

Potential of Marine Reserves to Enhance Nearshore Fisheries

Assessing Fish Populations in the Recently Established Big Creek Ecological Reserve

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Part One

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Abstract

The decline in the success and quality of Central California's nearshore rockfish fisheries over the past decades and the rapid expansion of the fishery of live/premium fish, which targets shallow water kelp forest fishes, have underscored the need for a revised management strategy for this resource. Marine protected areas have been suggested as an alternative or additional management tool to create sustainable fisheries. The overarching goal of the study is to provide a benchmark or "line in the sand" of data collected in a newly established marine protected area. Since both fishery-independent and fishery-dependent data are crucial in the evaluation of the reserve as a fishery management tool, we collected data from *in situ* surveys of fish populations within the recently established Big Creek Ecological Reserve (BCER) and Point Lobos Ecological Reserve (PLER), which was established in 1973, and adjacent areas. We also monitored the landings of commercial and recreational fisheries targeting fishes in the vicinity of BCER.

Permanent stations within, north, and south of BCER were established to eliminate the variability due to habitat during sampling over years. Our analysis shows that densities of all fish were significantly different among the three areas, when differences due to surge values were removed, and that densities of fish within BCER were higher than the numbers north or south of BCER. We also examined densities of all fish observed during random transects conducted within and adjacent to BCER. Randomly collected data are more representative of the surveyed areas and essential for statistical inference; however, they are more variable than data from permanent stations. Significant differences among years and areas were noted for randomly collected data. Few consistent differences were noted in the species densities or stage of sexual maturation among areas or among years within each area in the Big Creek study area. We found significant differences in densities and stage of sexual maturation of fish within PLER compared BCER and to Monolobo, an adjacent fished area. Length frequencies of individual species within PLER were generally larger compared to both BCER and Monolobo.

A high percentage of 1998-99 Big Sur commercial skiff fishery landings were composed of cabezon and black-and-yellow and gopher rockfishes. This

study documented that 4.5 times more trips, which departed from San Simeon, San Luis Obispo County, were made to the Cape San Martin region as were made to the Point Sur region. Most species taken in the Point Sur region were larger than those taken in the Cape San Martin region; however, there was not a significant difference in the catch-per-unit-effort (CPUE) between the two areas.

Introduction

Marine reserves, established as a fisheries management tool, are intended to manage exploited stocks by protecting populations of sexually mature individuals that would otherwise be vulnerable to fishing, thus ensuring a source of new recruits. Reserves have been reported to enhance fisheries in other parts of the nation and world; however, limited information is available to evaluate their effectiveness on California's sport and commercial rockfish fisheries.

Rockfish are an important and heavily exploited component of sport and commercial fisheries in California. The estimated value of the sport fishery to California's economy is about one billion dollars annually (Lenarz 1987), while the annual ex-vessel value of commercial fisheries for rockfish exceeds ten million dollars (CDFG unpubl. data). In 1995, California Commercial Passenger Fishing Vessels (CPFV) reported landing 1,174,991 rockfish; 62% were landed in central California (CDFG unpubl. data).

The success and quality of Central California's nearshore rockfish sport fisheries have declined over the past decades, particularly in areas close to ports (Miller and Gotshall 1965; VenTresca and Lea 1984; Reilly et al. 1993; Karpov et al. 1995; Mason 1995). In the Northern and Central California sport fishery, between the late 1950s and early 1980s, the average weight per rockfish declined by 13% (0.43 pounds per fish), and the average weight decreased for 12 of 16 major rockfish species (Karpov et al. 1995). In Monterey Bay, from 1987 to 1991, the average lengths of several rockfish species sampled in the CPFV fishery were below the average length at 50% sexual maturity (Reilly et al. 1993; Reilly et al. 1998). Presently, fishery managers are concerned with the rapid increase in fishing effort and landings of the emerging commercial live/premium fish fishery that has developed coast-wide for rockfish, cabezon, lingcod, and kelp greenling during recent years. The rapid expansion of this fishery is of greatest concern in the nearshore, shallow, rocky habitats where many of these species are concentrated. As stocks proximal to port become depleted, fishers have expanded their range further from port and into deeper waters. Many of these nearshore areas, especially along the Big Sur coast, had experienced little fishing pressure and until recently had functioned as *de facto* reserves.

Limited movement, relatively long life span, and late maturation of rockfishes, coupled with heavy sport and commercial fishing pressure, have resulted in the removal of many mature fish from reefs proximal to fishing

ports (Lea et al. 1999). Consequently, commercial and sport fishers are traveling farther from port to maintain a quality catch. Once large reproductive adults are removed, continued fishing pressure prevents remaining fish from reaching the size at which sexual maturity occurs. Reproductive potential is also affected by natural phenomena, such as an El Niño event. During these events growth rates and survival are often reduced (Bailey and Incze 1985; VenTresca et al. 1995).

Recognizing that a change in the current resource management approach is warranted, alternative regulatory and enhancement strategies are of paramount importance. Rockfish appear to be an excellent candidate for enhancement using a reserve management approach because, in addition to being residential and long-lived, they are extremely fecund and have a lengthy larval life-stage. Reserves, utilized as a rockfish management tool, would protect critical spawning stock biomass and ensure a continual recruitment supply to fished areas via larval dispersal and emigration. However, to determine the effectiveness of a reserve to enhance rockfish fisheries, baseline information is first needed to demonstrate that densities and sizes of fish populations within the reserve are greater than adjacent fished areas, and that absolute numbers of species of concern within the reserve are sufficient to provide a reasonable/significant source of larvae.

Marine fisheries reserves offer potential benefits to coastal fisheries and marine resource management. These benefits, including the enhancement and restoration of fishery yields through larval/egg transport; "spillover" from reserves to surrounding areas; protection of reproductive potential of targeted species, maintenance of biological diversity, and increased social and economic benefits to local communities (Russ 1985; Davis 1989; Bohnsack 1990; Roberts and Polunin 1991; Rowley 1994; Roberts et al. 1995). Additionally, reserves may increase the resiliency of heavily exploited fisheries during episodic environmental anomalies by serving as a buffer against drastic declines, thus hastening the recovery of these fisheries by supplying harvested stocks with new recruits (Carr and Reed 1993). Although reserves provide an excellent opportunity for *in situ* testing of concepts related to the protection and enhancement of fish populations, studies demonstrating a significant increase in fish population densities and average lengths within a reserve are few (Rowley 1992; Dugan and Davis 1993; Palsson and Pacunski 1995; Roberts et al. 1995; Russ and Alcala 1989; Paddock and Estes 2000). Studies showing enhancement or "spillover" are also limited but are probably most critical in convincing public user groups of the value of reserves (Rougharden and Iwasa 1986; Battershill et al. 1993; Rowley 1992).

Although marine reserves have been reported to enhance fisheries in other parts of the nation and world, limited information is available to evaluate their effectiveness on California's sport and commercial rockfish fisheries. Since improperly designed reserves may endanger a fishery by providing a false sense of protection, determining the effectiveness of a reserve is of

utmost importance (Carr and Reed 1993; Yoklavich 1998). The establishment of the BCER in Monterey County in January 1994 provided an excellent opportunity to evaluate the effects of a reserve on the nearshore rockfish resource; however, without first obtaining baseline information on the species composition, densities, and length frequencies of rockfish populations within and adjacent to BCER, determining change in population parameters or future benefits to adjacent and distant fisheries will be difficult at best. This study also compares the fish population structure in the newly established BCER to the population structure of fish within PLER, a marine protected area established in 1973 which is located in Monterey County, approximately 75 km up the coast from BCER.

Rockfishes are an excellent candidate genus for this study. They are long-lived, residential, fecund, and have an open ended reproductive system in which offspring are widely distributed. Resident populations of large sexually mature rockfishes within the reserve would be a continual source of larvae, which in turn would be carried via nearshore currents to other sections of the coastline (Chelton et al. 1982; Wyllie Echeverria 1987; VenTresca et al. 1996). A future management strategy might include a system of coastal reserves that would reinforce and enhance the reproductive strategies of rockfish.

Baseline information on species composition, densities, and size frequencies of rockfish populations within and adjacent to BCER are crucial to evaluate the effectiveness of this reserve. Furthermore, assessing the status of nearshore fish populations/stocks in the vicinity of BCER is timely and relevant due to the recent dramatic increase in commercial hook-and-line landings of nearshore species throughout California. The extensive kelp forests along the Big Sur coast were, until recently, one of the last remaining unexploited marine habitats in California. Now this area is being intensely fished to provide for the increasing demand in the lucrative live fish market. As fishing effort increases on these formerly pristine stocks, it becomes imperative to evaluate the effectiveness of a Central California coast reserve to protect and enhance rockfish stocks.

Most of the aforementioned studies of marine protected areas have focused on assessing changes in adjacent fisheries or changes in the population structure of fishes within the reserves and/or adjacent areas. Both of these sources of information are crucial in the evaluation of the reserve as a fishery management tool. We monitored both the landings of a commercial skiff fishery and the CPFV fisheries that target fishes near BCER. We used random and permanent transects to assess subtidal *in situ* fish population within and adjacent to BCER. The overarching goal of this study is to provide a benchmark or "line in the sand" of data collected on a newly established marine protected area. Our hope is that we have done an adequate job so that future studies can statistically document temporal changes in nearshore fish populations within and adjacent to BCER.

video images of each fish with the dots from the paired lasers, used as a size reference, were subsequently analyzed using computer technology by first capturing images from the video tapes and then digitizing and integrating the images into computer files. The mean of three total length measurements of each fish, from nonsuccessive frames, was entered into a database for obtaining estimates of mean total lengths for each species. This method provided a nondestructive sampling technique for obtaining fish lengths that is more accurate than visually estimating lengths underwater. Random video transects, conducted perpendicular to the coastline, were used to obtain *in situ* estimates of length frequencies of subadult and adult fishes in the Big Creek and Point Lobos study areas.

Landing of Commercial Skiff Fishery

Commercial skiff fishery landings along the Big Sur coast were monitored and sampled during 1997–1999. Sampling procedures were, in part, based on criteria developed by the California Cooperative Commercial Groundfish Survey (Thomas et al. 1995). We interviewed commercial skiff fishermen as they returned from fishing at Mill Creek State Park and BCER, Monterey County (Figure 4). For each returning fisherman, the sampler recorded date, port of landing, boat number, gear, estimated sampled weight and total weight of catch, CDFG Block number where fishing occurred, site-specific fishing location, time, and depth fished. Since fishermen wanted to transport the live fish to market as soon as possible they did not permit the sampler to weight the catch with a scale. Fishers used plastic laundry baskets and 5-gallon buckets to transport live and dead fish, respectively, from their skiffs to cars. The average weight of fish in a full basket was 65–75 pounds and 30–35 pounds in a full 5-gallon bucket. Fishers and the sampler estimated total weight and sampled weight of catch independently. Agreement between estimated weights was good. Fish in the sample subset were individually identified to species, total length measured, and their condition (dead or alive) was noted.

Catch of CPFV Fishery

Sport angler catch aboard CPFVs departing from San Simeon Cove, San Luis Obispo County, were sampled to obtain species composition and size data from remote areas along the Big Sur coast. Commercial passenger fishing vessels from San Simeon occasionally conducted 1- and 2-day long-range sport fishing trips that fished from Piedras Blancas north to Point Sur and encompassed the vicinity of BCER (Figure 4). In 1997–98, a sampler was placed on these trips, space and weather permitting, to observe and record fish caught, using sampling methodology established in 1987 by CDFG's Central California Marine Sport Fish Survey (Reilly et al. 1998). This effort provided a cost-efficient supplementary database of fish sizes and fishing

effort of nearshore sport fishes in the vicinity of BCER, an area that historically has received less sport and commercial fishing pressure than areas proximal to Monterey and Morro Bay.

Samplers were trained in marine fish species identification and were equipped with foul weather gear, gloves, clipboard, waterproof data sheets, fish-length measuring board, lead pencils, and field guides to California marine fishes. The sampler contacted the landing to secure passage on the vessel prior to the trip. The California Department of Fish and Game's vessel number, port code, departure time, type of fishing trip (offshore, nearshore, surface, bottom, mix), number of paid and free anglers, and type of fishing tackle used were recorded on a standard sampling form.

When the vessel arrived at the first fishing location, the sampler chose a subset of the total onboard anglers to observe throughout the trip and recorded this number (usually less than 15). The sampler recorded bottom depth, the time when fishing lines were lowered, the number of observed and total anglers, and either latitude and longitude, LORAN coordinates, or compass bearings and coastline features. When the last observed fishing line was raised, signifying the end of a "drift," time and depth were recorded and the process was repeated throughout the day.

Samplers observed anglers in the stern half of the vessel, where a larger sample size could be obtained. An assumption in this sampling methodology was that catch, effort, and CPUE data from observed anglers in the stern of the vessel were representative of all anglers on the vessel. This assumption was demonstrated to be statistically valid (Wilson-Vandenberg et al. 1996). Samplers identified fishes to species and recorded all fish caught by all observed anglers. The ultimate fate of each observed fish was recorded, as either kept, released, used as bait, or unknown. If a fish was released, the sampler attempted to determine if it survived or died. The combined catch by species for all observed anglers was recorded; however, individual catch-per-angler was not recorded.

When fishing had ceased for the day, the sampler measured total length (mm) of as many kept fish from observed anglers as possible. Not all kept fish, taken by observed anglers, were measured due to refusal of an angler to have his/her catch examined, early filleting by the deck hand, or hazardous working conditions caused by inclement weather. If time permitted, fish kept by unobserved anglers also were measured and their lengths were recorded.

Statistics and Statistical Terminology

We used a significance level of $\alpha = 0.05$ for all tests. Unless otherwise noted all error bars on graphs are one standard error. All statistical analyses except Cochran's tests were conducted using SYSTAT (SPSS, Inc. 1998. SYSTAT version 9, with 9.01 patch installed). Biostatistical Analysis, by J.H. Zar, was used as the reference for statistical procedures.

Oceanographic Conditions during *In Situ* Surveys

From 1993–98, annual mean sea surface temperatures (August–November), monitored at the Granite Canyon Pollution Laboratory (GCPL), located 65 km up the coast from BCER, were highest in 1993 and 1997 (Figure 38). Oceanographic conditions of high nearshore water visibility and calm seas normally occur from August through November along the Central California coast (VenTresca, pers. Observ.); therefore, this time period was chosen in which to conduct *in situ* surveys in the Point Lobos and Big Creek study areas.

Commercial Skiff Landings

From August 1997 to December 1999, landings of 149 commercial skiff fishermen were sampled at Mill Creek State Park and BCER, Monterey County (Table 6). When commercial fishers launched from and returned to Mill Creek, their fishing sites ranged from Fuller's Point ($36^{\circ} 12.70' N$), located 9.2 na. mi. north of the northern boundary of BCER to Gorda Point ($35^{\circ} 53.75' N$), located 13.6 na. mi. south of the southern boundary of BCER (Figure 4). When they launched from and returned to BCER their fishing sites ranged from Fuller's Point to Limekiln ($36^{\circ} 00.75' N$), located 2.5 na. mi. south of the southern boundary of BCER. Reported depths of fishing ranged from 5–600 feet (1.5–181.8 m); however, the majority of fishing occurred between 20–40 feet (6.0–12.1 m). Although rod-and-reel was occasionally used, most fishermen used "stick gear" and carried 10–15 units in their skiffs. Each stick gear unit was comprised of a 5-foot-long, weighted, 3/4-inch PVC pipe to which five to eight circle hooks were attached. Each unit had a line and buoy attached. Fishermen deployed each unit separately and retrieved them within 1–3 hours.

The total catch of the 149 landings weighed 15,015 pounds. Fifty-three percent (8,017 pounds) of the total catch, comprising 5,151 fishes from 24 species (Appendix 12), were sampled for species composition and length. Common and scientific names of fishes are listed in Table 7. From 1997 through 1998, we sampled 14%, 54%, and 65% of the landings, respectively (Figure 39). For the three-year sampling period, the majority of the landings occurred from July through October (Figure 40). During these months, sea conditions are more conducive to launching and landing a small skiff along the Big Sur Coast.

From 1997 to 1998, blue rockfish declined from comprising 31% of the sampled landings to 2% and in 1999 they comprised less than 2% (Figure 41). Cabezon comprised 7% of the sampled landings in 1997, dramatically increased to 42% in 1998 (6-fold increase), and then declined slightly to 38% in 1999. Black-and-yellow rockfish showed a steady increase in percent composition from 1997 (15%); to 1998 (20%), to 1999 (32%). Gopher rockfish comprised 16% of the sampled landings in both 1997 and 1998 and declined to 9% in 1999. Grass rockfish increased in percent composition of sampled landing from 1997 (5%) to 1998 (13%) and then declined in 1999 (11%).

Length values for species with a sample size fewer than 50 per year are included in the figures but not discussed in the text. Summary statistics for total lengths are included in Appendix 12.

Interpretation of the species length data must take into consideration a significant change in regulations, which occurred on January 1, 1999. Section 8588 (a) of the California Fish and Game Code (California Fish and Game Code, 2001) established a minimum size limit for many of the nearshore fishes taken by commercial fishermen (Appendix 13).

Black-and-yellow rockfish. The mean and median total lengths of black-and-yellow rockfish taken north of BCER varied little from 1997–98 (Figure 42). In 1999, the mean and median were the highest of the three-year period and the numbers of smaller fish decreased substantially from 1998. The decline in number of smaller fish may be related to the aforementioned regulation change. There was also a discernable change in the distribution of sizes from 1998 to 1999. In 1999, the interquartile range became smaller compared to 1998; both the upper and lower quartile points and the 10th and 90th percentile points shifted upwards, and the number of fish below the 10th percentile point declined. These changes indicate a narrowing in the size distribution of landed black-and-yellow rockfish from 1998 to 1999.

Although the same reduction was observed in the numbers of smaller fish taken in 1999 compared to 1998, for black-and-yellow rockfish taken south of BCER, the 1999 mean and median total lengths were slightly lower than those of 1998. There was not a substantial change in the distribution of sizes between the two years. The 90th percentile point and upper and lower quartile points remained similar; however, the 10th percentile point rose. This rise and the decline in numbers of small fish below the 10th percentile point may again be related to the aforementioned regulation change.

Gopher rockfish. The mean and median total lengths of gopher rockfish taken north of BCER were highest in 1997, declined in 1998, and then in 1999 rose to slightly below the 1997 values (Figure 43). The interquartile range and range between the 90th and 10th percentile point were markedly reduced in 1999 compared to 1997 or 1998, indicating a narrowing in the 1999 size distribution. The mean total length of gopher rockfish taken south of BCER increased 16 mm (6%) from 1997 to 1998 and 4 mm (2%) from 1998 to 1999. In 1999 the interquartile range was smaller than that of 1998 and the 10th percentile point rose. Both of these changes are an indication of a reduction in number of smaller fish taken in 1999.

Grass rockfish. The mean and median total lengths and interquartile ranges of grass rockfish landed north of BCER remained fairly similar from 1997 to 1999 (Figure 44). In 1999, the 10th percentile point rose and the range of fish below this point contracted. This reduction in numbers of smaller fish may be related to the aforementioned regulation change. From 1998–99, grass rockfish taken south of BCER exhibited a 10-mm (3%) increase in

mean length, an 8 mm (2%) increase in median length, and a slight upward shift in the size distribution. Similar to the distribution of grass rockfish taken north of BCER, the range of fish below the 10th percentile point declined south of BCER.

Cabezon. The size distribution, mean and median total lengths of cabezon taken north and south of BCER exhibited similar changes from 1998 to 1999 (Figure 45). Between those two years, the mean size of fish landed north of BCER increased 44 mm (11%) and the median increased 20 mm (5%). For the same period the mean of fish taken south of BCER increased 35 mm (9%) and the median increased 28 mm (8%). For both areas, from 1998 to 1999, the upper and lower quartile points and the 90th and 10th percentile points rose noticeably. This shift to larger fish may be related to the aforementioned regulation change.

Commercial Passenger Fishing Vessel Catch

From July 1997 to July 1998, twelve 1-day and three two-day CPFV trips (total of 18 days) were observed. All trips departed from San Simeon, San Luis Obispo County and headed as far north as Hurricane Point (Figure 4). Four days fishing in the Point Sur area, which extends from Ventura Rocks (2 na. mi. north of Point Sur, latitude 36° 20.24' N) to Pfeiffer Point (5 na. mi. south of Point Sur, latitude 36° 12.31' N). During the remaining 14 days, fishing took place in the Cape San Martin area, which extends from Gamboa Point (3 na. mi. north of Lopez Point, latitude 36° 02.60' N) to Piedras Blancas (latitude 35° 41.14' N). Fishing occurred in water depths ranging from 6 fathoms (10.9 m) to 90 fathoms (163.6 m). From collected data we could not discern a significant difference between depths fished in the two areas. The average number of drifts that occurred for one day of fishing was 12, with a range of 7–26 (Table 8). Total fishing time per day averaged approximately four hours and the average number of fish taken per day was 223. The sampler observed on average 10 anglers per day and each angler caught an average of 5.7 fish per angler-hour. We calculated daily CPUE for the 18 days of observed fishing. Fourteen days were spent in the Cape San Martin area and four days in the Point Sur area. Due to the insufficient sample size we were unable to analyze this data with a student t-test; therefore, we used a nonparametric equivalent Kruskal-Wallis, using alpha=0.05 and found no significant difference ($p = 0.089$) in CPUE between the two areas.

A total of 4,020 fish were taken by observed anglers during the 18 days of sampling. Common and scientific names of fishes are listed in Table 7. Three thousand and forty-eight fish, representing 34 species, were observed taken during 12 days of fishing in the Cape San Martin region and 972 fish, representing 21 species, were observed taken during 4 days of fishing in the Point Sur region. Blue rockfish ranked number one in species composition and comprised 26% of the total catch of fishes taken during fishing in the Cape

San Martin region. In the Point Sur area, blue rockfish ranked third and comprised 11.1% (Figure 46). Yellowtail rockfish ranked second and comprised 11.6% of the catch at Cape San Martin, but ranked first and comprised 19.6% of the catch from Point Sur. Olive rockfish ranked third and comprised 11.4% of the Cape San Martin catch; however, at Point Sur they shared the sixth rank with widow rockfish and only comprised 6.5% of the catch. Bocaccio were the second most abundant species taken at Point Sur and comprised 16.1% of the catch, whereas, in the Cape San Martin region they only ranked sixth and comprised 6.9% of the catch.

Fishery length data are usually assumed not to be normally distributed. We tested the total length of fish for each species taken in the Point Sur and Cape San Martin areas for assumptions of equal variances and normal distribution and, as expected, these tests failed for the majority of species. We then performed a nonparametric equivalent (Kruskal-Wallis) test for each species using $\alpha = 0.05$. There was a highly significant difference between Point Sur and Cape San Martin in the total lengths for 8 of the 11 species tested (Figure 47 and Table 9). Mean total lengths of blue, canary, copper, olive, vermilion, widow, and yellowtail rockfishes and lingcod were larger in the Point Sur region compared to the Cape San Martin region. Summary statistics for selected species measured during this study are included in Appendix 14.

Discussion

The decline in the success and quality of Central California's nearshore rockfish fisheries over the past decades and the rapid expansion of the live/premium fish fishery, which targets shallow water kelp forest fishes, have underscored the need for revised management strategy for this resource. Marine protected areas have been suggested as an alternative or additional management tool to create sustainable fisheries. There is little doubt that eliminating fishing in a designated area will help maintain the area's natural biological diversity and provide a "heritage area" for ecstatic and scientific purposes. However, before managers can advocate marine reserves as an effective management tool, they must first be able to demonstrate that the biomass and reproductive potential of target species within reserves are significantly greater than in fished areas.

The overarching goal of the study is to provide a benchmark or "line in the sand" of data collected in a newly established marine protected area. Our hope is that we have provided an adequate baseline of data, so that future studies can statistically document temporal changes in nearshore fish populations within and adjacent to BCER. Since both fishery independent and dependent data are crucial in the evaluation of the reserve as a fishery management tool, we collected data from *in situ* surveys of fish populations within BCER (newly established) and PLER (established for 27 years) and adjacent areas. We also monitored the landings of commercial and recreational fisheries targeting fishes in the vicinity of BCER.

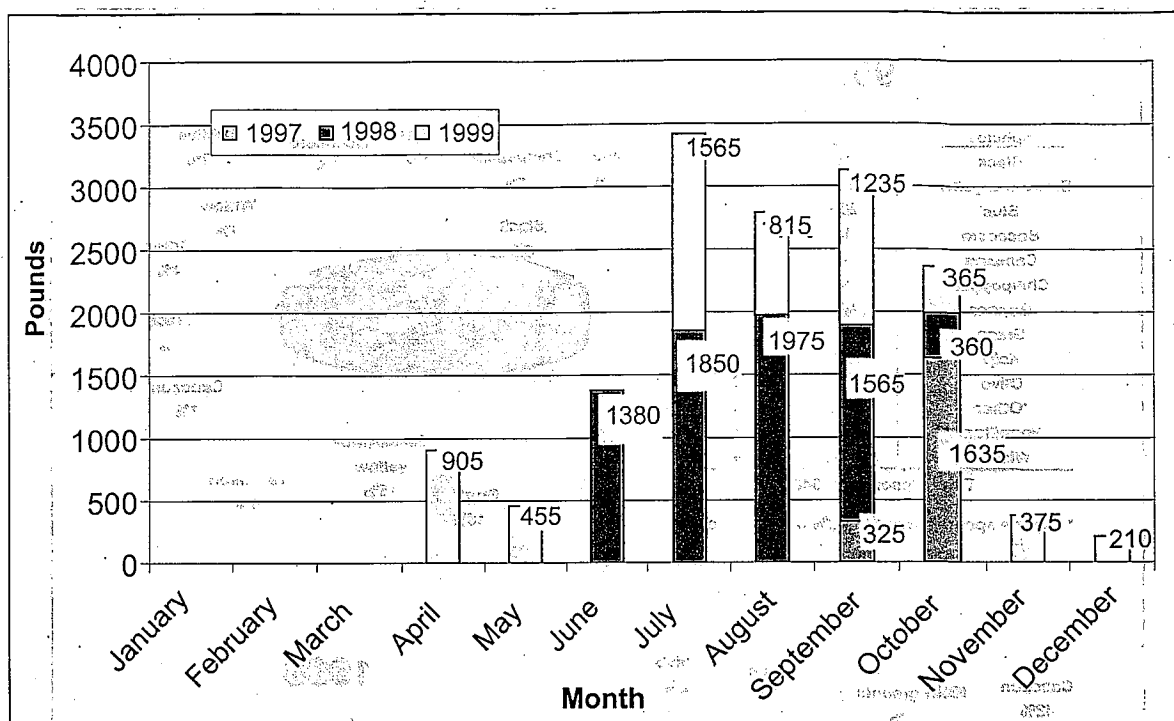


FIGURE 39. Monthly Big Sur commercial nearshore skiff landing in pounds, 1997-99.

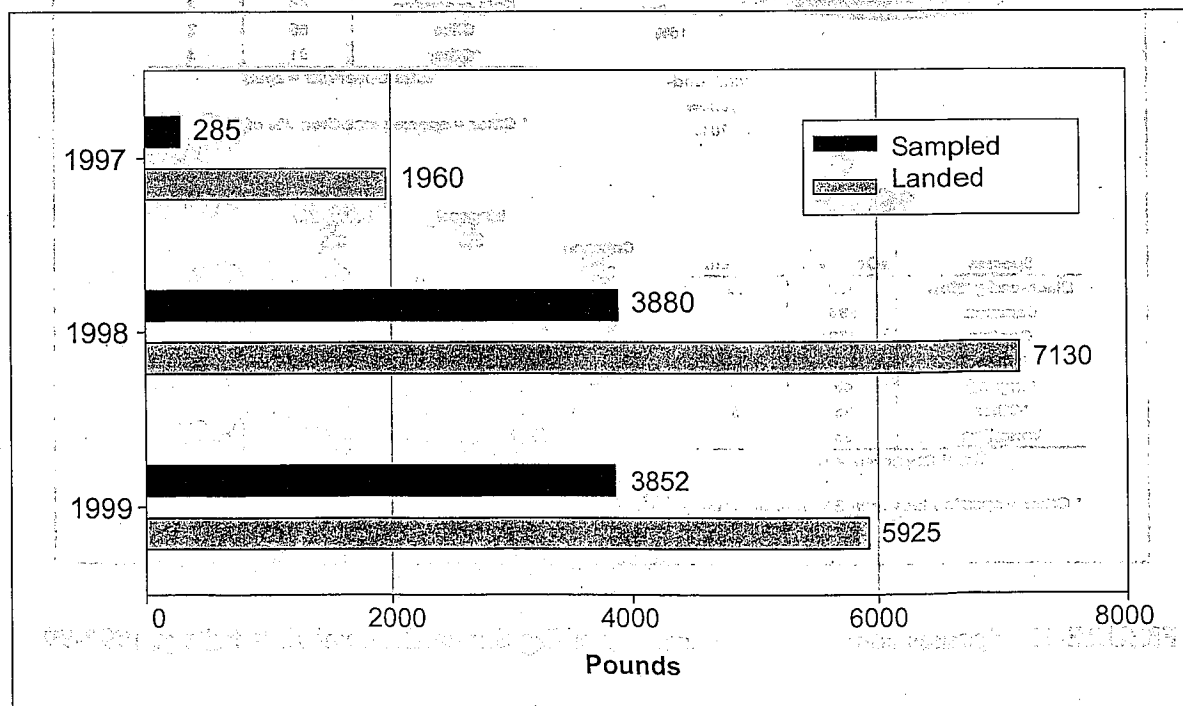


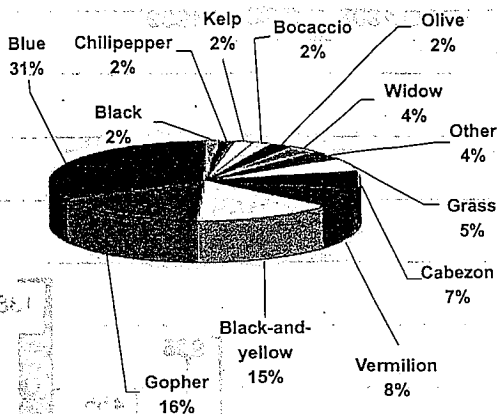
FIGURE 40. Annual Big Sur commercial nearshore skiff landings in pounds, 1997-99.

1997

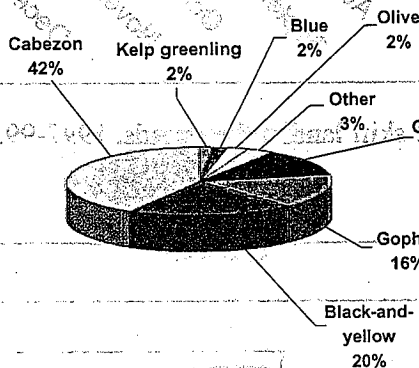
Species	#Observed	Percent
Black	10	2
Black-and-yellow	95	15
Blue	209	31
Bocaccio	13	2
Cabazon	45	7
Chilipepper	10	2
Gopher	109	16
Grass	33	5
Kelp	12	2
Olive	14	2
*Other	23	4
Vermilion	52	8
Widow	23	4

Total Observed = 648

* Other = species less than 2% of total catch



1998



Species	#Observed	Percent
Black-and-yellow	1541	20
Blue	45	2
Cabazon	1099	42
Gopher	430	16
Grass	343	13
Kelp greenling	44	2
Olive	65	2
*Other	91	3

Total Observed = 2658

* Other = species less than 2% of total catch

1999

Species	#Observed	Percent
Black-and-yellow	589	32
Cabazon	688	38
Gopher	173	9
Grass	196	11
Lingcod	46	2
*Other	95	5
Vermilion	58	3

Total Observed = 1845

* Other = species less than 2% of total catch

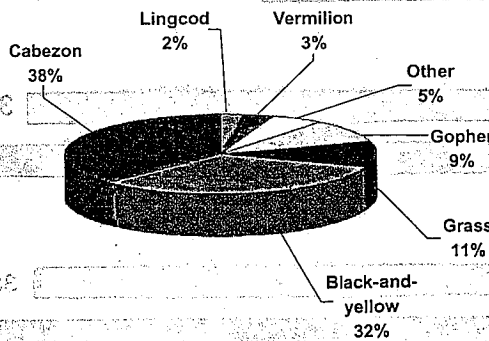


FIGURE 41. Species composition of landings of Big Sur commercial skiff fishery, 1997-99.

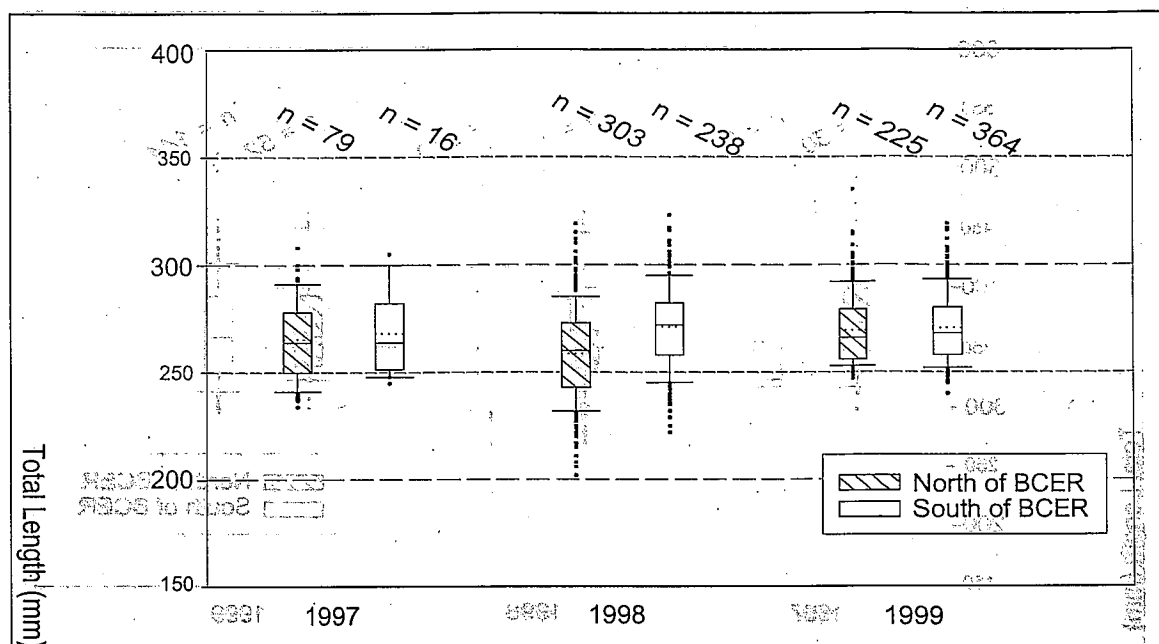


FIGURE 42. Total length of black-and-yellow rockfish from Big Sur commercial nearshore skiff landings, 1997-99. Dotted line represents the mean, solid line represents the median, boxed area is the interquartile range (50% of values), and the upper and lower "whiskers" represent 90th and 10th percentile points, respectively.

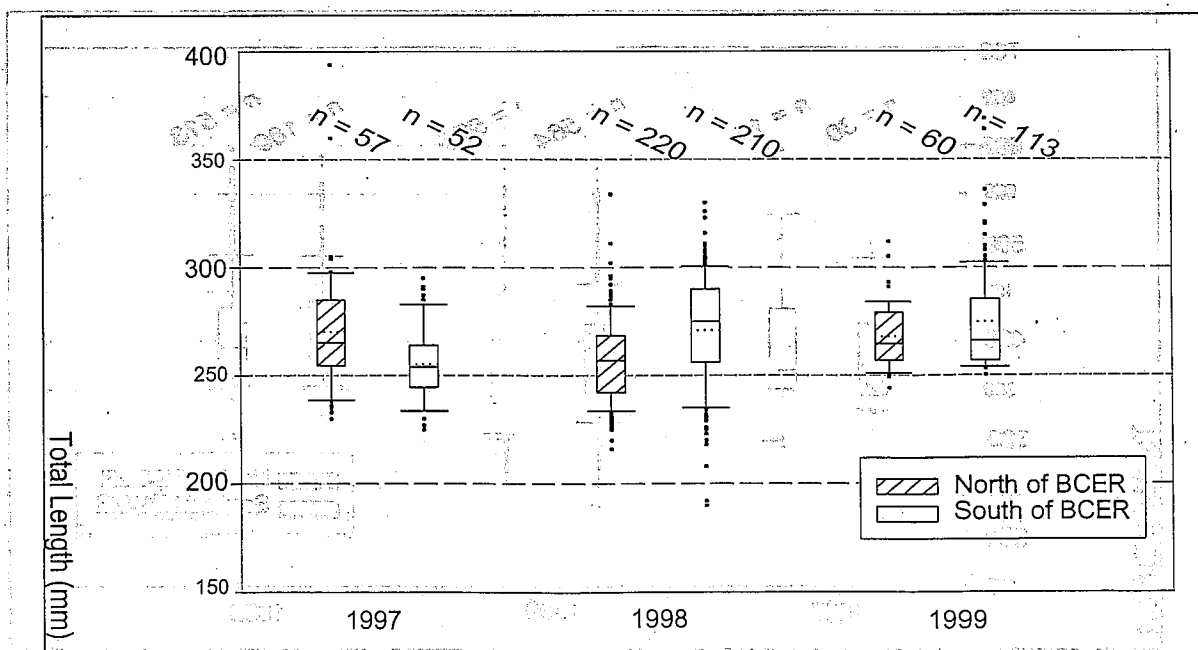


FIGURE 43. Total length of gopher rockfish from Big Sur commercial nearshore skiff landings, 1997-99. Dotted line represents the mean, solid line represents the median, boxed area is the interquartile range (50% of values), and the upper and lower "whiskers" represent 90th and 10th percentile points, respectively.

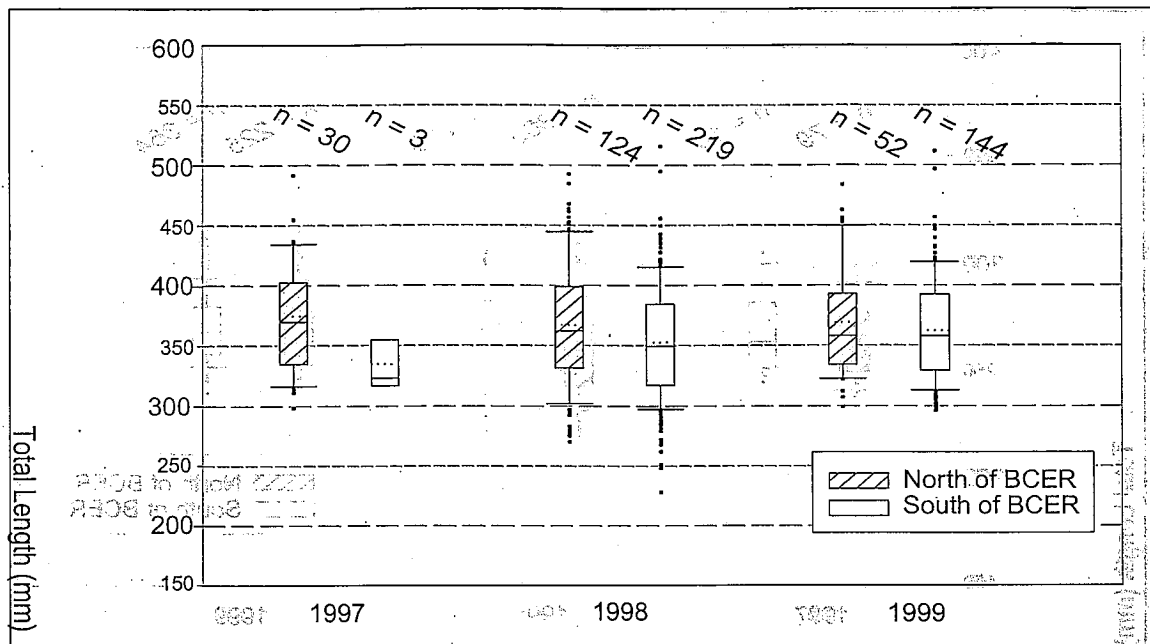


FIGURE 44. Total length of grass rockfish from Big Sur commercial nearshore skiff landings, 1997-99. Dotted line represents the mean, solid line represents the median, boxed area is the interquartile range (50% of values), and the upper and lower "whiskers" represent 90th and 10th percentile points, respectively.

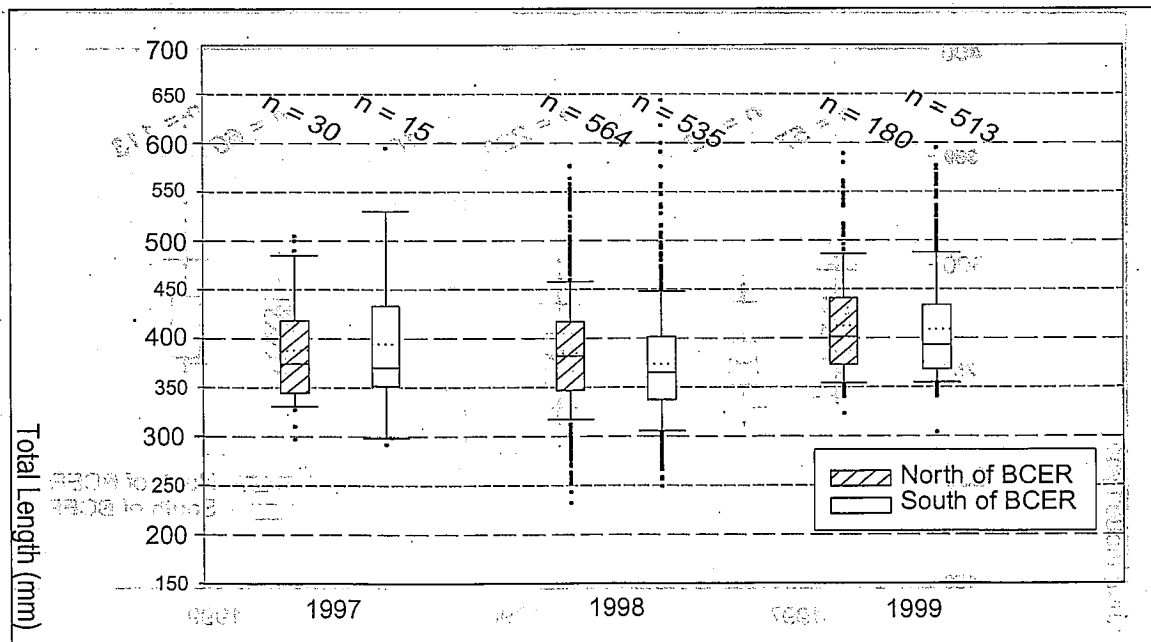


FIGURE 45. Total length of cabezon from Big Sur commercial nearshore skiff landing, 1997-99. Dotted line represents the mean, solid line represents the median, boxed area is the interquartile range (50% of values), and the upper and lower "whiskers" represent 90th and 10th percentile points, respectively.