



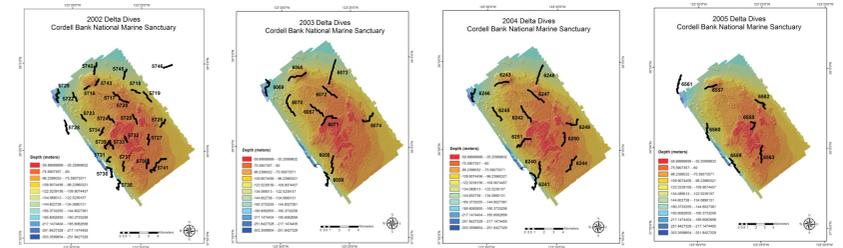
#### LOCATION

Cordell Bank is located 93 km NW of San Francisco. It is one of three contiguous National Marine Sanctuaries in Central California.

# Temporal Trends in Fish Size, Abundance, and Recruitment During a Four-Year Time Period at Cordell Bank National Marine Sanctuary

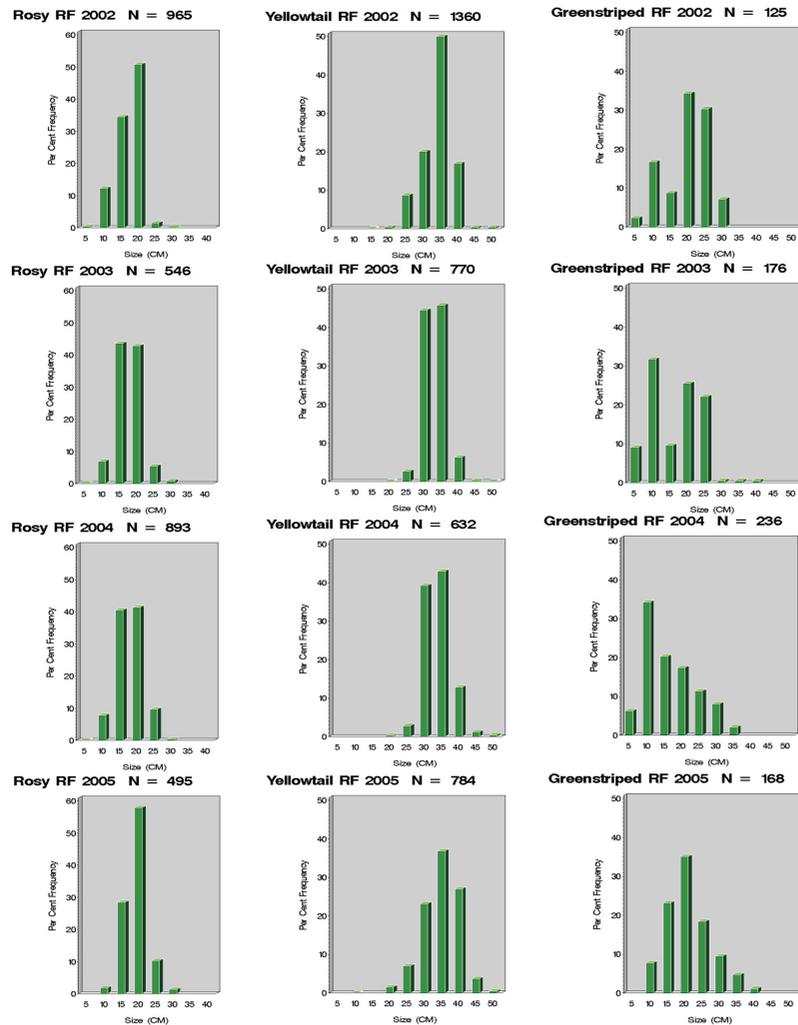
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Cordell Bank is the gemstone of Cordell Bank National Marine Sanctuary, one of 14 undersea regions recognized by NOAA for their significant natural or cultural resources and managed for their protection. The National Marine Sanctuaries Act specifically calls for long-term monitoring of Sanctuary resources to provide management with a basis for the assessment of Sanctuary health. During the fall of 2002 the Sanctuary conducted a submersible survey on the Bank as the first step in an anticipated long-term monitoring effort. Shortly after this survey, the Pacific Fishery Management Council implemented commercial and recreational Rockfish Conservation Areas for the region which includes Cordell Bank. Consequently, these surveys offer the opportunity to observe the effect of the area closure on the ichthyofauna of Cordell Bank.



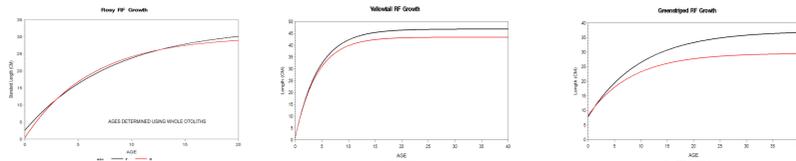
#### SURVEY METHODS

Fall benthic surveys were performed from 2002 through 2005 by Sanctuary staff and cooperating scientists. The number of transects per year was as follows: 2002 (60), 2003 (37), 2004 (47), 2005 (27). The two-person *Delta* submersible was employed to conduct quantitative visual strip transects using the methods of Stein et al. (1992) and Yoklavich et al. (1999). Observers recorded habitat characteristics as well as the size and abundance of non-cryptic fishes. Fish lengths were visually estimated to the nearest 5 cm. Transects were 2 m wide and 15 minutes in duration with between two and four transects completed per dive. During each field season surveys were spatially distributed to include a variety of habitats which included high relief rock, boulders, cobbles, pebbles, sand, and mud. Budget and weather limited the number of dives which could be accomplished.



#### FISH SIZE

Percent size frequency histograms for three of the most common and abundant species occurring on Cordell Bank. The species are representative of different habitats on the Bank. Rosy rockfish is a resident of the rocky reef crest while yellowtail rockfish is more common schooling in the water column and greenstriped rockfish is a resident of the soft bottom. There is a subtle increase in the proportion of the largest size classes for all three species in later years.

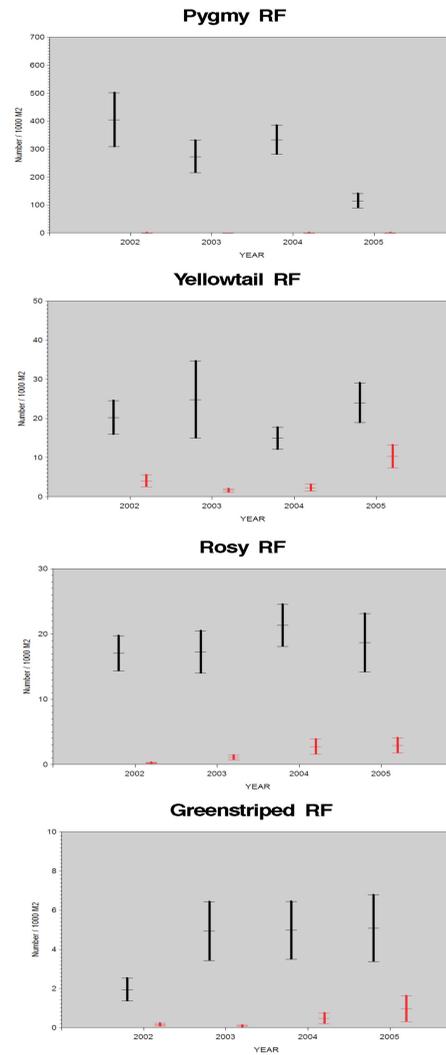


#### FISH GROWTH

Von Bertalanffy growth curves for rosy, yellowtail, and greenstriped rockfishes. Black curves are females and red curves are males. Figures show that with the exception of male greenstriped rockfish, these species can grow 5 cm during the four-year course of this study, therefore growth of resident fishes can account for the higher proportion of the largest size classes in the later years of this study. Growth parameters for yellowtail rockfish was taken from the 2004 stock assessment by Wallace and Lai. Parameters for rosy and greenstriped rockfishes were taken from Love et al. (2002).

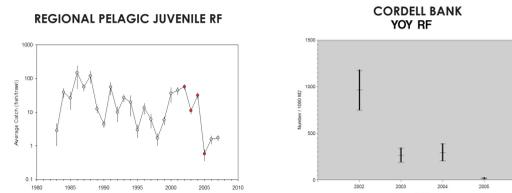
#### REFERENCES

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#### FISH DENSITY

Changes in fish density (number / 100 M2) for four of the most common and abundant species at Cordell Bank. Shown are mean densities +/- 1 SE. Black symbols represent "small" individuals while red represents "large". The dividing line between large and small was determined by inspection of the size frequency histograms. For yellowtail, rosy and greenstriped rockfish the number of large fish modestly increased during the study period while the number of pygmy rockfish (all sizes) declined. The decline of pygmies is consistent with hypotheses that predict the decline of forage species as the number of large predators recover. (Baskett, 2006).



#### ROCKFISH RECRUITMENT

The number of pelagic juvenile rockfishes captured by midwater trawl in the Pescadero to Point Reyes region (left) and density of young-of-year rockfishes observed from 2002 to 2005 at Cordell Bank (right). These data show that the decline in YOYs at Cordell Bank tracked the regional decline in rockfish recruitment. Pelagic juvenile rockfish data provided by S. Ralston, NMFS/Santa Cruz.

Common Name	2002		2003		2004		2005	
	% Frequency	Density						
Young of Year Rockfish	73.3	966.0	83.8	268.4	84.4	296.5	44.4	20.0
Pygmy Rockfish	65.0	406.6	67.6	274.2	86.7	342.8	77.8	116.9
Yellowtail Rockfish	66.7	24.5	75.7	26.5	75.6	17.8	74.1	34.5
Rosy Rockfish	58.3	17.3	62.2	18.4	73.3	24.7	55.6	21.7
Pacific Hake	0.0	0.0	0.0	0.0	0.0	0.0	33.3	78.4
Sebastes spp.	83.3	15.0	73.0	9.4	84.4	21.0	88.9	31.8
Widow Rockfish	30.0	4.0	16.2	19.6	4.4	0.1	33.3	41.0
Sebastes	80.0	13.0	83.8	13.7	88.9	17.1	85.2	16.7
Unidentified Fishes	91.7	19.9	91.9	11.1	97.8	11.0	100.0	8.6
Flatfishes	63.3	9.2	67.6	20.6	66.7	10.2	51.9	5.8
Squarespot Rockfish	25.0	3.1	40.5	16.1	40.0	18.4	51.9	5.5
Blackeye Goby	45.0	4.3	43.2	5.5	55.6	8.0	33.3	3.6
Greenstriped Rockfish	33.3	2.1	35.1	5.0	35.6	5.6	40.7	6.1
Stripetail Rockfish	16.7	2.0	13.5	3.8	11.1	4.1	37.0	7.1
Poachers	58.3	3.6	51.4	4.0	31.1	2.3	48.1	4.4
Greenspotted Rockfish	43.3	2.9	45.9	3.4	48.9	3.5	55.6	3.4
Pricklebacks	15.0	1.0	40.5	5.2	48.9	6.4	0.0	0.0
Spotfin sculpin	6.7	0.1	27.0	2.9	37.8	7.1	22.2	2.5
Unknown sculpin	35.0	2.8	54.1	4.1	60.0	4.2	29.6	0.9
Spotted Flatfish	31.7	2.2	21.6	0.7	35.6	2.1	40.7	6.8
Lingcod	65.0	2.1	64.9	3.3	82.2	2.7	55.6	1.9
Blue Rockfish	3.3	0.5	5.4	1.4	0.0	0.0	11.1	7.4
Sanddabs	28.3	5.1	24.3	1.5	28.9	1.4	7.4	0.5
Dover Sole	21.7	2.5	21.6	1.1	15.6	2.5	29.6	1.9
Comfishes	30.0	3.6	29.7	3.8	8.9	0.3	11.1	0.2
Shamehin Rockfish	6.7	1.8	10.8	2.8	8.9	2.4	14.8	0.7
Canary Rockfish	26.7	0.7	35.1	1.5	42.2	1.6	22.2	1.7
Speckled Rockfish	11.7	0.3	16.2	1.3	11.1	2.1	22.2	1.1
Hagfish	16.7	0.8	16.2	0.2	11.1	1.2	40.7	1.7
Kelp Greenling	31.7	0.5	27.0	1.4	33.3	0.8	33.3	0.8
Starry Rockfish	20.0	0.5	21.6	0.6	40.0	1.4	40.7	1.0
Bluebarred Prickleback	0.0	0.0	18.9	1.3	6.7	2.0	3.7	0.0
Bocaccio	21.7	0.5	27.0	0.8	33.3	1.0	29.6	0.9
Painted Greenling	26.7	0.9	32.4	0.9	26.7	0.7	18.5	0.5
Yelloweye Rockfish	28.3	0.6	32.4	0.6	40.0	1.1	33.3	0.7
Rex Sole	20.0	0.8	18.9	0.9	22.2	0.8	22.2	0.4
Longfin sculpin	0.0	0.0	21.6	0.8	28.9	1.8	0.0	0.0
Swordspine Rockfish	6.7	0.2	5.4	0.3	31.1	1.8	0.0	0.0
Splitnose Rockfish	5.0	0.2	2.7	0.1	0.0	0.0	18.5	1.9
Vermilion Rockfish	16.7	0.2	16.2	0.5	17.8	0.5	29.6	0.6
Rosethorn Rockfish	5.0	0.1	8.1	0.7	4.4	0.1	14.8	0.7
Longnose Skate	11.7	0.1	10.8	0.2	20.0	0.3	37.0	0.7
Slender Sole	13.3	0.3	16.2	0.6	0.0	0.0	14.8	0.2
English Sole	6.7	0.1	13.5	0.5	13.3	0.4	7.4	0.1

#### FISH ASSEMBLAGE

The numerically dominant top 44 taxa observed at Cordell Bank during the four years of the study are listed in order of abundance. Density is expressed as number of fish/1000 m2. Percent frequency is based on the number of transects in which the taxon was observed. Rockfishes dominated the fish assemblage accounting for 32% of the 97 taxa identified during the study. There was generally good concordance in the species rankings between years. A notable exception was Pacific hake which ranked second in abundance in 2005 but was not observed in any other year. The overfished species bocaccio, yelloweye rockfish, widow rockfish, and canary rockfish are reasonably common on the bank (occurring in all four years) but in rather low numbers.

#### SUMMARY

Data collected during the initial survey (2002) showed that rockfishes (Scorpaenidae) were the dominant fish family, accounting for 27 species and 95% of all individuals. Of these, young-of-year rockfishes were the most numerous, accounting for 64% of all rockfishes, and 61% of all groundfishes.

Rockfishes continued their numerical dominance during all four years (2002 through 2005) of the study; however, YOY rockfish underwent a steady decline in abundance. Temporal trends observed for some of the numerically dominant rockfish species were consistent with expected responses to a fishery closure. The numerical density and sizes of yellowtail rockfish and greenstriped rockfish increased throughout the study. However, other species such as pygmy rockfish declined in number and others had no discernable temporal trend. Our analysis of temporal trends is hampered by the lack of a suitable reference area where fishing is still occurring. Possible confounding and interacting factors influencing the observed temporal trends include episodic recruitment of juveniles and immigration of adults. For example, the low numbers of YOY rockfish observed at Cordell Bank in 2005 is very likely to be the result of recruitment failure caused by a broad-scale delay in the onset of upwelling in the northern California Current that affected primary productivity, and cannot be attributed to community dynamics brought on by the RCA closure. Extending the time series will greatly aid in description and explanation of temporal trends at Cordell Bank.

