and squarespot rockfish at reef habitat primarily accounts for the dissimilarity. Interestingly, the deep level at Ellen and Holly were more similar to reefs than to other platforms. Unlike the other platforms, squarespot rockfish occurred in relatively high abundance and bocaccio were rare at these two platforms. In 2009, YOY rockfishes occurred at the shallow level of only two platforms: KGB and OYT at Holly, and bocaccio and KGB at Gilda (Appendix 1).

The composition of YOY rockfish assemblages at the deeper levels of the platforms differed between years (Figs. 14-18). In 2008, widow rockfish, squarespot rockfish, KGB, OYT, and bocaccio, in descending order, were the most abundant in the YOY rockfish assemblage at the deep level of platforms. At the middle level, the relative importance of these same species, other than bocaccio which was absent at the middle level, was similar. In contrast, in 2009, bocaccio was the most abundant species at both of the deeper levels. Squarespot rockfish and shortbelly rockfish were important at the deep level, and OYT at the middle level. In both years, densities of individual species were highly variable (note large standard deviation:mean in figures) among sites within each habitat type (e.g., levels of platforms, reefs, wrecks) (Appendix 1).

In contrast to the platforms, the composition of the YOY rockfish assemblage at reefs and wrecks were more consistent between years (Figs. 19 and 20). Squarespot rockfish was the most abundant YOY rockfish, and blue rockfish also was important at reefs and wrecks in both years. KGB was more important in the YOY rockfish assemblage at reefs than at wrecks, and treefish occurred at reefs, but not at wrecks in both years. OYT was important at wrecks in both years. Calico rockfish, in both years, and vermillion rockfish, in 2009, were seen in wreck habitat, but not in reef or platform habitats.

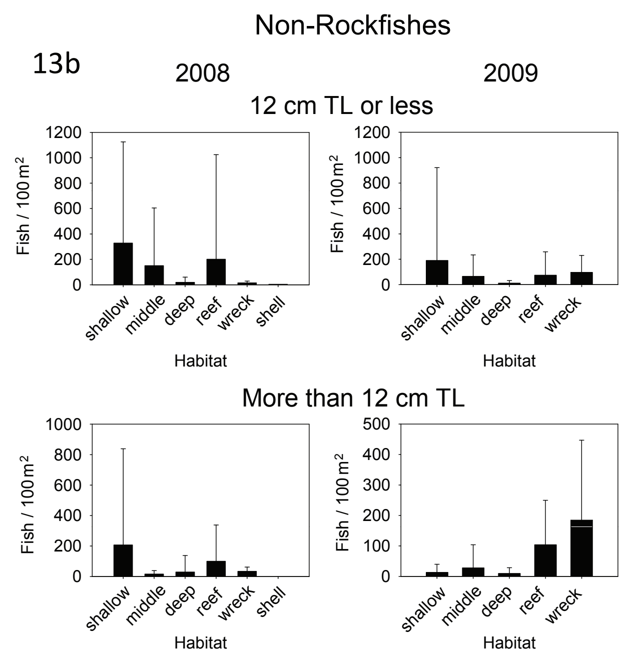


Figure 13. Annual average density (fish/100 m² ± 1 s.d.) of: (a) two size classes of rockfishes (12 cm TL or less, greater than 12 cm TL); (b) non-rockfishes 12 cm TL or less and non-rockfishes greater than 12 cm TL at the three platform levels, reefs, wrecks, and shell mound. Shallow level L1 ranged from 5-11 m, middle level 11-22 m, and deep level 26-35 m.

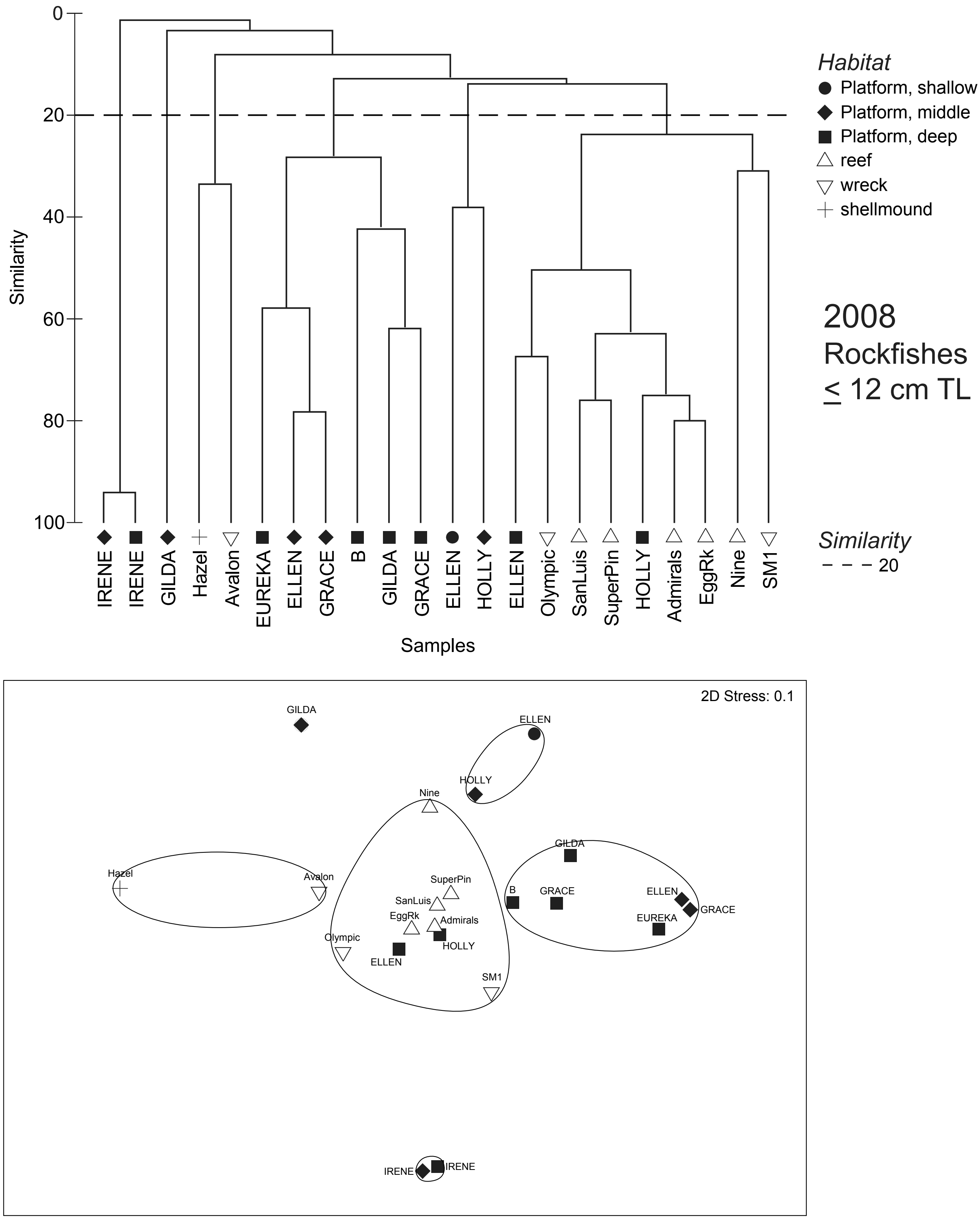


Figure 14. Species assemblage structure of rockfishes 12 cm TL or less from six habitats in 2008. Habitats are shallow (5-11 m), middle (11-22 m), and deep (26-35 m) levels of platforms, reefs, wrecks, and shell mound. (a) Dendrogram for hierarchical group-averaged clustering of the habitat sites from Bray-Curtis similarities on square root-transformed fish densities. 20% similarity threshold is indicated by horizontal line. (b) Non-metric multidimensional scaling configuration of the habitat sites from the same similarities with superimposed clusters from the dendrogram at the 20% similarity level.

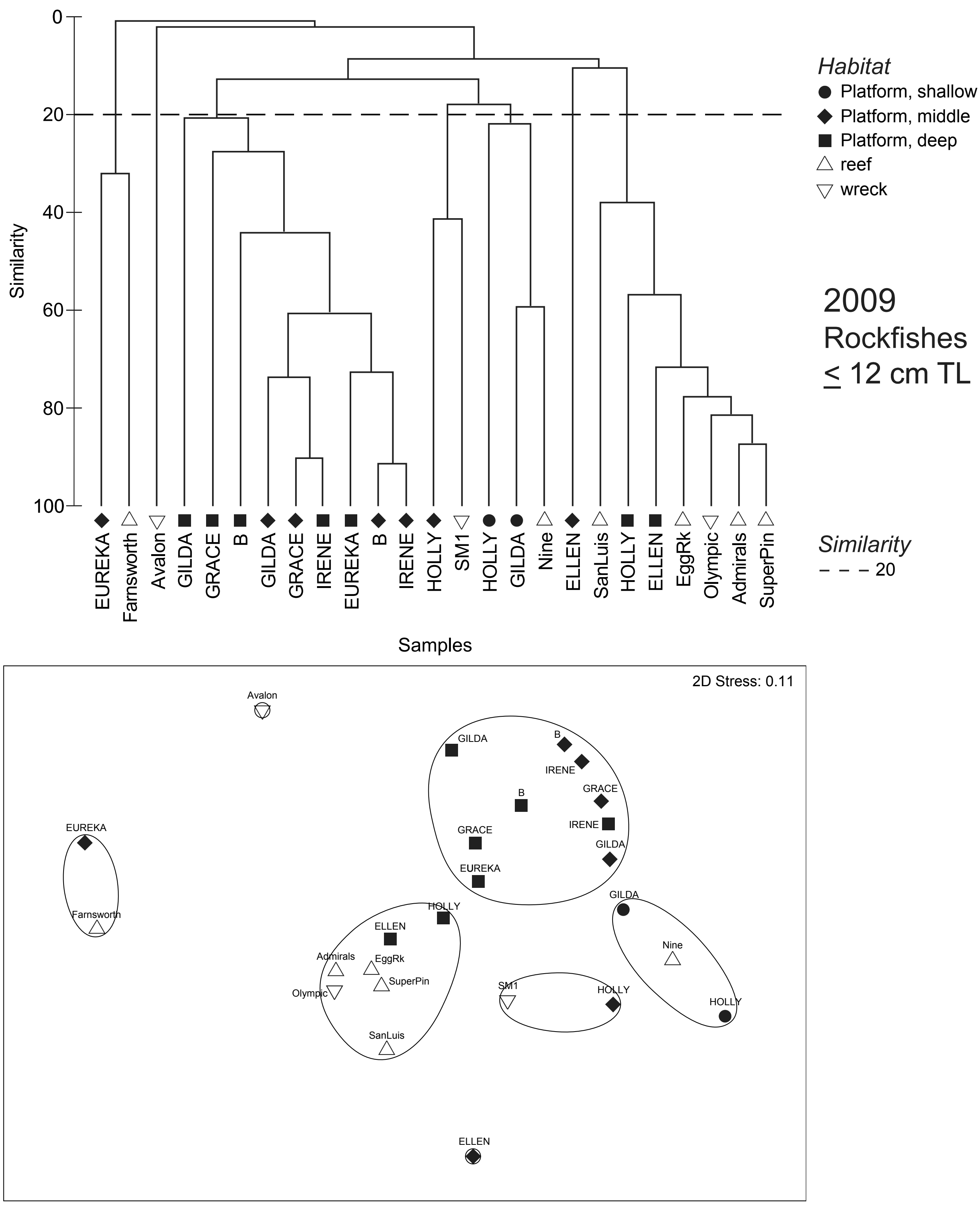
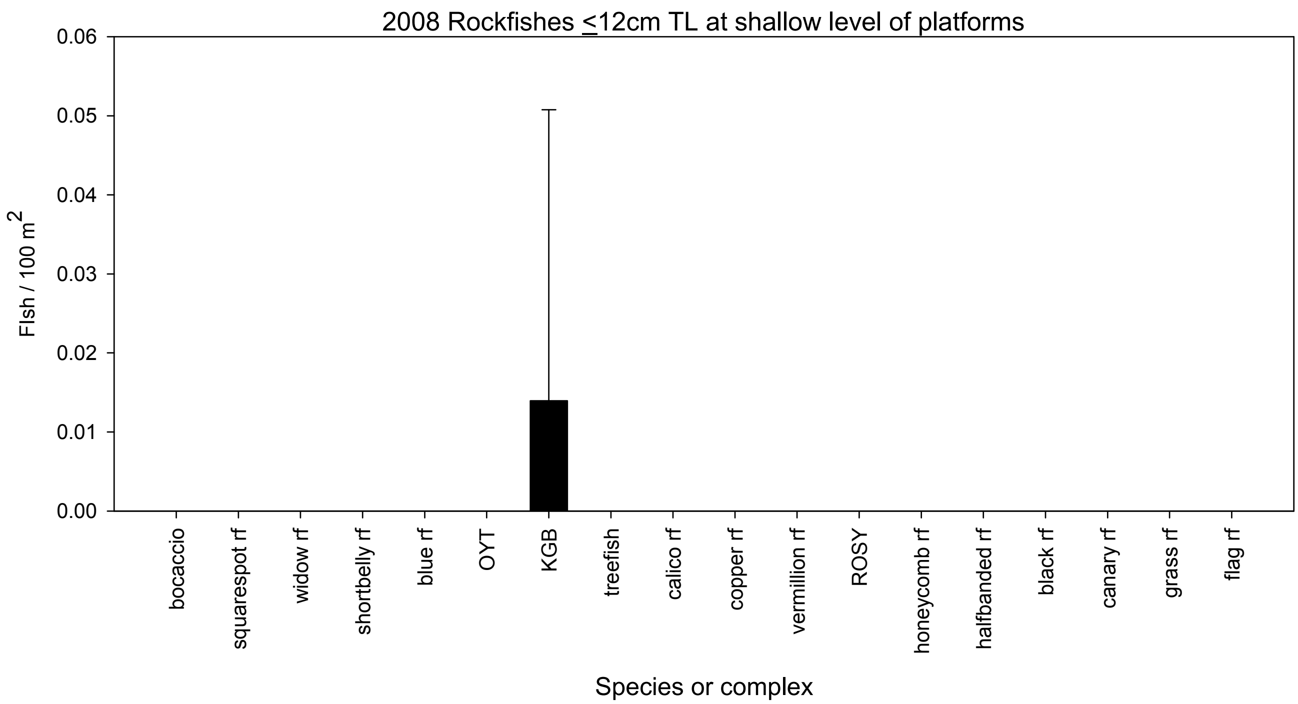


Figure 15. Species assemblage structure of rockfishes 12 cm TL or less from six habitats in 2009. Habitats are shallow (5-11 m), middle (11-22 m), and deep (26-35 m) levels of platforms, reefs, wrecks, and shell mound. (a) Dendrogram for hierarchical group-averaged clustering of the habitat sites from Bray-Curtis similarities on square root-transformed fish densities. 20% similarity threshold is indicated by horizontal line. (b) Non-metric multidimensional scaling configuration of the habitat sites from the same similarities with superimposed clusters from the dendrogram at the 20% similarity level.



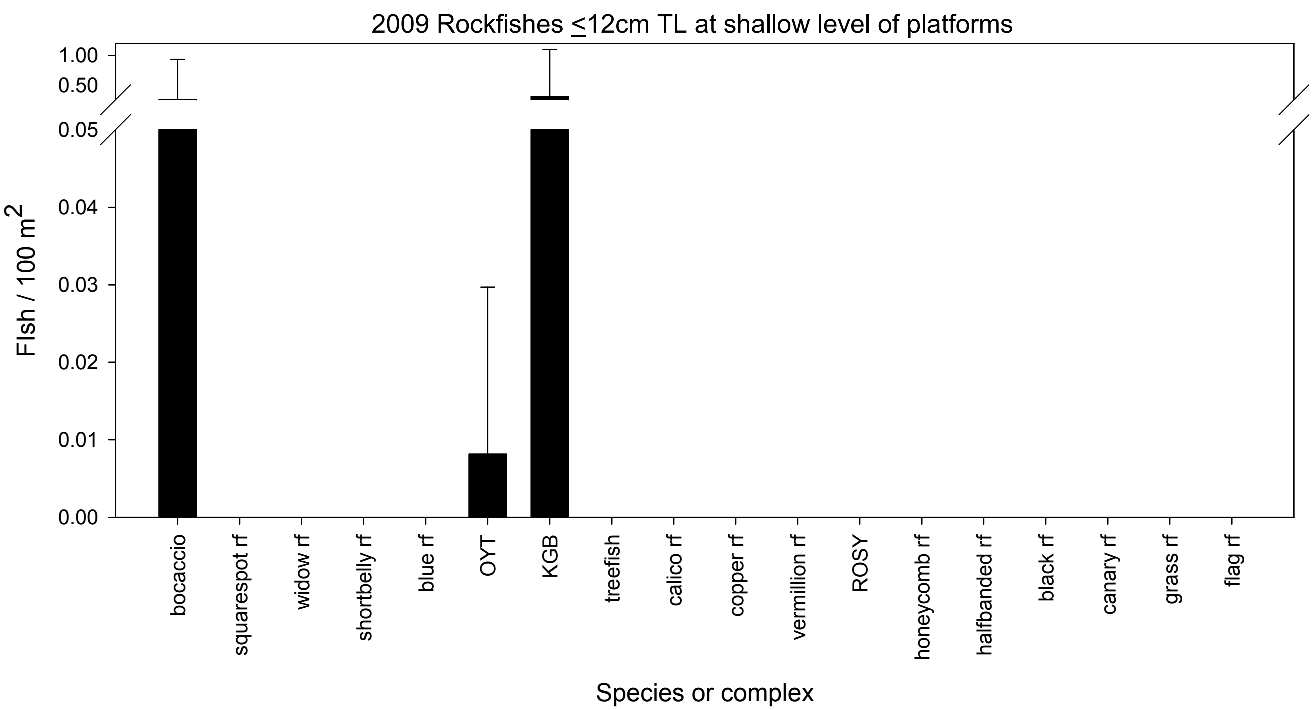
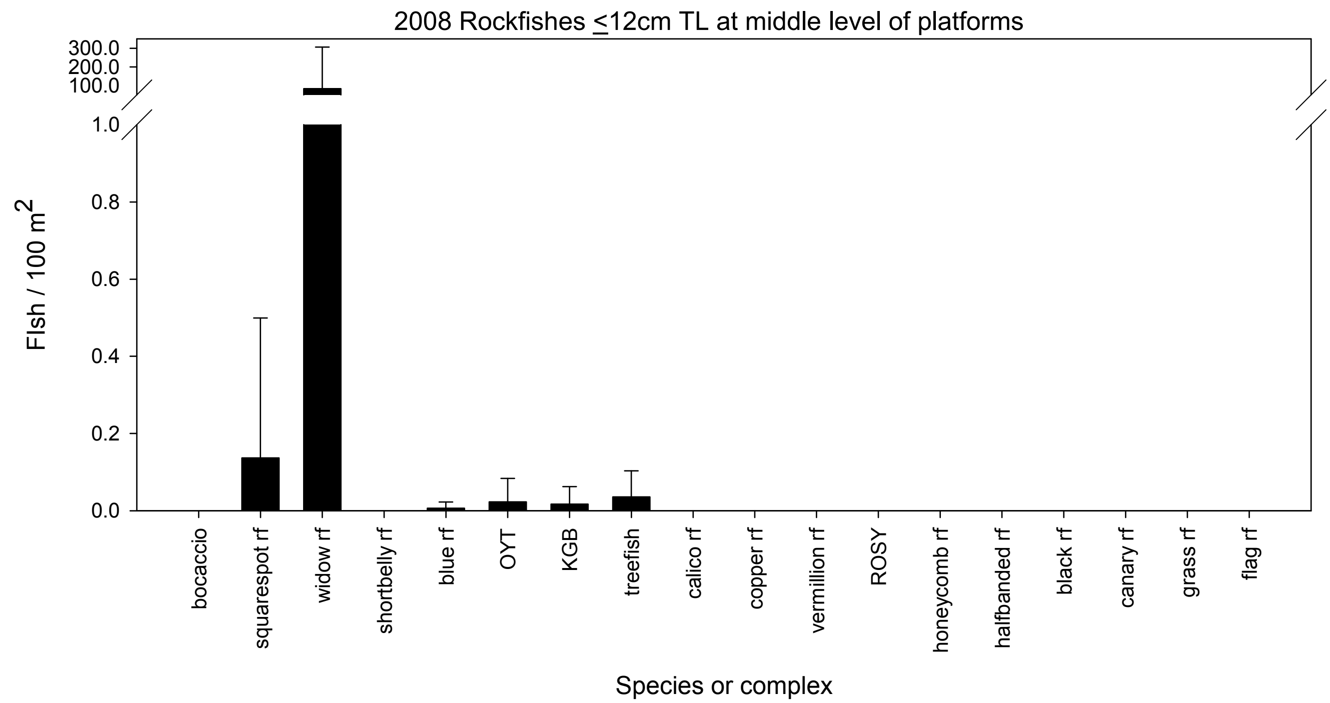


Figure 16. Average density of each taxon (fish/100 m^2 ±1 s.d.) in the assemblage of rockfishes 12 cm TL or less at the shallow level of platforms, 5-11 m depth, in (a) 2008 and (b) 2009.



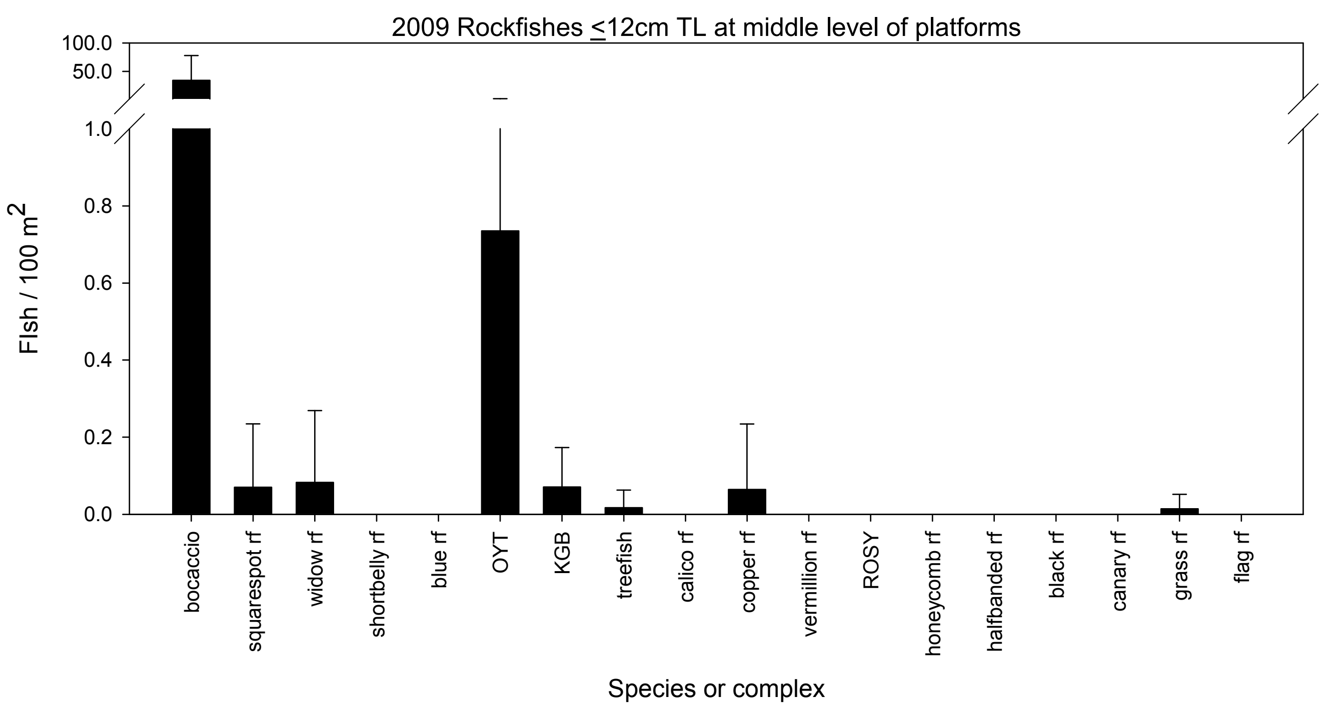
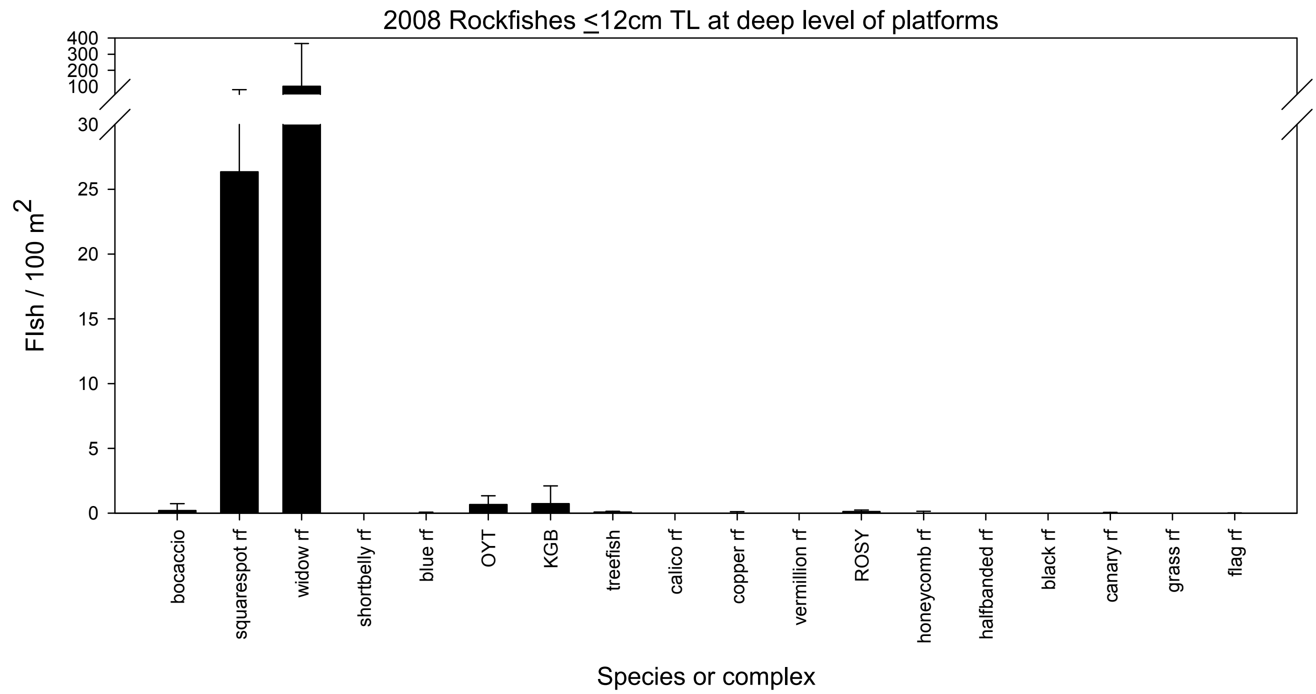


Figure 17. Average density of each taxon (fish/100 m² ±1 s.d.) in the assemblage of rockfishes 12 cm TL or less at the middle level of platforms, 11-22 m depth, in (a) 2008 and (b) 2009.



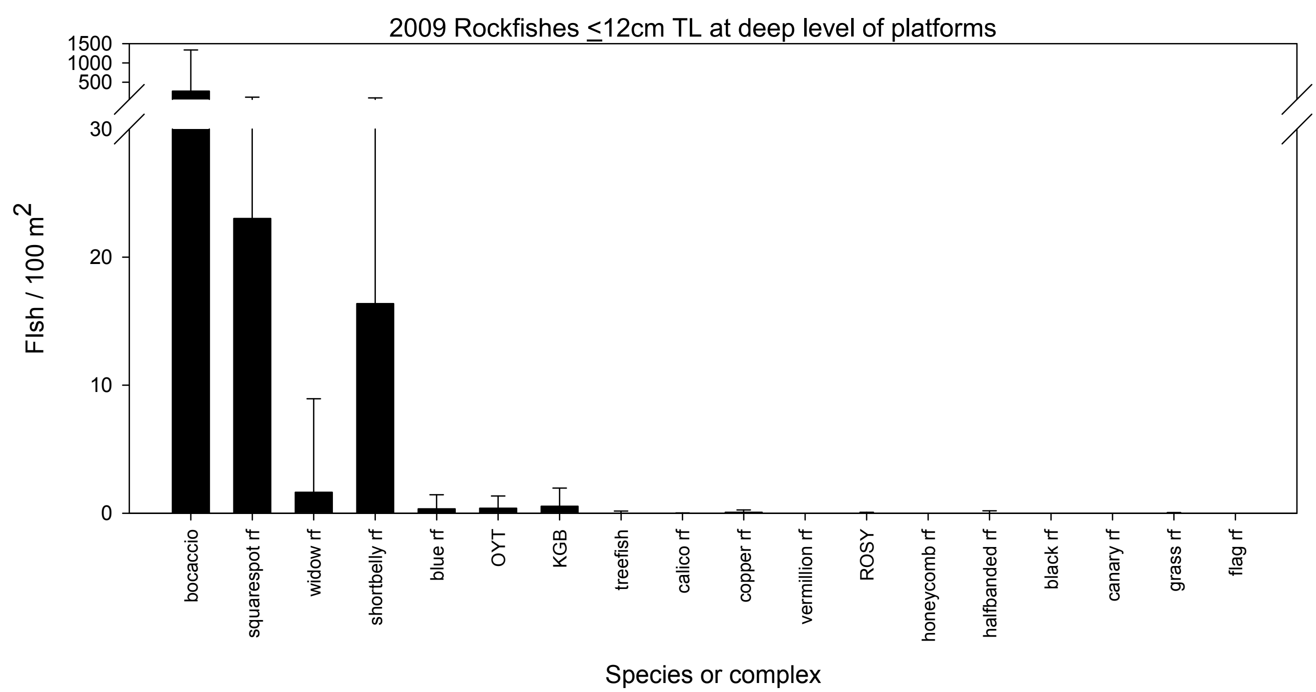
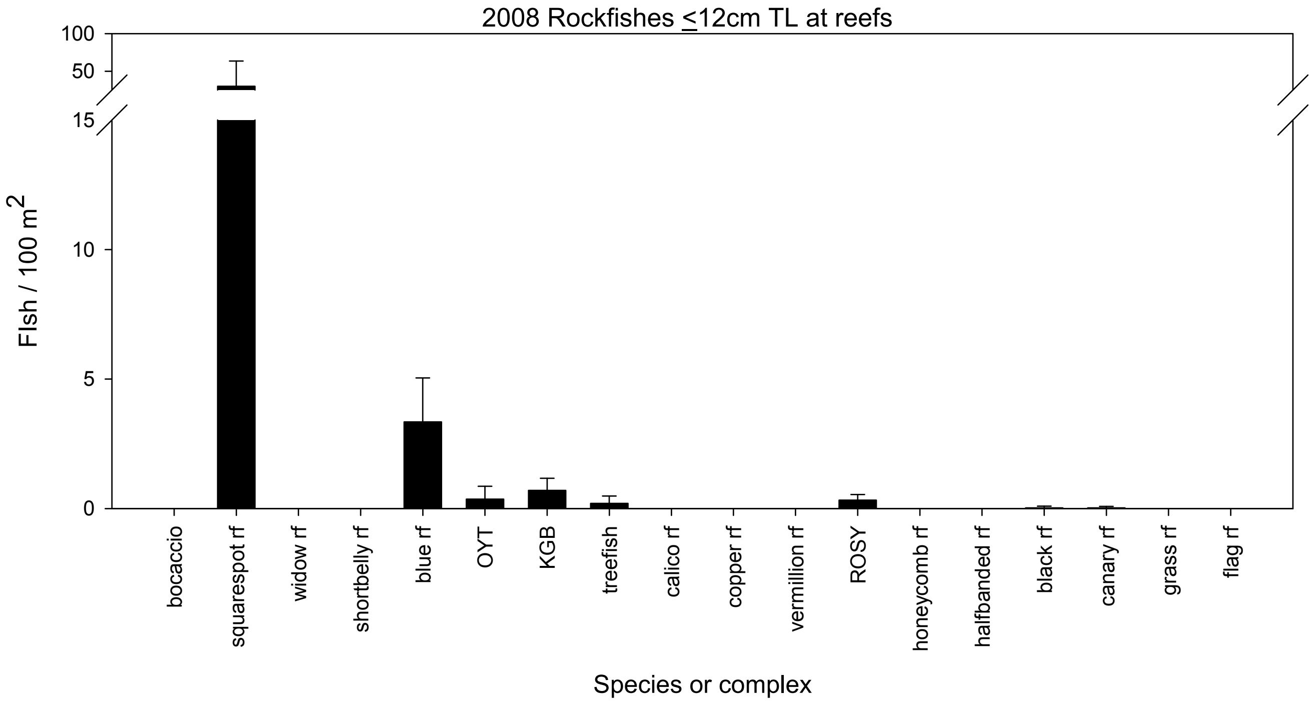


Figure 18. Average density of each taxon (fish/100 m² ±1 s.d.) in the assemblage of rockfishes 12 cm TL or less at the deep level of platforms, 26-35 m depth, in (a) 2008 and (b) 2009.



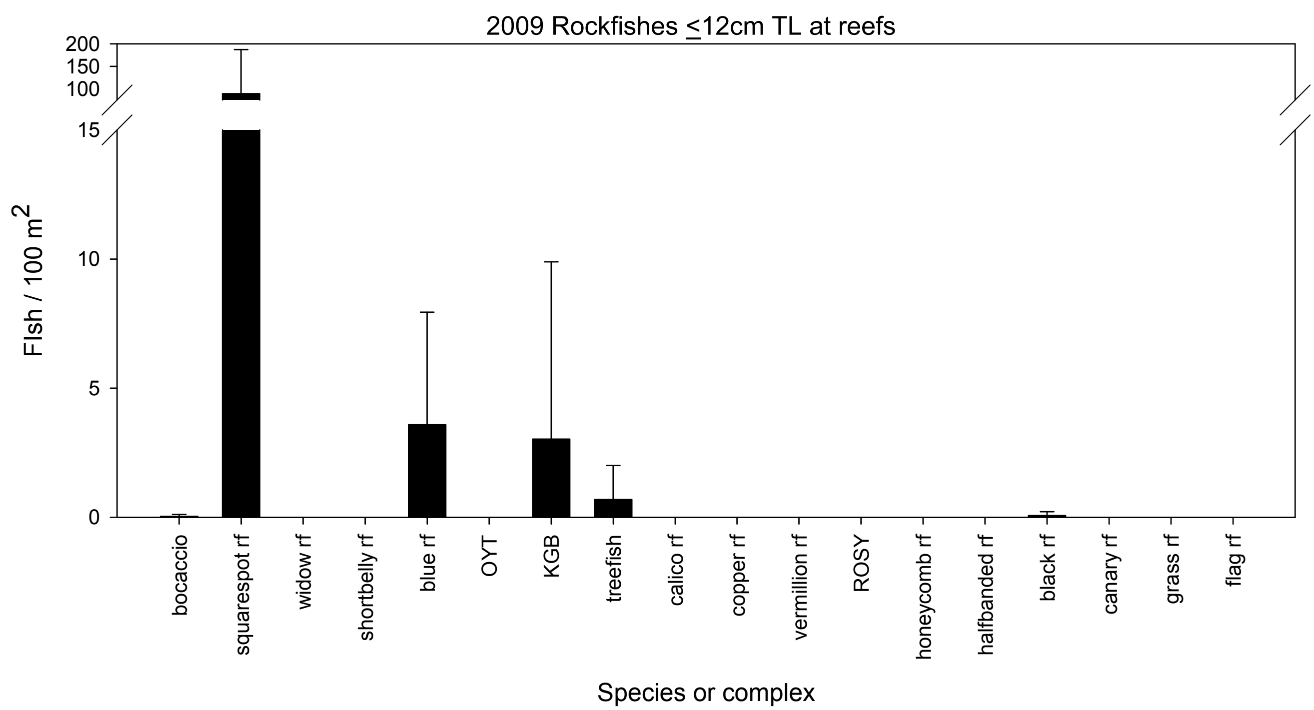
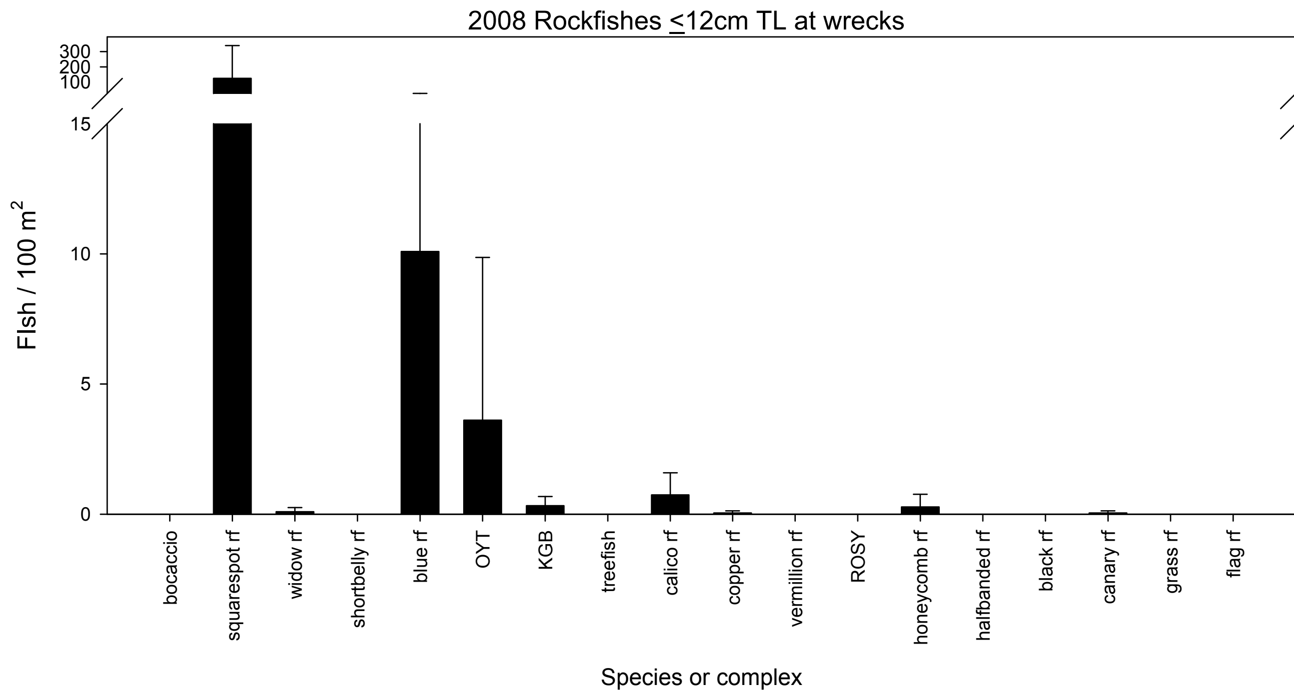


Figure 19. Average density of each taxon (fish/100 m^2 ±1 s.d.) in the assemblage of rockfishes 12 cm TL or less at reefs in (a) 2008 and (b) 2009.



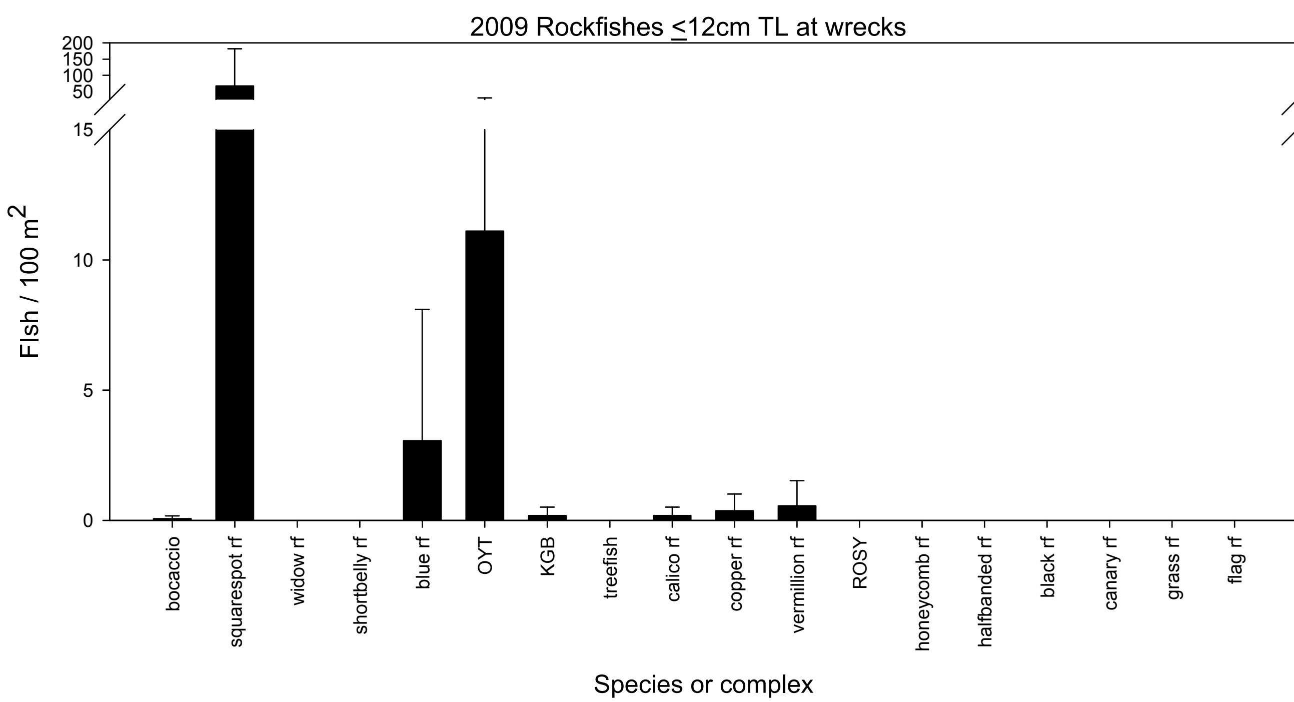


Figure 20. Average density of each taxon (fish/100 m² ±1 s.d.) in the assemblage of rockfishes 12 cm TL or less at wrecks in (a) 2008 and (b) 2009.

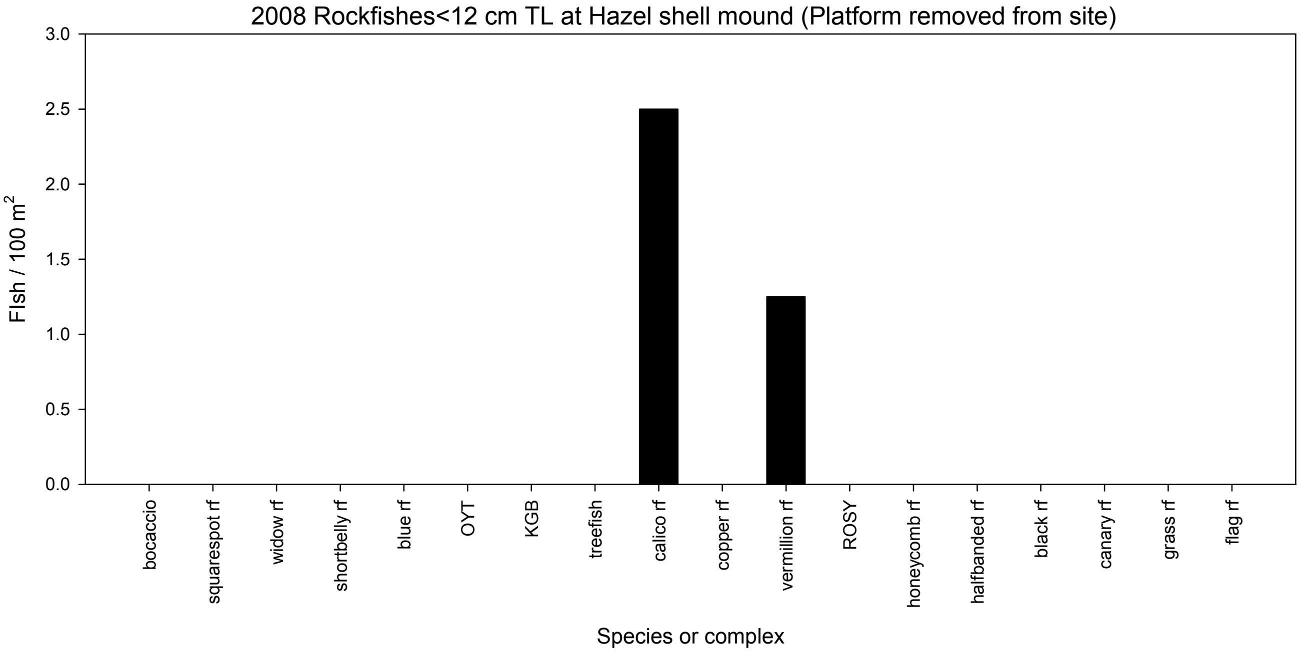


Figure 21. Average density of each taxon (fish/100 m²) in the assemblage of rockfishes 12 cm TL or less at the Hazel shell mound in 2008.

HABITAT USE OF ROCKFISHES GREATER THAN 12 CM TL

Rockfishes greater than 12 cm TL were very rare at the shallow level of the platforms (Fig. 4b). Similar to YOY rockfishes (size class 12 cm TL and less; Fig. 4a), the density of juvenile and adult rockfishes (size class greater than 12 cm TL) was centered at the deepest level of platforms in 2008 and 2009 (Fig. 4b). The larger size class of rockfishes was far less abundant than YOY rockfishes at the platforms (note the different scales of density in Figs. 4a and 4b).

Rockfishes greater than 12 cm TL occurred on all platforms except Irene in both survey years (Fig. 5b). The density of the larger size class of rockfishes at individual platforms was fairly stable between years.

The relative density of juvenile and adult rockfishes among platforms (Fig. 5b) was not related to that of YOY rockfishes among platforms (Fig. 5a). For example, no widow rockfish greater than 12 cm TL were observed in either survey year at Irene where high densities of YOY widow rockfish occurred.

Supplemental 2010 survey data summaries of the vertical distribution pattern of rockfish species greater than 12 cm TL at platforms and their densities at individual platforms are in Appendices 4.4a and 4.5a.

HABITAT USE OF NON-ROCKFISHES

The vertical distribution pattern of non-rockfishes and rockfishes at platforms markedly differed (Figs. 4a-d). Unlike YOY rockfishes with densities centered at the deepest level in both years surveyed (Fig 4a), non-rockfishes 12 cm TL and less generally were most abundant in shallower waters at the two uppermost levels (Fig. 4c). In 2008, non-rockfishes greater than 12 cm TL were most abundant at the shallowest level (Fig. 4d). Summaries of the vertical distribution of the most common non-rockfishes at the platforms are in Appendix 2.

Densities of non-rockfishes of both size classes were greater by an order of magnitude at the two platforms in the more southerly Southern California Bight (Ellen and Eureka) than at platforms in the Santa Barbara Channel (Figs. 5c and 5d). In both survey years, blacksmith were by far the most abundant fish at the shallow and middle levels at these two platforms. Non-rockfishes were rare at Platform Irene located north of the Channel (Appendix 2).

Supplemental 2010 survey data summaries of the vertical distribution pattern of non-rockfish species at platforms and their densities at individual platforms are in Appendices 4.4b and 4.5b.

FAD EXPERIMENT

Divers conducted 8 rounds of visual surveys and collections at two sets of FAD moorings from June through September 2009 (Table 2; Fig. 3). During 8 of the 96 sampling attempts (8 rounds x 2 sites x 6 moorings per array = 96), divers were unable to locate a mooring. In cases when a mooring could not be located, a new mooring was deployed to replace the lost mooring in its vicinity, and the surveys and collections resumed at the next sampling round.

During visual surveys by divers at the moorings, sightings of fishes were infrequent. Fishes were present during 11 of 41 mooring surveys at the Goleta array, and 25 of 47 mooring surveys at the Santa Barbara array. Juvenile jack mackerel, a schooling pelagic species, was the most abundant taxa accounting for 95% of the total of 1841 fishes counted and occurring in 26% of the 88 mooring surveys, the most often among the taxa. Pacific pompano and pipefish, the second and third most frequently occurring taxa, were observed in 9 and 6 mooring surveys, respectively. In contrast,

Table 9. Fishes observed in FAD experiment. Number of individuals observed on the floats, line, and FADs of the moorings with site, type of mooring, and frequency of occurrence in parentheses.*

Part of mooring	sfc marker	subsurface float	topline	top FAD	midline	deep FAD	deepline	TOTAL
Depth of feature	surface	6-9 m	6-9 m	7-9 m	12-24 m	23-27 m	32 m	
ROCKFISHES:								
Olive rockfish or yellowtail rockfish						10 (G-TB-1)		10
bocaccio				1 (S-TB-1)				1
unidentified rockfishes				1 (S-TB-1)				1
NON-ROCKFISHES:								
jack mackerel	350 (S-TB-1)	729 (S-TB-5, G-TB-3)	2 (S-B-2)	660 (G-TB-1, S-TB-6)		3 (G-B-1, S-B-1)		1744
Pacific pompano			1 (S-B-1)	45 (G-TB-1, S-TB-2)	11 (G-TB-1, S-TB-1, S-B-1)	1 (S-B-1)		58
Pacific pipefish			2 (G-B-1, S-B-1)	1 (G-TB-1)	2 G-TB-1, S-B-1)	1 (S-B-1)	1 (S-TB-1)	7
blacksmith				1 (G-TB-1)		1 (G-TB-1)		2
Scalloped ribbonfish					1 (G-TB-1)			1
unidentified fishes				1 (S-TB-1)		16 (G-B-1, S-B-1)		17
TOTAL	350	729	5	710	14	32	1	1841

*Codes separated by dashes in parentheses:

Mooring set, Goleta or Santa Barbara

Type of mooring, Top and Bottom FADs or Bottom FAD only

Number of observations when fish were present

Table 10. Fishes collected from FAD moorings at Site 1 near Platform Holly and Site 2 near Platform B in summer 2009. Experimental moorings (odd numbered) consisted of a bottom FAD unit, and control moorings (even numbered) consisted of a top FAD and bottom FAD units. SMURFs of the top (T) and bottom (B) FAD units of every mooring were sampled on eight visits to the sites. a) Data is coded: taxon*, number of fish collected; or NF = no fish in SMURF; or ND = no data (i.e., FAD mooring could not be located, see Table 2). Also, reported are fishes closely associated with the mooring line (L) that divers were able to collect. b) Number of rockfishes collected from the top SMURFs, lines, and bottom SMURFs summed. c) Number of non-rockfishes summed.

a. Collection dates	Site 1 / Site 2			2-Jun / 4-Jun	16-Jun / 18-Jun	30-Jun / 2-Jul	13-Jul / 14-Jul	28-Jul / 30-Jul	14-Aug / 14-Aug	27-Aug / 27-Aug	11-Sep / 11-Sep	b. Total rockfishes			c. Total non-rockfishes		
Site	Mooring	Top (ft)	Bottom (ft)	Round 1	Round 2	Round 3	Round 4	Round 5	Round 6	Round 7	Round 8	Top SMURF	Line	Bottom SMURF	Top SMURF	Line	Bottom SMURF
1	1		84	NF	NF	NF	NF	NF	ND	ND	ND		0	0		0	0
1	2	25	75	NF	ND	NF	T: SMAR, 1	NF	NF	NF	ND	0	0	0	1	0	0
1	3		90	NF	NF	NF	NF	NF	L: SYNG, 1	NF	NF		0	0		1	0
1	4	30	60	ND	NF	T: SMAR, 1	T: SMAR, 1	T: SMAR, 1	NF	NF	NF	0	0	0	3	0	0
1	5		75	NF	NF	NF	NF	NF	NF	L: SYNG, 1	NF		0	0		1	0
1	6	21	85	NF	ND	T: SMAR, 1	NF	NF	NF	NF	NF	0	0	0	1	0	0
2	7		84	NF	NF	NF	L: SMIN, 1	NF	NF	NF	L: SYNG, 2		1	0		2	0
2	8	23	88	ND	NF	NF	NF	L: SYNG, 2	NF	L: SYNG, 1 B: SYNG, 1	L: SYNG, 1	0	0	0	0	4	1
2	9		82	NF	NF	NF	NF	L: SYNG, 1	NF	L: SYNG, 2	B: SYNG, 1		0	0		3	1
2	10	25	88	NF	T: STRE, 1	L: PSIM, 1	T: SMAR, 1	B: SYNG, 1	L: SYNG, 1	T: RYOY, 1; SYNG, 1 L: SYNG, 1 B: SYNG, 1	NF	2	0	0	2	3	2
2	11		88	NF	NF	NF	NF	L: SYNG, 2	NF	L: SYNG, 2	L: SYNG, 1		0	0		5	0
2	12	34	93	NF	T: SMAR, 1	NF	NF	NF	NF	L: SYNG, 1	T: RYOY, 1	1	0	0	1	1	0
Total fish					2	3	4	7	2	12	6	3	1	0	8	20	4

* PSIM = *Peprilus simillimus* (Pacific pompano), SMAR = *Scorpaenichthys marmoratus* (cabezon), SMIN = *Sebastes miniatus* (vermillion rockfish), SYNG = *Syngnathus californiensis* (kelp pipefish), RYOY = unidentified Young-Of-Year rockfish.

rockfishes, represented by least three species and all YOY, were observed on only three occasions.

In visual surveys, divers observed 710 fishes (at least 6 species) around the shallow FADs (7-9 m), and 32 fishes (at least 6 species) around the deep FADs (23-27 m) (Table 9). Among these, 12 were rockfishes: 1 bocaccio (8 cm TL YOY) and 1 unidentified rockfish (2 cm TL YOY) around shallow FADs, and 10 OYT (7 cm TL YOY) around a deep FAD. This deep FAD was paired with a shallow FAD on the mooring line. Jack mackerel, exclusively, were observed schooling around the surface float (350 fish) and subsurface float between 6 and 9 m (729 fish). This species accounted for 93% of the fishes observed around the shallow FADs and only 9% of those near the deep FADs. Twenty fishes, none rockfishes, were observed along the mooring lines: 5 fishes (jack mackerel, pompano, pipefish) seen on the upper portion of the line between 6 and 9 m on moorings (topline); 14 fishes (pompano, pipefish, scalloped ribbonfish) on the line at middepth, 12 and 24 m (midline); and 1 pipefish on the line at 32 m (deep line).

Very few fishes were collected from SMURFS on the moorings (Table 10). Only 3 rockfishes (1 treefish, 2 unidentified rockfishes), 6 cabezon, and 1 pipefish were collected from the shallow SMURFS. Only 4 fish, all pipefish, were collected from the deep SMURFS. In addition to the fishes collected from the SMURFS, 1 vermillion rockfish and 19 pipefish were collected along the mooring line.

DISCUSSION

The 2008 and 2009 surveys and the supplemental 2010 survey provide two lines of evidence that indicate that rockfishes likely will recruit to platforms topped to subsurface depths between 25 and 30 m (the partial removal decommissioning option). The evidence is that: (1) YOY rockfishes are uncommon in shallow waters at platforms; and (2) YOY rockfishes recruit to natural reefs and artificial structures (wrecks) that crest at depths comparable to where decommissioned platforms would be topped. These findings were consistent in years of weak (e.g., 2008) and strong recruitment (e.g., 2010) for rockfishes.

A number of studies have shown that juvenile rockfish abundance at depths deeper than 26 m are greater than that in shallower waters at platforms in the Southern California Bight (Carr et al 2003; Love et al. 2003, Nishimoto et al. 2008,). In previous scuba surveys conducted at least once per year at nine platforms from Point Arguello (Irene) to near the east entrance of the Channel (Gina) during a six-year period (1995-2001), the majority of juvenile rockfish recruits resided at depths greater than 26 m at platforms. In a more recent scuba survey in 2004, Nishimoto et al. (2008) found that YOY rockfishes at two platforms, Gilda and Gail, were far less abundant in the upper 15 m of the platform than at depths between 25 and 30 m.

YOY rockfishes predominated the total fish assemblage at the deepest level of the platforms with bocaccio, widow rockfish, and squarespot rockfish as the most abundant of seventeen rockfish taxa observed. The YOY of these species have commonly been associated with the midwater of platform structures (Holbrook et al. 2000; Love et al. 2003). YOY rockfish recruitment at the platforms generally was greater in 2009 than in 2008, and higher densities at the deepest level of the platforms accounted for the increase. In 2010, the densities of YOY rockfishes increased at all three levels of the platforms with the stronger recruitment effect at the two deeper levels of the platforms primarily accounting for the increase in the total abundance of individual species at the platforms. Oceanographic monitoring at the platforms and regional physical conditions during the 2004 study at platforms Gail and Gilda indicated that offshore subsurface currents likely delivered juvenile rockfishes to the deepest portion of the upper 30 m surveyed where recruits were found at highest densities (Nishimoto et al. 2008).

Non-rockfishes, in contrast with rockfishes, generally were most abundant at the shallowest level of the platforms. Jack mackerel, a schooling pelagic species, and blacksmith, a schooling nearshore reef species, were the predominant non-rockfish taxa. Also numerous on occasion were other schooling species: jacksmelt (or topsmelt) and halfmoon. All of these schooling species are characteristic of the warm water assemblage of the San Diegan province (Pondella et al. 2005). Non-rockfishes were more abundant by an order of magnitude at platforms off San Pedro than platforms in the Santa Barbara Channel. At both platforms Ellen and Eureka, the distributions of non-rockfishes, unlike rockfishes, were centered at the two upper levels of the platform. Sheephead and garibaldi, two other species with warm-water affinities were found only on these two platforms in this study. Conspicuously rare were non-rockfishes at the northernmost platform, Irene; and like rockfishes, non-rockfishes were absent from the shallowest level.

Irene is located off Point Conception, where wind-induced upwelling occurs through much of the year with strong currents directed offshore and turbulent wave surges in surface waters.

Recent work by Martin and Lowe (2010) also has found significant differences among the assemblages of the deep 30-m level and shallower depths. They surveyed platforms on the San Pedro shelf in 2006 and 2007 and included Ellen and Eureka which we surveyed. Similar to our findings, Martin and Lowe reported that the platform fish community in waters above 20 m was greatly influenced by species characteristic of the warm water San Diegan biogeographic province. In comparison, they found, as we did, that species characteristic of the cold water Oregonian biogeographic province, in particular rockfishes and cabezon, tended to be found at the deep 30-m level.

A striking difference between the findings of Martin and Lowe (2010) and our study is the abundance of YOY rockfishes at the platforms. They report YOY rockfishes at only two of six platforms. The rarity of YOY and older rockfishes at platforms off Long Beach, CA, is in striking contrast to ours and previous surveys of platforms in the Santa Barbara Channel and around Point Conception (Love et al. 2003, 2010; Nishimoto et al. 2008). They observed YOY rockfishes only at Edith and Ellen, although the specific depth at which these fishes were observed was not reported. No YOY rockfishes were observed at Platform Eureka; however, Martin and Lowe did not survey as deep as we did. Because we were able to include the deep 30-m level of all platforms surveyed in our study, we are able to document that YOY rockfish recruit to Platform Eureka at densities comparable to that at some platforms in the Channel region. Love et al. (2010) report that numbers of YOY rockfishes observed in submersible surveys, 2005-2008, were second only to adult squarespot rockfish in the deeper midwater at Platform Eureka.

The relative abundance of total YOY rockfishes among platforms, reefs, and wrecks differed between years. In 2008 the density of YOY rockfishes at pinnacles and reefs were no greater than the density at the middle and deep levels of the platforms. In contrast, in 2009, rockfish densities at the deepest level of platforms exceeded the densities at reefs and wrecks. Densities of YOY rockfishes at reefs and wrecks increased in 2010 from the two previous years.

YOY rockfish assemblages at platforms changed between years due to the recruitment of different YOY species; whereas, in contrast, the composition of the YOY rockfish assemblage at reefs and wrecks were more consistent between years and similar among sites. The assemblages from the two deeper levels of the platforms, reefs and wrecks were more similar in 2008 than in 2009. In 2009, the assemblages of the two deeper platform habitats differed from reef habitat; the relatively high density of YOY bocaccio at the two deeper platform level habitats and squarespot rockfish at reef habitat primarily accounted for the dissimilarity.

The oceanographic conditions in this study area that is encompassed by the California Current System changed markedly from year to year (2008-2010). The dominant forcing were cool La Niña-type conditions during our 2008 survey that prevailed from the summer of 2007 through early 2009 (McClatchie et al. 2009). During spring 2009 through spring 2010, changes in the state of the CCS reflected a transition from cool La Niña conditions into and through a short-lived, relatively weak El Niño event. During the 2009 survey, weaker than normal upwelling and several extended relaxation events contributed to warming over much of the CCS (Bjorkstedt et al. 2010). The 2009–2010 El Niño diminished rapidly in early 2010, and upwelling off central and southern California resumed unusually early and strongly for a spring following an El Niño (Bjorkstedt et al. 2010). Caselle et al. (2010) showed that interannual variation in settlement of YOY rockfish species in nearshore shallow reefs in the Santa Barbara Channel is strongly and positively correlated to the summer Bakun upwelling index. The increase in rockfish recruitment in 2010 throughout the study area may be related to the effects of regional upwelling on dispersal or survival during the pelagic stage before settlement which lasts weeks to months depending on species.

We observed only light recruitment of young-of-the-year rockfishes to the FADs. This occurred despite evidence that the pelagic juveniles of a number of typical southern California rockfish species (e.g., copper, gopher, kelp, and olive rockfishes) will settle on such moored artificial structures as SMURFs (Caselle et al. 2010). There are several possible reasons for this low level of recruitment. First, both 2008 and 2009 saw generally poor rockfish recruitment in the Santa Barbara Channel (D. Kushner, National Parks Service, Channel Islands, pers. comm.; this report) and the supply of pelagic juveniles available for settlement on the FADs may have been low. Second, by chance, the location of the FADs may have been relatively poor.

The FADs were small structures and there is evidence that pelagic juvenile rockfish distribution is patchy (Nishimoto et al. 2008). Thus, by chance alone, these small groups of fishes may not have been in the vicinity to encounter the structures. In addition, species that will utilize SMURFs as recruitment habitat may more likely be nearshore species, whose larvae and pelagic juveniles may be primarily retained in nearshore waters, inshore of where we placed our FADs. Indeed, other work with SMURFs has all taken place within a few hundred meters of rocky shores or kelp beds, where densities of these juveniles may be highest (Ammann 2004, Caselle et al. 2010).

In this study, at least 17 of 52 rockfish species falling under the Pacific Groundfish Fishery Management Plan were found to inhabit platforms as YOY and adults. The adults of some of these species occur deeper in the midwaters of the structures or reside on the bottom under the platforms (e.g., submersible survey findings in Love et al. 2003). Under the Magnuson-Stevens Act of 1996, Congress defined "essential fish habitat" (EFH) for federally managed fish species as "those waters and substrate necessary to fish for spawning, breeding, feeding, or growth to maturity." In the present and previous studies (Love et al. 2003), a number of YOY rockfish species were common at platforms and occurred at lower densities at reefs. These included: bocaccio, widow rockfish, shortbelly rockfish, blue rockfish, the KGB complex, and OYT complex. Under the Magnuson-Stevens Act of 1996, US Federal agencies (e.g., BOEMRE) must consult with the National Marine Fisheries Service (NMFS) on actions (e.g., platform decommissioning) that may adversely affect EFH. NMFS recognizes that "the occurrence of juvenile and large adult rockfish at some platforms suggests that they may support important ecological functions" (Helvey 2002). Because rockfish show long-term population declines, Helvey (2002) concludes that the evaluation of platform ecological structure and function as EFH is warranted and should be integrated into the environmental review process of platform decommissioning.

In an assessment of platforms as EFH, it is important to determine whether platforms are necessary "to support a sustainable fishery or contribute to a healthy ecosystem, the two basic tenets of EFH" (Helvey 2002). In recent years, a few studies have been directed toward determining the ecological performance of a platform as nursery habitat.

Emery et al. (2006) demonstrated that a platform may serve important EFH functions that enhance the survivorship of juvenile rockfishes on account of its offshore location and vertical structure. Emery et al. (2006), modeling the drift paths of pelagic juvenile rockfishes using high-frequency radar, showed that, in the absence of a platform, many of the young-of-year rockfishes would not have been transported by currents to natural reefs and would have perished before finding settlement habitat.

According to Beck et al. (2001), the nursery role of habitats must be compared on a unit-area basis to allow the management and conservation of habitats even if they are small in area and particularly if these habitats are uncommon. The nursery value of habitat used by juveniles, regardless of the size of the habitat, can be evaluated for conservation and management. Precisely defined by Beck et al. (2001), "a habitat is a nursery for juveniles of a particular species if its contribution per unit area to the production of individuals of a particular species that recruit to adult populations is greater, on average, than production from other habitats in which juveniles occur." Any combination of four factors: (1) density, (2) growth, (3) survival of juveniles, and (4) movement to adult habitats support a habitat's contribution to adult populations.

Love and Schroeder (2006) provided evidence that survivorship may be enhanced around the midwater structure of offshore platforms by providing habitat away from predators that utilize the nearshore reefs. Love and Schroeder (2006) used a tethering experiment to determine the relative risk of predation for a small benthic fish, painted greenling, between a natural reef and an oil platform. The juvenile fish at the natural reef suffered a significantly greater predation rate than platform juveniles. Furthermore, while there was no difference between habitats in the predator-prey ratio, the number of predator species was greater at the natural reef which suggests that relative predation risk among habitat types may be affected by the habitat-suite of predators. Thus, decommissioning actions that alter the piscivore assemblage may impact the ecological performance of platform structure as juvenile fish habitat or EFH.

Findings from Love et al. (2007) indicate that a platform can outperform a natural reef as nursery habitat; young blue rockfish collected from a platform were found to have grown as well or better than congeners living on natural reefs based on age-length comparisons. Fish that recruit to platforms as YOY can thrive for years at a single platform through adulthood as shown in tagging studies by Hartman (1987). Love et al. (2006) suggested that a platform served as good nursery habitat for a strong year class of bocaccio that they were able to track by modal size from when the YOY recruited to the midwater habitat through several years to adulthood when the fish occupied the bottom habitat of the platform.

Based on an estimate of the number of YOY bocaccio at eight platforms in the Santa Barbara Channel in 2003, Love et al. (2006) estimated that the juveniles from these platforms contributed about a one percent increase to the stock at large. According to Fodrie and Levin (2008) the approach of using juvenile distributions as an indicator of unit-area productivity of different juvenile environments provided a remarkably good estimate of the contribution of local nurseries to adult stocks, particularly given that the individuals do not migrate far from their nursery origin. Minimally, the quantitative evaluation of the local nursery contribution of rockfishes from each platform to the regional population requires a comparison among all artificial and natural habitats that juveniles use. Presently, (and at the time of Love et al. (2006)) an estimate of the amount of rocky reef habitat in the region is not available, so the importance of platforms in relation to all available rockfish recruitment habitat is yet to be determined. Future studies with this aim of evaluating each platform's value as nursery habitat or EFH will help decision-makers determine the actions for decommissioning on a platform by platform basis.

In conclusion, the findings from this study show that YOY rockfish densities typically are concentrated below the shallow portion of the platform that would be removed should a platform be partially left in place when decommissioned. Additionally, YOY rockfish recruit to reefs and wrecks and these assemblages do not necessarily differ from the assemblage found between 25 and 30 m at platforms. Thus, it is plausible that the environmental consequences on local and regional rockfish populations from the partial removal of any of the platforms in this study will not be significant. However, to complicate the matter, the YOY rockfish assemblage and the abundance of YOY vary spatially and temporally among platforms. If the consequences of full removal of platforms, on a rig-by-rig basis, must be evaluated, then it is particularly important to determine the contribution of each platform to the fish stock in the region.

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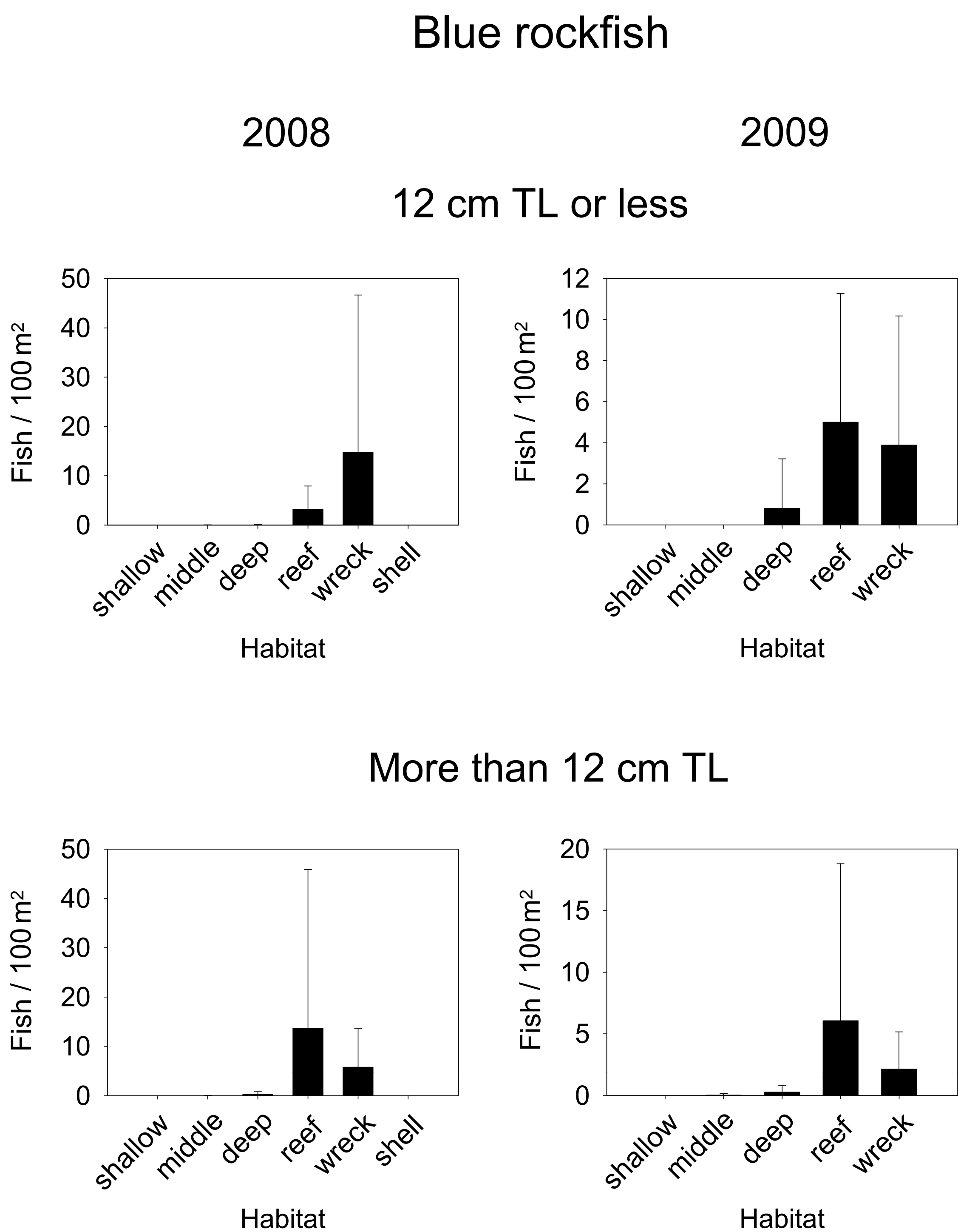
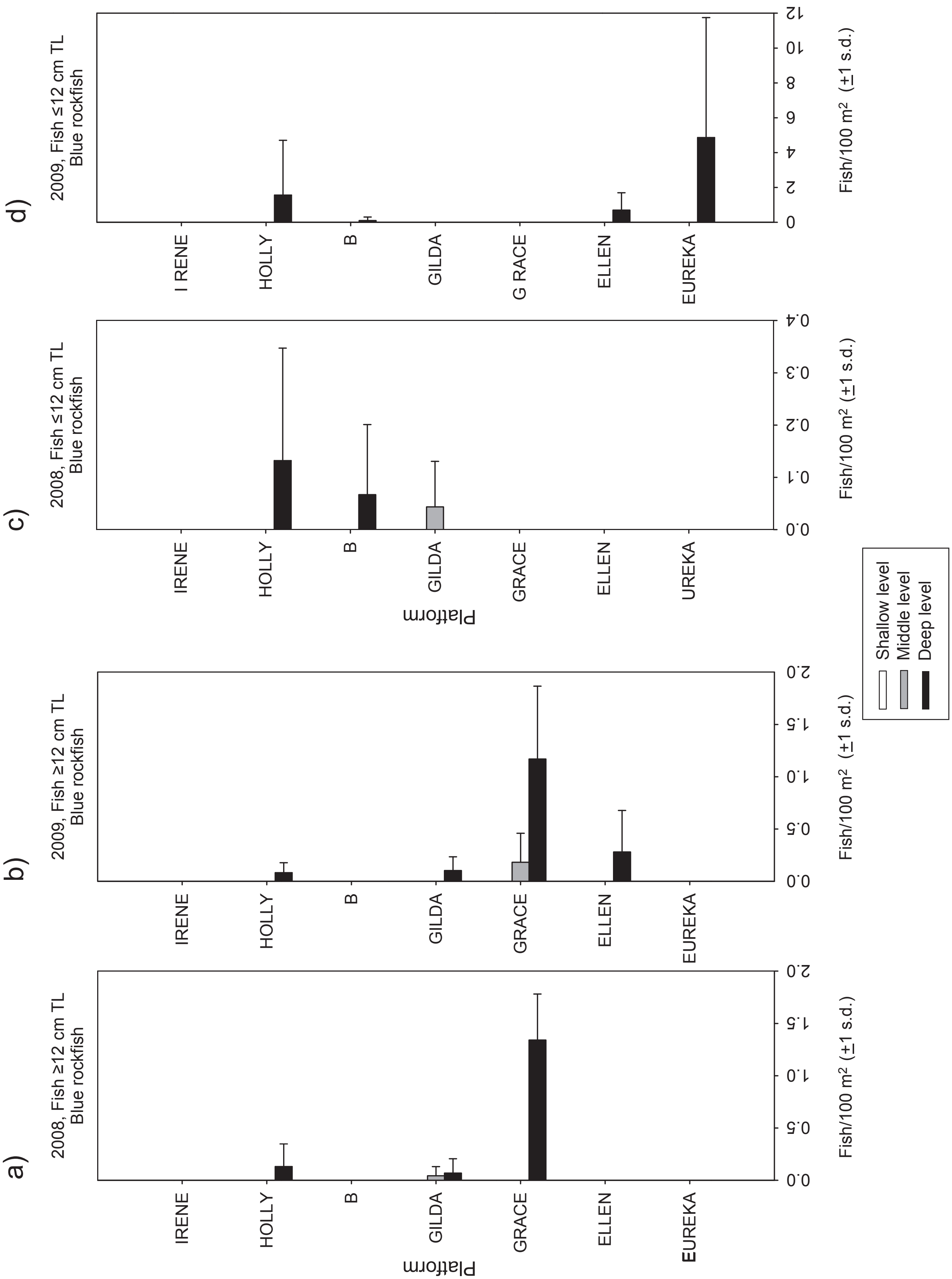
APPENDICES

APPENDIX 1

Summaries of rockfish species and complexes that were numerically important at the platforms during the two survey years, 2008 and 2009. The summaries include: (a) annual average densities (±1 s.d.) of two size classes (12 cm TL and less, greater than 12 cm TL) in five habitat types (the three levels of platforms, reefs and wrecks) and (b) annual average densities of the two size classes at individual platforms. Taxa are presented in alphabetical order of common names.





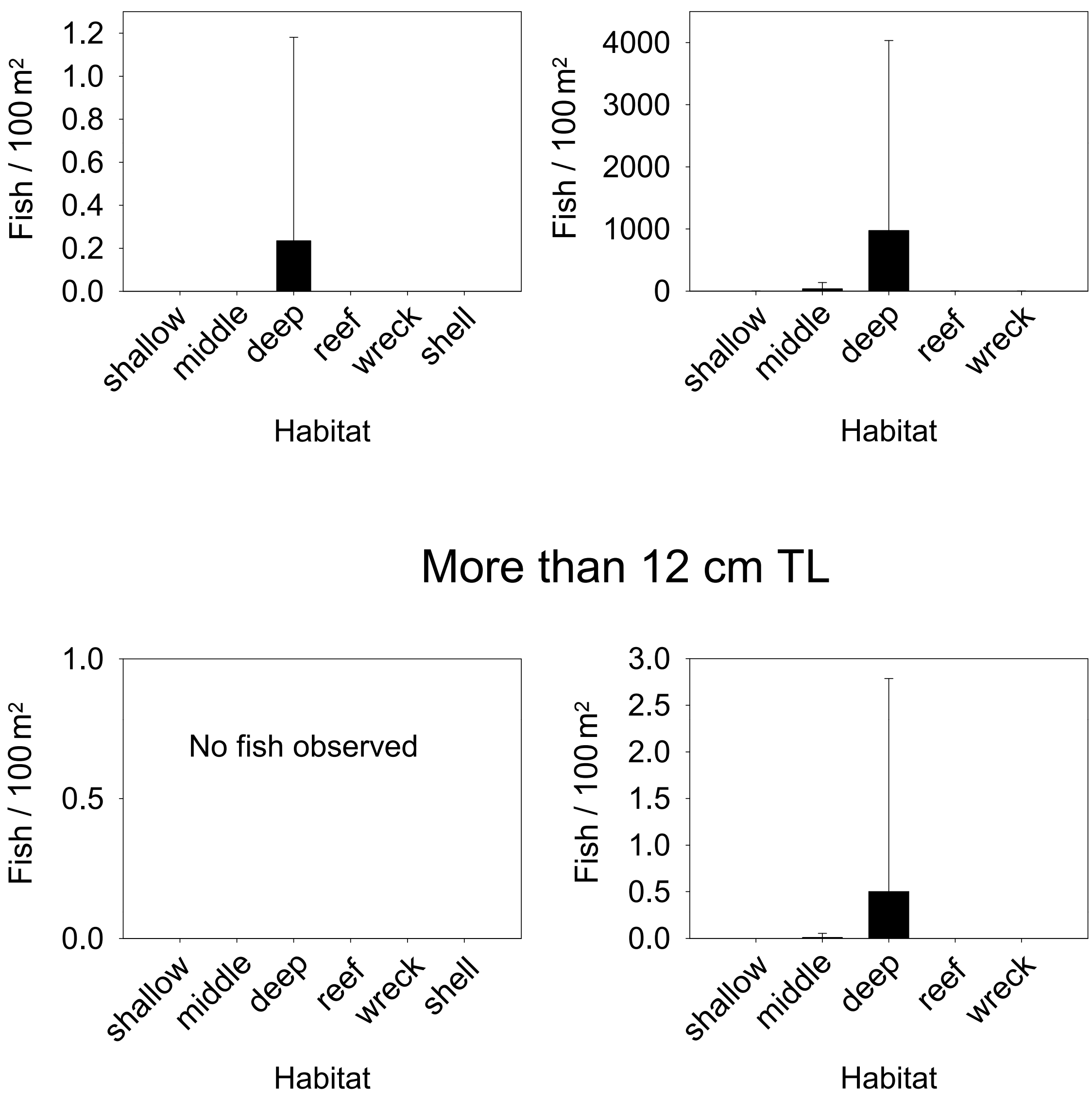
a)
2008, Fish ≥12 cm TL
Blue rockfish
b)
2009, Fish ≥12 cm TL
Blue rockfish
c)
2008, Fish ≤12 cm TL
Blue rockfish
d)
2009, Fish ≤12 cm TL
Blue rockfish
Platform
IRENE
HOLLY
B
GILDA
GRACE
ELLEN
EUREKA
UREKA
Fish/100 m² (±1 s.d.)
0.0
0.5
1.0
1.5
2.0
0.1
0.2
0.3
0.4
0
2
4
6
8
10
12
Shallow level
Middle level
Deep level

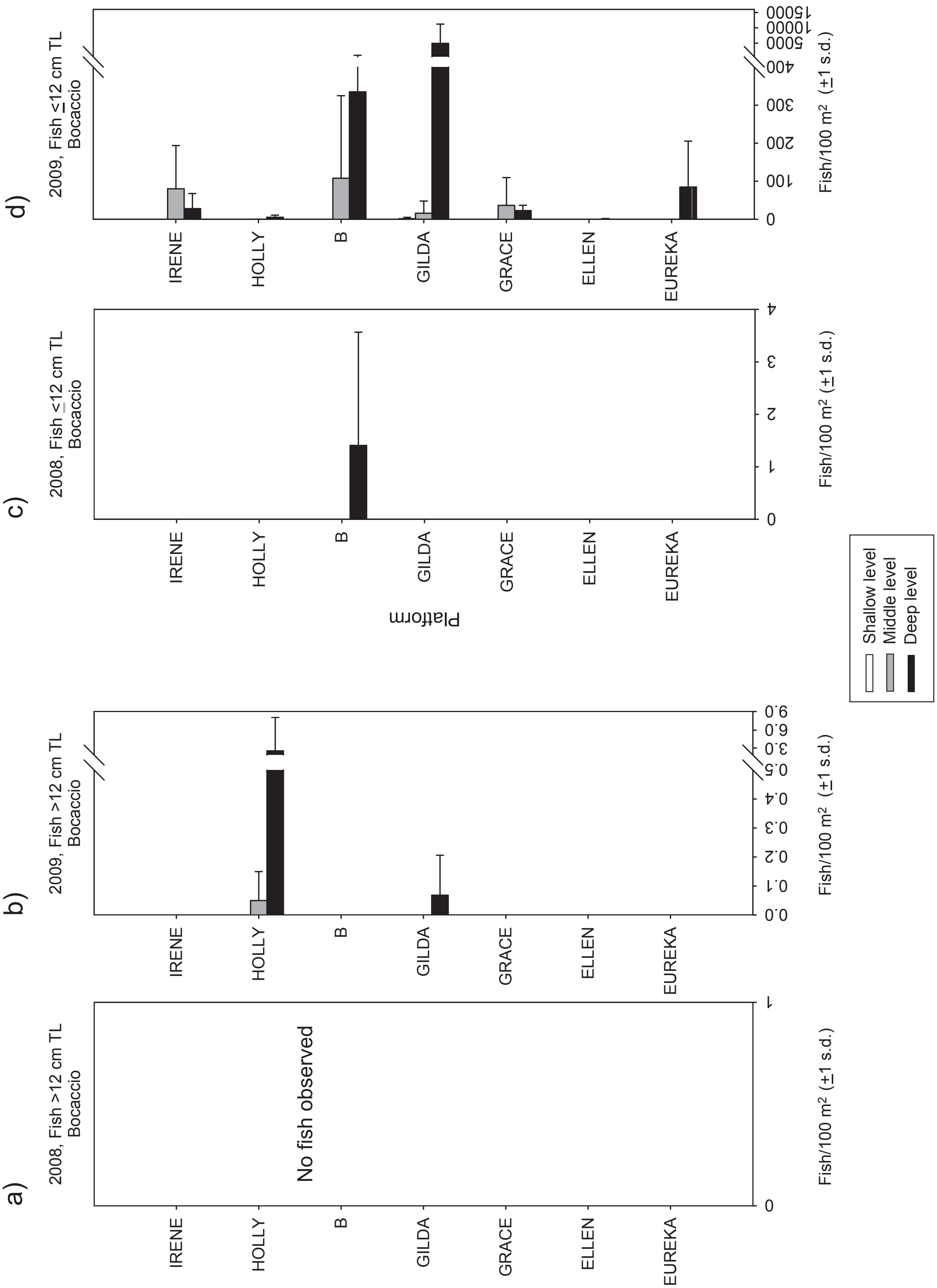
Bocaccio

2008 2009

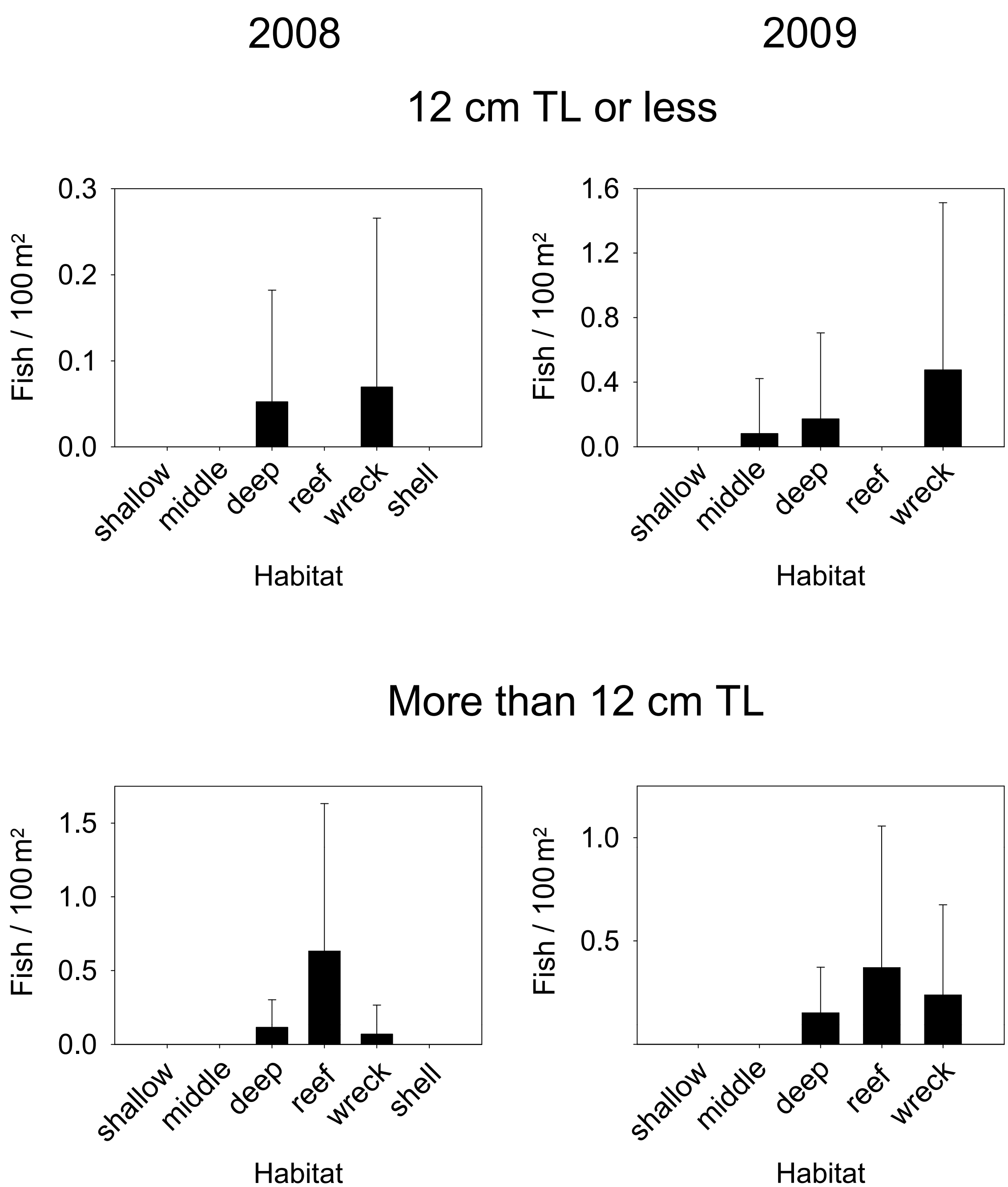
12 cm TL or less

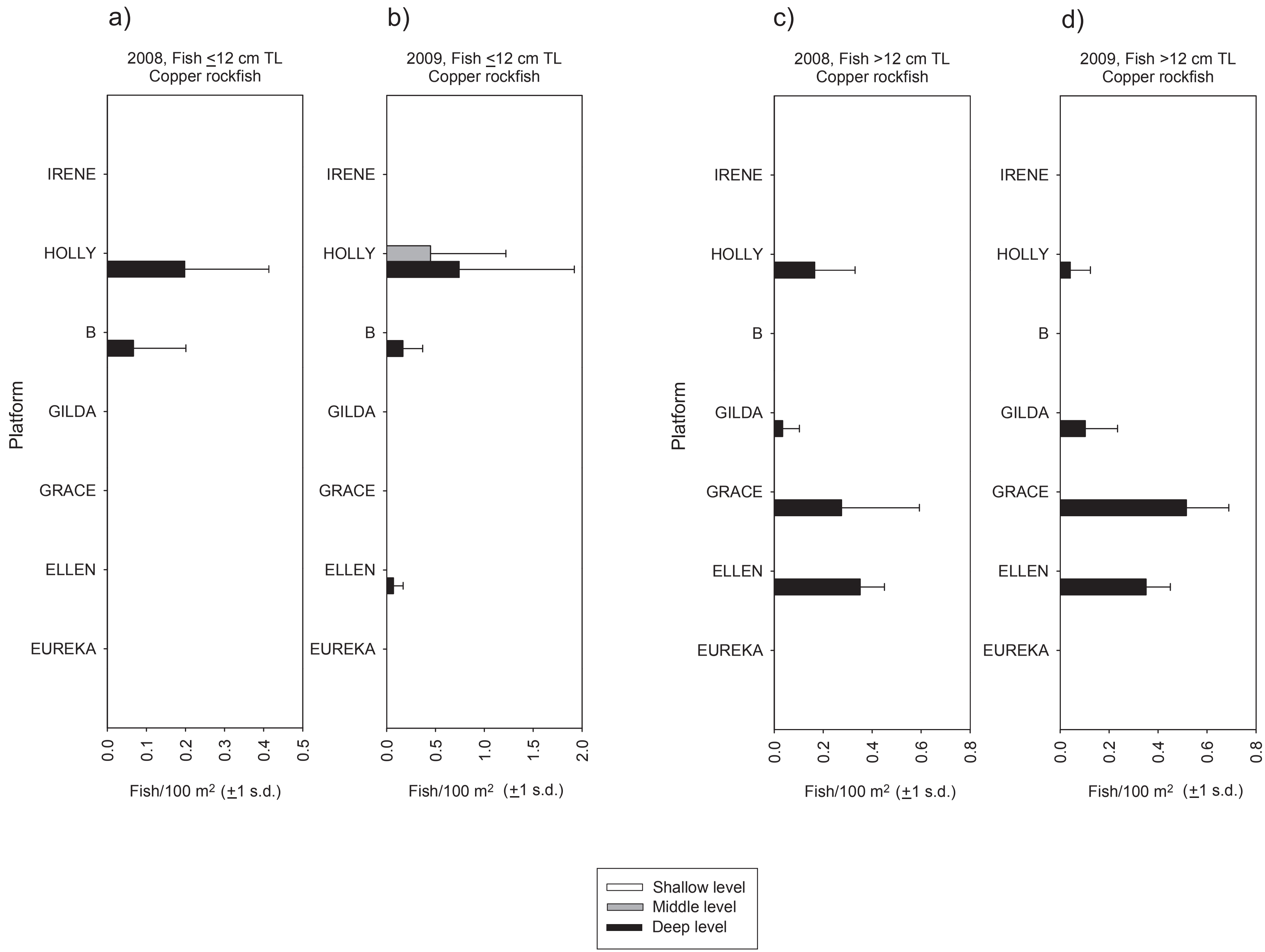
More than 12 cm TL




a)
2008, Fish >12 cm TL
Bocaccio
No fish observed
b)
2009, Fish >12 cm TL
Bocaccio
c)
2008, Fish ≤12 cm TL
Bocaccio
d)
2009, Fish ≤12 cm TL
Bocaccio
Platform
IRENE
HOLLY
B
GILDA
GRACE
ELLEN
EUREKA
Fish/100 m² (±1 s.d.)
Shallow level
Middle level
Deep level

Copper rockfish



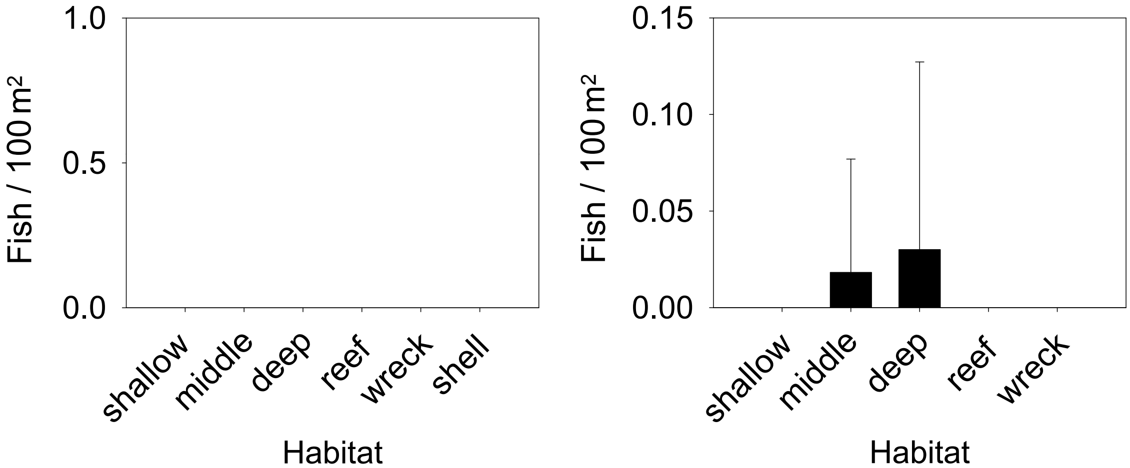


a)
2008, Fish ≤12 cm TL
Copper rockfish
b)
2009, Fish ≤12 cm TL
Copper rockfish
c)
2008, Fish >12 cm TL
Copper rockfish
d)
2009, Fish >12 cm TL
Copper rockfish
Platform
IRENE
HOLLY
B
GILDA
GRACE
ELLEN
EUREKA
0.0
0.1
0.2
0.3
0.4
0.5
1.0
1.5
2.0
0.6
0.8
Fish/100 m2 (±1 s.d.)
Shallow level
Middle level
Deep level

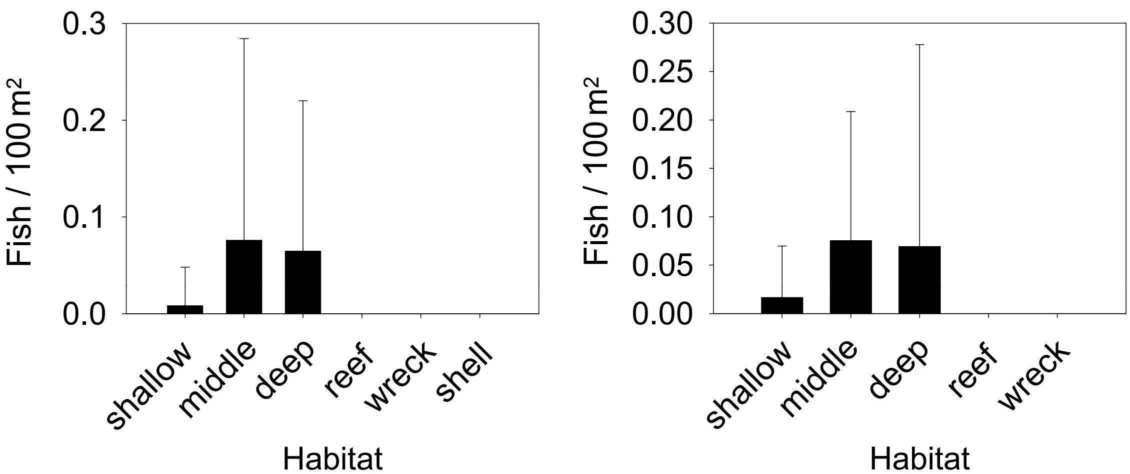
Grass rockfish

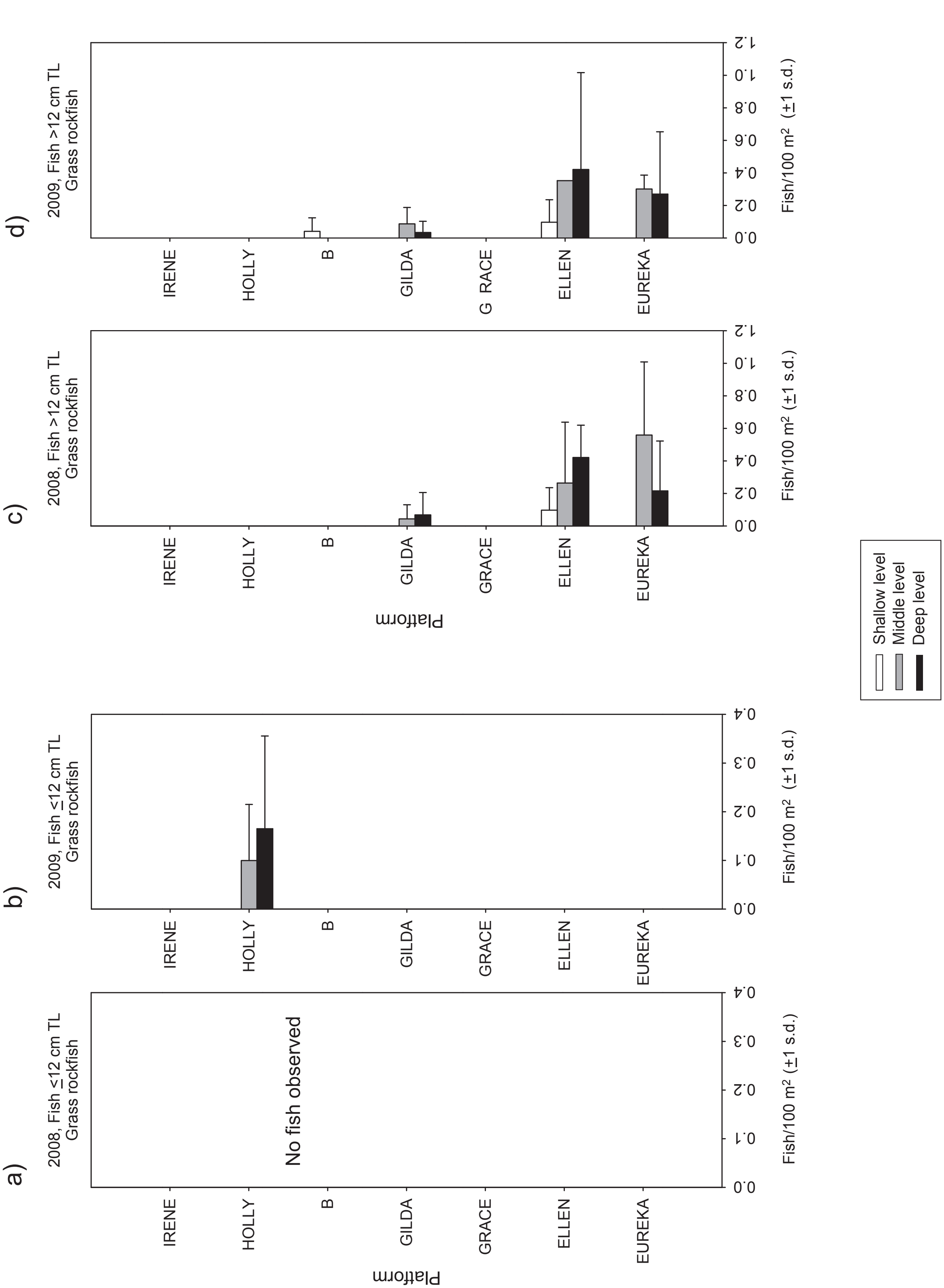
2008 2009

12 cm TL or less

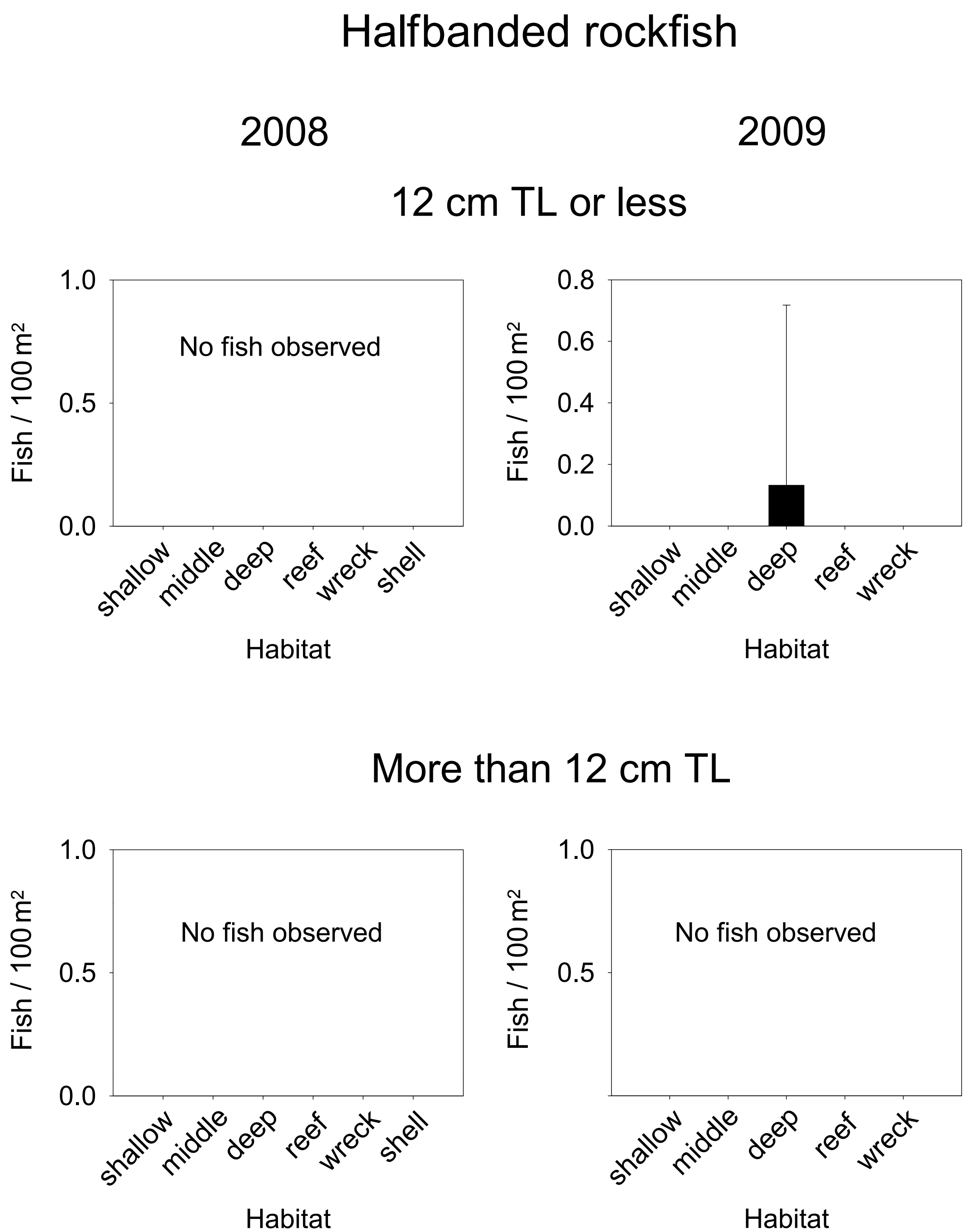


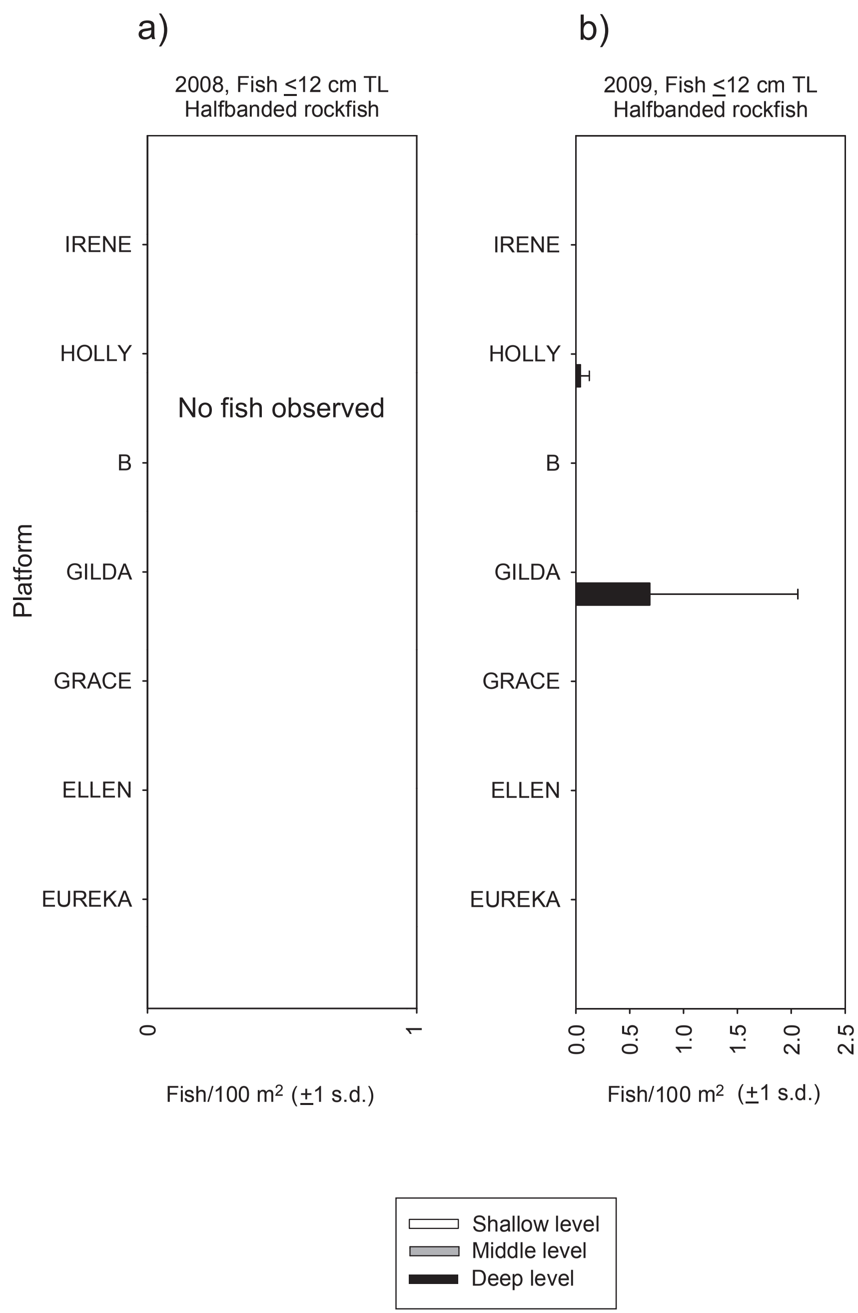
More than 12 cm TL





a)
2008, Fish ≤12 cm TL
Grass rockfish
No fish observed
b)
2009, Fish ≤12 cm TL
Grass rockfish
c)
2008, Fish >12 cm TL
Grass rockfish
d)
2009, Fish >12 cm TL
Grass rockfish
Platform
IRENE
HOLLY
B
GILDA
GRACE
G RACE
ELLEN
EUREKA
Fish/100 m2 (±1 s.d.)
0.0
0.1
0.2
0.3
0.4
0.6
0.8
1.0
1.2
Shallow level
Middle level
Deep level


Halfbanded rockfish
2008
2009
12 cm TL or less
1.0
0.5
0.0
Fish / 100 m2
No fish observed
shallow
middle
deep
reef
wreck
shell
Habitat
0.8
0.6
0.4
0.2
0.0
Fish / 100 m2
shallow
middle
deep
reef
wreck
Habitat
More than 12 cm TL
1.0
0.5
0.0
Fish / 100 m2
No fish observed
shallow
middle
deep
reef
wreck
shell
Habitat
1.0
0.5
Fish / 100 m2
No fish observed
shallow
middle
deep
reef
wreck
Habitat

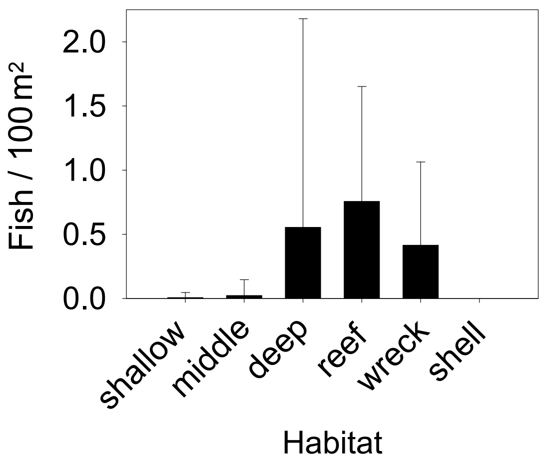


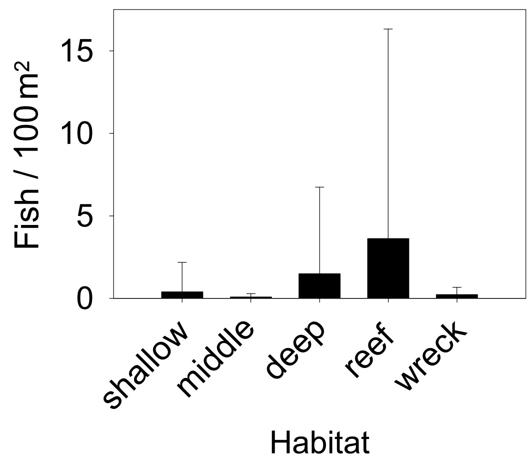
No halfbanded rockfish >12 cm TL
observed at platforms in 2008 or 2009

KGB rockfish complex

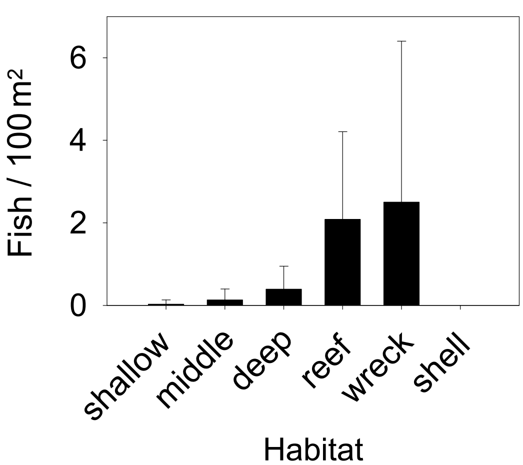
2008 2009

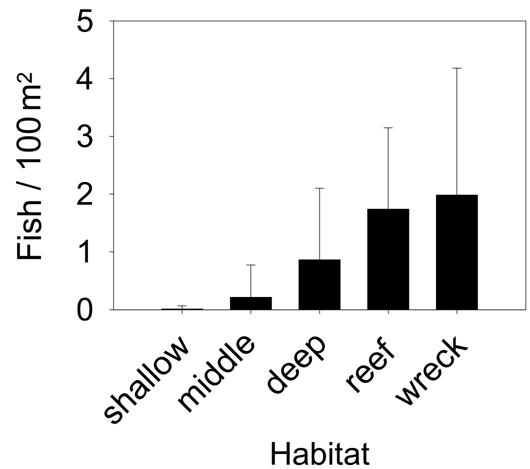
12 cm TL or less

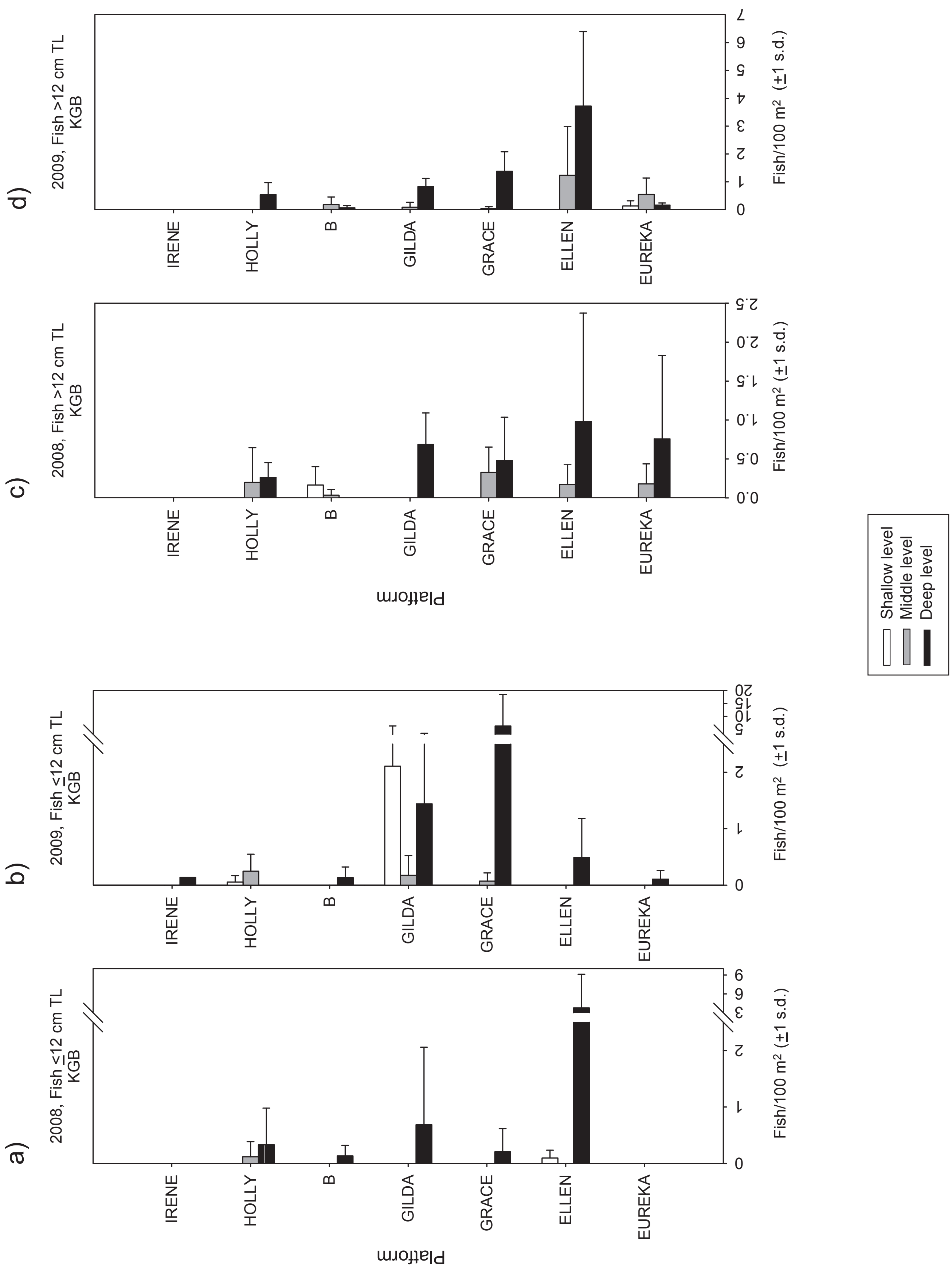




More than 12 cm TL





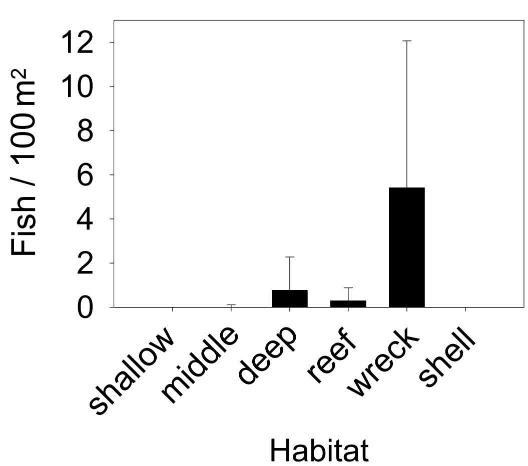


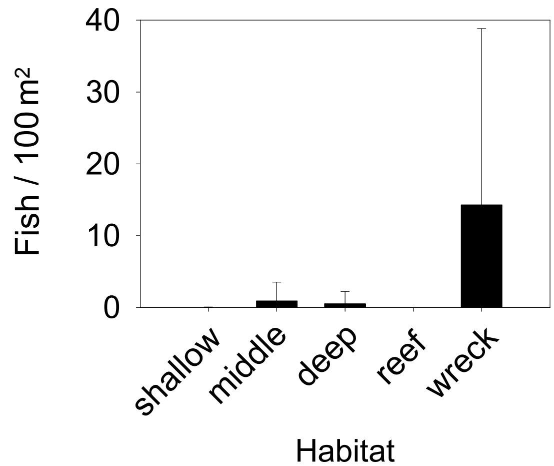
a)
2008, Fish ≤12 cm TL
KGB
b)
2009, Fish ≤12 cm TL
KGB
c)
2008, Fish >12 cm TL
KGB
d)
2009, Fish >12 cm TL
KGB
Platform
IRENE
HOLLY
B
GILDA
GRACE
ELLEN
EUREKA
Fish/100 m² (±1 s.d.)
Shallow level
Middle level
Deep level

OYT complex

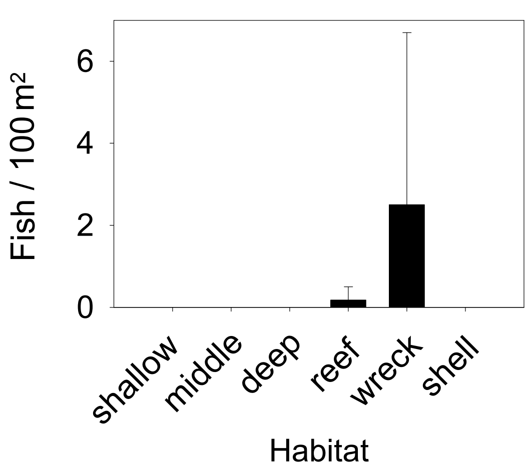
2008 2009

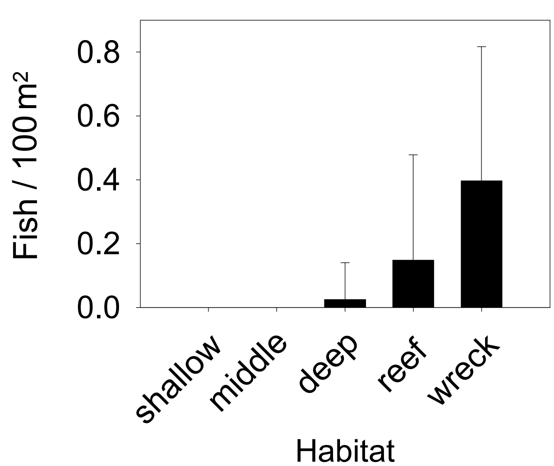
12 cm TL or less

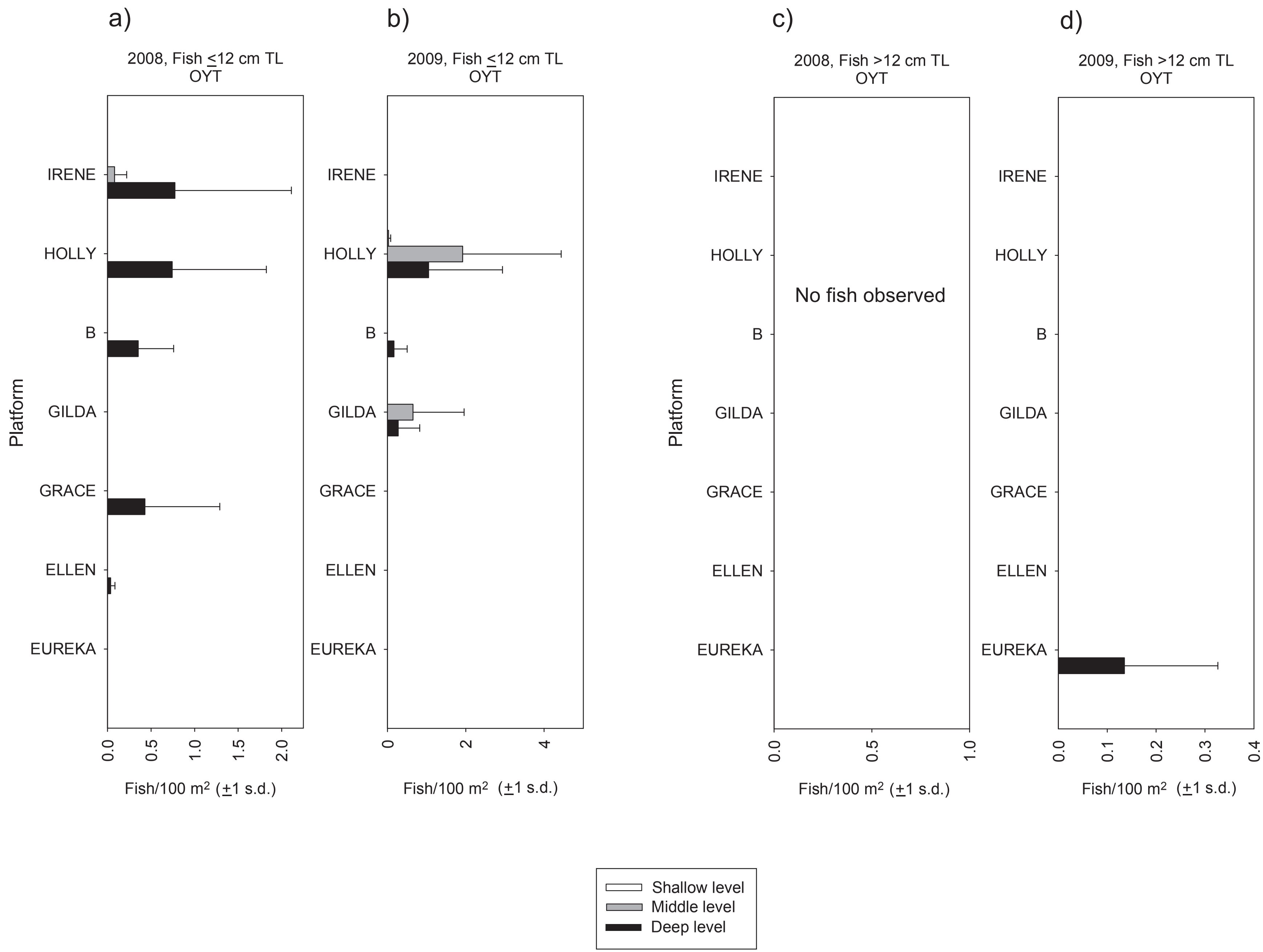




More than 12 cm TL





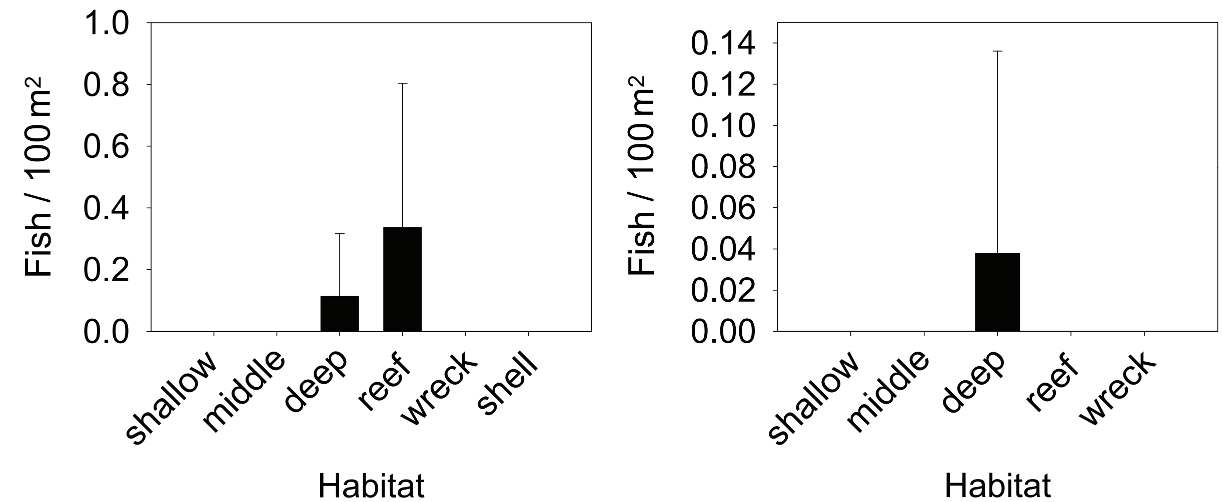


a)
2008, Fish ≤12 cm TL
OYT
b)
2009, Fish ≤12 cm TL
OYT
c)
2008, Fish >12 cm TL
OYT
No fish observed
d)
2009, Fish >12 cm TL
OYT
Platform
IRENE
HOLLY
B
GILDA
GRACE
ELLEN
EUREKA
0.0
0.5
1.0
1.5
2.0
0
2
4
0.1
0.2
0.3
0.4
Fish/100 m² (±1 s.d.)
Shallow level
Middle level
Deep level

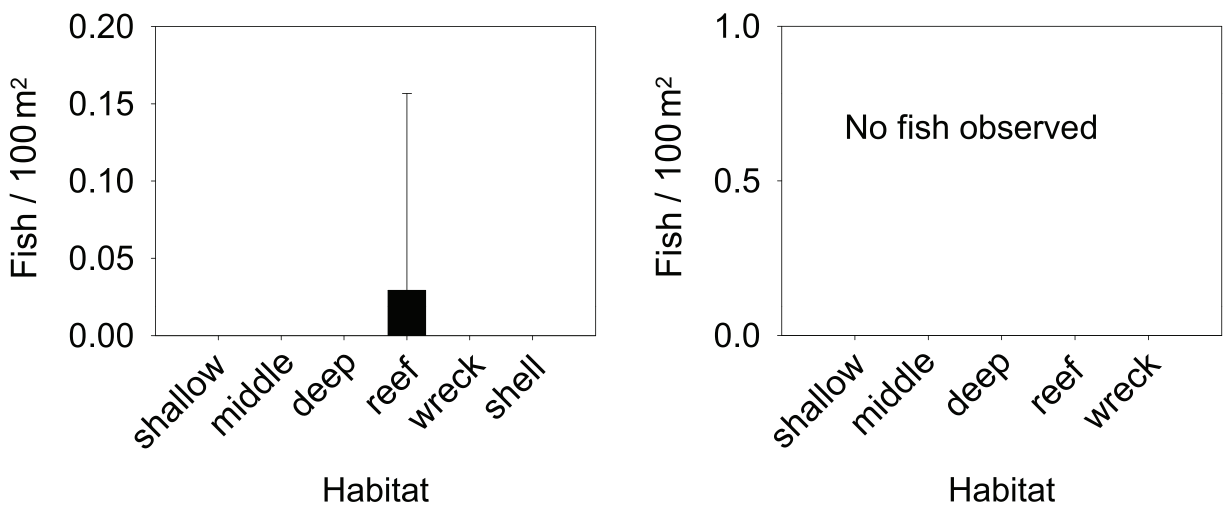
ROSY rockfish complex *(Sebastomus)*

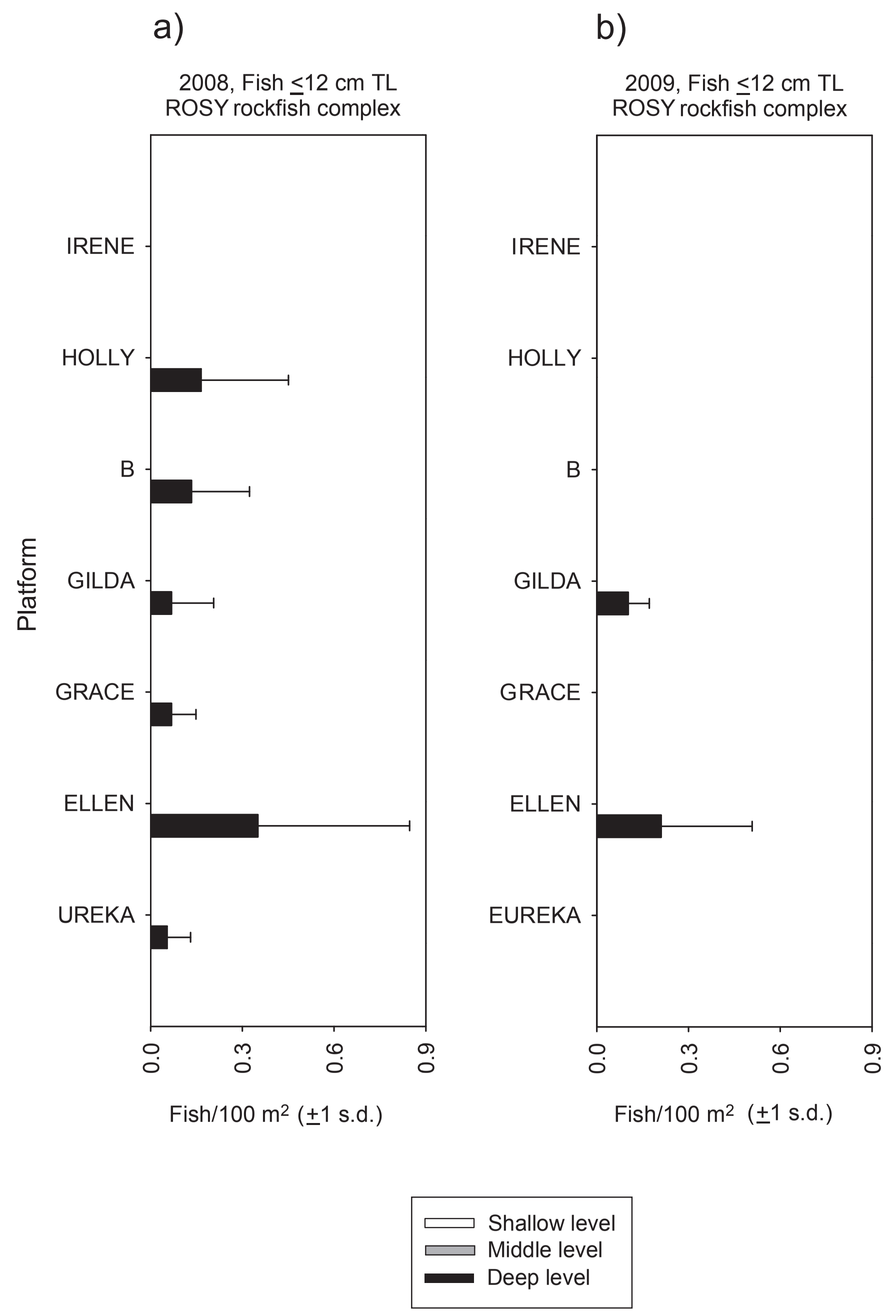
2008 2009

12 cm TL or less



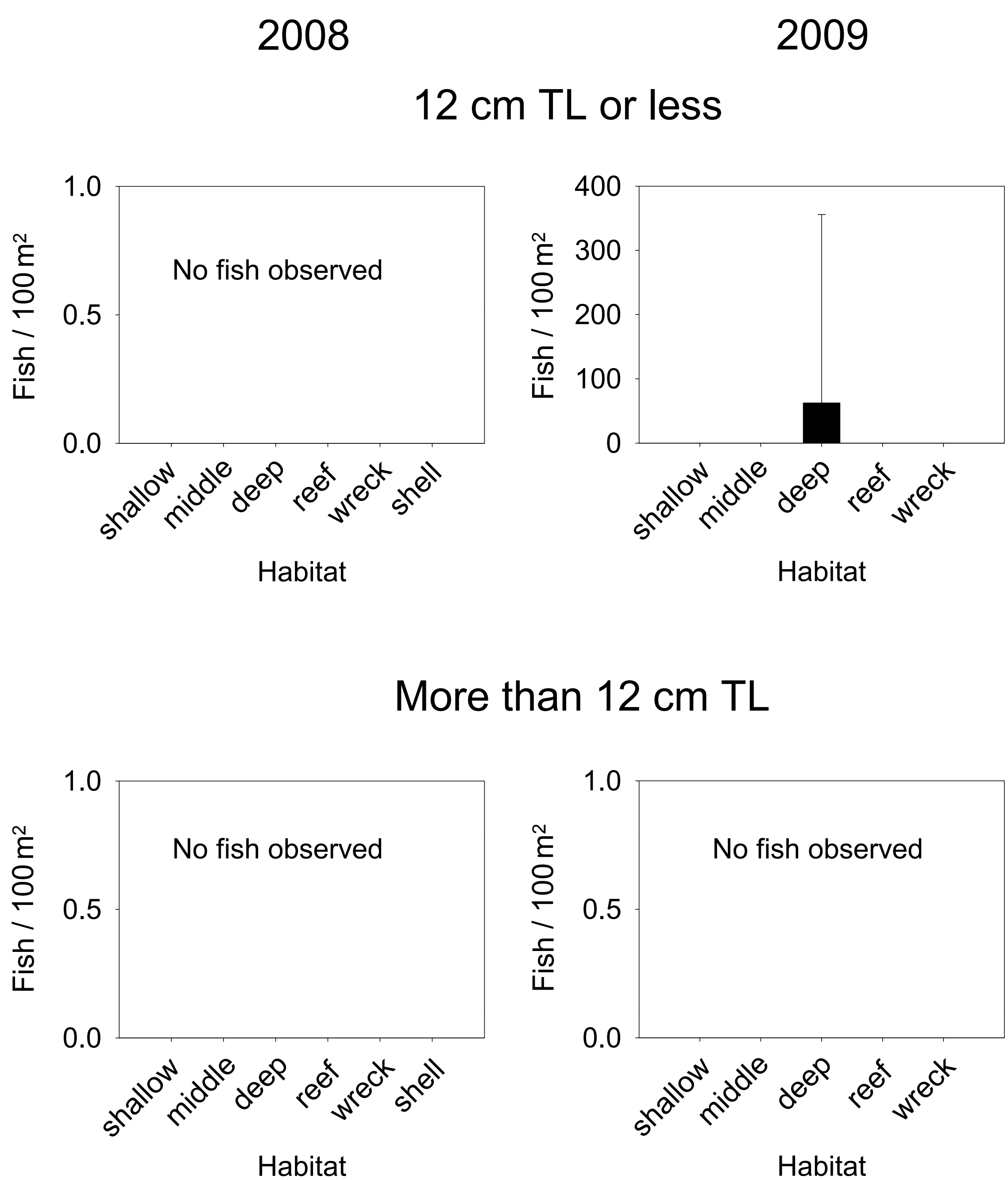
More than 12 cm TL

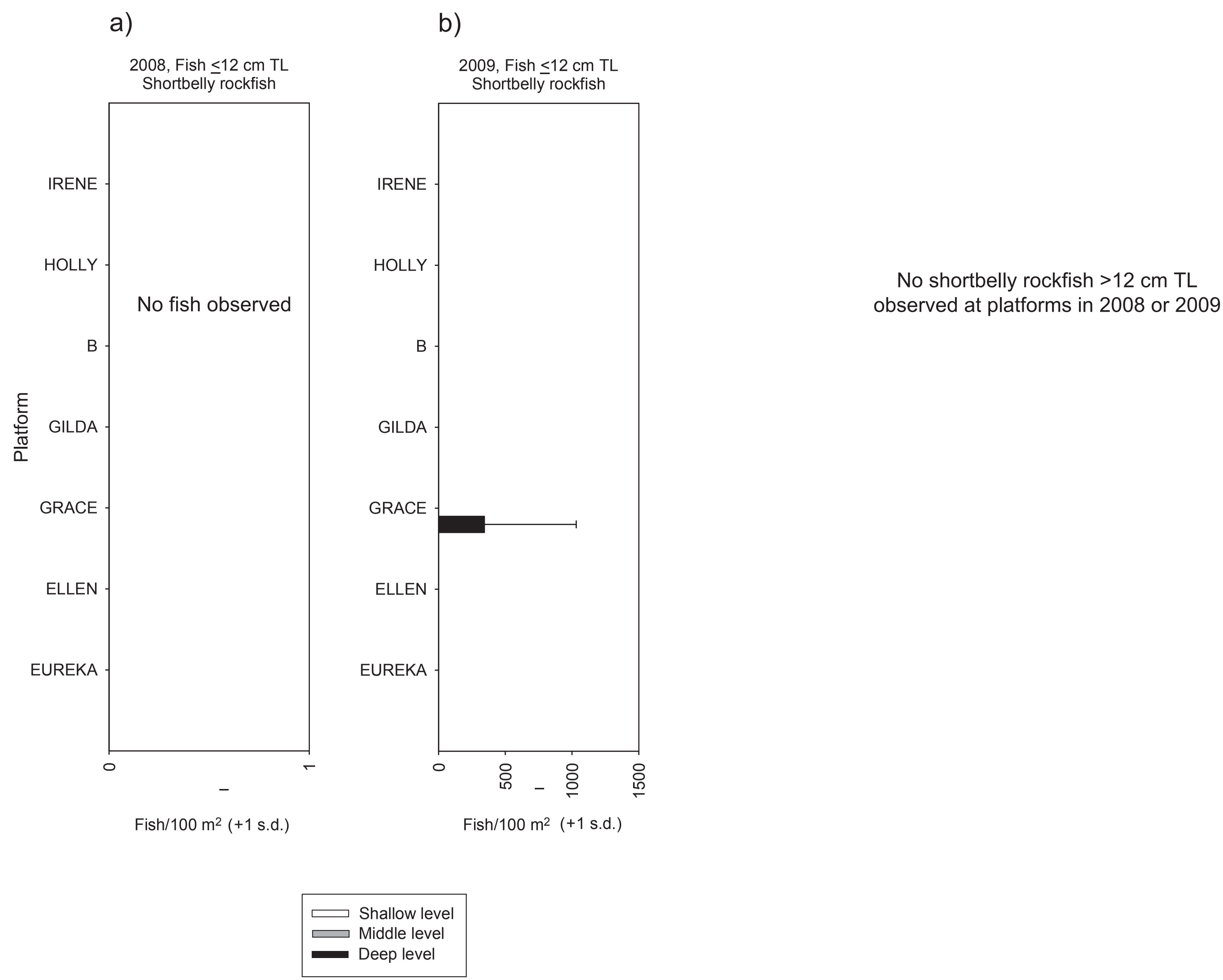




No ROSY complex >12 cm TL
observed at platforms in 2008 or 2009

Shortbelly rockfish



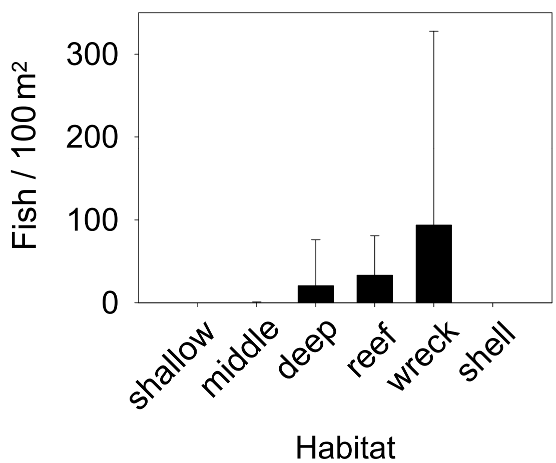


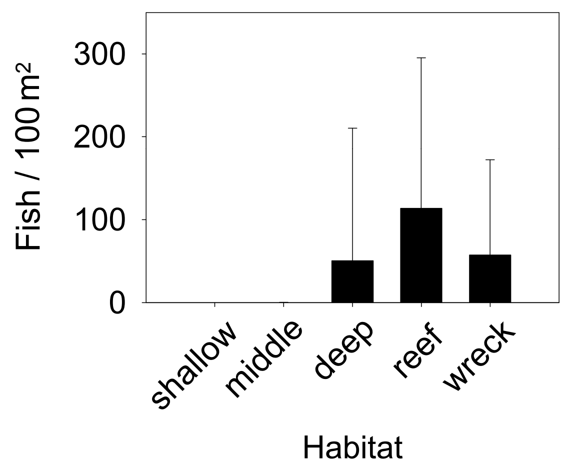
a)
2008, Fish ≤12 cm TL
Shortbelly rockfish
No fish observed
Platform
IRENE
HOLLY
B
GILDA
GRACE
ELLEN
EUREKA
0
1
Fish/100 m² (+1 s.d.)
b)
2009, Fish ≤12 cm TL
Shortbelly rockfish
0
500
1000
1500
Fish/100 m² (+1 s.d.)
Shallow level
Middle level
Deep level
No shortbelly rockfish >12 cm TL
observed at platforms in 2008 or 2009

Squarespot rockfish

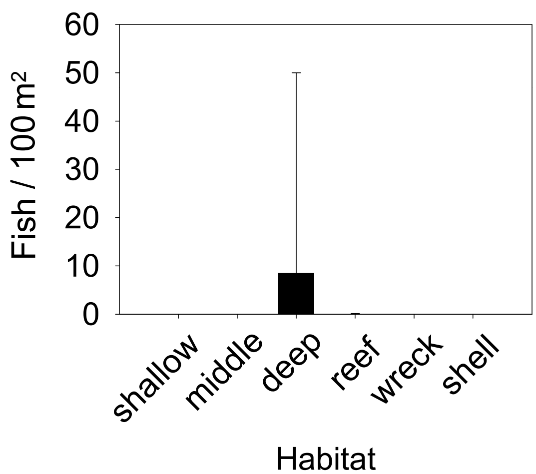
2008 2009

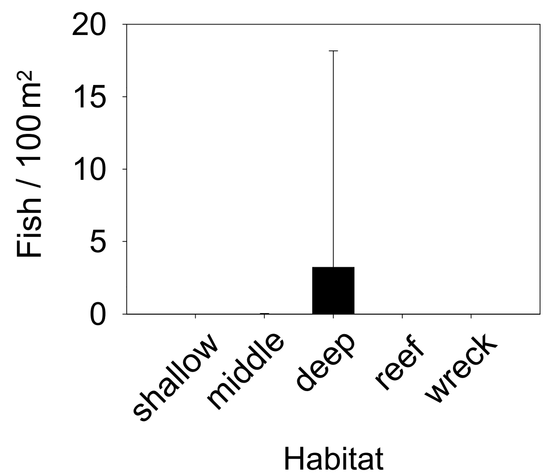
12 cm TL or less

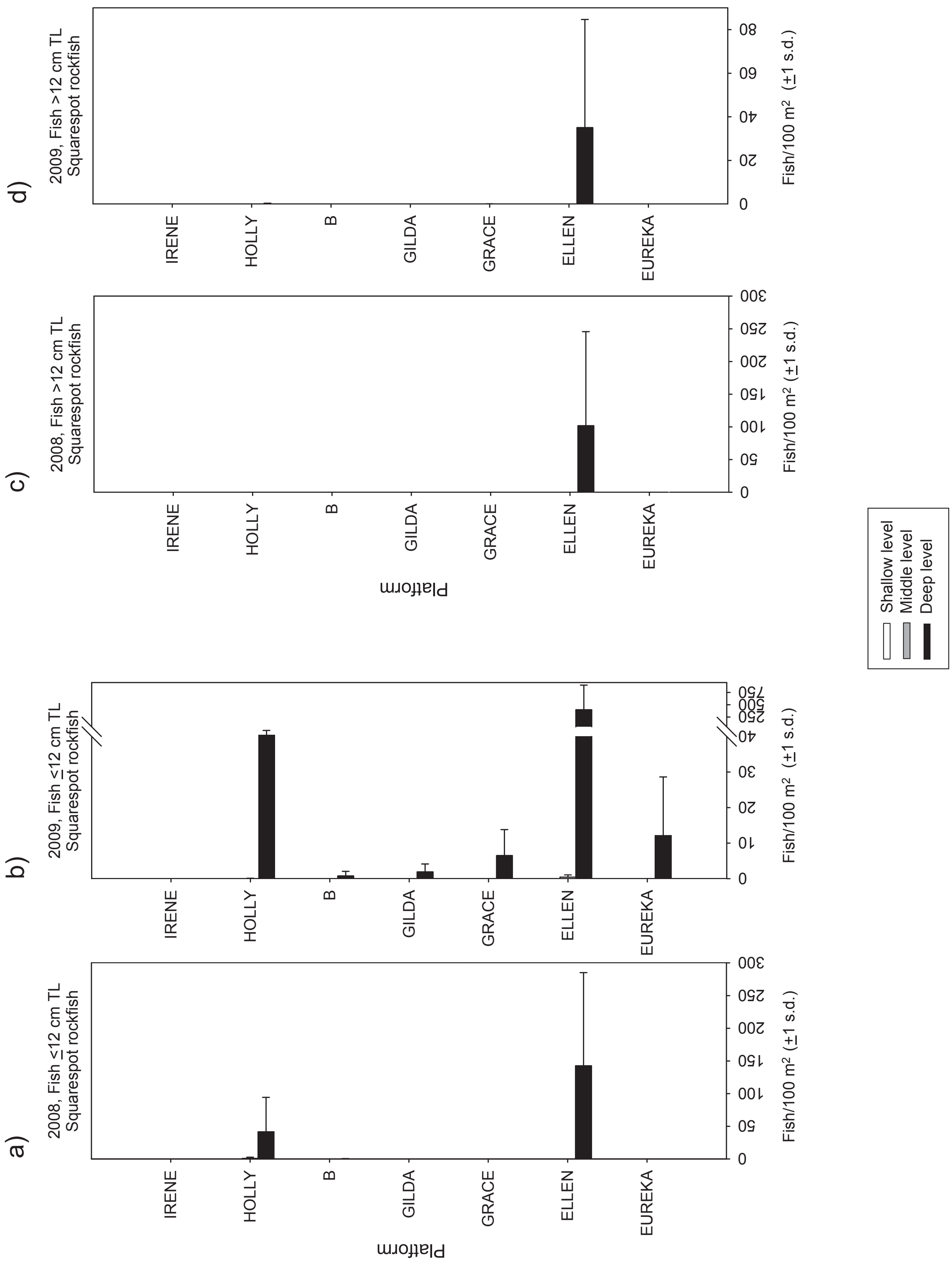




More than 12 cm TL





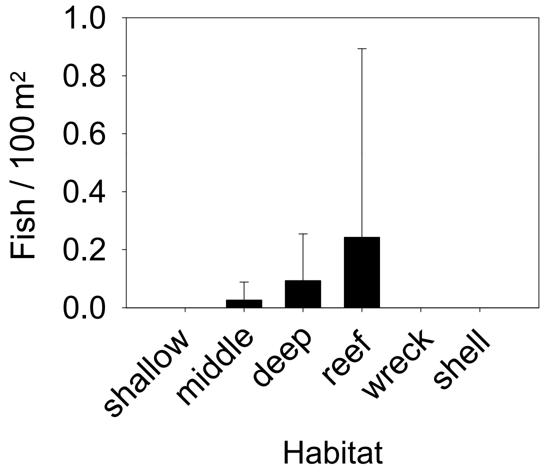


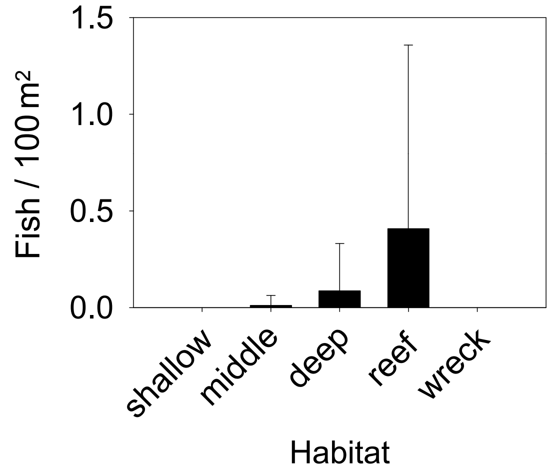
a)
2008, Fish ≤12 cm TL
Squarespot rockfish
b)
2009, Fish ≤12 cm TL
Squarespot rockfish
c)
2008, Fish >12 cm TL
Squarespot rockfish
d)
2009, Fish >12 cm TL
Squarespot rockfish
IRENE
HOLLY
B
GILDA
GRACE
ELLEN
EUREKA
Platform
Fish/100 m² (±1 s.d.)
0
10
20
30
40
50
60
80
100
150
200
250
300
500
750
Shallow level
Middle level
Deep level

Treefish

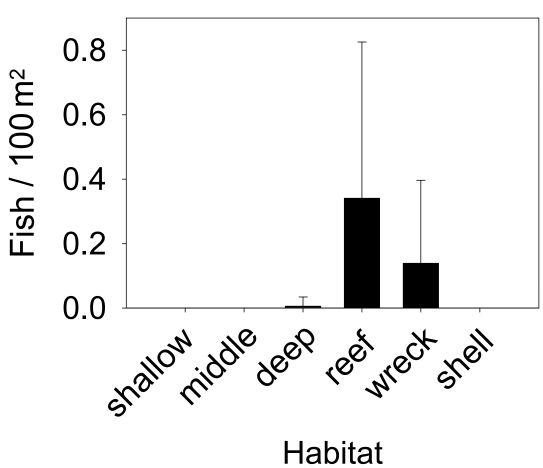
2008 2009

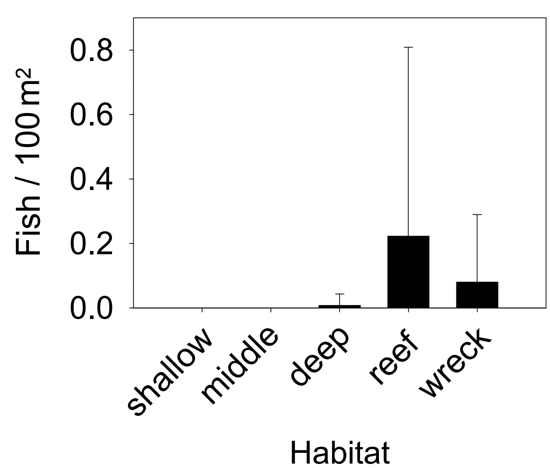
12 cm TL or less

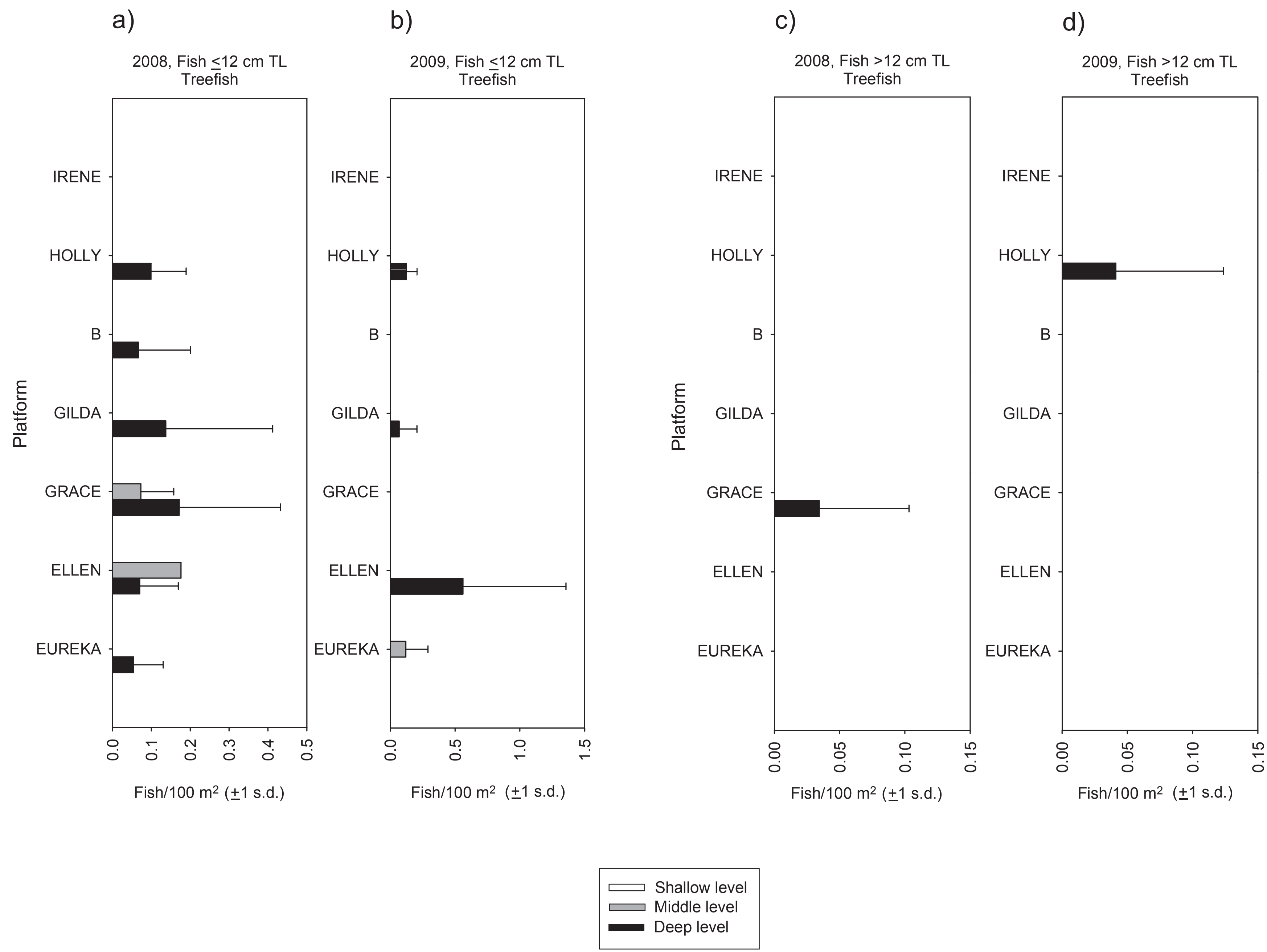




More than 12 cm TL



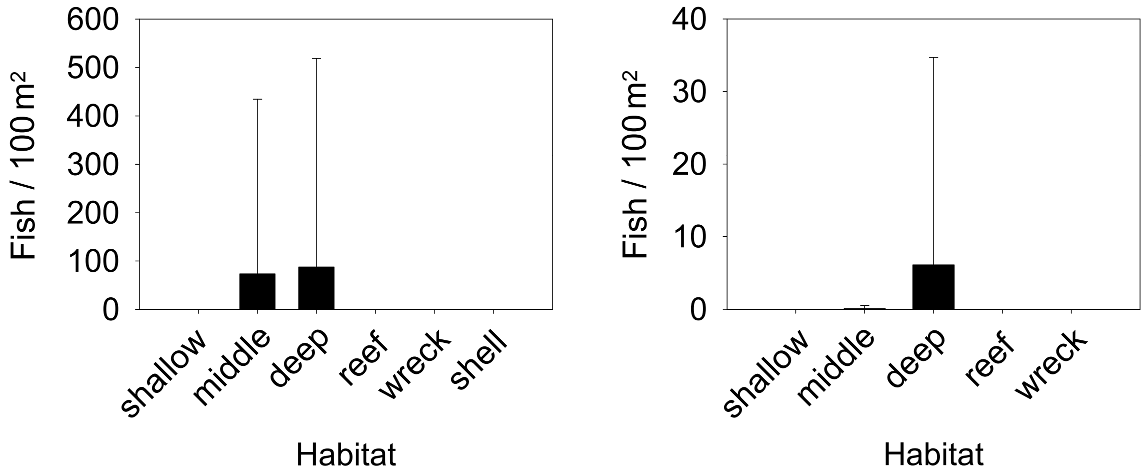



a)
2008, Fish ≤12 cm TL
Treefish
b)
2009, Fish ≤12 cm TL
Treefish
c)
2008, Fish >12 cm TL
Treefish
d)
2009, Fish >12 cm TL
Treefish
Platform
IRENE
HOLLY
B
GILDA
GRACE
ELLEN
EUREKA
0.0
0.1
0.2
0.3
0.4
0.5
0.5
1.0
1.5
0.00
0.05
0.10
0.15
Fish/100 m² (±1 s.d.)
Shallow level
Middle level
Deep level

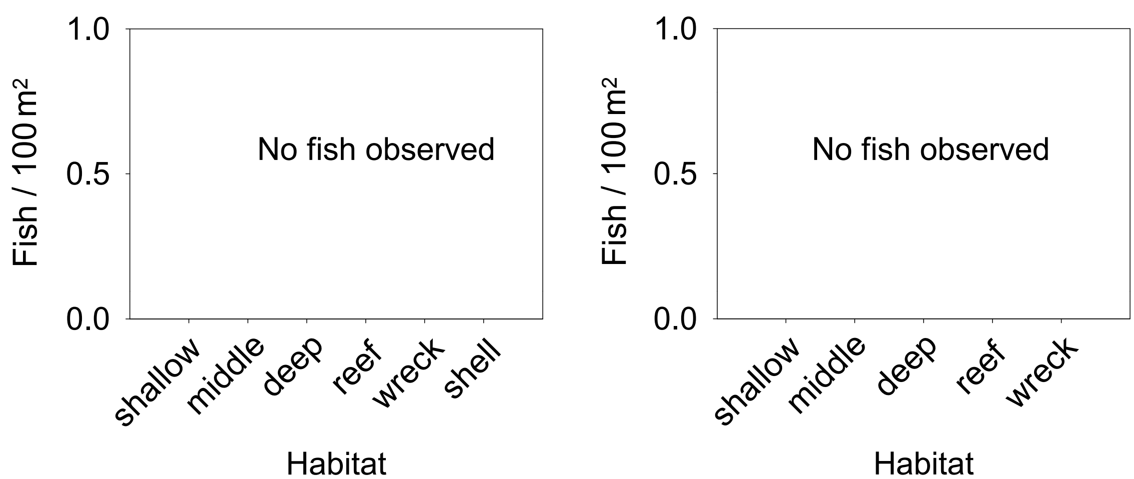
Widow rockfish

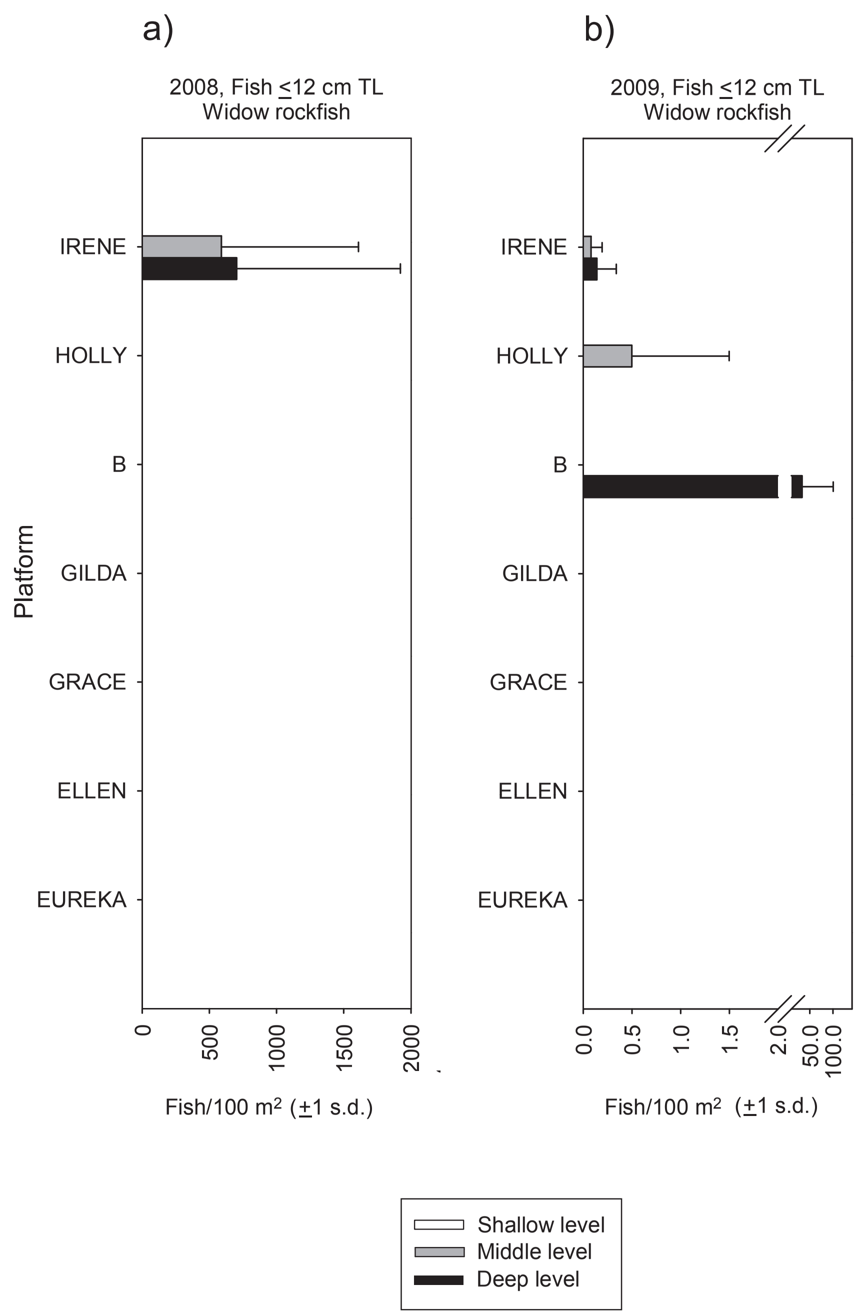
2008 2009

12 cm TL or less



More than 12 cm TL

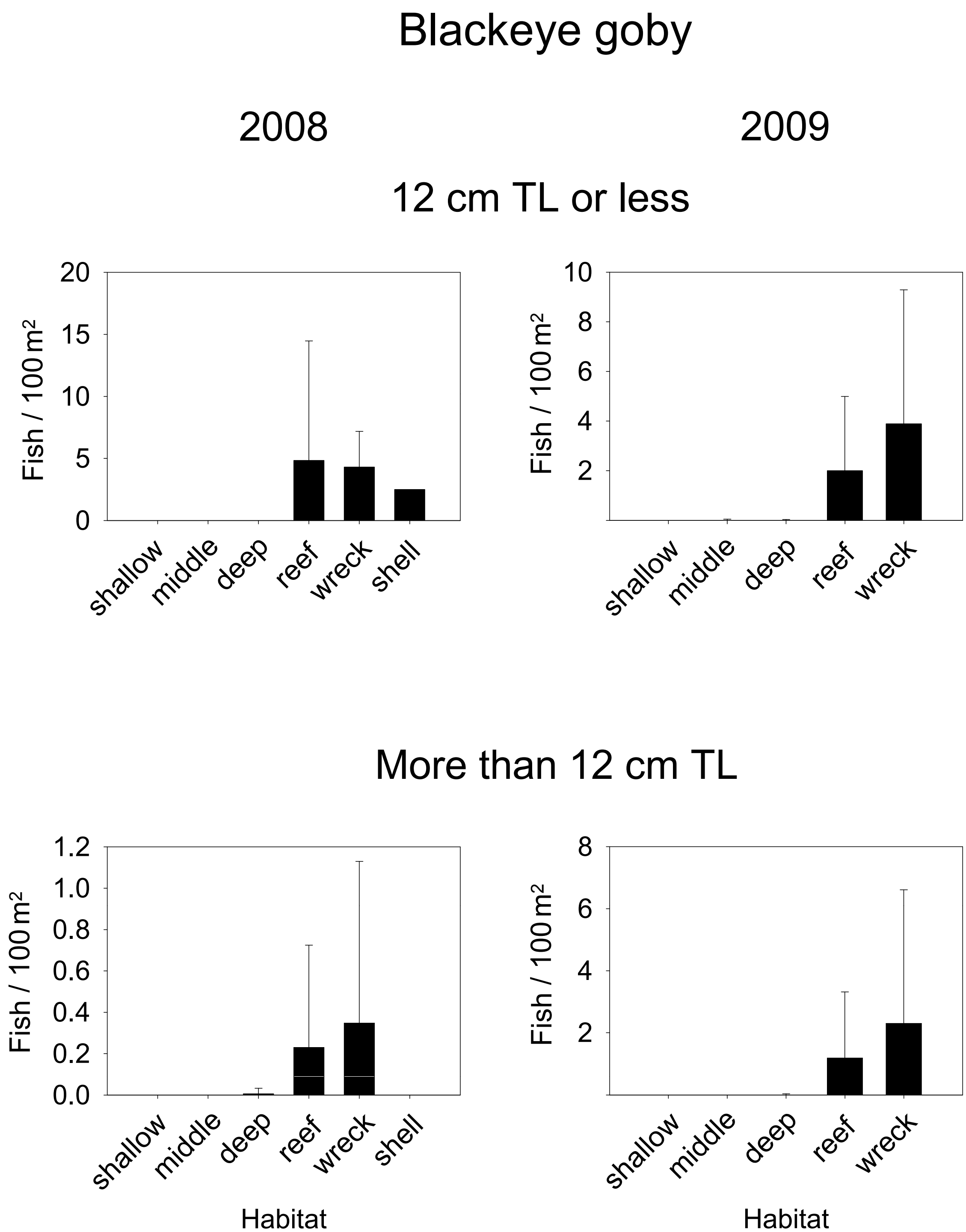


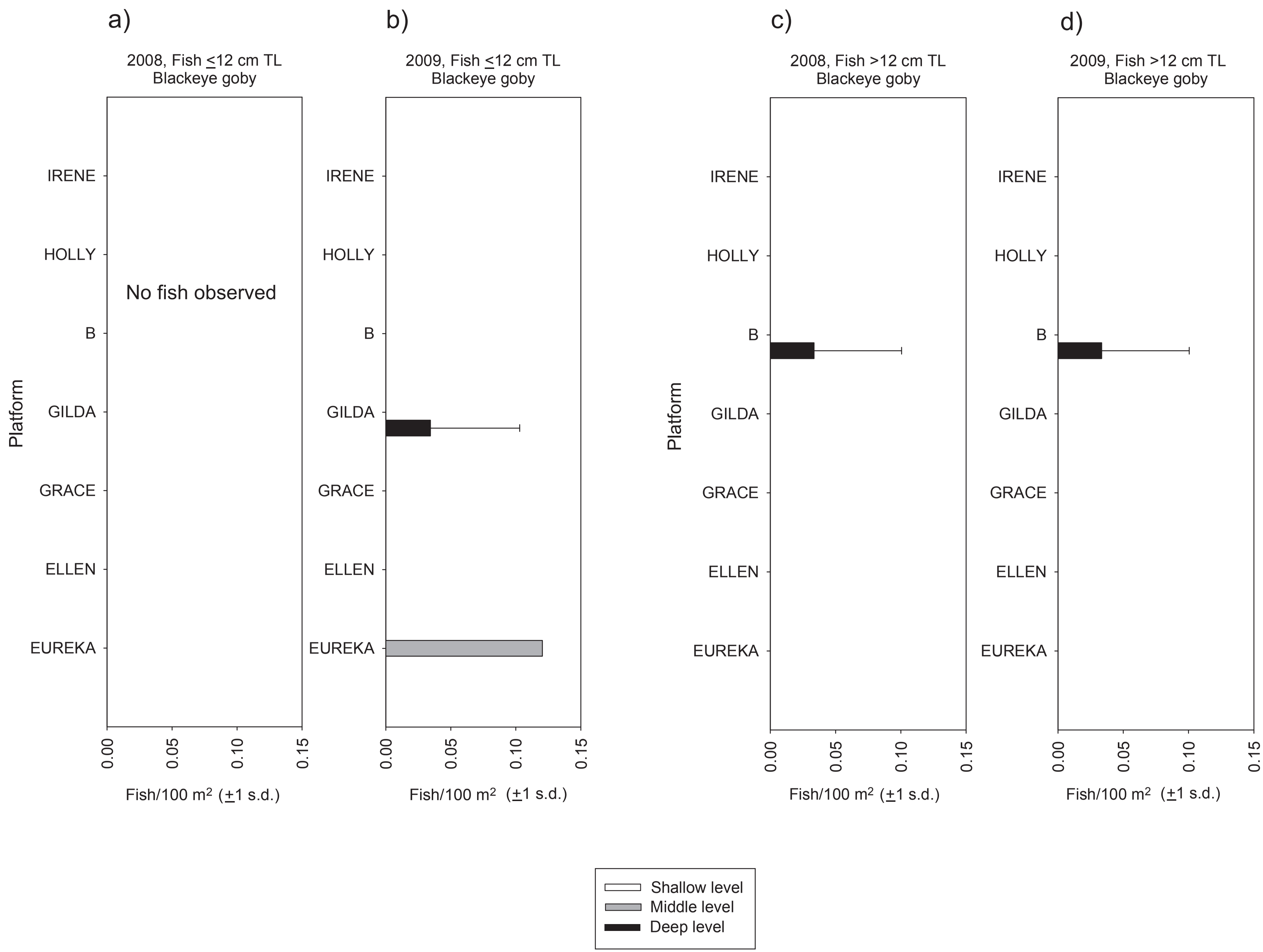


No widow rockfish >12 cm TL
observed at platforms in 2008 or 2009

APPENDIX 2

Summaries of non-rockfish species numerically important at the platforms during the two survey years, 2008 and 2009. The summaries include: (a) annual average densities (± 1 s.d.) of two size classes (12 cm TL and less, greater than 12 cm TL) in five habitat types (the three levels of platforms, reefs and wrecks); and (b) average annual densities of the two size classes at individual platforms. Taxa are presented in alphabetical order of common names.



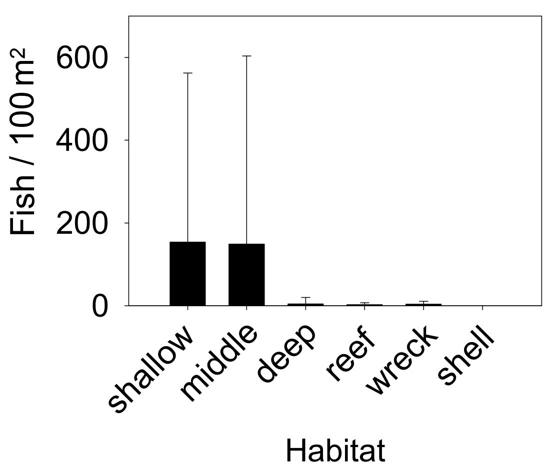


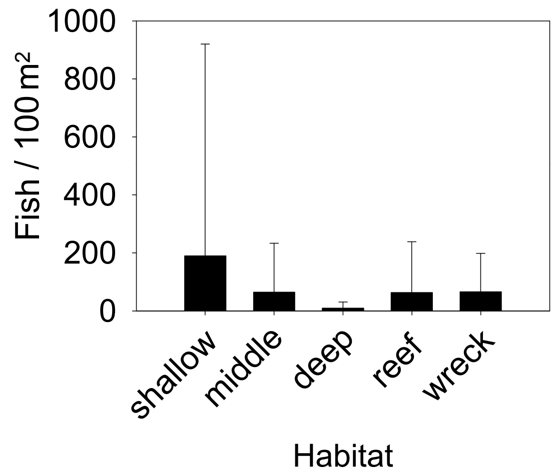
a)
2008, Fish ≤12 cm TL
Blackeye goby
No fish observed
b)
2009, Fish ≤12 cm TL
Blackeye goby
c)
2008, Fish >12 cm TL
Blackeye goby
d)
2009, Fish >12 cm TL
Blackeye goby
Platform
IRENE
HOLLY
B
GILDA
GRACE
ELLEN
EUREKA
0.00
0.05
0.10
0.15
Fish/100 m2 (±1 s.d.)
Shallow level
Middle level
Deep level

Blacksmith

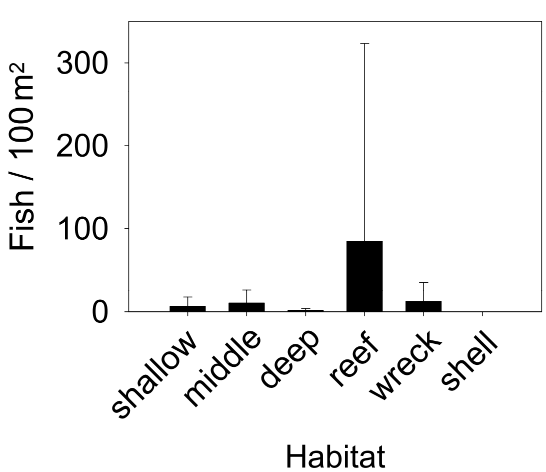
2008 2009

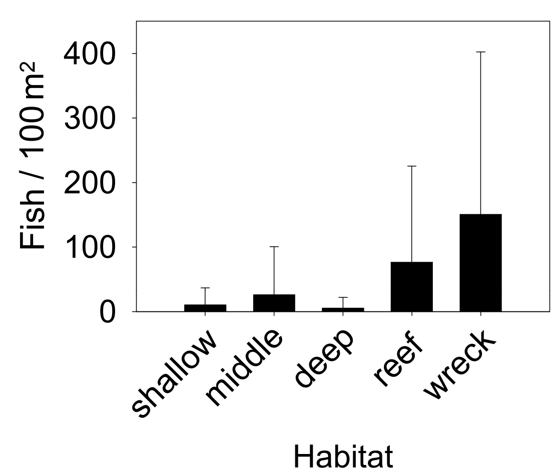
12 cm TL or less

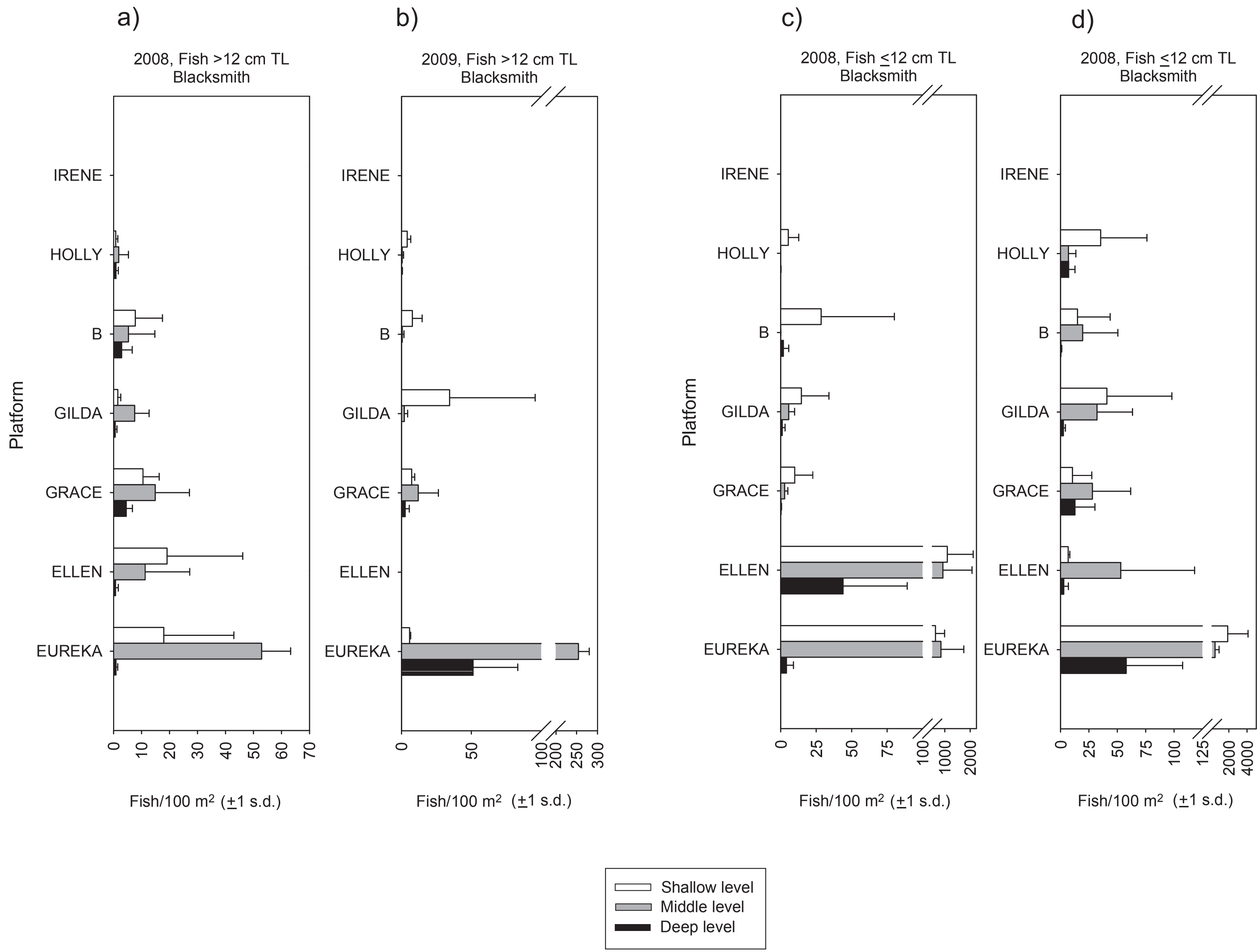




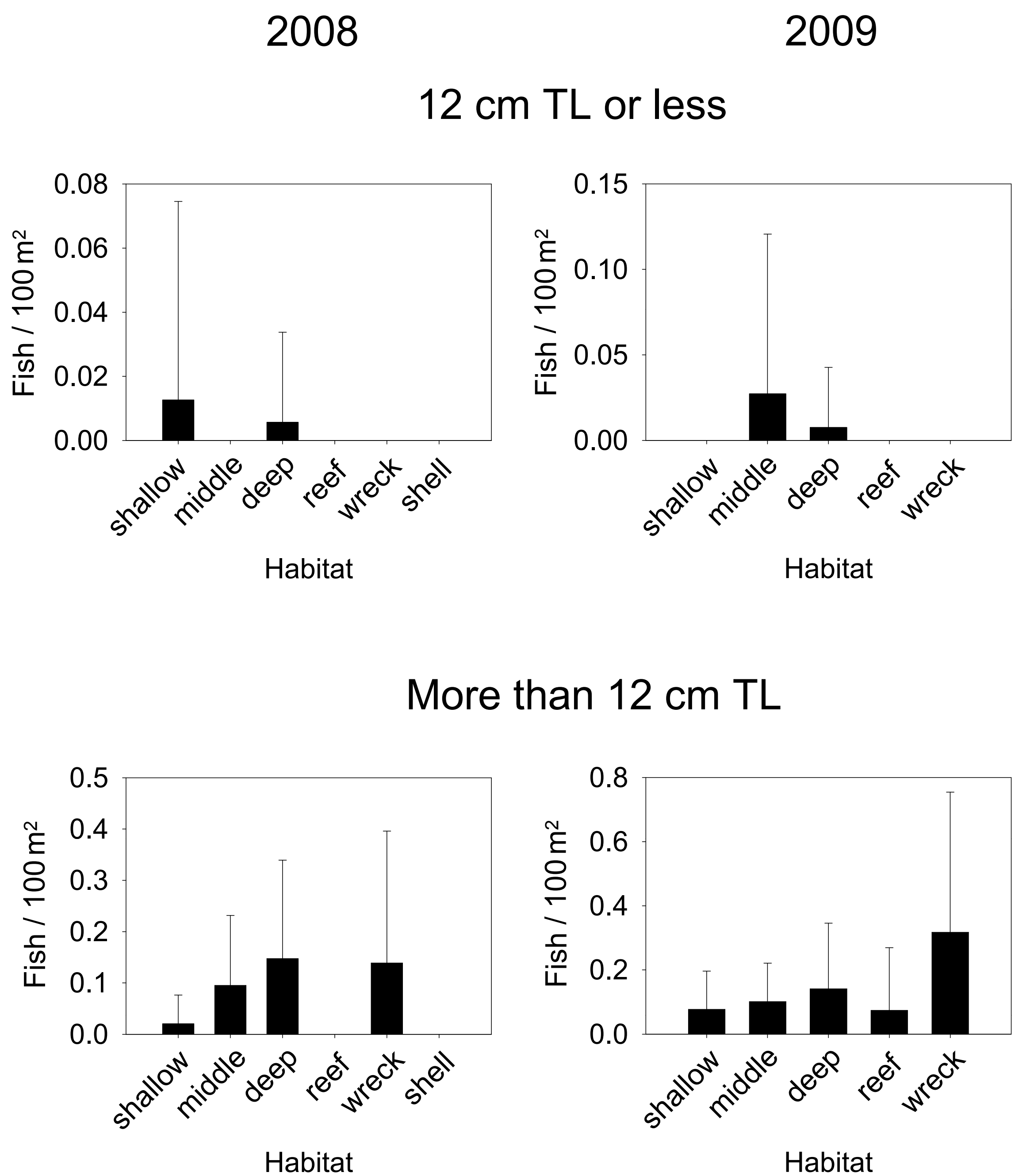
More than 12 cm TL



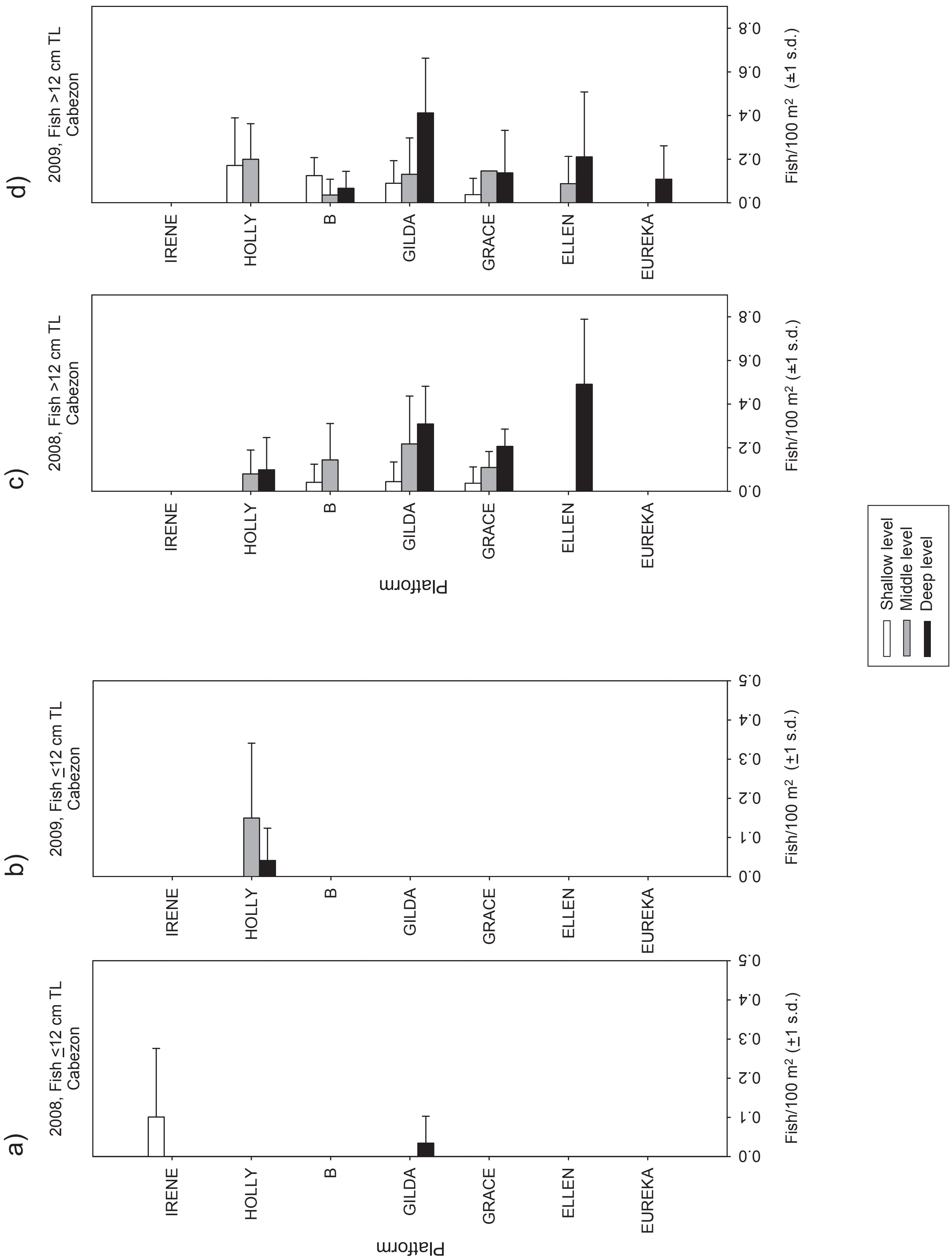



a)
2008, Fish >12 cm TL
Blacksmith
b)
2009, Fish >12 cm TL
Blacksmith
c)
2008, Fish ≤12 cm TL
Blacksmith
d)
2008, Fish ≤12 cm TL
Blacksmith
Platform
IRENE
HOLLY
B
GILDA
GRACE
ELLEN
EUREKA
Fish/100 m² (±1 s.d.)
Shallow level
Middle level
Deep level

Cabezon



2008
2009
12 cm TL or less
0.08
0.06
0.04
0.02
0.00
Fish / 100 m²
shallow
middle
deep
reef
wreck
shell
Habitat
0.15
0.10
0.05
0.00
Fish / 100 m²
shallow
middle
deep
reef
wreck
Habitat
More than 12 cm TL
0.5
0.4
0.3
0.2
0.1
0.0
Fish / 100 m²
shallow
middle
deep
reef
wreck
shell
Habitat
0.8
0.6
0.4
0.2
0.0
Fish / 100 m²
shallow
middle
deep
reef
wreck
Habitat

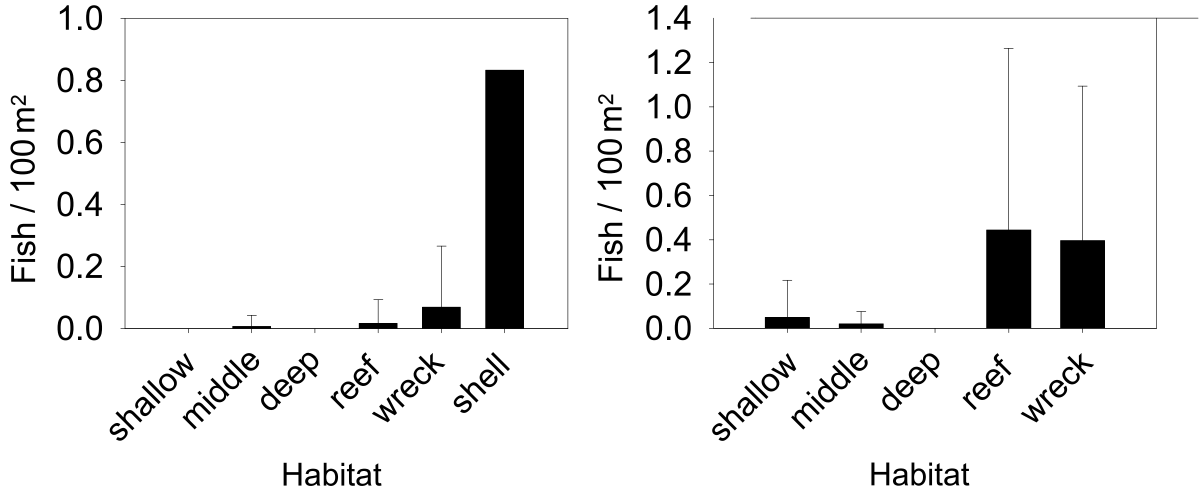


a)
2008, Fish ≤12 cm TL
Cabezon
b)
2009, Fish ≤12 cm TL
Cabezon
c)
2008, Fish >12 cm TL
Cabezon
d)
2009, Fish >12 cm TL
Cabezon
IRENE
HOLLY
B
GILDA
GRACE
ELLEN
EUREKA
Platform
Fish/100 m² (±1 s.d.)
0.0
0.1
0.2
0.3
0.4
0.5
0.6
0.8
Shallow level
Middle level
Deep level

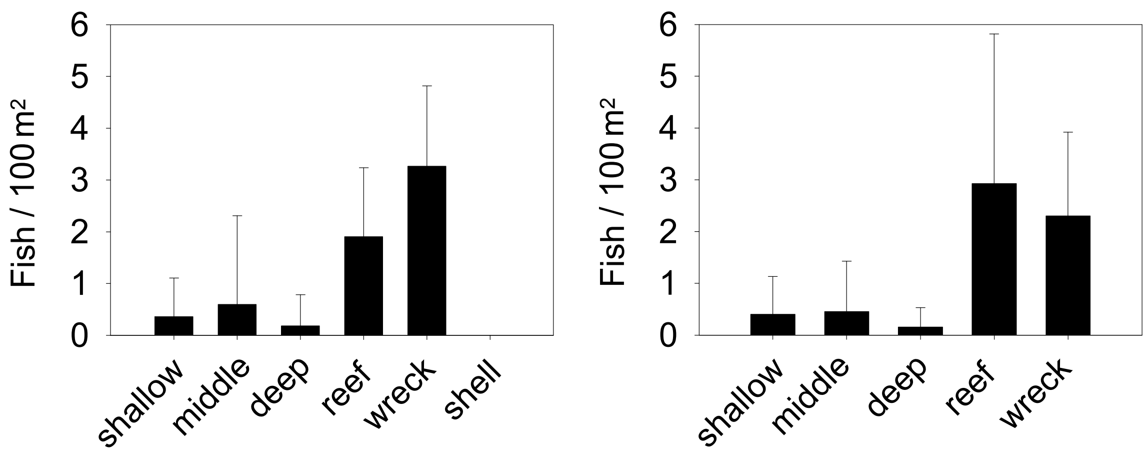
California sheephead

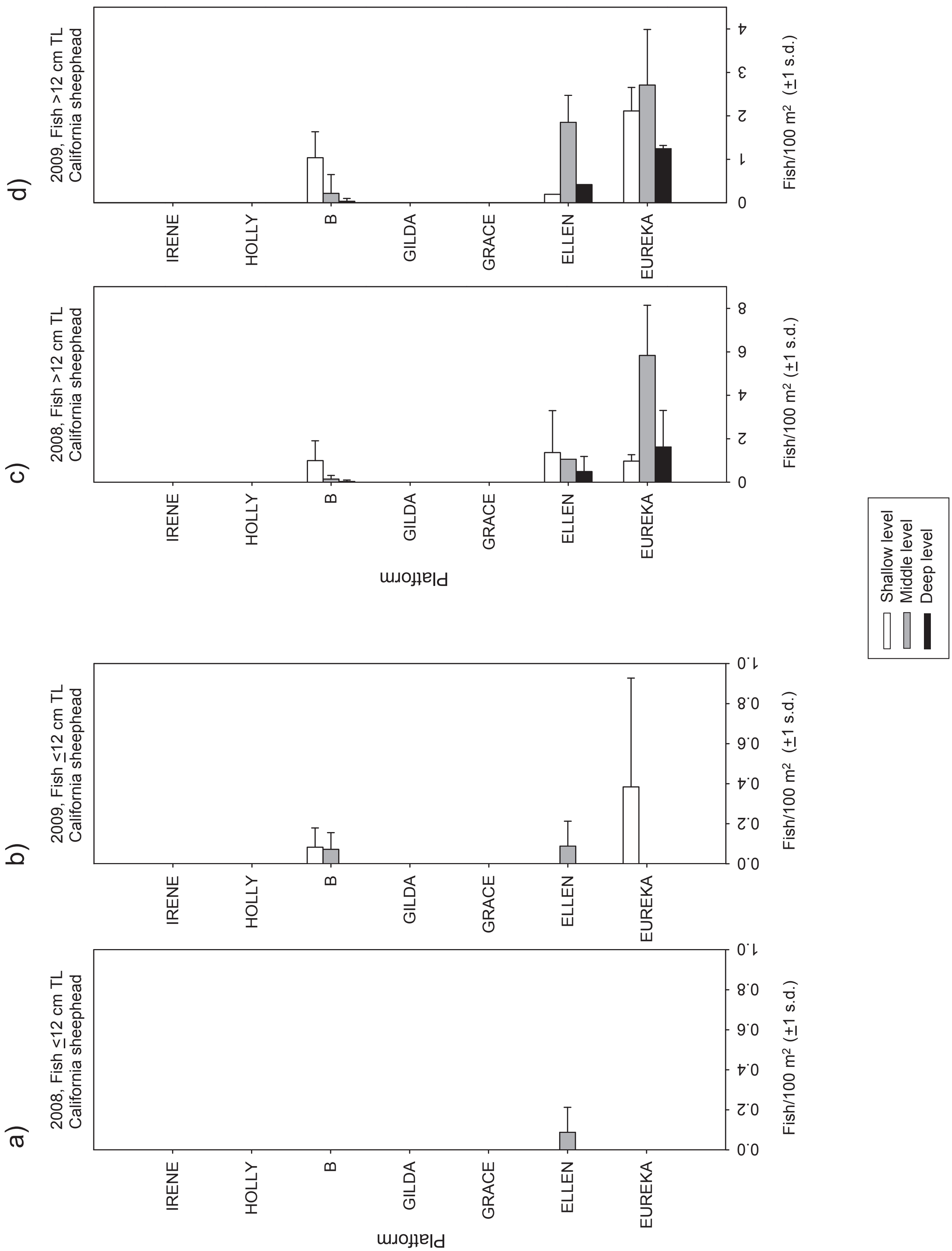
2008 2009

12 cm TL or less



More than 12 cm TL



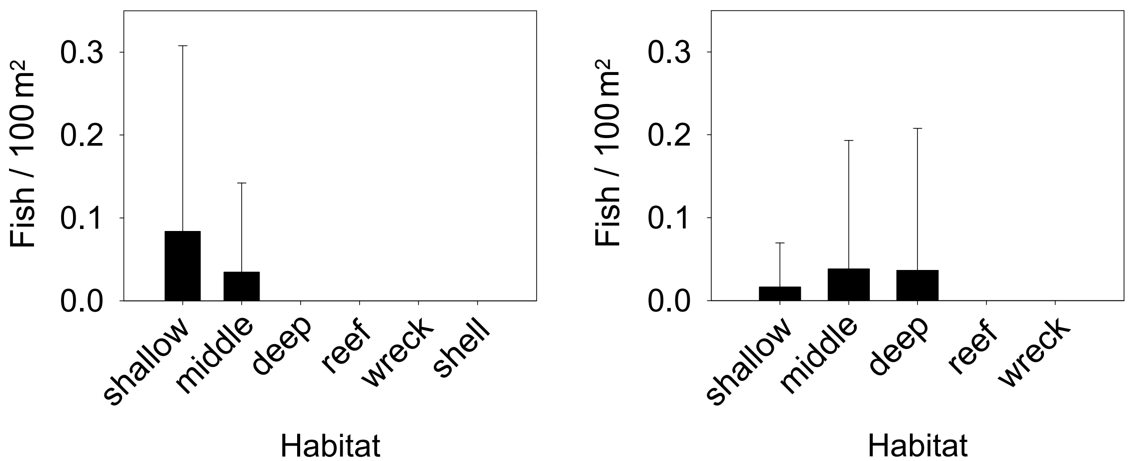


a)
2008, Fish ≤12 cm TL
California sheephead
b)
2009, Fish ≤12 cm TL
California sheephead
c)
2008, Fish >12 cm TL
California sheephead
d)
2009, Fish >12 cm TL
California sheephead
Platform
IRENE
HOLLY
B
GILDA
GRACE
ELLEN
EUREKA
Fish/100 m² (±1 s.d.)
0.0
0.2
0.4
0.6
0.8
1.0
0
1
2
3
4
6
8
Shallow level
Middle level
Deep level

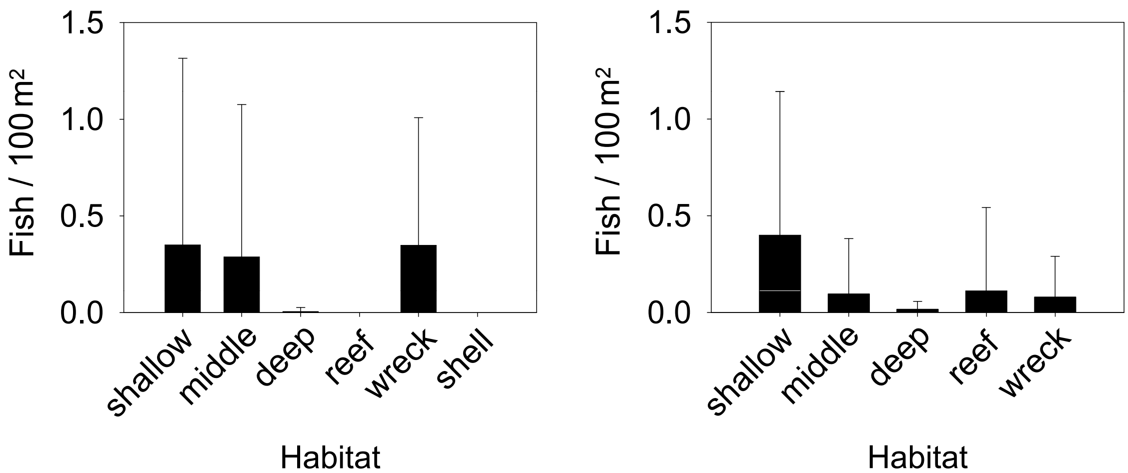
Garibaldi

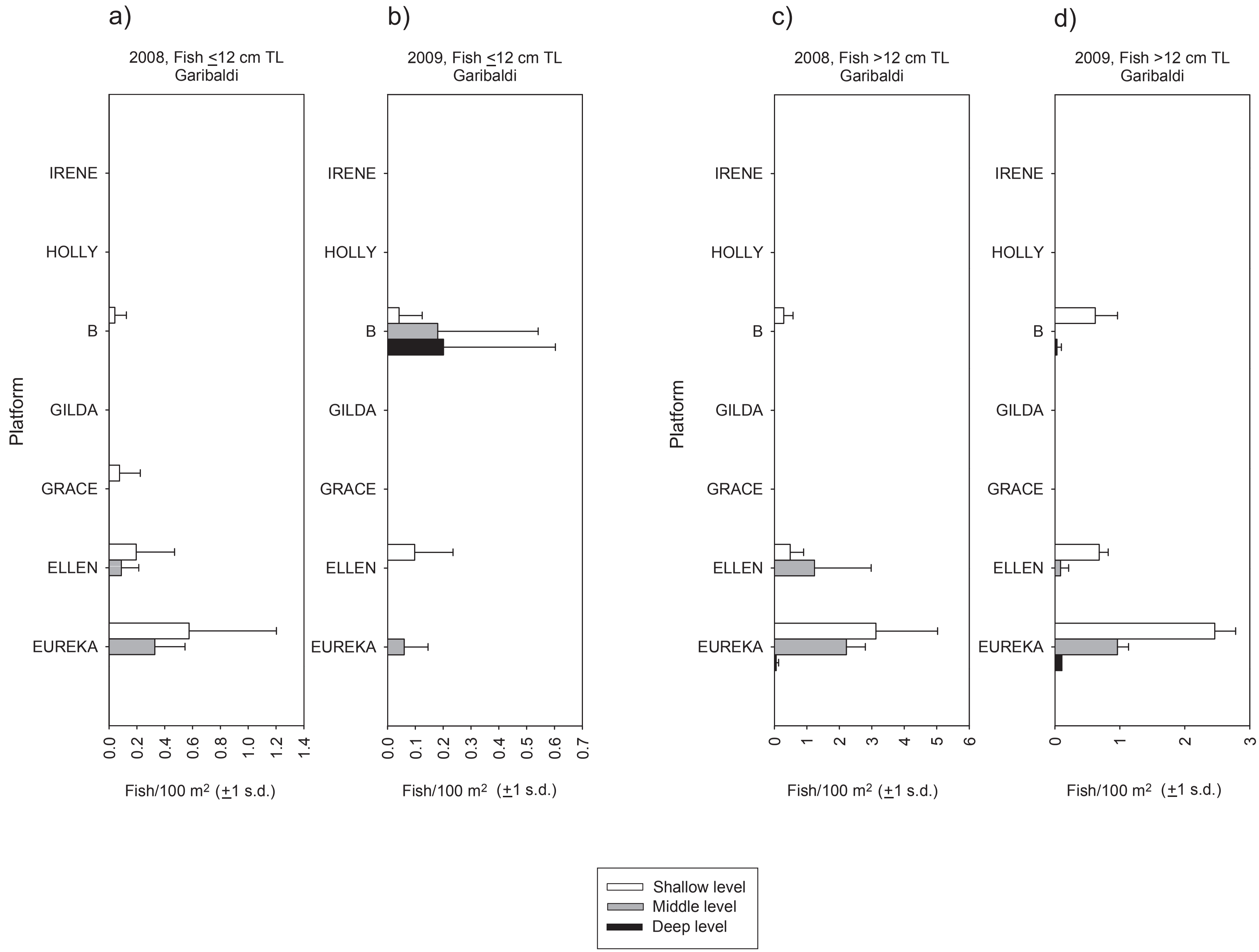
2008 2009

12 cm TL or less



More than 12 cm TL



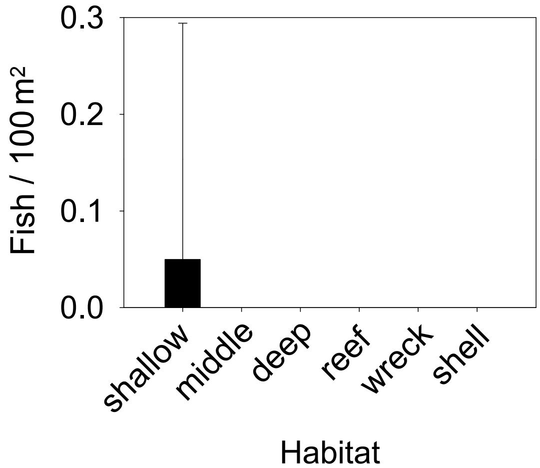


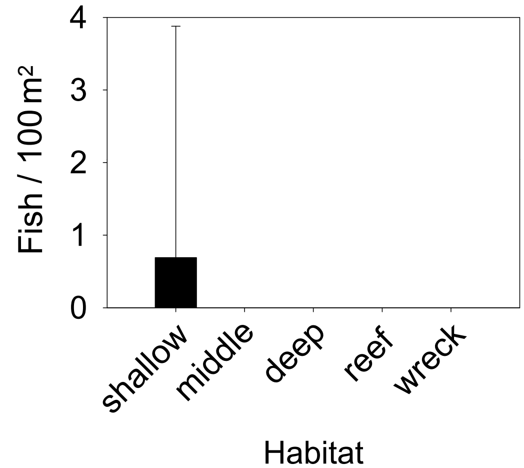
a)
2008, Fish ≤12 cm TL
Garibaldi
b)
2009, Fish ≤12 cm TL
Garibaldi
c)
2008, Fish >12 cm TL
Garibaldi
d)
2009, Fish >12 cm TL
Garibaldi
Platform
IRENE
HOLLY
B
GILDA
GRACE
ELLEN
EUREKA
0.0
0.2
0.4
0.6
0.8
1.0
1.2
1.4
0.0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0
1
2
3
4
5
6
Fish/100 m2 (±1 s.d.)
Shallow level
Middle level
Deep level

Halfmoon

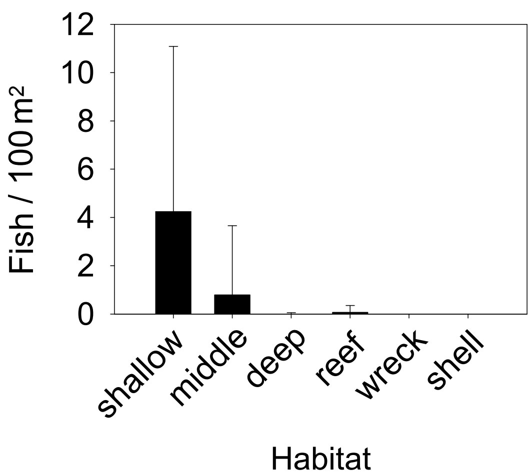
2008 | 2009

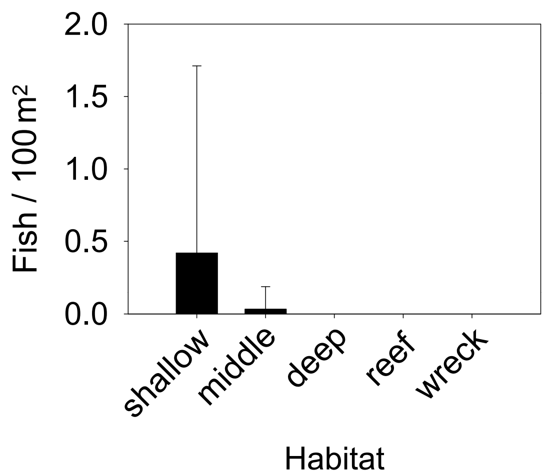
12 cm TL or less

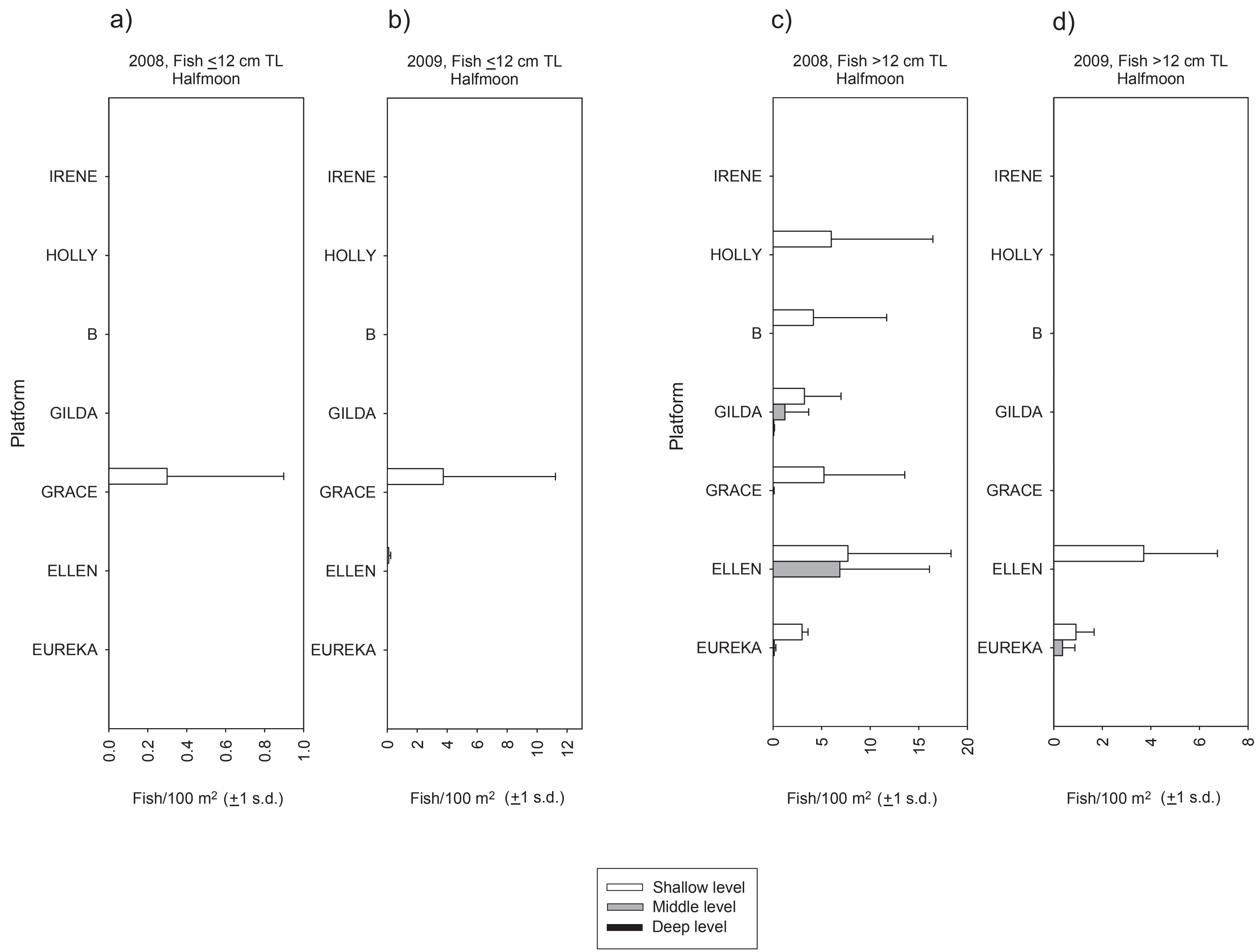




More than 12 cm TL



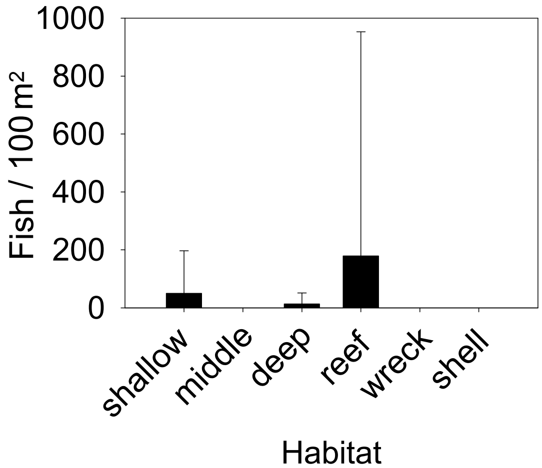


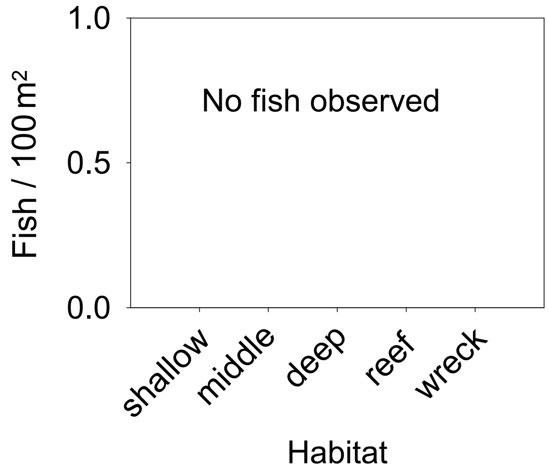

a)
2008, Fish ≤12 cm TL
Halfmoon
b)
2009, Fish ≤12 cm TL
Halfmoon
c)
2008, Fish >12 cm TL
Halfmoon
d)
2009, Fish >12 cm TL
Halfmoon
Platform
IRENE
HOLLY
B
GILDA
GRACE
ELLEN
EUREKA
Fish/100 m² (±1 s.d.)
Shallow level
Middle level
Deep level

Jack mackerel

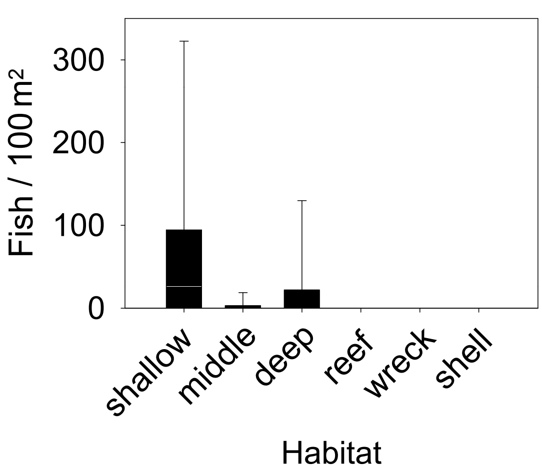
2008 2009

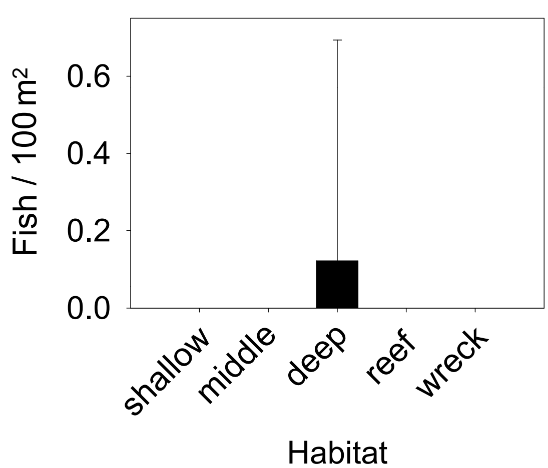
12 cm TL or less

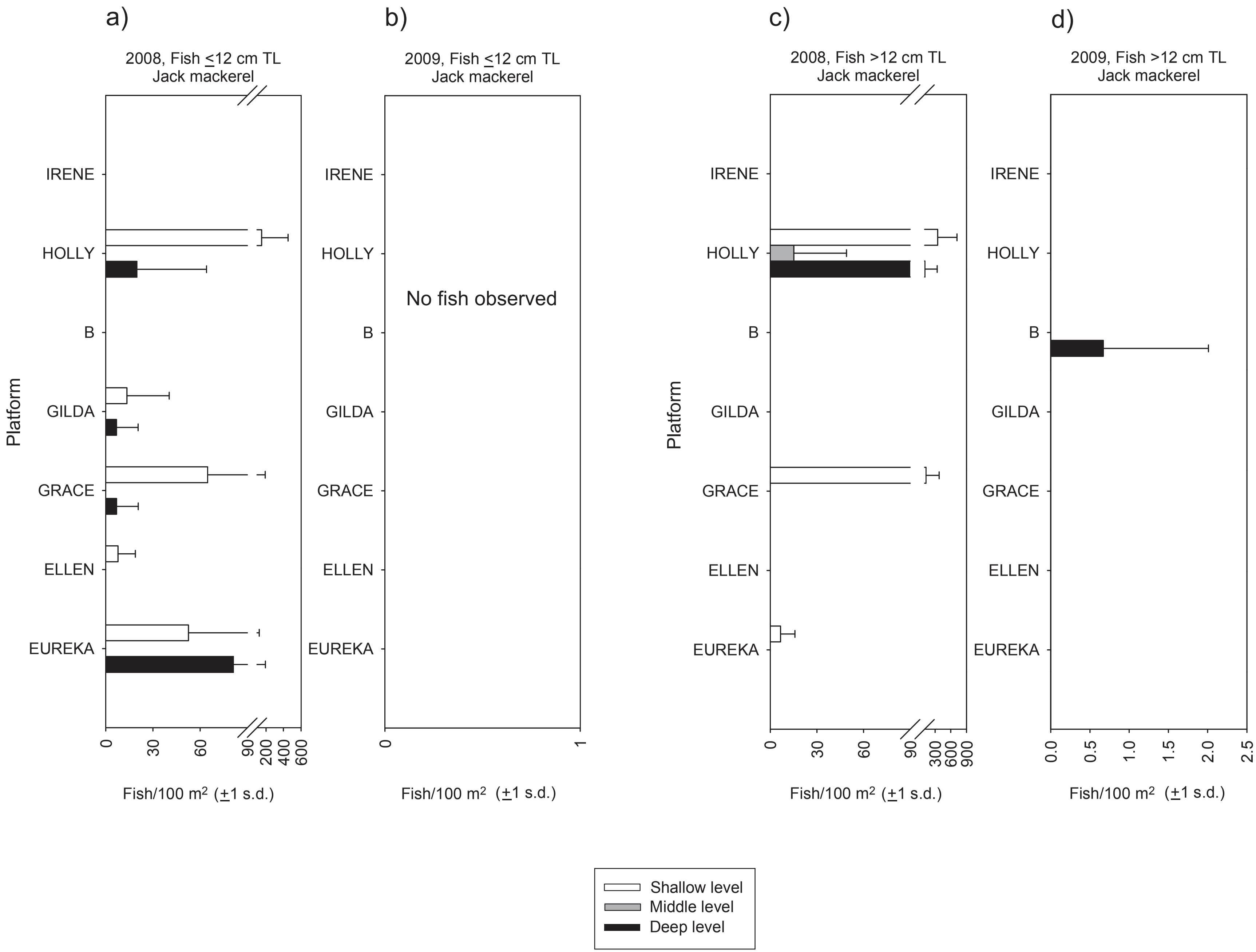




More than 12 cm TL





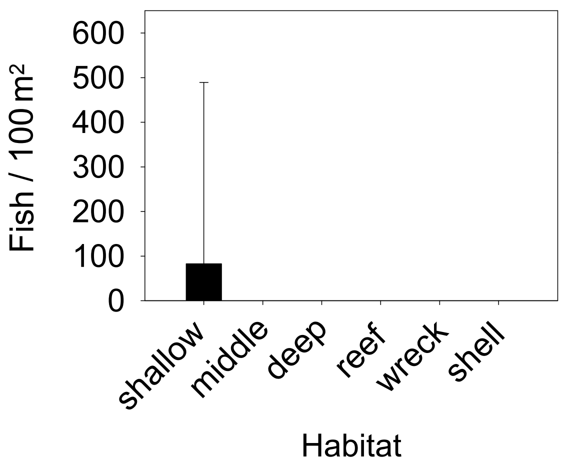


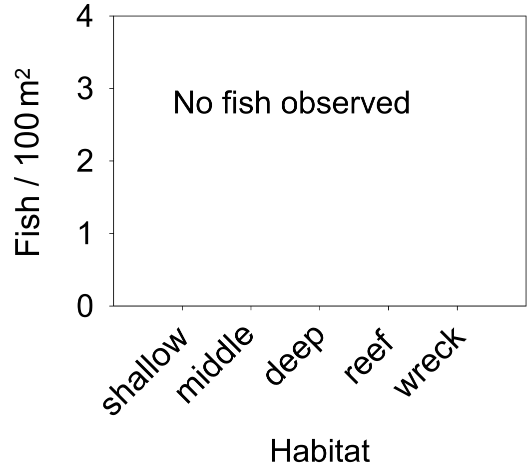
a)
2008, Fish ≤12 cm TL
Jack mackerel
b)
2009, Fish ≤12 cm TL
Jack mackerel
No fish observed
c)
2008, Fish >12 cm TL
Jack mackerel
d)
2009, Fish >12 cm TL
Jack mackerel
Platform
IRENE
HOLLY
B
GILDA
GRACE
ELLEN
EUREKA
0
30
60
90
200
400
600
300
900
1
0.0
0.5
1.0
1.5
2.0
2.5
Fish/100 m2 (±1 s.d.)
Shallow level
Middle level
Deep level

Jacksmelt or topsmelt

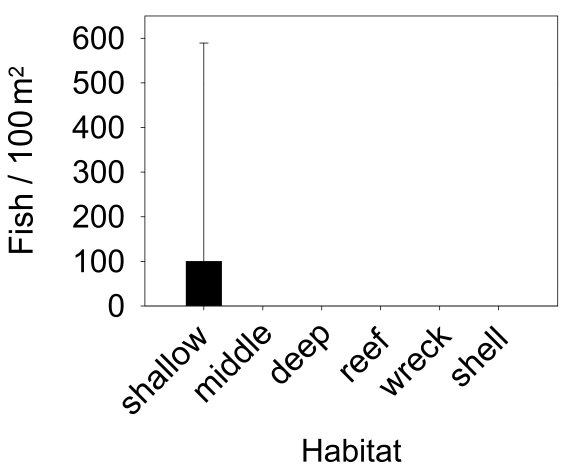
2008 2009

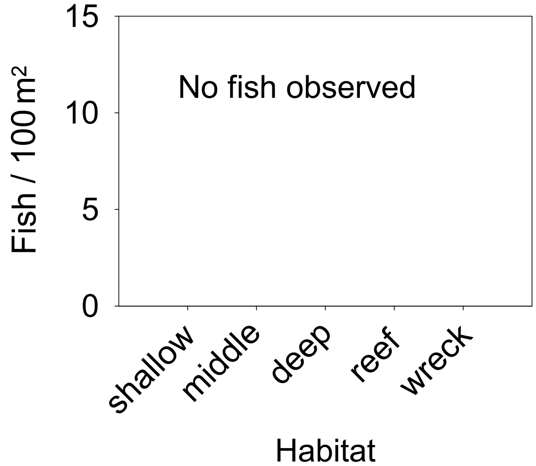
12 cm TL or less

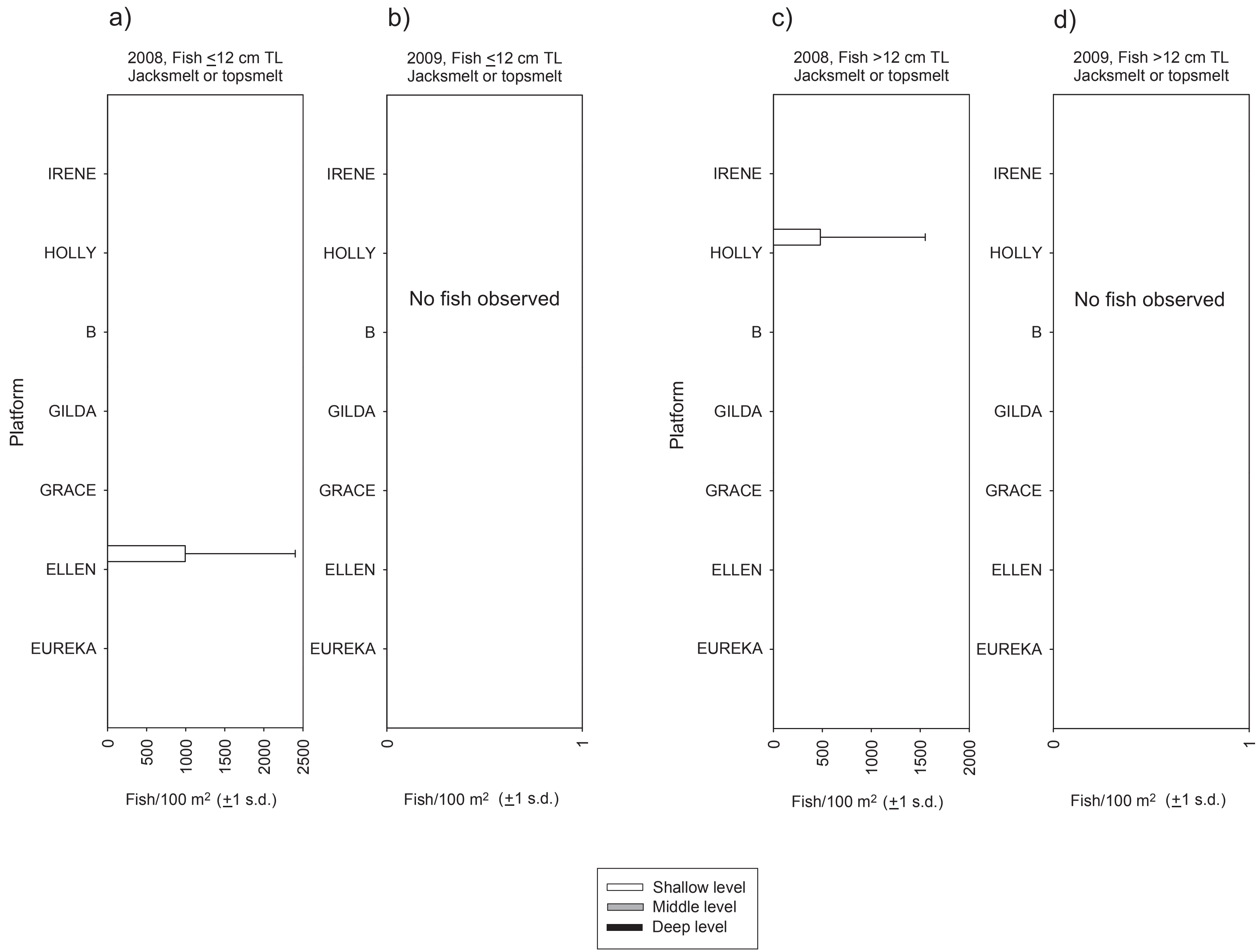




More than 12 cm TL



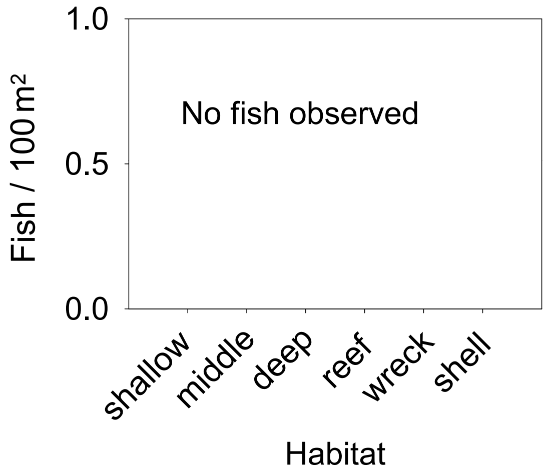


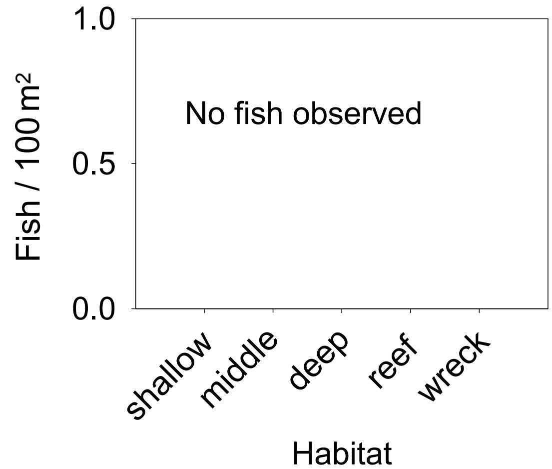

a)
2008, Fish ≤12 cm TL
Jacksmelt or topsmelt
b)
2009, Fish ≤12 cm TL
Jacksmelt or topsmelt
No fish observed
c)
2008, Fish >12 cm TL
Jacksmelt or topsmelt
d)
2009, Fish >12 cm TL
Jacksmelt or topsmelt
No fish observed
Platform
IRENE
HOLLY
B
GILDA
GRACE
ELLEN
EUREKA
0
500
1000
1500
2000
2500
1
Fish/100 m2 (±1 s.d.)
Shallow level
Middle level
Deep level

Kelp bass

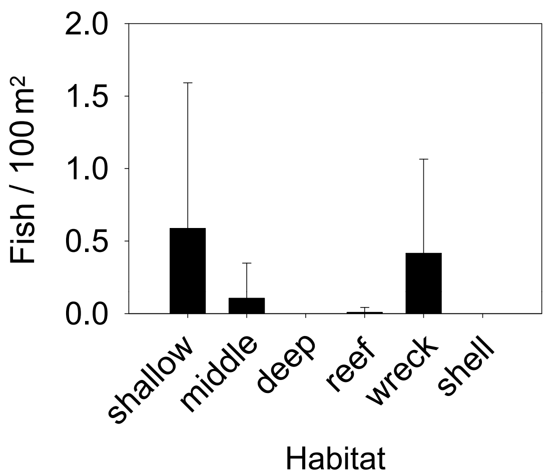
2008 2009

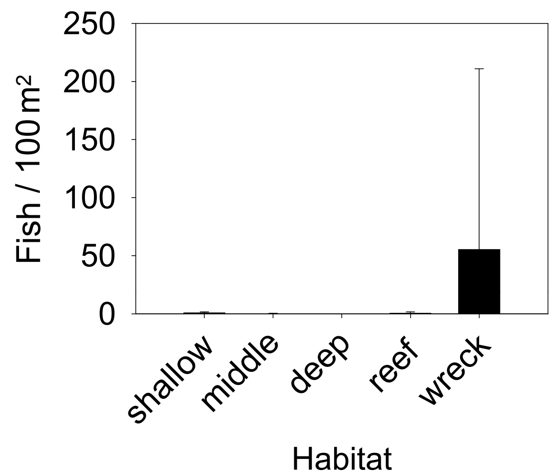
12 cm TL or less



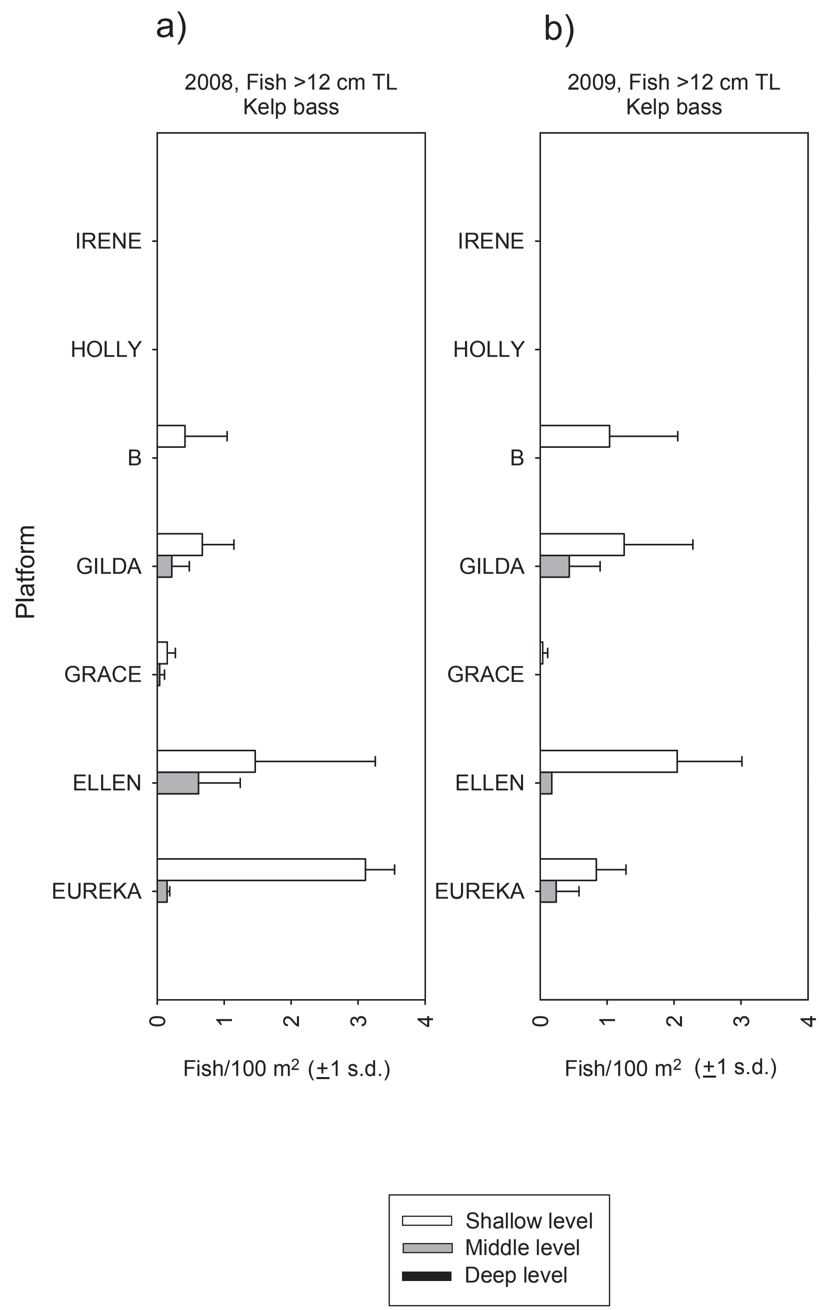


More than 12 cm TL





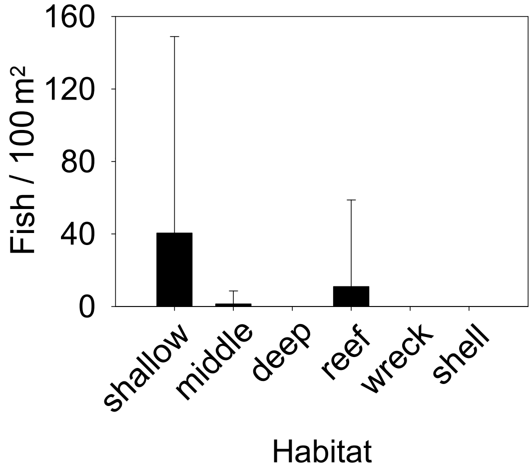
No kelp bass ≤12 cm TL
observed at platforms in 2008 or 2009

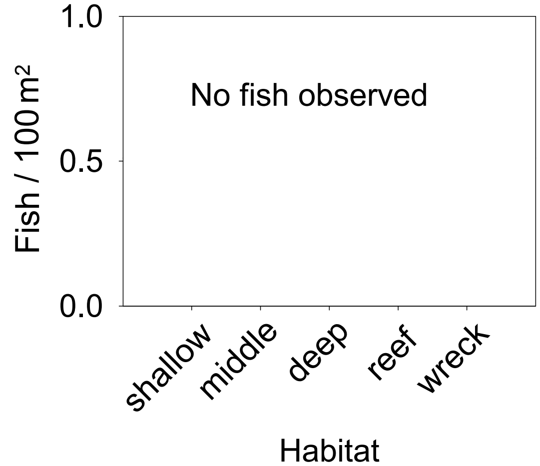


Pacific sardine

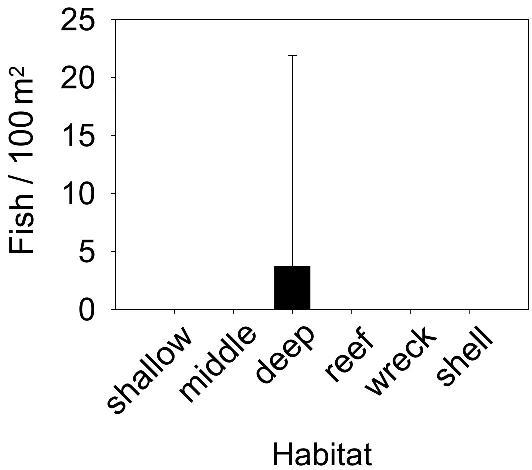
2008 | 2009

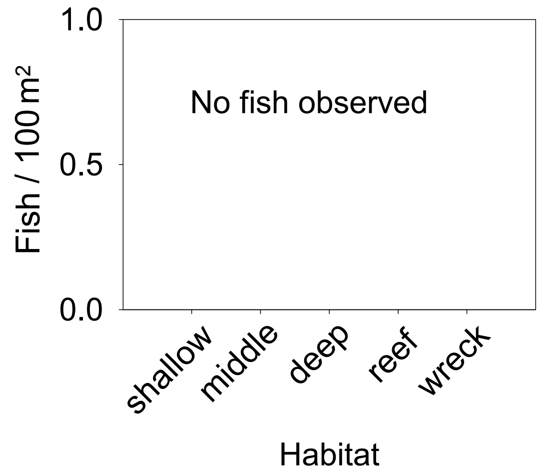
12 cm TL or less

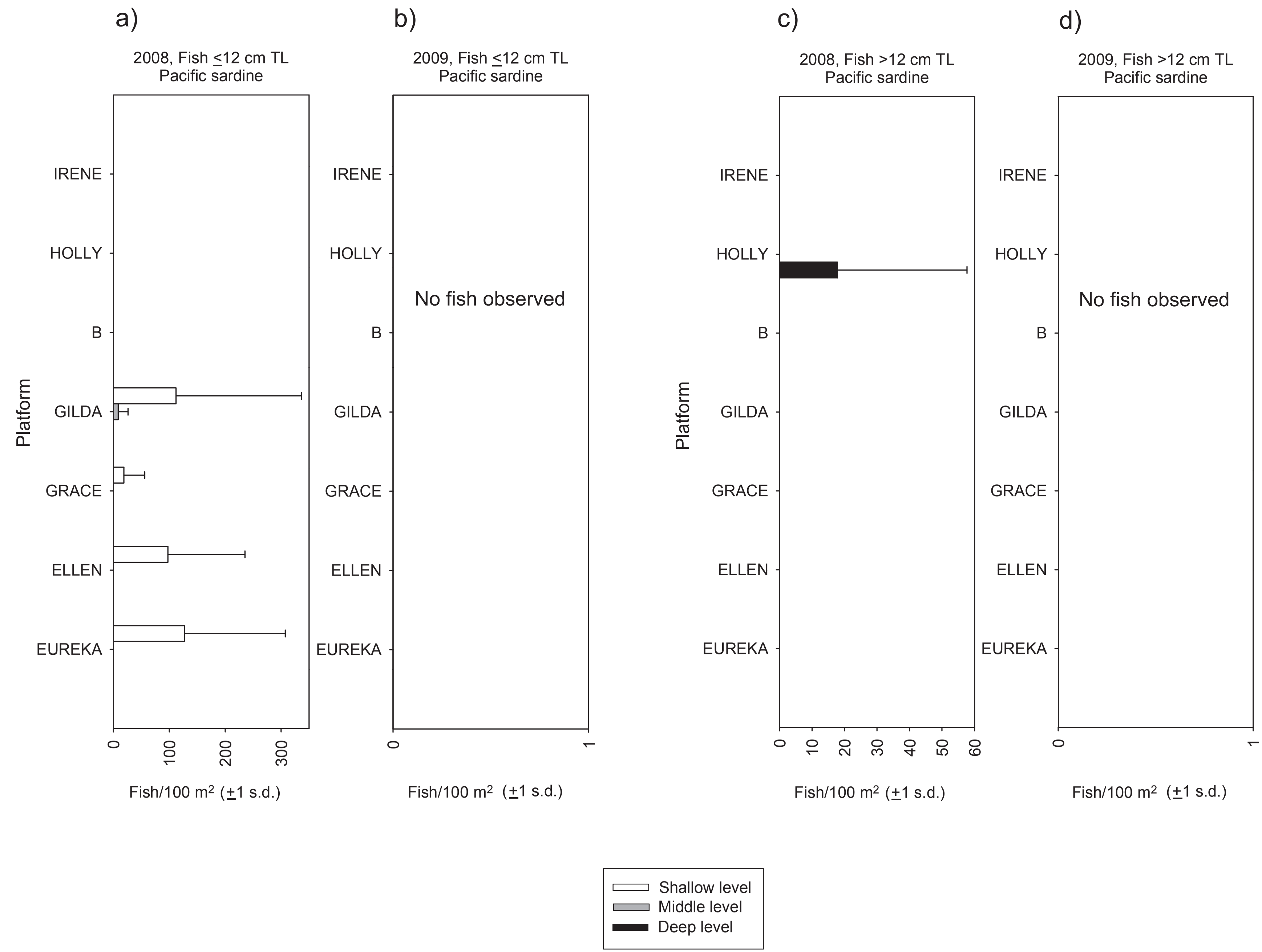




More than 12 cm TL





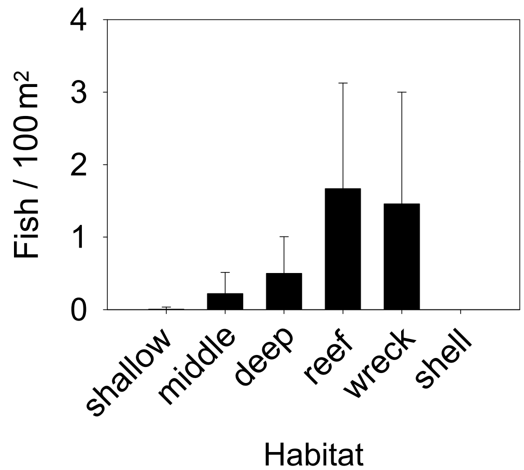


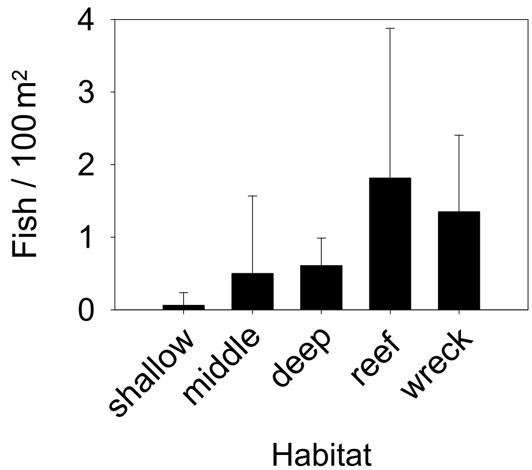
a)
2008, Fish ≤12 cm TL
Pacific sardine
b)
2009, Fish ≤12 cm TL
Pacific sardine
No fish observed
c)
2008, Fish >12 cm TL
Pacific sardine
d)
2009, Fish >12 cm TL
Pacific sardine
No fish observed
Platform
IRENE
HOLLY
B
GILDA
GRACE
ELLEN
EUREKA
Fish/100 m² (±1 s.d.)
0
100
200
300
1
10
20
30
40
50
60
Shallow level
Middle level
Deep level

Painted greenling

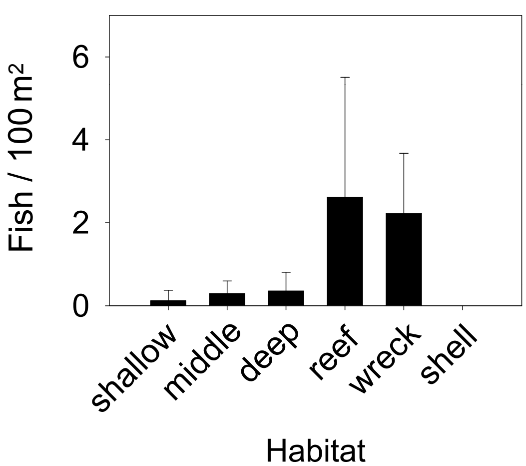
2008 2009

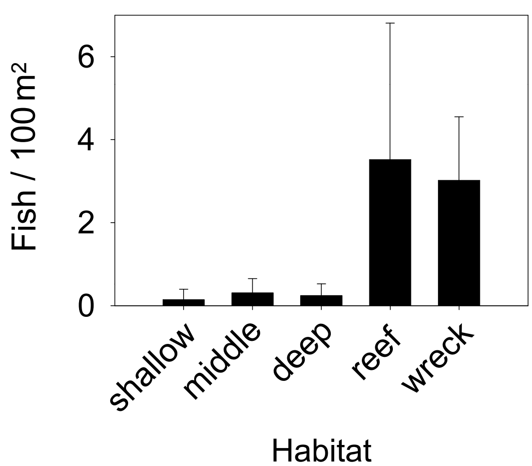
12 cm TL or less

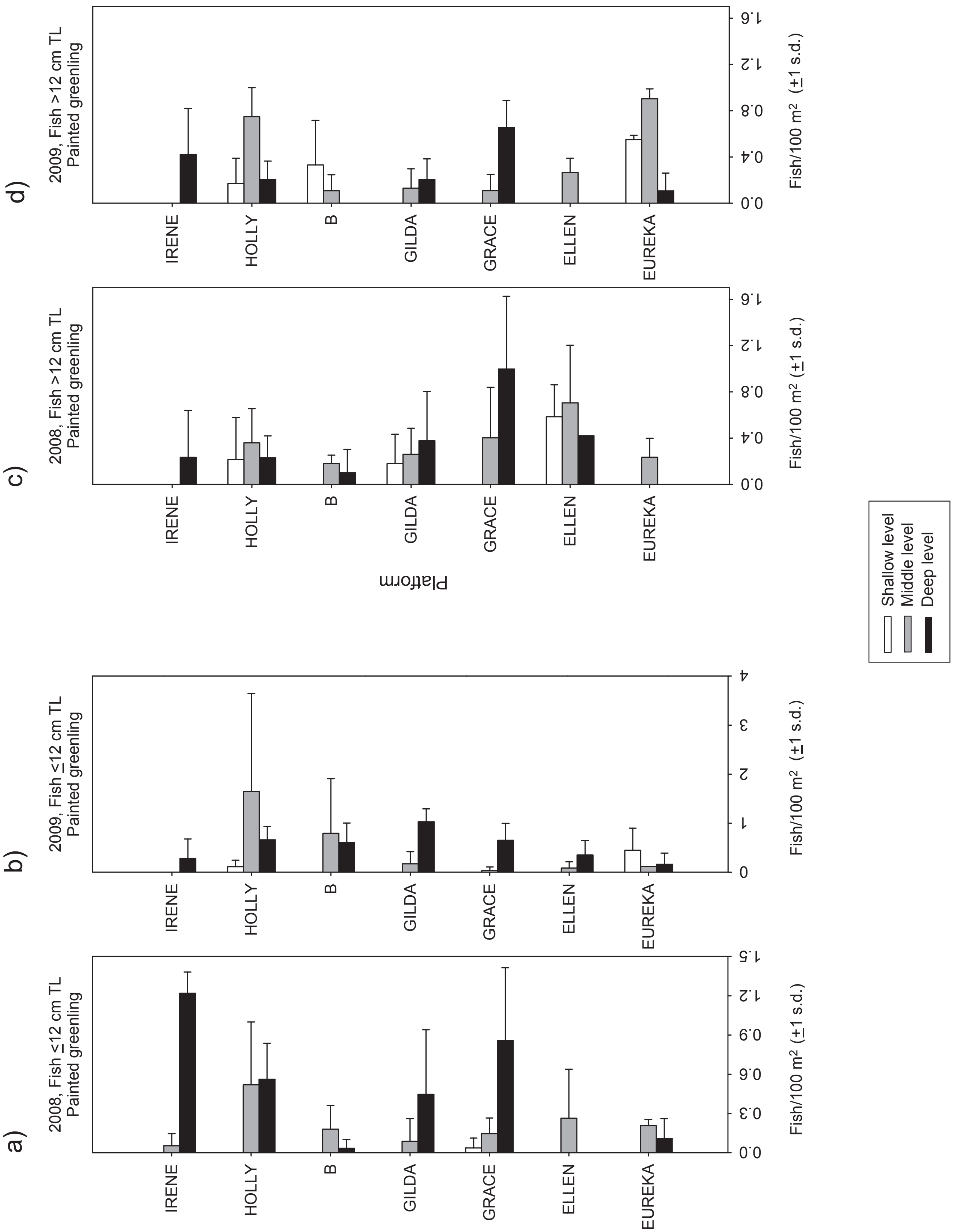




More than 12 cm TL





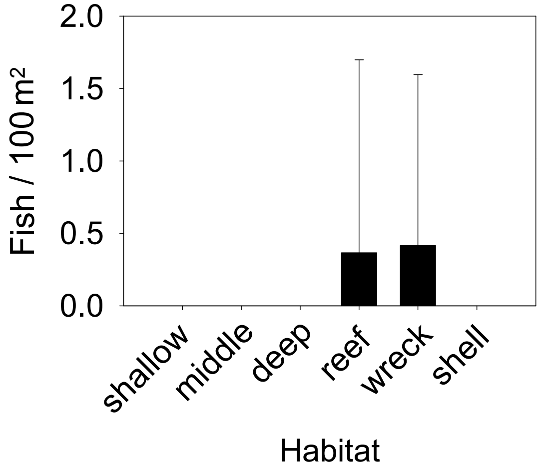


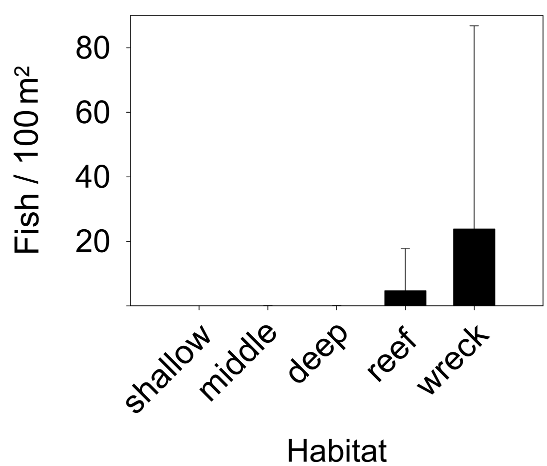
a)
2008, Fish ≤12 cm TL
Painted greenling
b)
2009, Fish ≤12 cm TL
Painted greenling
c)
2008, Fish >12 cm TL
Painted greenling
d)
2009, Fish >12 cm TL
Painted greenling
IRENE
HOLLY
B
GILDA
GRACE
ELLEN
EUREKA
Platform
Fish/100 m² (±1 s.d.)
0.0
0.3
0.6
0.9
1.2
1.5
0
1
2
3
4
0.4
0.8
1.6
Shallow level
Middle level
Deep level

Senorita

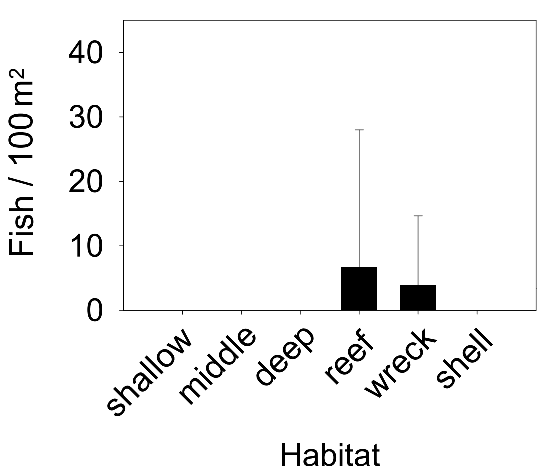
2008 2009

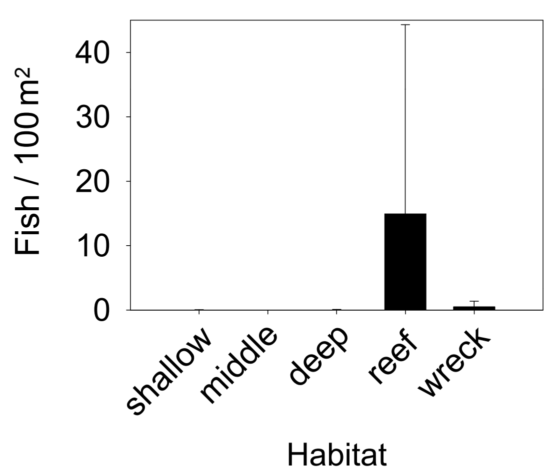
12 cm TL or less

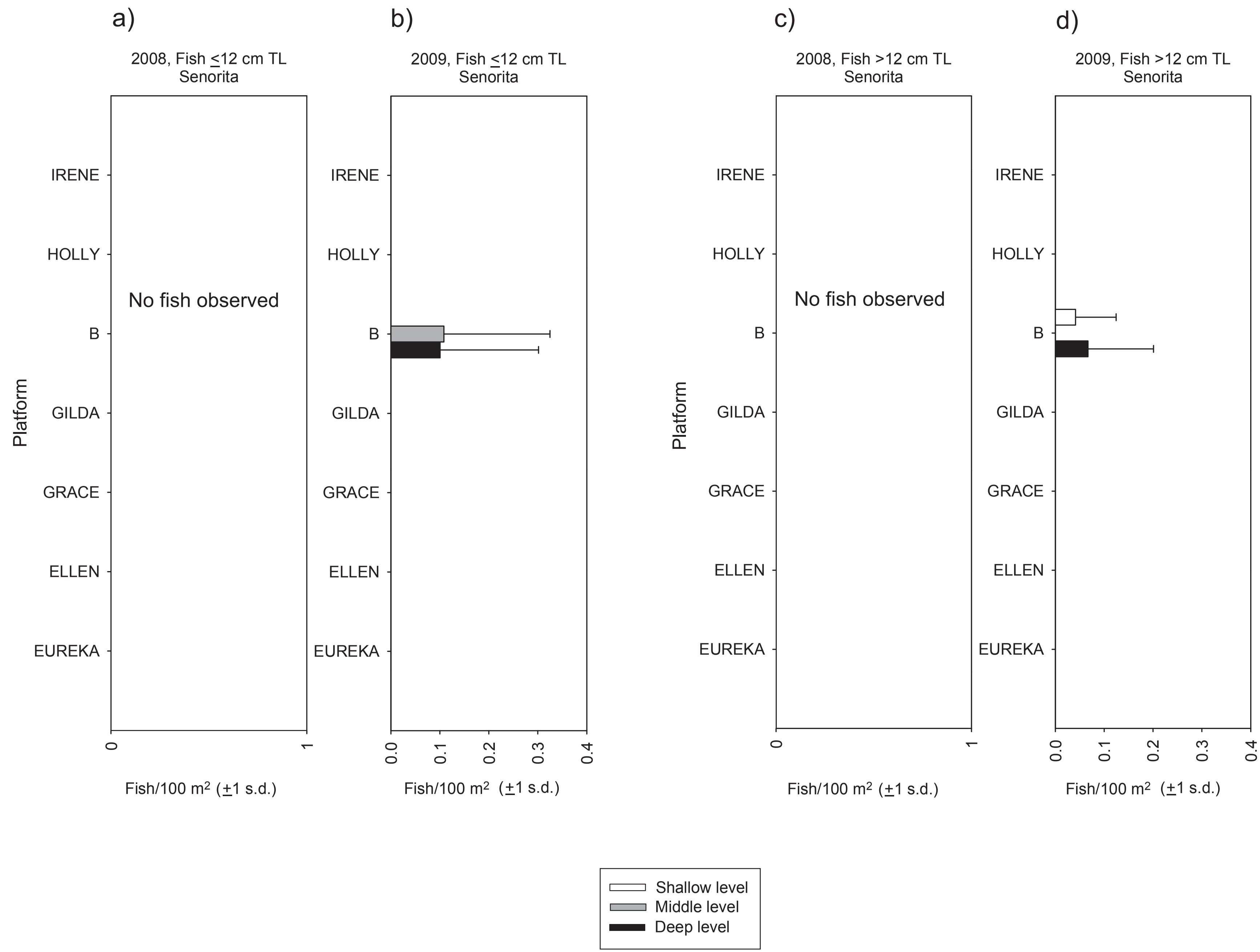




More than 12 cm TL



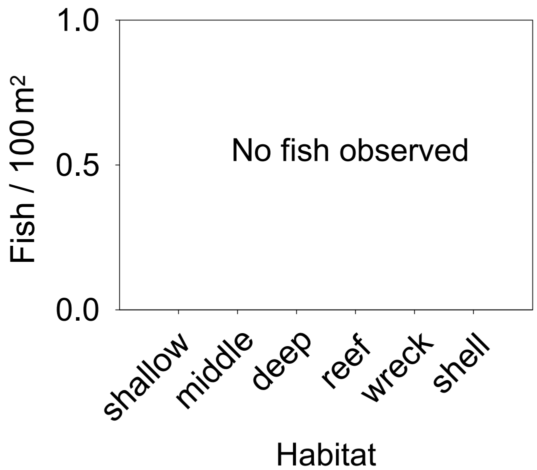


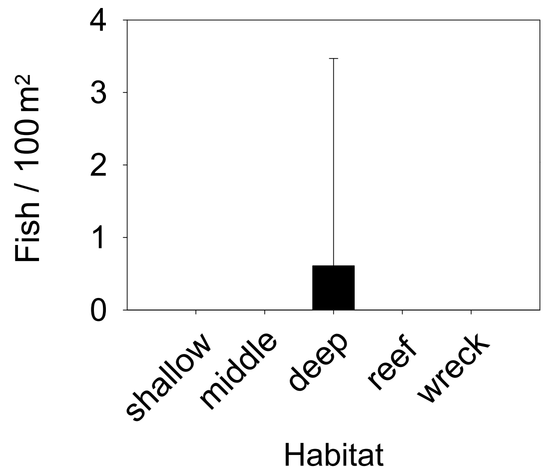

a)
2008, Fish ≤12 cm TL
Senorita
No fish observed
b)
2009, Fish ≤12 cm TL
Senorita
c)
2008, Fish >12 cm TL
Senorita
No fish observed
d)
2009, Fish >12 cm TL
Senorita
Platform
IRENE
HOLLY
B
GILDA
GRACE
ELLEN
EUREKA
Fish/100 m2 (±1 s.d.)
0
1
0.0
0.1
0.2
0.3
0.4
Shallow level
Middle level
Deep level

Sharpnose seaperch

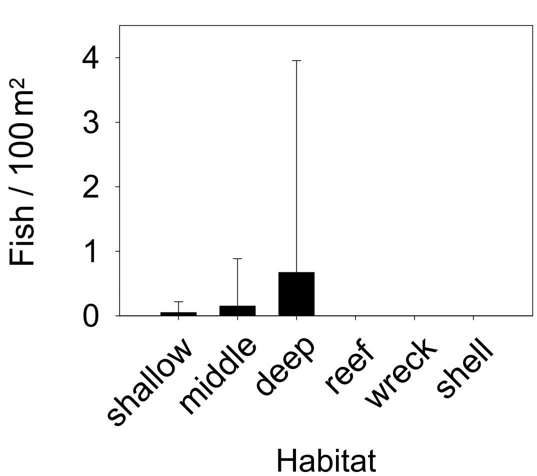
2008 2009

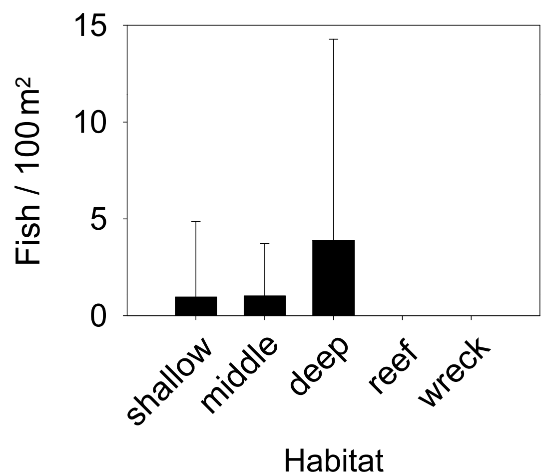
12 cm TL or less

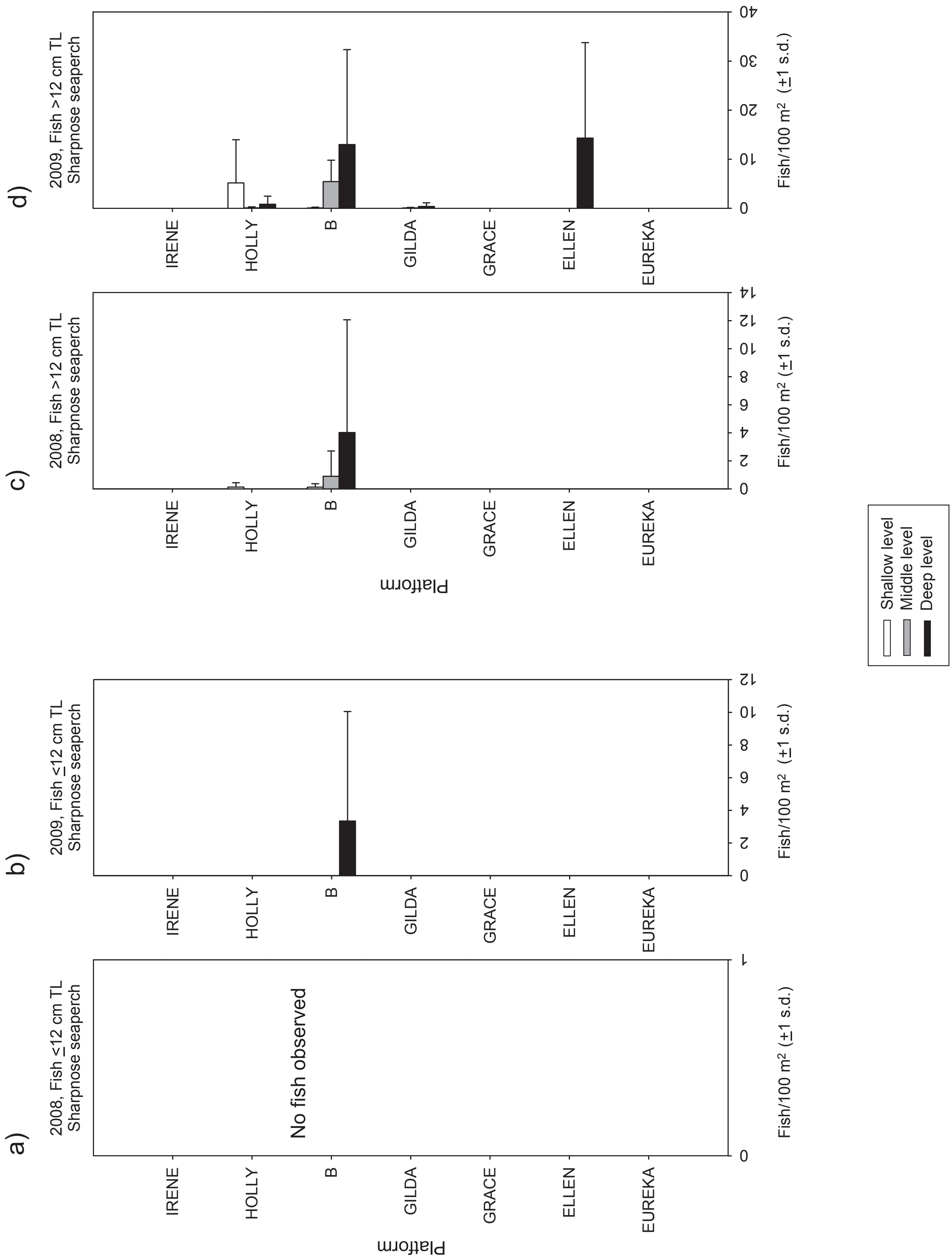




More than 12 cm TL







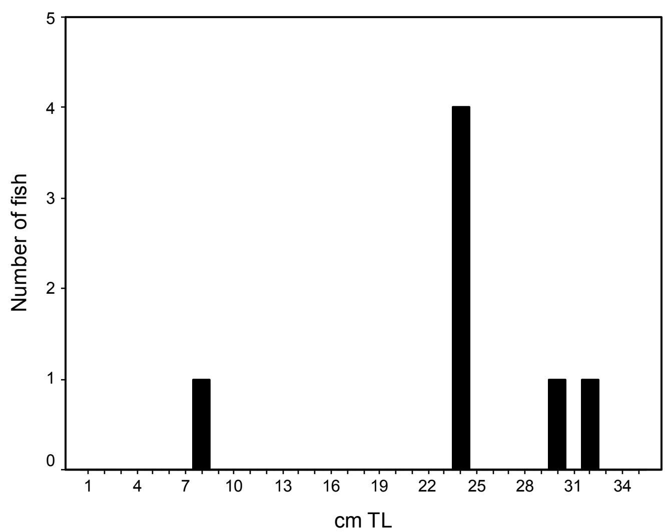
a)
2008, Fish ≤12 cm TL
Sharpnose seaperch
No fish observed
b)
2009, Fish ≤12 cm TL
Sharpnose seaperch
c)
2008, Fish >12 cm TL
Sharpnose seaperch
d)
2009, Fish >12 cm TL
Sharpnose seaperch
IRENE
HOLLY
B
GILDA
GRACE
ELLEN
EUREKA
Platform
Fish/100 m² (±1 s.d.)
Shallow level
Middle level
Deep level

APPENDIX 3

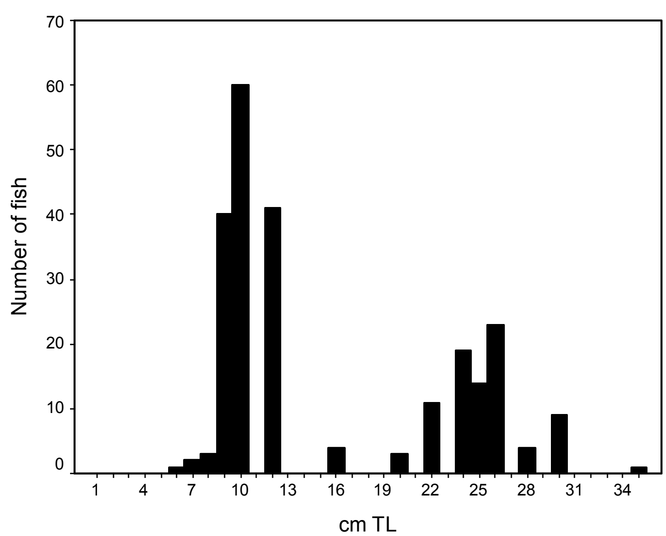
Size distribution of rockfish species and complexes that comprised more than 0.1% of the total number of fishes at the platforms in 2008 and 2009 combined. Histograms are the summed size frequency observations at the three platform levels, reefs, and wrecks from 2008 and 2009 combined. The contributions of individuals identifiable to species are added to the histograms of the two complexes, KGB and OYT. Taxa are presented in alphabetical order of common names.

Blue rockfish - Platform

No fish at shallow level

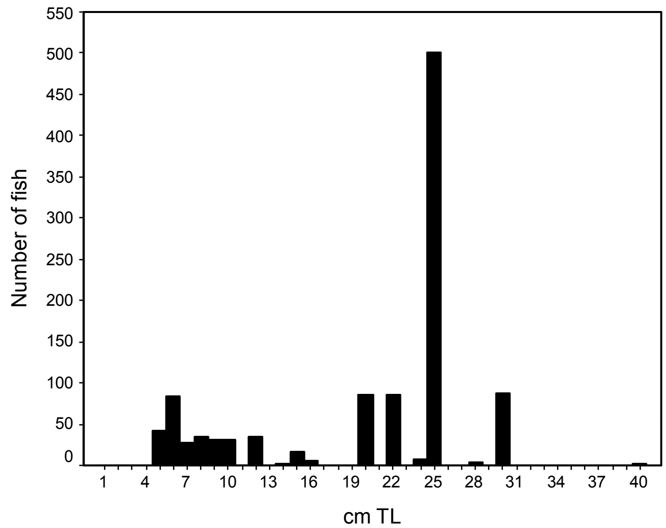


Middle level

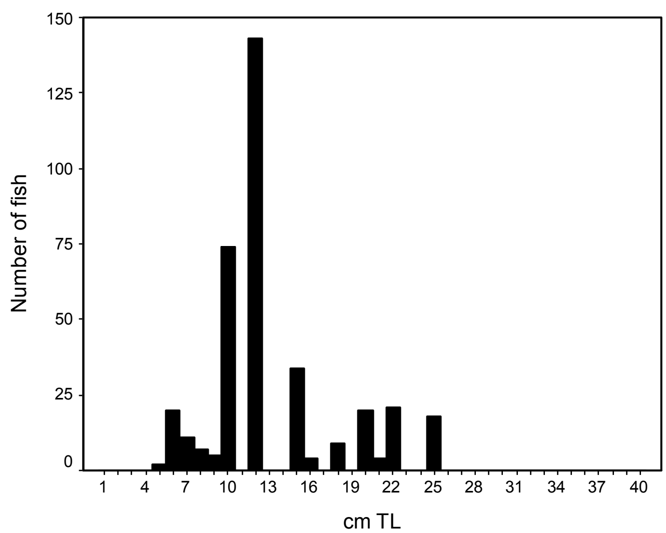


Deep level

Blue rockfish

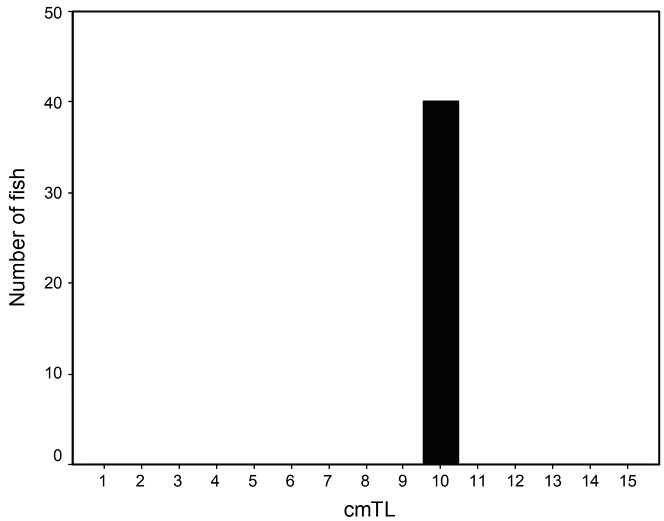


Reef

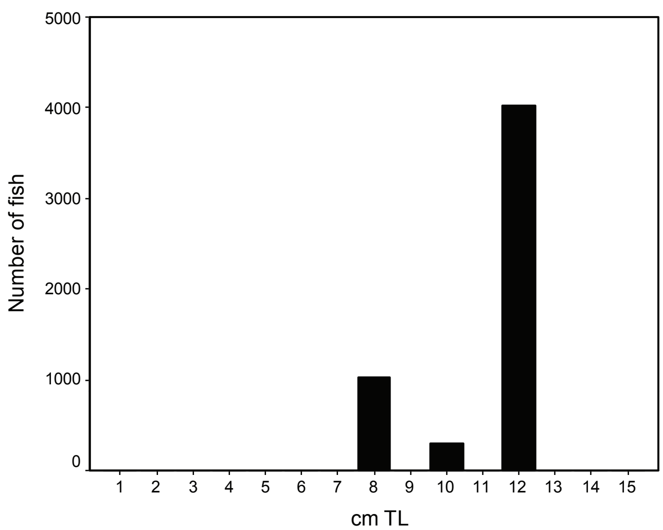


Wreck

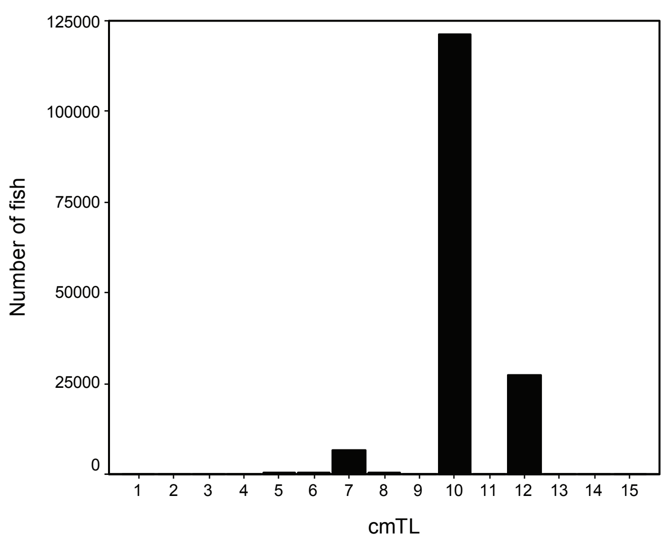
Bocaccio - Platform



Shallow level



Middle level



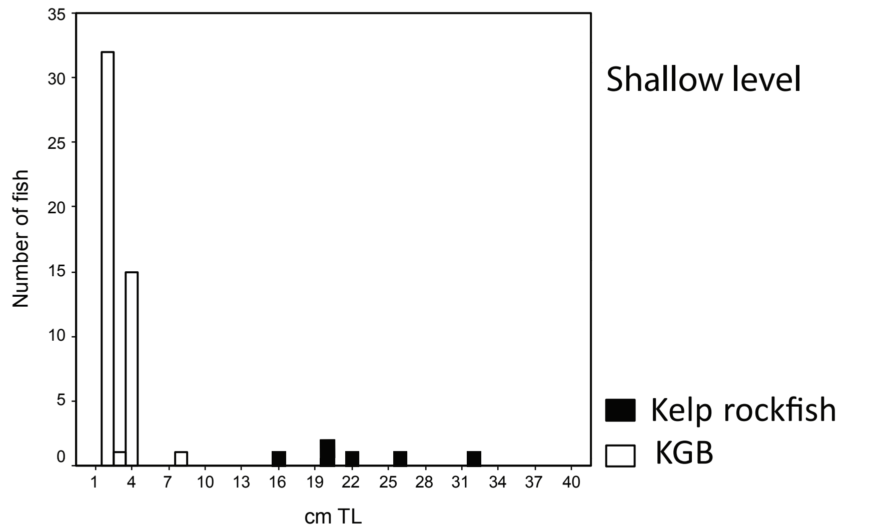
Deep level

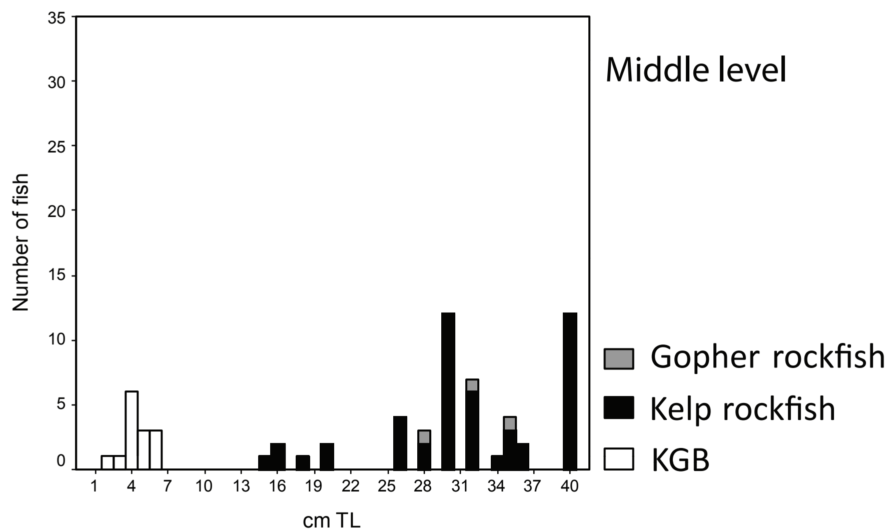
Bocaccio

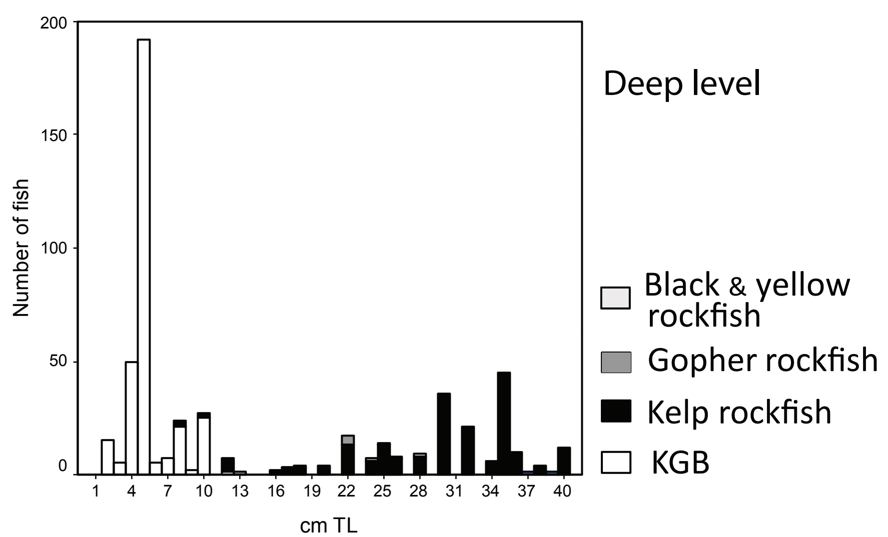
Reef:
No fish

Wreck:
No fish

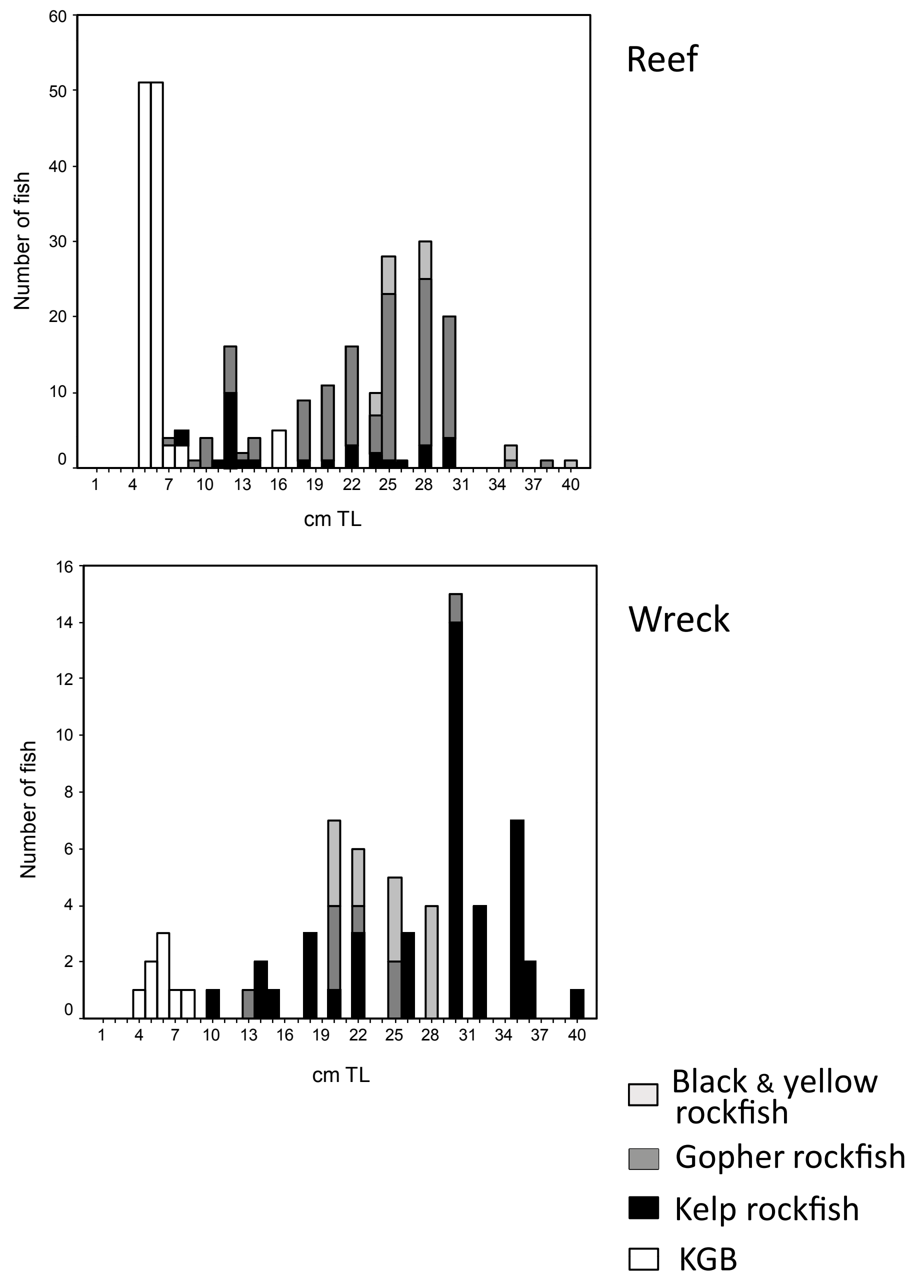
KGB complex - Platform



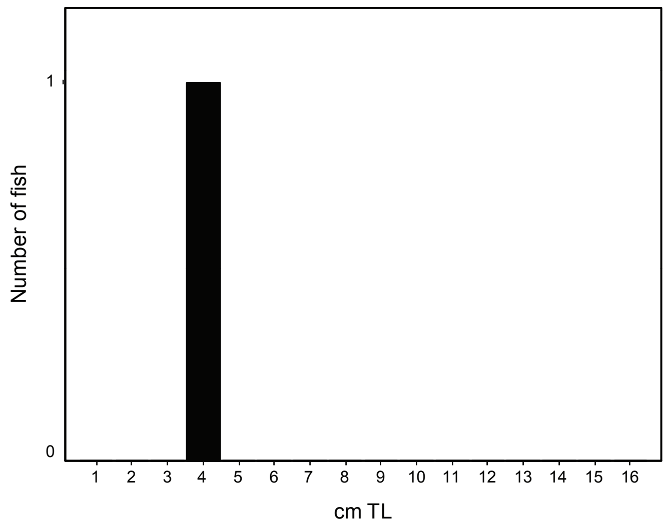




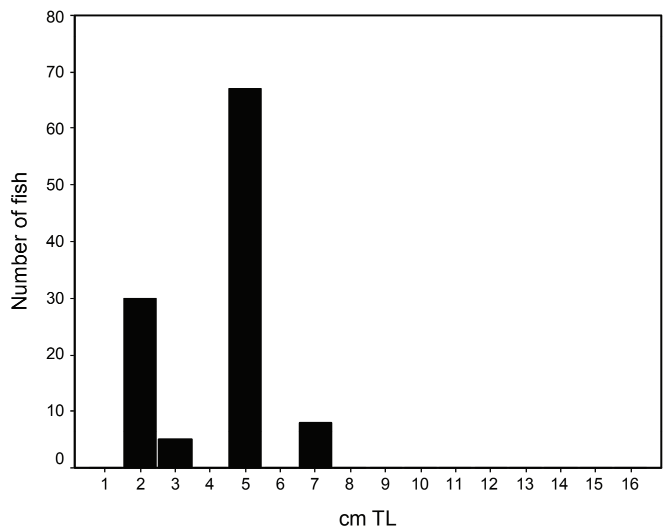
KGB complex


Reef
Number of fish
cm TL
Wreck
Number of fish
cm TL
Black & yellow rockfish
Gopher rockfish
Kelp rockfish
KGB

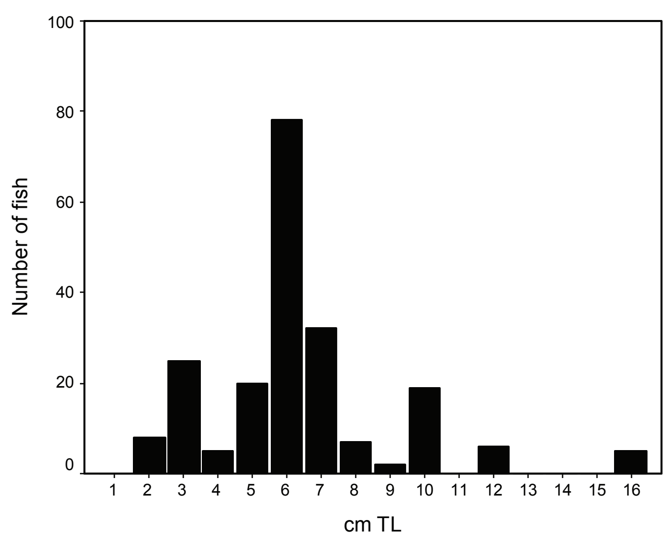
OYT complex - Platform



Shallow level

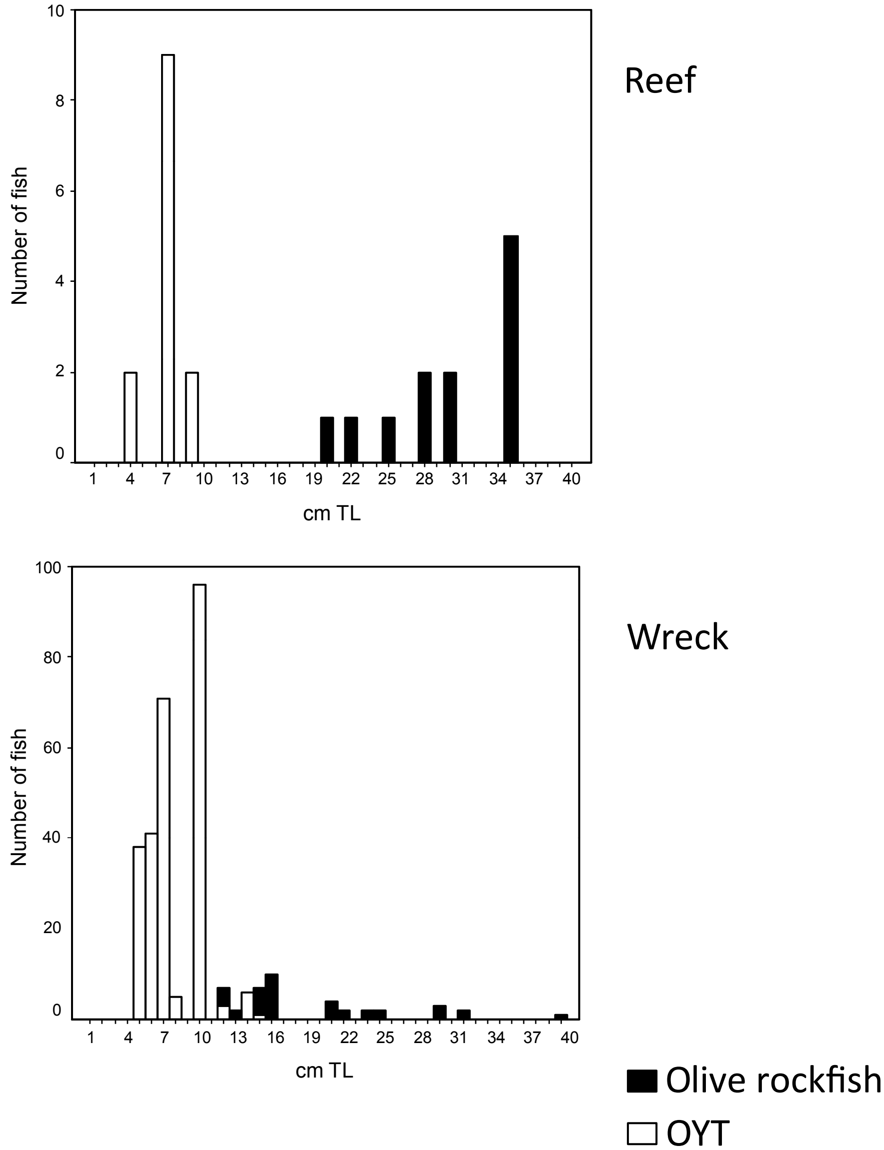


Middle level



Deep level

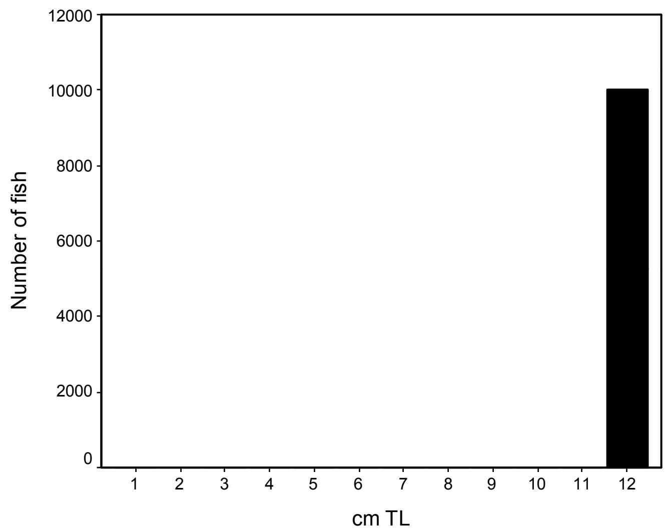
OYT complex


Reef
Number of fish
cm TL
Wreck
Number of fish
cm TL
Olive rockfish
OYT

Shortbelly rockfish - Platform

Shallow level: no fish

Middle level: no fish



Deep level

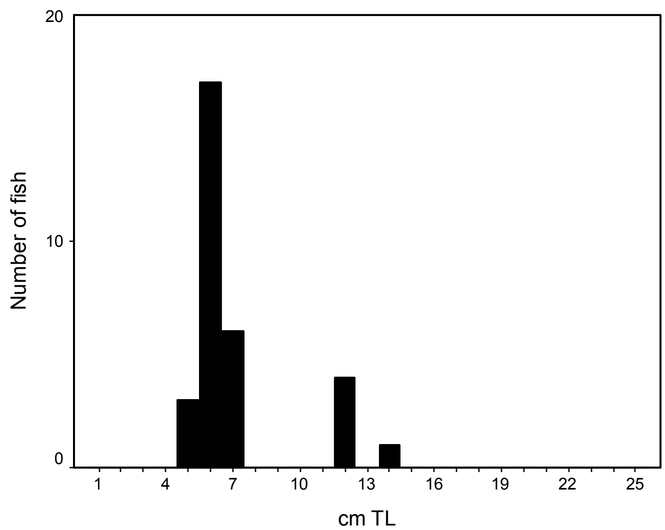
Shortbelly rockfish

Reef:
No fish

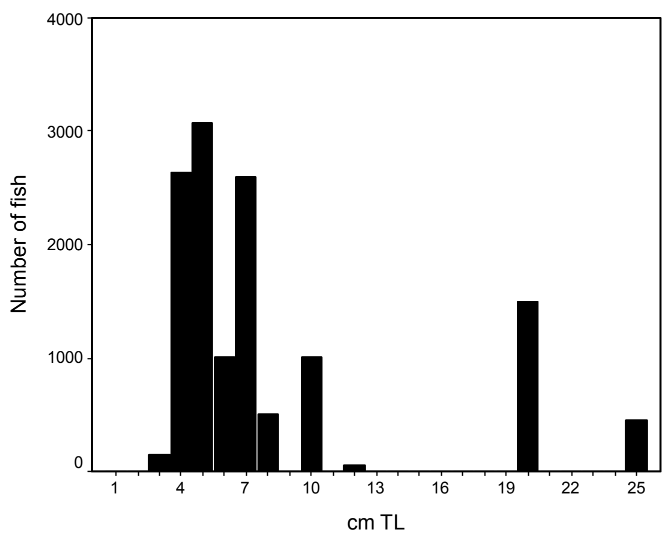
Wreck:
No fish

Squarespot rockfish - Platform

Shallow level: no fish



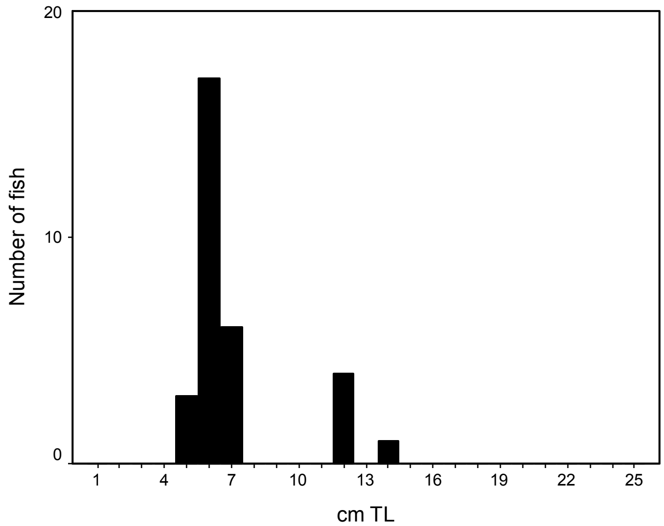
Middle level



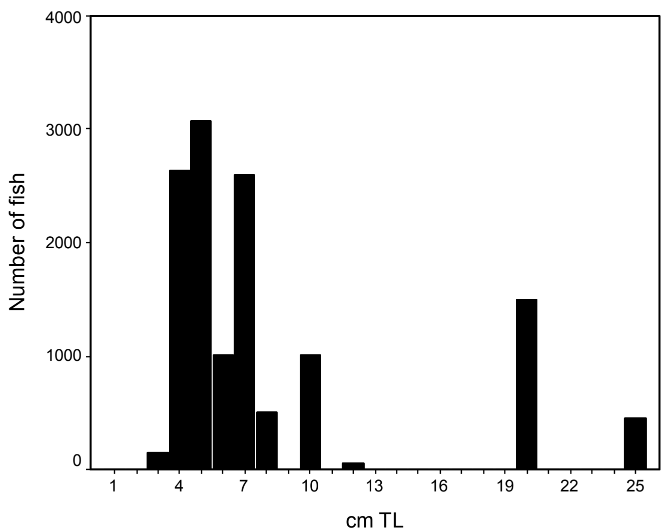
Deep level

Squarespot rockfish - Platform

Shallow level: no fish



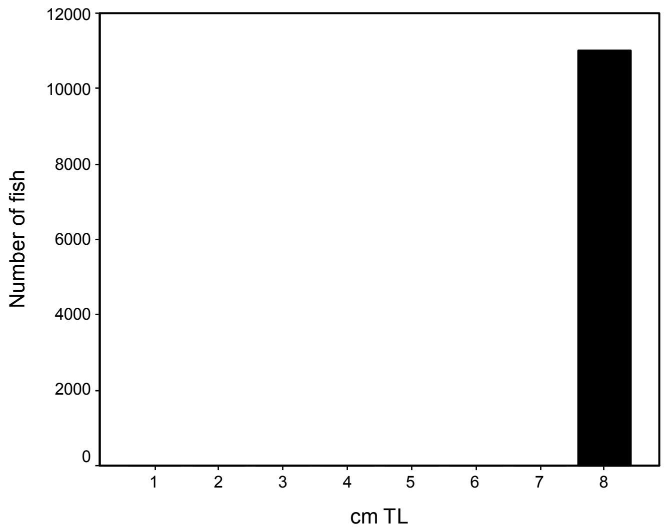
Middle level



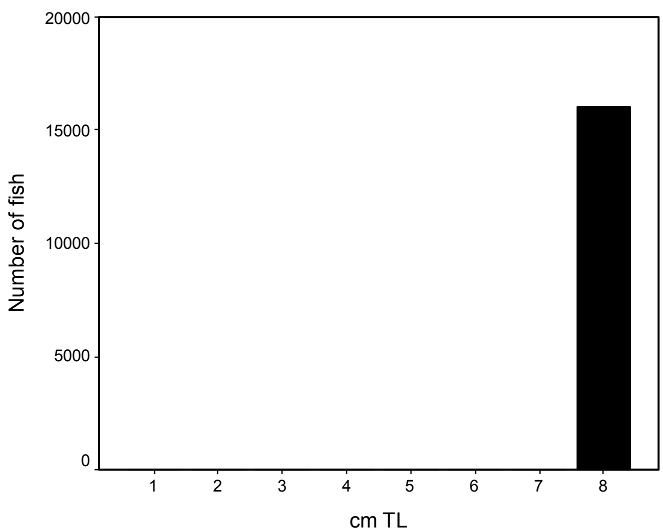
Deep level

Widow rockfish - Platform

Shallow level: no fish



Middle level



Deep level

Widow rockfish

Reef:
No fish

Wreck:
1 fish at 4 cm TL

APPENDIX 4.1A

Rockfishes and non-rockfishes observed at platforms during the 2010 supplemental survey season. Included are number of fish in each taxon, proportion of total count, size range, count and proportion of fish 12 cm TL or less and greater than 12 cm TL.

					Fish <= 12cmTL		Fish > 12cmTL	
Common name	Total Count	% of Total Count	Min cm TL	Max cm TL	Count	% of Total Count	Count	% of Total Count
ROCKFISHES								
bocaccio	324533	41.8%	5	16	302818	93.3%	21715	6.7%
shortbelly rockfish	308824	39.8%	8	15	308319	99.8%	505	0.2%
squarespot rockfish	82685	10.7%	4	22	82680	100.0%	5	0.0%
widow rockfish	24829	3.2%	5	13	24826	100.0%	3	0.0%
blue rockfish	6989	0.9%	3	30	6975	99.8%	14	0.2%
yellowtail rockfish or olive rockfish (OYT)	3388	0.4%	5	30	3381	99.8%	7	0.2%
halfbanded rockfish	1772	0.2%	3	8	1772	100.0%		
kelp rockfish, gopher rockfish, or black and yellow rockfish (KGB)	482	0.1%	4	10	482	100.0%		
calico rockfish	403	0.1%	6	9	403	100.0%		
kelp rockfish	237	0.0%	8	40	5	2.1%	232	97.9%
copper rockfish	141	0.0%	4	35	111	78.7%	30	21.3%
grass rockfish	26	0.0%	25	40			26	100.0%
treefish	15	0.0%	7	12	15	100.0%		
stripetail rockfish	6	0.0%	7	8	6	100.0%		
gopher rockfish	4	0.0%	15	30			4	100.0%
rosy rockfish	4	0.0%	6	8	4	100.0%		
brown rockfish	1	0.0%	28	28			1	100.0%
flag rockfish	1	0.0%	5	5	1	100.0%		
young-of-year rockfish spp.	1	0.0%	9	9	1	100.0%		
NON-ROCKFISHES								
blacksmith	10221	1.3%	3	30	6109	59.8%	4112	40.2%
jack mackerel	10100	1.3%	15	20			10100	100.0%
sharpnose seaperch	347	0.0%	15	25			347	100.0%
painted greenling	302	0.0%	3	20	168	55.6%	134	44.4%
California sheephead	176	0.0%	10	75	1	0.6%	175	99.4%
opaleye	141	0.0%	25	35			141	100.0%
senorita	140	0.0%	15	20			140	100.0%
garibaldi	98	0.0%	15	30			98	100.0%
cabezon	90	0.0%	3	60	18	20.0%	72	80.0%
jacksmelt or topsmelt	60	0.0%	12	15	50	83.3%	10	16.7%
kelp bass	30	0.0%	20	45			30	100.0%
kelp greenling	18	0.0%	8	15	15	83.3%	3	16.7%
pile perch	12	0.0%	20	35			12	100.0%
blackeye goby	5	0.0%	8	12	5	100.0%		
sculpin spp.	2	0.0%	8	12	2	100.0%		
lingcod	2	0.0%	22	22			2	100.0%
unidentified fish	1	0.0%	20	20			1	100.0%
Rockfishes	754341	97.2%			731799	97.0%	22542	3.0%
Non-rockfishes	21745	2.8%			6368	29.3%	15377	70.7%
Total	776086	100.0%			738167	95.1%	37919	4.9%

APPENDIX 4.1B

Rockfishes and non-rockfishes observed at reefs during the 2010 supplemental survey season. Included are number of fish in each taxon, proportion of total count, size range, count and proportion of fish 12 cm TL or less and greater than 12 cm TL.

					Fish <= 12cmTL		Fish > 12cmTL	
Common name	Total Count	% of Total Count	Min cm TL	Max cm TL	Count	% of Total Count	Count	% of Total Count
ROCKFISHES								
shortbelly rockfish	110000	48.4%	8	10	110000	100.0%		
bocaccio	92921	40.9%	5	15	92912	100.0%	9	0.0%
squarespot rockfish	17840	7.8%	6	10	17840	100.0%		
blue rockfish	1976	0.9%	6	30	1609	81.4%	367	18.6%
young-of-year rockfish spp.	73	0.0%	10	12	73	100.0%		
widow rockfish	55	0.0%	8	10	55	100.0%		
California sheephead	42	0.0%	12	75	2	4.8%	40	95.2%
yellowtail rockfish or olive rockfish (OYT)	40	0.0%	5	8	40	100.0%		
kelp rockfish, gopher rockfish, or black and yellow rockfish (KGB)	25	0.0%	4	10	25	100.0%		
treefish	25	0.0%	7	30	15	60.0%	10	40.0%
halfbanded rockfish	24	0.0%	6	6	24	100.0%		
gopher rockfish	22	0.0%	12	30	1	4.5%	21	95.5%
kelp rockfish	12	0.0%	20	30			12	100.0%
olive rockfish	5	0.0%	18	30			5	100.0%
copper rockfish	3	0.0%	30	40			3	100.0%
black and yellow rockfish	3	0.0%	25	30			3	100.0%
rosy rockfish	2	0.0%	4	30	1	50.0%	1	50.0%
vermillion rockfish	1	0.0%	40	40			1	100.0%
NON-ROCKFISHES								
blacksmith	3570	1.6%	10	25	2254	63.1%	1316	36.9%
senorita	368	0.2%	12	20			368	100.0%
sharpnose seaperch	105	0.0%	8	22	103	98.1%	2	1.9%
painted greenling	95	0.0%	6	20	34	35.8%	61	64.2%
black perch	26	0.0%	10	30	6	23.1%	20	76.9%
pile perch	18	0.0%	12	35	2	11.1%	16	88.9%
blackeye goby	17	0.0%	9	13	11	64.7%	6	35.3%
striped seaperch	5	0.0%	8	30	3	60.0%	2	40.0%
lingcod	5	0.0%	40	60			5	100.0%
garibaldi	4	0.0%	25	25			4	100.0%
zebra goby	3	0.0%	8	8	3	100.0%		
shiner perch	2	0.0%	10	10	2	100.0%		
kelp bass	2	0.0%	35	35			2	100.0%
rubberlip seaperch	2	0.0%	35	40			2	100.0%
California scorpionfish	2	0.0%	30	35			2	100.0%
California moray	1	0.0%	12	12	1	100.0%		
opaleye	1	0.0%	28	28			1	100.0%
halfmoon	1	0.0%	30	30			1	100.0%
white seaperch	1	0.0%	20	20			1	100.0%
cabezon	1	0.0%	35	35			1	100.0%
Rockfishes	223069	98.1%			222597	99.8%	472	0.2%
Non-rockfishes	4229	1.9%			2419	57.2%	1810	42.8%
Total	227298	100.0%			225016	99.0%	2282	1.0%

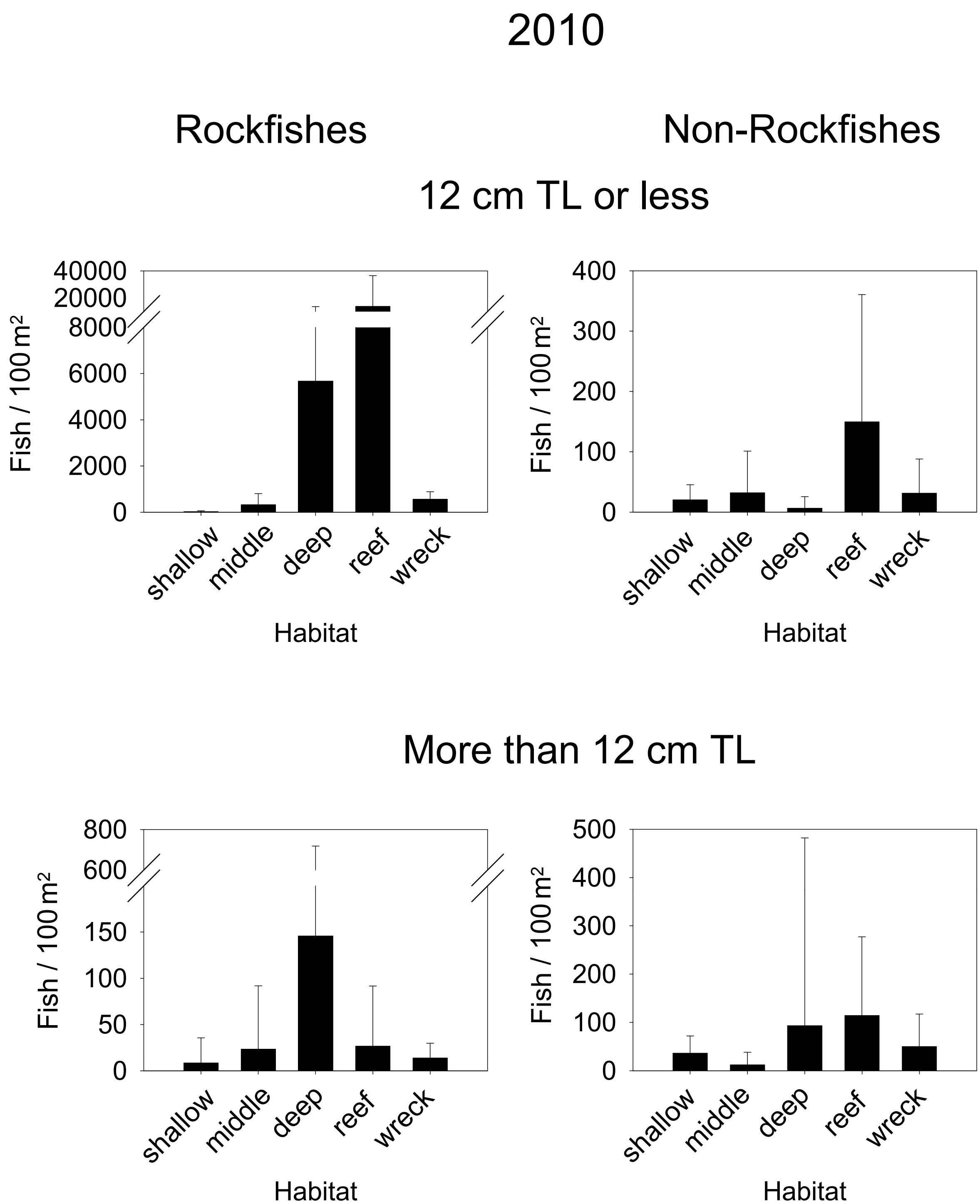
APPENDIX 4.1C

Rockfishes and non-rockfishes observed at wrecks during the 2010 supplemental survey season. Included are number of fish in each taxon, proportion of total count, size range, count and proportion of fish 12 cm TL or less and greater than 12 cm TL.

					Fish <= 12cmTL		Fish > 12cmTL	
Common name	Total Count	% of Total Count	Min cm TL	Max cm TL	Count	% of Total Count	Count	% of Total Count
ROCKFISHES								
bocaccio	1419	29.9%	8	13	1403	98.9%	16	1.1%
squarespot rockfish	1160	24.5%	6	9	1160	100.0%		
blue rockfish	700	14.8%	6	25	683	97.6%	17	2.4%
halfbanded rockfish	572	12.1%	4	8	572	100.0%		
yellowtail rockfish or olive rockfish (OYT)	218	4.6%	6	10	218	100.0%		
vermillion rockfish	24	0.5%	15	15			24	100.0%
rosy rockfish	12	0.3%	8	25	5	41.7%	7	58.3%
copper rockfish	10	0.2%	9	30	3	30.0%	7	70.0%
brown rockfish	9	0.2%	30	40			9	100.0%
black and yellow rockfish	9	0.2%	22	30			9	100.0%
gopher rockfish	7	0.1%	8	30	3	42.9%	4	57.1%
kelp rockfish, gopher rockfish, or black and yellow rockfish (KGB)	6	0.1%	6	8	6	100.0%		
olive rockfish	5	0.1%	14	30			5	100.0%
treefish	4	0.1%	8	10	4	100.0%		
calico rockfish	2	0.0%	10	15	1	50.0%	1	50.0%
flag rockfish	1	0.0%	7	7	1	100.0%		
NON-ROCKFISHES								
blacksmith	227	4.8%	8	20	6	2.6%	221	97.4%
senorita	206	4.3%	10	18	200	97.1%	6	2.9%
black perch	31	0.7%	15	30			31	100.0%
California sheephead	28	0.6%	10	80	3	10.7%	25	89.3%
blackeye goby	27	0.6%	5	13	12	44.4%	15	55.6%
painted greenling	26	0.5%	10	15	2	7.7%	24	92.3%
rubberlip seaperch	14	0.3%	35	40			14	100.0%
pile perch	8	0.2%	13	40			8	100.0%
ronquil spp.	5	0.1%	15	18			5	100.0%
garibaldi	3	0.1%	22	24			3	100.0%
lingcod	3	0.1%	45	75			3	100.0%
sculpin spp.	2	0.0%	12	12	2	100.0%		
kelp perch	1	0.0%	12	12	1	100.0%		
kelp greenling	1	0.0%	30	30			1	100.0%
kelp bass	1	0.0%	40	40			1	100.0%
barred sandbass	1	0.0%	50	50			1	100.0%
California scorpionfish	1	0.0%	35	35			1	100.0%
Rockfishes	4158	87.7%			4059	97.6%	99	2.4%
Non-rockfishes	585	12.3%			226	38.6%	359	61.4%
Total	4743	100.0%			4285	90.3%	458	9.7%

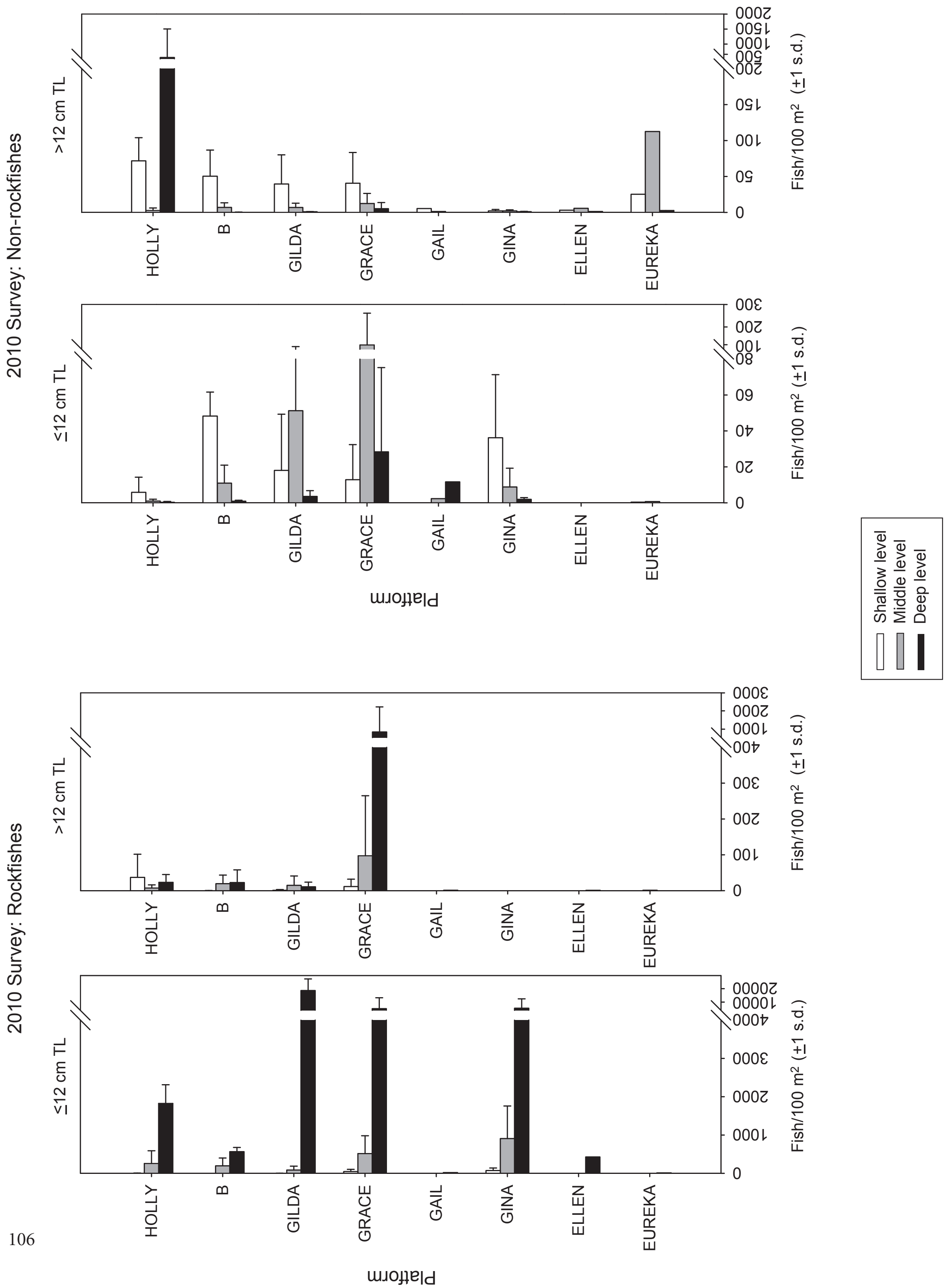
APPENDIX 4.2

Supplemental survey season 2010: annual average density (fish/100 m2 ± 1 s.d.) of two size classes (12 cm TL or less) of rockfishes and non-rockfishes at three levels of the platforms, reefs, and wrecks. Shallow level ranged from 5-11 m, middle level ranged from 11-22 m, and deep level 26-35 m among platforms.



APPENDIX 4.3

Supplemental survey season 2010: annual average density (fish/100 m2 ± 1 s.d.) of two size classes (12 cm TL or less, and greater than 12 cm TL) of (a) rockfishes and (b) non-rockfishes at the three levels surveyed at individual platforms. Shallow level ranged from 5-11 m, middle level ranged from 11-22 m, and deep level 26-35 m among platforms.



APPENDIX 4.4A

Supplemental survey season 2010: annual average density (fish/100 m2 ± 1 s.d.) of two size classes (12 cm TL or less, greater than 12 cm TL) of rockfish species and complexes in five habitats (three platform levels, reefs, and wrecks). Surveyed levels, L1 ranged from 5-11 m, L2 11-22 m, and L3 26-35 m among platforms. Taxa are presented in alphabetical order of common names.

Species or complex		< 12 cm TL		> 12 cm TL		
	habitat	mean	s.d.	mean	s.d.	N
black and yellow rockfish						
	L1	-	-	-	-	18
	L2	-	-	-	-	18
	L3	-	-	-	-	18
	reef	-	-	0.19	0.39	9
	wreck	-	-	1.25	2.15	4
blue rockfish						
	L1	9.54	22.38	-	-	18
	L2	53.82	86.14	-	-	18
	L3	14.58	19.37	0.12	0.21	18
	reef	99.32	69.88	22.65	64.45	9
	wreck	94.86	159.20	2.36	3.15	4
bocaccio						
	L1	1.03	3.61	8.37	27.12	18
	L2	94.77	245.76	22.87	68.24	18
	L3	2353.88	4305.30	139.84	554.79	18
	reef	5735.31	14639.85	0.56	1.18	9
	wreck	194.86	389.72	2.22	4.44	4
brown rockfish						
	L1	-	-	-	-	18
	L2	-	-	-	-	18
	L3	-	-	0.01	0.03	18
	reef	-	-	-	-	9
	wreck	-	-	1.25	1.84	4
calico rockfish						
	L1	-	-	-	-	18
	L2	-	-	-	-	18
	L3	4.07	14.05	-	-	18
	reef	-	-	-	-	9
	wreck	0.14	0.28	0.14	0.28	4
copper rockfish						
	L1	0.24	0.73	-	-	18
	L2	0.92	2.98	0.14	0.44	18
	L3	0.08	0.23	0.15	0.30	18
	reef	-	-	0.19	0.28	9
	wreck	0.42	0.83	0.97	1.94	4
flag rockfish						
	L1	-	-	-	-	18
	L2	-	-	-	-	18
	L3	0.01	0.04	-	-	18
	reef	-	-	-	-	9
	wreck	0.14	0.28	-	-	4

Species or complex	habitat	< 12 cm TL mean	< 12 cm TL s.d.	> 12 cm TL mean	> 12 cm TL s.d.	N
gopher rockfish						
	L1	-	-	-	-	18
	L2	-	-	0.02	0.05	18
	L3	-	-	0.02	0.05	18
	reef	0.06	0.19	1.30	1.27	9
	wreck	0.42	0.83	0.56	0.45	4
grass rockfish						
	L1	-	-	0.02	0.06	18
	L2	-	-	0.10	0.35	18
	L3	-	-	0.07	0.16	18
halfbanded rockfish						
	L1	-	-	-	-	18
	L2	-	-	-	-	18
	L3	17.87	41.30	-	-	18
	reef	1.48	4.44	-	-	9
	wreck	79.44	97.40	-	-	4
kelp rockfish						
	L1	-	-	0.05	0.16	18
	L2	0.06	0.27	0.22	0.43	18
	L3	0.02	0.09	1.55	2.07	18
	reef	-	-	0.74	1.82	9
	wreck	-	-	-	-	4
KGB complex						
	L1	0.20	0.71	-	-	18
	L2	1.96	3.71	-	-	18
	L3	2.15	3.50	-	-	18
	reef	1.54	2.63	-	-	9
	wreck	0.83	0.72	-	-	4
Olive rockfish						
	reef	-	-	0.31	0.56	9
	wreck	-	-	0.69	1.39	4
ROSY complex						
	L1	-	-	-	-	18
	L2	-	-	-	-	18
	L3	0.04	0.13	-	-	18
	reef	0.06	0.19	0.06	0.19	9
	wreck	0.69	1.39	0.97	1.94	4
shortbelly rockfish						
	L1	-	-	-	-	18
	L2	35.35	149.97	-	-	18
	L3	2487.83	6133.44	3.86	16.20	18
	reef	6790.12	20370.37	-	-	9
	wreck	-	-	-	-	4

Species or complex	habitat	< 12 cm TL mean	< 12 cm TL s.d.	> 12 cm TL mean	> 12 cm TL s.d.	N
squarespot rockfish						
	L1	5.60	22.89	-	-	18
	L2	66.62	176.20	-	-	18
	L3	600.96	517.85	0.05	0.14	18
	reef	1101.23	1150.50	-	-	9
	wreck	161.11	235.97	-	-	4
stripetail rockfish						
	L1	-	-	-	-	18
	L2	-	-	-	-	18
	L3	0.06	0.19	-	-	18
treefish						
	L1	0.02	0.07	-	-	18
	L2	0.07	0.16	-	-	18
	L3	0.05	0.09	-	-	18
	reef	0.93	2.19	0.62	0.98	9
	wreck	0.56	0.79	-	-	4
vermillion rockfish						
	reef	-	-	0.06	0.19	9
	wreck	-	-	3.33	4.71	4
widow rockfish						
	L1	0.25	1.08	-	-	18
	L2	43.89	139.48	0.03	0.14	18
	L3	180.45	350.94	-	-	18
	reef	3.40	6.77	-	-	9
	wreck	-	-	-	-	4
OYT complex						
	L1	4.59	13.54	0.02	0.07	18
	L2	30.58	92.73	-	-	18
	L3	8.69	33.68	0.08	0.32	18
	reef	2.47	4.04	-	-	9
	wreck	30.28	47.84	-	-	4
YOY rockfish spp.						
	L1	-	-	-	-	18
	L2	-	-	-	-	18
	L3	0.01	0.03	-	-	18
	reef	4.51	13.52	-	-	9
	wreck	-	-	-	-	4

APPENDIX 4.4B

Supplemental survey season 2010: annual average density (fish/100 m2 ± 1 s.d.) of two size classes (12 cm TL or less, greater than 12 cm TL) of non-rockfish taxa in five habitats (three platform levels, reefs, and wrecks). Surveyed levels, L1 ranged from 5-11 m, L2 11-22 m, and L3 26-35 m among platforms. Taxa are presented in alphabetical order of common names.

Species or complex		≤ 12 cm TL		> 12 cm TL		
	habitat	mean	s.d.	mean	s.d.	N
barred sandbass						
	reef	-	-	-	-	9
	wreck	-	-	0.14	0.28	4
black perch						
	reef	0.37	0.79	1.23	2.30	9
	wreck	-	-	4.31	6.58	4
blackeye goby						
	L1	-	-	-	-	18
	L2	-	-	-	-	18
	L3	0.05	0.10	-	-	18
	reef	0.68	0.99	0.37	0.92	9
	wreck	1.67	2.22	2.08	4.17	4
blacksmith						
	L1	19.73	25.23	27.13	33.79	18
	L2	31.32	69.03	8.97	23.52	18
	L3	5.28	19.46	0.90	3.49	18
	reef	139.14	209.53	81.23	161.58	9
	wreck	0.83	1.67	30.69	53.89	4
cabezon						
	L1	0.17	0.39	0.44	1.15	18
	L2	0.04	0.13	0.12	0.20	18
	L3	0.02	0.06	0.23	0.32	18
	reef	-	-	0.06	0.19	9
	wreck	-	-	-	-	4
California moray						
	reef	0.06	0.19	-	-	9
	wreck	-	-	-	-	4
California scorpionfish						
	reef	-	-	0.12	0.37	9
	wreck	-	-	0.14	0.28	4
California sheephead						
	L1	-	-	0.51	1.04	18
	L2	0.01	0.03	0.71	2.24	18
	L3	-	-	0.09	0.36	18
	reef	0.12	0.37	2.47	2.47	9
	wreck	0.42	0.53	3.47	3.28	4
garibaldi						
	L1	-	-	0.57	2.16	18
	L2	-	-	0.14	0.60	18
	L3	-	-	-	-	18
	reef	-	-	0.25	0.74	9
	wreck	-	-	0.42	0.83	4

Species or complex	habitat	≤ 12 cm TL mean	s.d.	> 12 cm TL mean	s.d.	N
halfmoon						
	L1	-	-	-	-	18
	L2	-	-	-	-	18
	L3	-	-	-	-	18
	reef	-	-	0.06	0.19	9
	wreck	-	-	-	-	4
jack mackerel						
	L1	-	-	1.27	5.38	18
	L2	-	-	-	-	18
	L3	-	-	91.69	389.02	18
	reef	-	-	-	-	9
	wreck	-	-	-	-	4
jacksmelt or topsmelt						
	L1	-	-	0.13	0.54	18
	L2	-	-	-	-	18
	L3	0.38	1.62	-	-	18
kelp bass						
	L1	-	-	0.24	0.32	18
	L2	-	-	0.06	0.15	18
	L3	-	-	-	-	18
	reef	-	-	0.12	0.37	9
	wreck	-	-	0.14	0.28	4
kelp greenling						
	L1	-	-	-	-	18
	L2	0.04	0.10	0.02	0.07	18
	L3	0.09	0.21	0.01	0.03	18
	reef	-	-	-	-	9
	wreck	-	-	0.14	0.28	4
kelp perch						
	reef	-	-	-	-	9
	wreck	0.14	0.28	-	-	4
lingcod						
	L1	-	-	-	-	18
	L2	-	-	-	-	18
	L3	-	-	0.02	0.09	18
	reef	-	-	0.31	0.49	9
	wreck	-	-	0.42	0.28	4
opaleye						
	L1	-	-	1.27	3.13	18
	L2	-	-	0.14	0.49	18
	L3	-	-	-	-	18
	reef	-	-	0.06	0.19	9
	wreck	-	-	-	-	4

Species or complex	habitat	≤ 12 cm TL mean	≤ 12 cm TL s.d.	> 12 cm TL mean	> 12 cm TL s.d.	N
painted greenling						
	L1	0.33	0.70	0.41	0.58	18
	L2	0.66	0.83	0.64	0.72	18
	L3	0.72	0.76	0.30	0.40	18
	reef	2.10	2.32	3.77	2.47	9
	wreck	0.28	0.32	3.33	1.57	4
pile perch						
	L1	-	-	0.02	0.05	18
	L2	-	-	0.07	0.19	18
	L3	-	-	0.01	0.04	18
	reef	0.12	0.37	0.99	1.03	9
	wreck	-	-	1.11	0.64	4
ronquil spp.						
	L1	-	-	-	-	18
	L2	-	-	-	-	18
	L3	-	-	-	-	18
	reef	-	-	-	-	9
	wreck	-	-	0.69	1.05	4
rubberlip seaperch						
	reef	-	-	0.12	0.24	9
	wreck	-	-	1.94	3.16	4
sculpin spp.						
	L1	0.02	0.06	-	-	18
	L2	-	-	-	-	18
	L3	-	-	-	-	18
	reef	-	-	-	-	9
	wreck	0.28	0.56	-	-	4
senorita						
	L1	-	-	1.29	3.67	18
	L2	-	-	-	-	18
	L3	-	-	-	-	18
	reef	-	-	22.72	40.35	9
	wreck	27.78	55.56	0.83	1.67	4
sharpnose seaperch						
	L1	-	-	2.78	11.55	18
	L2	-	-	1.02	3.14	18
	L3	-	-	0.09	0.39	18
	reef	6.36	14.61	0.12	0.37	9
	wreck	-	-	-	-	4
shiner perch						
	reef	0.12	0.37	-	-	9
	wreck	-	-	-	-	4

Species or complex	habitat	≤ 12 cm TL mean	s.d.	> 12 cm TL mean	s.d.	N
striped seaperch						
	L1	-	-	-	-	18
	L2	-	-	-	-	18
	L3	-	-	-	-	18
	reef	0.19	0.56	0.12	0.37	9
	wreck	-	-	-	-	4
white seaperch						
	L1	-	-	-	-	18
	L2	-	-	-	-	18
	L3	-	-	-	-	18
	reef	-	-	0.06	0.19	9
	wreck	-	-	-	-	4
zebra goby						
	reef	0.19	0.56	-	-	9
	wreck	-	-	-	-	4
	L1	-	-	-	-	18
	L2	-	-	-	-	18
	L3	-	-	-	-	18

APPENDIX 4.5A

Supplemental survey season 2010: annual average density (fish/100 m2 ± 1 s.d.) of two size classes (12 cm TL or less, and greater than 12 cm TL) of rockfish species and complexes at the three levels surveyed at individual platforms. Shallow level ranged from 5-11 m, middle level ranged from 11-22 m, and deep level 26-35 m among platforms. Taxa are presented in alphabetical order of common names.

ROCKFISHES		Shallow level				Middle level				Deep level			
Platform	N surveys	≤ 12 cm TL		> 12 cm TL		≤ 12 cm TL		> 12 cm TL		≤ 12 cm TL		> 12 cm TL	
		Mean	s.d.	Mean	s.d.	Mean	s.d.	Mean	s.d.	Mean	s.d.	Mean	s.d.
blue rockfish													
HOLLY	3	0.6	0.5	--	--	15.1	14.6	--	--	0.4	0.3	0.4	0.2
B	3	--	--	--	--	84.3	72.5	--	--	20.8	27.0	--	--
GILDA	3	1.4	1.9	--	--	22.8	36.5	--	--	16.9	18.9	0.0	0.1
GRACE	3	8.7	7.8	--	--	25.5	34.6	--	--	16.4	25.5	0.3	0.4
GINA	3	46.5	40.6	--	--	175.2	149.5	--	--	30.4	21.7	--	--
GAIL	1	--		--		--		--		8.0		--	
ELLEN	1	--		--		--		--		--		--	
EUREKA	1	--		--		--		--		--		--	
bocaccio													
HOLLY	3	0.1	0.1	37.3	64.6	3.0	5.2	6.2	9.9	60.7	105.2	21.6	21.4
B	3	--	--	--	--	64.2	108.4	19.4	24.0	56.4	97.7	22.8	35.2
GILDA	3	0.2	0.2	1.2	2.1	40.2	35.8	15.1	26.1	6893.2	4849.3	7.0	11.8
GRACE	3	5.3	8.8	11.8	20.4	87.9	127.8	96.6	167.3	4811.2	7823.0	787.6	1363.3
GINA	3	0.6	1.0	--	--	373.3	579.3	--	--	2299.9	2956.9	--	--
GAIL	1	--		--		--		--		5.5		--	
ELLEN	1	--		--		--		--		--		0.1	
EUREKA	1	--		--		--		--		--		--	
brown rockfish													
HOLLY	3	--	--	--	--	--	--	--	--	--	--	--	--
B	3	--	--	--	--	--	--	--	--	--	--	--	--
GILDA	3	--	--	--	--	--	--	--	--	--	--	--	--
GRACE	3	--	--	--	--	--	--	--	--	--	--	0.0	0.1
GINA	3	--	--	--	--	--	--	--	--	--	--	--	--
GAIL	1	--		--		--		--		--		--	
ELLEN	1	--		--		--		--		--		--	
EUREKA	1	--		--		--		--		--		--	
calico rockfish													
HOLLY	3	--	--	--	--	--	--	--	--	--	--	--	--
B	3	--	--	--	--	--	--	--	--	--	--	--	--
GILDA	3	--	--	--	--	--	--	--	--	0.0	0.1	--	--
GRACE	3	--	--	--	--	--	--	--	--	--	--	--	--
GINA	3	--	--	--	--	--	--	--	--	24.4	30.6	--	--
GAIL	1	--		--		--		--		--		--	
ELLEN	1	--		--		--		--		--		--	
EUREKA	1	--		--		--		--		--		--	

ROCKFISHES		Shallow level				Middle level				Deep level			
Platform	N surveys	≤ 12 cm TL		> 12 cm TL		≤ 12 cm TL		> 12 cm TL		≤ 12 cm TL		> 12 cm TL	
		Mean	s.d.	Mean	s.d.	Mean	s.d.	Mean	s.d.	Mean	s.d.	Mean	s.d.
copper rockfish													
HOLLY	3	1.4	1.4	--	--	5.5	6.1	0.9	0.8	0.1	0.1	0.6	0.6
B	3	--	--	--	--	--	--	--	--	--	--	0.0	0.1
GILDA	3	--	--	--	--	--	--	--	--	0.3	0.6	0.1	--
GRACE	3	--	--	--	--	--	--	--	--	--	--	0.1	0.2
GINA	3	--	--	--	--	--	--	--	--	--	--	--	--
GAIL	1	--		--		--		--		0.2		--	
ELLEN	1	--		--		--		--		--		--	
EUREKA	1	--		--		--		--		--		--	
flag rockfish													
HOLLY	3	--	--	--	--	--	--	--	--	--	--	--	--
B	3	--	--	--	--	--	--	--	--	--	--	--	--
GILDA	3	--	--	--	--	--	--	--	--	--	--	--	--
GRACE	3	--	--	--	--	--	--	--	--	--	--	--	--
GINA	3	--	--	--	--	--	--	--	--	0.1	0.1	--	--
GAIL	1	--		--		--		--		--		--	
ELLEN	1	--		--		--		--		--		--	
EUREKA	1	--		--		--		--		--		--	
gopher rockfish													
HOLLY	3	--	--	--	--	--	--	--	--	--	--	0.1	0.1
B	3	--	--	--	--	--	--	0.1	0.1	--	--	0.0	0.1
GILDA	3	--	--	--	--	--	--	--	--	--	--	--	--
GRACE	3	--	--	--	--	--	--	--	--	--	--	--	--
GINA	3	--	--	--	--	--	--	--	--	--	--	--	--
GAIL	1	--		--		--		--		--		--	
ELLEN	1	--		--		--		--		--		--	
EUREKA	1	--		--		--		--		--		--	
grass rockfish													
HOLLY	3	--	--	--	--	--	--	--	--	--	--	--	--
B	3	--	--	0.1	0.1	--	--	--	--	--	--	--	--
GILDA	3	--	--	0.1	0.1	--	--	--	--	--	--	--	--
GRACE	3	--	--	--	--	--	--	--	--	--	--	0.2	0.3
GINA	3	--	--	--	--	--	--	--	--	--	--	--	--
GAIL	1	--		--		--		--		--		--	
ELLEN	1	--		--		--		0.4		--		0.4	
EUREKA	1	--		--		--		1.4		--		0.2	

ROCKFISHES		Shallow level				Middle level				Deep level			
Platform	N surveys	≤ 12 cm TL		> 12 cm TL		≤ 12 cm TL		> 12 cm TL		≤ 12 cm TL		> 12 cm TL	
		Mean	s.d.	Mean	s.d.	Mean	s.d.	Mean	s.d.	Mean	s.d.	Mean	s.d.
halfbanded rockfish													
HOLLY	3	--	--	--	--	--	--	--	--	--	--	--	--
B	3	--	--	--	--	--	--	--	--	0.0	0.1	--	--
GILDA	3	--	--	--	--	--	--	--	--	--	--	--	--
GRACE	3	--	--	--	--	--	--	--	--	--	--	--	--
GINA	3	--	--	--	--	--	--	--	--	106.7	17.1	--	--
GAIL	1	--		--		--		--		--		--	
ELLEN	1	--		--		--		--		1.4		--	
EUREKA	1	--		--		--		--		--		--	
kelp rockfish													
HOLLY	3	--	--	--	--	--	--	0.2	0.3	--	--	0.6	0.2
B	3	--	--	0.3	0.3	--	--	0.1	0.1	--	--	--	--
GILDA	3	--	--	--	--	--	--	--	--	--	--	3.8	1.4
GRACE	3	--	--	--	--	--	--	0.9	0.8	--	--	4.8	0.5
GINA	3	--	--	--	--	0.4	0.7	--	--	0.1	0.2	--	--
GAIL	1	--		--		--		0.2		--		--	
ELLEN	1	--		--		--		0.2		--		0.6	
EUREKA	1	--		--		--		--		--		0.1	
kelp rockfish, gopher rockfish, or black and yellow rockfish (KGB)													
HOLLY	3	--	--	--	--	0.1	0.1	--	--	0.1	0.2	--	--
B	3	--	--	--	--	6.8	1.7	--	--	8.9	3.1	--	--
GILDA	3	--	--	--	--	--	--	--	--	0.3	0.2	--	--
GRACE	3	1.0	1.7	--	--	0.4	0.3	--	--	0.5	0.4	--	--
GINA	3	0.2	0.3	--	--	4.5	7.0	--	--	2.7	2.0	--	--
GAIL	1	--		--		--		--		--		--	
ELLEN	1	--		--		--		--		0.8		--	
EUREKA	1	--		--		--		--		0.4		--	
rosy rockfish													
HOLLY	3	--	--	--	--	--	--	--	--	--	--	--	--
B	3	--	--	--	--	--	--	--	--	0.0	0.1	--	--
GILDA	3	--	--	--	--	--	--	--	--	--	--	--	--
GRACE	3	--	--	--	--	--	--	--	--	--	--	--	--
GINA	3	--	--	--	--	--	--	--	--	0.2	0.3	--	--
GAIL	1	--		--		--		--		--		--	
ELLEN	1	--		--		--		--		--		--	
EUREKA	1	--		--		--		--		--		--	

ROCKFISHES		Shallow level				Middle level				Deep level			
Platform	N surveys	≤ 12 cm TL		> 12 cm TL		≤ 12 cm TL		> 12 cm TL		≤ 12 cm TL		> 12 cm TL	
		Mean	s.d.	Mean	s.d.	Mean	s.d.	Mean	s.d.	Mean	s.d.	Mean	s.d.
shortbelly rockfish													
HOLLY	3	--	--	--	--	--	--	--	--	--	--	--	--
B	3	--	--	--	--	--	--	--	--	--	--	--	--
GILDA	3	--	--	--	--	--	--	--	--	11081.8	11342.1	--	--
GRACE	3	--	--	--	--	--	--	--	--	114.9	198.9	23.2	39.5
GINA	3	--	--	--	--	212.1	367.3	--	--	3728.7	6457.6	--	--
GAIL	1	--		--		--		--		4.8		--	
ELLEN	1	--		--		--		--		--		--	
EUREKA	1	--		--		--		--		--		--	
squarespot rockfish													
HOLLY	3	--	--	--	--	9.2	13.5	--	--	903.0	487.9	0.3	0.3
B	3	--	--	--	--	16.5	17.8	--	--	385.8	203.6	--	--
GILDA	3	1.2	2.1	--	--	20.3	35.2	--	--	645.7	400.5	--	--
GRACE	3	32.4	56.2	--	--	346.1	347.8	--	--	1234.7	628.4	--	--
GINA	3	--	--	--	--	7.6	13.2	--	--	289.1	347.0	--	--
GAIL	1	--		--		--		--		2.8		--	
ELLEN	1	--		--		--		--		426.1		--	
EUREKA	1	--		--		--		--		13.5		--	
stripetail rockfish													
HOLLY	3	--	--	--	--	--	--	--	--	--	--	--	--
B	3	--	--	--	--	--	--	--	--	--	--	--	--
GILDA	3	--	--	--	--	--	--	--	--	--	--	--	--
GRACE	3	--	--	--	--	--	--	--	--	--	--	--	--
GINA	3	--	--	--	--	--	--	--	--	0.4	0.4	--	--
GAIL	1	--		--		--		--		--		--	
ELLEN	1	--		--		--		--		--		--	
EUREKA	1	--		--		--		--		--		--	
treefish													
HOLLY	3	--	--	--	--	0.3	0.3	--	--	--	--	--	--
B	3	--	--	--	--	--	--	--	--	0.1	0.1	--	--
GILDA	3	--	--	--	--	--	--	--	--	--	--	--	--
GRACE	3	0.1	0.2	--	--	0.1	0.2	--	--	0.1	0.2	--	--
GINA	3	--	--	--	--	--	--	--	--	--	--	--	--
GAIL	1	--		--		--		--		--		--	
ELLEN	1	--		--		--		--		0.3		--	
EUREKA	1	--		--		0.1		--		--		--	

ROCKFISHES		Shallow level				Middle level				Deep level			
Platform	N surveys	≤ 12 cm TL		> 12 cm TL		≤ 12 cm TL		> 12 cm TL		≤ 12 cm TL		> 12 cm TL	
		Mean	s.d.	Mean	s.d.	Mean	s.d.	Mean	s.d.	Mean	s.d.	Mean	s.d.
widow rockfish													
HOLLY	3	1.5	2.6	--	--	208.2	322.5	0.2	0.3	859.6	435.7	--	--
B	3	--	--	--	--	--	--	--	--	93.7	54.6	--	--
GILDA	3	--	--	--	--	--	--	--	--	82.2	73.2	--	--
GRACE	3	--	--	--	--	55.1	95.5	--	--	47.2	81.8	--	--
GINA	3	--	--	--	--	--	--	--	--	--	--	--	--
GAIL	1	--		--		--		--		--		--	
ELLEN	1	--		--		--		--		--		--	
EUREKA	1	--		--		--		--		--		--	
yellowtail rockfish or olive rockfish (OYT)													
HOLLY	3	0.6	0.7	--	--	15.9	9.8	--	--	1.0	1.1	--	--
B	3	--	--	--	--	25.2	37.0	--	--	1.1	1.4	--	--
GILDA	3	--	--	--	--	4.4	4.4	--	--	49.5	81.5	--	--
GRACE	3	0.1	0.3	--	--	1.9	3.2	--	--	--	--	--	--
GINA	3	26.8	25.9	0.1	0.2	136.2	225.4	--	--	0.4	0.4	--	--
GAIL	1	--		--		--		--		0.5		1.4	
ELLEN	1	--		--		--		--		--		--	
EUREKA	1	--		--		--		--		--		--	
young-of-year rockfish spp.													
HOLLY	3	--	--	--	--	--	--	--	--	--	--	--	--
B	3	--	--	--	--	--	--	--	--	--	--	--	--
GILDA	3	--	--	--	--	--	--	--	--	--	--	--	--
GRACE	3	--	--	--	--	--	--	--	--	0.0	0.1	--	--
GINA	3	--	--	--	--	--	--	--	--	--	--	--	--
GAIL	1	--		--		--		--		--		--	
ELLEN	1	--		--		--		--		--		--	
EUREKA	1	--		--		--		--		--		--	

APPENDIX 4.5B

Supplemental survey season 2010: annual average density (fish/100 m2 ± 1 s.d.) of two size classes (12 cm TL or less, and greater than 12 cm TL) of non-rockfish taxa at the three levels surveyed at individual platforms. Shallow level ranged from 5-11 m, middle level ranged from 11-22 m, and deep level 26-35 m among platforms. Taxa are presented in alphabetical order of common names.

Non-Rockfishes		Shallow level				Middle level				Deep level			
Platform	N surveys	≤ 12 cm TL		> 12 cm TL		≤ 12 cm TL		> 12 cm TL		≤ 12 cm TL		> 12 cm TL	
		Mean	s.d.	Mean	s.d.	Mean	s.d.	Mean	s.d.	Mean	s.d.	Mean	s.d.
blackeye goby													
HOLLY	3	--	--	--	--	--	--	--	--	--	--	--	--
B	3	--	--	--	--	--	--	--	--	--	--	--	--
GILDA	3	--	--	--	--	--	--	--	--	--	--	--	--
GRACE	3	--	--	--	--	--	--	--	--	--	--	--	--
GINA	3	--	--	--	--	--	--	--	--	0.2	0.1	--	--
GAIL	1	--		--		--		--		--		--	
ELLEN	1	--		--		--		--		0.1		--	
EUREKA	1	--		--		--		--		--		--	
blacksmith													
HOLLY	3	4.7	8.2	44.5	42.8	--	--	--	--	--	--	--	--
B	3	48.3	13.4	38.4	39.7	9.8	10.0	1.7	1.9	0.2	0.2	--	--
GILDA	3	17.9	31.1	31.8	43.7	51.1	60.9	5.3	6.3	--	--	0.1	0.2
GRACE	3	12.7	19.5	40.4	42.1	118.8	141.8	11.8	13.1	27.6	47.5	5.0	8.6
GINA	3	34.6	35.6	0.9	1.5	7.3	10.3	0.2	0.3	--	--	--	--
GAIL	1	--		5.4		2.3		1.4		11.5		--	
ELLEN	1	--		2.9		--		3.5		--		--	
EUREKA	1	0.4		12.2		0.6		99.5		--		1.1	
cabezon													
HOLLY	3	0.8	0.7	2.2	2.3	0.1	0.2	0.3	0.3	--	--	0.2	0.2
B	3	--	--	0.1	0.2	--	--	0.0	0.1	--	--	0.1	0.1
GILDA	3	0.1	0.1	0.1	0.1	--	--	--	--	--	--	0.1	0.2
GRACE	3	--	--	0.0	0.1	--	--	--	--	--	--	0.2	0.2
GINA	3	0.2	0.3	0.2	0.3	0.1	0.2	0.3	0.3	0.1	0.1	0.4	0.3
GAIL	1	--		--		--		--		--		--	
ELLEN	1	--		--		--		0.2		--		1.3	
EUREKA	1	--		--		--		0.1		--		--	
California sheephead													
B	3	--	--	1.7	0.3	--	--	0.4	0.7	--	--	--	--
ELLEN	1	--		0.2		--		2.1		--		0.1	
EUREKA	1	--		3.8		0.1		9.4		--		1.5	
GAIL	1	--		--		--		--		--		--	
GILDA	3	--	--	--	--	--	--	--	--	--	--	--	--
GINA	3	--	--	--	--	--	--	--	--	--	--	--	--
GRACE	3	--	--	0.0	0.1	--	--	0.0	0.1	--	--	--	--
HOLLY	3	--	--	--	--	--	--	--	--	--	--	--	--

Non-Rockfishes		Shallow level				Middle level				Deep level			
Platform	N surveys	≤ 12 cm TL		> 12 cm TL		≤ 12 cm TL		> 12 cm TL		≤ 12 cm TL		> 12 cm TL	
		Mean	s.d.	Mean	s.d.	Mean	s.d.	Mean	s.d.	Mean	s.d.	Mean	s.d.
garibaldi													
HOLLY	3	--	--	--	--	--	--	--	--	--	--	--	--
B	3	--	--	0.3	0.2	--	--	--	--	--	--	--	--
GILDA	3	--	--	--	--	--	--	--	--	--	--	--	--
GRACE	3	--	--	0.0	0.1	--	--	--	--	--	--	--	--
GINA	3	--	--	--	--	--	--	--	--	--	--	--	--
GAIL	1	--		--		--		--		--		--	
ELLEN	1	--		--		--		--		--		--	
EUREKA	1	--		9.2		--		2.5		--		--	
jack mackerel													
HOLLY	3	--	--	7.6	13.2	--	--	--	--	--	--	550.2	952.9
B	3	--	--	--	--	--	--	--	--	--	--	--	--
GILDA	3	--	--	--	--	--	--	--	--	--	--	--	--
GRACE	3	--	--	--	--	--	--	--	--	--	--	--	--
GINA	3	--	--	--	--	--	--	--	--	--	--	--	--
GAIL	1	--		--		--		--		--		--	
ELLEN	1	--		--		--		--		--		--	
EUREKA	1	--		--		--		--		--		--	
jacksmelt or topsmelt													
HOLLY	3	--	--	0.8	1.3	--	--	--	--	--	--	--	--
B	3	--	--	--	--	--	--	--	--	--	--	--	--
GILDA	3	--	--	--	--	--	--	--	--	2.3	4.0	--	--
GRACE	3	--	--	--	--	--	--	--	--	--	--	--	--
GINA	3	--	--	--	--	--	--	--	--	--	--	--	--
GAIL	1	--		--		--		--		--		--	
ELLEN	1	--		--		--		--		--		--	
EUREKA	1	--		--		--		--		--		--	
kelp bass													
HOLLY	3	--	--	--	--	--	--	--	--	--	--	--	--
B	3	--	--	0.6	0.3	--	--	--	--	--	--	--	--
GILDA	3	--	--	0.2	0.3	--	--	0.3	0.3	--	--	--	--
GRACE	3	--	--	0.2	0.3	--	--	--	--	--	--	--	--
GINA	3	--	--	0.3	0.5	--	--	0.1	0.2	--	--	--	--
GAIL	1	--		--		--		--		--		--	
ELLEN	1	--		--		--		--		--		--	
EUREKA	1	--		0.1		--		--		--		--	

Non-Rockfishes		Shallow level				Middle level				Deep level			
Platform	N surveys	≤ 12 cm TL		> 12 cm TL		≤ 12 cm TL		> 12 cm TL		≤ 12 cm TL		> 12 cm TL	
		Mean	s.d.	Mean	s.d.	Mean	s.d.	Mean	s.d.	Mean	s.d.	Mean	s.d.
kelp greenling													
HOLLY	3	--	--	--	--	--	--	--	--	--	--	--	--
B	3	--	--	--	--	0.1	0.2	--	--	--	--	--	--
GILDA	3	--	--	--	--	0.1	0.2	--	--	0.2	0.2	0.0	0.1
GRACE	3	--	--	--	--	--	--	0.0	0.1	0.3	0.5	--	--
GINA	3	--	--	--	--	--	--	0.1	0.2	0.1	0.1	--	--
GAIL	1	--		--		--		--		--		--	
ELLEN	1	--		--		--		--		--		--	
EUREKA	1	--		--		--		--		--		--	
lingcod													
HOLLY	3	--	--	--	--	--	--	--	--	--	--	--	--
B	3	--	--	--	--	--	--	--	--	--	--	--	--
GILDA	3	--	--	--	--	--	--	--	--	--	--	--	--
GRACE	3	--	--	--	--	--	--	--	--	--	--	--	--
GINA	3	--	--	--	--	--	--	--	--	--	--	0.1	0.2
GAIL	1	--		--		--		--		--		--	
ELLEN	1	--		--		--		--		--		--	
EUREKA	1	--		--		--		--		--		--	
opaleye													
HOLLY	3	--	--	--	--	--	--	--	--	--	--	--	--
B	3	--	--	--	--	--	--	--	--	--	--	--	--
GILDA	3	--	--	7.6	3.4	--	--	0.8	1.1	--	--	--	--
GRACE	3	--	--	--	--	--	--	--	--	--	--	--	--
GINA	3	--	--	--	--	--	--	--	--	--	--	--	--
GAIL	1	--		--		--		--		--		--	
ELLEN	1	--		--		--		--		--		--	
EUREKA	1	--		--		--		--		--		--	
painted greenling													
HOLLY	3	0.3	0.3	0.3	0.5	0.9	1.2	0.5	0.4	0.3	0.4	--	--
B	3	0.1	0.1	1.2	0.2	1.1	0.7	0.5	0.3	0.7	0.3	0.2	0.2
GILDA	3	0.1	0.1	--	--	0.1	0.1	0.3	0.3	1.1	0.9	0.8	0.3
GRACE	3	0.1	0.2	0.0	0.1	0.5	0.7	0.6	0.9	0.5	0.8	0.1	0.1
GINA	3	1.4	1.3	1.0	0.7	1.4	1.0	1.6	1.1	1.6	1.0	0.6	0.6
GAIL	1	--		--		--		--		0.2		--	
ELLEN	1	--		--		--		--		--		--	
EUREKA	1	--		--		--		1.1		--		0.1	

Non-Rockfishes		Shallow level				Middle level				Deep level			
Platform	N surveys	≤ 12 cm TL		> 12 cm TL		≤ 12 cm TL		> 12 cm TL		≤ 12 cm TL		> 12 cm TL	
		Mean	s.d.	Mean	s.d.	Mean	s.d.	Mean	s.d.	Mean	s.d.	Mean	s.d.
pile perch													
HOLLY	3	--	--	--	--	--	--	--	--	--	--	--	--
B	3	--	--	0.1	0.1	--	--	0.2	0.2	--	--	0.1	0.1
GILDA	3	--	--	--	--	--	--	0.2	0.4	--	--	--	--
GRACE	3	--	--	--	--	--	--	--	--	--	--	--	--
GINA	3	--	--	--	--	--	--	--	--	--	--	--	--
GAIL	1	--		--		--		--		--		--	
ELLEN	1	--		--		--		--		--		--	
EUREKA	1	--		--		--		--		--		--	
sculpin spp.													
HOLLY	3	0.1	0.1	--	--	--	--	--	--	--	--	--	--
B	3	--	--	--	--	--	--	--	--	--	--	--	--
GILDA	3	--	--	--	--	--	--	--	--	--	--	--	--
GRACE	3	0.0	0.1	--	--	--	--	--	--	--	--	--	--
GINA	3	--	--	--	--	--	--	--	--	--	--	--	--
GAIL	1	--		--		--		--		--		--	
ELLEN	1	--		--		--		--		--		--	
EUREKA	1	--		--		--		--		--		--	
senorita													
HOLLY	3	--	--	--	--	--	--	--	--	--	--	--	--
B	3	--	--	7.7	6.3	--	--	--	--	--	--	--	--
GILDA	3	--	--	--	--	--	--	--	--	--	--	--	--
GRACE	3	--	--	--	--	--	--	--	--	--	--	--	--
GINA	3	--	--	--	--	--	--	--	--	--	--	--	--
GAIL	1	--		--		--		--		--		--	
ELLEN	1	--		--		--		--		--		--	
EUREKA	1	--		--		--		--		--		--	
sharpnose seaperch													
HOLLY	3	--	--	16.4	28.3	--	--	2.0	3.5	--	--	0.6	1.0
B	3	--	--	0.3	0.3	--	--	4.1	7.0	--	--	--	--
GILDA	3	--	--	--	--	--	--	--	--	--	--	--	--
GRACE	3	--	--	--	--	--	--	--	--	--	--	--	--
GINA	3	--	--	--	--	--	--	--	--	--	--	--	--
GAIL	1	--		--		--		--		--		--	
ELLEN	1	--		--		--		--		--		--	
EUREKA	1	--		--		--		--		--		--	

APPENDIX 5

Locations and descriptions of structures surveyed, June to September, 2008–2010.

Platforms

Irene: 34°36’N, 120°43’W. Bottom depth 73 m; distance from shore 7.6 km.
Holly: 34°22’N, 119·52’W, Bottom depth 64 m; distance from shore 2.9 km.
B: 34°19’N, 119°37’W. Bottom depth 58 m; distance from shore 9.1 km.
Gail: 34°07’N, 119°24’W. Bottom depth 224 m; distance from shore 15.9 km.
Gina: 34°07’N, 119°16’W. Bottom depth 29 m; distance from shore 6.0 km.
Grace: 34°10’N, 119°28’W. Bottom depth 96 m; distance from shore 16.9 km.
Gilda: 34°10’N, 119°25’W. Bottom depth 62 m; distance from shore 14.2 km.
Ellen: 33°34’N, 118°08’W. Bottom depth 80 m; distance from shore depths 13.8 km.
Eureka: 33°33’N, 118°06’W. Bottom depth 212 m; distance from shore 14.8 km.

Reefs

San Luis: 35°48’N, 120°28’W. This pinnacle is the smallest of the seafloor features surveyed in this study. It is a small bladelike spire of rock that is approximately 25 m long and 5 m wide at its peak. It rises to a depth of 20 m and drops nearly vertically along smooth walls on all sides to a depth of 38 m. It is surrounded by sand.

Super Pin: 34°03’N, 120°13’W. This pinnacle lies off the north coast of San Miguel Island, rising from 49 to 61 m deep up to a depth of 21 to 24 m. The top is roughly circular measuring 30 to 37 m across, dropping steeply on all sides.

Egg Rock: 34°02’N, 120°09’W. Egg Rock lies between Santa Rosa and San Miguel Islands, rising from a depth of about 61 m. The top is relatively flat, measures 44 m long by 26 m wide, and is 20 to 23 m deep. It drops steeply on all sides, the walls having many overhangs and caves.

The Nine: 33°33’N, 119°35’W. The Nine is an oblong rise off the southeast corner of Santa Rosa Island. It rises to a depth of 17 to 21 m. The flat rock is crossed by numerous channels of gravel and sand. The edges drop off gradually to sandy gravel on all sides. Northward towards Santa Rosa Island the surrounding sand flats are 26 m deep. To the south the sand begins at approximately 31 m deep.

Admiral’s: 34°00’N, 119°16’W. This pinnacle is one of several that rise from the sea floor off the east side of Anacapa Island. It rises sharply from a depth of 38 m. The top of the feature is a plateau approximately 15 by 21 m long that ranges from 21–27 m deep. To the north and west it drops nearly vertically to the sea floor, while the other sides slope somewhat more gradually to boulder piles that begin at 30 m deep.

Four Mile: 34°13’N, 119°23’W. The Four Mile is a small, roughly circular, seafloor feature that is perhaps 30 m across. It rises from a depth of 46 to 61 m to a peak at 32 m. The top is of very high relief and much of it is 37 m deep. It has numerous overhangs, crevices, and channels running across it.

Farnsworth Bank: 33°21’N, 118°33’W. Farnsworth Bank, covering about 6 hectares, is a series of hard bedrock pinnacles, rising to as shallow as 15 m, but mostly in 24 m and deeper, from a soft sediment sea floor. Much of this feature is covered in purple hydrocoral, *Stylaster californica*.

Shipwrecks

SM1: 34°16’N, 120°14’W. The *SM1* was a metal U.S. Navy landing ship that was converted to an oil drilling rig in the 1950s. It sank in 1961 and now lies upside down in 23 m of water just east of Government Point. It has numerous holes in it ranging from several inches to several meters in diameter. The top of the wreck (or the bottom of the hull) rises 6 m off the seafloor.

Avalon: 33°28'N, 118°15'W. The *Avalon* was a steel 82 m passenger ship that sank off Palos Verdes in 1964 in 23 m of water on a bottom of sand and boulders. Today it is nothing more than a widely scattered pile of debris, although some sections of the hull are still recognizable and stand 6 m off the bottom.

Olympic: 33°23'N, 118°08'W. The *Olympic* was an iron 79 m fishing barge that sank off San Pedro after a collision with the Japanese freighter *Sakito Maru* in 1940. Considered a hazard to navigation, the wreckage was blown up soon after. As a result the wreckage is strewn about widely, most lying flat on the bottom although a few sections of the hull still stand as high as 10 m off the bottom. The remains lie in 30 m of water on a sandy bottom.