Pacific Outer Continental Shelf Region

OCS Study
BOEM 2015-019

ANALYSIS OF FISH POPULATIONS AT PLATFORMS OFF SUMMERLAND, CALIFORNIA

Bureau of Ocean Energy Management

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ANALYSIS OF FISH POPULATIONS AT PLATFORMS OFF SUMMERLAND, CALIFORNIA

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Report Availability

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TECHNICAL SUMMARY

Study Title: Analysis of Fish Populations at Platforms off Summerland, California
Report Title: Analysis of Fish Populations at Platforms off Summerland, California
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Project Manager: Milton Love
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Principal Investigator: Milton Love
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Background and Objectives

The BOEM defines decommissioning as the process of ending oil, gas, or sulfur requirements of the regulations. The BOEM works to ensure that wells are plugged to prevent pollution; that pipelines are decommissioned and sometimes removed to prevent seepage of hydrocarbons and to resolve conflicts with other uses of the OCS; and that all sites are cleared of obstructions to minimize use conflicts. The BOEM will conduct detailed environmental reviews of any proposed decommissioning projects to evaluate the impacts from platform removal on regional fish populations. Obviously, when a platform is disassembled, habitat is removed, and numerous fishes and invertebrates are killed.

The fate of spent offshore platforms off California has been a subject of considerable debate, much of which is focused on the potential importance of fish populations residing at these facilities. These platforms contribute considerable hard structure habitat for marine fishes; providing both a food source and complex physical habitat for fishes in an area that would otherwise be void of such associated fauna. In addition, recent research has shown that oil and gas platforms off the coast of California have the highest secondary fish production per unit area of seafloor of any marine habitat that has been studied (Claisse et al. 2014). The majority of species found on California platforms are rockfishes but include many other groups of fishes including some not well represented on nearby natural reefs or in coastal kelp beds.

The role that each California platform may play as fish habitat must be seen in light of the Secretary of the Department of Commerce's 2000 declaration designating the West Coast groundfish fishery a disaster with extremely small populations remaining. Recent BOEM-funded studies (Love et al. 2005, Love and York 2006, Nishimoto and Love 2011) have revealed that some of the platforms hold large numbers of both juvenile and reproductively mature rockfishes in numbers far greater than any natural reef that has been surveyed. The observed rockfish species include bocaccio and cowcod, both of which are species of concern, with bocaccio once considered for listing as threatened under the Endangered Species Act. Additionally, four more federally declared overfished species have been observed, sometimes in large numbers, at some platforms: canary, darkblotched, widow and yelloweye rockfishes. All of these species are subject to federal rebuilding plans, as specified by the Magnuson-Stevens Fishery Conservation Act. The Pacific Fishery Management Council and the State of California began to severely restrict targeted fishing for these species in 2002 and 2003 and created the Cowcod Conservation Area in southern California to protect that species. Since 2001, cowcod have been managed as a no-retention fishery in California. In addition, the State of California banned the spot prawn trawl fishery in order to eliminate all by-catch of bocaccio. Populations of rockfishes at platforms, and the platforms as habitat for specific life history stages (e.g., nursery habitat for juveniles), may prove to be vital for timely recovery of the regional rockfish populations and fisheries. However, yet unknown are the impacts of platform removal on regional populations of coastal organisms, particularly the economically important rockfish species, on the Pacific 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.

Pacific OCS platforms reside in a variety of depths and oceanographic conditions (Love et al. 2003) and there are large differences in fish assemblages between platforms (Love et al. 2003, Love and York 2006, Nishimoto and Love 2011). Thus, this assemblage variability suggests that a case-by-case scenario is likely for decommissioning decisions. In order to analyze the environmental consequences of platform decommissioning on local or regional fish populations, it is essential to know the role that each platform plays as fish habitat. Data gaps concerning the fish assemblages exist at some of the oldest facilities, yet these facilities may be the first to be decommissioned. Knowledge of the potential importance of the local population at platforms to the depleted Pacific rockfish stocks is essential for fully evaluating the various options proposed for decommissioning California's offshore oil platforms.

The eight platforms within the Dos Cuadras oil field, off Summerland, California (C, B, A, Hillhouse, Henry, Houchin, Hogan, and Habitat) have been in operation for over four decades and are expected to be some of the first to be in line for decommissioning. Problematically, these structures are situated in a depositional, and hence turbid-water, region. In practice, this has meant that, despite a number of attempts over 15 years, water visibility at the bottom of the platform jackets has been judged by the pilots of manned submersibles too poor to safely allow assessment of fish assemblages. However, a review of segments of a remotely operated vehicle (ROV) survey of one of these platforms indicated that fish populations at these platform habitats could be adequately surveyed using a combination of SCUBA and ROV techniques.

Information is needed as soon as possible for the use by the State of California to consider for decommissioning options under the California legislation AB 2503 (the California Marine Resources Legacy Act). The Act requires California to consider reefing OCS oil and gas platforms, if their ecological value warrants, before decommissioning and potential removal. BOEM can specify requirements to industry or other interested parties when decommissioning occurs. Using the results, BOEM can ensure that specified criteria can be properly evaluated during the decommissioning process pursuant to the federal regulations at 30 CFR 250.1730 and the State of California can ensure proper evaluation under the California Rigs-to-Reefs Program law AB 2503 (the California Marine Resources Legacy Act).

The primary goals of this research were:

1) To make a more detailed assessment of the fish assemblages of these eight platforms (and by extension a more accurate picture of their ecological importance) than is currently available and
2) To compare these assemblages with some other platforms in the Santa Barbara Channel.

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Description

We conducted fish assemblage surveys around the midwaters, bottoms, and shell mounds of eight oil and gas platforms (A, B, C, Habitat, Henry, Hillhouse, Hogan, and Houchin) off Summerland, California. We conducted scuba surveys in the upper 39 m of the water column, from June–September of 2012 and 2013. Deeper midwaters, bottoms, and shell mounds were surveyed with a remotely operated vehicle.

Significant Results

We conducted 57 transects around eight platforms encompassing 34,389 m^2 of habitat. Over all platforms, we observed 108,303 individual fish, comprising a minimum of 46 species. Rockfishes, of at least 22 species, were most characteristic of all of the assemblages; we observed 105,114 individual rockfishes and this represented 97.1% of all fishes recorded. Rockfishes comprised between 76.8% (shell mounds) and 98.3% (midwaters) of all fishes observed. In particular, YOY rockfishes comprised most of the midwater fish assemblage (94.7% of all fishes observed) and about 20% of the bottom and shell mound assemblages (21.1% and 22.9%, respectively). Of the top ten species ranked by density, all were rockfishes and seven of these taxa were YOY stages. Of particular importance were squarespot, blue, shortbelly, widow, and halfbanded rockfishes, and bocaccio. Among non-rockfish species, lingcod, senorita, painted greenling, shortspine combfish, and blacksmith comprised at least one percent of the assemblages as measured by density.

Around platform bottoms, we conducted 29 transects, covering 4,792 m^2. A total of 5,193 fish (a minimum of 34 species) were observed. Rockfishes, of a minimum of 19 species and totaling 4,359 individuals (83.9% of all fishes observed) dominated the assemblages. About 25% of all fishes observed were YOY rockfishes (1,098 of 4,359). The bottom fish assemblages were fairly similar across all platforms and most different at the deepest (Habitat) and shallowest (Hogan) structures.

There was a tendency for the mid-depth platforms to harbor the highest number of species; a high of 26 was observed at Platform B and a low of 12 was seen at Hogan. On the other hand, the overall density of fishes at various platform bottoms did not vary statistically with bottom depth because at most platforms overall fish density varied greatly between years. This was due primarily to substantial interannual differences in densities linked to quite variable recruitment of YOY squarespot, shortbelly, halfbanded, and calico rockfishes and California lizardfish, as well as changes in densities of somewhat older juvenile squarespot, vermilion, and blue rockfishes and bocaccio. Most of the fishes we observed around platform bottoms were relatively small, about 70% were 15 cm or less. These fishes were either juvenile fishes (e.g., calico, copper, halfbanded, squarespot, and vermilion rockfishes, bocaccio, and lingcod) or were dwarf species such as halfbanded and calico rockfishes.

We conducted 28 transects on the shell mounds and these transects covered 4,433 m^2. A total of 2,822 fishes, of at least 32 species, were observed. As with the platform bottoms, rockfishes (2,168 individuals of at least 16 species) again dominated the species assemblage; they comprised 76.8% of all fishes observed. Almost 30% of all fishes observed were YOY rockfishes (646 of 2,168). While shell mound fish assemblages were similar across all platforms, we observed relatively small differences between the deeper platforms Habitat, A, and B, and the rest of the structures. However, there was no evidence that the shell mound assemblage of any platform was unique.

The shell mound around Platform B was the most species rich (22 taxa) and that around Habitat (11 species), Henry (11 species), and Hogan (10 species) harbored the fewest taxa. Similar to our observation around platform bottoms, a substantial inter-annual variation in fish densities at several platforms made it difficult to determine if densities varied among platforms. Species that exhibited large interannual differences in densities included calico, halfbanded, shortbelly and squarespot rockfishes YOYs, blue, calico, halfbanded and vermilion rockfishes and California lizardfish. Again, as with platform bottoms, small fishes (of 20 cm or less) were by far most abundant in this habitat at all platforms. Species that characterized this habitat included calico, halfbanded, squarespot, and vermilion rockfishes, as well as California lizardfish, lingcod (particularly YOYs) and painted greenling.

We observed a total of 100,287 fishes in platform midwaters, composed of at least 28 species. Of these fishes, 98,587 (98.3% of the total) were rockfishes (of 17 species), and 96.4% of these were YOYs. YOY rockfishes dominated this habitat and comprised 94.7% of all fishes observed. Densities of five rockfish species (i.e., blue, bocaccio, shortbelly, squarespot, and widow) greatly exceeded those of other taxa.

We observed between 27 (Platform B) and 14 (Platform Henry) species in the midwaters of eight platforms. No pattern in species richness among the platforms was observed. Around most platforms, fish densities varied greatly between years and this variability was due to very large interannual differences in YOY recruitment of blue, shortbelly, squarespot, and widow rockfishes, bocaccio and blacksmith. Midwater fish assemblages around these eight platforms were fairly similar – perhaps the greatest differences were within-platform interannual ones driven by this recruitment variability. The overwhelming importance of YOY rockfishes in this habitat explains our observations that almost all of the fishes observed in the platform midwaters were small, 10 cm or less long.

We compared the bottom and shell mound assemblages of the Summerland platforms with previous findings from Platforms Holly and Gilda; these structures are located within the Santa Barbara Channel and are in similar bottom depths. We found that the Summerland fish assemblages are closely related to these two other platforms. Given that the Summerland platforms are arguably in some of the most turbid waters of any California platforms, the implication is that bottom turbidity plays less of a role in structuring fish assemblages as do other habitat characteristics such as bottom depth.

Overall, the data from 2012–2013 found that:

1) The fish assemblages found around the Summerland platforms are similar to those around other platforms situated in the same bottom depths in the Santa Barbara Channel (i.e., Holly and Gilda);
2) There is substantial overlap in the species living in the midwaters, bottoms, and shell mounds on many, if not all, of these relatively shallow water platforms. This is at least partially due to a suite of rockfish species that recruit as YOYs to platform midwaters and are then able to occupy both midwater and bottom depths;
3) Based on the high densities of juveniles, one of the major functions of the Summerland platforms is as a nursery ground for a suite of species, primarily rockfishes but also including lingcod and painted greenling. Adult fishes (e.g., blacksmith, cabezon, garibaldi, and sheephead) are present, sometimes in substantial numbers, but juvenile rockfish dominance relegates these other species to a relatively small fraction of the total fish population.
4) The densities of fishes in the midwaters of most California platforms vary greatly between years, regardless of platform bottom depth, because juvenile rockfish recruitment varies (sometimes dramatically) between years (Nishimoto and Love 2011). At many shallower platforms (such as those off Summerland) the three habitat assemblages, which share a variety of juvenile rockfish species, are linked and thus fish densities at all depths and habitats may vary greatly interannually.

Analysis of Fish Populations at Platforms off Summerland, California

EXECUTIVE SUMMARY

Information Needed

There are 27 oil and gas platforms in the waters off California, located between 1.2 and 10.5 miles from shore and at depths ranging from 11 to 363 m (35–1,198 ft). All platforms have a finite economic life and the life spans of some California platforms may be nearing an end. Once an industrial decision is made to cease oil and gas production at a platform, manager must decide what to do with the structure, a process known as decommissioning. The BOEM defines decommissioning as the process of ending oil, gas, or sulfur requirements of the regulations. The BOEM works to ensure that wells are plugged to prevent pollution; that pipelines are decommissioned and sometimes removed to prevent seepage of hydrocarbons and to resolve conflicts with other uses of the OCS; and that all sites are cleared of obstructions to minimize use conflicts. The BOEM will conduct detailed environmental reviews of any proposed decommissioning projects to evaluate the impacts from platform removal on regional fish populations. Obviously, when a platform is disassembled, habitat is removed, and numerous fishes and invertebrates are killed.

The fate of spent offshore platforms off California has been a subject of considerable debate, much of which is focused on the potential importance of fish populations residing at these facilities. These platforms contribute considerable hard structure habitat for marine fishes; providing both a food source and complex physical habitat for fishes in an area that would otherwise be void of such associated fauna. In addition, recent research has shown that oil and gas platforms off the coast of California have the highest secondary fish production per unit area of seafloor of any marine habitat that has been studied. The majority of species found on California platforms are rockfishes but include many other groups of fishes including some not well represented on nearby natural reefs or in coastal kelp beds.

The role that each California platform may play as fish habitat must be seen in light of the Secretary of the Department of Commerce's 2000 declaration designating the West Coast groundfish fishery a disaster with extremely small populations remaining. Recent BOEM-funded studies have revealed that some of the platforms hold large numbers of both juvenile and reproductively mature rockfishes in numbers far greater than any natural reef that has been surveyed. The observed rockfish species include bocaccio and cowcod, both of which are species of concern, with bocaccio once considered for listing as threatened under the Endangered Species Act. Additionally, four more federally declared overfished species have been observed, sometimes in large numbers, at some platforms: canary, darkblotched, widow and yelloweye rockfishes. All of these species are subject to federal rebuilding plans, as specified by the Magnuson-Stevens Fishery Conservation Act. The Pacific Fishery Management Council and the State of California began to severely restrict targeted fishing for these species in 2002 and 2003 and created the Cowcod Conservation Area in southern California to protect that species. Since 2001, cowcod have been managed as a no-retention fishery in California. In addition, the State of California banned the spot prawn trawl fishery in order to eliminate all by-catch of bocaccio. Populations of rockfishes at platforms, and the platforms as habitat for specific life history stages (e.g., nursery habitat for juveniles), may prove to be vital for timely recovery of the regional rockfish populations and fisheries. However, yet unknown are the impacts of platform removal on regional populations of coastal organisms, particularly the economically important rockfish species, on the Pacific 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.

Pacific OCS platforms reside in a variety of depths and oceanographic conditions and there are large differences in fish assemblages between platforms. Thus, this assemblage variability suggests that a case-by-case scenario is likely for decommissioning decisions. In order to analyze the environmental consequences of platform decommissioning on local or regional fish populations, it is essential to know the role that each platform plays as fish habitat. Data gaps concerning the fish assemblages exist at some of the oldest facilities, yet these facilities may be the first to be decommissioned. Knowledge of the potential importance of the local population at platforms to the depleted Pacific rockfish stocks is essential for fully evaluating the various options proposed for decommissioning California's offshore oil platforms.

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Research Summary

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We conducted 57 transects encompassing 34,389 m^2 of habitat. Over all platforms, we observed 108,303 individual fish, comprising a minimum of 46 species. Rockfishes, of at least 22 species, were most characteristic of all of the assemblages; we observed 105,114 individual rockfishes and this represented 97.1% of all fishes recorded. Rockfishes comprised between 76.8% (shell mounds) and 98.3% (midwaters) of all fishes observed. In particular, YOY rockfishes comprised most of the midwater fish assemblage (94.7% of all fishes observed) and about 20% of the bottom and shell mound assemblages (21.1% and 22.9%, respectively). Of the top ten species ranked by density, all were rockfishes and seven of these taxa were YOY stages. Of particular importance were squarespot, blue, shortbelly, widow, and halfbanded rockfishes, and bocaccio. Among non-rockfish species, lingcod, senorita, painted greenling, shortspine combfish, and blacksmith comprised at least one percent of the assemblages as measured by density.

Around platform bottoms, we conducted 29 transects, covering 4,792 m^2. A total of 5,193 fish (a minimum of 34 species) were observed. Rockfishes, of a minimum of 19 species and totaling 4,359 individuals (83.9% of all fishes observed) dominated the assemblages. About 25% of all fishes observed were YOY rockfishes (1,098 of 4,359). The bottom fish assemblages were fairly similar across all platforms and most different at the deepest (Habitat) and shallowest (Hogan) structures.

There was a tendency for the mid-depth platforms to harbor the highest number of species; a high of 26 was observed at Platform B and a low of 12 was seen at Hogan. On the other hand, the overall density of fishes at various platform bottoms did not vary statistically with bottom depth because at most platforms overall fish density varied greatly between years. This was due primarily to substantial interannual differences in densities linked to quite variable recruitment of YOY squarespot, shortbelly, halfbanded, and calico rockfishes and California lizardfish, as well as changes in densities of somewhat older juvenile squarespot, vermilion, and blue rockfishes and bocaccio. Most of the fishes we observed around platform bottoms were relatively small, about 70% were 15 cm or less. These fishes were either juvenile fishes (e.g., calico, copper, halfbanded, squarespot, and vermilion rockfishes, bocaccio, and lingcod) or were dwarf species such as halfbanded and calico rockfishes.

We conducted 28 transects on the shell mounds and these transects covered 4,433 m^2. A total of 2,822 fishes, of at least 32 species, were observed. As with the platform bottoms, rockfishes (2,168 individuals of at least 16 species) again dominated the species assemblage; they comprised 76.8% of all fishes observed. Almost 30% of all fishes observed were YOY rockfishes (646 of 2,168). While shell mound fish assemblages were similar across all platforms, we observed relatively small differences between the deeper platforms Habitat, A, and B, and the rest of the structures. However, there was no evidence that the shell mound assemblage of any platform was unique.

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We observed a total of 100,287 fishes in platform midwaters, composed of at least 28 species. Of these fishes, 98,587 (98.3% of the total) were rockfishes (of 17 species), and 96.4% of these were YOYs. YOY rockfishes dominated this habitat and comprised 94.7% of all fishes observed. Densities of five rockfish species (i.e.,

blue, bocaccio, shortbelly, squarespot, and widow) greatly exceeded those of other taxa.
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Conclusions

Overall, the data from 2012–2013 found that:

1) The fish assemblages found around the Summerland platforms are similar to those around other platforms situated in the same bottom depths in the Santa Barbara Channel (i.e., Holly and Gilda);
2) There is substantial overlap in the species living in the midwaters, bottoms, and shell mounds on many, if not all, of these relatively shallow water platforms. This is at least partially due to a suite of rockfish species that recruit as YOYs to platform midwaters and are then able to occupy both midwater and bottom depths;
3) Based on the high densities of juveniles, one of the major functions of the Summerland platforms is as a nursery ground for a suite of species, primarily rockfishes but also including lingcod and painted greenling. Adult fishes (e.g., blacksmith, cabezon, garibaldi, and sheephead) are present, sometimes in substantial numbers, but juvenile rockfish dominance relegates these other species to a relatively small fraction of the total fish population.
4) The densities of fishes in the midwaters of most California platforms vary greatly between years, regardless of platform bottom depth, because juvenile rockfish recruitment varies (sometimes dramatically) between years (Nishimoto and Love 2011). At many shallower platforms (such as those off Summerland) the three habitat assemblages, which share a variety of juvenile rockfish species, are linked and thus fish densities at all depths and habitats may vary greatly interannually.

ANALYSIS OF FISH POPULATIONS AT PLATFORMS OFF SUMMERLAND, CALIFORNIA

Abstract

Using a remotely operated vehicle, surveys were conducted in 2012–2013, around eight platforms off Summerland, California. We conducted 57 transects encompassing 34,389 m^2 of habitat. Over all platforms, we observed 108,303 individual fish, comprising a minimum of 46 species. Rockfishes, of at least 22 species, were most characteristic of all of the assemblages; we observed 105,114 individual rockfishes and this represented 97.1% of all fishes recorded. Rockfishes comprised between 76.8% (shell mounds) and 98.3% (midwaters) of all fishes observed. In particular, YOY rockfishes comprised most of the midwater fish assemblage (94.7% of all fishes observed) and about 20% of the bottom and shell mound assemblages (21.1% and 22.9%, respectively). Of the top ten species ranked by density, all were rockfishes and seven of these taxa were YOY stages. Of particular importance were squarespot, blue, shortbelly, widow, and halfbanded rockfishes, and bocaccio. Among non-rockfish species, lingcod, senorita, painted greenling, shortspine combfish, and blacksmith comprised at least one percent of the assemblages as measured by density.

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We conducted 28 transects on the shell mounds and these transects covered 4,433 m^2. A total of 2,822 fishes, of at least 32 species, were observed. As with the platform bottoms, rockfishes (2,168 individuals of at least 16 species) again dominated the species assemblage; they comprised 76.8% of all fishes observed. Almost 30% of all fishes observed were YOY rockfishes (646 of 2,168). While shell mound fish assemblages were similar across all platforms, we observed relatively small differences between the deeper platforms Habitat, A, and B, and the rest of the structures. However, there was no evidence that the shell mound assemblage of any platform was unique.

The shell mound around Platform B was the most species rich (22 taxa) and that around Habitat (11 species), Henry (11 species), and Hogan (10 species) harbored the fewest taxa. Similar to our observation around platform bottoms, a substantial inter-annual variation in fish densities at several platforms made it difficult to determine if densities varied among platforms. Species that exhibited large interannual differences in densities included calico, halfbanded, shortbelly and squarespot rockfishes YOYs, blue, calico, halfbanded and vermilion rockfishes and California lizardfish. Again, as with platform bottoms, small fishes (of 20 cm or less) were by far most abundant in this habitat at all platforms. Species that characterized this

habitat included calico, halfbanded, squarespot, and vermilion rockfishes, as well as California lizardfish, lingcod (particularly YOYs) and painted greenling.

We observed a total of 100,287 fishes in platform midwaters, composed of at least 28 species. Of these fishes, 98,587 (98.3% of the total) were rockfishes (of 17 species), and 96.4% of these were YOYs. YOY rockfishes dominated this habitat and comprised 94.7% of all fishes observed. Densities of five rockfish species (i.e., blue, bocaccio, shortbelly, squarespot, and widow) greatly exceeded those of other taxa.

We observed between 27 (Platform B) and 14 (Platform Henry) species in the midwaters at the eight platforms. No pattern in species richness among the platforms was observed. Around most platforms, fish densities varied greatly between years and this variability was due to very large interannual differences in YOY recruitment of blue, shortbelly, squarespot, and widow rockfishes, bocaccio and blacksmith. Midwater fish assemblages around these eight platforms were fairly similar – perhaps the greatest differences were within-platform interannual ones driven by this recruitment variability. The overwhelming importance of YOY rockfishes in this habitat explains our observations that almost all of the fishes observed in the platform midwaters were small, 10 cm or less long.

We compared the bottom and shell mound assemblages of the Summerland platforms with previous findings from Platforms Holly and Gilda; these structures are located within the Santa Barbara Channel and are in similar bottom depths. We found that the Summerland fish assemblages are closely related to these two other platforms. Given that the Summerland platforms are arguably in some of the most turbid waters of any California platforms, the implication is that bottom turbidity plays less of a role in structuring fish assemblages as do other habitat characteristics such as bottom depth.

Overall, the data from 2012–2013 found that:

1) The fish assemblages found around the Summerland platforms are similar to those around other platforms situated in the same bottom depths in the Santa Barbara Channel (i.e., Holly and Gilda);

2) There is substantial overlap in the species living in the midwaters, bottoms, and shell mounds on many, if not all, of these relatively shallow water platforms. This is at least partially due to a suite of rockfish species that recruit as YOYs to platform midwaters and are then able to occupy both midwater and bottom depths;

3) Based on the high densities of juveniles, one of the major functions of the Summerland platforms is as a nursery ground for a suite of species, primarily rockfishes but also including lingcod and painted greenling. Adult fishes (e.g., blacksmith, cabezon, garibaldi, and sheephead) are present, sometimes in substantial numbers, but juvenile rockfish dominance relegates these other species to a relatively small fraction of the total fish population.

4) The densities of fishes in the midwaters of most California platforms vary greatly between years, regardless of platform bottom depth, because juvenile rockfish recruitment varies (sometimes dramatically) between years (Nishimoto and Love 2011). At many shallower platforms (such as those off Summerland) the three habitat assemblages, which share a variety of juvenile rockfish species, are linked and thus fish densities at all depths and habitats may vary greatly interannually.

Introduction

The BOEM defines decommissioning as the process of ending oil, gas, or sulfur requirements of the regulations. The BOEM works to ensure that wells are plugged to prevent pollution; that pipelines are decommissioned and sometimes removed to prevent seepage of hydrocarbons and to resolve conflicts with other uses of the OCS; and that all sites are cleared of obstructions to minimize use conflicts. The BOEM will conduct detailed environmental reviews of any proposed decommissioning projects to evaluate the impacts from platform removal on regional fish populations. Obviously, when a platform is disassembled, habitat is removed, and numerous fishes and invertebrates are killed.

The fate of spent offshore platforms off California has been a subject of considerable debate, much of which is focused on the potential importance of fish populations residing at these facilities. These platforms contribute considerable hard structure habitat for marine fishes; providing both a food source and complex physical habitat for fishes in an area that would otherwise be void of such associated fauna. In addition, recent research has shown that oil and gas platforms off the coast of California have the highest secondary fish production per unit area of seafloor of any marine habitat that has been studied (Claisse et al. 2014). The majority of species found on California platforms are rockfishes but include many other groups of fishes including some not well represented on nearby natural reefs or in coastal kelp beds.

The role that each California platform may play as fish habitat must be seen in light of the Secretary of the Department of Commerce's 2000 declaration designating the West Coast groundfish fishery a disaster with extremely small populations remaining. Recent BOEM-funded studies (Love et al. 2005, Love and York 2006, Nishimoto and Love 2011) have revealed that some of the platforms hold large numbers of both juvenile and reproductively mature rockfishes in numbers far greater than any natural reef that has been surveyed. The observed rockfish species include bocaccio and cowcod, both of which are species of concern, with bocaccio once considered for listing as threatened under the Endangered Species Act. Additionally, four more federally declared overfished species have been observed, sometimes in large numbers, at some platforms: canary, darkblotched, widow and yelloweye rockfishes. All of these species are subject to federal rebuilding plans, as specified by the Magnuson-Stevens Fishery Conservation Act. The Pacific Fishery Management Council and the State of California began to severely restrict targeted fishing for these species in 2002 and 2003 and created the Cowcod Conservation Area in southern California to protect that species. Since 2001, cowcod have been managed as a no-retention fishery in California. In addition, the State of California banned the spot prawn trawl fishery in order to eliminate all by-catch of bocaccio. Populations of rockfishes at platforms, and the platforms as habitat for specific life history stages (e.g., nursery habitat for juveniles), may prove to be vital for timely recovery of the regional rockfish populations and fisheries. However, yet unknown are the impacts of platform removal on regional populations of coastal organisms, particularly the economically important rockfish species, on the Pacific 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.

Pacific OCS platforms reside in a variety of depths and oceanographic conditions (Love et al. 2003) and there are large differences in fish assemblages between platforms (Love et al. 2003, Love and York 2006, Nishimoto and Love 2011). Thus, this assemblage variability suggests that a case-by-case scenario is likely for decommissioning decisions. In order to analyze the environmental consequences of platform decommissioning on local or regional fish populations, it is essential to know the role that each platform plays as fish habitat. Data gaps concerning the fish assemblages exist at some of the oldest facilities, yet these facilities may be the first to be decommissioned. Knowledge of the potential importance of the local population at platforms to the depleted Pacific rockfish stocks is essential for fully evaluating the various options proposed for decommissioning California's offshore oil platforms.

The eight platforms within the Dos Cuadras oil field, off Summerland, California (C, B, A, Hillhouse, Henry, Houchin, Hogan, and Habitat) have been in operation for over four decades and are expected to be some of the first to be in line for decommissioning (Figure 1). Problematically, these structures are situated in a depositional, and hence turbid-water, region. In practice, this has meant that, despite a number of attempts over 15 years, water visibility at the bottom of the platform jackets has been judged by the pilots of manned submersibles too poor to safely allow assessment of fish assemblages. However, a review of segments of a remotely operated vehicle (ROV) survey of one of these platforms, indicated that fish populations at these platform habitats could be adequately surveyed using a combination of SCUBA and ROV techniques. The goal of this research was to provide those responsible for making decommissioning decisions with a much more detailed assessment of the fish assemblages of these eight platforms (and by extension a more accurate picture of their ecological importance) than is currently available. Information is needed as soon as possible for the use by the State of California to consider for decommissioning options under the California legislation AB 2503 (the California Marine Resources Legacy Act). The Act requires California to consider reefing OCS oil and gas platforms, if their ecological value warrants, before decommissioning and potential removal. This study will also extend the application of the methodology to develop results applicable

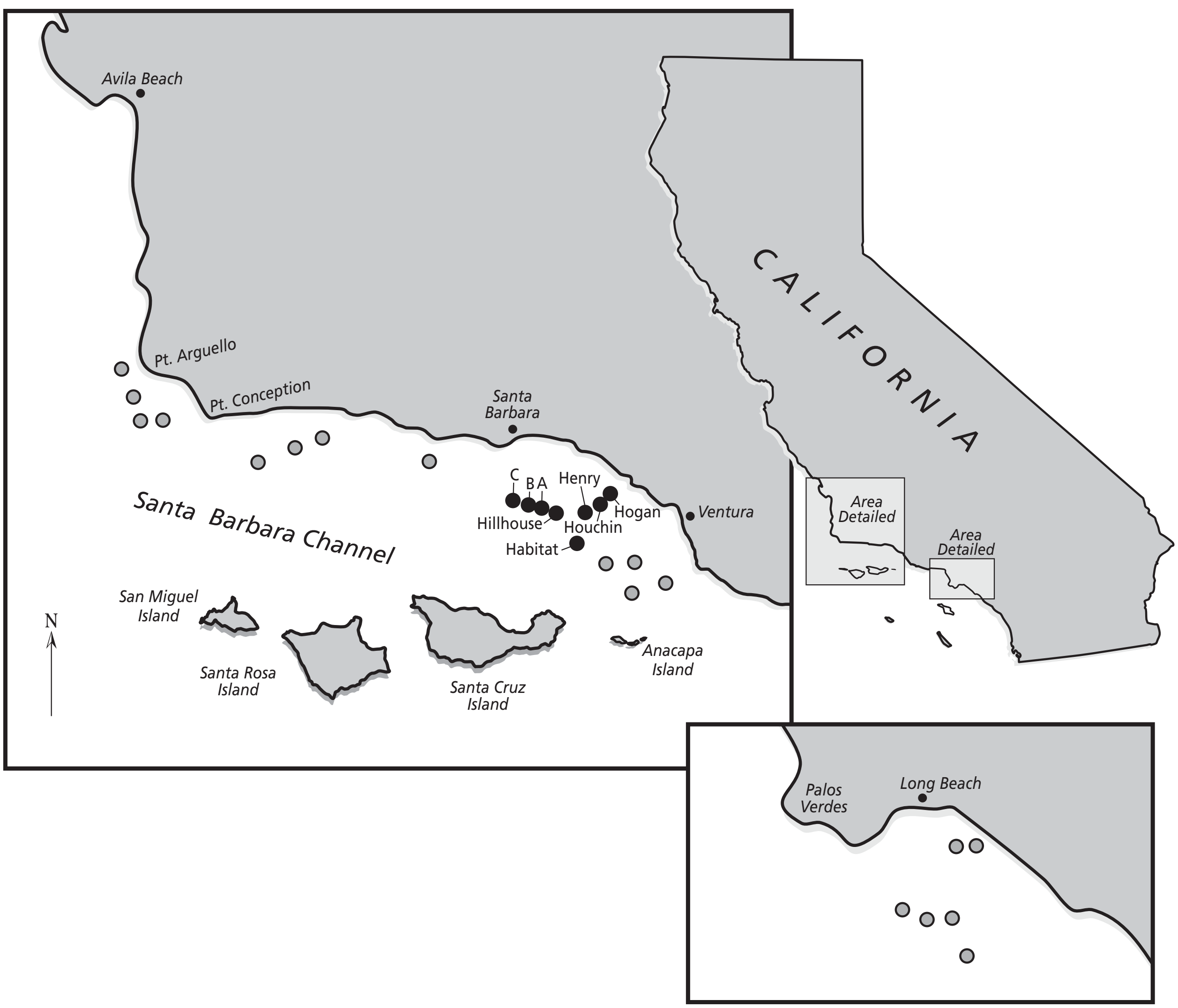


Figure 1. Locations of all oil and gas platforms off California. Study platforms off Summerland, California, are darkened and named.

specifically for BOEM management decisions so that BOEM can specify requirements to industry or other interested parties when decommissioning occurs. Using the results, BOEM can ensure that specified criteria can be properly evaluated during the decommissioning process pursuant to the federal regulations at 30 CFR 250.1730 and the State of California can ensure proper evaluation under the California Rigs-to-Reefs Program law AB 2503 (the California Marine Resources Legacy Act). Thus, the overarching purpose of this research is to provide those responsible for making decommissioning decisions with a much more detailed assessment of the fish assemblages of these eight platforms (and by extension a more accurate picture of their ecological importance) than is currently available.

Methods

The eight platforms were surveyed using two techniques: 1) by divers using scuba in the more shallow areas and 2) with an ROV around the deeper midwaters, platform bottoms, and shell mounds.

ROV Surveys

We conducted fish assemblage surveys around the deeper midwaters, bottom, and surrounding shell mounds of each platform (see Figure 2 for a schematic of a typical platform and Table 1 for bottom depths of platforms) using an ROV leased from Haaland Diving Incorporated of Santa Barbara and launched from the M/V *Danny C*. The *Danny C* is a vessel commonly used by platform operators as a stage for ROV structural inspections and other tasks and has been used by BOEM in past studies. These surveys were conducted during November of 2012 and 2013 (Table 2). As with our previous manned submersible work, but in this case using an ROV, each platform was circled first on the shell mound away from the jacket and then at the bottom of the jacket. As the ROV moved forwards, belt transects were conducted using a high-definition video camera that was oriented to look sideways off the starboard side. Parenthetically, we note that this is identical to the methodology used in previous manned submersible surveys. We conducted belt transects (2 m width) about 2 m from the substrata, while the ROV maintained a speed of about 0.5 knots. ROV surveys were conducted during daylight hours between one hour after sunrise and one hour before sunset. Again, this is identical to other surveys we have conducted around platforms off southern California and thus any effect due to daylight or season on the species, population, or numbers of fish present during surveying is consistent over time. During all transects we identified (to lowest possible taxon), counted, and estimated the lengths of all fishes. Fish lengths were esti-

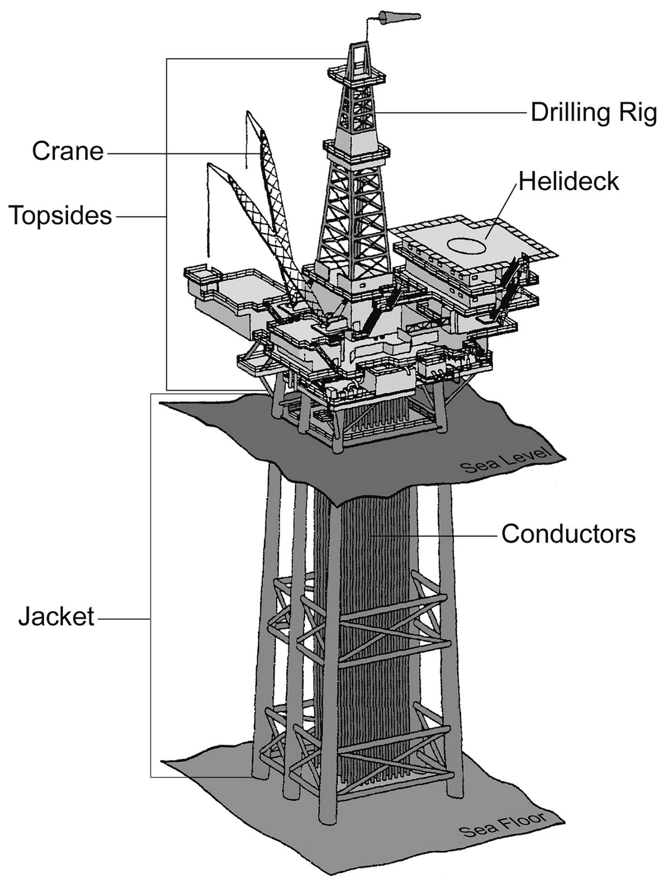


Figure 2. Platform diagram. The platform midwater habitat encompasses the hard substrate of the platform structure from the water surface to 2 m above the seafloor, whereas the platform base habitat is the bottom 2 m of the platform structure. The platform structure consists of outer vertical pilings and horizontal crossbeams (i.e., the platform jacket) and the vertical oil and gas conductors in the center. Note this is a general display diagram and the designs of these structures vary from platform to platform.

Table 1. Bottom depths of platforms discussed in this report.

PLATFORM	DEPTH (M)
A	59
B	60
C	63
Gilda	62
Habitat	88
Henry	55
Hillhouse	59
Hogan	47
Holly	64
Houchin	51

mated using a pair of parallel lasers (20 cm apart) mounted on either side of the external video camera. At least three researchers at a time observed the ROV surveys. All of the surveys were recorded and during each survey, one of the researchers voiced over the recording, identifying (with the help of the other researchers) the fishes observed. In the laboratory, transect data was transcribed into a MS Access database.

Scuba Surveys

For the scuba surveys, we utilized the sampling design and protocols developed to assess platform fish populations in previous Minerals Management Survey-funded research (Love et al. 2003, Nishimoto et al. 2008, Nishimoto and Love 2011). Platform surveys were conducted between June and September, once in 2012 and twice in 2013 (Table 3). For each platform survey, scuba divers recorded observations while swimming rectangular belt transects that incorporated all four corner legs and the major horizontal crossbeams and portions underneath the platform jacket. The transects (2 m width x 2 m height) were conducted along the horizontal cross members at various depths from 6.1–39.0 m (Table 3). Scuba divers identified, counted, and estimated the sizes of all fishes observed with the aid of a ruler on the data recording slate. Observers were trained to visually estimate the total length of fishes to the nearest centimeter. These surveys allowed us to estimate and compare the density (number of individuals per m^2 surveyed) and size distribution of all fishes observed.

Data Analysis

Platform Bottoms and Shell Mounds – Varying proportions of platform base and shell mound habitats were surveyed by one or more dives each year. In some cases a segment of a platform-habitat was surveyed by more than one dive in a year. Dive densities (count/100m2) of each taxon were treated as observations and transformed to the fourth root to satisfy variance homogeneity assumptions for discriminant analyses. To be consistent, we used the same transformation for cluster analysis. Densities for each species were standardized to a mean of zero and standard deviation of one. We used the lda procedure of R 3.1.2 to perform discriminant analysis. The procedure hclust was used for the analysis, along with the average linkage option of the Unweighted Pair-Groups Method for performing the hierarchical agglomerative clustering. The Euclidean method was used for calculating distances. Averages of standardized transformed densities of taxa within high order clusters were calculated for each habitat type. We also summarized the data using untransformed densities for each platform-habitat by year. Note that counts were not included in the summary tables because varying survey coverage of habitats precluded meaningful comparison of counts among platforms, habitats, and years.

Platform Midwaters – Because previous research had demonstrated that the entirety of platform midwater fish assemblages formed a discrete entity (i.e., separate from platform bottoms and shell mounds) we chose to combine the results of the ROV and SCUBA surveys for characterizing midwater fish communities. However because, unlike the scuba surveys, the ROV surveys were not made on platform vertical

Table 2. Location, dates, and depths of ROV surveys of the midwaters, bottoms, and shell mounds of eight oil and gas platforms off Summerland, California, 2012–2013.

2012

	PLATFORM	**DEPTH AT**	
PLATFORM	**DATE**	**TRANSECT TYPE**	**START OF TRANSECT (M)**
A	11 November	Bottom	59
A	11 November	Shell Mound	59
A	13 November	Bottom	59
A	13 November	Midwater	46
B	11 November	Bottom	60
B	11 November	Shell Mound	60
B	11 November	Midwater	56
B	11 November	Midwater	47
C	10 November	Bottom	63
C	10 November	Shell Mound	60
C	10 November	Midwater	60
C	10 November	Midwater	46
C	11 November	Bottom	61
C	12 November	Shell Mound	61
C	12 November	Midwater	57
C	12 November	Midwater	45
Habitat	09 November	Bottom	88
Habitat	09 November	Shell Mound	88
Habitat	09 November	Midwater	68
Habitat	09 November	Midwater	46
Habitat	09 November	Midwater	26
Habitat	13 November	Bottom	90
Habitat	13 November	Shell Mound	89
Habitat	13 November	Midwater	66
Habitat	13 November	Midwater	44
Henry	11 November	Bottom	55
Henry	11 November	Shell Mound	53
Henry	12 November	Bottom	55
Henry	12 November	Shell Mound	55
Henry	12 November	Midwater	39
Hillhouse	11 November	Bottom	59
Hillhouse	11 November	Shell Mound	58
Hillhouse	11 November	Midwater	41
Hillhouse	13 November	Bottom	60
Hillhouse	13 November	Shell Mound	59
Hillhouse	13 November	Midwater	41
Hogan	12 November	Bottom	47
Hogan	12 November	Shell Mound	47
Hogan	12 November	Midwater	35
Houchin	12 November	Bottom	51
Houchin	12 November	Shell Mound	51
Houchin	12 November	Shell Mound	51
Houchin	12 November	Midwater	38

Table 2. (Continued)

2013

PLATFORM	PLATFORM DATE	DEPTH AT TRANSECT TYPE	START OF TRANSECT (M)
A	09 November	Bottom	56
A	09 November	Shell Mound	57
A	09 November	Midwater	56
A	09 November	Midwater	44
B	10 November	Bottom	58
B	10 November	Shell Mound	58
B	10 November	Midwater	56
B	10 November	Midwater	44
C	09 November	Bottom	59
C	09 November	Shell Mound	59
C	09 November	Midwater	56
C	09 November	Midwater	44
C	09 November	Bottom	59
C	09 November	Shell Mound	59
C	09 November	Midwater	55
C	09 November	Midwater	44
Habitat	08 November	Bottom	91
Habitat	08 November	Shell Mound	95
Habitat	08 November	Midwater	57
Habitat	08 November	Midwater	45
Henry	10 November	Bottom	53
Henry	10 November	Shell Mound	53
Henry	10 November	Midwater	46
Henry	10 November	Midwater	38
Henry	11 November	Bottom	52
Henry	11 November	Shell Mound	52
Henry	11 November	Midwater	37
Hillhouse	10 November	Bottom	57
Hillhouse	10 November	Shell Mound	59
Hillhouse	10 November	Midwater	52
Hillhouse	10 November	Midwater	41
Hillhouse	11 November	Bottom	58
Hillhouse	11 November	Shell Mound	57
Hillhouse	11 November	Midwater	39
Hogan	11 November	Bottom	45
Hogan	11 November	Shell Mound	47
Hogan	11 November	Midwater	35
Hogan	11 November	Bottom	44
Hogan	11 November	Shell Mound	45
Hogan	11 November	Midwater	34
Houchin	11 November	Bottom	48
Houchin	11 November	Shell Mound	50
Houchin	11 November	Midwater	37
Houchin	11 November	Bottom	48
Houchin	11 November	Shell Mound	47
Houchin	11 November	Midwater	37

Table 3. Location, dates, and depths of scuba surveys of the midwaters of eight oil and gas platforms off Summerland, California, 2012–2013.

PLATFORM	2012	2013	DEPTHS (M)
A	26 June	6 June, 21 August	7.9, 19.5, 31.7
B	7 July	6 June, 21 August	9.1, 18.3, 31.1
C	27 July, 8 August	18 June, 21 August	7.0, 18.9, 30.5
Habitat	11 July, 27 July	2 July, 29 August	9.1, 24.1, 30.5
Henry	21 June	21 June, 4 September	7.9, 20.7, 36.0
Hillhouse	29 June	27 June, 13 September	6.1, 22.6, 39.0
Hogan	14 June, 18 June	18 June, 29 August	7.6, 20.4, 33.5
Houchin	12 June	2 July, 6 September	10.0, 23.2, 36.6

components, we did not include the vertical components of the scuba surveys. Midwater fish assemblages were analyzed in ways similar to those of platform bottoms and shell mounds with one exception; we did not conduct an inter-platform discriminant analysis. Our rationale for this was the following: Results of all mid-water surveys, regardless of depth or month, made at a platform were combined for each year - resulting in 16 observations. As there are 8 platforms and only 16 observations, only 8 taxa could be used for a discriminant analysis. There was not a meaningful way to choose taxa to include in a discriminant analysis, as many were counted in a majority of the surveys. Thus, we concluded that it would not be useful to conduct a discriminant analysis.

Overall Midwater, Bottom and Shell Mound Comparison – For the discussion, we compared not only all of the Summerland study platforms, but also platforms Holly and Gilda, also located within the Santa Barbara Channel and in the same bottom depth range (Table 1). Unlike the limited observation and species issues we faced with the platform midwaters, because we had a number of years of observations around Holly and Gilda, we were able to conduct an overall discriminant analysis of the species assemblages of these and the Summerland structures (see Discussion).

Results

Overall Summary of Platform Fish Assemblages

During 2012 and 2013, we conducted 57 transects around eight platforms (Figure 1) encompassing 34,389 m2 of habitat (Table 4). Over all platforms, we observed 108,303 individual fish, comprising a minimum of 46 species (Tables 4–6). Rockfishes, of at least 22 species, were most characteristic of all of the assemblages; we observed 105,114 individual rockfishes and this represented 97.1% of all fishes recorded. Rockfishes comprised between 76.8% (shell mounds) and 98.3% (midwaters) of all fishes observed. In particular, YOY rockfishes comprised most of the midwater fish assemblage (94.7% of all fishes observed) and about 20% of the bottom and shell mound assemblages (21.1% and 22.9%, respectively). Of the top ten species ranked by density (Table 6), all were rockfishes and seven of these taxa were YOY stages. Of particular importance were squarespot, blue, shortbelly, widow, and halfbanded rockfishes, and bocaccio. Among non-rockfish species, lingcod, senorita, painted greenling, shortspine combfish, and blacksmith comprised at least one percent of the assemblages as measured by density.

Platform Bottoms

Around platform bottoms, we conducted 29 transects, covering 4,792 m^2 (Table 4). A total of 5,193 fish (a minimum of 34 species) were observed (Table 4). Rockfishes, of a minimum of 19 species and totaling 4,359 individuals (83.9% of all fishes observed) dominated the assemblages. About 25% of all fishes observed were YOY rockfishes (1,098 of 4,359) (Table 4). The bottom fish assemblages were fairly similar

Table 4. A summary of the number of transects, areas surveyed (m²), numbers of fishes, numbers of rockfishes, and number of rockfish YOY from eight platforms, based on scuba and ROV surveys, 2012–2013. YOY = young-of-the-year. Scientific names are listed in Table 3.

	BOTTOM	SHELL MOUND	MIDWATER	TOTAL
Number of transects	29	28	16	57
Area surveyed (m^2)	4,792	4,433	20,432	34,389
Number of fishes counted	5,193	2,822	100,287	108,303
Number of rockfishes counted	4,359	2,168	98,587	105,114
All rockfishes % of all fishes	83.9	76.8	98.3	97.1
Number of rockfish YOY	1,098	646	95,020	96,764
All rockfish YOY % of all rockfishes	25.2	29.8	96.4	92.1
All rockfish YOY % of all fishes	21.1	22.9	94.7	89.3
Minimum number of species	34	32	28	46
Minimum number of rockfish species	19	16	17	22

Table 5. Common and scientific names of fishes observed by scuba or remotely operated vehicle around eight platforms in southern California, 2012–2013.

Black-and-yellow rockfish	*Sebastes chrysomelas*
Blackeye goby	*Rhinogobiops nicholsii*
Blacksmith	*Chromis punctipinnis*
Bluebanded ronquil	*Rathbunella hypoplecta*
Blue rockfish	*Sebastes mystinus*
Bocaccio	*Sebastes paucispinis*
Brown rockfish	*Sebastes auriculatus*
Bull sculpin	*Enophrys taurina*
Cabezon	*Scorpaenichthys marmoratus*
Calico rockfish	*Sebastes dallii*
California lizardfish	*Synodus lucioceps*
California halibut	*Paralichthys californicus*
California sheephead	*Semicossyphus pulcher*
Canary rockfish	*Sebastes pinniger*
Chilipepper	*Sebastes goodei*
Copper rockfish	*Sebastes caurinus*
Cowcod	*Sebastes levis*
Flag rockfish	*Sebastes rubrivinctus*
Garibaldi	*Hypsypops rubicundus*
Gopher rockfish	*Sebastes carnatus*
Grass rockfish	*Sebastes rastrelliger*
Greenspotted rockfish	*Sebastes chlorostictus*
Jack mackerel	*Trachurus symmetricus*
Halfbanded rockfish	*Sebastes semicinctus*
Halfmoon	*Medialuna californiensis*
Honeycomb rockfish	*Sebastes umbrosus*
Kelp bass	*Paralabrax clathratus*
Kelp greenling	*Hexagrammos decagrammus*
Kelp rockfish	*Sebastes atrovirens*
Lingcod	*Ophiodon elongatus*
Longspine combfish	*Zaniolepis latipinnis*
Ocean sunfish	*Mola mola*
Olive rockfish	*Sebastes serranoides*
Opaleye	*Girella nigricans*
Pacific sardine	*Sardinops sagax*
Rubberlip seaperch	*Rhacochilus toxotes*
Pacific hake	*Merluccius productus*
Painted greenling	*Oxylebius pictus*
Pile perch	*Damalichthys vacca*
Pink seaperch	*Zalembius rosaceus*
Rosy rockfish	*Sebastes rosaceus*
Rubberlip seaperch	*Rhacochilus toxotes*
Senorita	*Oxyjulis californica*
Sharpnose seaperch	*Phanerodon atripes*
Shortbelly rockfish	*Sebastes jordani*
Shortspine combfish	*Zaniolepis frenata*
Spotted scorpionfish	*Scorpaena guttata*
Squarespot rockfish	*Sebastes hopkinsi*
Starry flounder	*Platichthys stellatus*
Starry rockfish	*Sebastes constellatus*
Stripefin ronquil	*Sebastes alleni*
Treefish	*Sebastes serriceps*
Unidentified flatfishes	Families Paralicthyidae and Pleuronectidae
Unidentified rockfishes[1]	*Sebastes* spp.
Unidentified ronquil	Family Bathymasteridae
Unidentified sanddab	*Citharichthys* spp.
Unidentified sculpin	Family Cottidae
Unidentified surfperch	Family Embiotocidae
Vermilion rockfish	Likely a combination of vermilion rockfish, *S. miniatus*, and sunset rockfish, *S. crocotulus*
White seaperch	*Phanerodon furcatus*
Widow rockfish	*Sebastes entomelas*
Wolf-eel	*Anarrhichthys ocellatus*
Yelloweye rockfish	*Sebastes ruberrimus*
Yellowtail rockfish	*Sebastes flavidus*

[1]These were primarily unidentified YOY rockfishes and, particularly in the platform midwaters, were members of the "KGB" group, composed of black-and-yellow, copper, gopher, and kelp rockfishes.

Table 6. A summary of the average densities (fish per 100 m^2) of each species observed around eight platforms, based on scuba and ROV surveys, 2012–2013. YOY = young-of-the-year. Scientific names are listed in Table 3.

SPECIES	AVERAGE DENSITY	SPECIES	AVERAGE DENSITY
Squarespot rockfish YOY	38.7	Yellowtail rockfish	0.2
Blue rockfish YOY	34.6	Vermilion rockfish YOY	0.1
Shortbelly rockfish YOY	28.4	Gopher rockfish	0.1
Widow rockfish YOY	18.0	California sheephead	0.1
Unidentified rockfishes YOY	15.3	Kelp bass	0.1
Halfbanded rockfish	13.2	Blackeye goby	0.1
Bocaccio YOY	11.2	Flag rockfish	0.1
Squarespot rockfish	6.3	Gopher rockfish YOY	0.1
Calico rockfish	6.3	White seaperch	0.1
Halfbanded rockfish YOY	5.5	Cabezon	>0.1
Vermilion rockfish	4.9	Chilipepper	>0.1
Calico rockfish YOY	3.9	Rosy rockfish	>0.1
Lingcod YOY	2.5	Unidentified combfishes	>0.1
Senorita	2.3	Rubberlip seaperch	>0.1
Painted greenling	2.3	Longspine combfish	>0.1
Unidentified rockfishes	2.2	Treefish	>0.1
Bocaccio	2.0	Unidentified ronquil	>0.1
Blue rockfish	1.9	Wolf-eel	>0.1
Copper rockfish	1.5	Greenspotted rockfish	>0.1
Olive rockfish	1.4	Unidentified sculpin	>0.1
Shortspine combfish	1.4	Shortbelly rockfish	>0.1
Unidentified sanddab	1.0	Grass rockfish	>0.1
Blacksmith YOY	1.0	Spotted scorpionfish	>0.1
Brown rockfish	0.8	Olive rockfish YOY	>0.1
Pile perch	0.7	Brown rockfish YOY	>0.1
Lingcod	0.7	Yellowtail rockfish YOY	>0.1
Widow rockfish	0.5	Pink seaperch	>0.1
Unidentified fishes	0.5	Pacific sanddab	>0.1
Kelp rockfish	0.5	Canary rockfish	>0.1
Unidentified flatfishes	0.4	Garibaldi	>0.1
Unidentified surfperch	0.4	Black-and-yellow rockfish	>0.1
California lizardfish	0.3	Total	213.3
Blacksmith	0.3		
Kelp greenling	0.3	Minimum Number of Species	46
Painted greenling YOY	0.2	Total Rockfish YOY	156.0
Sharpnosed seaperch	0.2	Total Rockfish	198.3
Sebastomus spp.	0.2	% Rockfish YOY	73.2
Copper rockfish YOY	0.2	% Rockfish	93.0

across all platforms and most different at the deepest (Habitat) and shallowest (Hogan) structures (Figures 3–5, Table 7).

There was a tendency for the mid-depth platforms to harbor the highest number of species; a high of 26 was observed at Platform B and a low of 12 was seen at Hogan (Table 7, Figure 6). On the other hand, the overall density of fishes at various platform bottoms did not vary statistically with bottom depth (Figure 2) because at most platforms overall fish density varied greatly between years (Table 7). This was due primarily to substantial interannual differences in densities linked to quite variable recruitment of YOY squarespot, shortbelly, halfbanded, and calico rockfishes and California lizardfish, as well as changes in densities of somewhat older juvenile squarespot, vermilion, and blue rockfishes and bocaccio. Most of the fishes we observed around platform bottoms were relatively small, about 70% were 15 cm or less (Figure 7). These fishes

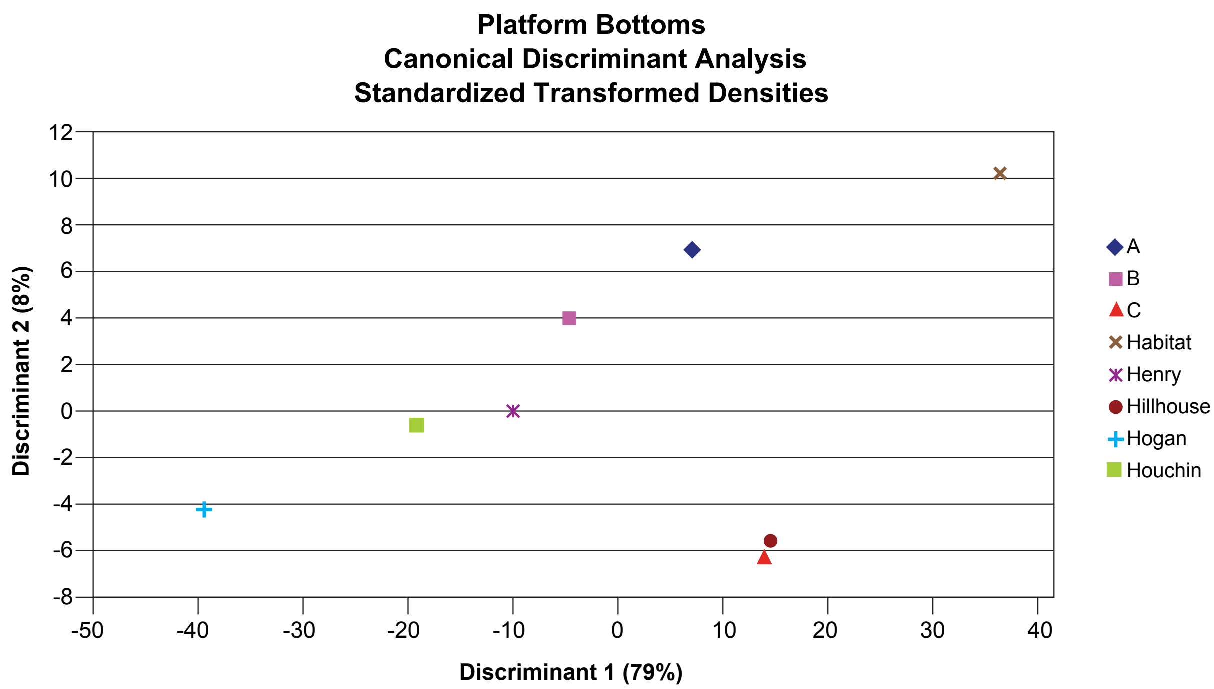


Figure 3. A canonical discriminant analysis of fish assemblages around the bottoms of eight platforms off Summerland, California, based on centroids of surveys conducted in 2012–2013.

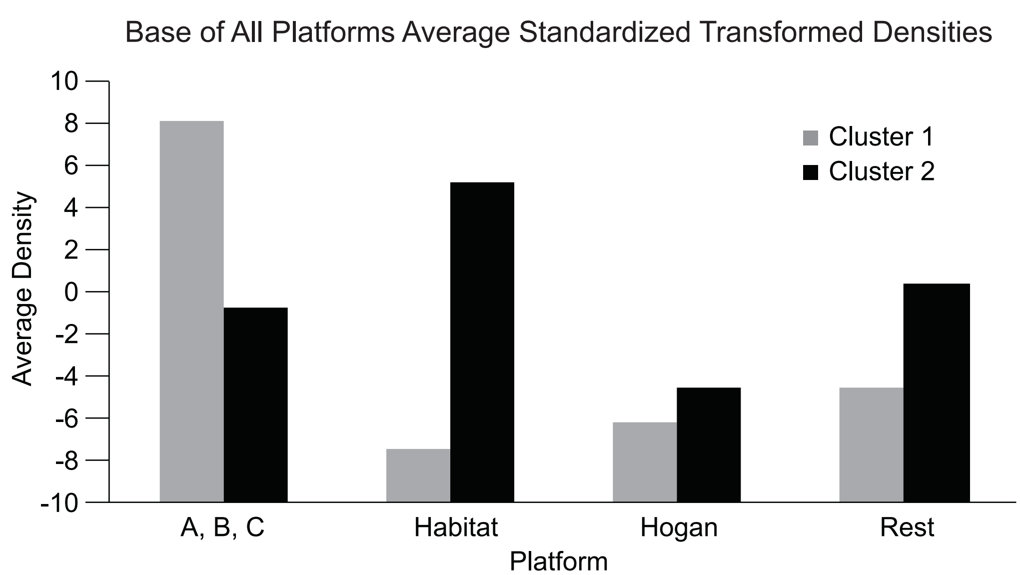


Figure 4. A comparison of densities of two bottom species clusters (Cluster 1 = gopher rockfish to squarespot rockfish; Cluster 2 = flag rockfish to painted greenling) from eight Summerland, California, shown in Figure 5. Note that we do not include the California lizardfish in a cluster as it is composed of one species.

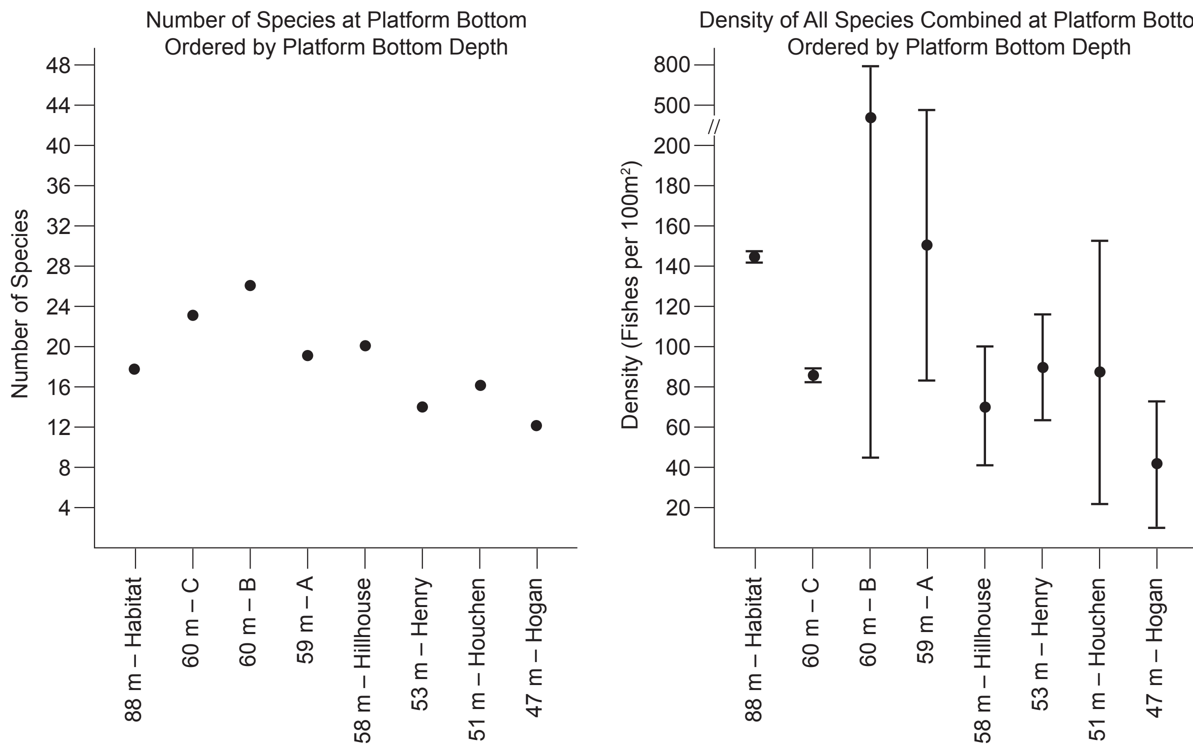


Figure 5. A cluster analysis of the characteristics species of platform bottoms, Summerland, California, 2012–2013.

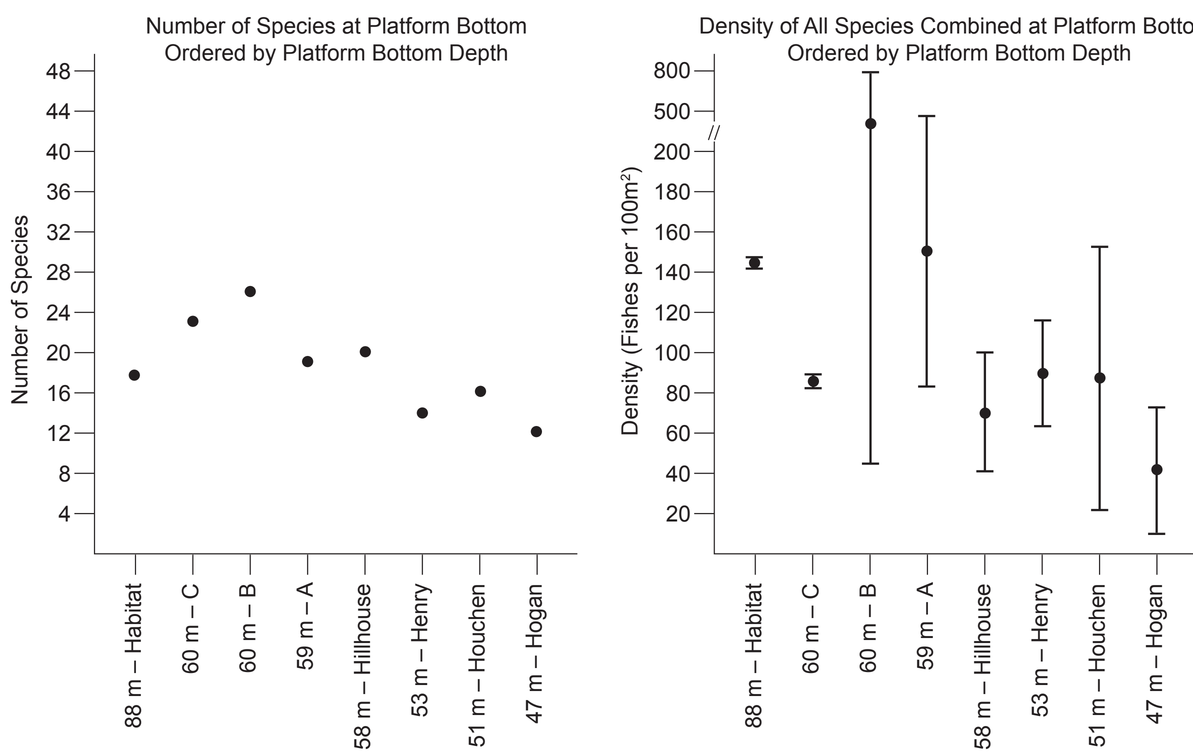


Figure 6. Number of species and density of all species observed at the bottoms of eight platforms off Summerland, California, 2012–2013. Platforms are listed from shallowest to deepest.

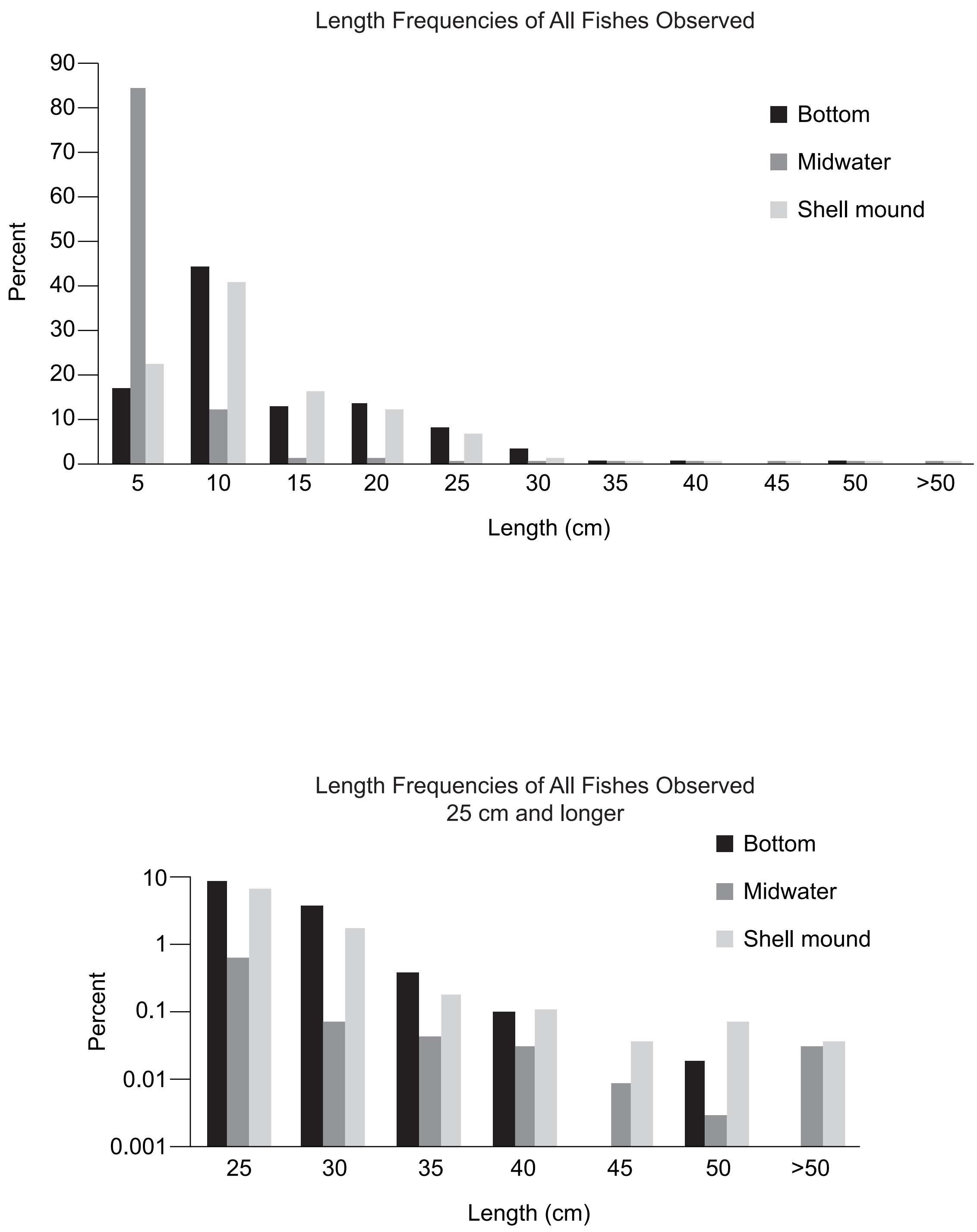


Figure 7. A length-frequency histogram of all fishes observed at platform bottoms, shell mounds, and midwaters around eight platforms off Summerland, California, 2012–2013.

Table 7. Densities of all fishes observed from a remotely operated vehicle around the bottom of eight platforms in the Santa Barbara Channel. Platforms are ordered from westernmost (C) to easternmost (Hogan) with the exception of the more offshore Platform Habitat (listed first). Platform bottom depth is listed after platform name. YOY = young-of-the-year. Density is in fish per 100 m^2. Scientific names are listed in Table 4. Note that counts of fishes are not included in this table because varying survey coverage of this precluded meaningful comparison of counts among platforms, habitats, and years.

PLATFORM HABITAT (DEPTH = 88 M)

	DENSITY			STANDARD ERROR
Species	**2012**	**2013**	**2012–2013**	
Halfbanded rockfish	105.0	125.8	115.4	10.4
Lingcod YOY	16.2	4.7	10.4	5.8
Copper rockfish	4.1	0.9	2.5	1.6
Sebastomus spp.	4.1	0.9	2.5	1.6
Painted greenling	1.8	2.5	2.1	0.3
Flag rockfish	1.5	0.9	1.2	0.3
Unidentified rockfishes	2.3	0.0	1.2	1.2
Calico rockfish	0.3	1.9	1.1	0.8
Lingcod	1.0	0.9	1.0	0.0
Vermilion rockfish	1.3	0.0	0.6	0.6
Unidentified flatfishes	0.0	1.2	0.6	0.6
Greenspotted rockfish	0.5	0.3	0.4	0.1
Unidentified fishes	0.8	1.2	0.4	0.4
Kelp greenling	0.5	0.0	0.3	0.3
Bocaccio	0.0	0.3	0.2	0.2
Cabezon	0.0	0.3	0.2	0.2
Brown rockfish YOY	0.3	0.0	0.1	0.1
Halfbanded rockfish YOY	0.3	0.0	0.1	0.1
Kelp rockfish	0.3	0.0	0.1	0.1
Painted greenling YOY	0.3	0.0	0.1	0.1
Rosy rockfish	0.3	0.0	0.1	0.1
Shortspine combfish	0.3	0.0	0.1	0.1
Unidentified ronquil	0.3	0.0	0.1	0.1
Total	141.3	140.7	141.2	0.3
Minimum number of species	16	10	17	
Total rockfish YOY	0.5	0.0	0.3	
Total rockfishes	120.2	131.1	125.6	
Rockfish YOY % of all fishes surveyed	0.4	0.0	0.2	
All rockfishes % of all fishes surveyed	85.1	93.1	89.1	

PLATFORM C (DEPTH = 63 M)

	DENSITY			STANDARD ERROR
Species	**2012**	**2013**	**2012–2013**	
Calico rockfish	34.7	18.5	26.6	8.1
Squarespot rockfish	4.5	16.1	10.3	5.8
Painted greenling	8.5	3.3	5.9	2.6
Olive rockfish	0.5	9.6	5.0	4.5
Unidentified rockfishes	1.9	7.8	4.8	2.9
Lingcod YOY	7.1	1.8	4.4	2.6
Widow rockfish YOY	0.0	7.2	3.6	3.6
Vermilion rockfish	3.8	3.3	3.5	0.2
Copper rockfish	3.1	2.7	2.9	0.2
Widow rockfish	0.0	4.5	2.2	2.2

Table 7. (Continued)

		DENSITY		STANDARD ERROR
Species	**2012**	**2013**	**2012–2013**	
Pile perch	3.8	0.9	2.1	1.2
Calico rockfish YOY	3.8	0.0	1.9	1.9
Unidentified fishes	1.2	1.8	1.5	0.3
Lingcod	0.9	1.5	1.4	0.4
Bocaccio	0.2	1.5	0.9	0.6
Gopher rockfish	0.2	1.5	0.9	0.6
Brown rockfish	0.7	0.9	0.8	0.1
Blue rockfish	0.5	0.9	0.7	0.2
Kelp greenling	0.7	0.6	0.7	0.1
Halfbanded rockfish	0.9	0.3	0.6	0.3
Copper rockfish YOY	0.7	0.0	0.4	0.4
Kelp rockfish	0.7	0.0	0.4	0.4
Sharpnose seaperch	0.7	0.0	0.4	0.4
Shortbelly rockfish	0.7	0.0	0.4	0.4
Unidentified rockfishes YOY	0.7	0.0	0.3	0.4
Treefish	0.2	0.3	0.3	0.0
Painted greenling YOY	0.5	0.0	0.2	0.2
Sebastomus spp.	0.5	0.0	0.2	0.2
Unidentified surfperch	0.5	0.0	0.2	0.2
Chilipepper	0.0	0.3	0.1	0.1
Olive rockfish YOY	0.0	0.3	0.1	0.1
Blackeye goby	0.2	0.0	0.1	0.1
Canary rockfish	0.2	0.0	0.1	0.1
Halfbanded rockfish YOY	0.2	0.0	0.1	0.1
Shortbelly rockfish YOY	0.2	0.0	0.1	0.1
Total	82.7	85.7	84.2	1.5
Minimum number of species	22	18	23	
Total rockfish YOY	5.7	7.5	6.6	
Total rockfishes	59.1	75.6	67.3	
Rockfish YOY %				
of all fishes surveyed	6.9	8.7	7.8	
All rockfishes %				
of all fishes surveyed	71.4	88.2	79.9	

PLATFORM B (DEPTH = 60 M)

		DENSITY		STANDARD ERROR
Species	**2012**	**2013**	**2012–2013**	
Squarespot rockfish	125.4	4.2	64.8	60.6
Squarespot rockfish YOY	111.3	0.0	55.7	55.7
Shortspine combfish	65.5	0.0	32.7	32.7
Shortbelly rockfish YOY	40.9	0.0	20.5	20.5
Unidentified rockfishes YOY	18.3	0.7	9.5	8.8
Calico rockfish	12.1	6.1	9.1	3.0
Vermilion rockfish	6.9	9.6	8.3	1.4
Widow rockfish YOY	1.0	12.2	6.6	5.6
Olive rockfish	2.0	9.9	5.9	4.0
Halfbanded rockfish	8.5	0.0	4.3	4.3
Lingcod YOY	4.3	4.0	4.1	0.1
Painted greenling	6.2	1.6	3.9	2.3
Bocaccio	0.0	6.3	3.2	3.2

Table 7. (Continued)

		DENSITY		STANDARD ERROR
Species	**2012**	**2013**	**2012–2013**	
Widow rockfish	0.7	5.4	3.0	2.4
Unidentified rockfishes	0.7	4.7	2.7	2.0
Copper rockfish	0.0	4.2	2.1	2.1
Halfbanded rockfish YOY	3.9	0.0	2.0	2.0
Pile perch	2.6	0.5	1.5	1.1
Blue rockfish	1.6	0.9	1.3	0.3
Unidentified fishes	1.3	0.9	1.1	0.2
Calico rockfish YOY	2.0	0.0	1.0	1.0
Yellowtail rockfish	0.0	1.9	0.9	0.9
Lingcod	0.3	1.4	0.9	0.5
Unidentified surfperch	1.6	0.0	0.8	0.8
Brown rockfish	0.7	0.9	0.8	0.1
Kelp rockfish	0.7	0.0	0.7	0.0
Kelp greenling	1.3	0.0	0.7	0.7
Gopher rockfish	0.7	0.5	0.6	0.1
Unidentified sanddab	0.0	0.9	0.5	0.5
Grass rockfish	0.7	0.0	0.3	0.3
Sharpnose seaperch	0.7	0.0	0.3	0.3
California lizardfish	0.0	0.5	0.2	0.2
Blackeye goby	0.3	0.0	0.2	0.2
Painted greenling YOY	0.3	0.0	0.2	0.2
Rosy rockfish	0.3	0.0	0.2	0.2
Rubberlip seaperch	0.3	0.0	0.2	0.2
Total	423.1	78.2	250.6	172.4
Minimum number of species	19	17	26	
Total rockfish YOY	177.5	12.9	95.2	
Total rockfishes	338.3	68.4	203.3	
Rockfish YOY % of all fishes surveyed	42.0	16.5	38.0	
All rockfish % of all fishes surveyed	80.0	87.4	81.1	

PLATFORM A (DEPTH = 59 M)

		DENSITY		STANDARD ERROR
Species	**2012**	**2013**	**2012–2013**	
Vermilion rockfish	103.7	11.1	57.4	46.3
Squarespot rockfish	4.5	25.6	15.1	10.5
Copper rockfish	17.5	9.4	13.4	4.0
Blue rockfish	25.4	0.9	13.1	12.3
Bocaccio	20.9	0.4	10.6	10.2
Calico rockfish	1.1	16.6	8.9	7.8
Brown rockfish	7.3	4.3	5.8	1.5
Calico rockfish YOY	6.2	0.0	3.1	3.1
Unidentified rockfishes	2.3	3.4	2.8	0.6
Squarespot rockfish YOY	5.1	0.4	2.2	2.3
Olive rockfish	3.4	1.3	2.3	1.1
Widow rockfish	2.3	2.1	2.2	0.1
Kelp rockfish	3.9	0.4	2.2	1.8
Unidentified surfperch	3.4	0.4	1.9	1.5
Painted greenling	1.1	1.7	1.4	0.3

Table 7. (Continued)

Species	DENSITY 2012	2013	2012–2013	STANDARD ERROR
Halfbanded rockfish YOY	1.7	0.0	0.8	0.6
Pile Perch	1.7	0.4	1.1	0.6
Lingcod	0.0	1.7	0.9	0.9
Widow rockfish YOY	0.0	1.7	0.9	0.9
Painted greenling YOY	1.1	0.4	0.8	0.4
Sharpnose seaperch	1.1	0.0	0.6	0.6
Unidentified rockfish YOY	1.1	0.0	0.6	0.6
Kelp greenling	0.6	0.4	0.5	0.1
Lingcod YOY	0.6	0.4	0.5	0.1
Treefish	0.0	0.9	0.4	0.4
Gopher rockfish	0.6	0.0	0.3	0.3
Rubberlip seaperch	0.6	0.0	0.3	0.3
Unidentified fishes	0.0	0.4	0.2	0.2
Total	217.0	84.9	151.0	66.1
Minimum number of species	18	16	19	
Total rockfish YOY	14.1	2.6	8.8	
Total rockfishes	206.9	78.9	142.9	
Rockfish YOY % of all fishes surveyed	6.5	3.0	5.5	
All rockfishes % of all fishes surveyed	95.3	93.0	94.7	

PLATFORM HILLHOUSE (DEPTH = 59 M)

Species	DENSITY 2012	2013	2012–2013	STANDARD ERROR
Calico rockfish	37.1	13.4	25.2	11.8
Olive rockfish	7.9	7.5	7.7	0.2
Copper rockfish	12.1	0.3	6.2	5.9
Painted greenling	10.0	1.9	5.9	4.1
Unidentified rockfishes	10.3	6.6	8.4	1.4
Vermilion rockfish	5.6	1.2	3.1	1.9
Lingcod YOY	5.3	0.9	3.1	2.2
Halfbanded rockfish	0.3	5.6	3.0	2.7
Blue rockfish	4.4	0.0	2.2	2.2
Lingcod	1.2	2.2	1.7	0.5
Unidentified fishes	2.4	0.9	1.6	0.7
Calico rockfish YOY	2.4	0.0	1.2	1.2
Unidentified surfperch	2.4	0.0	1.2	1.2
Brown rockfish	1.8	0.0	0.9	0.9
Kelp rockfish	1.8	0.0	0.9	0.9
Pile perch	1.8	0.0	0.9	0.9
Squarespot rockfish	0.0	1.6	0.8	0.8
White seaperch	1.5	0.0	0.7	0.7
Unidentified sanddab	0.0	1.2	0.6	0.6
Kelp greenling	0.9	0.3	0.6	0.3
California lizardfish	0.0	0.6	0.3	0.3
Flag rockfish	0.0	0.6	0.3	0.3
Yellowtail rockfish	0.0	0.6	0.3	0.3
Unidentified flatfishes	0.0	0.3	0.2	0.2
Unidentified sculpin	0.0	0.3	0.2	0.2

Table 7. (Continued)

Species	2012	DENSITY 2013	2012–2013	STANDARD ERROR
Halfbanded rockfish YOY	0.3	0.0	0.1	0.1
Rosy rockfish	0.3	0.0	0.1	0.1
Sebastomus spp.	0.3	0.0	0.1	0.1
Total	104.5	42.5	73.5	31.0
Minimum number of species	14	14	20	
Total rockfish YOY	2.6	0.0	1.3	
Total rockfishes	79.2	33.7	56.4	
Rockfish YOY % of all fishes surveyed	2.5	0.0	1.8	
All rockfishes % of all fishes surveyed	75.8	79.4	76.8	

PLATFORM HENRY (DEPTH = 55 M)

SPECIES	2012	DENSITY 2013	2012–2013	STANDARD ERROR
Halfbanded rockfish YOY	35.8	0.0	17.9	17.9
Squarespot rockfish	2.4	23.1	12.8	10.4
Calico rockfish	18.9	6.3	12.6	6.3
Calico rockfish YOY	24.1	0.0	12.1	12.1
Unidentified rockfishes	2.0	9.8	5.9	3.9
Lingcod YOY	8.0	2.8	5.4	2.6
Halfbanded rockfish	8.4	0.0	4.2	4.2
Painted greenling	5.6	1.4	3.5	2.1
Olive rockfish	0.0	5.3	2.6	2.6
Unidentified rockfishes YOY	3.2	0.0	1.6	2.1
Widow rockfish	0.0	2.8	1.4	1.6
Lingcod	0.0	3.9	1.9	1.9
Unidentified rockfishes	3.2	0.0	1.6	1.6
Widow rockfish YOY	0.0	2.8	1.4	1.4
California lizardfish	0.0	2.1	1.1	1.1
Brown rockfish	0.8	0.0	0.4	0.4
Painted greenling YOY	0.4	0.4	0.4	0.0
Unidentified sanddab	0.0	0.7	0.4	0.4
Sebastomus spp.	0.4	0.0	0.2	0.2
Squarespot rockfish YOY	0.4	0.0	0.2	0.2
Unidentified ronquil	0.5	0.0	0.2	0.2
Vermilion rockfish	0.5	0.0	0.2	0.2
Wolf-eel	0.5	0.0	0.2	0.2
Unidentified fishes	0.0	0.4	0.2	0.2
Total	111.8	63.0	87.4	24.4
Minimum number of species	10	8	14	
Total rockfish YOY	63.5	2.8	33.2	
Total rockfishes	96.9	51.5	74.2	
Rockfish YOY % of all fishes surveyed	56.8	4.4	37.9	
All rockfishes % of all fishes surveyed	86.7	81.7	84.9	

Table 7. (Continued)

PLATFORM HOUCHIN (DEPTH = 51 M)

		DENSITY		STANDARD ERROR
Species	**2012**	**2013**	**2012–2013**	
Halfbanded rockfish YOY	84.5	0.0	42.2	42.2
Calico rockfish YOY	37.9	0.0	19.0	19.0
Calico rockfish	6.4	3.9	5.2	1.3
Painted greenling	5.7	2.5	4.1	1.6
Lingcod YOY	3.6	2.5	3.0	0.5
Yellowtail rockfish	0.0	3.3	1.7	1.7
Unidentified surfperch	2.9	0.0	1.4	1.4
Halfbanded rockfish	1.4	1.1	1.3	0.2
Pile perch	2.1	0.3	1.2	0.9
Unidentified fishes	0.7	0.6	0.6	0.1
California lizardfish	0.0	0.8	0.4	0.4
Blackeye goby	0.7	0.0	0.4	0.4
Kelp greenling	0.7	0.0	0.4	0.4
Lingcod	0.7	0.0	0.4	0.4
Olive rockfish	0.7	0.0	0.4	0.4
White seaperch	0.7	0.0	0.4	0.4
Copper rockfish	0.0	0.3	0.1	0.1
Squarespot rockfish	0.0	0.3	0.1	0.1
Unidentified combfish	0.0	0.3	0.1	0.1
Unidentified flatfish	0.0	0.3	0.1	0.1
Unidentified rockfishes	0.0	0.3	0.1	0.1
Unidentified sanddab	0.0	0.3	0.1	0.1
Widow rockfish YOY	0.0	0.3	0.1	0.1
Total	148.9	16.9	82.9	66.0
Minimum number of species	8	12	16	
Total rockfish YOY	122.4	0.3	61.3	
Total rockfishes	131.0	9.4	70.2	
Rockfish YOY % of all fishes surveyed	82.2	1.6	74.0	
All rockfishes % of all fishes surveyed	88.0	55.7	84.7	

PLATFORM HOGAN (DEPTH = 47 M)

		DENSITY		STANDARD ERROR
Species	**2012**	**2013**	**2012–2013**	
Calico rockfish YOY	37.0	0.3	18.6	18.4
Calico rockfish	16.8	0.9	8.8	7.9
Halfbanded rockfish YOY	9.8	0.0	4.9	4.9
Pile perch	3.5	0.3	1.9	1.6
Unidentified rockfishes YOY	2.1	0.3	1.2	0.9
Unidentified rockfishes	1.4	0.3	0.8	0.6
California lizardfish	0.0	1.5	0.7	0.7
Halfbanded rockfish	1.4	0.0	0.7	0.7
Unidentified fishes	1.4	0.0	0.7	0.7
Vermilion rockfish	0.0	0.9	0.4	0.4
Gopher rockfish	0.7	0.0	0.3	0.3
Olive rockfish	0.7	0.0	0.3	0.3
Squarespot rockfish	0.7	0.0	0.3	0.3
Lingcod YOY	0.0	0.6	0.3	0.3

Table 7. (Continued)

	DENSITY			STANDARD ERROR
Species	**2012**	**2013**	**2012–2013**	
Brown rockfish	0.0	0.3	0.1	0.1
Kelp greenling	0.0	0.3	0.1	0.1
Painted greenling	0.0	0.3	0.1	0.1
Painted greenling YOY	0.0	0.3	0.1	0.1
Total	75.4	6.1	40.7	34.6
Minimum number of species	6	9	12	
Total rockfish YOY	48.9	0.6	24.7	
Total rockfishes	70.5	2.9	36.7	
Rockfish YOY % of all fishes surveyed	64.8	9.5	60.7	
All rockfishes % of all fishes surveyed	93.5	47.6	90.1	

were either juvenile fishes (e.g., calico, copper, halfbanded, squarespot, and vermilion rockfishes, bocaccio, and lingcod) or were dwarf species such as halfbanded and calico rockfishes.

Platform Shell Mounds

We conducted 28 transects on the shell mounds and these transects covered 4,433 m^2 (Table 4). A total of 2,822 fishes, of at least 32 species, were observed (Tables 4, 8). As with the platform bottoms, rockfishes (2,168 individuals of at least 16 species) again dominated the species assemblage; they comprised 76.8% of all fishes observed. Almost 30% of all fishes observed were YOY rockfishes (646 of 2,168) (Table 4). While shell mound fish assemblages were similar across all platforms (Figure 8), we observed relatively small differences between the deeper platforms Habitat, A, and B, and the rest of the structures (Figures 9, 10 and Table 8). However, there was no evidence that the shell mound assemblage of any platform was unique.

The shell mound around Platform B was the most species rich (22 taxa) and that around Habitat (11 species), Henry (11 species), and Hogan (10 species) harbored the fewest taxa (Figure 7). Similar to our observation around platform bottoms, a substantial inter-annual variation in fish densities at several platforms made it difficult to determine if densities varied among platforms (Table 8). Species that exhibited large interannual differences in densities included calico, halfbanded, shortbelly and squarespot rockfishes YOYs, blue, calico, halfbanded and vermilion rockfishes and California lizardfish. Again, as with platform bottoms, small fishes (of 20 cm or less) were by far most abundant in this habitat at all platforms (Figure 11). Species that characterized this habitat included calico, halfbanded, squarespot, and vermilion rockfishes, as well as California lizardfish, lingcod (particularly YOYs) and painted greenling.

Platform Midwaters

We observed a total of 100,287 fishes in platform waters, composed of at least 28 species. Of these fishes, 98,587 (98.3% of the total) were rockfishes (of 17 species), and 96.4% of these were YOYs (Table 4). YOY rockfishes dominated this habitat and comprised 94.7% of all fishes observed. Densities of five rockfish species (i.e., blue, bocaccio, shortbelly, squarespot, and widow) greatly exceeded those of other taxa (Table 9).

We observed between 27 (Platform B) and 14 (Platform Henry) species at the eight platforms. No pattern in species richness among the platforms was observed. Around most platforms, fish densities varied greatly between years (Table 9, Figure 12) and this variability was due to very large interannual differences in YOY recruitment of blue, shortbelly, squarespot, and widow rockfishes, bocaccio and blacksmith. Midwater fish assemblages around these eight platforms were fairly similar – perhaps the greatest differences were

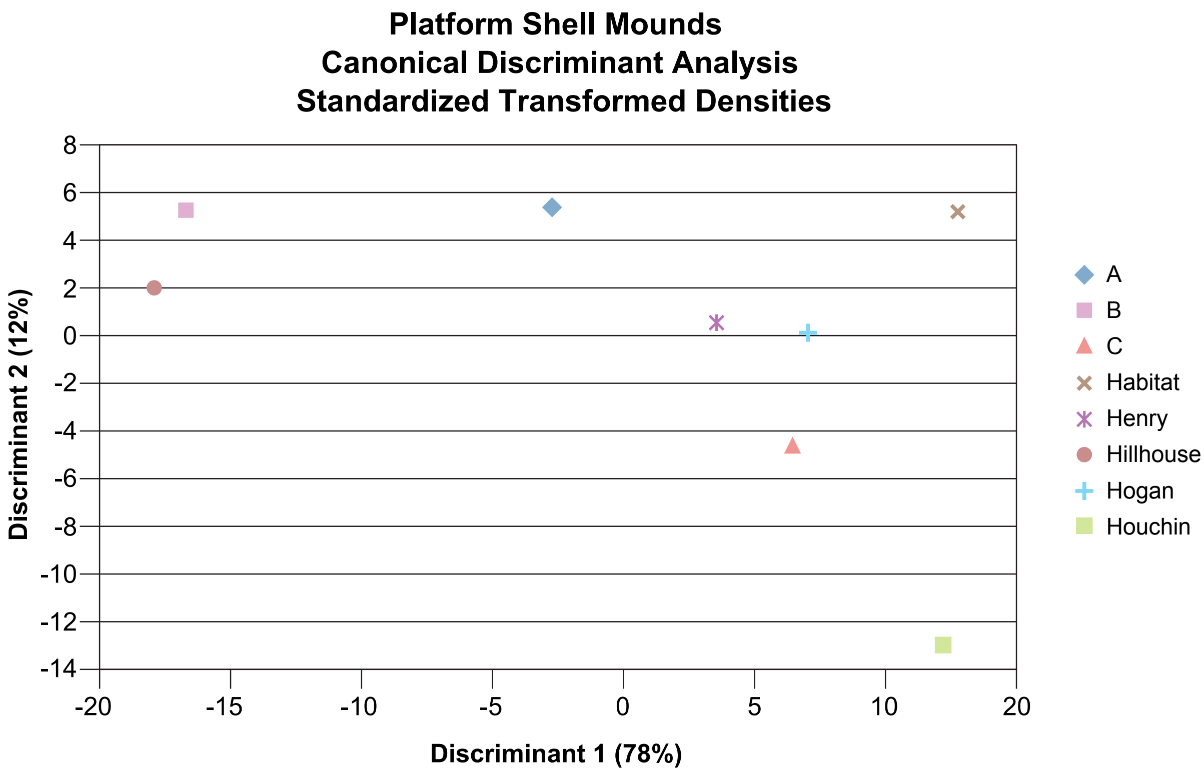


Figure 8. A canonical discriminant analysis of platform shell mound fish assemblages around eight platforms off Summerland, California, based on centroids of surveys conducted in 2012–2013.

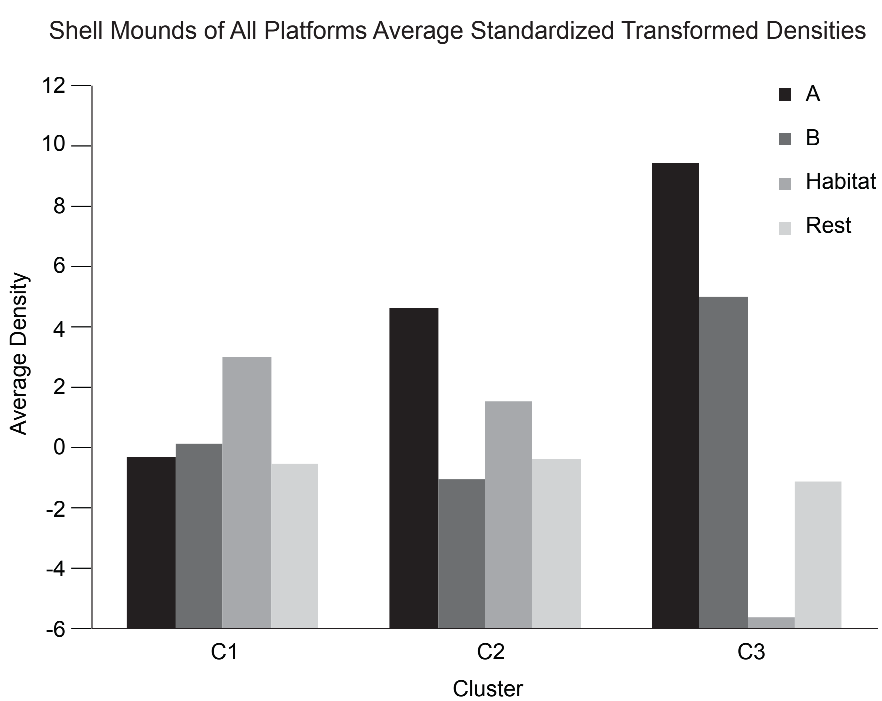


Figure 9. A comparison of densities of three species clusters on shell mounds around eight platforms off Summerland, California, shown in Figure 10.

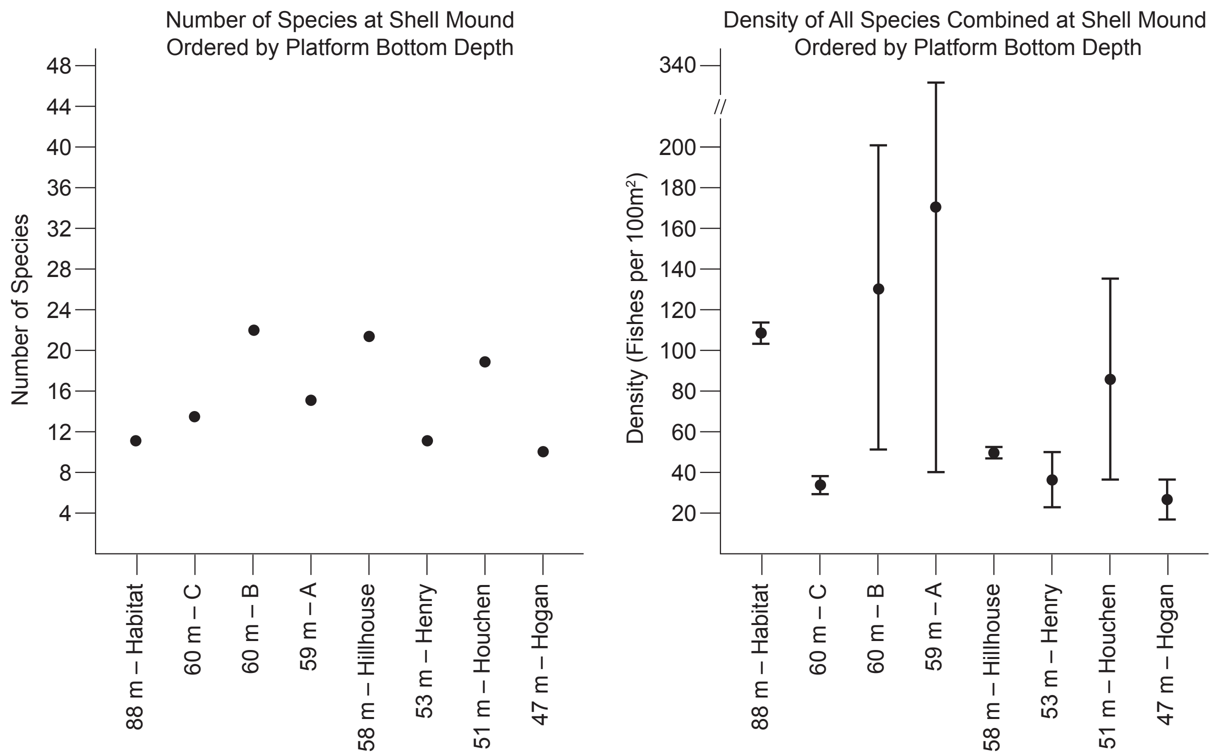


Figure 10. A cluster analysis of the characteristics species of shell mounds around eight platforms off Summerland, California, 2012–2013.

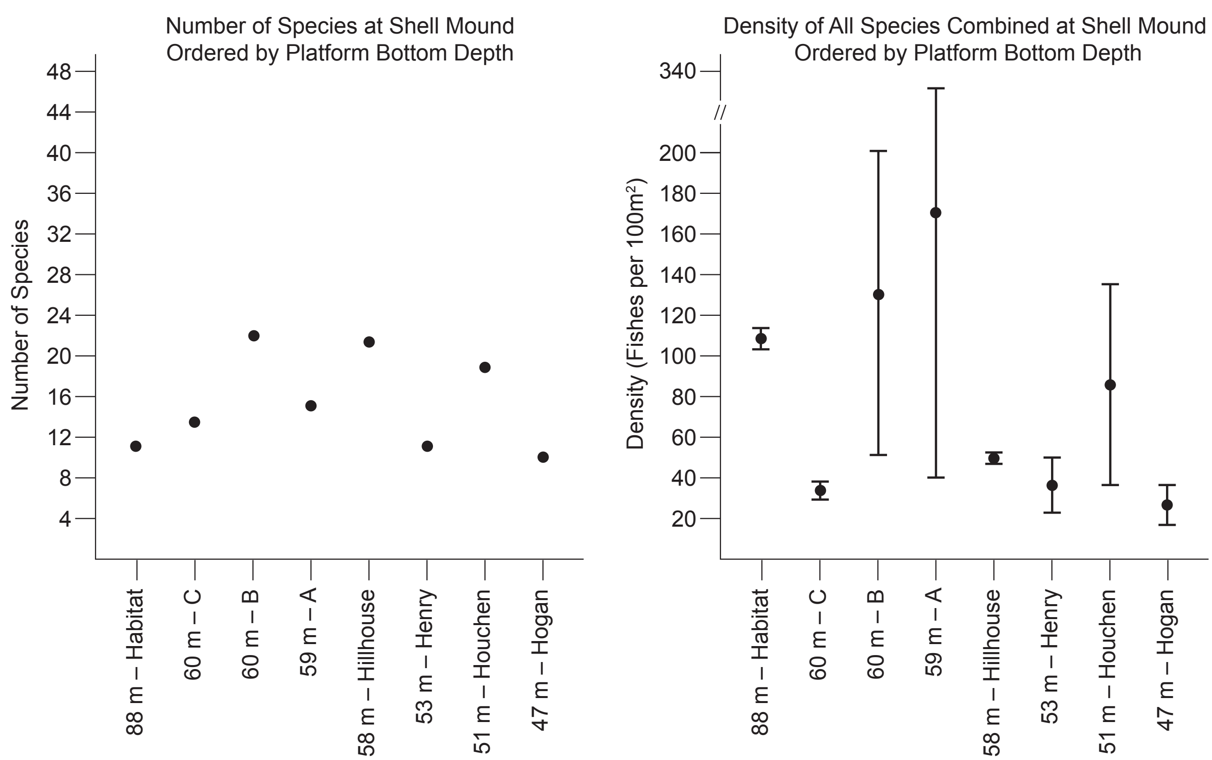


Figure 11. Number of species and density of all species observed on the shell mounds of eight platforms, 2012–2013. Platforms are listed from shallowest to deepest

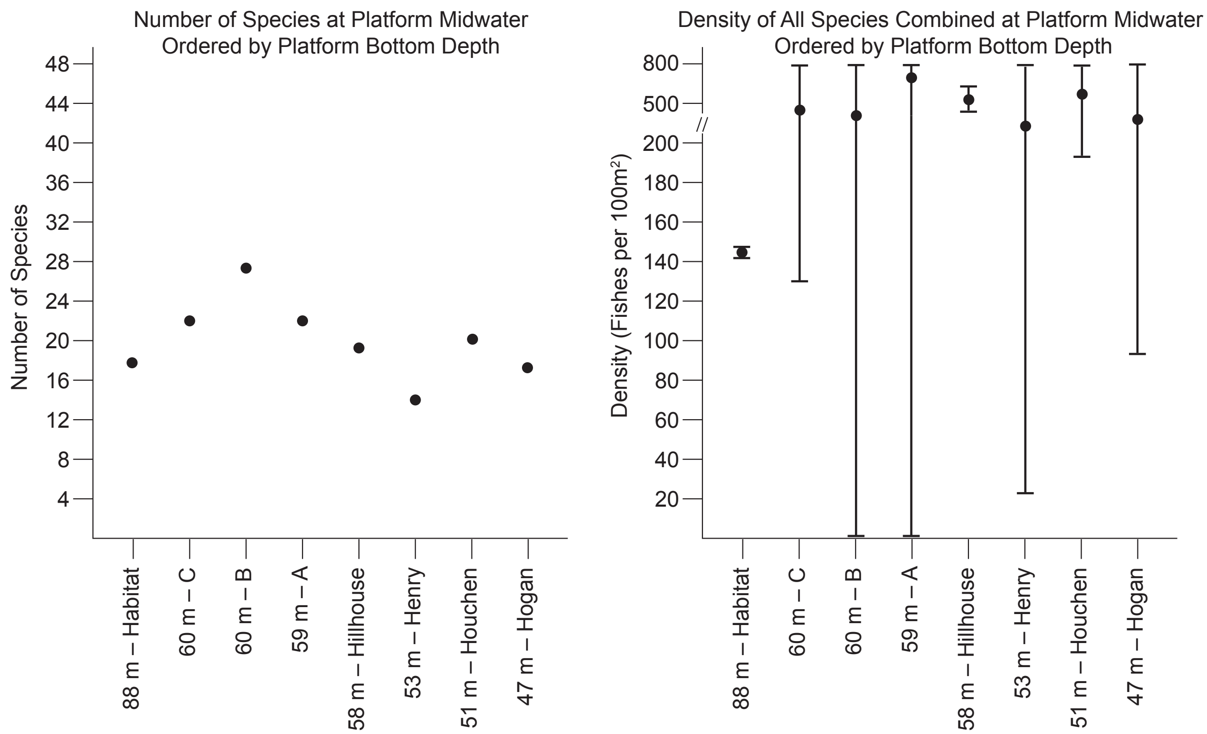


Figure 12. Number of species and density of all species observed in the midwaters of eight platforms off Summerland, California, 2012–2013. Platforms are listed from shallowest to deepest.

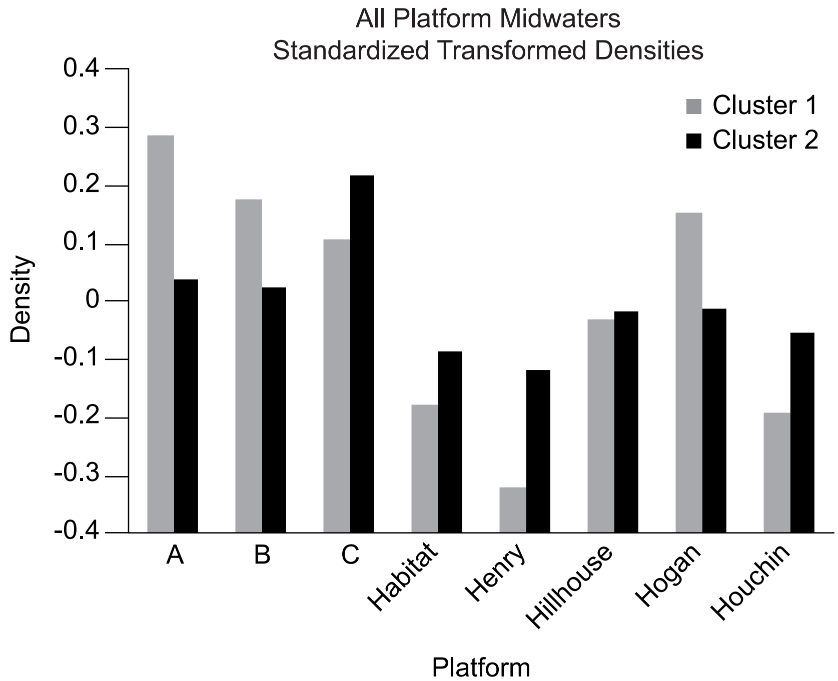
within-platform interannual ones driven by this recruitment variability (Figures 13, 14). The overwhelming importance of YOY rockfishes in this habitat explains our observations that almost all of the fishes observed in the platform midwaters were small, 10 cm or less long.

Discussion

The goal of this research was to provide a more detailed assessment of the fish assemblages at the eight platforms off Summerland, California; platforms that are situated in a turbid area that precludes surveys with manned submersibles. Here we discuss 1) the species assemblages of these eight platforms and 2) compare how the results of this study dovetails with results from some other platforms.

Previous work (Love et al. 1999a, b, Love and Nishimoto 2012) demonstrated that around most or all California platforms there are two distinct fish assemblages; one found in the midwaters above the bottom and another formed by the platform bottom and adjacent shell mound. Thus shell mounds usually do not harbor distinct fish assemblages, but rather these assemblages have a number of attributes in common with those of platform bottoms. In addition, Love et al. (1999a) and Love and Nishimoto (2012) found that, among California platforms, the shell mound assemblage was sometimes more similar to the bottom of its adjacent platform than to other shell mounds. In the current study, we again found that the bottom and shell mound assemblages shared many of the same species across all platforms and that the two habitats were often very similar (Figure 15).

Across the range of the eight platforms, what species were most characteristic of this bottom-shell mound habitat? While there was some variability between platforms, this assemblage was primarily composed of a suite of juveniles and adults of dwarf species (i.e. calico, halfbanded, and squarespot rockfishes and painted greenling) and juveniles of species that grow relatively large (i.e., copper and vermilion rockfishes) and lingcod. Thus, this was an assemblage comprised primarily of small fishes (Figure 7). Why might



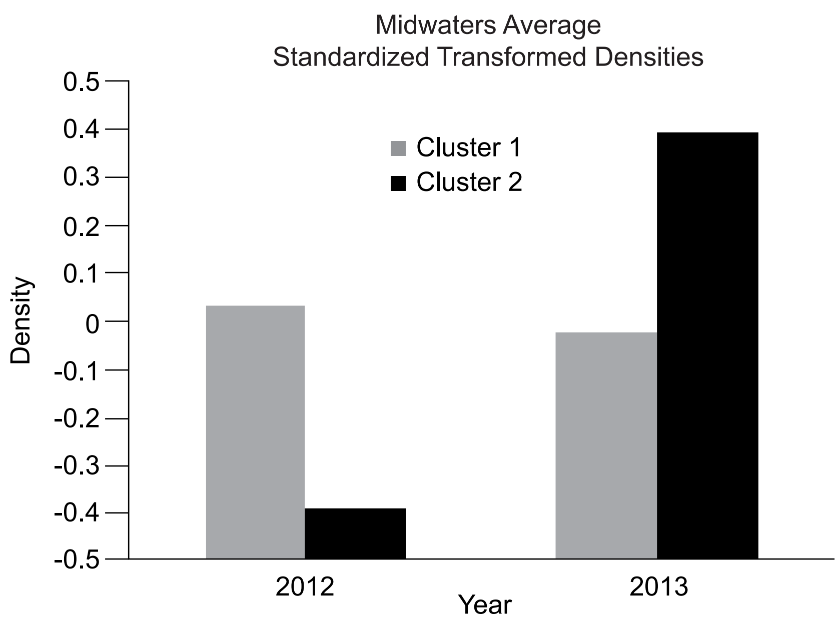


Figure 13. A comparison of densities of two midwater species clusters at eight platforms off Summerland, California, shown in Figure 13.

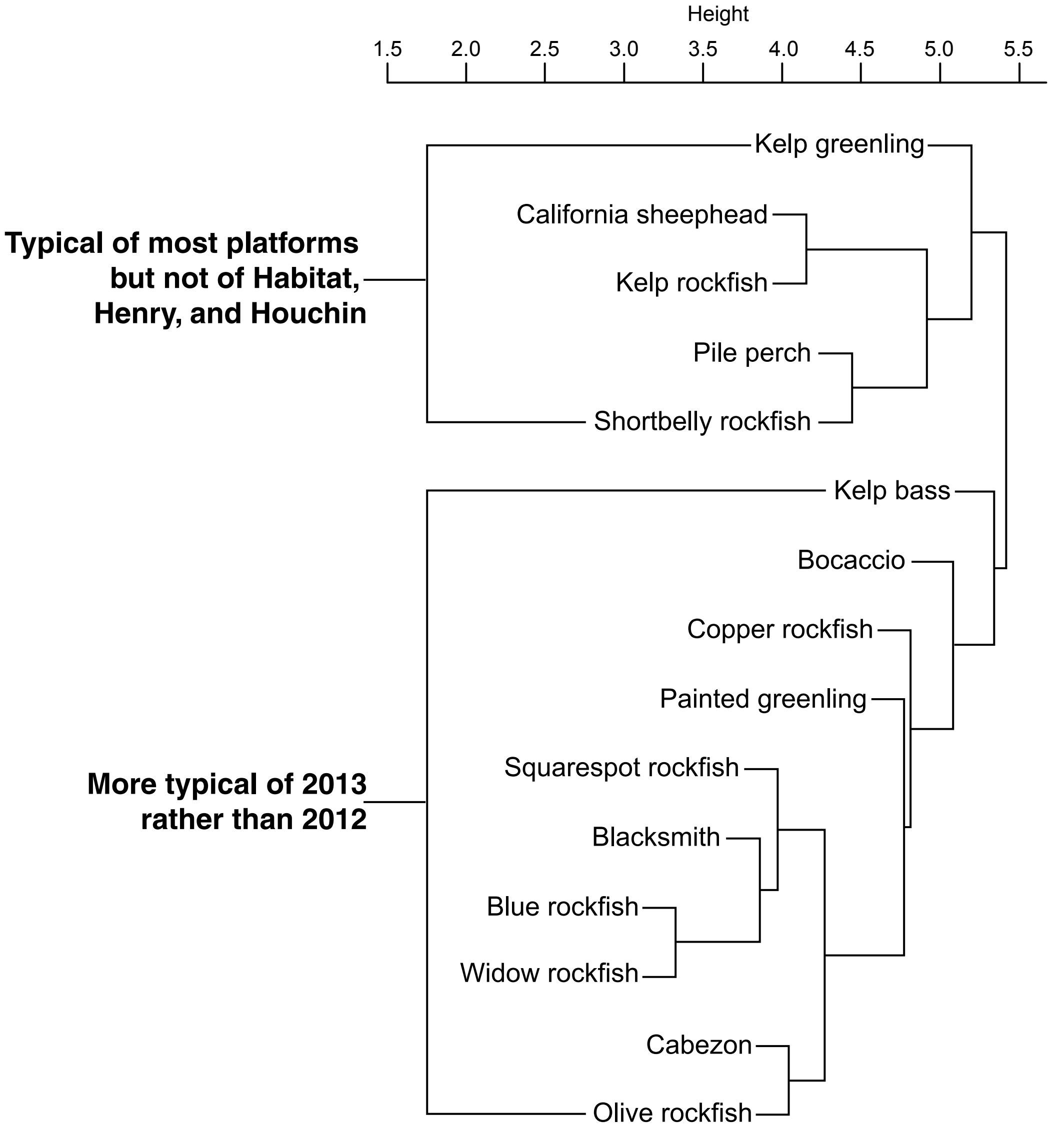


Figure 14. A cluster analysis of the characteristics species of platform midwaters of either platforms off Summerland, California, 2012–2013.

this be the case? There is substantial evidence from both platform and natural reef sites (Caselle et al. 2002, Love and York 2006, Love et al. 2006, Love and Yoklavich 2008) that adults of a number of rockfish species require sheltering sites. Around platforms, the major sheltering habitat is formed by uncovered (i.e., not buried by shells) and undercut bottom crossbeams. Unlike many of the other platforms we have surveyed off California, there is substantial shell deposition around much of the bases of the Summerland platforms and the result is that the bottom crossbeams are often buried. This is in contrast to the condition found in a number of other southern California platforms, where this crossbeam is undercut, creating extensive sheltering areas. The effect of this heavy layer of shells is that, from a fish's perspective, the platform bottom may not be distinguishable from the adjacent shell mound; both lack significant sheltering sites and thus both are less suitable for larger individuals of many species.

While bottom and shell mound fish assemblages share a common core of species, previous research from other California platforms has demonstrated that, of the two habitats, both overall species richness

Table 8. Densities of all fishes observed from a remotely operated vehicle on the shell mounds of eight platforms in the Santa Barbara Channel. Platforms are ordered from westernmost (C) to easternmost (Hogan) with the exception of the more offshore Platform Habitat (listed first). Platform bottom depth is listed after platform name. YOY = young-of-the-year. Scientific names are listed in Table 4. Note that counts of fishes are not included in this table because varying survey coverage of this precluded meaningful comparison of counts among platforms, habitats, and years.

PLATFORM HABITAT (DEPTH = 88 M)

		DENSITY		**STANDARD ERROR**
Species	**2012**	**2013**	**2012–2013**	
Halfbanded rockfish	97.3	84.1	90.7	6.6
Lingcod YOY	8.8	7.6	8.2	0.6
Unidentified flatfishes	0.5	3.5	2.0	1.5
Sebastomus spp.	2.6	0.0	1.3	1.3
Copper rockfish	0.3	1.0	0.6	0.4
Painted greenling	0.5	0.5	0.5	0.0
Unidentified combfishes	0.5	0.5	0.5	0.0
Rosy rockfish	0.5	0.0	0.3	0.3
Unidentified rockfishes	0.5	0.0	0.3	0.3
Unidentified sanddab	0.5	0.0	0.3	0.3
Lingcod	0.0	0.5	0.3	0.3
Unidentified fishes	0.0	0.5	0.3	0.3
Calico rockfish	0.3	0.0	0.1	0.1
Greenspotted rockfish	0.3	0.0	0.1	0.1
Pacific sanddab	0.3	0.0	0.1	0.1
Shortspine combfish	0.3	0.0	0.1	0.1
Squarespot rockfish	0.3	0.0	0.1	0.1
Wolf-eel	0.3	0.0	0.1	0.1
Total	113.8	98.2	106.0	7.8
Minimum number of species	11	5	11	
Total rockfish YOY	0.3	0.0	0.1	
Total rockfishes	102.2	85.1	93.7	
Rockfish YOY % of all fishes surveyed	0.2	0.0	0.1	
All rockfishes % of all fishes surveyed	89.8	86.7	88.4	

PLATFORM C (DEPTH = 60 M)

		DENSITY		**STANDARD ERROR**
Species	**2012**	**2013**	**2012–2013**	
Calico rockfish	11.3	2.1	6.7	4.6
Halfbanded rockfish	0.0	13.1	6.6	6.6
Unidentified sanddab	0.0	11.9	6.0	6.0
Lingcod YOY	3.7	5.4	4.5	0.8
Painted greenling	5.2	2.4	3.8	1.4
Calico rockfish YOY	4.7	0.0	2.3	2.3
Lingcod	0.2	2.1	1.2	0.9
Squarespot rockfish	0.0	2.1	1.0	1.0
Pile perch	2.0	0.0	1.0	1.0
Unidentified flatfishes	0.0	1.8	0.9	0.9
Unidentified rockfishes	0.7	0.9	0.8	0.1
Unidentified fishes	0.7	0.0	0.4	0.4
Cabezon	0.0	0.6	0.3	0.3
Kelp greenling	0.5	0.0	0.2	0.2
Unidentified rockfishes YOY	0.5	0.0	0.2	0.2

Table 8. (Continued)

		DENSITY		STANDARD ERROR
Species	**2012**	**2013**	**2012–2013**	
Unidentified surfperch	0.0	0.3	0.1	0.1
Widow rockfish YOY	0.0	0.3	0.1	0.1
Wolf-eel	0.0	0.3	0.1	0.1
Brown rockfish YOY	0.2	0.0	0.1	0.1
Rosy rockfish	0.2	0.0	0.1	0.1
Unidentified ronquil	0.1			
Total	30.2	43.3	36.8	6.5
Minimum number of species	8	9	13	
Total rockfish YOY	5.4	0.3	2.9	
Total rockfishes	17.7	18.5	18.1	
Rockfish YOY % of all fishes surveyed	17.9	0.7	7.8	
All rockfishes % of all fishes surveyed	58.5	42.8	49.2	

PLATFORM B (DEPTH = 60 M)

		DENSITY		STANDARD ERROR
Species	**2012**	**2013**	**2012–2013**	
Squarespot rockfish YOY	87.5	0.0	43.7	43.7
Unidentified rockfishes	26.6	1.1	13.8	12.8
Unidentified sanddab	0	24.4	12.2	12.2
Calico rockfish	20.0	2.8	11.4	8.6
Lingcod YOY	8.0	4.2	6.1	1.9
Shortbelly rockfish YOY	11.3	0.0	5.7	5.7
Painted greenling	9.1	1.8	5.4	3.7
Unidentified rockfishes YOY	10.6	0.0	5.3	5.3
Squarespot rockfish	8.0	1.8	4.9	3.1
Unidentified flatfishes	0.0	6.0	3.0	3.0
Vermilion rockfish	3.3	1.1	2.2	1.1
Lingcod	1.1	3.2	2.1	1.0
Unidentified fishes	1.1	2.1	1.6	0.5
Olive rockfish	1.1	1.1	1.1	0.0
Pile perch	1.5	0.4	0.9	0.6
Chilipepper	0.0	1.8	0.9	0.9
Brown rockfish	1.5	0.0	0.7	0.7
Calico rockfish YOY	1.5	0.0	0.7	0.7
Halfbanded rockfish	1.5	0.0	0.7	0.7
Blackeye goby	1.1	0.0	0.5	0.5
Blue rockfish	1.1	0.0	0.5	0.5
Kelp greenling	0.7	0.4	0.5	0.2
Bocaccio	0.0	1.1	0.5	0.5
California lizardfish	0.0	1.1	0.5	0.5
Copper rockfish	0.7	0.0	0.4	0.4
Halfbanded rockfish YOY	0.7	0.0	0.4	0.4
Painted greenling YOY	0.7	0.0	0.4	0.4
Rubberlip seaperch	0.7	0.0	0.4	0.4
Sebastomus spp.	0.4	0.0	0.2	0.2
Spotted scorpionfish	0.4	0.0	0.2	0.2
Unidentified sculpin	0.4	0.0	0.2	0.2
Unidentified surfperch	0.0	0.4	0.2	0.2

Table 8. (Continued)

Species	2012	DENSITY 2013	2012–2013	STANDARD ERROR
Total	200.5	54.5	127.5	73.0
Minimum number of species	17	11	22	
Total rockfish YOY	111.5	0.0	55.8	
Total rockfishes	175.7	10.6	93.2	
Rockfish YOY % of all fishes surveyed	55.6	0.0	43.7	
All rockfishes % of all fishes surveyed	87.6	19.5	73.1	

PLATFORM A (DEPTH = 59 M)

Species	2012	DENSITY 2013	2012–2013	STANDARD ERROR
Halfbanded rockfish	148.0	6.6	77.3	70.7
Vermilion rockfish	77.7	1.5	39.6	38.1
Blue rockfish	25.9	0.0	13.0	13.0
Calico rockfish	2.5	12.4	7.4	5.0
Copper rockfish	8.6	1.2	4.9	3.7
Squarespot rockfish	8.6	1.2	4.9	3.7
Kelp rockfish	7.4	0.0	3.7	1.9
Brown rockfish	6.2	2.3	4.2	3.7
Olive rockfish	6.2	0.8	3.5	2.7
Lingcod	1.2	3.9	2.6	1.3
Lingcod YOY	3.7	1.2	2.4	1.3
Pile perch	2.5	3.5	2.4	1.2
Unidentified flatfishes	0.0	2.7	1.4	1.2
Painted greenling	1.2	0.4	0.8	0.4
Unidentified sanddab	0.0	1.5	0.8	0.8
Blackeye goby	1.2	0.0	0.6	0.6
Unidentified fishes	1.2	0.0	0.6	0.6
Unidentified rockfishes	0.0	1.2	0.6	0.6
Halfbanded rockfish YOY	0.0	0.4	0.2	0.2
Kelp greenling	0.0	0.4	0.2	0.2
Total	302.2	37.1	169.7	132.5
Minimum number of species	13	10	15	
Total rockfish YOY	0.0	0.4	0.2	
Total rockfishes	291.1	27.5	159.3	
Rockfish YOY % of all fishes surveyed	0.0	1.0	0.1	
All rockfishes % of all fishes surveyed	96.3	74.0	93.9	

PLATFORM HILLHOUSE (DEPTH = 58 M)

Species	2012	DENSITY 2013	2012–2013	STANDARD ERROR
Calico rockfish	30.7	5.3	18.0	12.7
Halfbanded rockfish	0.0	20.2	10.1	10.1
Unidentified sanddab	0.0	7.2	3.6	3.6
Lingcod YOY	5.8	0.6	3.6	2.6
Painted greenling	2.6	0.8	1.7	0.9
Unidentified flatfishes	0.0	3.0	1.5	1.5

Table 8. (Continued)

	DENSITY			STANDARD ERROR
Species	**2012**	**2013**	**2012–2013**	
Unidentified surfperch	2.6	0.0	1.3	1.3
Calico rockfish YOY	1.8	0.0	0.9	0.9
Unidentified rockfishes	1.2	0.6	0.9	0.3
California lizardfish	0.0	1.7	0.8	0.8
Vermilion rockfish	1.5	0.0	0.7	0.7
Longspine combfish	0.0	1.1	0.6	0.6
Kelp greenling	0.9	0.0	0.4	0.4
Copper rockfish	0.6	0.3	0.4	0.2
Brown rockfish	0.6	0.0	0.3	0.3
Olive rockfish	0.6	0.0	0.3	0.3
Pile perch	0.6	0.0	0.3	0.3
Unidentified rockfishes YOY	0.6	0.0	0.3	0.3
Lingcod	0.3	0.3	0.3	0.0
Unidentified fishes	0.0	0.6	0.3	0.3
Pink seaperch	0.3	0.0	0.1	0.1
Rosy rockfish	0.3	0.0	0.1	0.1
Spotted scorpionfish	0.3	0.0	0.1	0.1
Flag rockfish	0.0	0.3	0.1	0.1
Gopher rockfish	0.0	0.3	0.1	0.1
Kelp rockfish	0.0	0.3	0.1	0.1
Squarespot rockfish	0.0	0.3	0.1	0.1
Unidentified combfishes	0.0	0.3	0.1	0.1
Yellowtail rockfish	0.0	0.3	0.1	0.1
Total	51.2	43.2	47.2	4.0
Minimum number of species	13	13	21	
Total rockfish YOY	2.3	0.0	1.2	
Total rockfishes	37.7	27.7	32.9	
Rockfish YOY % of all fishes surveyed	4.6	0.0	2.5	
All rockfishes % of all fishes surveyed	73.7	64.1	69.3	

PLATFORM HENRY (DEPTH = 53 M)

	DENSITY			STANDARD ERROR
Species	**2012**	**2013**	**2012–2013**	
Halfbanded rockfish YOY	22.1	0.0	11.1	11.1
Calico rockfish	6.4	6.7	6.5	0.1
Calico rockfish YOY	6.4	0.0	3.2	3.2
California lizardfish	0.0	4.9	2.5	2.5
Lingcod YOY	2.8	1.1	1.9	0.9
Painted greenling	2.0	1.4	1.7	0.3
Squarespot rockfish	0.8	1.8	1.3	0.5
Unidentified rockfishes YOY	1.6	0.4	1.0	0.6
Lingcod	0.4	1.1	0.7	0.3
Olive rockfish	0.0	1.4	0.7	0.7
Unidentified flatfishes	0.0	1.4	0.7	0.7
Unidentified rockfishes	0.0	1.4	0.7	0.7
Unidentified fishes	0.8	0.4	0.6	0.2
Unidentified sanddab	0.0	0.7	0.4	0.4
Unidentified sculpin	0.4	0.0	0.2	0.2

Table 8. (Continued)

Species	2012	DENSITY 2013	2012–2013	STANDARD ERROR
Longspine combfish	0.0	0.4	0.2	0.2
Painted greenling YOY	0.0	0.4	0.2	0.2
Unidentified combfishes	0.0	0.4	0.2	0.2
Unidentified ronquil	0.0	0.4	0.2	0.2
Total	43.8	23.8	33.8	10.0
Minimum Number of Species	7	11	11	
Total Rockfish YOY	30.2	0.4	15.3	
Total Rockfish	37.4	11.6	24.5	
Rockfish YOY percentage of all fishes surveyed	68.8	1.5	45.1	
All rockfishes percentage of all fishes surveyed	85.3	48.5	72.4	

PLATFORM HOUCHIN (DEPTH = 51 M)

Species	2012	DENSITY 2013	2012–2013	STANDARD ERROR
Halfbanded rockfish YOY	86.6	0.0	43.3	43.3
Calico rockfish YOY	37.2	0.0	18.6	18.6
Brown rockfish	9.3	0.3	4.8	4.5
Calico rockfish	1.4	4.7	3.0	1.6
Painted greenling	4.3	1.7	3.0	1.3
Lingcod YOY	2.9	0.9	1.9	1.0
Unidentified rockfishes	1.4	1.5	1.4	0.0
Pile perch	2.9	0.0	1.4	1.4
Unidentified surfperch	2.1	0.0	1.1	1.1
Unidentified fishes	0.7	1.2	0.9	0.2
Sharpnose seaperch	0.0	1.7	0.9	0.9
Halfbanded rockfish	1.4	0.3	0.9	0.6
Copper rockfish	0.7	0.6	0.6	0.1
Kelp rockfish	0.7	0.0	0.4	0.4
Painted greenling YOY	0.7	0.0	0.4	0.4
Sebastomus spp.	0.7	0.0	0.4	0.4
Unidentified rockfishes YOY	0.7	0.0	0.4	0.4
Vermilion rockfish	0.7	0.0	0.4	0.4
Lingcod	0.0	0.6	0.3	0.3
California lizardfish	0.0	0.3	0.1	0.1
Olive rockfish	0.0	0.3	0.1	0.1
Squarespot rockfish	0.0	0.3	0.1	0.1
Unidentified flatfishes	0.0	0.3	0.1	0.1
Unidentified sanddab	0.0	0.3	0.1	0.1
Unidentified sculpin	0.0	0.3	0.1	0.1
Wolf-eel	0.0	0.3	0.1	0.1
Yellowtail rockfish	0.0	0.3	0.1	0.1
Total	154.6	15.4	85.0	69.6
Minimum number of species	12	13	19	
Total rockfish YOY	124.6	0.0	62.3	
Total rockfishes	141.0	8.1	74.6	
Rockfish YOY % of all fishes surveyed	80.6	0.0	73.3	
All rockfishes % of all fishes surveyed	91.2	52.8	87.7	

Table 8. (Continued)

PLATFORM HOGAN (DEPTH = 47 M)

Species	DENSITY 2012	2013	2012–2013	STANDARD ERROR
Calico rockfish YOY	22.3	0.3	11.3	11.0
Halfbanded rockfish YOY	13.3	0.3	6.8	6.5
Painted greenling	1.4	1.7	1.6	0.2
Calico rockfish	0.7	1.7	1.2	0.5
California lizardfish	0.0	2.3	1.2	1.2
Unidentified rockfishes YOY	0.7	0.6	0.6	0.1
Lingcod YOY	0.0	1.2	0.6	0.6
Unidentified rockfishes	0.7	0.3	0.5	0.2
Halfbanded rockfish	0.7	0.0	0.3	0.3
Lingcod	0.7	0.0	0.3	0.3
Unidentified fishes	0.7	0.0	0.5	0.3
Pile perch	0.0	0.6	0.3	0.3
Copper rockfish	0.0	0.3	0.1	0.1
Olive rockfish	0.0	0.3	0.1	0.1
Painted greenling YOY	0.0	0.3	0.1	0.1
Unidentified flatfishes	0.0	0.3	0.1	0.1
Widow rockfish YOY	0.0	0.3	0.1	0.1
Total	41.2	10.5	25.8	15.4
Minimum number of species	4	10	10	
Total rockfish YOY	36.3	1.5	18.9	
Total rockfish	38.4	4.1	21.2	
Rockfish YOY % of all fishes surveyed	88.1	13.9	73.1	
All rockfishes % of all fishes surveyed	93.2	38.9	82.2	

Table 9. Densities of all fishes observed from a remotely operated vehicle and from scuba surveys around the midwaters of eight platforms in the Santa Barbara Channel. Platforms are ordered from westernmost (C) to easternmost (Hogan) with the exception of the more offshore Platform Habitat (listed first). YOY = young-of-the-year. Density is in fish per 100 m^2. Scientific names are listed in Table 4.

PLATFORM HABITAT

Species	DENSITY 2012	2013	2012-2013	STANDARD ERROR
Squarespot rockfish YOY	102.9	25.3	64.1	38.8
Unidentified rockfishes YOY	75.2	14.6	44.9	30.3
Bocaccio YOY	0.2	67.7	33.9	33.8
Blue rockfish YOY	1.6	55.2	28.4	26.8
Widow rockfish YOY	0.0	26.1	13.1	13.1
Bocaccio	0.0	22.3	11.2	11.2
Squarespot rockfish	2.6	5.1	3.9	1.2
Shortbelly rockfish YOY	6.6	0.5	3.5	3.1
Unidentified rockfishes	0.2	3.5	1.9	1.6
Blue rockfish	0.0	3.7	1.9	1.9
Copper rockfish	0.5	1.9	1.2	0.7
Yellowtail rockfish	0.0	2.0	1.0	1.0
Painted greenling	0.5	1.1	0.8	0.3
Olive rockfish	0.0	1.1	0.6	0.6
Painted greenling YOY	0.7	0.3	0.5	0.2

Table 9. (Continued)

Species	2012	DENSITY 2013	2012–2013	STANDARD ERROR
Blacksmith	0.0	0.8	0.4	0.4
Kelp greenling	0.4	0.2	0.3	0.1
Lingcod YOY	0.0	0.5	0.2	0.2
Widow rockfish	0.0	0.5	0.2	0.2
Copper rockfish YOY	0.1	0.3	0.2	0.1
Yellowtail rockfish YOY	0.0	0.3	0.2	0.2
Unidentified fishes	0.1	0.2	0.1	0.1
Kelp rockfish	0.0	0.3	0.1	0.1
Cabezon	0.0	0.2	0.1	0.1
Olive rockfish YOY	0.0	0.2	0.1	0.1
Shortbelly rockfish	0.0	0.2	0.1	0.1
Pile surfperch	0.2	0.0	0.1	0.1
Calico rockfish	0.0	0.1	0.1	0.0
Sebastomus sp.	0.0	0.1	0.1	0.0
Total	191.7	234.3	213.0	21.3
Minimum number of species	8	16	18	
Total rockfish YOY	186.4	190.3	188.4	
Total rockfishes	189.8	230.9	210.4	
Rockfish YOY % of all fishes surveyed	97.3	81.2	88.4	
All rockfishes % of all fishes surveyed	99.0	98.6	98.8	

PLATFORM C

Species	2012	DENSITY 2013	2012-2013	STANDARD ERROR
Shortbelly rockfish YOY	201.9	0.3	101.0	100.8
Blue rockfish YOY	5.2	191.9	98.6	93.4
Widow rockfish YOY	0.0	129.5	64.7	64.7
Bocaccio YOY	100.5	22.7	61.6	39.0
Squarespot rockfish YOY	21.0	101.2	61.1	40.1
Unidentified rockfishes YOY	44.0	69.1	56.6	12.5
Unidentified rockfishes	5.4	7.8	6.6	1.2
Bocaccio	0.0	11.5	5.8	5.8
Squarespot rockfish	1.0	5.9	3.4	2.4
Blacksmith	0.0	5.1	2.6	2.6
Painted greenling	3.2	1.5	2.4	0.9
Widow rockfish	0.0	2.2	1.1	1.1
Pile surfperch	1.2	0.7	0.9	0.3
Blue rockfish	0.0	1.6	0.8	0.8
Blacksmith YOY	0.0	1.2	0.6	0.6
Painted greenling YOY	0.5	0.2	0.4	0.2
Kelp rockfish	0.4	0.2	0.3	0.1
Olive rockfish	0.1	0.4	0.3	0.2
Kelp bass	0.0	0.5	0.2	0.2
Copper rockfish YOY	0.2	0.3	0.2	0.1
Kelp greenling	0.3	0.2	0.2	0.1
Vermilion rockfish	0.4	0.0	0.2	0.2
Senorita	0.0	0.3	0.1	0.1
Copper rockfish	0.1	0.2	0.1	0.1
Unidentified surfperch	0.0	0.2	0.1	0.1
Cabezon	0.1	0.1	0.1	0.1

Table 9. (Continued)

Species	2012	DENSITY 2013	2012–2013	STANDARD ERROR
California sheephead	0.0	0.1	0.1	0.1
Calico rockfish YOY	0.1	0.0	0.1	0.1
Halfbanded rockfish	0.1	0.0	0.1	0.1
Gopher rockfish	0.0	0.1	0.1	0.1
Lingcod	0.0	0.1	0.1	0.1
Lingcod YOY	0.0	0.1	0.1	0.1
Unidentified fishes	0.00	0.1	0.1	0.1
Total	385.9	554.7	470.3	84.4
Minimum number of species	14	18	22	
Total rockfish YOY	373.0	514.9	443.9	
Total rockfishes	380.6	544.7	462.6	
Rockfish YOY % of all fishes surveyed	96.7	92.8	94.4	
All rockfishes % of all fishes surveyed	98.6	98.2	98.4	

PLATFORM B

Species	2012	DENSITY 2013	2012-2013	STANDARD ERROR
Squarespot rockfish YOY	11.4	235.9	123.7	112.3
Widow rockfish YOY	0.0	241.6	120.8	120.8
Blue rockfish YOY	16.1	194.5	105.3	89.2
Shortbelly rockfish YOY	21.2	69.3	45.3	24.0
Bocaccio	0.0	21.0	10.5	10.5
Unidentified rockfishes YOY	5.4	13.8	9.6	4.2
Squarespot rockfish	0.8	11.5	6.2	5.4
Bocaccio YOY	0.0	12.0	6.0	6.0
Blue rockfish	0.0	9.7	4.9	4.9
Blacksmith YOY	0.0	7.6	3.8	3.8
Blacksmith	0.0	5.8	2.9	2.9
Olive rockfish	0.1	2.4	1.2	1.1
Unidentified rockfishes	1.1	1.4	1.2	0.2
Widow rockfish	0.0	1.8	0.9	0.9
Painted greenling	0.6	1.1	0.9	0.3
Kelp rockfish	0.6	0.5	0.6	0.1
California sheephead	0.7	0.4	0.6	0.2
Painted greenling YOY	0.7	0.4	0.5	0.2
Kelp greenling	0.2	0.5	0.3	0.1
Vermilion rockfish	0.0	0.3	0.2	0.2
Yellowtail rockfish	0.0	0.3	0.2	0.2
Kelp bass	0.1	0.2	0.2	0.1
Senorita	0.1	0.2	0.2	0.1
Unidentified fishes	0.3	0.0	0.1	0.1
Pile surfperch	0.1	0.2	0.1	0.1
Lingcod	0.0	0.2	0.1	0.1
Sharpnose surfperch	0.1	0.1	0.1	0.1
Unidentified surfperch	0.2	0.0	0.1	0.1
Lingcod YOY	0.0	0.2	0.1	0.1
Garibaldi	0.1	0.1	0.1	0.1
Gopher rockfish	0.0	0.1	0.1	0.1
Shortbelly rockfish	0.1	0.0	0.1	0.1
Vermilion rockfish YOY	0.1	0.0	0.1	0.1
Black-and-yellow rockfish	0.0	0.1	0.1	0.1

Table 9. (Continued)

Species	2012	DENSITY 2013	2012–2013	STANDARD ERROR
Brown rockfish	0.0	0.1	0.1	0.1
Cabezon	0.0	0.1	0.1	0.1
Copper rockfish	0.0	0.1	0.1	0.1
White surfperch	0.0	0.1	0.1	0.03
Total	59.9	833.2	446.5	386.6
Minimum number of species	14	25	27	
Total rockfish YOY	54.2	767.1	410.7	
Total rockfishes	56.8	816.3	436.6	
Rockfish YOY % of all fishes surveyed		90.4	92.1	92.0
All rockfishes % of all fishes surveyed		94.8	98.0	97.8

PLATFORM A

Species	2012	DENSITY 2013	2012-2013	STANDARD ERROR
Shortbelly rockfish YOY	501.6	1.2	251.4	250.2
Squarespot rockfish YOY	15.6	393.1	204.3	188.7
Blue rockfish YOY	1.1	294.0	147.5	146.4
Widow rockfish YOY	0.0	143.2	71.6	71.6
Bocaccio YOY	0.4	31.6	16.0	15.6
Blacksmith YOY	1.9	23.8	12.8	11.0
Squarespot rockfish	0.0	13.7	6.8	6.8
Unidentified rockfishes YOY	0.6	10.1	5.3	4.8
Bocaccio	0.0	9.6	4.8	4.8
Blue rockfish	6.9	0.7	3.8	3.1
Blacksmith	0.0	2.6	1.3	1.3
Sharpnose surfperch	0.0	2.1	1.1	1.1
Painted greenling	0.4	1.5	1.0	0.6
California sheephead	0.4	1.1	0.7	0.3
Kelp rockfish	0.7	0.5	0.6	0.1
Pile surfperch	0.6	0.6	0.6	0.0
Kelp greenling	0.4	0.7	0.5	0.2
Olive rockfish	0.0	1.0	0.5	0.5
Unidentified surfperch	0.7	0.0	0.4	0.4
Painted greenling YOY	0.4	0.3	0.3	0.1
Widow rockfish	0.0	0.6	0.3	0.3
Kelp bass	0.0	0.5	0.3	0.3
Vermilion rockfish	0.0	0.4	0.2	0.2
Copper rockfish	0.0	0.2	0.1	0.1
Gopher rockfish	0.0	0.2	0.1	0.1
Cabezon	0.0	0.1	0.1	0.1
Unidentified rockfishes	0.0	0.1	0.1	0.1
Brown rockfish	0.0	0.1	0.1	0.1
Lingcod	0.0	0.1	0.1	0.1
Olive rockfish YOY	0.0	0.1	0.1	0.1
Yellowtail rockfish	0.0	0.1	0.1	0.1
Total	531.5	933.5	732.5	201.0
Minimum number of species	10	21	22	
Total rockfish YOY	519.3	873.2	696.2	
Total rockfishes	526.9	900.2	713.5	
Rockfish YOY % of all fishes surveyed		97.7	93.5	95.1
All rockfishes % of all fishes surveyed		99.1	96.4	97.4

Table 9. (Continued)

PLATFORM HILLHOUSE

		DENSITY		STANDARD ERROR
Species	**2012**	**2013**	**2012-2013**	
Shortbelly rockfish YOY	390.1	0.1	195.1	195.0
Blue rockfish YOY	0.0	299.7	149.8	149.8
Squarespot rockfish YOY	94.1	154.7	124.4	30.3
Widow rockfish YOY	0.2	45.1	22.6	22.5
Unidentified rockfishes YOY	9.8	9.1	9.4	0.4
Bocaccio YOY	0.2	6.9	3.5	3.4
Gopher rockfish YOY	0.0	2.9	1.5	1.5
Painted greenling	1.0	1.5	1.3	0.3
Blue rockfish	0.0	2.3	1.2	1.2
Squarespot rockfish	0.3	1.1	0.7	0.4
Blacksmith YOY	0.0	1.4	0.7	0.7
Painted greenling YOY	0.7	0.2	0.5	0.3
Unidentified surfperch	0.9	0.0	0.4	0.4
Pile surfperch	0.7	0.0	0.4	0.4
Cabezon	0.0	0.6	0.3	0.3
Olive rockfish	0.0	0.6	0.3	0.3
Widow rockfish	0.0	0.6	0.3	0.3
Blacksmith	0.0	0.6	0.3	0.3
Yellowtail rockfish	0.0	0.5	0.3	0.3
Copper rockfish YOY	0.2	0.2	0.2	0.1
Kelp rockfish	0.2	0.2	0.2	0.1
Kelp greenling	0.2	0.1	0.1	0.1
California sheephead	0.0	0.2	0.1	0.1
Kelp bass	0.0	0.2	0.1	0.1
Unidentified rockfishes	0.0	0.1	0.1	0.1
White surfperch	0.0	0.1	0.1	0.1
Gopher rockfish	0.0	0.1	0.1	0.1
Total	498.3	529.2	513.8	15.4
Minimum number of species	9	17	19	
Total rockfish YOY	494.4	518.7	506.6	
Total rockfishes	494.8	524.3	509.6	
Rockfish YOY % of all fishes surveyed		99.2	98.0	98.6
All rockfishes % of all fishes surveyed		99.3	99.1	99.2

PLATFORM HENRY

		DENSITY		STANDARD ERROR
Species	**2012**	**2013**	**2012-2013**	
Blue rockfish YOY	6.0	176.2	91.1	85.1
Squarespot rockfish YOY	65.0	112.1	88.6	23.6
Widow rockfish YOY	0.5	152.2	76.4	75.9
Unidentified rockfishes YOY	5.1	10.6	7.9	2.8
Sharpnose surfperch	4.6	0.0	2.3	2.3
Halfbanded rockfish YOY	2.3	1.0	1.6	0.7
Painted greenling	0.5	1.2	0.8	0.4
Kelp bass	0.7	0.7	0.7	0.1
Copper rockfish YOY	0.7	0.1	0.4	0.3
Blacksmith YOY	0.0	0.7	0.4	0.4
Painted greenling YOY	0.0	0.5	0.3	0.3
Olive rockfish	0.0	0.4	0.2	0.2
Unidentified rockfishes	0.0	0.4	0.2	0.2

Table 9. (Continued)

		DENSITY		STANDARD ERROR
Species	**2012**	**2013**	**2012–2013**	
Kelp greenling	0.2	0.2	0.2	0.1
Squarespot rockfish	0.0	0.4	0.2	0.2
Copper rockfish	0.2	0.0	0.1	0.1
Shortbelly rockfish YOY	0.0	0.2	0.1	0.1
Blue rockfish	0.0	0.1	0.1	0.1
Pile surfperch	0.0	0.1	0.1	0.1
Unidentified fishes	0.0	0.1	0.1	0.1
Widow rockfish	0.0	0.1	0.1	0.1
Total	85.9	457.2	271.5	185.7
Minimum number of species	9	12	14	
Total rockfish YOY	79.6	452.3	266.0	
Total rockfishes	79.8	453.7	266.8	
Rockfish YOY % of all fishes surveyed		92.7	98.9	98.0
All rockfishes % of all fishes surveyed		93.0	99.2	98.3

PLATFORM HOUCHIN

		DENSITY		STANDARD ERROR
Species	**2012**	**2013**	**2012-2013**	
Unidentified rockfishes YOY	239.8	54.5	147.1	92.7
Bocaccio YOY	270.8	20.5	145.6	125.2
Blue rockfish YOY	0.0	283.7	141.8	141.8
Squarespot rockfish YOY	0.1	154.7	77.4	77.3
Widow rockfish YOY	0.0	61.2	30.6	30.6
Shortbelly rockfish YOY	0.0	22.9	11.5	11.5
Vermilion rockfish YOY	0.0	5.9	3.0	3.0
Copper rockfish YOY	0.0	2.9	1.4	1.4
Painted greenling	0.4	1.7	1.0	0.7
Kelp bass	0.6	0.1	0.3	0.3
Pile surfperch	0.5	0.2	0.3	0.2
Unidentified rockfishes	0.0	0.6	0.3	0.3
Olive rockfish	0.4	0.2	0.3	0.1
Painted greenling YOY	0.2	0.2	0.2	0.0
Kelp rockfish	0.2	0.7	0.1	0.1
Halfbanded rockfish YOY	0.0	0.2	0.1	0.1
Lingcod YOY	0.0	0.2	0.1	0.1
Squarespot rockfish	0.0	0.2	0.1	0.1
Yellowtail rockfish	0.0	0.2	0.1	0.1
Unidentified fishes	0.1	0.0	0.1	0.1
Bocaccio	0.0	0.1	0.1	0.1
California sheephead	0.0	0.1	0.1	0.1
Brown rockfish	0.0	0.1	0.1	0.1
Cabezon	0.0	0.1	0.1	0.1
Grass rockfish	0.0	0.1	0.1	0.1
Widow rockfish	0.0	0.1	0.1	0.1
Total	513.1	610.4	561.7	48.7
Minimum number of species	7	19	20	
Total rockfish YOY	510.7	606.3	558.5	
Total rockfishes	511.3	607.8	559.6	
Rockfish YOY % of all fishes surveyed		99.6	99.3	99.4
All rockfishes % of all fishes surveyed		99.7	99.6	99.6

Table 9. (Continued)

PLATFORM HOGAN

Species	**DENSITY** **2012**	**2013**	**2012-2013**	**STANDARD ERROR**
Squarespot rockfish YOY	11.4	156.2	83.8	72.4
Blue rockfish YOY	9.3	125.1	67.2	57.9
Unidentified rockfishes YOY	67.7	61.3	64.5	3.2
Shortbelly rockfish YOY	96.5	1.1	48.8	47.7
Widow rockfish YOY	0.0	36.4	18.2	18.2
Squarespot rockfish	0.2	28.3	14.3	14.0
Bocaccio YOY	3.5	1.6	2.5	1.0
Blacksmith YOY	0.0	4.6	2.3	2.3
Copper rockfish YOY	0.0	4.3	2.2	2.2
Blue rockfish	0.0	3.2	1.6	1.6
Olive rockfish	0.1	2.3	1.2	1.1
Unidentified rockfishes	0.0	1.8	0.9	0.9
Painted greenling	0.5	1.2	0.8	0.4
California sheephead	0.8	0.3	0.6	0.3
Kelp rockfish	0.6	0.4	0.5	0.1
Pile surfperch	0.2	0.4	0.3	0.1
Blacksmith	0.0	0.4	0.2	0.2
Kelp greenling	0.4	0.1	0.2	0.1
Kelp bass	0.4	0.0	0.2	0.2
Painted greenling YOY	0.2	0.1	0.2	0.1
Unidentified fishes	0.1	0.1	0.1	0.1
Widow rockfish	0.0	0.1	0.1	0.1
Copper rockfish	0.1	0.0	0.1	0.1
Unidentified surfperch	0.1	0.0	0.1	0.1
Cabezon	0.0	0.1	0.1	0.1
Olive rockfish YOY	0.0	0.1	0.1	0.1
Yellowtail rockfish	0.0	0.1	0.1	0.1
Total	192.0	429.3	310.7	118.7
Minimum number of species	12	15	17	
Total rockfish YOY	188.3	386.0	287.2	
Total rockfishes	189.4	422.2	305.8	
Rockfish YOY % of all fishes surveyed		98.1	89.9	92.4
All rockfishes % of all fishes surveyed		98.6	98.3	98.4

and mean fish lengths are often greater at platform bottoms (Love et al. 2010). And indeed, in our current research, species richness at platform bottoms was greater at six of eight platforms (Figures 6, 11, Tables 7, 8) and overall mean length was slightly larger at platform bottoms (Table 10). What might lead to this disparity? We suspect that while there is substantial similarity in the dominant species found at the two habitats, bottom habitats with their pilings and crossbeams (if not covered over with shells) tend to provide extra structural complexity, providing habitat for 1) additional, but rare, species and 2) slightly larger individuals. On the other hand, intra-platform, overall fish densities tended to be similar at these two habitats (Love et al. 2010) and we found this also to be true in five of eight platforms our current study; although fish densities at the bottoms of three platforms were higher than at adjacent shell mounds (Figure 16, Tables 7, 8).

Among California platforms, it is clear that along with habitat characteristics such as the degree of bottom crossbeam undercut, platform bottom depth is also a major factor in the structuring of species' assemblages (a parameter also important on natural reefs) (Love et al. 2009, Love et al. 2010). In line with these observations, we compared the bottom and shell mound assemblages of the Summerland platforms with previous findings from Platforms Holly and Gilda; these structures are located within the Santa Barbara Channel and are in similar bottom depths (Table 1). We found that the Summerland fish assemblages are closely related to these two other platforms (Figure 17, Table 11). Moreover, Love et al. (2010) determined that this platform bottom fish assemblage is found in similar-depth platforms from north of Point Arguello to off Long Beach and labeled it the "shallowest depth" platform bottom assemblage. What is particularly interesting about these similarities is that they occur in platforms ranging over more than 300 km of coastline in platforms found within at least two water masses. Given that the Summerland platforms are arguably in some of the most turbid waters of any California platforms, the implication is that bottom turbidity plays less of a role in structuring fish assemblages as do other habitat characteristics such as bottom depth.

The midwaters of most California platforms are fish nursery grounds and are dominated by YOY and somewhat older juvenile fishes (primarily rockfishes, but also juveniles of such taxa as blacksmith, garibaldi, kelp and painted greenlings). In addition, and to a lesser extent at many platforms, there is also a suite of the adults of a number of "typical" reef fishes (e.g., blacksmith, garibaldi, sheephead, pile perch, and white seaperch) (Love et al. 1999a, Love et al. 2003, Love et al. 2010, Nishimoto and Love 2011). The midwater assemblages of the Summerland platforms followed this pattern, with YOY and juvenile rockfishes (of at least five species and the KGB complex [i.e., black-and-yellow, copper, gopher, and kelp) and, to a lesser extent, blacksmith, comprising the majority of all the fishes observed (Table 9).

This current research, and that at other platforms in previous years, demonstrates the following:

1) The fish assemblages found around the Summerland platforms are similar to those around other platforms situated in the same bottom depths in the Santa Barbara Channel (i.e., Holly and Gilda) (Figure 17). The Summerland platforms lie in a particularly depositional and turbid zone and, arguably, Holly and Gilda lie in waters that are at least somewhat less turbid. In addition, many of the species that characterize all of these platforms are also found over natural reefs in relatively clear waters. This implies that there is a suite of species that is able to tolerate a broad range of water clarity. Moreover, it also implies that platform bottom depth, rather than water clarity, is a major factor in generating species assemblages.

2) There is substantial overlap in the species living in the midwaters, bottoms, and shell mounds on many, if not all, of these relatively shallow water platforms. This is at least partially due to a suite of rockfish species that recruit as YOYs to platform midwaters and are then able to occupy both midwater and bottom depths. As an example, both blue and olive rockfishes recruit to platform midwaters and are also able to tolerate the bottom depths at the Summerland platforms. This is not the case at such deeper-water platforms as Gail and Eureka, whose bottom depths are too deep for these species. Thus, in the case of Gail and Eureka, there is more of a disconnect among the species assemblages. We also note that a number of other taxa typical of platform midwaters, such as garibaldi and white seaperch, are able to live around the bottom of the Summerland platforms, but are unable to live at the bottom of deeper platforms.

3) Based on the high densities of juveniles, one of the major functions of the Summerland platforms is as a nursery ground for a suite of species, primarily rockfishes but also including lingcod and painted greenling. Adult fishes (e.g., blacksmith, cabezon, garibaldi, and sheephead) are present, sometimes in substantial numbers, but juvenile rockfish dominance relegates these other species to a relatively small fraction of the total fish population. Juvenile fishes predominate, not only because rockfishes are extremely important to California coastal shelf assemblages, but because the life history patterns of this group dictate the overwhelming importance of juvenile fishes at these structures.

Although there are a few exceptions, in general there are two life history patterns among the rockfishes:

A) Those species that recruit to shallow waters and remain there through adulthood (e.g., such nearshore species as blue, gopher, and olive rockfishes) and B) those species that recruit to shallow waters and move deeper as they mature (e.g., bocaccio, halfbanded, shortbelly, and widow rockfishes). However, for reasons discussed below, it is likely that the young of most of the characteristic Summerland platform rockfishes use the Summerland platforms only during early life stages.

Table 10. Overall mean total lengths (cm) of fishes observed around the bottoms, shell mounds, and midwaters of eight platforms off Summerland, California, 2012–2013.

	BOTTOM	SHELL MOUND	MIDWATER
Number counted	5,193	2,822	100,287
Mean	13.2	12.4	6.2
Standard error	0.1	0.01	0.12

Table 11. A summary of the average densities (fishes per 100 m^2) of each species observed around Platforms Gilda (surveyed all years between 2001 and 2009 except 2002 and 2005) and Holly (surveyed all years between 1996 and 2010 except 2000 and 2002) based on manned submersible surveys, all habitats and all years combined. YOY = young-of-the-year. Scientific names are listed in Table 3.

AVERAGE DENSITY			
Species	**Platform Gilda**	**Platform Holly**	**Both Platforms**
Halfbanded rockfish	231.6	9.5	120.6
Calico rockfish	9.9	27.6	18.7
Bocaccio	29.2	0.2	14.7
Jack mackerel	0.0	29.2	14.6
Vermilion rockfish	20.5	6.0	13.3
Shortbelly rockfish	17.3	0.1	8.6
Squarespot rockfish	0.3	14.5	7.4
Pacific sardine	0.0	12.7	6.4
Widow rockfish YOY	0.0	12.2	6.1
Unidentified rockfish YOY	5.0	6.5	5.7
Lingcod YOY	7.0	1.0	4.0
Painted greenling	4.4	2.7	3.6
Squarespot rockfish YOY	1.5	4.8	3.1
Copper rockfish	1.0	4.5	2.8
Sharpnose seaperch	0.7	2.9	1.8
Widow rockfish	1.8	1.8	1.8
Rosy rockfish	0.4	2.2	1.3
Blacksmith YOY	0.3	1.7	1.0
Unidentified rockfishes	0.7	1.3	1.0
Blackeye goby	0.1	1.9	1.0
Pink seaperch	0.5	1.3	0.9
Brown rockfish	0.6	1.1	0.8
Pile perch	0.8	0.7	0.8
Unidentified flatfishes	1.1	0.4	0.8
Painted greenling YOY	0.3	1.1	0.7
Halfbanded rockfish YOY	0.0	1.4	0.7
Lingcod	0.6	0.5	0.5
Pacific sanddab	0.2	0.8	0.5
Flag rockfish	0.4	0.7	0.5
Vermilion rockfish YOY	0.9	0.1	0.5
Unidentified ronquil	0.1	0.8	0.5
Canary rockfish	0.2	0.8	0.5
Sebastomus spp.	0.1	0.8	0.4
Olive rockfish	0.3	0.6	0.4
Kelp rockfish	0.2	0.6	0.4
Unidentified sanddab	0.5	0.3	0.4
Bocaccio YOY	0.2	0.4	0.3
Unidentified surfperch	0.1	0.5	0.3
Blacksmith	0.2	0.3	0.2
Honeycomb rockfish	0.0	0.4	0.2
White seaperch	0.4	0.0	0.2

Table 11. (Continued)

AVERAGE DENSITY			
Species	**Platform Gilda**	**Platform Holly**	**Both Platforms**
Kelp greenling	0.1	0.3	0.2
Shortspine combfish	0.2	0.2	0.2
Cabezon	0.3	0.1	0.2
Blue rockfish	0.0	0.3	0.2
Unidentified fishes	0.1	0.2	0.2
Sebastomus YOY	0.1	0.2	0.2
Copper rockfish YOY	0.1	0.2	0.1
Spotted scorpionfish	0.1	0.1	0.1
Treefish	0.1	0.2	0.1
Halfmoon	0.2	0.0	0.1
Gopher rockfish	0.1	0.1	0.1
Yellowtail rockfish YOY	0.0	0.2	0.1
Bluebanded ronquil	0.1	0.1	0.1
Unidentified combfishes	0.1	0.1	0.1
Pacific hake	0.0	0.1	0.1
Calico rockfish YOY	0.1	0.1	0.1
Rubberlip seaperch	0.1	0.1	0.1
Yellowtail rockfish	0.0	0.1	0.1
Starry rockfish	0.1	0.1	0.1
Longspine combfish	0.1	0.1	0.1
Unidentified sculpin	0.1	0.1	0.1
Flag rockfish YOY	0.0	0.1	0.1
Starry rockfish YOY	0.1	0.1	0.1
Brown rockfish YOY	0.1	0.1	0.1
Stripefin ronquil	0.0	0.1	0.1
Bull sculpin	0.0	0.1	0.1
Chilipepper	0.1	0.1	0.1
Wolf-eel	0.1	0.1	0.1
Rosy rockfish YOY	0.1	0.1	0.1
California lizardfish	0.0	0.1	0.1
California halibut	0.1	0.0	0.1
Greenspotted rockfish	0.1	0.1	0.1
Olive rockfish YOY	0.1	0.1	0.1
Yelloweye rockfish	0.1	0.1	0.1
Treefish YOY	0.1	0.0	0.1
Yelloweye rockfish YOY	0.0	0.1	0.1
Opaleye	0.1	0.0	0.1
Honeycomb rockfish YOY	0.0	0.1	0.1
Starry flounder	0.0	0.1	0.1
Grass rockfish	0.1	0.0	0.1
Stripetail rockfish	0.1	0.0	0.1
Cowcod	0.0	0.1	0.1
Shortspine thornyhead	0.0	0.1	0.1
Icelinus spp.	0.0	0.1	0.1
Cowcod YOY	0.0	0.1	0.1
Ocean sunfish	0.0	0.1	0.1
Total	341.1	160.2	250.6
Minimum Number of Species	42	50	55
Total Rockfish YOY	7.8	26.3	17.1
Total Rockfish	322.3	99.7	211.1
% Rockfish YOY	2.3	16.4	6.8
% Rockfish	94.5	62.3	84.2

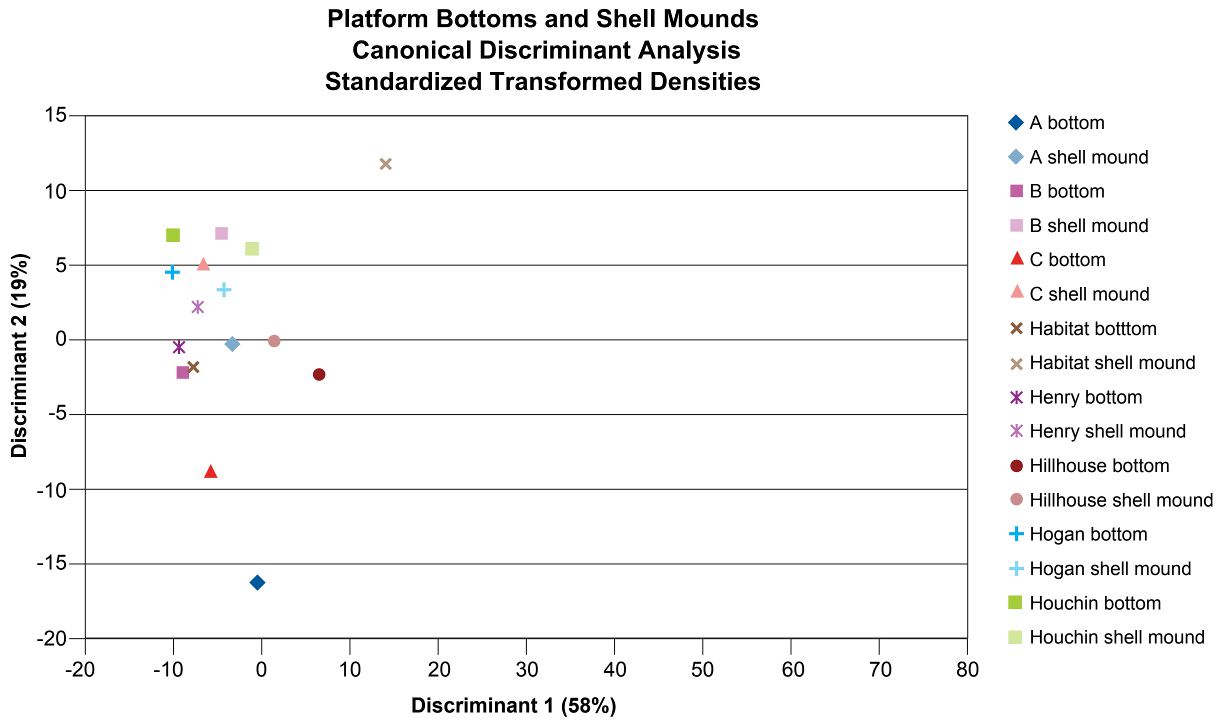


Figure 15. A canonical discriminant analysis of bottom and shell mound assemblages at eight platforms off Summerland, California, based on centroids of surveys conducted in 2012–2013.

Let us first look at species using life history pattern A. It might be expected that species such as blue and olive rockfishes, having recruited to the platform midwaters, would take up permanent residence as adults. This would be because the adult depths of these species include the bottom depths of most of these platforms. However, the adults of these species appear to require complex habitat with suitable sheltering sites. As noted previously, the Summerland platforms have relatively few such sites, in fact none in midwaters and few at the bottoms or shell mounds. The exceptions to this need for shelter are calico and halfbanded rockfishes. These species recruit to the platform bottoms and shell mounds and, as adults, likely remain there throughout their lives.

Fishes that fall into category B — recruiting shallow and moving deeper as they mature — are also very abundant at the Summerland platforms. However, in this instance the platform bottom depths are too shallow for the adult stages; these fishes use the platforms are settlement areas and then migrate deeper, often within a year of arrival. As an example, movements of YOY bocaccio from the Summerland platforms to a variety of natural reefs were documented by Hartmann (1987). Parenthetically, we note that the bottoms of deepwater platforms tend to harbor larger fishes and some of these adults likely derive from individuals that recruit to the platform midwater and move downwards as they mature. For instance, it is highly likely that the high densities of adult bocaccio living at the bottom of Platform Gail are derived from YOYs that had settled out a few years before (M. Love, unpubl. data). Lastly, an exception to all of these patterns is probably the vermilion rockfish. YOYs of this species do not recruit to platform midwaters; rather they settle out in shallow, low-relief substrate in the nearshore (shallower than the Summerland platforms) and within a short time likely migrate to these platforms where at least some likely remain until they mature.

4) The densities of fishes in the midwaters of most California platforms vary greatly between years, regardless of platform bottom depth, because juvenile rockfish recruitment varies (sometimes dramatically) between years (Nishimoto and Love 2011). At many shallower platforms (such as those off Summerland) the three habitat assemblages, which share a variety of juvenile rockfish species, are linked and thus fish

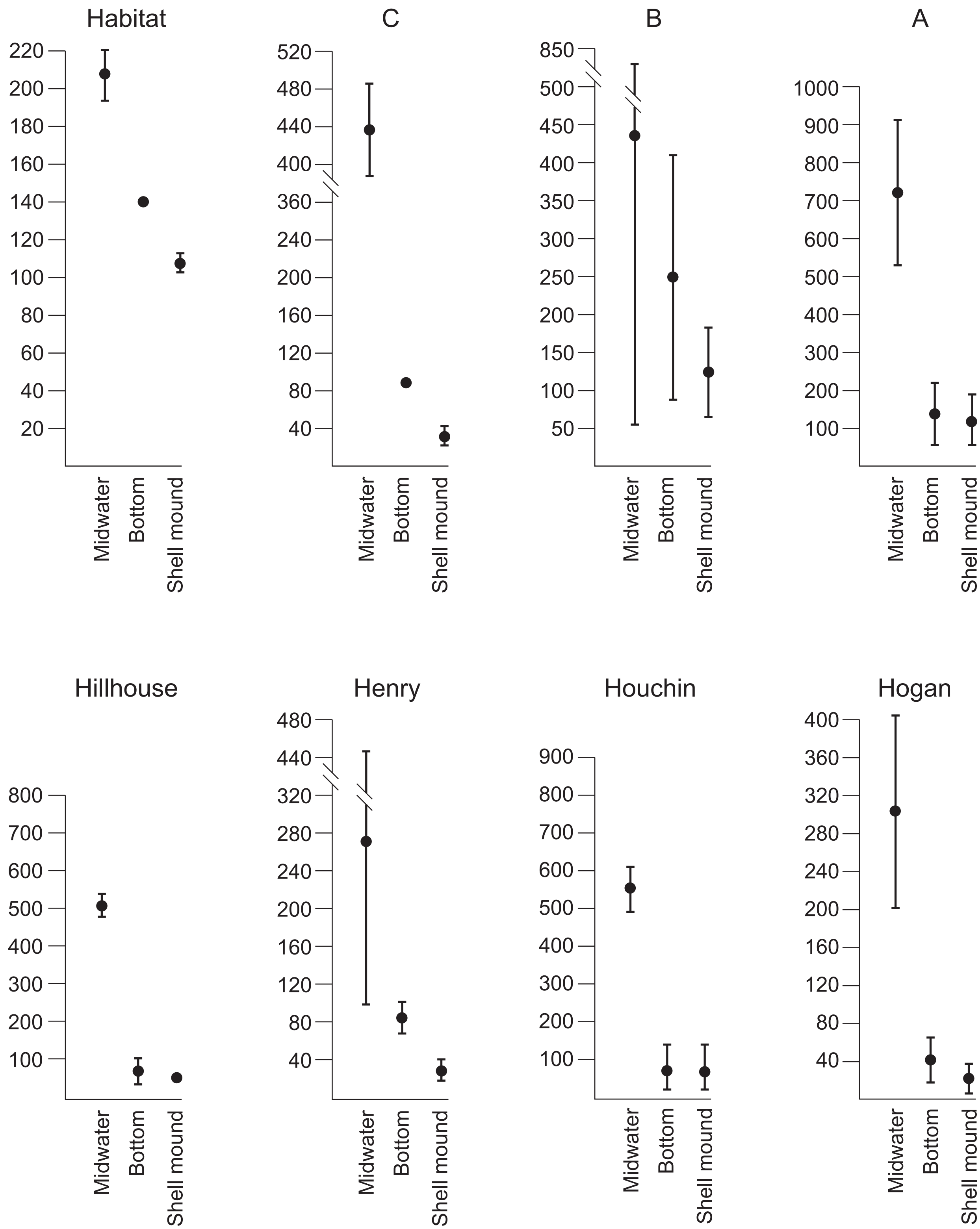


Figure 16. Mean overall densities (with standard errors) of all fishes observed during 2012–2013, midwaters, bottoms, and shell mounds of eight platforms off Summerland, California.

densities at all depths and habitats may vary greatly interannually (Figure 16). This contrasts with the fish assemblages at the bottoms of deeper platforms. Here adult fishes are most important. Many of these individuals are likely to be resident and thus overall fish densities are more stable over time (M. Love, unpubl. data).

5) However, it is noteworthy that any annual large-scale variability in fish densities does not necessarily mean that the *overall* composition of any fish assemblage will substantially alter. Our research has shown that, regardless of recruitment success by any species in any given year, there remains a typical suite of rockfish species (along with such other taxa as blacksmith and kelp and painted greenlings) that recruit from the plankton to platform midwaters, bottoms, and shell mounds. Among the rockfishes, these species include blue, the kelp, gopher, and brown complex, olive, shortbelly, widow, and yellowtail rockfishes, as well as bocaccio. On the shell mound and platform bottoms, heavily recruiting species include calico and halfbanded rockfishes, as well as rockfishes of the *Sebastomus* subgenus (e.g., greenspotted, rosy, and swordspine), cowcod, and lingcod. Thus, absent a profound regime shift, that causes a number of fish species to either leave or enter California waters, the overall species assemblages are likely to remain intact. And it would be expected that should offshore structures for renewable energy or oil and gas production be installed in similar water depths, either somewhat further northwards (into central California) or southwards (below the Long Beach area), their species assemblages would be similar to those found around current structures.

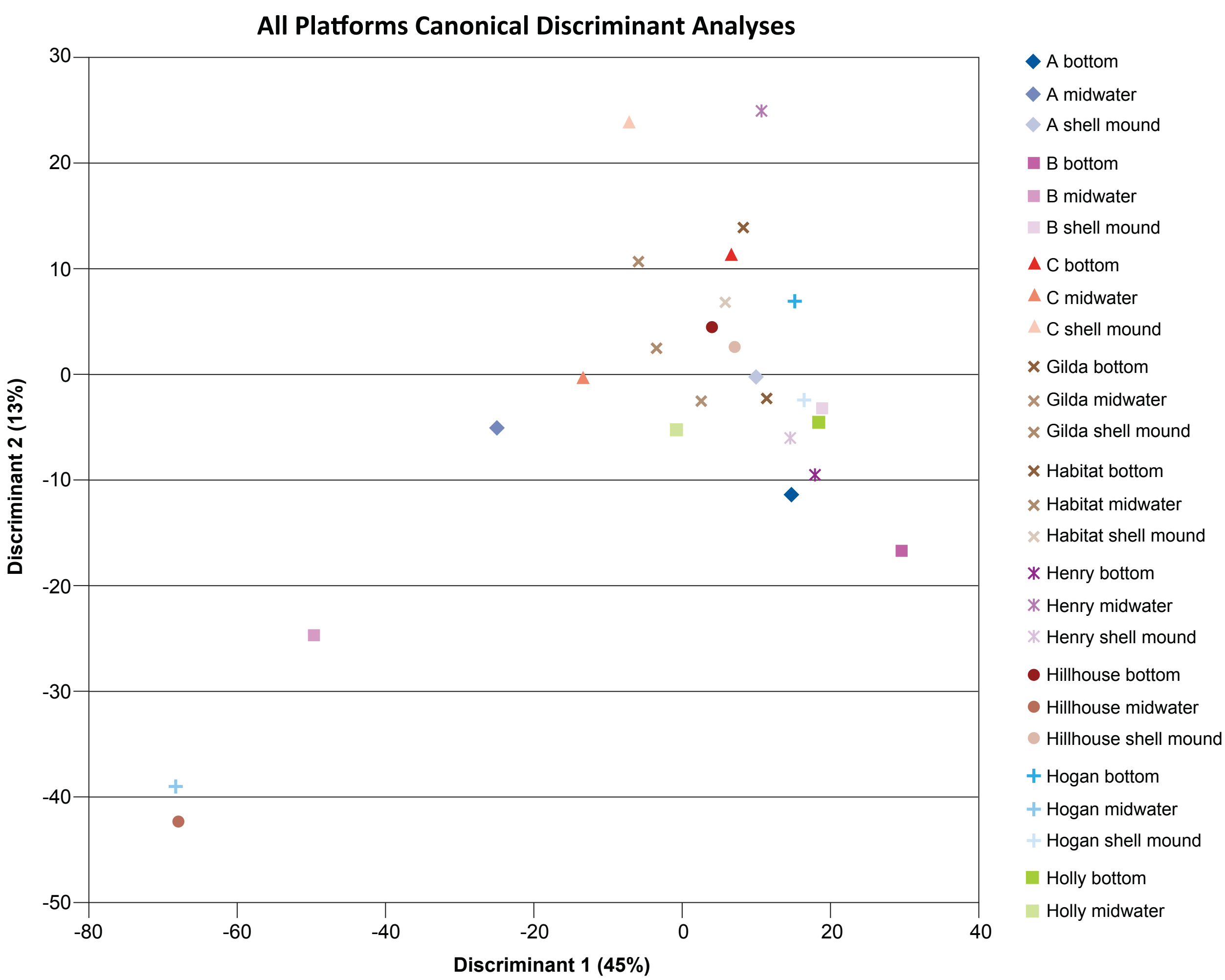


Figure 17. A canonical discriminant analysis of midwater, bottom, and shell mound assemblages at eight platforms off Summerland, California, and at two other platforms (Holly and Gilda) also in the Santa Barbara Channel.

6) As noted previously, YOY rockfish recruitment varies between years at the Summerland platforms. However, for at least some rockfish species, there is also substantial within-year inter-platform consistency in both recruitment occurrences and recruitment strength. In Table 12, we have summarized YOY recruitment patterns of five rockfish species. Two of the species, blue and olive rockfishes, displayed complete homogeneity in recruitment patterns. In both instances, rockfishes recruited to at least some platforms in both years, but highest densities at all of the platforms for each species were observed in 2013. Recruitment of the three other species (i.e., shortbelly and squarespot rockfishes and bocaccio) was somewhat more variable, but again in each case densities of these taxa were highest in 2013. From this it is clear that, at least for these species, those oceanographic factors that drive recruitment success impact a taxonomically wide range of pelagic juvenile rockfishes.

Table 12. A summary of YOY recruitment patterns for five rockfish species in the midwaters of eight platforms off Summerland, 2012–2013. Using blue rockfish as an example, at least one YOY was observed at six platforms in 2012 and at all eight platforms in 2013. However, the highest densities of this species at each platform were observed in 2013. Data summarized from Table 8.

	NUMBER OF PLATFORMS RECRUITED TO		**YEAR WITH HIGHEST DENSITY**	
	2012	**2013**	**2012**	**2013**
Blue rockfish	6	8	8	
Widow rockfish	2	8	8	
Squarespot rockfish	8	8	1	7
Bocaccio	6	7	2	5
Shortbelly rockfish	5	8	3	5

7) We would like to reinforce our previous findings (Love and York 2006, Love et al. 2006) that structure complexity, for instance as exemplified by degree of bottom-crossbeam undercut, appears to be a major factor in structuring both species richness and density, particularly of the adults of larger reef fishes. This is true both around the bottoms of platforms and on natural reefs. Additional evidence for the role of complexity comes from our surveys of the midwaters of Platform Eureka, whose crossbeams are unique in their quite varied complexity and whose species assemblage resembles a bottom habitat yet are actually in mid-water depths. (Love et al. 2010). Although there was relatively little complexity at the Summerland platforms, we note that Platform B, with the highest species richness, also had the most debris on bottom and shell mound. Although we have not yet quantified the amount of debris around platforms, our sense is that the bottom and shell mound of Holly, another very species-rich platform, also is one of the more debris-ridden. Regarding the decommissioning of California platforms, these observations might have a bearing on what options might be most appropriate as platforms lacking bottom complexity, and therefore harboring fewer species and numbers of some fishes, might be candidates for adding additional structure on the seafloor around the platforms.

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