



*Monitoring MPAs in Deep Water
Off Central California*



2007 IMPACT Submersible Baseline Survey



Acknowledgements

Many people participated in the 2007 IMPACT submersible baseline surveys, which helped us achieve all of our objectives associated with monitoring deepwater communities in eight newly formed marine protected areas in Central California. Funding for this project was provided by the California Ocean Protection Council and California Department of Fish and Game through a competitive grant program administered by the California Sea Grant College Program. Additional funding was provided by NOAA Fisheries Southwest Fisheries Science Center, University of California Sea Grant Extension Program, Moss Landing Marine Laboratories and Washington State University, Vancouver.

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Introduction

Deep rocky banks and outcrops, underwater pinnacles, and submarine canyons, ranging in depth from 30 m to >1,000 m, are important habitats in California waters. These deepwater habitats comprise 75% of the seafloor in state waters within the Central Coast region, and are home to hundreds of species of fishes and macroinvertebrates. Flatfishes, combfishes, poachers, and eelpouts are the dominant fish taxa on soft sediments, along with invertebrates such as sea pens and seastars. Rocky areas are dominated by more than 40 species of rockfishes and many invertebrate taxa such as feather stars, anemones, and gorgonian corals. Although deep habitats on the continental shelf and upper slope contain a high diversity of species that have been fished for decades, far less is known about these habitats and associated communities than those occurring in shallow water.

On September 21, 2007, 29 marine protected areas (MPAs) were established off Central California, including two types in deep water: State Marine Reserves (SMR) and State Marine Conservation Areas (SMCA). These MPAs are a result of the 1999 California Marine Life Protection Act that increased protection to coastal marine habitats and species. The creation of this large network of MPAs is a new approach to marine resource management, and has been initiated with a scientific monitoring program that will be used to evaluate the effectiveness of the MPAs and the network.



Lingcod

Mary Yoklavich

In 2007, through a competitive grant program, the California Ocean Protection Council and the California Department of Fish and Game provided funding for our team to collect baseline data in the deep portions of eight of the new MPAs and associated Reference sites. We used the manned submersible *Delta* to survey all fishes and structure-forming invertebrates (e.g., deepsea coral communities) in 164,000 m² of seafloor habitats from 24–365 m deep in Monterey Bay and along the Big Sur coast. During 337 quantitative transects, we observed nearly 66,000 fishes from 110 taxa, and 158,000 aggregating and 14,000 structure-forming invertebrates from 70 taxa. This comprehensive baseline will be used in the future to critically evaluate the effectiveness of the new MPAs by assessing changes in the diversity, density, and size composition of species using seafloor habitats in the new MPAs.



Spiny seastar, strawberry anemones, and a young starry rockfish

Jason Michaelson

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Front cover photos: *Widow rockfish*, Tom Laidig; *Canary rockfish* and *starry rockfish*, Rick Starr; *Feather stars* and *strawberry anemones*, Brian Tissot

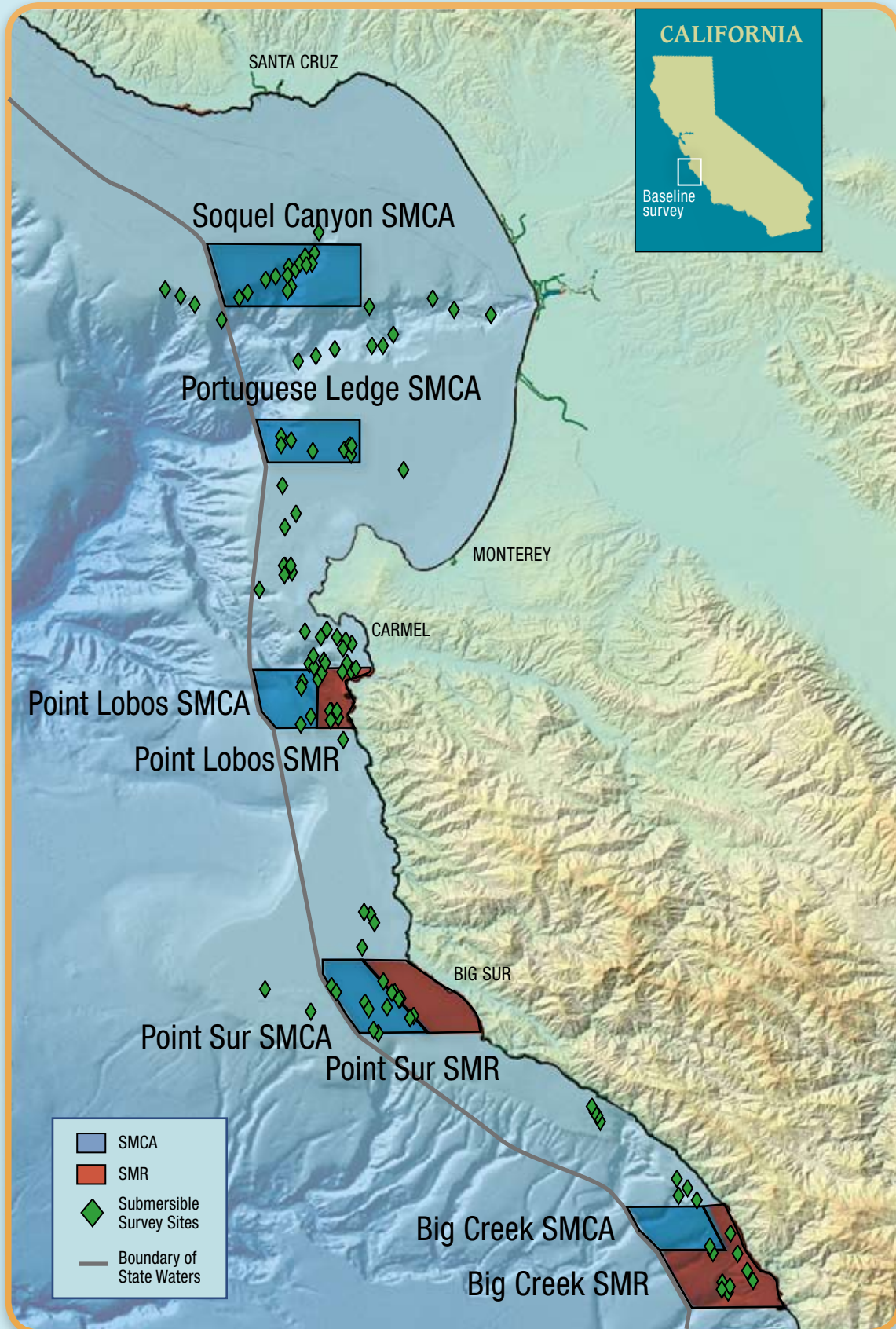
Acknowledgements page photo: Rick Starr

MPAs and Dive Sites map: *Modified from map provided by the Monterey Bay National Marine Sanctuary*
Methods page images: *Submersible and pilot*, Tom Laidig; *Equipment*, Rick Starr; *Survey graphic modified from drawing by Brian Tissot*; *Seafloor map provided by Rikk Kvitek, and modified by Diana Watters*

Back cover photos: *Widow rockfish* and *white-plummed anemones*, Tom Laidig; *Vermilion rockfish*, Rick Starr

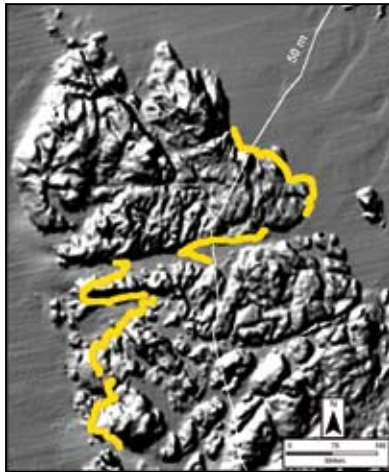
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2007 Deepwater Submersible Dives in Baseline Survey of MPAs and Reference Sites Off Central California



Methods

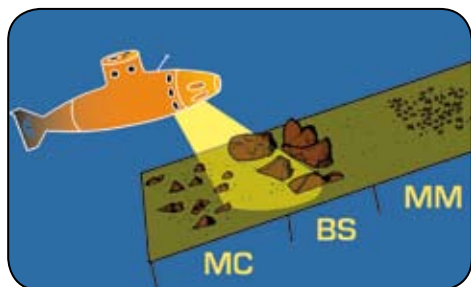
The *Delta* submersible is a proven tool for nonextractive research on fishes, invertebrates, and associated seafloor habitats in water depths to 365 m. Over the past 20 years, nearly 7,000 dives have been completed and more than 85 scientific publications have resulted from *Delta* submersible studies.¹ This two-person submersible can be deployed from a variety of research vessels, with minimal disturbance to seafloor communities. *Delta* is especially useful for studying diverse assemblages of fishes and invertebrates in high-relief rocky habitats, which are difficult to survey using other tools. During our evaluation of the new MPAs, we identified 95% of the rockfish species that occur in Central California. An additional benefit of surveying with a manned submersible is that our ability to detect and identify cryptic or small species and



Delta transect (yellow line) with multibeam map of seafloor

individuals that are critical prey items of larger fishes is much greater than observations made from videotape alone, as with a drop-camera or ROV (remotely operated vehicle). Our approach is cost-effective, nondestructive, and essential for ecosystem-based management of MPAs.

Using *Delta* in 2007, we conducted quantitative, visual strip transects to characterize seafloor habitats and to identify, count, and measure species of fishes and macroinvertebrates on or near the seafloor in each MPA and Reference site. We chose sampling locations based on the occurrence of rocky habitats that were identified from multibeam bathymetric maps (many funded by the California Ocean Protection Council and provided by the California State University Monterey Bay Seafloor Mapping Lab), and on the knowledge of seafloor habitats that we have gained in 15 years of submersible surveys off Central California.



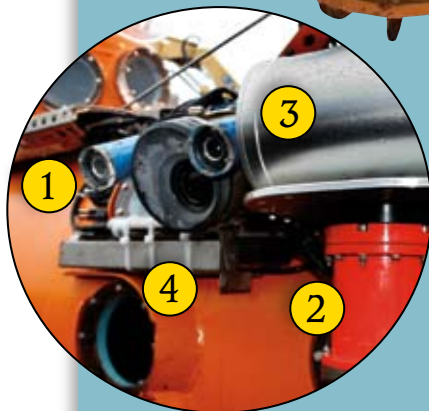
Schematic of habitat patches of mud-cobble (MC), boulder-sand (BS), and mud-mud (MM) being surveyed along a transect using *Delta*

Transect width was estimated by scientific observers with the aid of a hand-held sonar device. Each transect was documented with an external video camera (4) and annotated in real-time by the scientist. Invertebrates and habitats were quantified from the videotape. These transects provided estimates of abundance, size distribution, and species composition of adult and juvenile fish assemblages and key invertebrate species in the new MPAs.

Using *Delta* in 2007, we conducted quantitative, visual strip transects to characterize seafloor habitats and to identify, count, and measure species of fishes and macroinvertebrates on or near the seafloor in each MPA and Reference site. We chose sam-

pling locations based on the occurrence of rocky habitats that were identified from multibeam bathymetric maps (many funded by the California Ocean Protection Council and provided by the California State University Monterey Bay Seafloor Mapping Lab), and on the knowledge of seafloor habitats that we have gained in 15 years of submersible surveys off Central California.

Submersible surveys followed protocols that have been vetted and peer-reviewed in the scientific literature. A pilot operated the submersible while an experienced scientist identified all fish species and estimated their lengths, using paired lasers (1) as a guide, within a 2 m-wide strip adjacent to the submersible. Each dive included multiple 10 min-long transects in a predetermined habitat. The length of each transect was determined accurately using a Doppler velocity log (2) and ring-laser gyrocompass (3).



¹Yoklavich, M.M. and V. O'Connell. In: Reynolds, J.R. et al. (eds.), 2008. Marine Habitat Mapping Technology for Alaska. Alaska Sea Grant College Program, University of Alaska Fairbanks

Soquel Canyon SMCA Reference



Sunflower star

Rick Starr

Habitats:

Reference sites for the Soquel Canyon SMCA are located along the north and south edges of the Monterey Submarine Canyon. High-relief rock ridges and rock-mud slopes accounted for 58% of the habitats we surveyed in the Soquel Canyon SMCA Reference sites, while 42% were comprised of mud, mud-cobble, and mud-rock.



Splitnose rockfish

Milton Love

Fishes:

Poachers, bocaccio, and widow, greenspotted, bank, and rosethorn rockfishes were observed in densities

>1 per 100 m² at depths of 100–200 m. High-density species at depths >200 m, such as splitnose, rosethorn, and bank rockfishes, and Dover and Rex soles, commonly were found over soft sediment. We did not survey habitats at depths <100 m in the Reference sites.



Bocaccio

Rick Starr

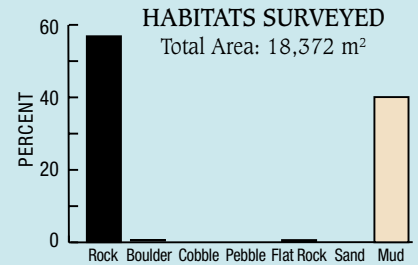
Invertebrates:

Brachiopods (49%), brittlestars (22%), and red seastars (10%) accounted for 81% of all invertebrates observed in the Soquel Canyon SMCA Reference sites. Brachiopods and brittlestars often co-occurred on small boulder and cobble habitats, with red seastars on a variety of habitats.



Rex sole

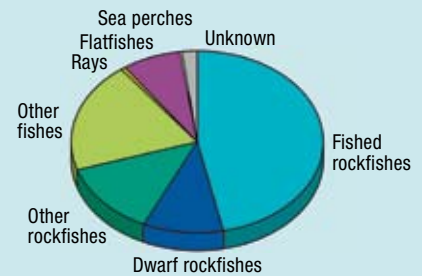
Linda Snook



DENSITY OF FISHES BY DEPTH ZONE

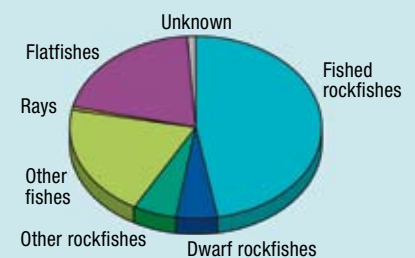
100–200 m

(17.0 Fish/100 m²)



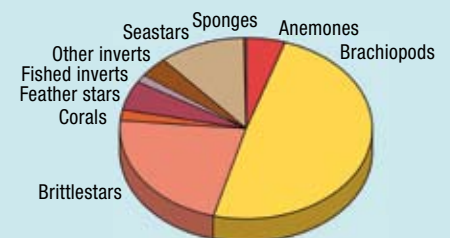
>200 m

(14.6 Fish/100 m²)

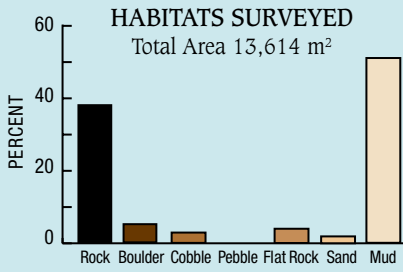


PROPORTION OF INVERTEBRATES COUNTED

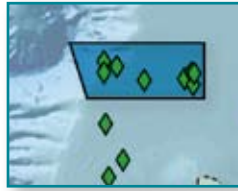
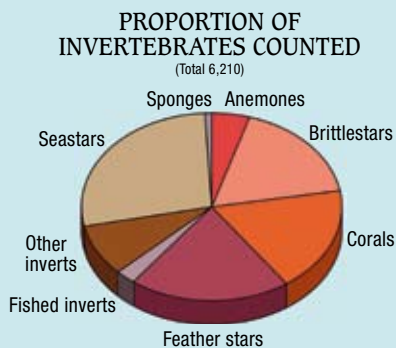
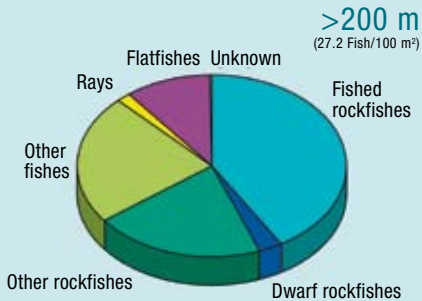
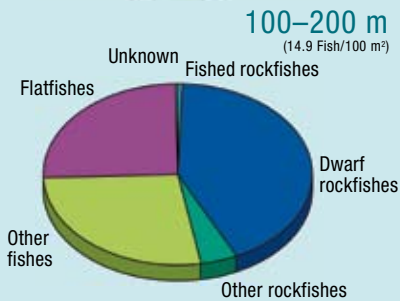
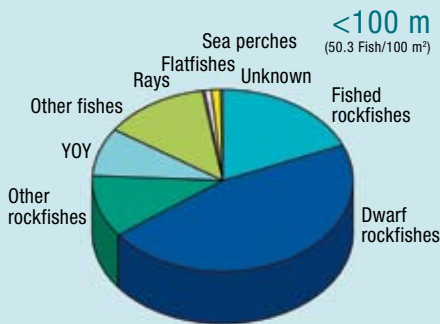
(Total 27,656)



Portuguese Ledge SMCA



DENSITY OF FISHES BY DEPTH ZONE



Yelloweye rockfish next to lost crab trap Rick Starr

Portuguese Ledge SMCA encompasses approximately 10.9 mi² in the southern half of Monterey Bay, and extends out to the boundary of state waters. This SMCA provides increased protection to submarine canyon and shelf habitats and all associated seafloor species. Specific objectives of this MPA include the restoration of species in an area that has been fished heavily for decades and has become less productive.



Flag rockfish Rick Starr

Habitats:

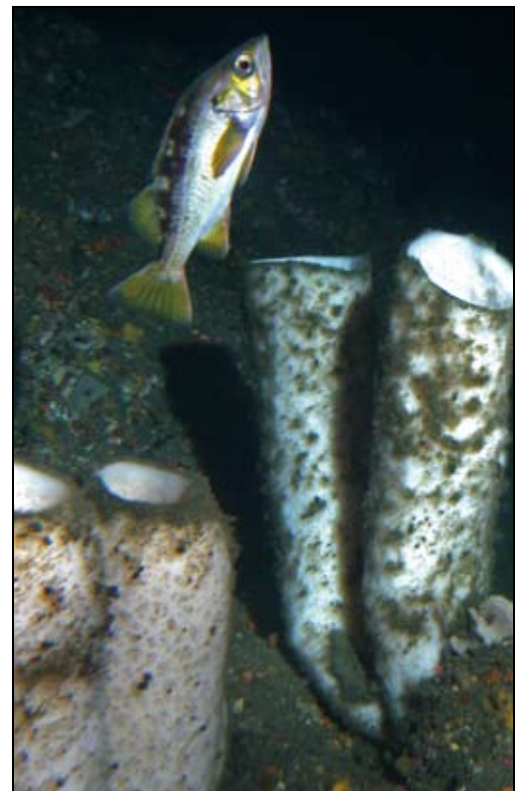
Depths range from <100 m to >1400 m. The majority of this MPA is represented by low-relief soft sediments. Portuguese Ledge itself is formed by high-relief rock outcrop and boulders. The west edge of this MPA contains steep rock and sediment slopes that are part of the Monterey Canyon. Mud habitats accounted for 51% of the surveyed habitats, and rock ridges, rock-mud, rock-boulder, and rock-cobble comprised 38% of all surveyed habitats.

Fishes:

We observed 68 taxa of fishes in this MPA. Pygmy rockfish dominated habitats <100 m deep. Young-of-the-year (YOY) rockfishes, blackeye gobies, and square-spot, rosy, yellowtail, starry, and widow rockfishes were all observed in densities >1 per 100 m². Halfbanded rockfishes, flatfishes, and combfishes dominated the soft sediments at 100–200 m depths. High-density species in habitats >200 m included splitnose, shortbelly, bank, and rosethorn rockfishes, as well as poachers, thornyheads, and Dover sole.

Invertebrates:

Seastars, feather stars, corals, and brittlestars accounted for 83% of all invertebrates observed in the Portuguese Ledge SMCA. These invertebrates were usually associated with rock ridges and mixed rock habitats. Fished species (2.7%) included spot prawns and sea cucumbers.



Yellowtail rockfish and barrel sponges Jen Blaine

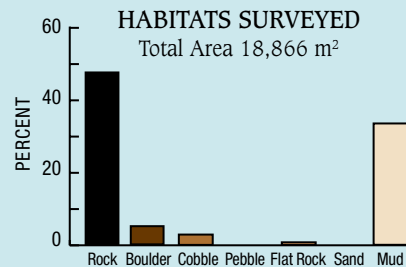
Portuguese Ledge SMCA Reference



Barrel sponge, squat lobster and feather stars
Mary Nishimoto

Habitats:

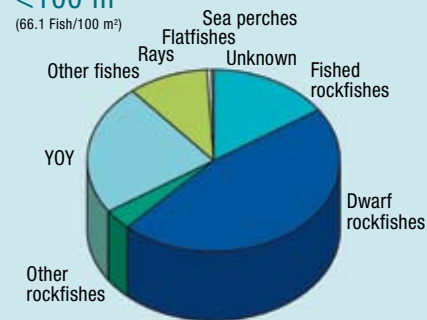
Reference sites for the Portuguese Ledge SMCA are located on the south edge of the Monterey Submarine Canyon and on the relatively flat shelf near Point Pinos. Rock-ridge, rock-cobble, rock-boulder, and rock-mud accounted for 47% of the habitats, and mud habitats accounted for 37% of the areas surveyed.



DENSITY OF FISHES BY DEPTH ZONE

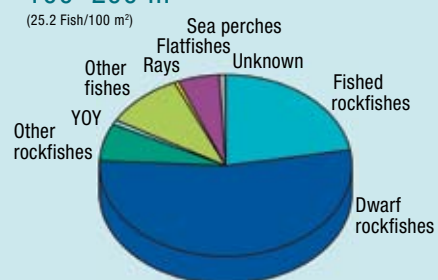
<100 m

(66.1 Fish/100 m²)



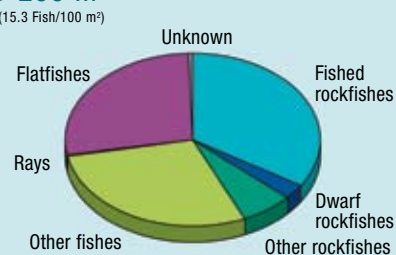
100–200 m

(25.2 Fish/100 m²)



>200 m

(15.3 Fish/100 m²)



Fishes:

In water depths <100 m, densities of pygmy rockfish averaged 27 per 100 m². Young-of-the-year rockfishes, blackeye gobies, and rosy, squarespot, yellowtail, and starry rockfishes also were abundant (>1 fish per 100 m²). Halfbanded, pygmy, bocaccio, and greenspotted rockfishes, and poachers were abundant in habitats at 100–200 m. High densities of splitnose, rosethorn, and bank rockfishes, poachers, thornyheads, and Dover and Rex soles, occurred at depths >200 m.



Squarespot rockfish

Rick Starr

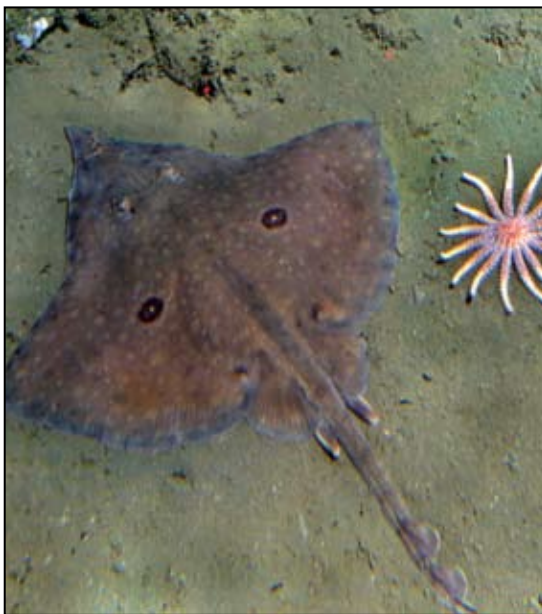
Invertebrates:

Half (50%) of all invertebrates observed at Portuguese Ledge SMCA Reference sites were brachiopods or feather stars. Red seastars, brittlestars, and sea-whip corals also were common.



Shortspine thornyhead

Liz Sassone

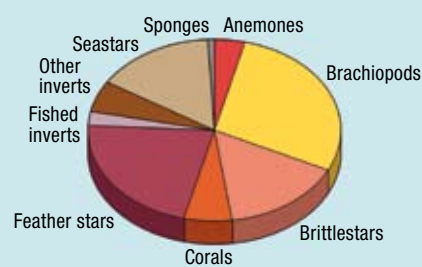


Longnose skate and sunflower star

Milton Love

PROPORTION OF INVERTEBRATES COUNTED

(Total 16,328)

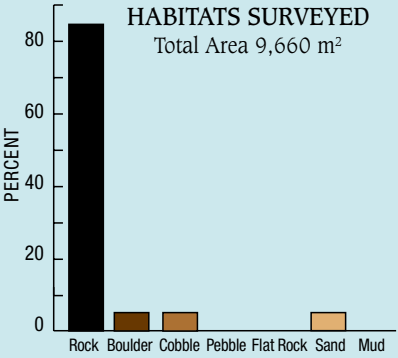


Point Lobos SMR

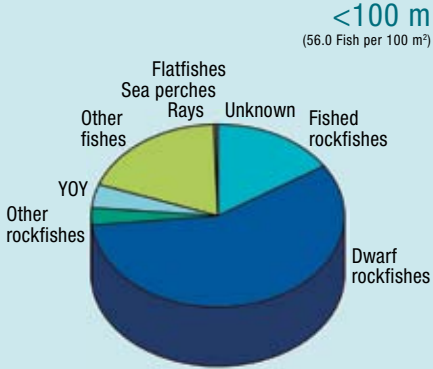


Point Lobos

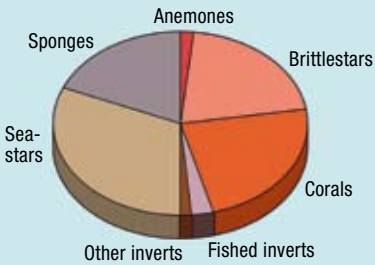
Zoe Schumacher



DENSITY OF FISHES BY DEPTH ZONE



PROPORTION OF INVERTEBRATES COUNTED
(Total 6,061)



Point Lobos SMR encompasses approximately 5.4 mi² on the south side of Carmel Bay. This SMR provides increased protection of nearshore rocky habitats through the expansion of an existing, small state marine reserve that was established in 1973. One specific objective of this new MPA is the protection of the relatively high species diversity that is characteristic of the granitic Central Coast.

Habitats:

Water depths range from intertidal to 125 m deep. The majority of this MPA contains high-relief granitic outcrops, boulders, cobbles, and sandy sediment. Kelp covers the rocky areas out to a depth of about 30 m. Rock, boulder, and cobble habitats accounted for 96% of the area we surveyed.

Fishes:

We observed 38 taxa of fishes in this MPA. Pygmy rockfish (29 per 100 m²) dominated depths <100 m. The blackeye goby occurred in densities of >9 per 100 m². Rosy, squarespot, blue, olive, and young-of-the-year rockfishes, and painted greenlings also were abundant.



Squarespot rockfish and strawberry anemones

Rick Starr

Invertebrates:

Ten species of seastar, four species of coral, brittlestars, and foliose, nipple, and puffball sponges accounted for 94% of all invertebrates observed at Point Lobos SMR. These taxa occurred in similar abundances primarily on high relief rock habitats.



Blue rockfish

Tom Laidig



Olive rockfish

Tom Laidig

Point Lobos SMR Reference



Hydrocoral

Victoria O'Connell



Juvenile starry rockfish

Tom Laidig

Habitats:

Reference sites for the Point Lobos SMR are located in Carmel Bay and south of Yankee Point. Rock, cobble, and boulder habitats accounted for 92% of the area we surveyed.

Fishes:

Young-of-the-year rockfishes (>13 per 100 m²) and blackeye gobies (10 per 100 m²) were abundant at depths <100 m. Pygmy, rosy, squarespot, and blue rockfishes all occurred in densities >1 per 100 m².

Invertebrates:

Red and bat seastars, sea whip corals, and hydrocorals were the most abundant invertebrates at Point Lobos SMR Reference sites. Seastars accounted for 62% of all invertebrates. The other taxa (brittlestars and feather stars) were more abundant than in Point Lobos SMR, reflecting the increased diversity of habitats in the reference sites.



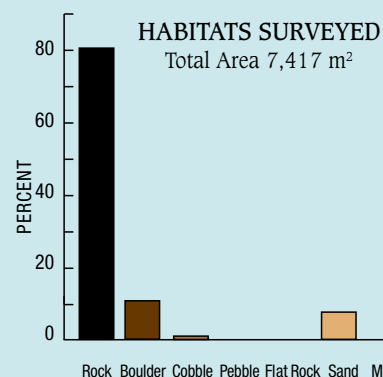
Pygmy rockfish

Rick Starr



Blackeye goby and red seastar

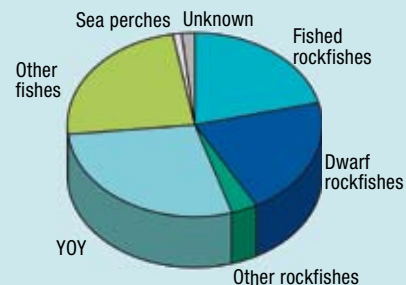
Rick Starr



DENSITY OF FISHES BY DEPTH ZONE

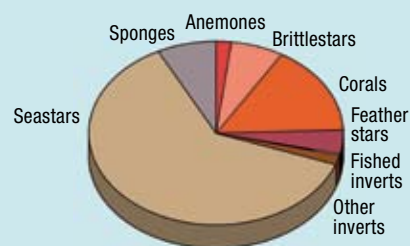
<100 m

(48.0 Fish per 100 m²)



PROPORTION OF INVERTEBRATES COUNTED

(Total 4,011)

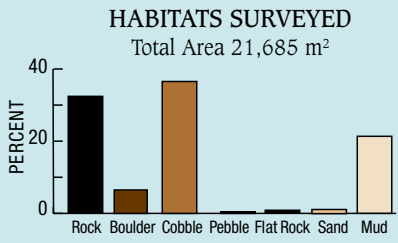


Point Lobos SMCA

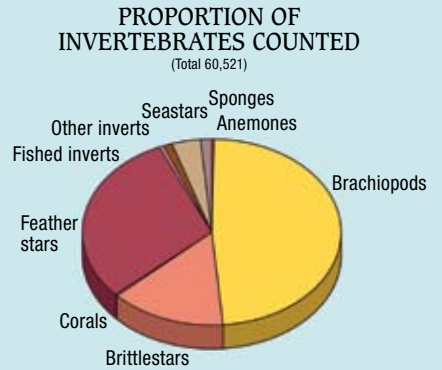
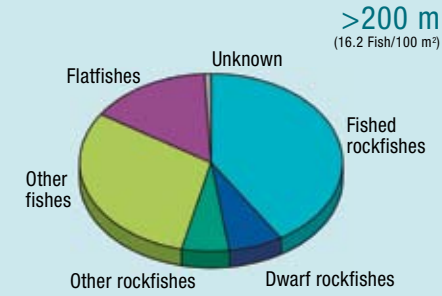
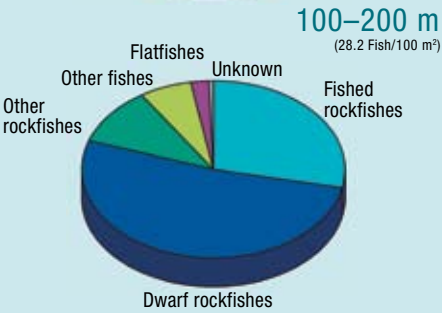
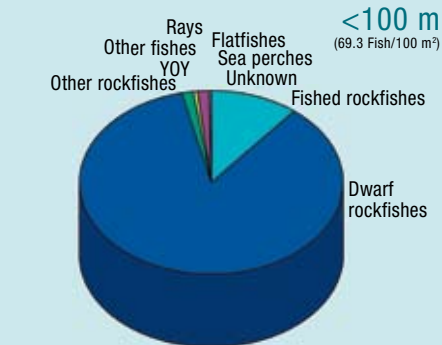


Ratfish

Victoria O'Connell



DENSITY OF FISHES BY DEPTH ZONE



Point Lobos SMCA encompasses approximately 8.9 mi² on the south side of the Carmel Canyon. It is located just offshore and adjacent to the Point Lobos SMR, and extends out to the boundary of state waters. This SMCA provides increased protection of fishes in an area of diverse habitats. A specific objective is the protection of seafloor communities across a wide depth range, in close proximity to each other.

Habitats:

Depths range from 80 m to >550 m. This MPA contains high-relief granitic outcrops in 80–100 m of water. In deeper water, canyon habitats include steep sediment and rock slopes, large cobble fields, and expanses of soft sediment. Our survey included primarily cobble (37%), rock (33%), and mud, mud-pebble, and mud-rock (21%) habitats.

Fishes:

We observed 64 taxa of fishes in this MPA. Pygmy (31 per 100 m²) and squarespot (23 per 100 m²) rockfishes were by far the most abundant fishes in the shallow



Bank rockfish and red seastar

Rick Starr



Rosy rockfish

Rick Starr



Brachiopods and pygmy rockfish

Mary Yoklavich

portions of this MPA. Halfbanded, rosy, widow, and starry rockfishes also were abundant in habitats <100 m deep. Halfbanded, pygmy, rosethorn, bank, Sebastomus, and striptail rockfishes occurred in densities >1 per 100 m² in depths of 100–200 m. Bank, striptail, and rosethorn rockfishes, flatfishes, poachers, and thornyheads were the most abundant species in waters >200 m deep.

Invertebrates:

Brachiopods (48%), feather stars (30%), and brittlestars (15%) dominated the invertebrate assemblage in Point Lobos SMCA. This reflects the abundance of small boulder and cobble habitats in this area.

Point Lobos SMCA Reference



Mushroom soft coral
Zoe Schumacher

Habitats:

Reference sites for the Point Lobos SMCA are located in Carmel Bay, Carmel Canyon, and areas northwest of Cypress Point. Rock, cobble, and boulders accounted for about 70% of the habitats in our survey, and mud, mud-cobble, and mud-rock bottoms represented 27% of the habitats.



Rosethorn rockfish and fragile sea urchins
Liz Sassone

Fishes:

Young-of-the-year, pygmy, rosy, squarespot, and blue rockfishes, and blackeye gobies were the most abundant fishes in the shallow (<100 m deep) portions of these Reference sites. Rosethorn, halfbanded, and bank rockfishes occurred in densities >1 per 100 m² at depths of 100–200 m. Bank, splitnose, and rosethorn rockfishes and poachers were the most abundant fishes in waters >200 m deep.



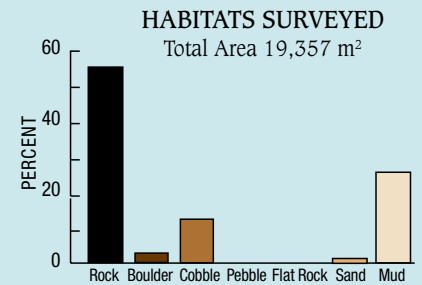
Halfbanded rockfish and brachiopods
Mary Yoklavich

Invertebrates:

Brittlestars, feather stars, and seastars (especially batstars) were the most abundant invertebrates at Point Lobos SMCA Reference sites. We also observed other taxa, such as squat lobsters, which were more abundant than in Point Lobos SMCA, reflecting the increased diversity of habitats in the Reference sites.

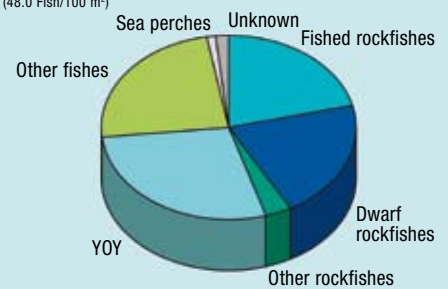


Fish-eating seastar on catshark eggs
Rick Starr

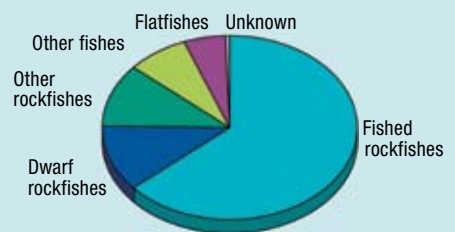


DENSITY OF FISHES BY DEPTH ZONE

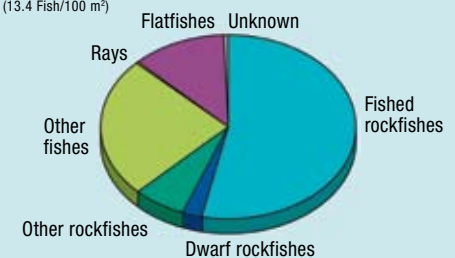
<100 m
(48.0 Fish/100 m²)



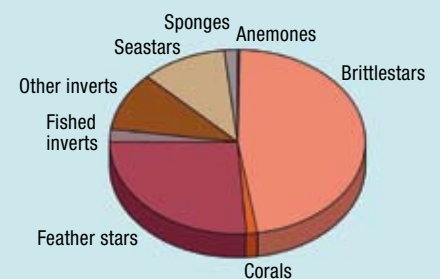
100–200 m
(12.8 Fish/100 m²)



>200 m
(13.4 Fish/100 m²)



PROPORTION OF INVERTEBRATES COUNTED (Total 16,663)



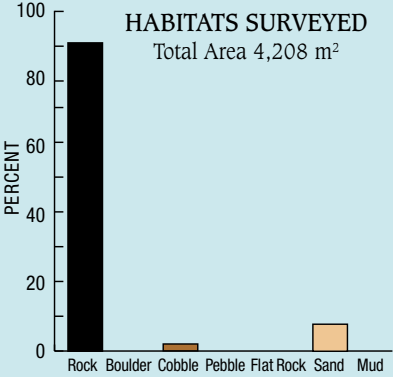
Point Sur SMR



Rosy rockfish
Linda Snook

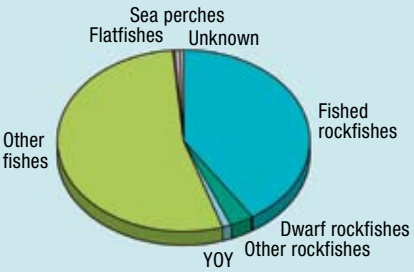


Point Sur SMR encompasses approximately 8.7 mi² on the south side of Point Sur. This SMR provides protection for a diverse array of habitats and associated fishes and invertebrate species. This MPA specifically protects the high species diversity associated with an upwelling site located in the lee of a headland.



DENSITY OF FISHES BY DEPTH ZONE

<100 m
(12.5 Fish/100 m²)



Gopher rockfish
Linda Snook

Habitats:

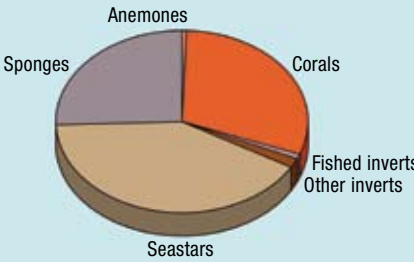
The majority of this MPA contains a mixture of rock outcrops and sand habitats in a high-energy environment. Kelp covers the rocky areas to a depth of about 30 m. Rock-ridge, rock-sand, and rock-cobble habitats accounted for 91% of our survey area.

Fishes:

We observed 23 taxa of fishes in this MPA. Blackeye gobies, rosy and gopher rockfishes, and painted greenlings occurred in the highest densities at depths of 35–50 m.

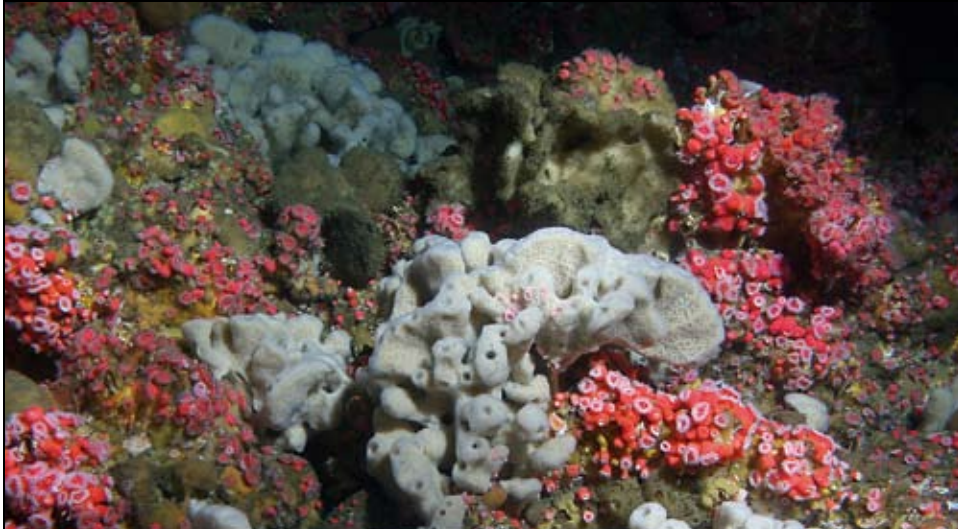
PROPORTION OF INVERTEBRATES COUNTED

(Total 1,462)



Invertebrates:

Bat seastars (41%), red gorgonian corals and hydrocorals (30%), and nipple sponges (26%) dominated the invertebrate assemblages at Point Sur SMR. The overwhelming abundance of these groups reflects the conditions of high relief and energy that occur at Point Sur.



Sponges and strawberry anemones
Liz Sassone

Point Sur SMR Reference



Blackeye goby and cup corals

Rick Starr

Habitats:

Reference sites for the Point Sur SMR are located in rocky areas immediately north of Point Sur. Rock habitats accounted for 95% of our survey area. Reference sites were located at depths of 35–50 m.



Vermilion rockfish

Rick Starr



Painted greenling, strawberry anemones and blood seastar

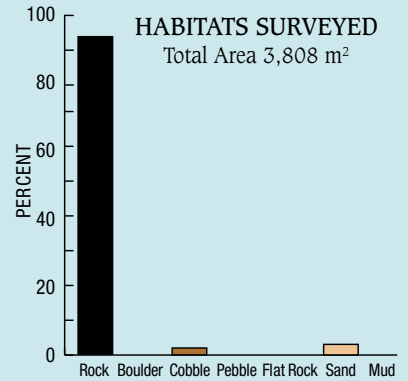
Tom Laidig

Fishes:

Rock habitats in <50 m of water harbored rosy, olive, blue, gopher, vermilion, and young-of-the-year rockfishes, blackeye gobies, and painted greenlings at densities >1 fish per 100 m²

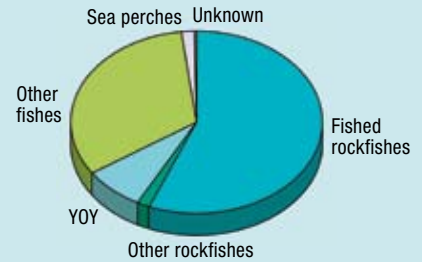
Invertebrates:

Bat and red seastars, sponges, seawhip corals, and hydrocorals accounted for almost all of the invertebrates counted in Point Sur SMR Reference sites. The composition of invertebrates reflects the high-energy environment at Point Sur.



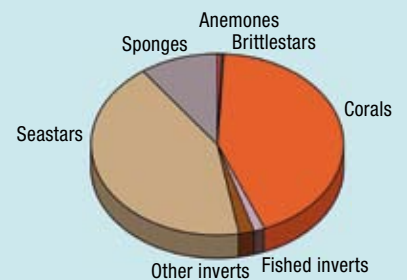
DENSITY OF FISHES BY DEPTH ZONE

<100 m
(20.5 Fish/100 m²)



PROPORTION OF INVERTEBRATES COUNTED

(Total 1,979)



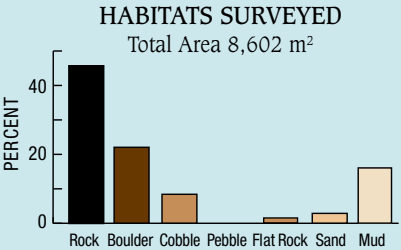
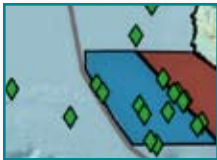
Curious sea lions

Liz Sassone

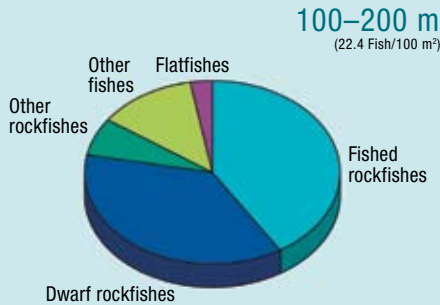
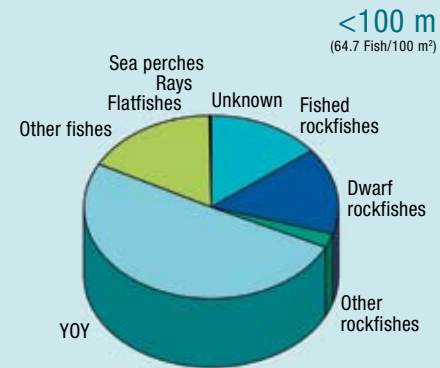
Point Sur SMCA



Octopus Rick Starr



DENSITY OF FISHES BY DEPTH ZONE



Yelloweye rockfish Mary Nishimoto

Habitats:

This MPA contains high-relief rock outcrops, boulder and cobble fields, and large expanses of sediment in a high-energy environment. We surveyed habitats at depths of 46–190 m. Rock, boulder, and cobble habitats accounted for 80% of the survey area, and mud, mud-boulder, mud-cobble, and mud-rock bottoms comprised an additional 16% of these habitats.

Fishes:

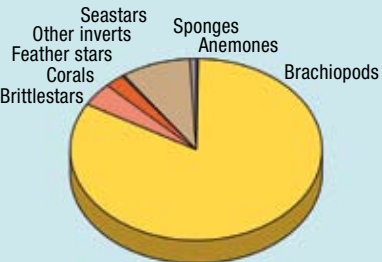
We observed 47 taxa of fishes at this MPA. Young-of-the-year rockfishes by far were the most abundant group (33 per 100 m²) in the shallow portions of this MPA. Blackeye gobies, painted greenlings, and rosy, pygmy, and squarespot rockfishes occurred in densities of >1 per 100 m² at depths <100 m. Pygmy, greenspotted, and rosethorn rockfishes, and poachers were abundant at depths of 100–200 m.

Invertebrates:

Brachiopods were the dominant invertebrates observed in Point Sur SMCA, accounting for 83% of the total. Also common were red seastars, sea whip corals, and feather stars.

PROPORTION OF INVERTEBRATES COUNTED

(Total 12,223)



Lingcod among brachiopods Mary Yoklavich

Point Sur SMCA Reference



Rockfish next to feather star on rim of sponge Rick Starr

Habitats:

Reference sites for the Point Sur SMCA are located on the large bank located immediately west of the Point Sur SMCA, at depths of about 50–190 m. Mixtures of rock and boulder habitats accounted for 90% of the survey area.

Fishes:

Rock habitats in <100 m of water harbored high densities (53 fish per 100 m²) of young-of-the-year rockfishes; abundance of young rockfishes was higher at the Point Sur study sites (both SMCA and Reference) than at any other site in our survey. Pygmy, rosy, starry, squarespot, widow, and yellowtail rockfishes occurred in numbers >1 per 100 m², as did blackeye gobies. Pygmy rockfish were extremely abundant (99 per 100 m²) in the 100–200 m depth zone. Squarespot, Sebastomus, yellowtail, rosy, vermilion, young-of-the-year, bocaccio, starry, speckled, and widow rockfishes, and blackeye gobies all occurred in densities >1 per 100 m².



Vase sponge with feather stars Rick Starr

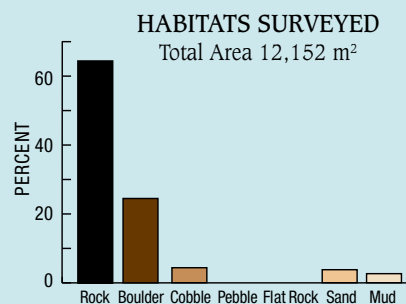
Invertebrates:

Red and bat seastars, red gorgonian corals, feather stars, brachiopods, and barrel sponges accounted for almost all of the invertebrates observed in Point Sur SMCA Reference sites. Also occurring here were nipple sponges and cookie seastars.



Young-of-the-year pygmy rockfishes

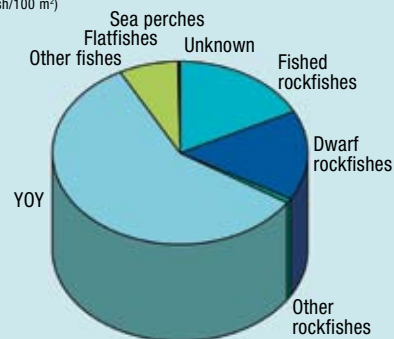
Tom Laidig



DENSITY OF FISHES BY DEPTH ZONE

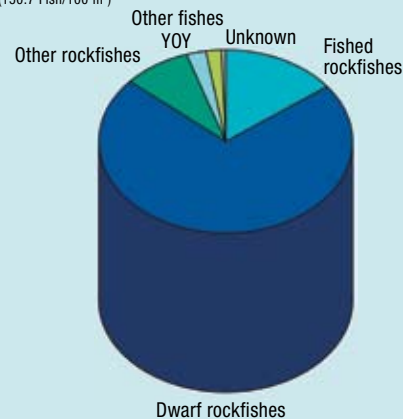
<100 m

(91.9 Fish/100 m²)



100–200 m

(150.7 Fish/100 m²)



PROPORTION OF INVERTEBRATES COUNTED

(Total 4,672)



Big Creek SMR



Rosethorn rockfish and seastar

Rick Starr



Big Creek SMR encompasses approximately 12.4 mi² toward the southern end of the Big Sur coastline, extending offshore from the shoreline to the boundary of state waters. Through expansion of the existing, small Big Creek Ecological Reserve (established in 1990), this new SMR provides greater protection for a diverse array of shallow and deep habitats and highly diverse assemblages of associated fish and invertebrate species.

Habitats:

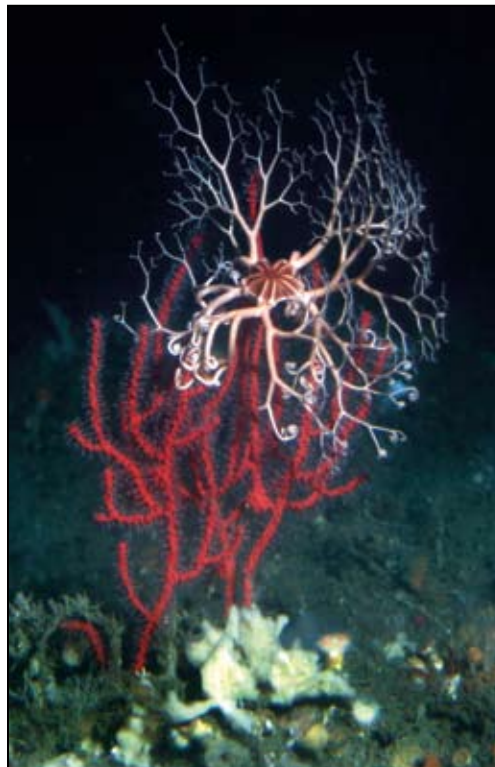
Shallow habitats include sandy beach, rocky intertidal, surfgrass, kelp beds, pinnacles, rock outcrops and soft sediments from 0 to 50 m deep. Sand flats, and boulder and cobble fields occur in deeper water on the continental shelf, which transitions to submarine canyon habitats. Our survey included about half complex rock habitats and half low-relief sand and mud habitats.

Fishes:

We observed 70 taxa of fishes in this MPA. Blue rockfish (12.7 per 100 m²), blackeye gobies, young-of-the-year, olive, vermilion, and gopher rockfishes, and sanddabs were all abundant in habitats <100 m deep. Pygmy (17.6 per 100 m²), squarespot, Sebastomus, halfbanded, rosethorn, bank, greenspotted, and vermilion rockfishes, and poachers were abundant at depths from 100–200 m. Bank, splitnose, and rosethorn rockfishes were the most abundant species in seafloor habitats deeper than 200 m.

Invertebrates:

Red, bat, and sunflower seastars (26%), nipple and puffball sponges (24%), brittlestars (23%), and other invertebrates, such as squat lobsters and sea pens (13%) accounted for almost of all invertebrates observed in Big Creek SMR. This even distribution of primary groups reflects the varied habitats over a broad depth range in Big Creek SMR.



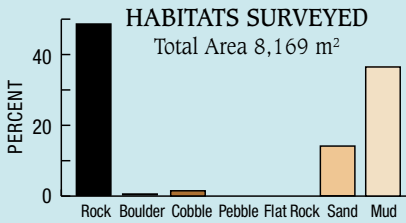
Basket star and red gorgonian coral

Rick Starr

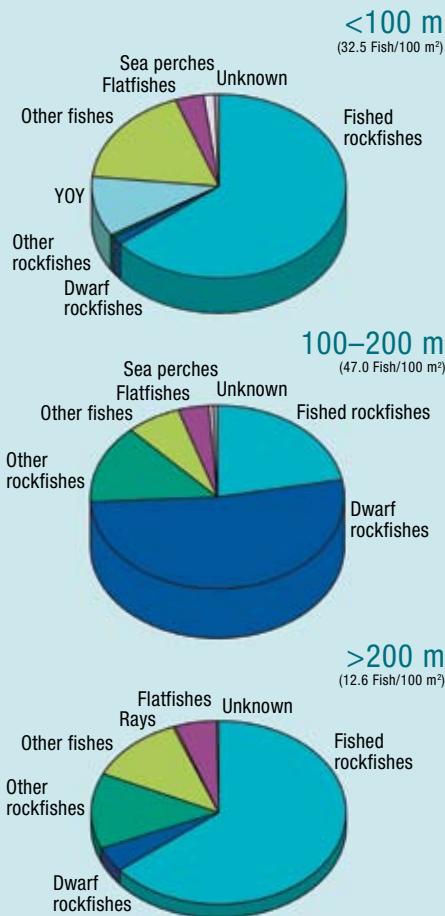


Bank rockfish

Tom Laidig



DENSITY OF FISHES BY DEPTH ZONE

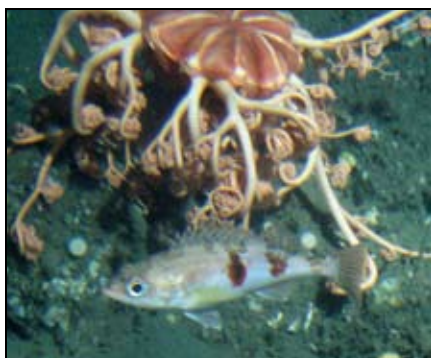


PROPORTION OF INVERTEBRATES COUNTED

(Total 4,150)



Big Creek SMR Reference



Halfbanded rockfish and basket star

Rick Starr

Habitats:

Shallow water Reference sites for the Big Creek SMR are located to the north of the SMR and near Lopez Point to the south. Deep-water Reference sites are located just northwest of the SMR and in Partington Canyon, which is located further north along the Big Sur coast. Rock, mud, and sand account for 39%, 30%, and 28%, respectively, of the habitats surveyed.



Bigfin eelpout

Mary Nishimoto

Fishes:

Blue, olive, vermilion, and young-of-the-year rockfishes, and blackeye gobies were the only species that occurred in densities >1 per 100 m² in habitats <100 m deep. Halfbanded, pygmy, Sebastomus, greenspotted, squarespot, rosethorn, and green-striped rockfishes, and poachers were abundant in rocky habitats at depths 100–200 m. In waters deeper than 200 m, eelpouts, poachers, hake, unidentified rockfishes, and flatfishes were abundant.

Invertebrates:

The Big Creek SMR Reference sites have a broad diversity of invertebrates, in accordance with the wide depth range encompassed by this study site. Brachiopods (26%), red, bat, and short-spined seastars (25%), and nipple and puffball sponges (15%) accounted for 66% of all invertebrates observed, and 6% of the total was represented by species that are fished (such as spot prawns and various crabs).



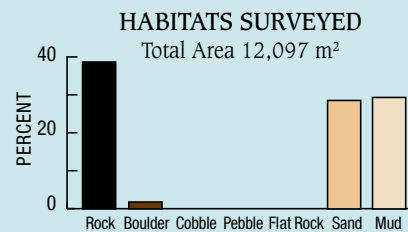
Swordspine rockfish and brittlestar

Rick Starr



Squat lobster

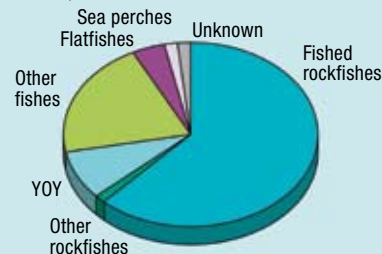
Tom Laidig



DENSITY OF FISHES BY DEPTH ZONE

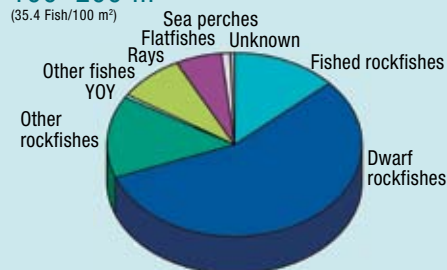
<100 m

(17.0 Fish/100 m²)



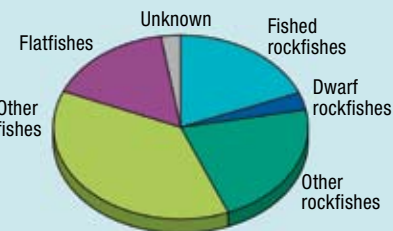
100–200 m

(35.4 Fish/100 m²)



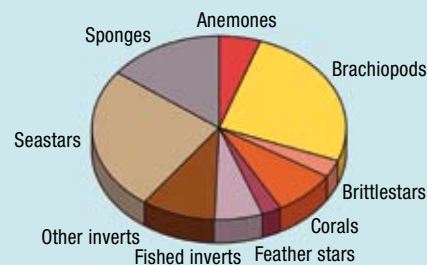
>200 m

(11.7 Fish/100 m²)



PROPORTION OF INVERTEBRATES COUNTED

(Total 6,515)



Big Creek SMCA



Stripetail rockfish Mary Nishimoto

Big Creek SMCA encompasses approximately 7.9 mi² at the south end of the Big Sur coastline, extending offshore from the shoreline to the boundary of state waters. This SMCA provides protection for seafloor habitats and associated fish and invertebrate species adjacent to the Big Creek SMR.

Habitats:

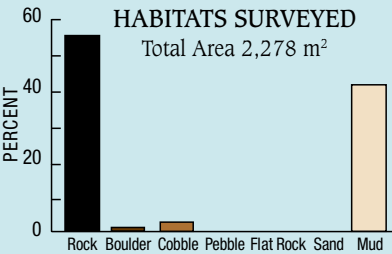
Habitats range from 50–600 m deep. This MPA contains deep rock, soft sediments, pinnacles on the continental shelf, and shallow and deep submarine canyon habitats. We conducted our survey at depths of 100–200 m. Rock, boulder, and cobble habitats accounted for 58% of the habitats in our survey, and mud, mud-rock, and mud-cobble represented 42% of the habitats.

Fishes:

We observed 31 taxa of fishes in this MPA. Bank, Sebastomus, rosethorn, pygmy, and greenspotted rockfishes were abundant in rock habitats. Poachers, and stripetail and shortbelly rockfishes were abundant in soft sediments at 150–200 m depths.

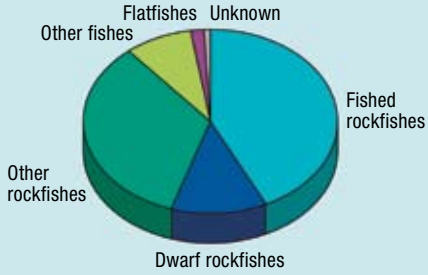


Dover sole and fragile red sea urchins Linda Snook

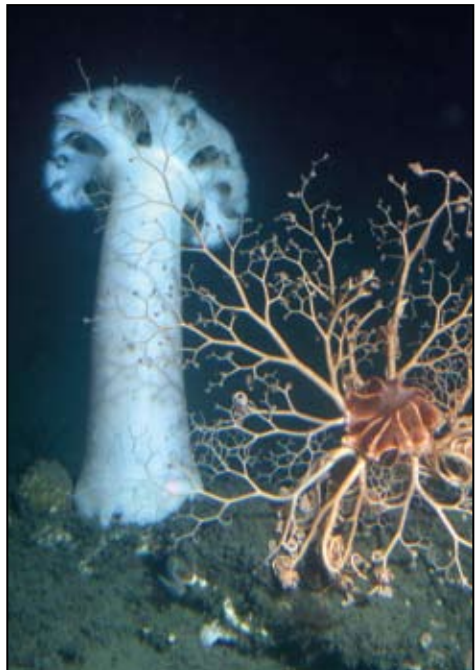
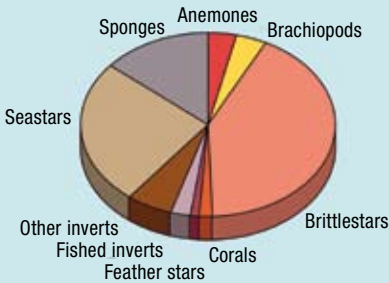


DENSITY OF FISHES BY DEPTH ZONE

100–200 m
(28.3 Fish/100 m²)



PROPORTION OF INVERTEBRATES COUNTED
(Total 1,102)



White plumed anemone and basket star Rick Starr

Invertebrates:

Brittlestars (42%), red, sunflower, and other seastars (25%), and shelf sponges (14%) accounted for 81% of all invertebrates observed in Big Creek SMCA. Many of these invertebrates were encountered in deeper water where mixed rock habitats were most abundant.



Poacher Rick Starr



Delta off Big Creek bridge
Liz Sassone

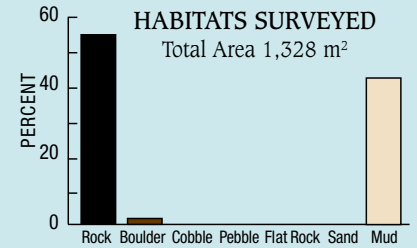
Big Creek SMCA Reference

Habitats:

Shallow water Reference sites are located just north of the Big Creek SMCA and near Lopez Point, south of the reserve. Deep-water Reference sites are located at Partington Canyon and just north of the Big Creek SMCA. Rock habitats accounted for 55% of the area we surveyed and mud habitats accounted for 45% of the area surveyed.

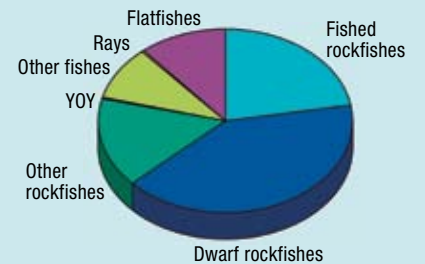


Greenspotted rockfish and fish-eating seastars
Bob Lea



DENSITY OF FISHES BY DEPTH ZONE

100-200 m
(25.3 Fish/100 m²)



Seapen
Rick Starr

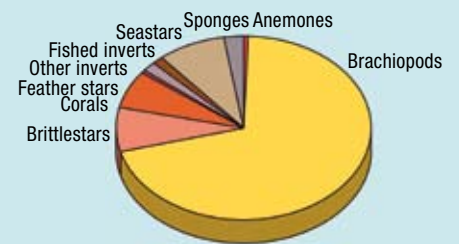
Fishes:

Halfbanded, Sebastomus, bank, rosethorn, pygmy, greenspotted, and greenstriped rockfishes occurred in densities >1 per 100 m² in rocky habitats located at depths of 150–200 m; slender sole and poachers were abundant over soft sediments.

Invertebrates:

The Big Creek SMCA Reference sites were dominated by brachiopods (70%), with smaller numbers of red and bat seastars, brittlestars and nipple sponges. Spot prawns were observed on mud sediment.

PROPORTION OF INVERTEBRATES COUNTED (Total 2,392)



Greenstriped rockfish
Camelia Bianchi



Shortspine combfish
Tom Laidig

Average density for an MPA: Not observed Lightest shade = 0-1 fish per 100 m² Middle shade = 1-2 fish per 100 m² Darkest shade = >2 fish per 100 m²

Density in fish per 100 m²

Fished rockfishes Other rockfishes Other fishes Flatfishes Unknown
 Dwarf rockfishes Young-of-the year (YOY) Rockfishes Rays Sea perches

Common Name	Soquel Canyon SMCA	Portuguese Ledge SMCA	Point Lobos SMR	Point Lobos SMCA	Point Sur SMR	Point Sur SMCA	Big Creek SMR	Big Creek SMCA
Aurora rockfish								
Aurora-Splitnose rockfish								
Bank rockfish								
Black rockfish								
Blackgill rockfish								
Blue rockfish								
Bocaccio								
Bronzespotted rockfish								
Canary rockfish								
China rockfish								
Copper rockfish								
Cowcod								
Darkblotched rockfish								
Flag rockfish								
Gopher rockfish								
Greenblotched rockfish								
Greenspotted-Greenblotched rockfish								
Greenspotted rockfish								
Kelp rockfish								
Olive rockfish								
Quillback rockfish								
Redbanded rockfish								
Rosethorn rockfish								
Rosy rockfish								
Sharpchin rockfish								
Speckled rockfish								
Splitnose rockfish								
Starry rockfish								
Treefish								
Vermilion rockfish								
Widow rockfish								
Yelloweye rockfish								
Yellowtail rockfish								
Halfbanded rockfish								
Puget Sound rockfish								
Pygmy rockfish								
Squarespot rockfish								
Stripetail rockfish								
Swordspine rockfish								
Chameleon rockfish								
Greenstriped rockfish								
Pinkrose rockfish								
Rockfish group								
Sebastomus rockfish								
Shortbelly rockfish								
Young-of-the-year rockfishes								

Common Name	Soquel Canyon SMCA	Portuguese Ledge SMCA	Point Lobos SMR	Point Lobos SMCA	Point Sur SMR	Point Sur SMCA	Big Creek SMR	Big Creek SMCA
Bigfin eelpout								
Blackeye goby								
Bluebarred prickleback								
California scorpionfish								
Codling group								
Combfish group								
Eelpout group								
Gunnel group								
Hagfish								
<i>Icelinus</i> sculpins								
Kelp greenling								
Lingcod								
Longspine combfish								
Longspine thornyhead								
Pacific lamprey								
Painted greenling								
Plainfin midshipman								
Poacher group								
Prickleback group								
Ratfish								
Red brotula								
Ronquil group								
Sculpin group								
Sheephead								
Shortspine combfish								
Shortspine thornyhead								
Spotted cusk-eel								
Stripefin ronquil								
Thornyhead group								
Threadfin sculpin								
Wolf eel								
Big skate								
California skate								
Longnose skate								
Pacific electric ray								
Skate group								
Dover Sole								
English sole								
Flatfish								
Pacific halibut								
Petrale sole								
Rex sole								
Rock sole								
Sanddab group								
Slender sole								
Black seaperch								
Pile seaperch								
Pink seaperch								
Rubberlip seaperch								
Sharpnose seaperch								
Striped seaperch								
Seaperch group								
Unidentified fish								



For more information on this project contact:

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Rick Starr
starr@mlml.calstate.edu

*For more information on the Marine Life
Protection Act, visit <http://www.dfg.ca.gov/mlpa/>*



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