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The 2004–2007 Hook and Line Survey of Shelf Rockfish in the Southern California Bight:

Estimates of Distribution, Abundance, and Length Composition

October 2008

U.S. DEPARTMENT OF COMMERCE
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The 2004–2007 Hook and Line Survey of Shelf Rockfish in the Southern California Bight:

Estimates of Distribution, Abundance, and Length Composition

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Executive Summary

The hook and line survey is a collaborative project among the National Marine Fisheries Service's Northwest Fisheries Science Center, the Pacific States Marine Fisheries Commission, and the commercial passenger fishing vessel industry. The primary objective of this survey is to provide an annual index of relative abundance and a time series of biological data for several key species of shelf rockfish (genus *Sebastes*) in the Southern California Bight (SCB), including bocaccio (*S. paucispinis*), the vermilion rockfish complex (e.g., *S. miniatus* and *S. crocotulus*), and greenspotted rockfish (*S. chlorostictus*).

The hook and line survey complements existing research conducted by the Fishery Resource Analysis and Monitoring Division of the Northwest Fisheries Science Center, including the bottom trawl survey and the acoustic survey for hake, as part of a suite of programs aimed at monitoring long-term trends in distribution and abundance of west coast groundfish.

Using chartered sportfishing vessels, the survey is conducted each fall, with the 2004 survey occurring in mid-November and the 2005–2007 cruises occurring during the last week of September through the first week of October. The survey uses hook and line gear to sample rocky, high-relief habitat areas generally not sampled well by trawl gear. Approximately 100 fixed sites are sampled each year, covering a depth range of 37–229 m. The sampling area is bounded by Point Arguello in the north (lat 34°30′N) and the border of the U.S.-Mexican exclusive economic zone in the south (lat 32°00′N). The sites are stratified by 19 different geographic areas to ensure sampling coverage throughout the SCB.

Sites are specific locations on the seafloor defined by global positioning system coordinates. A 100-yard radius around a site is provided to allow vessel captains flexibility in targeting the site given year-to-year changes in prevailing wind and ocean conditions. Sampling consists of three deckhands using rod and reel gear to make five coordinated drops of a vertically-arranged five-hook sampling gangion, providing for a maximum possible catch of 75 fish per site. To assist in catch per unit effort analyses and modeling, deckhands use stopwatches to keep track of the soak time for each drop.

Since 2004, 43 different species of fish have been caught by the survey, including 33 species of rockfish. Twenty-five species have been caught in all of the first four survey years, including 21 species of rockfish. The three primary target species—bocaccio, vermilion rockfish, and greenspotted rockfish—have been caught in at least 76%, 71%, and 45%, respectively, of all sites sampled in each of the four survey years.

Bocaccio abundances were consistently highest on the Santa Rosa Flats and 60 Mile Bank. Other areas including Point Conception, San Miguel Island, Catalina Island, San Clemente Island, and Nine Mile Bank were characterized by more mixed abundance levels. The highest abundances for vermilion rockfish were distributed throughout the Santa Barbara

Channel from Point Conception to the north shores of San Miguel and Santa Rosa islands. Occasional high catches of vermilion rockfish were also observed at Nine Mile Bank. Sites along the southern coast of the SCB from San Diego to Long Beach tended to be much less productive for both of these key species. Catch rates for the three primary species have shown a relatively flat trend, though the highest mean catch rates for all three species were observed in 2004. Catch rates for the three species generally increased with depth up to 146 m.

Length frequency analyses for bocaccio suggest a trend toward an increasingly heterogeneous age composition since the 2004 survey, which was dominated by the strong 1999 year-class. Subsequent survey cruises have suggested moderately strong recruitment for the 2003 and 2005 year-classes. In contrast, the populations of vermilion rockfish and, to a somewhat lesser degree, greenspotted rockfish appear to have experienced more constant recruitment levels during the first four survey years.

Acknowledgments

The Fishery Resource Analysis and Monitoring Division of the Northwest Fisheries Science Center recognizes the following individuals for their input and participation into the design, conduct, and implementation of the Southern California shelf rockfish hook and line survey: Keith Bosley, Andy Brooks, Toby Carpenter, Elizabeth Clarke, Jason Cope, Jen Cramer, E. J. Dick, Kate Guthrie, Owen Hamel, Pete Halmay, Chris Harvey, Tom Helser, Jennifer Hempelmann, Beth Horness, Melanie Johnson, Aimee Keller, John LaFargue, Bob Lauth, Scott McEntire, Jon McVeigh, Kevin Morgan, David Ono, Pat Patterson, Sylvia Pauly, Kevin Piner, Steve Ralston, Victor Simon, Ian Stewart, Ben Susman, Stan Tomich, Waldo Wakefield, John Wallace, and Curt Whitmire.

Special thanks are due to Captain Mike Thompson and the crew of the fishing vessel (FV) *Aggressor* and Captain Joe Villareal and the crew of the FV *Mirage* for the four years of hard work and constructive feedback they have invested in this project. We also recognize the captains and crews of the FVs *Amigo, Nikki J*, and *Sea Horse* for their input and involvement in this project, as well as several other sport and commercial fishermen who contributed fishing locations, advice, and expertise during the development of this survey.

Several state and federal permits were issued to facilitate the sampling involved in the hook and line survey. These include permit numbers SC-006780, SC-006781, SC-006782, and SC-008009 issued by California Department of Fish and Game; permit numbers SRP-05-2003, SRP-03-2004, SRP-01-2005, SRP-01-2006, and SRP-01-2007 issued by the Northwest Regional Office of the National Marine Fisheries Service; and permit number CINMS-2007-002 issued by the Channel Islands National Marine Sanctuary of the National Oceanic and Atmospheric Administration's National Ocean Service.

Background and Rationale

Historically, structure-associated rockfish within the Southern California Bight (SCB) have not been sufficiently sampled by coast-wide fisheries monitoring programs. Two primary factors for this include the geographic extent of fishery-independent groundfish surveys and the type of gear employed during their conduct. Annual and triennial groundfish trawl surveys conducted by the National Marine Fisheries Service's (NMFS) Alaska Fisheries Science Center and more recently by the Northwest Fisheries Science Center (NWFSC) throughout much of their history covered only the area from the Canadian border to Point Conception, California. The SCB was generally not sampled during these surveys.

In 2000 the Pacific Fishery Management Council recommended that the annual groundfish trawl survey conducted by the NWFSC be extended to include the SCB and that, if trawl gear was not appropriate to sample the region, a hook and line survey should be initiated (Seger 2000). Trawl survey coverage for the SCB began in 2002 and this expanded range has been a significant asset in improving the data available for groundfish found over soft bottom habitats. However, fish associated with rocky, generally untrawlable habitats, including dozens of species of rockfish (*Sebastes* spp.), are often poorly sampled using bottom trawls (Jagielo et al. 2003).

The need to improve research survey data for structure-associated shelf rockfish in Southern California became more pressing in light of the 2002 stock assessment for bocaccio (*S. paucispinis*). This assessment described evidence of a significant coast-wide decline in bocaccio biomass, but suggested the decline might be less severe and the stock more able to rebuild in Southern California relative to the rest of the coast (MacCall 2002). In an effort to rebuild the depleted bocaccio stocks, subsequent management measures curtailed most fishing opportunities for shelf rockfish. Southern California, which supports a large sportfishing presence from Santa Barbara to San Diego, was particularly affected.

To develop strategies for studying shelf rockfish within the SCB, a cooperative effort between members of the Southern California sportfishing industry and scientists from the NWFSC, Southwest Fisheries Science Center (SWFSC), and Pacific States Marine Fisheries Commission (PSMFC) was begun. Meetings commenced in July 2002, and one of the preliminary decisions reached during this collaboration was to initiate field research aimed at developing an annual time series of catch-rate data for bocaccio and, if possible, other shelf rockfish in the region.

In spring 2003 two pilot research cruises were conducted aboard three chartered vessels. The objective of these pilot cruises was to field test some of the fishing gear and sampling protocols discussed during the series of meetings between researchers and industry representatives. The first cruise was conducted aboard two sportfishing vessels (part of the commercial passenger fishing vessel [CPFV] industry) using rod and reel gear to sample

predetermined sites. The second cruise utilized one vessel from the commercial groundfish fishing industry sampling with vertical setline gear.

Beginning in 2004, all subsequent hook and line survey cruises have been conducted aboard sportfishing vessels. This decision was made primarily due to the composition of the commercial groundfish fleet in Southern California. These vessels are typically smaller boats that are not able to provide the deck space and number of berths the project requires.

The hook and line survey spans from approximately Point Arguello in the north (lat 34°30′N) to 60 Mile Bank along the U.S.-Mexican exclusive economic zone (EEZ) in the south (lat 32°00′N). All sites fall within a depth range of 20 fathoms ([fm], 37 m) to 125 fm (229 m). The survey is habitat specific, targeting only rocky reefs or other areas of hard bottom and structure. Sample sites have been geographically consolidated into 19 sampling areas to ensure spatial coverage throughout the SCB (Figure 1). Appendix A provides a detailed summary of habitat observations for all sites sampled during the hook and line survey. Each year two sportfishing vessels are concurrently chartered for 10–11 days each in an effort to sample a total of 100 sites. All sampling is conducted using standardized hook and line gear deployed from rods and reels.

The hook and line survey complements other fishery-independent research surveys conducted by NMFS as part of its suite of programs aimed at monitoring long-term trends in distribution and abundance of U.S. West Coast groundfish. These surveys include the annual groundfish bottom trawl survey and the biennial hake acoustic survey conducted by the NWFSC and the annual ichthyoplankton survey conducted by the SWFSC in conjunction with the California Cooperative Oceanic Fisheries Investigations.

This project began and continues as a collaborative venture between NMFS, PSMFC, and the SCB's sportfishing industry. Input from fishermen and other CPFV industry members played a critical role in determining the project's sampling gear, identifying species of particular interest, establishing sampling sites, and developing hypotheses about fish behavior. Vessel captains also provide significant ongoing consultation on matters of vessel safety, ocean and weather conditions, and most at sea–related issues.

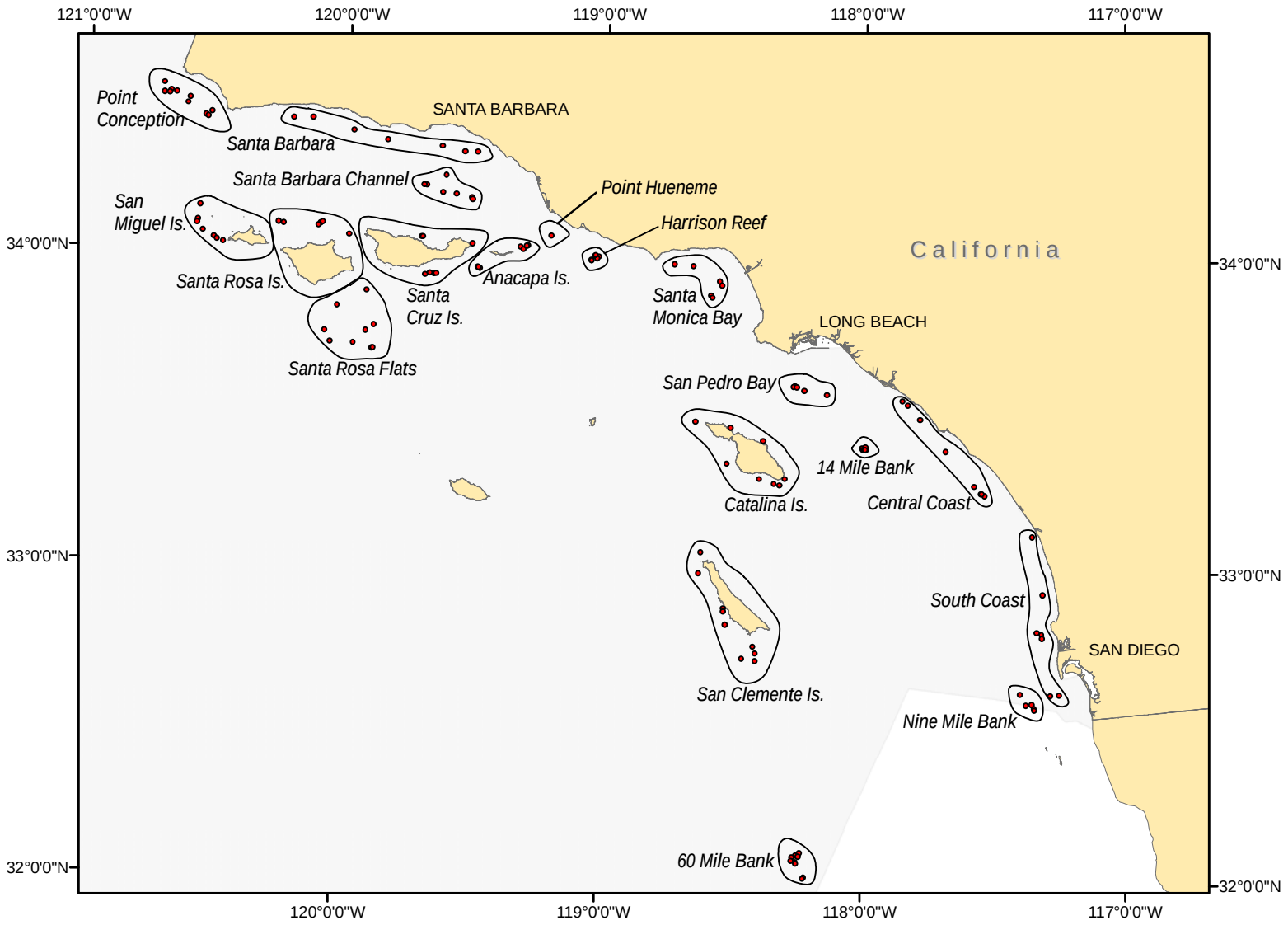

Figure 1. Map of the SCB showing sampling sites and boundaries of the 19 sampling areas.

Objectives

The primary objective of the hook and line survey is to develop an annual index of relative abundance for bocaccio and other structure-associated shelf rockfish within the SCB. These species may include the vermilion rockfish complex (*Sebastes miniatus* and *S. crocotulus*), greenspotted rockfish (*S. chlorostictus*), chilipepper (*S. goodei*), speckled rockfish (*S. ovalis*), and starry rockfish (*S. constellatus*). Secondary objectives include improving the biological information base for all rockfish species encountered during the survey by collecting length, weight, age, and sex information.

Tissue samples are collected for DNA analyses aimed at confirming species identification, determining stock structure, and other genetic work. These specimens may also be useful for preserving the ability to develop separate indices or other data parameters in the event of future taxonomic subdivisions among species (e.g., Hyde et al. 2008). Observations on weather, habitat, and ocean conditions are also collected for each site sampled. This includes wind and current speed, tide and moon phases, sea surface temperature, bottom depth, and habitat information interpreted from the vessels' echosounders.

Survey Methods

Survey Period and Sampling Area

Since 2005 the hook and line survey has been conducted during late September through early October. Two vessels sample for approximately 11 days each, divided into two legs of five or six days each. Due to vessel availability, the 2004 survey was conducted in mid-November, and the 2003 pilot cruises were conducted in May and June. Sampling is constrained to daylight hours and typically begins 10–15 minutes after sunrise and ends shortly before sunset.

Each year 100 sites are scheduled for sampling; however, factors including weather, crew and vessel issues, and, in earlier years, encountering soft-bottom habitat at sample sites can limit the number of sites that are actually sampled (Table 1). All sites sampled during the hook and line survey are within the SCB. The northern extent of sampling is Point Arguello (lat 34°30′N), and the southern extent is 60 Mile Bank along the U.S.-Mexico EEZ (lat 32°00′N). Minimum and maximum sampling depths are set at 20 fm (37 m) and 125 fm (229 m) which is an approximation of the common depth range for bocaccio (Love et al. 2002). No sampling occurs within the Cowcod Conservation Areas.

Vessels and Sampling Gear

During the 2003 pilot cruises, two sportfishing vessels and one commercial fishing vessel (FV) were chartered. The two sportfishing vessels were the FV *Amigo* (Newport Beach) and the FV *Mirage* (Port Hueneme). The commercial vessel was the FV *Nikki J* (Oxnard). The FV *Aggressor* (Newport Beach) and the FV *Mirage* were chartered for each of the four hook and line surveys from 2004–2007. The FV *Sea Horse* (Dana Point) was chartered for two experimental cruises in 2004 and 2005. Table 2 provides an overview of the vessels chartered during all

Table 1. Summary of sites visited during hook and line survey cruises, 2004–2007.

Sampling type	Activity	2004	2005	2006	2007
Hook and line sampling	Sites visited[a]	81	96	95	101
	Survey sites[b]	74	89	90	99
Other sampling	Camera drop sites	7	5	7	4
	Genetics sampling sites	N/A	1	4	4

[a]Includes sites later removed or not sampled due to inappropriate habitat and sites aborted due to weather or other considerations.
[b]Of these, 42 sites have been sampled in each of the 4 years, 2004–07.

Table 2. Summary of all cruises related to the hook and line survey through 2007.

Year	Vessel name	Vessel type	Length (LOA in ft)	Beam (ft)	Draft (ft)	Home port	Cruise type	Date	Days at sea
2003	*Amigo*	Sport	60	18.0	3.5	Newport Beach, CA	Pilot	21–25 May 2003	5
	Mirage	Sport	59	18.3	5.3	Port Hueneme, CA	Pilot	21–25 May 2003	5
	Nikki J	Commercial	42	14.0	4.5	Oxnard, CA	Pilot	12–16 June 2003	5
2004	*Sea Horse*	Sport	65	20.0	5.0	Dana Point, CA	Camera	9–19 Aug. 2004	9
	Mirage	Sport	59	18.3	5.3	Port Hueneme, CA	Survey	10–21 Nov. 2004	10
	Aggressor	Sport	62	17.0	4.0	Newport Beach, CA	Survey	10–21 Nov. 2004	10
2005	*Mirage*	Sport	59	18.3	5.3	Port Hueneme, CA	Genetics	4–7 April 2005	4
	Sea Horse	Sport	65	20.0	5.0	Dana Point, CA	Camera	2 Aug.–2 Sept. 2005	10
	Mirage	Sport	59	18.3	5.3	Port Hueneme, CA	Survey	27 Sept.–8 Oct. 2005	10
	Aggressor	Sport	62	17.0	4.0	Newport Beach, CA	Survey	27 Sept.–8 Oct. 2005	10
2006	*Mirage*	Sport	59	18.3	5.3	Port Hueneme, CA	Survey/genetics	26 Sept.–8 Oct. 2006	11
	Aggressor	Sport	62	17.0	4.0	Newport Beach, CA	Survey/genetics	26 Sept.–8 Oct. 2006	11
2007	*Mirage*	Sport	59	18.3	5.3	Port Hueneme, CA	Survey/genetics	25 Sept.–7 Oct. 2007	11
	Aggressor	Sport	62	17.0	4.0	Newport Beach, CA	Survey/genetics	25 Sept.–7 Oct. 2007	11

cruises through 2007. Vessel crew generally includes a captain, three deckhands, and a relief captain. The biological staff consists of a chief scientist and two biologists.

Sampling is conducted using hook and line gear deployed by rods and reels. Decisions about the specific design of the sampling rig as well as the choice of rods, reels, and other gear and tackle were made with input from members of the local sportfishing industry. Of primary importance was the ability of the gear to effectively target bocaccio and other shelf rockfish across a wide range of depths and habitats.

The reels are Penn Senators (model 114HL), and the rods are heavy-duty trolling rods and include roller tips and stripper guides. The sampling rig consists of a gangion with five red-and-yellow shrimp flies baited with strips of previously-frozen squid (Figure 2). The shrimp flies are tied directly to 6″ leaders that are spaced along the gangion at 16″ intervals. The hooks are size 5/0 long-shank, kirbed J-hooks, and the gangion is made from 60 lb monofilament. Depending on factors such as bottom depth and weather conditions, sinkers ranging in weight from 1 to 5 lb are attached to the terminal end of the gangion using a 1/0 barrel swivel and a length of 30 lb monofilament. This weaker piece of line serves as a "breakaway," sacrificing the sinker but preserving the rest of the rig should the sinker become snagged on the bottom. The gangion attaches to the 80 lb Spectra Mainline with a 1/0 barrel swivel. Gear performance is coded to note acceptable drops as well as lost sinkers, tangles, snags, and broken or lost gangions. When referenced in subsequent tables and figures, the hooks are numbered sequentially from 1 through 5 where "Hook 1" corresponds to the bottom hook.

Sampling Frame and Site Selection

The sampling frame was developed after extensive consultation with sport and commercial fishermen within the region. Industry members provided input on the locations of historically productive fishing areas throughout the region and gave their observations of the type of habitat present and whether the productivity at some of these areas has changed over time. Taking this into account, effort was made to develop a sampling frame that would include sites at different perceived levels of depletion and sites in both prime and more-marginal habitats.

After initial experimentation with a grid design during the 2003 pilot project, all subsequent hook and line survey cruises have employed a sampling frame comprised of point locations defined by global positioning system (GPS) coordinates. These sites were compiled mainly from discussions with industry but were augmented with locations provided by California Department of Fish and Game from earlier monitoring programs and sites opportunistically sampled during previous hook and line cruises.

To ensure sampling coverage throughout the SCB, the region was subdivided into 19 smaller sampling areas of varying size (see Figure 1). Each of these areas contains between four and eight sites based on the hypothesized (and later, observed) range in catch rates. The one exception is the Point Hueneme area, which currently contains only one site; other sites were removed due to inappropriate habitat and difficulty in locating replacements.

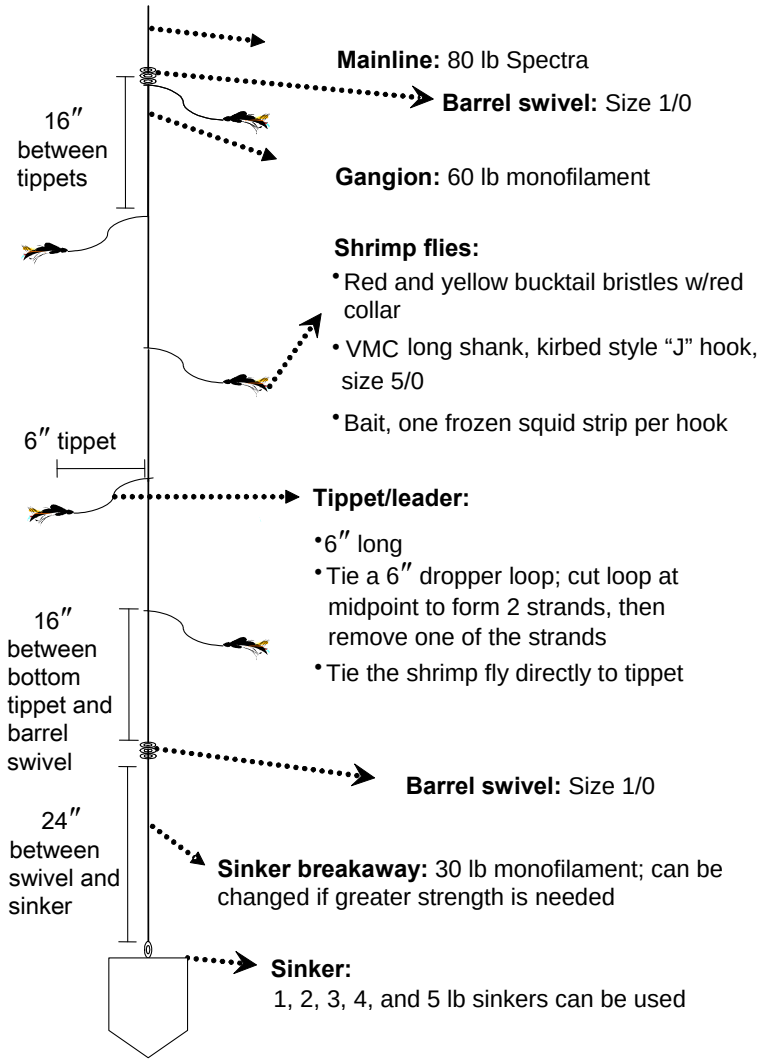

Figure 2. Diagram of sampling rig used during the hook and line survey.

The 2004 and 2005 hook and line surveys used a combined fixed and random site design. Of the 100 sites scheduled for sampling, 60 were established as fixed sites that would be sampled every year. Forty additional sites were randomly selected each year from the remaining compilation of sampling sites. In 2006 the survey adopted a fixed-only station design, based in part upon concerns of high intersite variability in observed catch rates.

Each vessel samples half the sites within each area. Given that constraint, sites are randomly assigned to the two vessels. No formalized attempt was made to select sites according to depth stratification, although it was a consideration to include sites representing a variety of depths. Figure 3 describes the depth distribution of sites sampled during the four survey cruises from 2004–2007.

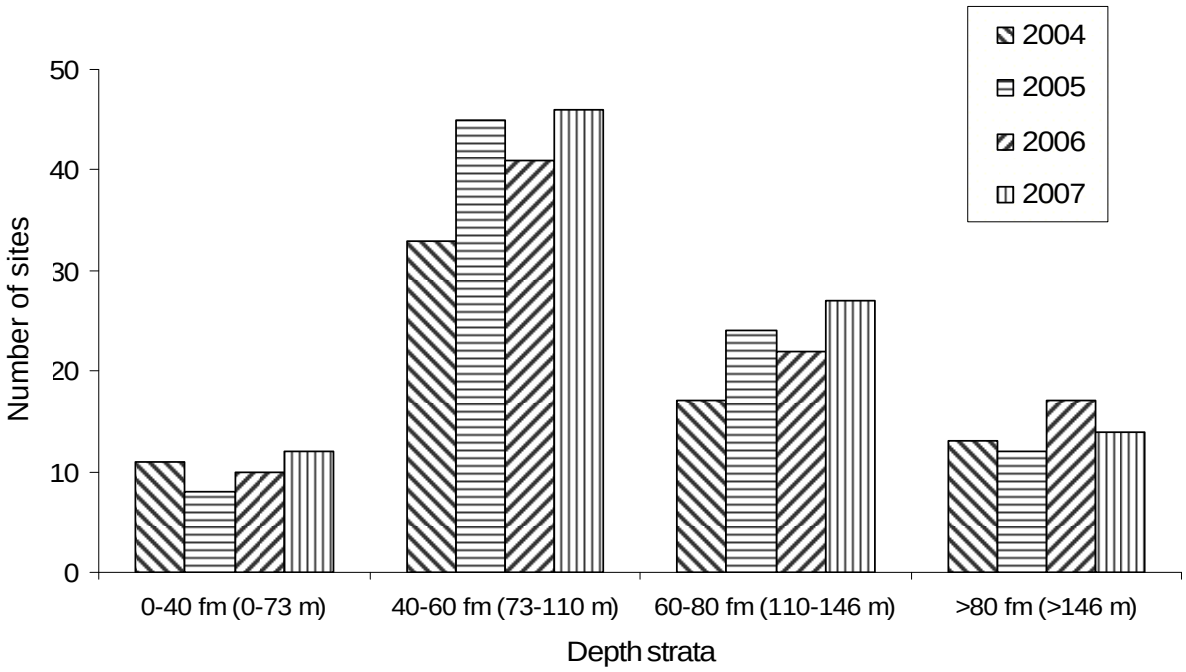

Figure 3. Depth distribution of sample sites for the hook and line survey cruises, 2004–2007.

Sampling Protocols

Overview

Sampling consists of the three deckhands each making five coordinated deployments (or drops) of a five-hook sampling rig at each site. Thus a maximum of 75 individual fish may be caught at any site. Drops are made as the vessel drifts with the prevailing winds and currents over a particular target area of the seafloor, which may include a habitat feature, fish aggregation, or both. During sampling, it is assumed that the captain and crew actively take measures to maximize catch, within the constraints of survey design.

The process for sampling each site begins with the chief scientist providing GPS coordinates to the captain, who navigates the vessel to the specified location. Upon arrival at the site, the captain may use up to 30 minutes to reconnoiter the immediate area for suitable habitat or evidence of aggregations of shelf rockfish. The captain may position the vessel anywhere within a 100-yard radius of the site's GPS coordinates to initiate the first sampling drift. This cushion is provided to take into consideration differences from year to year in wind, tide, and currents that may require the vessel to "lead" a spot differently. Additionally, each site is interpreted as a "fishing opportunity" rather than a precise location on the seafloor. The aggregations of fish targeted during the survey often move to different sections of a particular reef or area of hard bottom, and the 100-yard radius allows these aggregations to be targeted within reasonable constraints. The captain repositions the vessel after each drift and is not obligated to target the same aggregation or habitat feature on every drop; however, all five drops must begin no more than 100 yards from the site's official coordinates.

Fishing Operations

Each deckhand is provided a stopwatch to time four separate events per drop: 1) when the sinker reaches the bottom, 2) when the deckhand feels the first bite on the line, 3) when line retrieval begins, and 4) when the fishing gear reaches the surface. This allows the time the gear is on bottom and "available" to demersal shelf rockfish and the total time the gear is in the water to be calculated. As the deckhands report these times, they are recorded by one of the biologists (identified as Biologist-1). The maximum allowable time for the gear to remain on the seafloor is 5 minutes, after which all anglers must begin retrieval. However, anglers need not wait the entire 5 minutes to begin retrieval. If a deckhand encounters bites and believes there are fish on the line, it is left to that angler's discretion when to begin retrieval, up to the 5-minute limit of bottom time. This discretion is provided for situations where a deckhand may be concerned about hooked fish slipping free of the sampling rig while waiting for the 5-minute time period to elapse.

As the fishing lines are brought to the surface, Biologist-1 records the disposition of each hook from each angler on a hook matrix form (Appendix B) noting whether there is a fish, no bait on hook, bait on hook, or no hook. All fish are identified to species. Also noted are snags, lost sinkers, broken gangions, and tangles with other anglers. For each fish caught, Biologist-1 records the angler, drop, and hook number on a waterproof Tyvek tag. The tag is then stapled securely to the fish's operculum, and the fish is placed in a basket with other fish from that drop and brought to the sampling table toward the stern of the boat.

Biological Sampling

Biological sampling begins when the second biologist (identified as Biologist-2) receives a basket of tagged fish at the sampling table. The fish species and associated angler, drop, and hook numbers are recorded on a Duracopy species data sheet (Appendix B). Length, weight, and sex information are recorded, and both sagittal otoliths are extracted. A fingernail-sized portion from the left pectoral fin is clipped and preserved for future DNA analyses. Nonrockfish specimens are generally not sexed, do not have their otoliths removed, and are released alive where possible. Samples or observations for any special or ancillary projects are taken at this time and noted on the species data sheet. Some of these projects have included:

- Providing vermilion rockfish otoliths for microchemistry analysis on how periodic climatic shifts including El Niño-Southern Oscillation events affect individuals' growth and movement
- Collecting muscle tissue for a histological study analyzing levels of key enzymes as a proxy for estimating burst swimming speed for a variety of rockfish species
- Capturing digital photographs and other morphological data to determine whether visual cues exist for differentiating between vermilion rockfish and sunset rockfish
- Collecting whole specimens of rockfish for inclusion in a genetics voucher program
- Capturing tissue using custom-fabricated biopsy hooks and employing DNA microsatellite analyses as a genetic "mark-recapture" process to test the viability of generating nonlethal population estimates

- Deploying an underwater video system to gather direct visual observations of the habitat and species composition and abundance at sample sites

After the biological sampling has been completed, the vessel crew stores the fish on ice in the fish hold. The retained fish are sold to appropriately licensed buyers at the conclusion of each five-day leg, and proceeds help offset the cost of the survey (≈4% of the cost of the charter).

Sensor Data and Wheelhouse/Galley Operations

During sampling, the chief scientist records and monitors sensor and other data at an electronics work station in the galley and maintains communication with the captain in the wheelhouse. Electronic data are collected and stored to one or more laptop computers using NMFS's Scientific Computing System software and Nobeltec's Visual Navigational Suite software (http://www.nobeltec.com/products/prod_suite.asp). This information includes time and date, vessel position, speed, bottom depth, and sea surface temperature. The start points of each drop are marked in Nobeltec, and a running trackline records the vessel's complete path during the course of sampling a site (Figure 4). Observations on weather, wind speed and direction, sea state, currents, tide, and moon phase are made using a variety of analog equipment and recorded onto a site data sheet (Appendix B). In addition, redundant observations on time, date, position, and depth are made manually on the site data sheet.

Observations of the site's habitat and fish aggregations are collected based on readings from the vessel's echosounder. These qualitative observations help to discern whether there is hard or soft bottom present, the relative relief of the local seafloor, and whether any demersal or pelagic aggregations of fish are in proximity. Observations are recorded on the site data sheet and compiled with notes from previous visits to the site, if any.

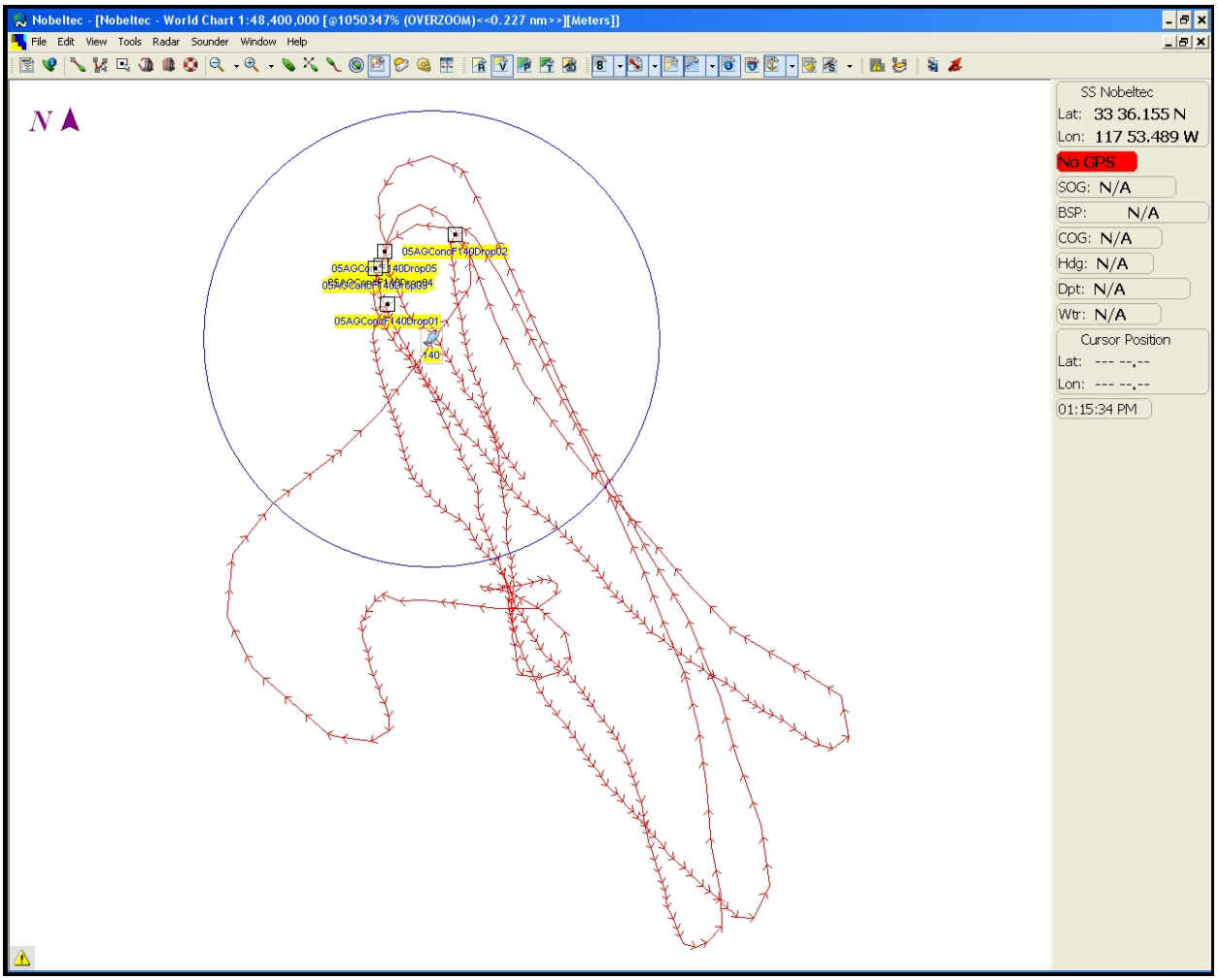

Figure 4. Screen capture of marks and tracklines as captured by Nobeltec's Visual Navigation Suite software during sampling operations. The large circle is the 100-yard radius around the site's coordinates. The sites' coordinates are indicated by a fish icon at the center of the circle and the five square icons indicate where each drop was made.

Results

The charts and tables in this section provide a statistical summary of data and observations collected during the four hook and line survey cruises from 2004 to 2007. Data from the 2003 pilot cruises were used primarily to improve the design and protocols of the hook and line survey, and have been excluded from the charts and tables.

Catch Summaries

Table 3 summarizes the species composition and weight of catch observed during sampling operations from 2004 to 2007. During the 4 years of sampling, 43 unique species of fish have been caught at least once, including 33 species of rockfish. Twenty-five species of fish have been caught at least once in all four survey years, including 21 rockfish species.

Bocaccio and vermilion rockfish dominate the catch, accounting for more than 61% by frequency and more than 73% by weight of all fish hooked during the 4 years of the survey. Table 4 provides the positive proportion of sites in which at least one individual from a species has been hooked during a survey cruise sampling operation from 2004 to 2007, as well as the minimum, maximum, and mean depths of encounter for each species. Again, bocaccio and vermilion rockfish are the most commonly encountered species, appearing in at least 76% and 71%, respectively, of all sites sampled in any year. Greenspotted rockfish have been caught in at least 45% of all sites sampled in a particular survey year.

Table 3. Species composition of catch by count and weight for the hook and line survey cruises, 2004–2007.

Species	Scientific name	Number of individuals					Weight (kg)				
		2004	2005	2006	2007	Total	2004	2005	2006	2007	Total
Bank rockfish	*Sebastes rufus*	13	24	49	15	101	14.97	29.38	54.10	19.36	117.81
Barred sand bass	*Paralabrax nebulifer*	3	1	0	0	4	2.92	1.83	0.00	0.00	4.75
Blue rockfish	*Sebastes mystinus*	47	65	41	22	175	23.24	33.39	20.97	12.87	90.47
Bocaccio	*S. paucispinis*	791	669	745	649	2,854	1,121.37	1,097.12	1,053.57	881.06	4,153.12
Bonito	*Sarda chiliensis*	0	3	4	0	7	0.00	1.96	2.48	0.00	4.44
Bronzespotted rockfish	*Sebastes gilli*	0	0	0	1	1	0.00	0.00	0.00	6.44	6.44
Brown rockfish	*S. auriculatus*	1	3	0	2	6	0.46	3.66	0.00	1.72	5.84
California scorpionfish	*Scorpaena guttata*	0	1	2	1	4	0.00	0.30	0.52	0.10	0.92
Canary rockfish	*Sebastes pinniger*	7	13	8	18	46	6.98	19.84	13.06	33.82	73.70
Chilipepper	*S. goodei*	68	74	50	85	277	72.39	62.70	42.24	80.15	257.48
Copper rockfish	*S. caurinus*	33	70	61	80	244	42.29	85.63	67.57	95.76	291.25
Cowcod	*S. levis*	5	17	11	23	56	25.30	76.45	42.44	86.02	230.21
Flag rockfish	*S. rubrivinctus*	10	6	11	12	39	4.74	2.24	4.68	6.05	17.71
Freckled rockfish	*S. lentiginosus*	2	0	0	0	2	0.22	0.00	0.00	0.00	0.22
Gopher rockfish	*S. carnatus*	0	1	0	2	3	0.00	0.40	0.00	0.64	1.04
Greenblotched rockfish	*S. rosenblatti*	15	33	25	53	126	9.90	26.42	17.64	48.40	102.36
Greenspotted rockfish	*S. chlorostictus*	223	133	220	186	762	117.61	66.05	112.32	107.40	403.38
Greenstriped rockfish	*S. elongatus*	8	8	15	19	50	2.15	1.66	3.88	5.84	13.53
Halfbanded rockfish	*S. semicinctus*	2	37	25	15	79	0.22	3.10	2.08	1.30	6.70
Honeycomb rockfish	*S. umbrosus*	3	11	6	9	29	0.70	1.86	0.71	1.08	4.35
Lingcod	*Ophiodon elongatus*	34	41	18	30	123	90.96	111.63	52.11	83.94	338.64
Lizardfish	*Synodus* spp.	1	0	0	0	1	0.06	0.00	0.00	0.00	0.06
Mexican rockfish	*Sebastes macdonaldi*	0	1	1	2	4	0.00	0.94	1.42	2.34	4.70
Ocean whitefish	*Caulolatilus princeps*	4	9	14	6	33	4.06	11.32	10.95	5.62	31.94
Olive rockfish	*Sebastes serranoides*	16	3	21	20	60	13.85	2.98	19.92	21.90	58.65
Pacific mackerel	*Scomber japonicus*	9	7	11	20	46	2.35	2.46	3.42	6.08	14.31
Pink rockfish	*Sebastes eos*	0	0	0	1	1	0.00	0.00	0.00	1.14	1.14
Pinkrose rockfish	*S. simulator*	0	0	1	0	1	0.00	0.00	0.06	0.00	0.06
Rosethorn rockfish	*S. helvomaculatus*	34	0	0	0	34	3.42	0.00	0.00	0.00	3.42
Rosy rockfish	*S. rosaceus*	21	11	13	53	98	3.07	1.98	2.10	6.69	13.84
Sanddab unident.	*Citharichthys* spp.	11	10	37	18	76	2.16	1.77	5.45	3.44	12.81
Silvergrey rockfish	*Sebastes brevispinis*	0	1	0	0	1	0.00	1.30	0.00	0.00	1.30
Speckled rockfish	*S. ovalis*	42	28	117	42	229	28.40	15.90	69.36	22.68	136.34
Spiny dogfish	*Squalus acanthias*	0	2	1	0	3	0.00	5.90	2.20	0.00	8.10
Squarespot rockfish	*Sebastes hopkinsi*	6	28	36	10	80	1.23	5.36	6.56	2.58	15.73
Starry rockfish	*S. constellatus*	24	34	63	64	185	14.27	19.25	33.32	38.19	105.02

Table 3 continued. Species composition of catch by count and weight for the hook and line survey cruises, 2004–2007.

Species	Scientific name	Number of individuals					Weight (kg)				
		2004	2005	2006	2007	Total	2004	2005	2006	2007	Total
Stripetail rockfish	*S. saxicola*	0	1	0	0	1	0.00	0.21	0.00	0.00	0.21
Swordspine rockfish	*S. ensifer*	0	12	5	10	27	0.00	1.08	0.54	1.46	3.08
Unknown		1	0	2	1	4	N/A*	N/A	N/A	N/A	N/A
Vermilion rockfish	*Sebastes miniatus*	758	873	588	934	3,153	1,053.31	1,242.84	772.34	1,308.42	4,376.91
White croaker	*Genyonemus lineatus*	0	0	0	1	1	0.00	0.00	0.00	0.16	0.16
Widow rockfish	*Sebastes entomelas*	56	76	70	43	245	44.30	47.73	32.01	24.62	148.66
Yelloweye rockfish	*S. ruberrimus*	1	0	1	4	6	1.70	0.00	5.16	7.74	14.60
Yellowtail rockfish	*S. flavidus*	129	132	91	129	481	121.27	108.78	79.40	153.75	463.20
Grand total		2,377	2,438	2,363	2,580	9,758	2,817.25	3,070.01	2,503.01	3,021.09	11,538.68

*N/A = not available.

Table 4. Proportion of positive survey sites and minimum, maximum, and mean depths for all species encountered during the hook and line survey cruises, 2004–2007.

					Depth (m)		
Species	**2004**	**2005**	**2006**	**2007**	**Min.**	**Max.**	**Mean**
Bank rockfish	0.122	0.112	0.133	0.081	121.7	206.8	162.3
Barred sand bass	0.014	0.011	0.000	0.000	43.7	85.1	54.6
Blue rockfish	0.081	0.101	0.100	0.051	42.8	91.5	69.0
Bocaccio rockfish	0.797	0.764	0.800	0.798	42.1	206.8	118.6
Bonito	0.000	0.022	0.033	0.000	74.0	141.0	87.9
Bronzespotted rockfish	0.000	0.000	0.000	0.010	164.7	164.7	164.7
Brown rockfish	0.014	0.022	0.000	0.020	43.7	98.3	69.2
California scorpionfish	0.000	0.011	0.022	0.010	75.0	104.9	89.9
Canary rockfish	0.054	0.034	0.044	0.051	70.5	161.8	116.7
Chilipepper rockfish	0.176	0.146	0.133	0.141	78.1	201.3	142.8
Copper rockfish	0.149	0.157	0.144	0.182	42.8	113.5	75.5
Cowcod rockfish	0.054	0.101	0.089	0.131	94.8	199.5	148.9
Flag rockfish	0.108	0.045	0.100	0.101	40.3	177.1	101.1
Freckled rockfish	0.027	0.000	0.000	0.000	86.0	97.0	91.5
Gopher rockfish	0.000	0.011	0.000	0.020	53.3	59.1	55.4
Greenblotched rockfish	0.054	0.112	0.078	0.081	82.4	203.1	148.1
Greenspotted rockfish	0.514	0.506	0.544	0.455	68.4	201.3	126.1
Greenstriped rockfish	0.081	0.079	0.089	0.111	78.3	199.3	131.7
Halfbanded rockfish	0.014	0.101	0.067	0.081	75.9	148.2	93.0
Honeycomb rockfish	0.041	0.045	0.044	0.040	43.2	104.9	75.0
Lingcod	0.257	0.213	0.144	0.192	51.6	197.6	111.0
Lizardfish	0.014	0.000	0.000	0.000	51.6	51.6	51.6
Mexican rockfish	0.000	0.011	0.011	0.010	81.4	151.9	131.7
Ocean whitefish	0.054	0.056	0.033	0.030	40.3	125.4	67.2
Olive rockfish	0.108	0.022	0.078	0.071	41.7	96.6	78.4
Pacific mackerel	0.068	0.045	0.022	0.051	43.7	106.1	67.7
Pink rockfish	0.000	0.000	0.000	0.010	173.5	173.5	173.5
Pinkrose rockfish	0.000	0.000	0.011	0.000	148.4	148.4	148.4
Rosethorn rockfish	0.041	0.000	0.000	0.000	100.7	175.7	121.7
Rosy rockfish	0.122	0.079	0.089	0.141	42.5	192.2	99.5
Sanddab unident.	0.068	0.067	0.133	0.111	55.6	177.9	100.4
Silvergray rockfish	0.000	0.011	0.000	0.000	160.1	160.1	160.1
Speckled rockfish	0.203	0.112	0.367	0.202	69.4	172.4	110.2
Spiny dogfish	0.000	0.022	0.011	0.000	87.3	91.5	89.2
Squarespot rockfish	0.054	0.191	0.144	0.081	42.6	133.6	86.0
Starry rockfish	0.176	0.191	0.300	0.303	41.7	192.2	111.6
Stripetail rockfish	0.000	0.011	0.000	0.000	194.0	194.0	194.0

Table 4 continued. Proportion of positive survey sites and minimum, maximum, and mean depths for all species encountered during the hook and line survey cruises, 2004–2007.

					Depth (m)		
Species	**2004**	**2005**	**2006**	**2007**	**Min.**	**Max.**	**Mean**
Swordspine rockfish	0.000	0.067	0.056	0.051	97.7	169.3	134.3
Unknown	0.014	0.000	0.022	0.010	N/A	N/A	N/A
Vermilion rockfish	0.730	0.798	0.711	0.717	42.8	206.8	111.9
White croaker	0.000	0.000	0.000	0.010	82.4	82.4	82.4
Widow rockfish	0.176	0.157	0.156	0.121	66.2	159.4	92.6
Yelloweye rockfish	0.014	0.000	0.011	0.040	71.7	167.4	109.9
Yellowtail rockfish	0.189	0.157	0.067	0.182	42.5	159.2	102.2

Survey Descriptive Information

Tables in this section provide descriptive information about the survey's sampling operations. This includes tabulated information on the disposition of each hook deployed among the two vessels (Table 5), three angler positions (Table 6), five drops (Table 7), and five hook positions (Table 8). Only observations deemed valid have been included in Tables 5 though 8. Some of the criteria for excluding observations include "floater" fish where the angler, drop, or hook that caught the fish is not known; drops where the gangion snags on the bottom and is not easily retrieved; or when there is significant damage or malfunction with the gear or timer. Table 9 summarizes the distribution of missing or broken hooks observed during sampling. Through 2007 approximately 1.4% of all hooks deployed have been recorded as lost or broken.

Table 5. Summary of hook results for both vessels during the hook and line survey, 2004–2007.

		FV *Aggressor*		FV *Mirage*		Both vessels	
Year	Hook result	No. hooks	% vessel total	No. hooks	% vessel total	No. hooks	% total
2004	Bait only	1,422	52.2%	1,225	44.8%	2,647	48.5%
	Fish	1,097	40.3%	1,259	46.0%	2,356	43.2%
	Empty hook	176	6.5%	225	8.2%	401	7.3%
	Missing hook	27	1.0%	27	1.0%	54	1.0%
2005	Bait only	1,923	58.9%	1,870	56.4%	3,793	57.7%
	Fish	1,157	35.4%	1,255	37.9%	2,412	36.7%
	Empty hook	161	4.9%	163	4.9%	324	4.9%
	Missing hook	24	0.7%	25	0.8%	49	0.7%
	Multiple hook*	1	0.0%	2	0.1%	3	0.0%
2006	Bait only	1,897	58.8%	2,033	59.3%	3,930	59.0%
	Fish	1,076	33.3%	1,223	35.7%	2,299	34.5%
	Empty hook	222	6.9%	147	4.3%	369	5.5%
	Missing hook	32	1.0%	25	0.7%	57	0.9%
	Multiple hook*	0	0.0%	2	0.1%	2	0.0%
2007	Bait only	2,013	58.1%	2,248	58.6%	4,261	58.4%
	Fish	1,221	35.2%	1,359	35.4%	2,580	35.3%
	Empty hook	216	6.2%	206	5.4%	422	5.8%
	Missing hook	11	0.3%	20	0.5%	31	0.4%
	Multiple hook*	3	0.1%	5	0.1%	8	0.1%

* Indicates instances when a fish was hooked or snagged by more than one hook.

Table 6. Hook results by angler position during the hook and line survey cruises, 2004–2007.

		Angler 1		Angler 2		Angler 3	
Year	Hook result	No.	% all anglers	No.	% all anglers	No.	% all anglers
2004	Bait only	849	32.1%	884	33.4%	914	34.5%
	Fish	841	35.8%	757	32.3%	749	31.9%
	Empty hook	128	31.9%	147	36.7%	126	31.4%
	Missing hook	11	20.4%	19	35.2%	24	44.4%
2005	Bait only	1,198	31.6%	1,302	34.3%	1,293	34.1%
	Fish	878	36.5%	749	31.1%	779	32.4%
	Empty hook	91	28.1%	118	36.4%	115	35.5%
	Missing hook	22	44.9%	17	34.7%	10	20.4%
	Multiple hook*	1	33.3%	0	0.0%	2	66.7%
2006	Bait only	1,269	32.3%	1,374	35.0%	1,287	32.7%
	Fish	799	34.9%	716	31.3%	776	33.9%
	Empty hook	114	30.9%	107	29.0%	148	40.1%
	Missing hook	19	33.3%	18	31.6%	20	35.1%
	Multiple hook*	0	0.0%	1	50.0%	1	50.0%
2007	Bait only	1,354	31.8%	1,402	32.9%	1,505	35.3%
	Fish	902	35.0%	900	34.9%	775	30.1%
	Empty hook	152	36.0%	138	32.7%	132	31.3%
	Missing hook	15	48.4%	7	22.6%	9	29.0%
	Multiple hook*	3	37.5%	4	50.0%	1	12.5%

* Indicates instances when a fish was hooked or snagged by more than one hook.

Table 7. Hook results by drop number during the hook and line survey cruises, 2004–2007.

		Drop 1		Drop 2		Drop 3		Drop 4		Drop 5	
Year	Hook result	No.	% all drops	No.	% all drops	No.	% all drops	No.	% all drops	No.	% all drops
2004	Bait only	502	19.0%	481	18.2%	535	20.2%	559	21.1%	570	21.5%
	Fish	499	18.9%	512	19.3%	471	17.8%	436	16.5%	429	16.2%
	Empty hook	69	2.6%	83	3.1%	82	3.1%	88	3.3%	79	3.0%
	Missing hook	5	0.2%	11	0.4%	14	0.5%	12	0.5%	12	0.5%
2005	Bait only	699	26.4%	725	27.4%	777	29.4%	783	29.6%	809	30.6%
	Fish	528	19.9%	524	19.8%	463	17.5%	448	16.9%	441	16.7%
	Empty hook	75	2.8%	55	2.1%	61	2.3%	83	3.1%	50	1.9%
	Missing hook	8	0.3%	11	0.4%	7	0.3%	10	0.4%	13	0.5%
	Multiple hook*	0	0.0%	0	0.0%	2	0.1%	0	0.0%	1	0.0%
2006	Bait only	766	28.9%	755	28.5%	804	30.4%	807	30.5%	798	30.1%
	Fish	490	18.5%	480	18.1%	428	16.2%	425	16.1%	468	17.7%
	Empty hook	58	2.2%	71	2.7%	85	3.2%	91	3.4%	64	2.4%
	Missing hook	12	0.5%	9	0.3%	9	0.3%	17	0.6%	10	0.4%
	Multiple hook*	0	0.0%	0	0.0%	1	0.0%	1	0.0%	0	0.0%
2007	Bait only	815	30.8%	799	30.2%	826	31.2%	904	34.2%	917	34.6%
	Fish	568	21.5%	550	20.8%	553	20.9%	458	17.3%	448	16.9%
	Empty hook	80	3.0%	83	3.1%	78	2.9%	90	3.4%	91	3.4%
	Missing hook	5	0.2%	9	0.3%	3	0.1%	8	0.3%	6	0.2%
	Multiple hook*	2	0.1%	2	0.1%	0	0.0%	1	0.0%	3	0.1%

* Indicates instances when a fish was hooked or snagged by more than one hook.

Table 8. Hook results by hook number during the hook and line survey cruises, 2004–2007.

		Hook 1		Hook 2		Hook 3		Hook 4		Hook 5	
Year	Hook result	No.	% all hooks	No.	% all hooks	No.	% all hooks	No.	% all hooks	No.	% all hooks
2004	Bait only	374	14.1%	514	19.4%	563	21.3%	600	22.7%	596	22.5%
	Fish	592	25.4%	461	19.7%	448	19.2%	415	17.8%	423	18.1%
	Empty hook	100	24.9%	97	24.2%	72	18.0%	69	17.2%	63	15.7%
	Missing hook	21	38.9%	14	25.9%	5	9.3%	6	11.1%	8	14.8%
2005	Bait only	610	16.1%	717	18.9%	811	21.4%	809	21.3%	846	22.3%
	Fish	607	25.3%	503	20.9%	435	18.1%	441	18.4%	415	17.3%
	Empty hook	77	23.8%	85	26.2%	55	17.0%	57	17.6%	50	15.4%
	Missing hook	22	44.9%	7	14.3%	11	22.4%	6	12.2%	3	6.1%
	Multiple hook*	0	0.0%	1	33.3%	1	33.3%	1	33.3%	0	0.0%
2006	Bait only	594	15.1%	779	19.8%	826	21.0%	881	22.4%	850	21.6%
	Fish	610	26.7%	451	19.8%	427	18.7%	381	16.7%	414	18.1%
	Empty hook	100	27.1%	83	22.5%	68	18.4%	61	16.5%	57	15.4%
	Missing hook	24	42.1%	14	24.6%	8	14.0%	5	8.8%	6	10.5%
	Multiple hook*	0	0.0%	0	0.0%	0	0.0%	1	50.0%	1	50.0%
2007	Bait only	648	15.2%	808	19.0%	903	21.2%	948	22.2%	954	22.4%
	Fish	692	26.9%	550	21.4%	470	18.3%	423	16.4%	438	17.0%
	Empty hook	110	26.1%	86	20.4%	81	19.2%	81	19.2%	64	15.2%
	Missing hook	10	32.3%	8	25.8%	4	12.9%	6	19.4%	3	9.7%
	Multiple hook*	0	0.0%	5	62.5%	1	12.5%	1	12.5%	1	12.5%

* Indicates instances when a fish was hooked or snagged by more than one hook.

Table 9. Summary of missing or invalid drops and hooks during the hook and line survey cruises.

	Year				
	2004	**2005**	**2006**	**2007**	**All years**
Percent of valid drops with one or more missing hooks	1.3%	1.1%	1.2%	0.6%	1.0%
Percent of hooks from valid drops recorded as missing	1.0%	0.7%	0.9%	0.4%	0.7%
Percent of hooks from all drops recorded as missing	1.9%	1.3%	1.7%	0.8%	1.4%

Size Compositions

Length Frequencies

Figures in this section include length frequency distributions for key rockfish species. All lengths are fork lengths. Length frequencies are a function of the selectivity of the survey gear. A quantitative analysis of the hooks used during sampling is presented in Appendix C.

A species is included in these charts if a total of at least 100 individuals have been hooked during the 4 years of the survey 2004–2007. These species include: bocaccio (Figures 5 through 9), vermilion rockfish (Figures 10 through 14), greenspotted rockfish (Figures 15 through 19), bank rockfish (*Sebastes rufus*) (Figures 20 through 23), blue rockfish (*S. mystinus*) (Figures 24 through 27), chilipepper (Figures 28 through 31), copper rockfish (*S. caurinus*) (Figures 32 through 35), cowcod (*S. levis*) (Figures 36 through 39), greenblotched rockfish (*Sebastes rosenblatti*) (Figures 40 through 43), lingcod (*Ophiodon elongatus*) (Figures 44 through 47), speckled rockfish (Figures 48 through 51), starry rockfish (Figures 52 through 55), widow rockfish (*S. entomelas*)(Figures 56 through 59), and yellowtail rockfish (*S. flavidus*) (Figures 60 through 63). Cowcod is included—despite not reaching the 100-fish threshold—because it is a species of particular interest in the region. The figures are broken down by year with males and females plotted separately on the same chart. When there is a significant number of unsexed individuals in a particular year, they are also plotted separately. Figures 9, 14, and 19 include combined male and female length frequency results from all 4 years on the same charts for bocaccio, vermilion rockfish, and greenspotted rockfish, respectively, and are provided to illustrate changes in year-class compositions of the catch through time.

Bocaccio size composition features multiple modes characteristic of episodic recruitment events. Figure 7 shows three clearly defined peaks corresponding to the 2005, 2003, and 1999 year-classes. Some indication of sexual dimorphism is also apparent in Figure 7, with the length disparity between females and males tending to increase with age. Annual growth of the individuals that compose the three primary year-classes is visible in Figure 9. Bocaccio tend to be fast-growing for rockfish, with individuals adding approximately 8–10 cm in length between age one and age two. The decline in the corporate size of the 1999 year-class from its peak in 2004 is illustrated in Figure 9 as individuals are subject to natural and fishing mortality and possibly emigration to depths and latitudes not sampled during the hook and line survey.

Vermilion rockfish exhibit more normally distributed size composition than bocaccio (Figures 10 through 14). Although the species' 1999 year-class was strong, especially in southern California (MacCall 2005), the length frequency plots from the hook and line survey are characteristic of more constant levels of recruitment, suggesting exposure to additional mortality or emigration prior to being recruited to the survey. The recent delineation of sunset rockfish (*S. crocotulus*), a cryptic form of vermilion rockfish (Hyde et al. 2008), provides additional complexity for research and management (MacCall 2005). Tissue samples from all hooked specimens have been retained for genetic analyses, providing the ability to generate separate biological profiles and relative abundance indices for both vermilion rockfish and sunset rockfish.

Greenspotted rockfish also appear to be subject to more constant levels of recruitment than bocaccio during the four survey years.

Several species including bank rockfish, blue rockfish, chilipepper, and speckled rockfish are dominated by females. In most years, females comprise at least 80% of the total catch for these four species.

In 2006 inclement weather precluded all sampling within the San Miguel Island area. This is a highly productive area for bocaccio and vermilion rockfish, and the absence of fish from this area skews the 2006 length frequency distributions for these species relative to the other 3 years of sampling.

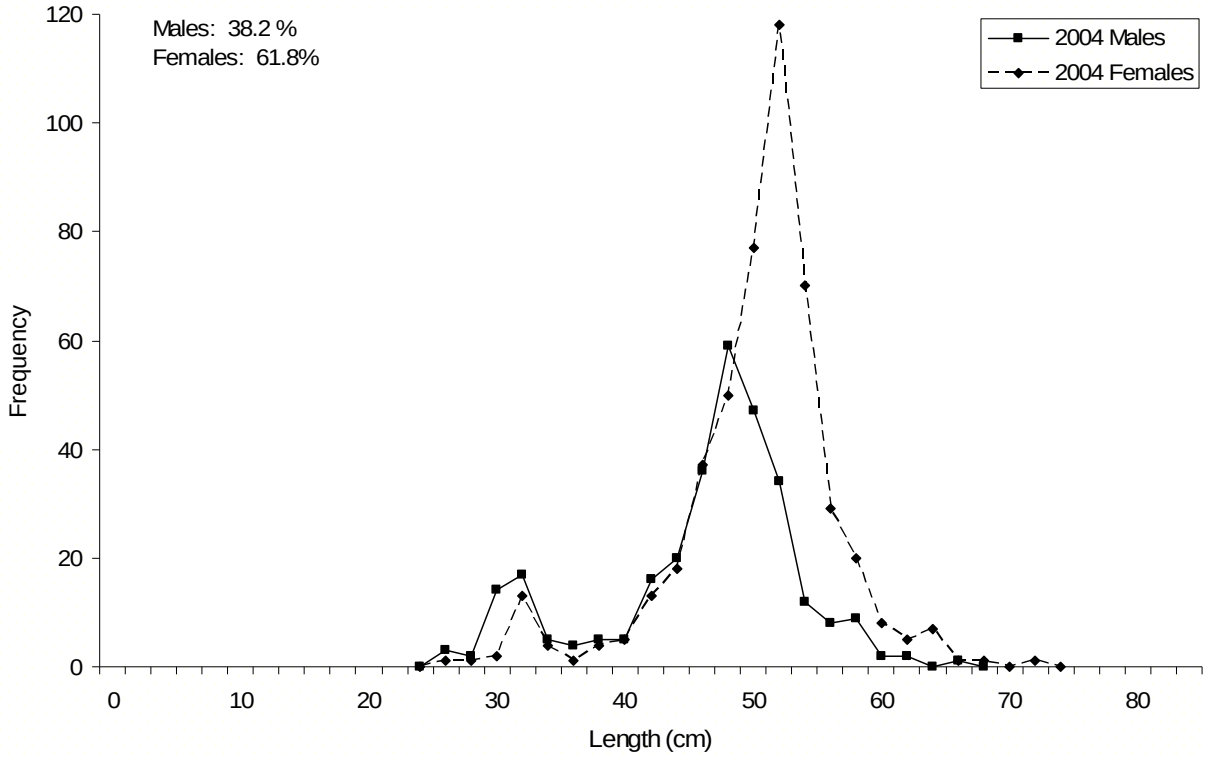

Figure 5. Length frequency distribution by sex for bocaccio for all sites sampled, 2004.

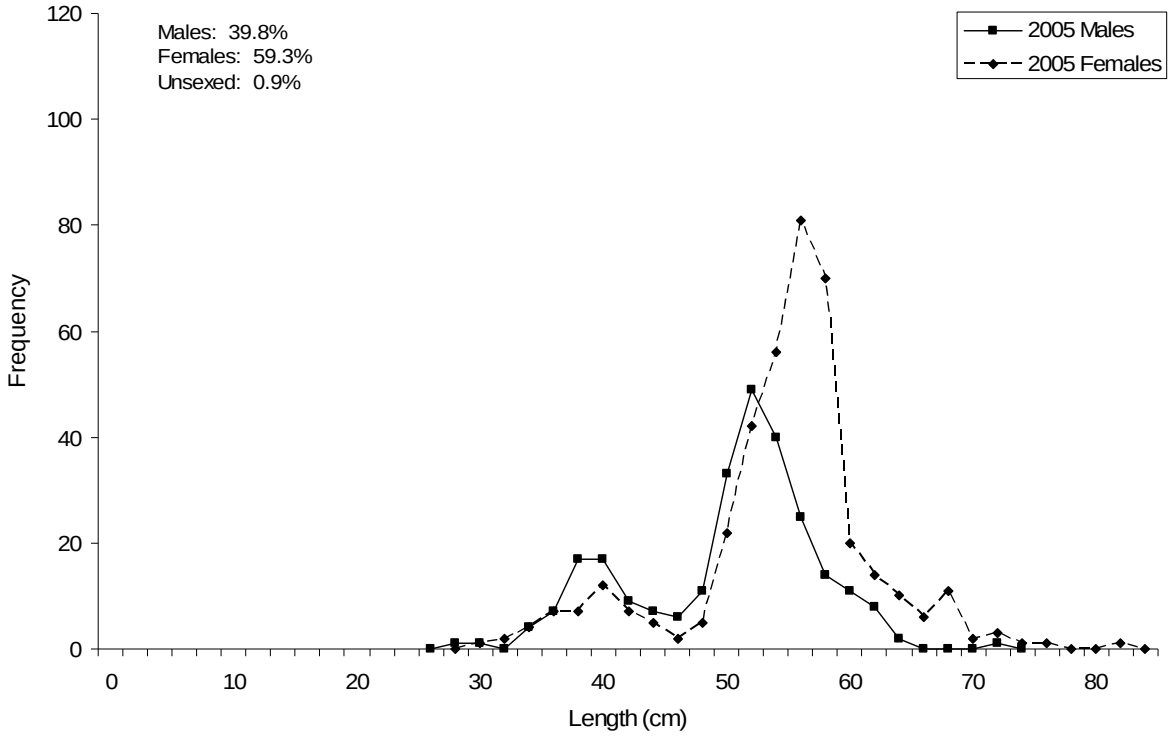

Figure 6. Length frequency distribution by sex for bocaccio for all sites sampled, 2005.

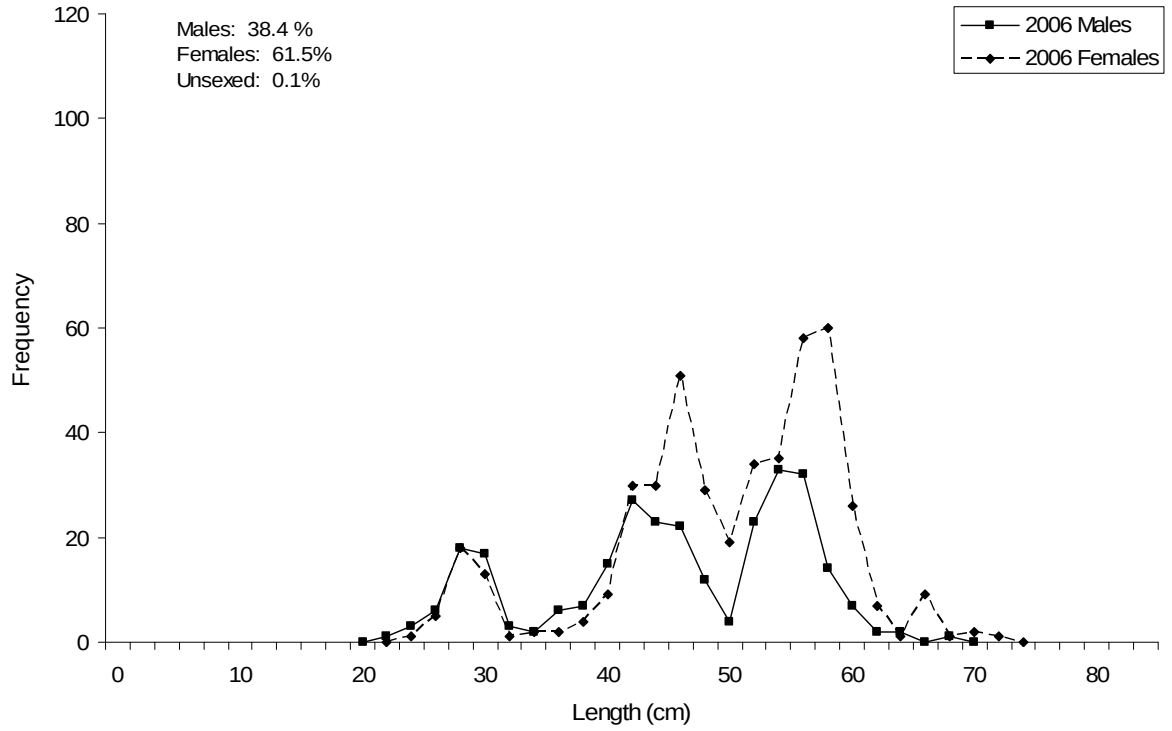

Figure 7. Length frequency distribution by sex for bocaccio for all sites sampled, 2006.

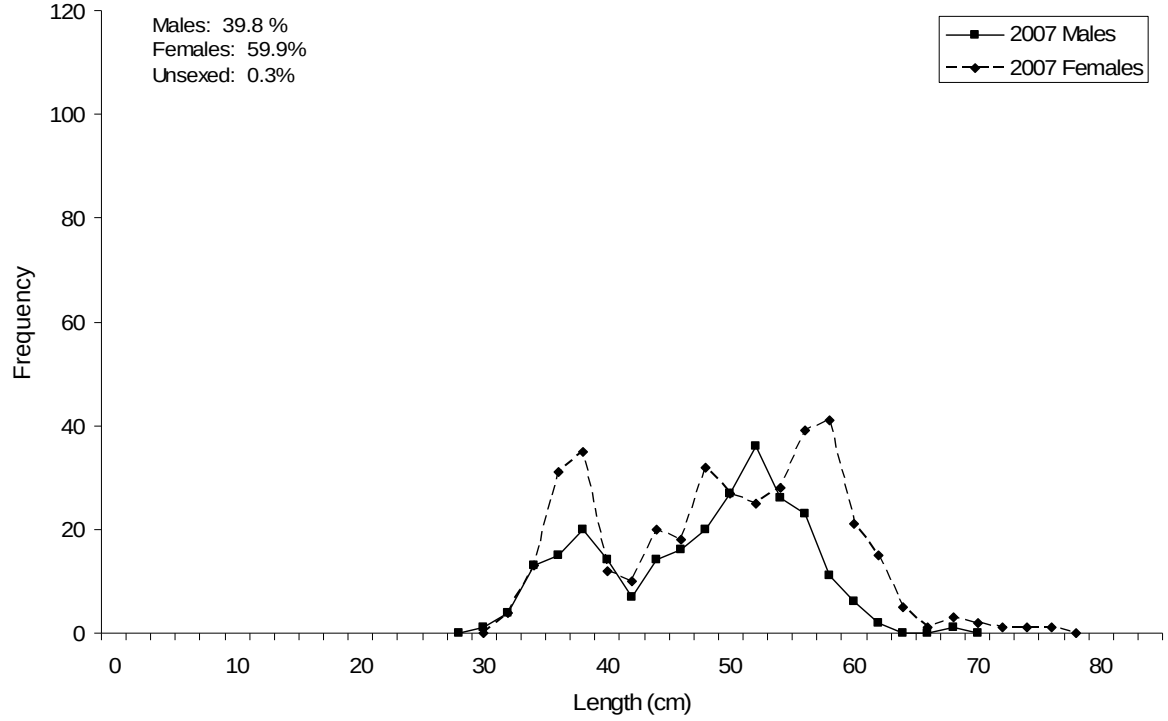

Figure 8. Length frequency distribution by sex for bocaccio for all sites sampled, 2007.

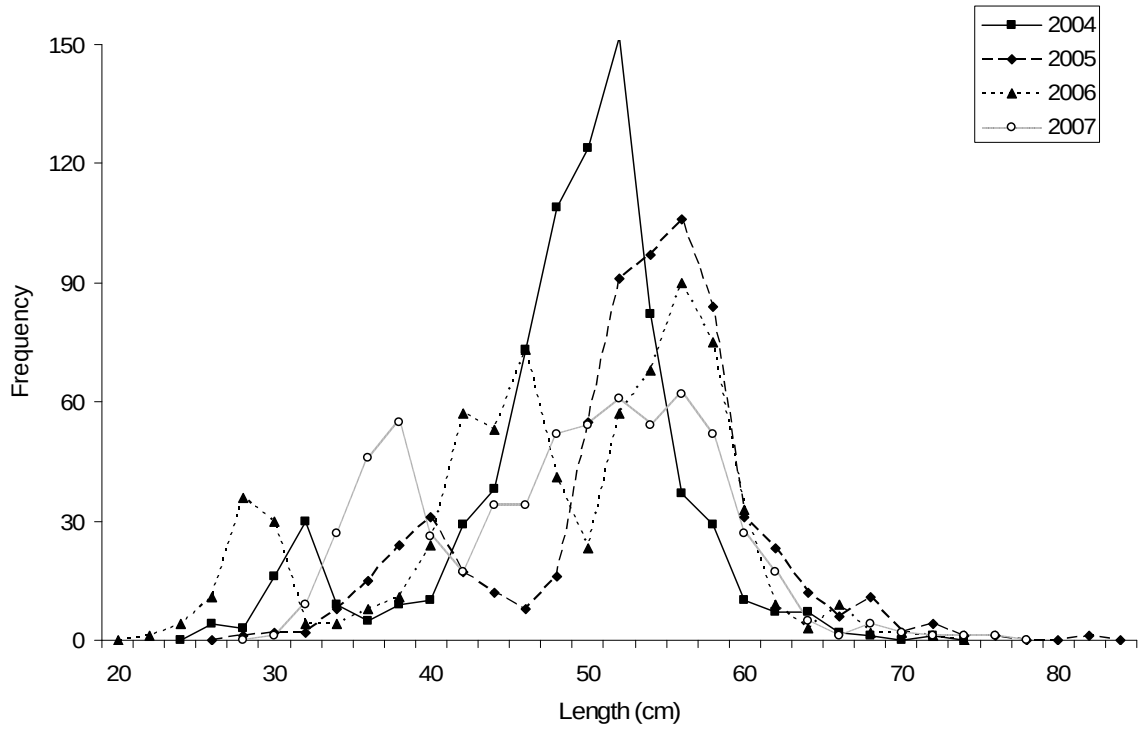

Figure 9. Length frequency distribution for all bocaccio specimens for all sites sampled, 2004–2007.

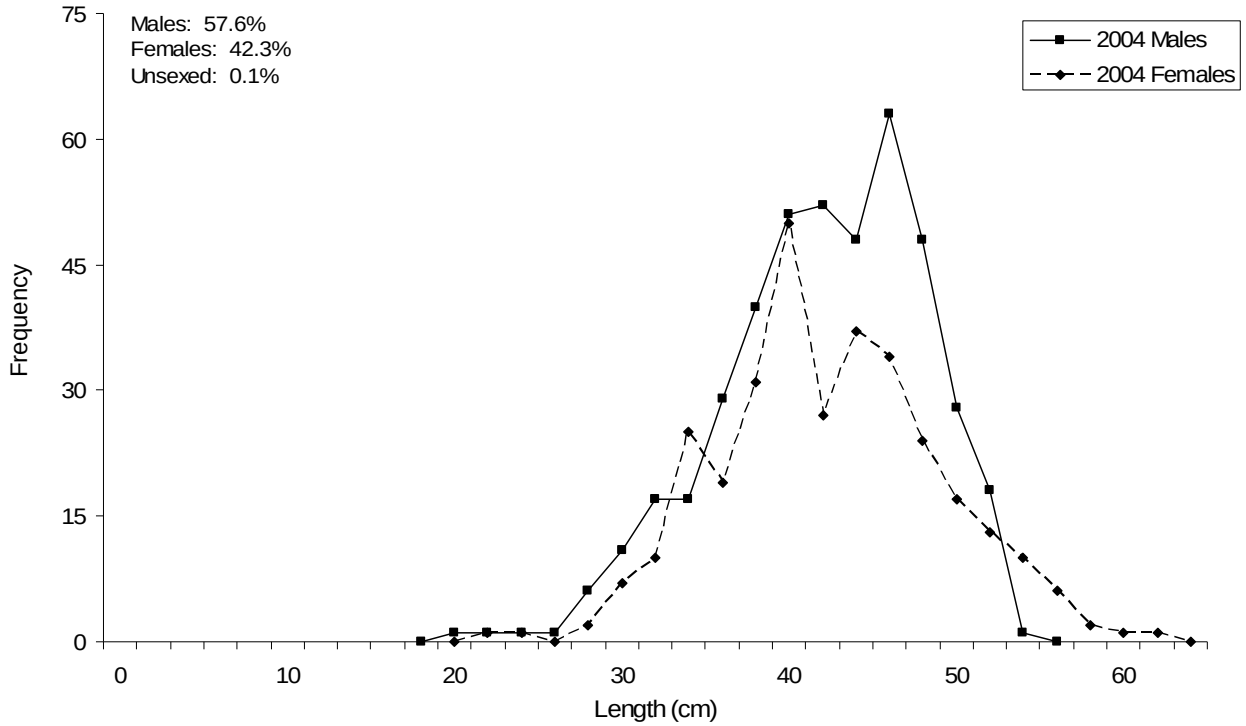

Figure 10. Length frequency distribution by sex for vermilion rockfish for all sites sampled, 2004.

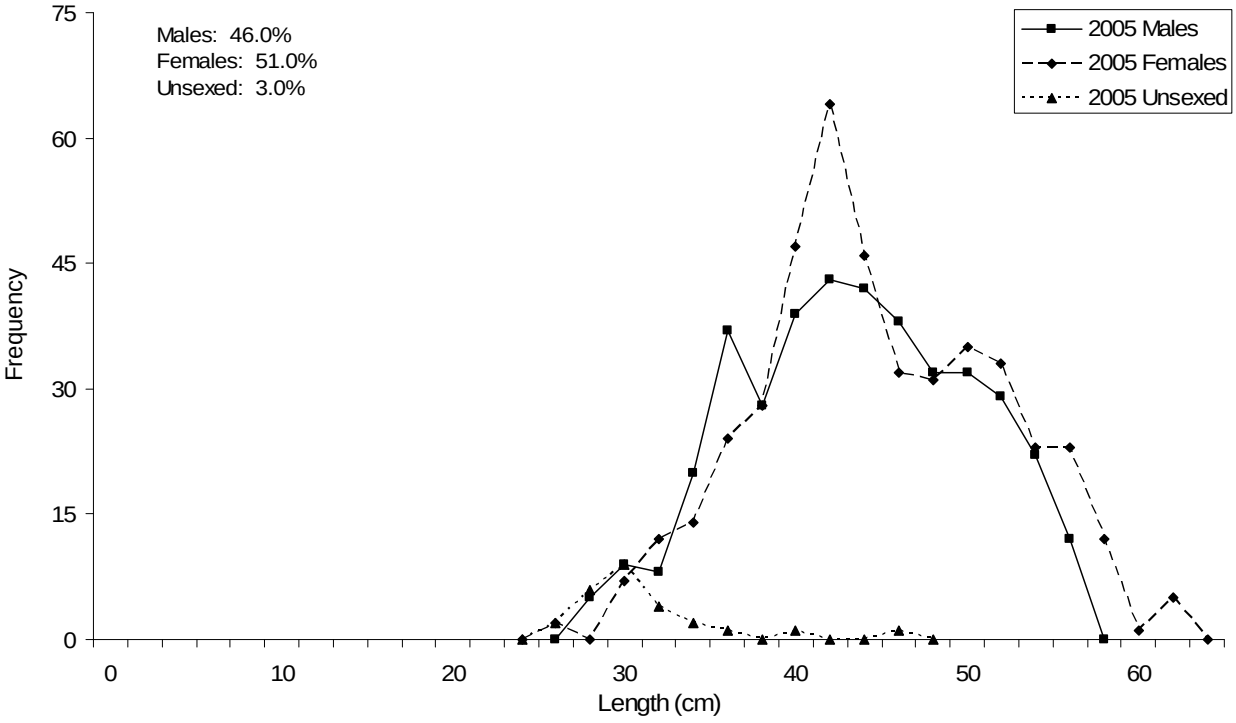

Figure 11. Length frequency distribution by sex for vermilion rockfish for all sites sampled, 2005.

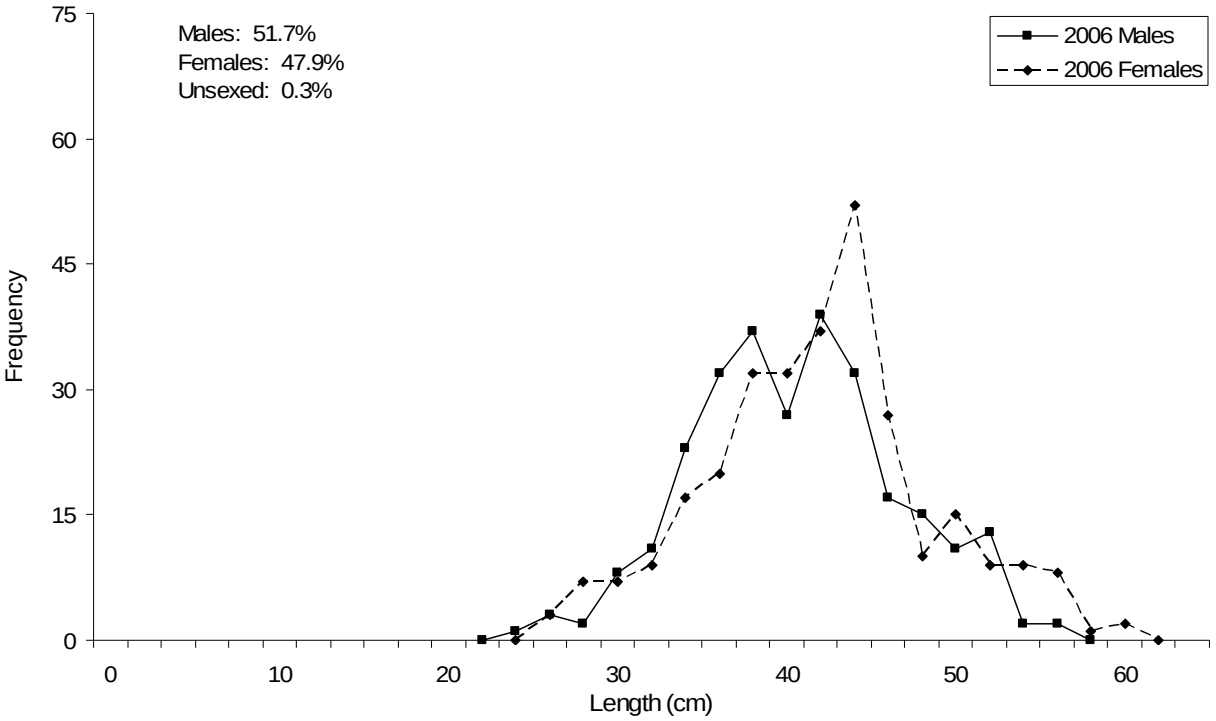

Figure 12. Length frequency distribution by sex for vermilion rockfish for all sites sampled, 2006.

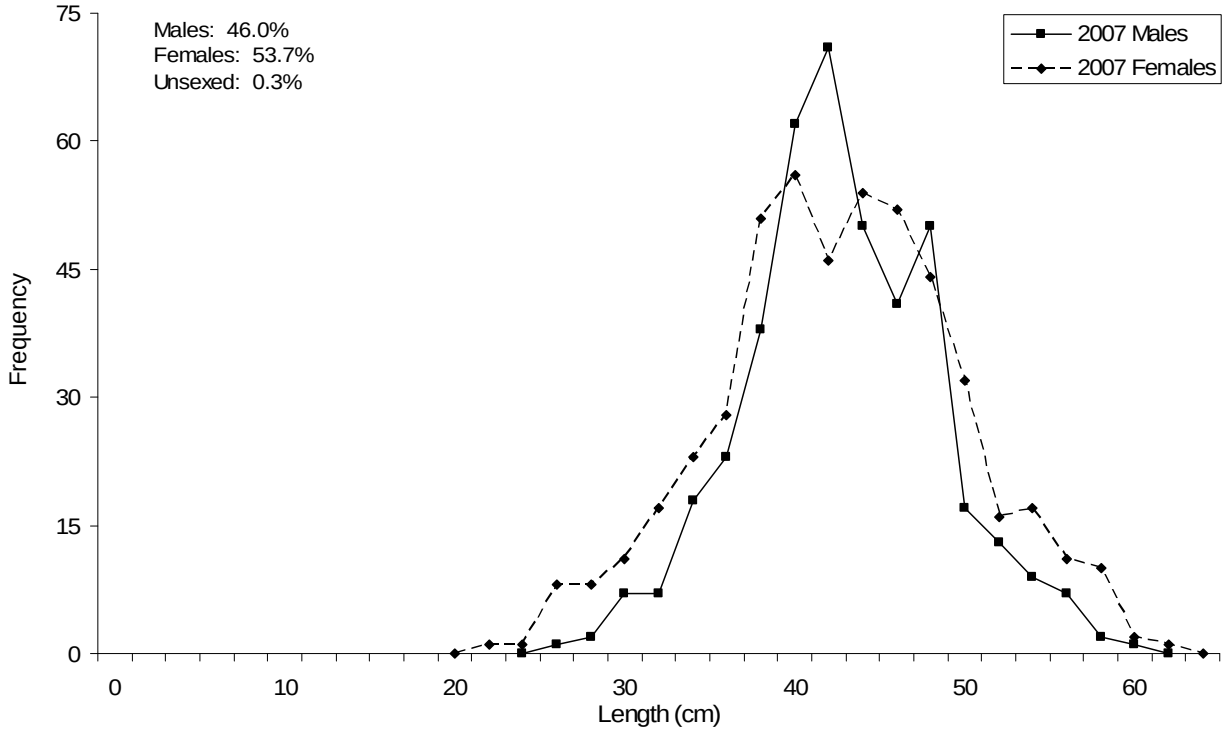

Figure 13. Length frequency distribution by sex for vermilion rockfish for all sites sampled, 2007.

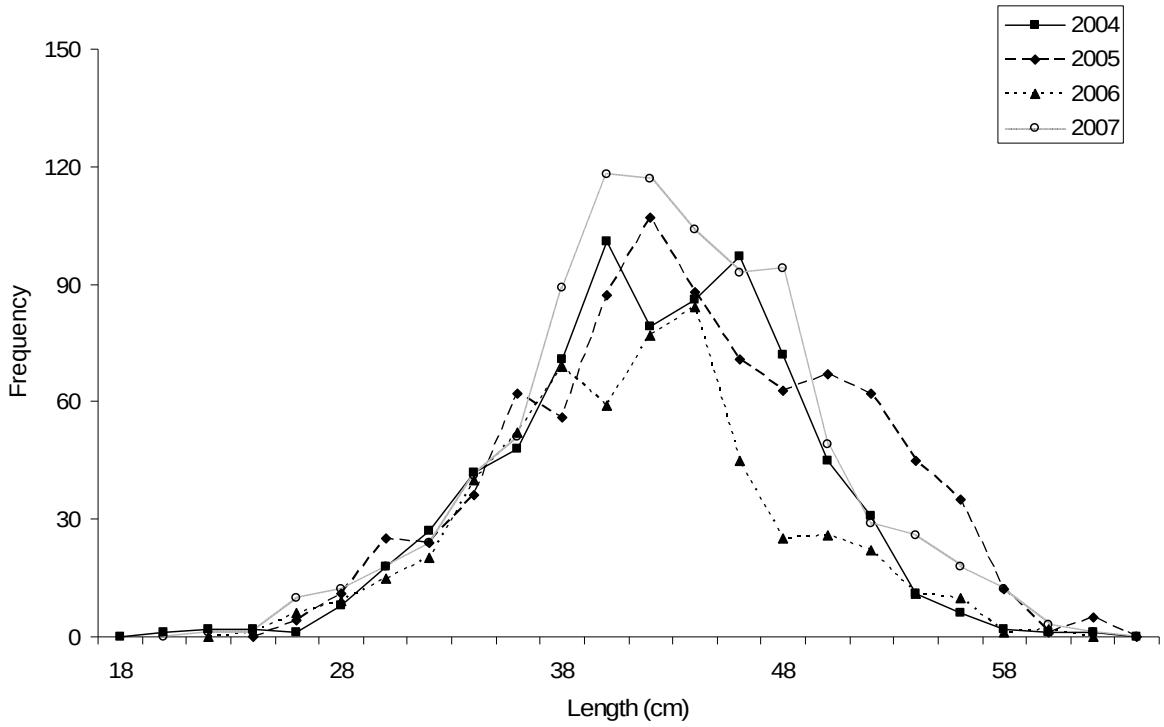

Figure 14. Length frequency distribution for all vermilion rockfish specimens for all sites sampled, 2004–2007.

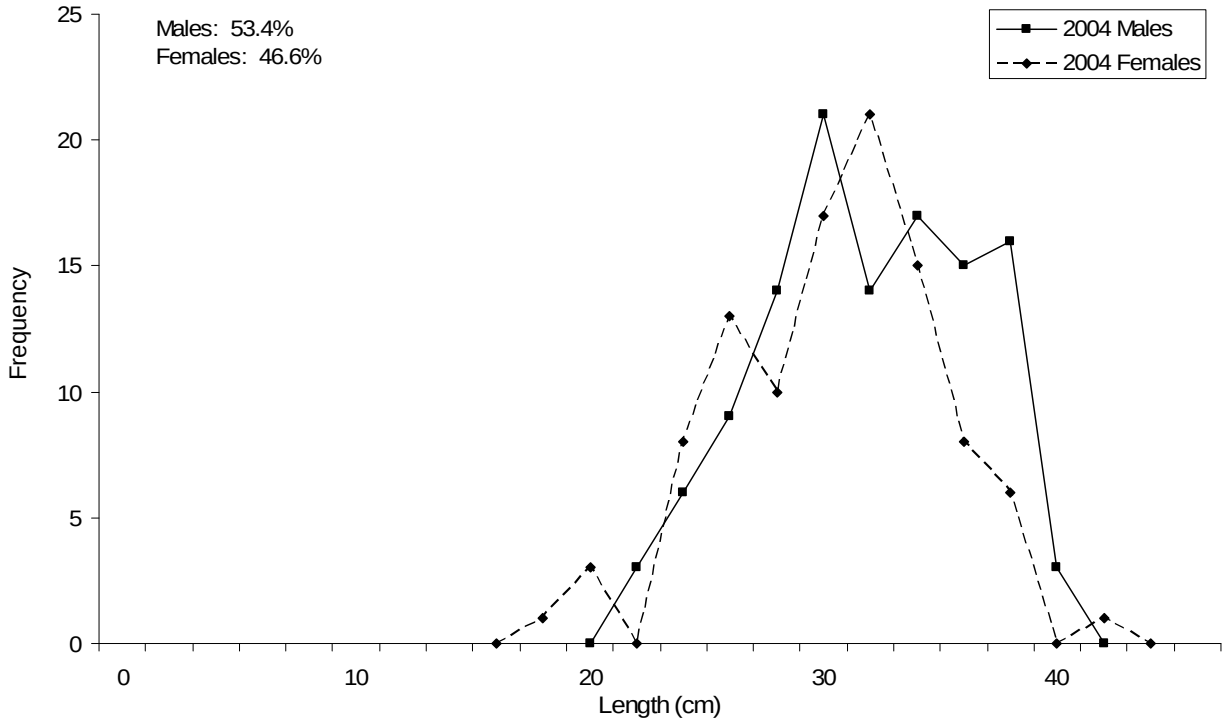

Figure 15. Length frequency distribution by sex for greenspotted rockfish for all sites sampled, 2004.

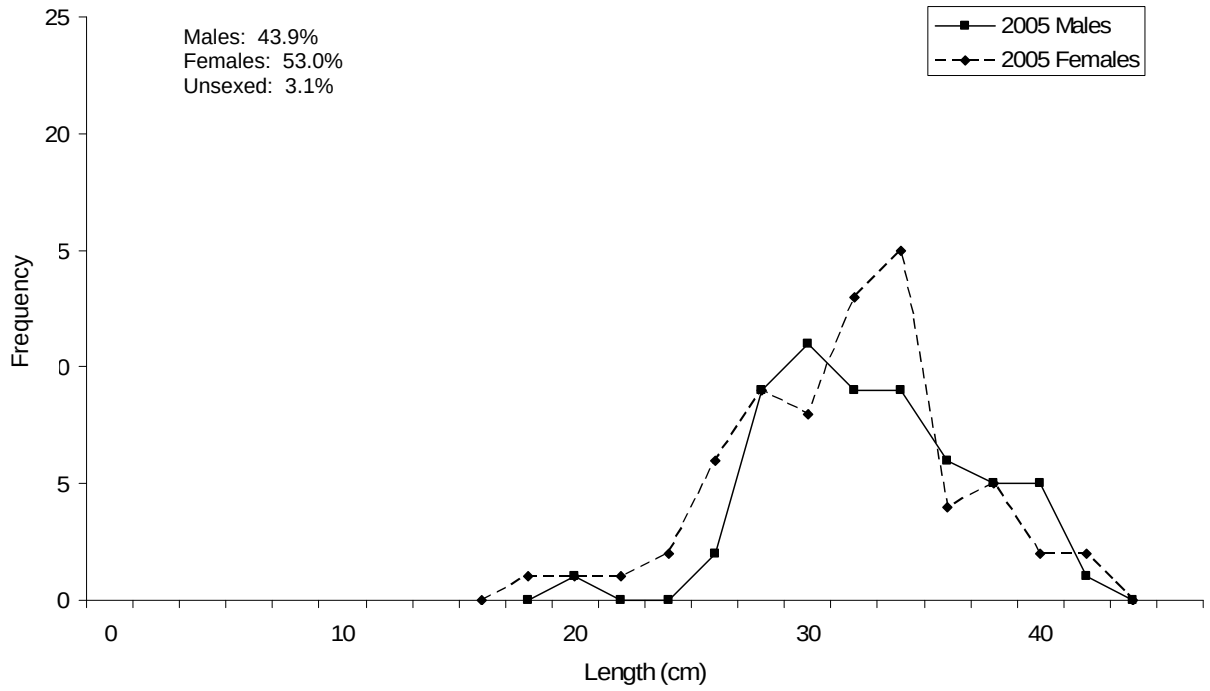

Figure 16. Length frequency distribution by sex for greenspotted rockfish for all sites sampled, 2005.

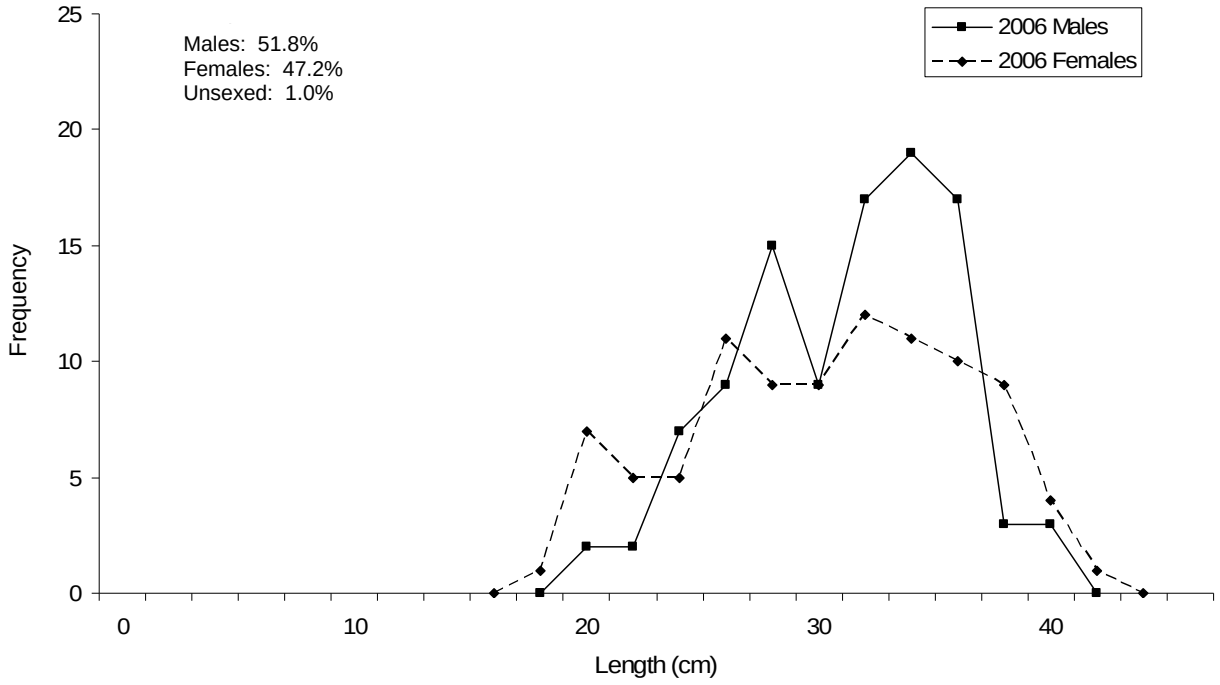

Figure 17. Length frequency distribution by sex for greenspotted rockfish for all sites sampled, 2006.

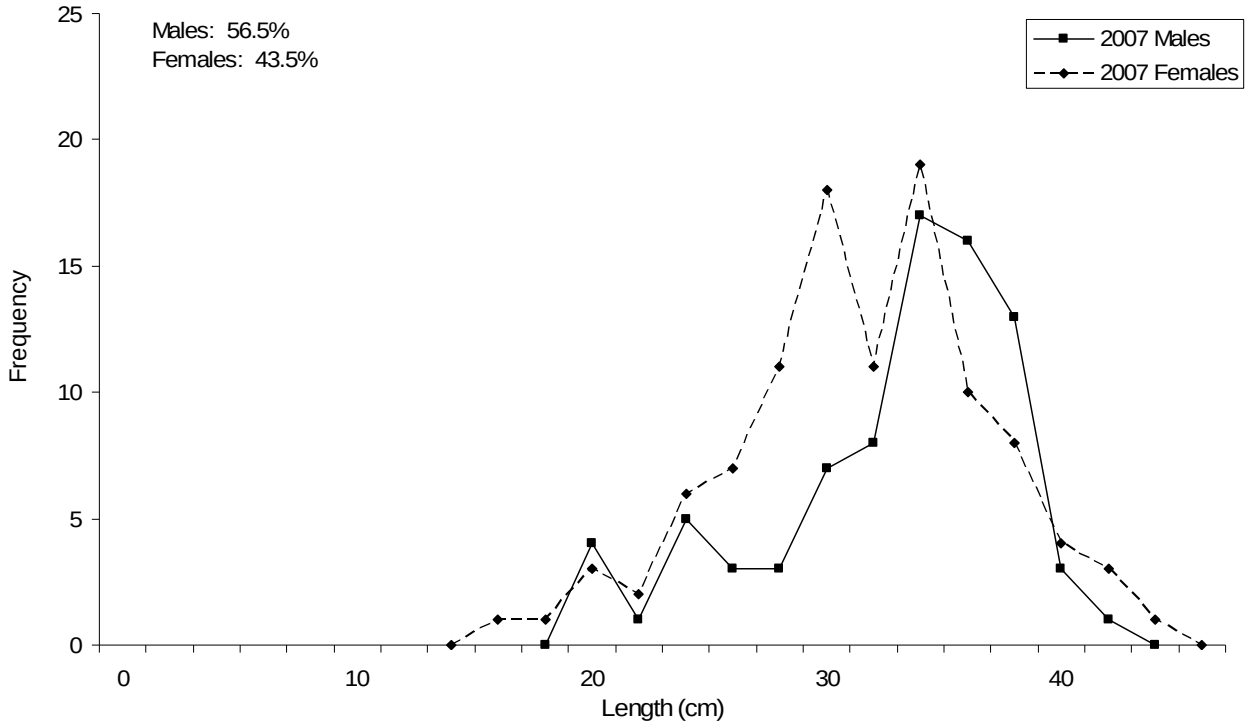

Figure 18. Length frequency distribution by sex for greenspotted rockfish for all sites sampled, 2007.

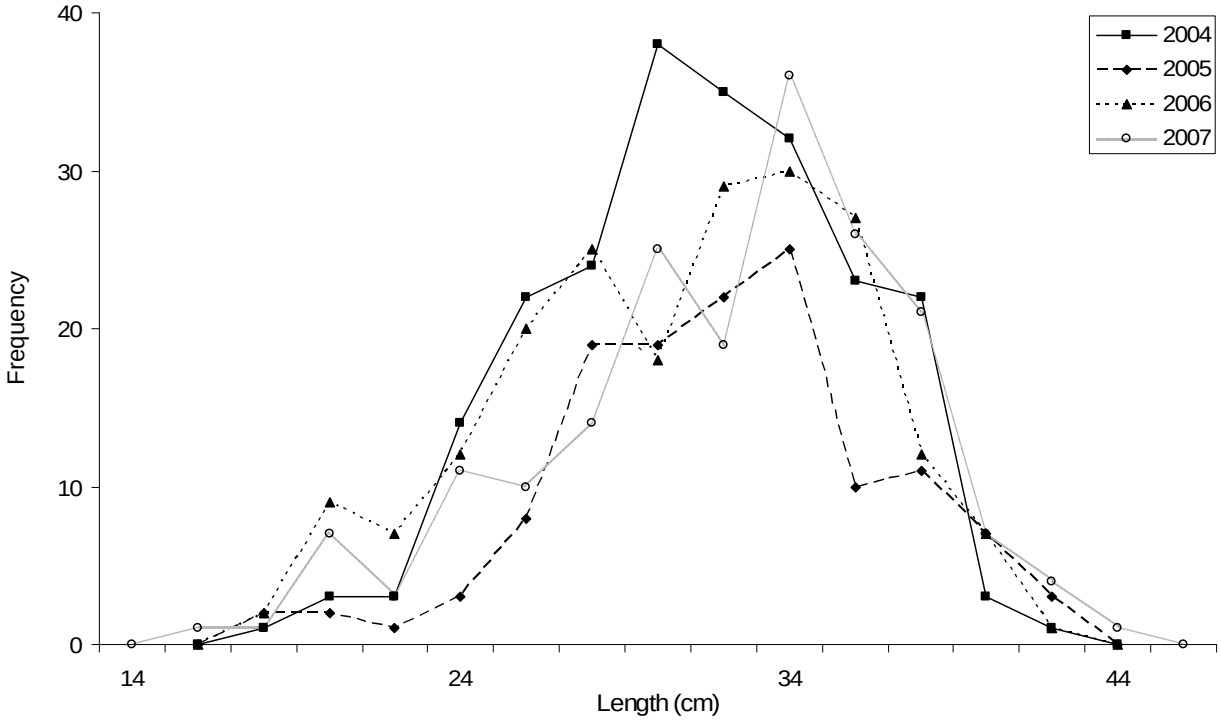

Figure 19. Length frequency distribution for all greenspotted rockfish specimens for all sites sampled, 2004–2007.

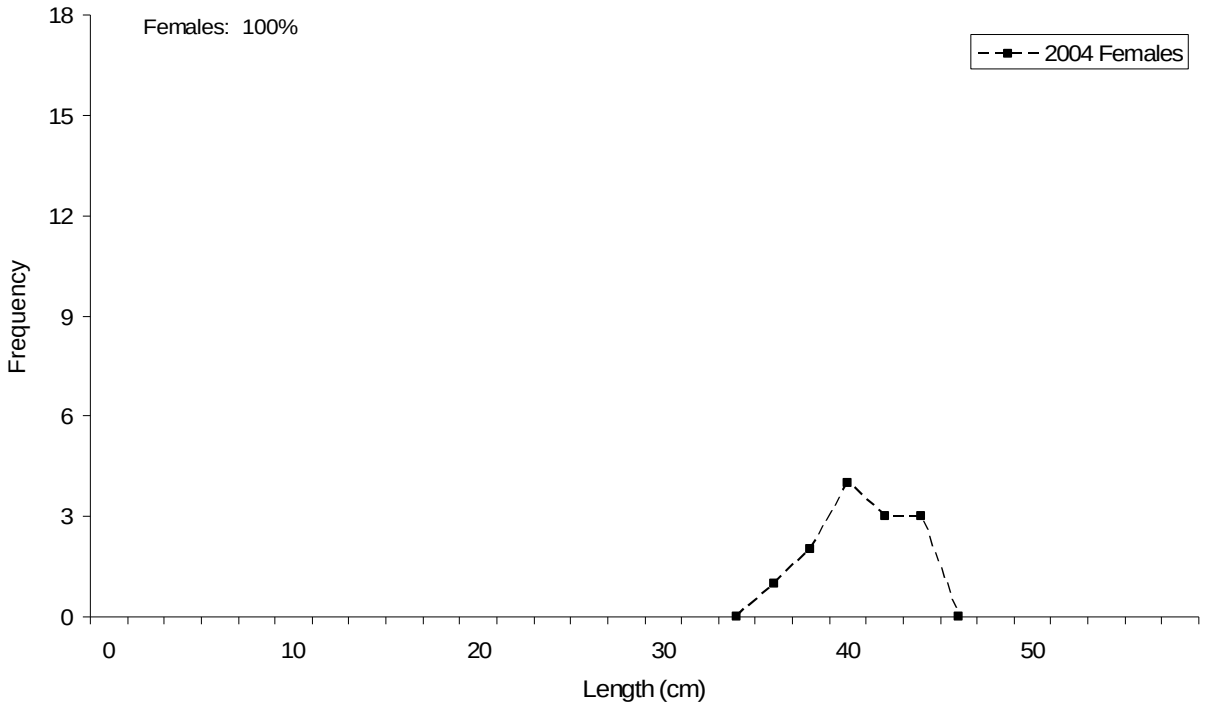

Figure 20. Length frequency distribution by sex for bank rockfish for all sites sampled, 2004.

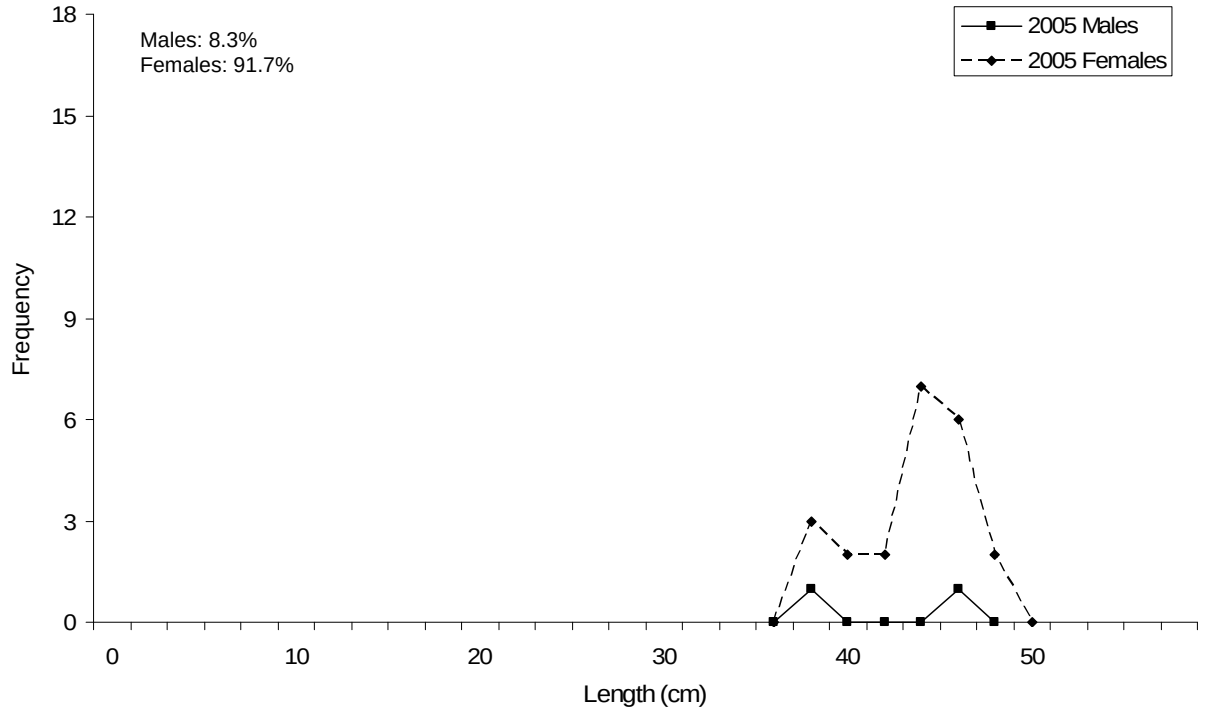

Figure 21. Length frequency distribution by sex for bank rockfish for all sites sampled, 2005.

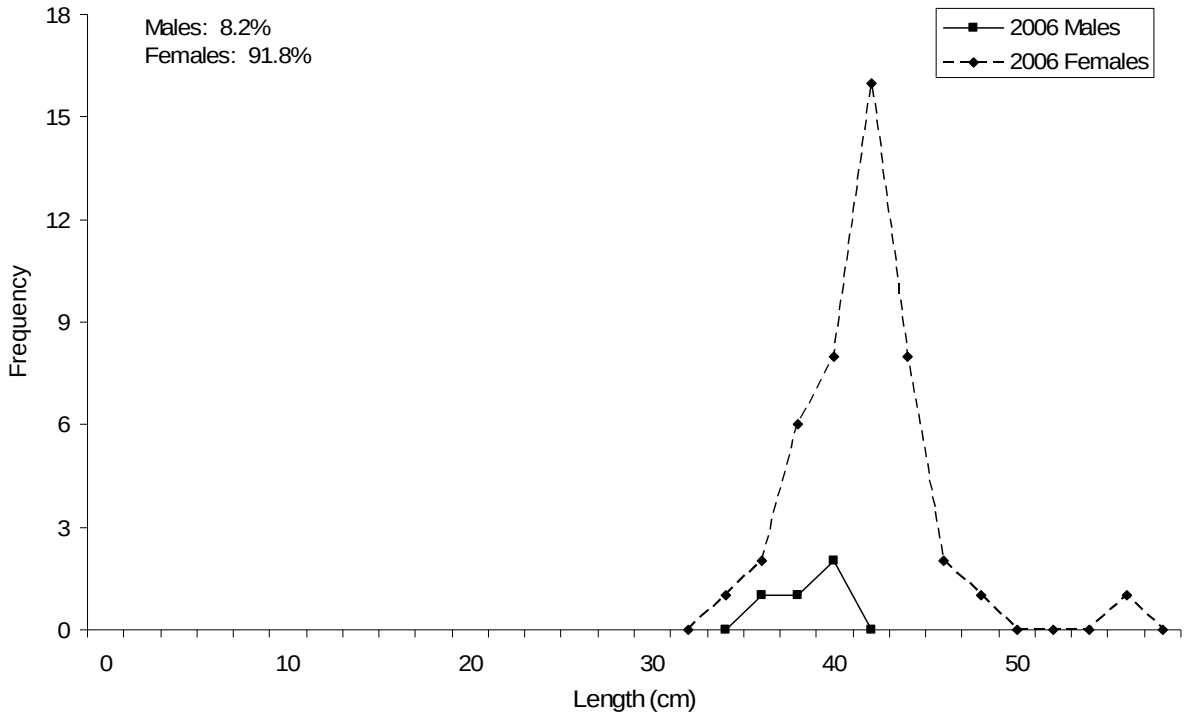

Figure 22. Length frequency distribution by sex for bank rockfish for all sites sampled, 2006.

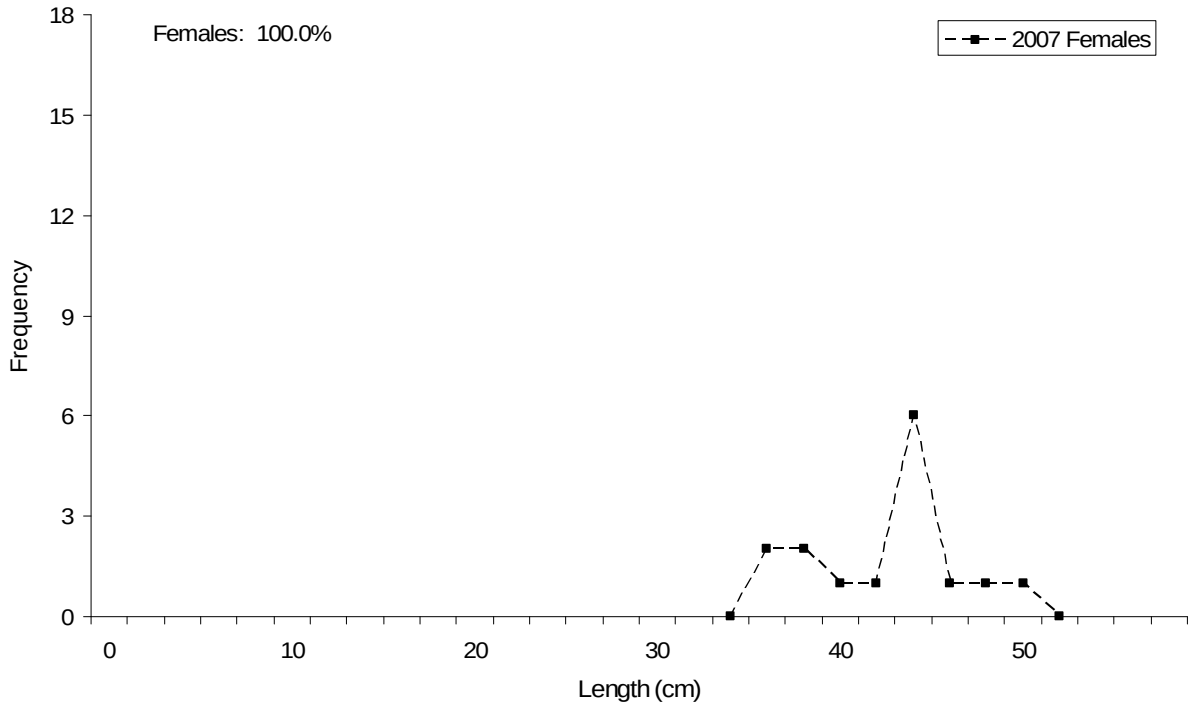

Figure 23. Length frequency distribution by sex for bank rockfish for all sites sampled, 2007.

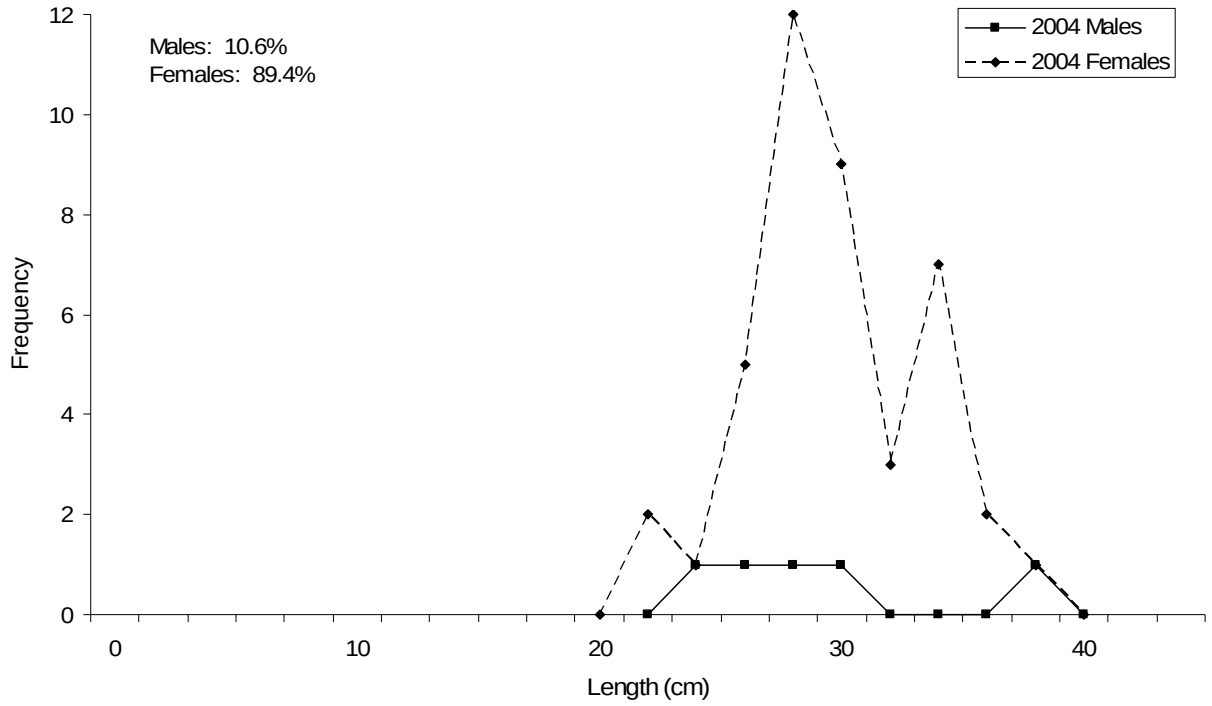

Figure 24. Length frequency distribution by sex for blue rockfish for all sites sampled, 2004.

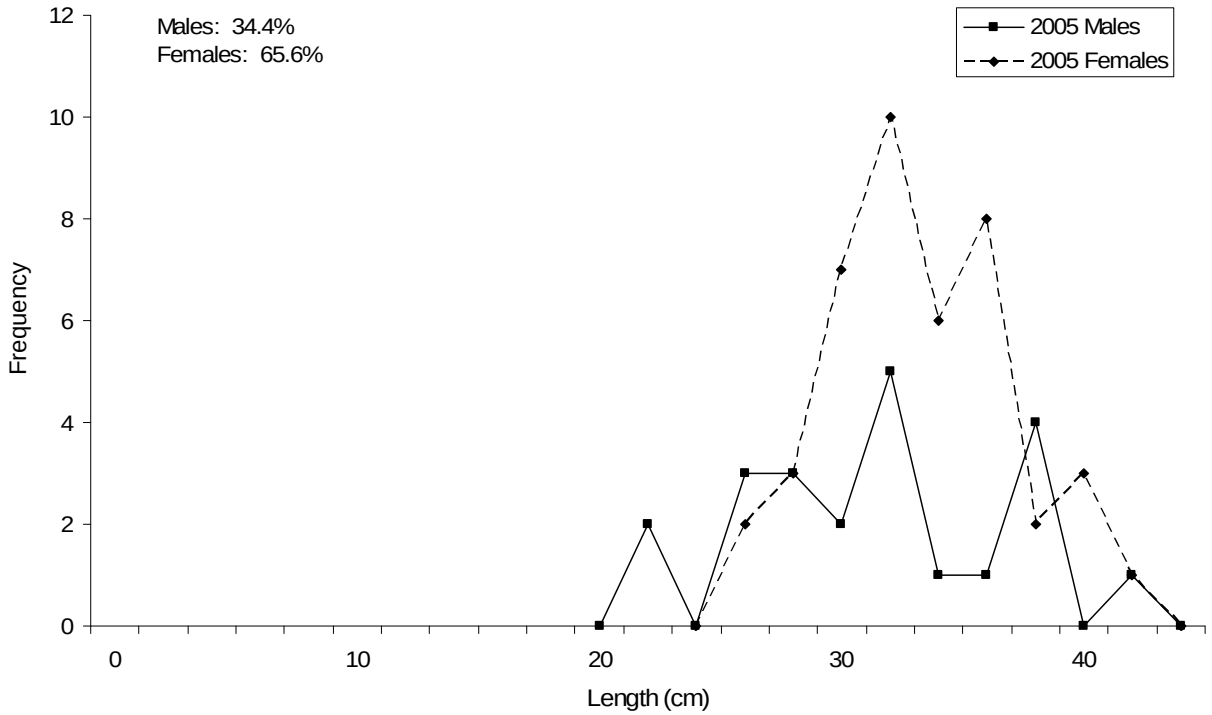

Figure 25. Length frequency distribution by sex for blue rockfish for all sites sampled, 2005.

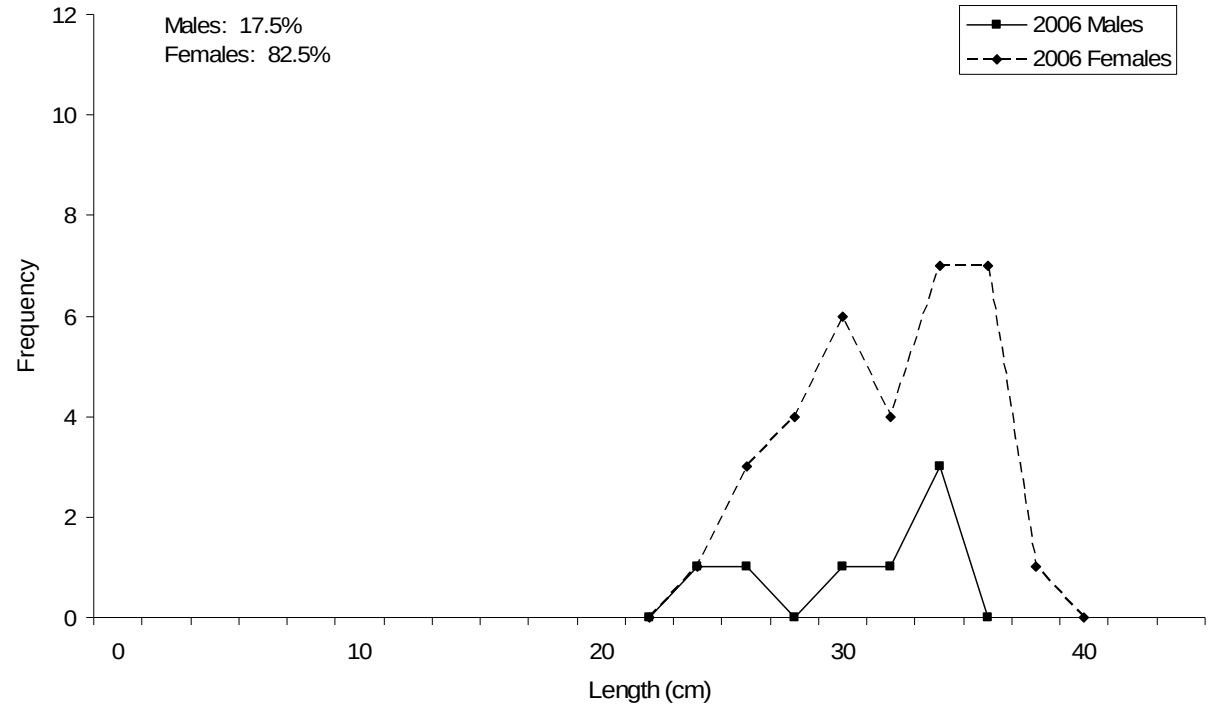

Figure 26. Length frequency distribution by sex for blue rockfish for all sites sampled, 2006.

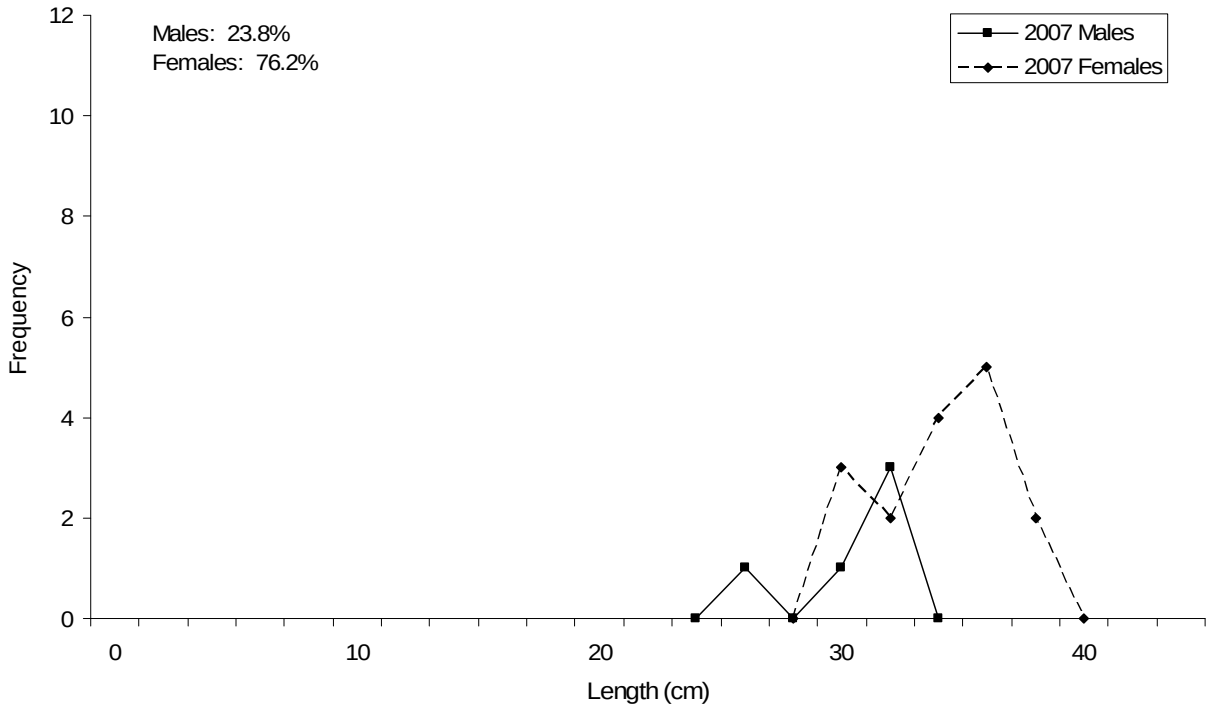

Figure 27. Length frequency distribution by sex for blue rockfish for all sites sampled, 2007.

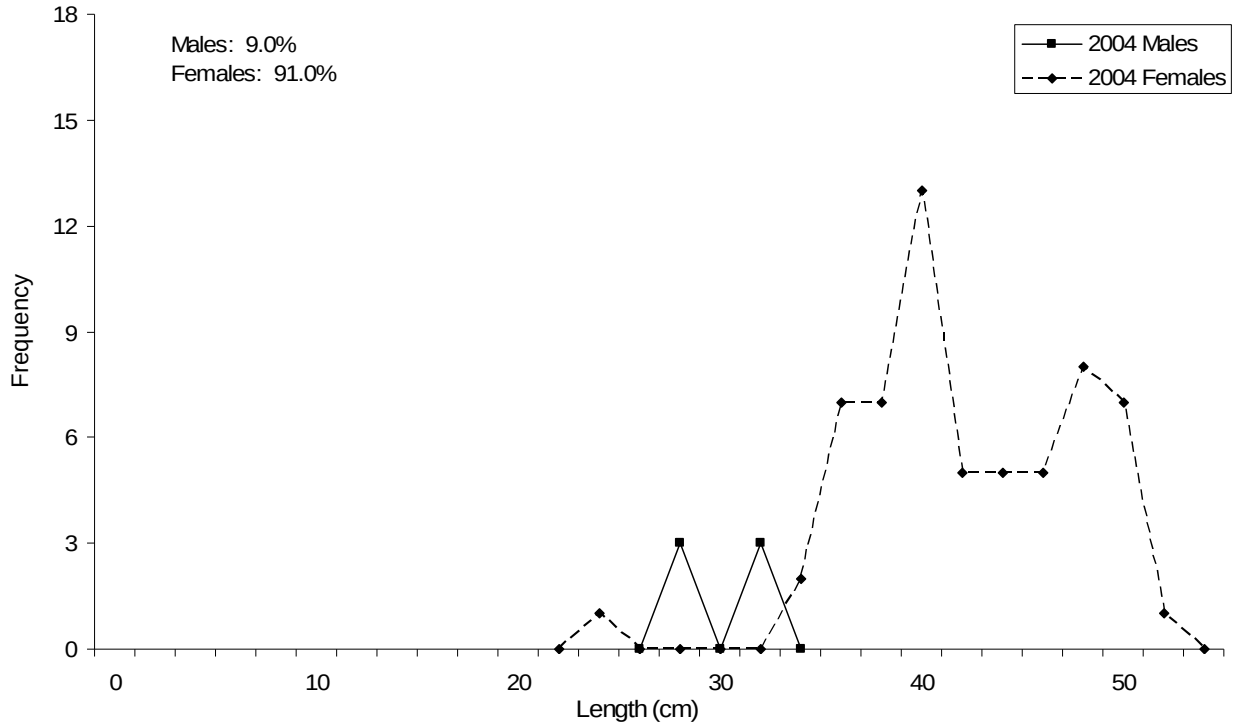

Figure 28. Length frequency distribution by sex for chilipepper for all sites sampled, 2004.

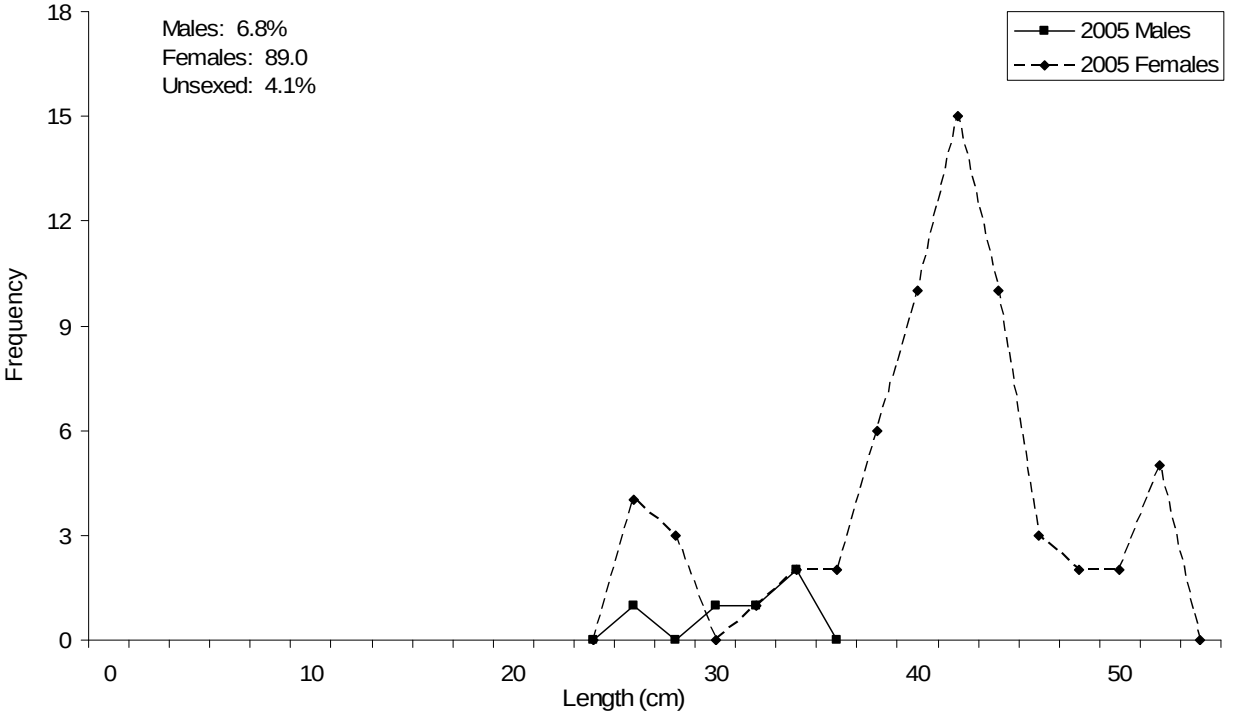

Figure 29. Length frequency distribution by sex for chilipepper for all sites sampled, 2005.

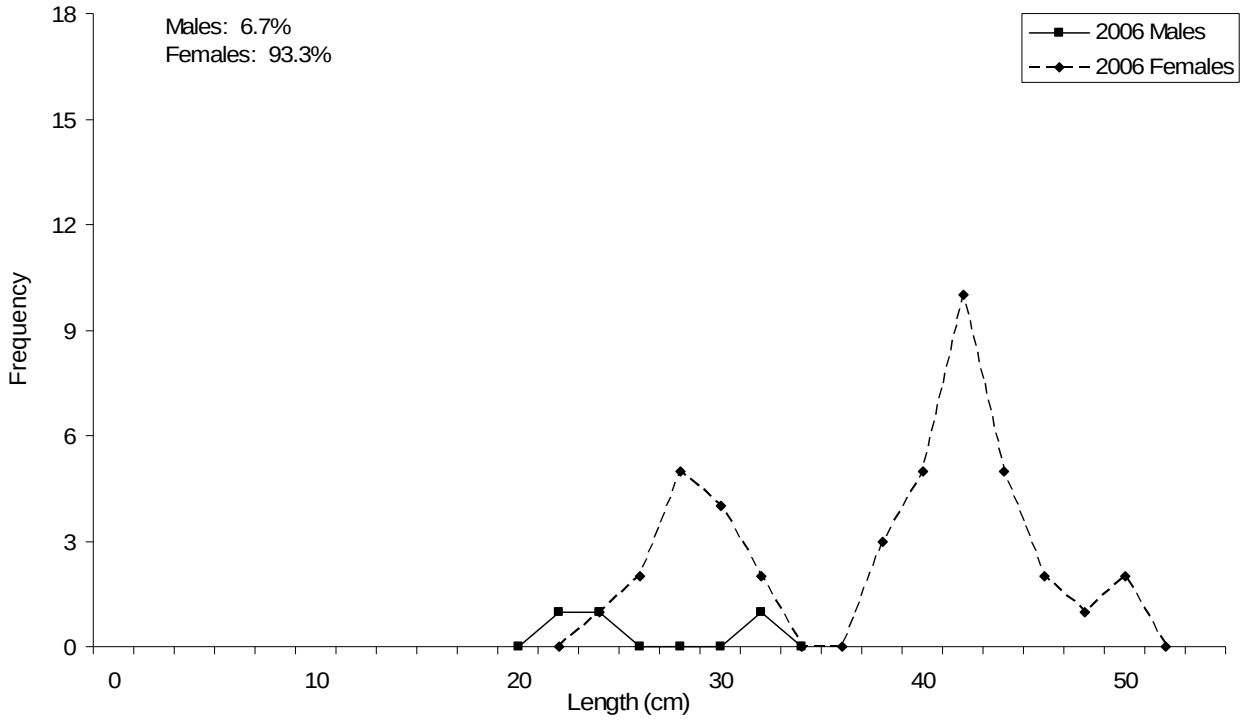

Figure 30. Length frequency distribution by sex for chilipepper for all sites sampled, 2006.

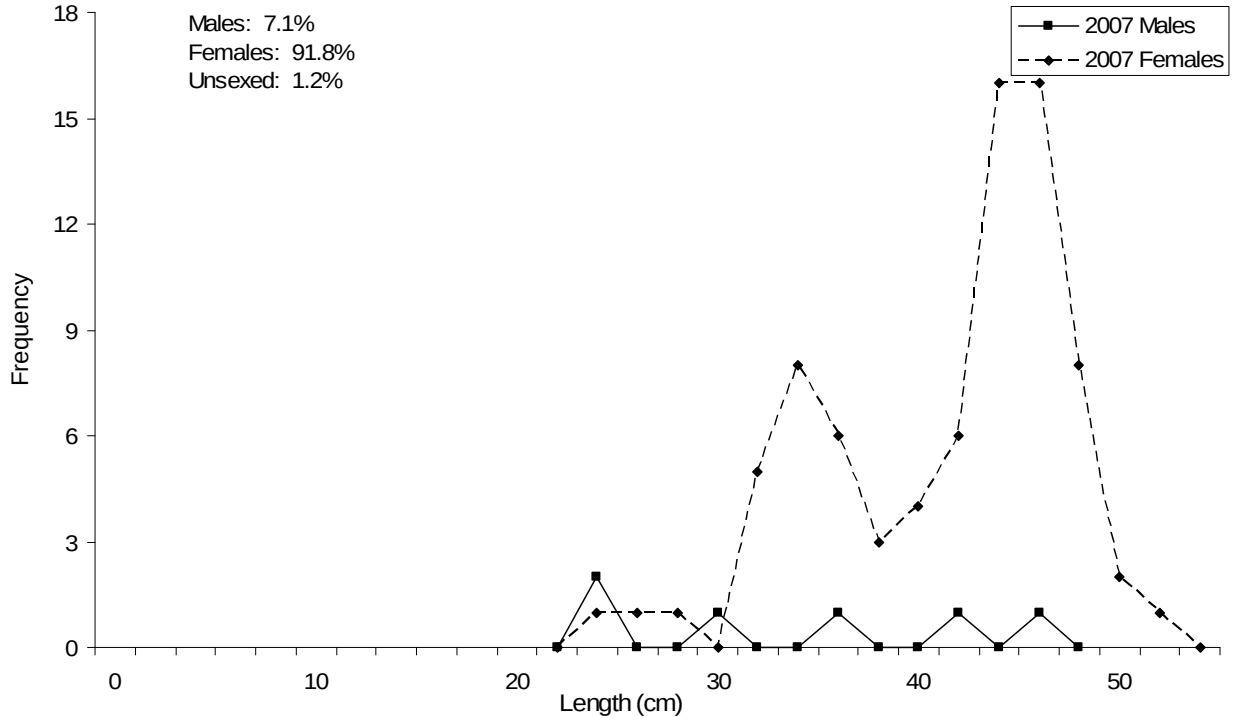

Figure 31. Length frequency distribution by sex for chilipepper for all sites sampled, 2007.

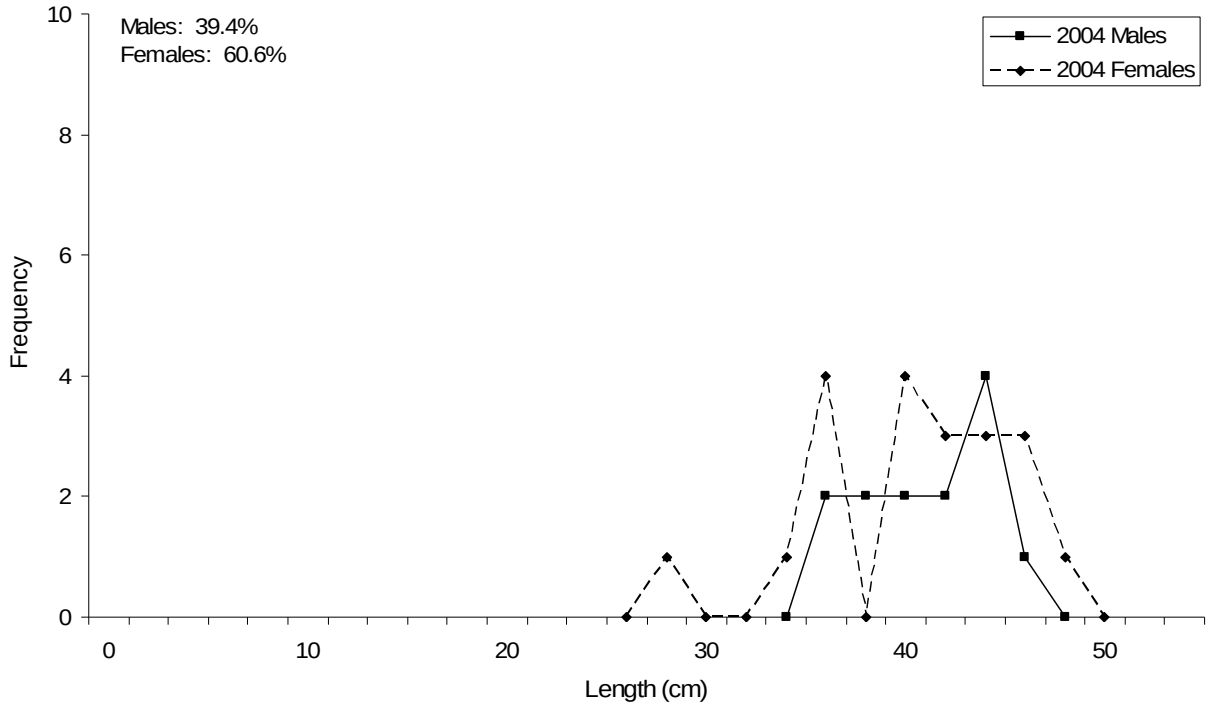

Figure 32. Length frequency distribution by sex for copper rockfish for all sites sampled, 2004.

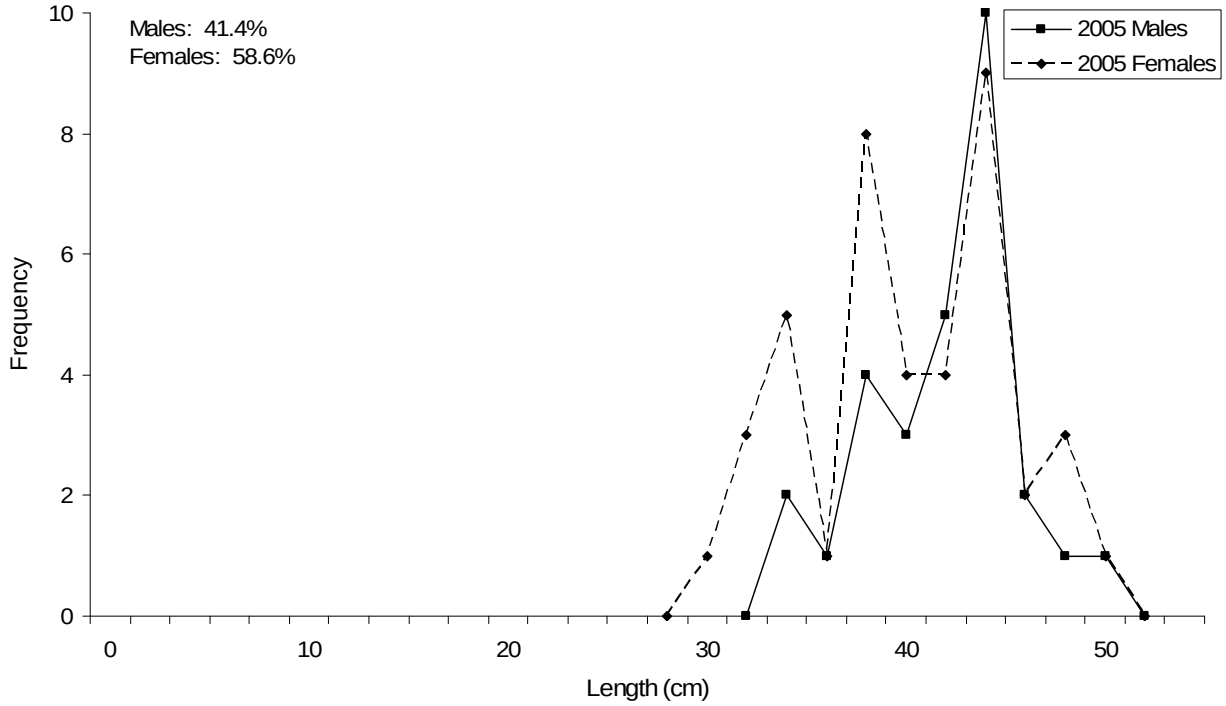

Figure 33. Length frequency distribution by sex for copper rockfish for all sites sampled, 2005.

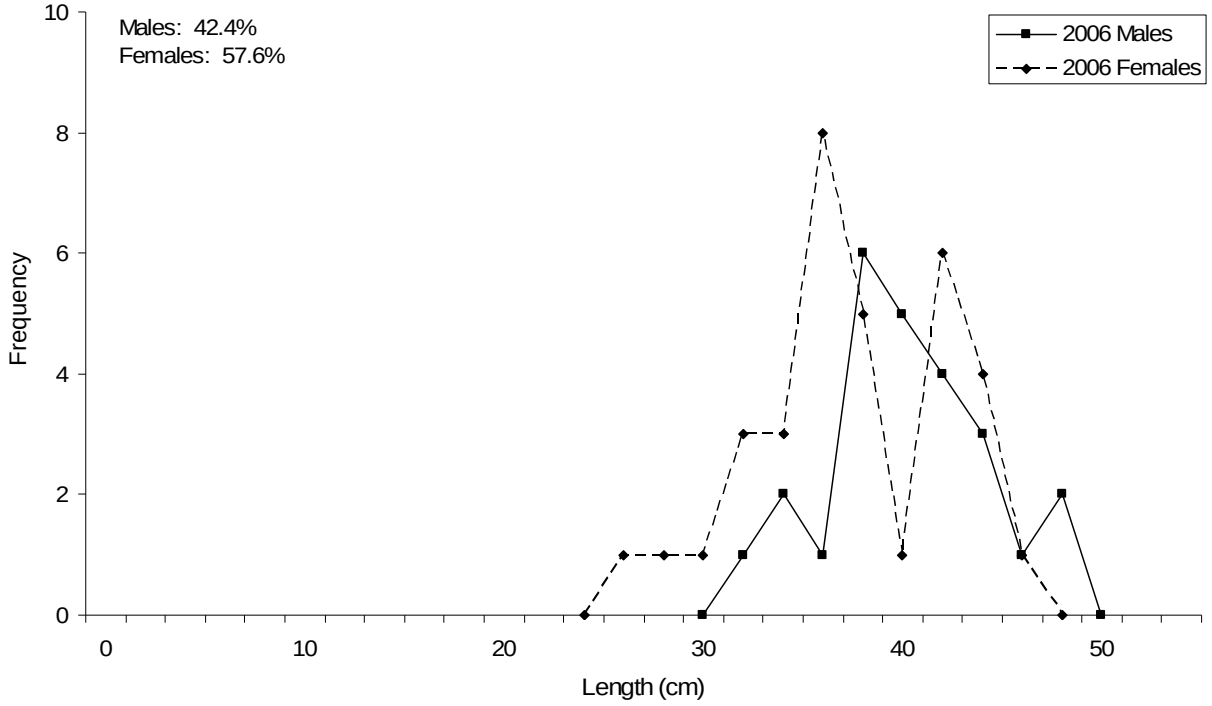

Figure 34. Length frequency distribution by sex for copper rockfish for all sites sampled, 2006.

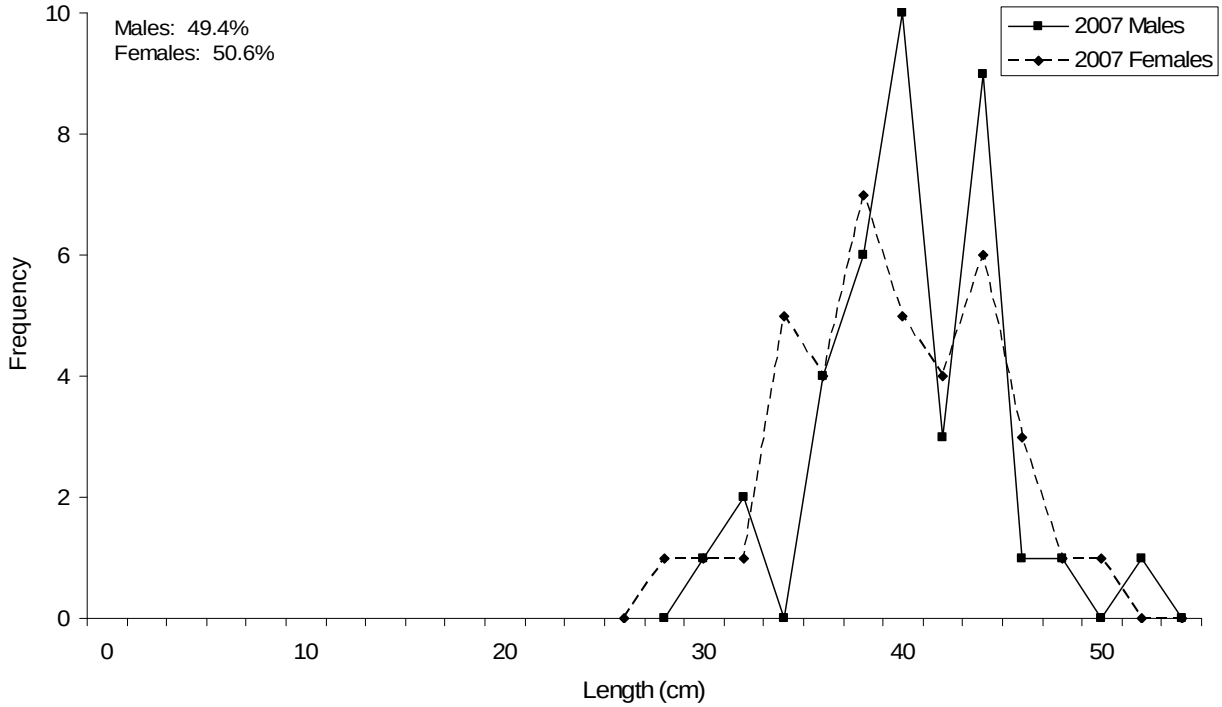

Figure 35. Length frequency distribution by sex for copper rockfish for all sites sampled, 2007.

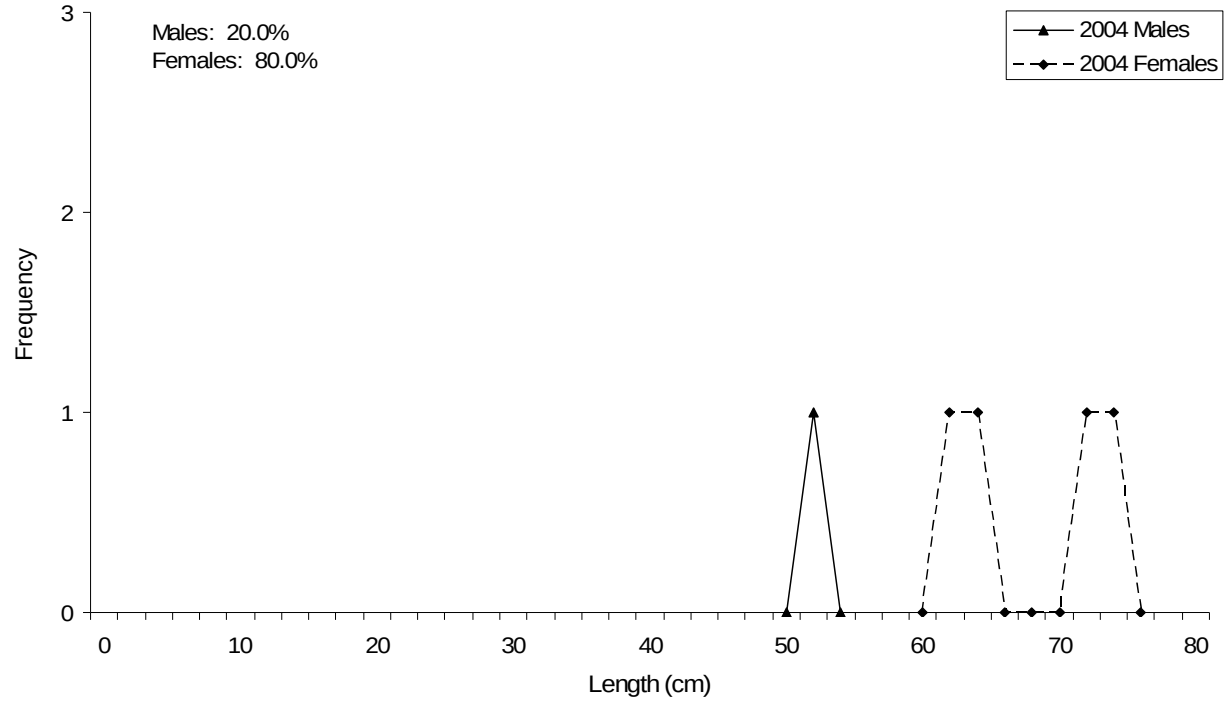

Figure 36. Length frequency distribution by sex for cowcod for all sites sampled, 2004.

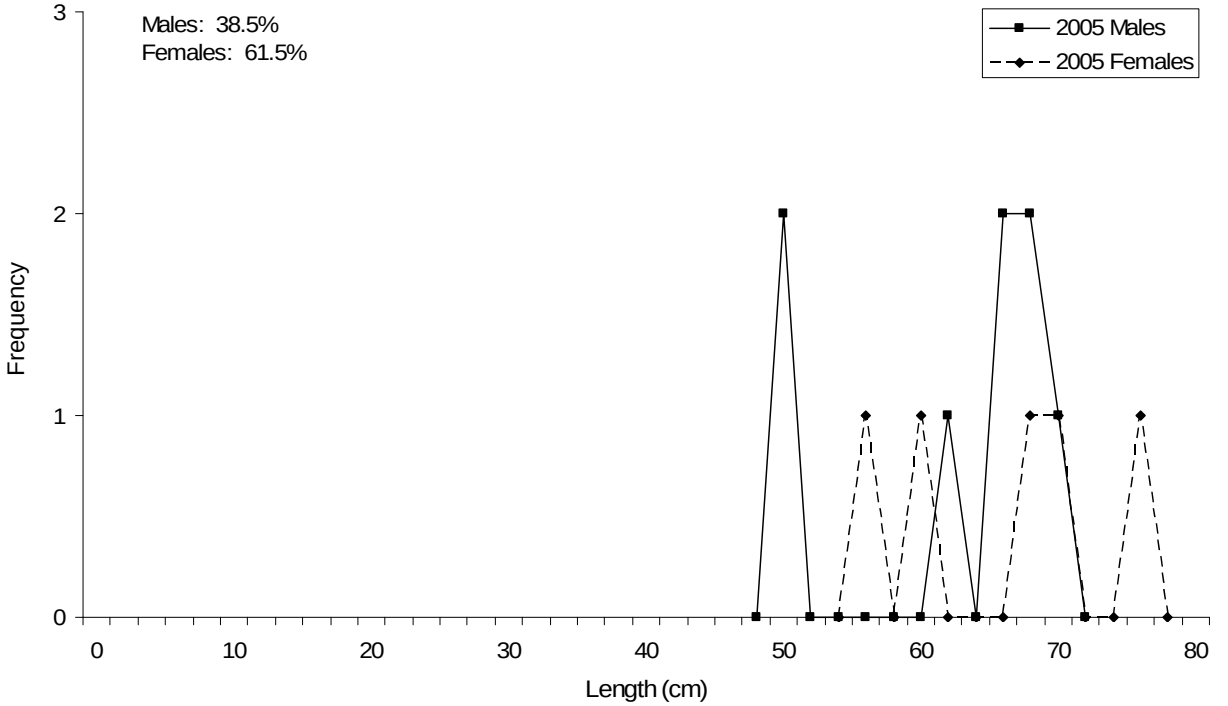

Figure 37. Length frequency distribution by sex for cowcod for all sites sampled, 2005.

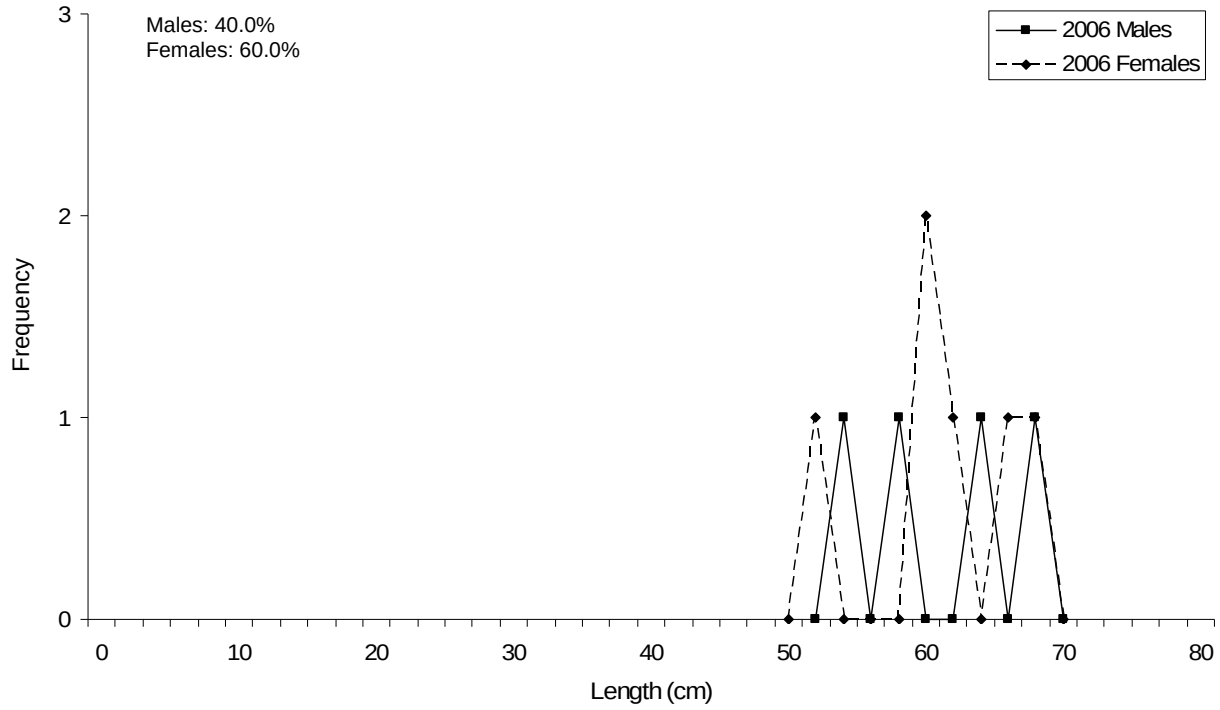

Figure 38. Length frequency distribution by sex for cowcod for all sites sampled, 2006.

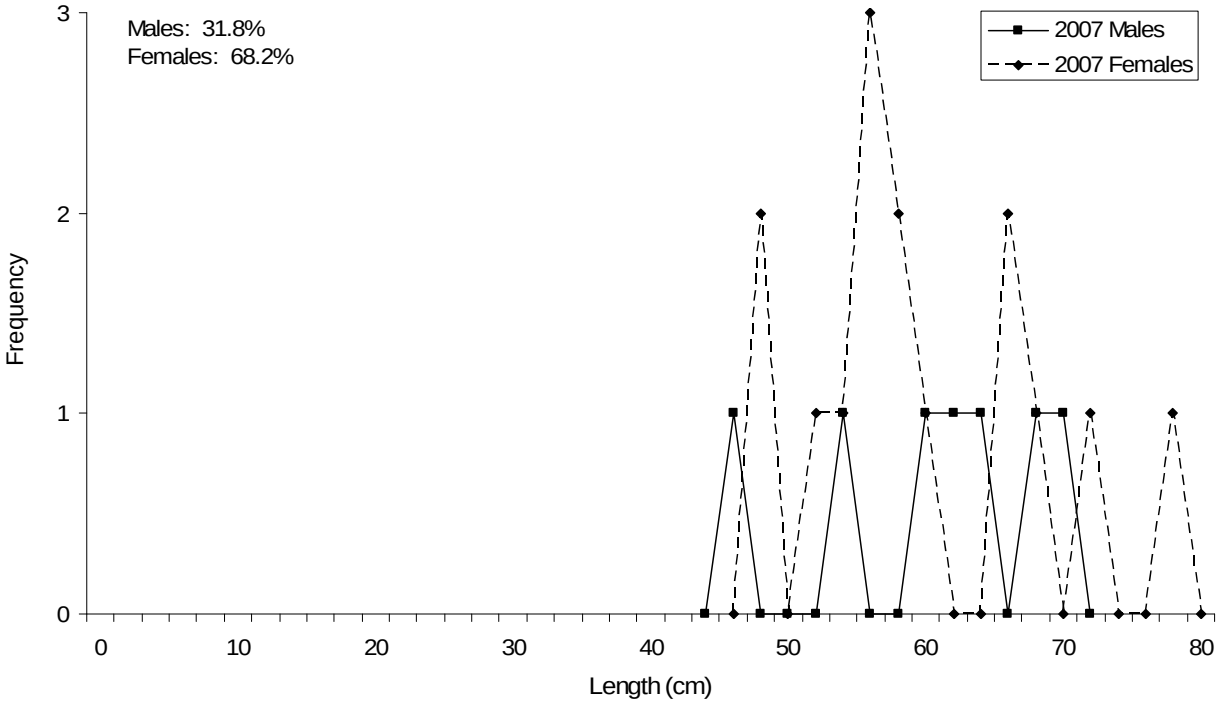

Figure 39. Length frequency distribution by sex for cowcod for all sites sampled, 2007.

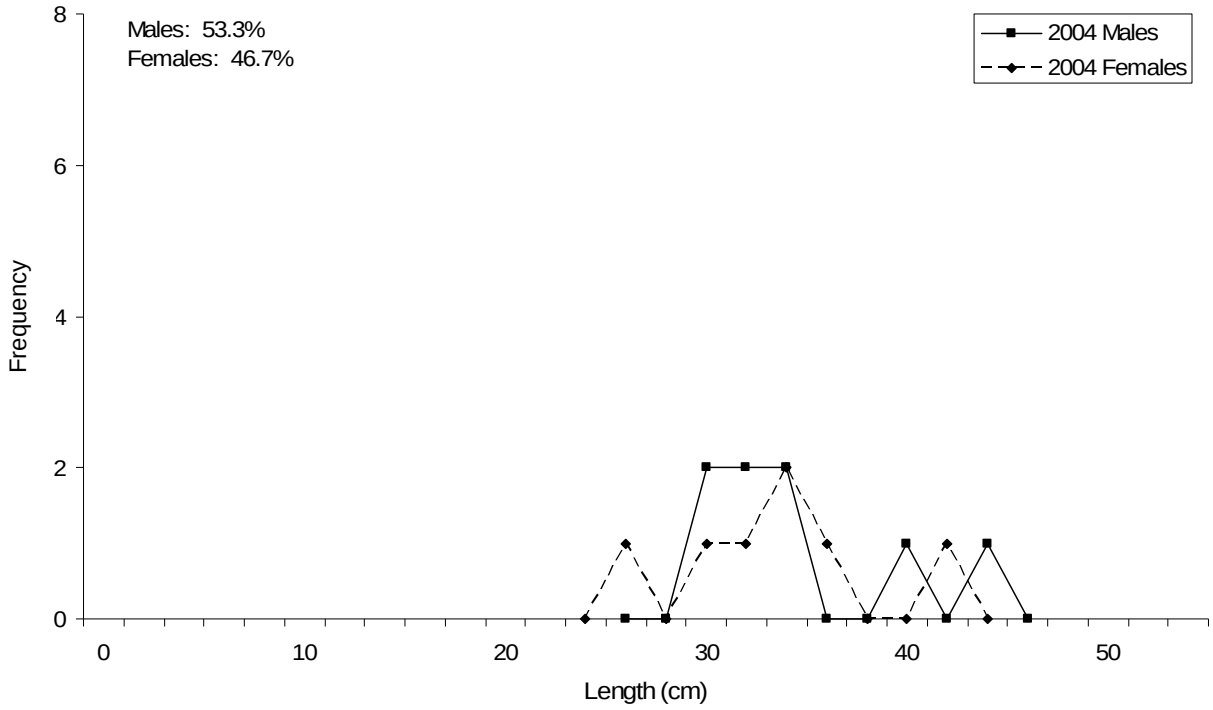

Figure 40. Length frequency distribution by sex for greenblotched rockfish for all sites sampled, 2004.

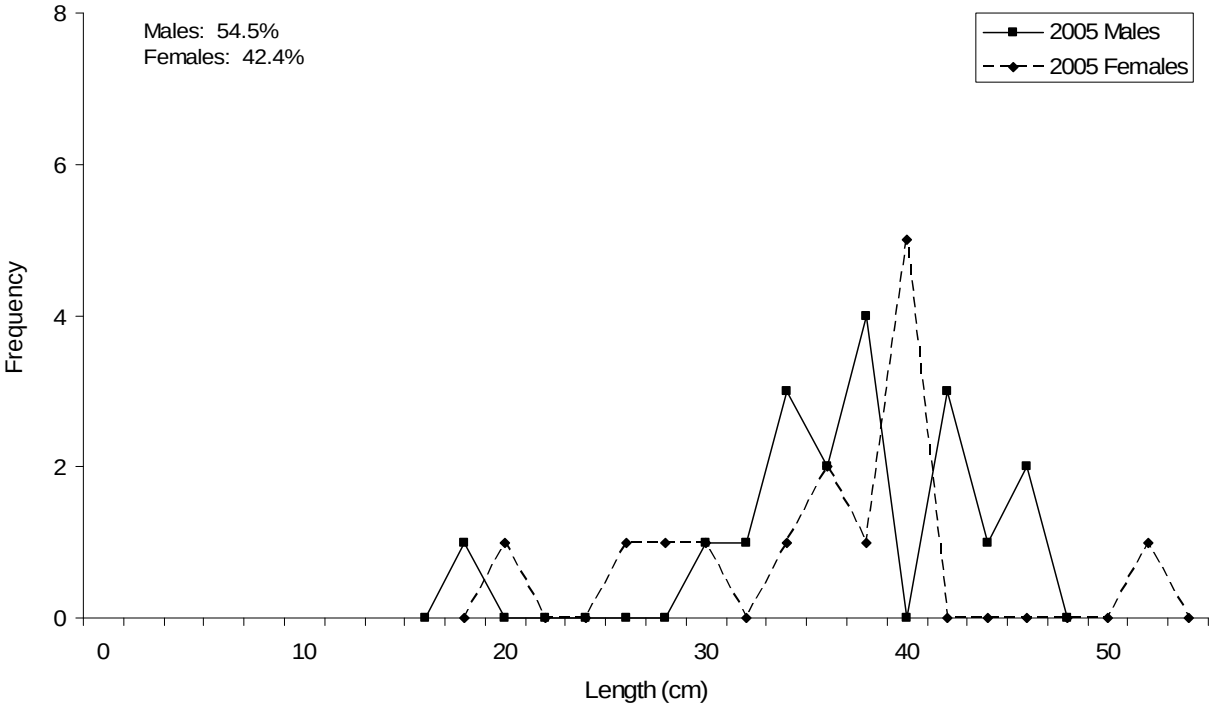

Figure 41. Length frequency distribution by sex for greenblotched rockfish for all sites sampled, 2005.

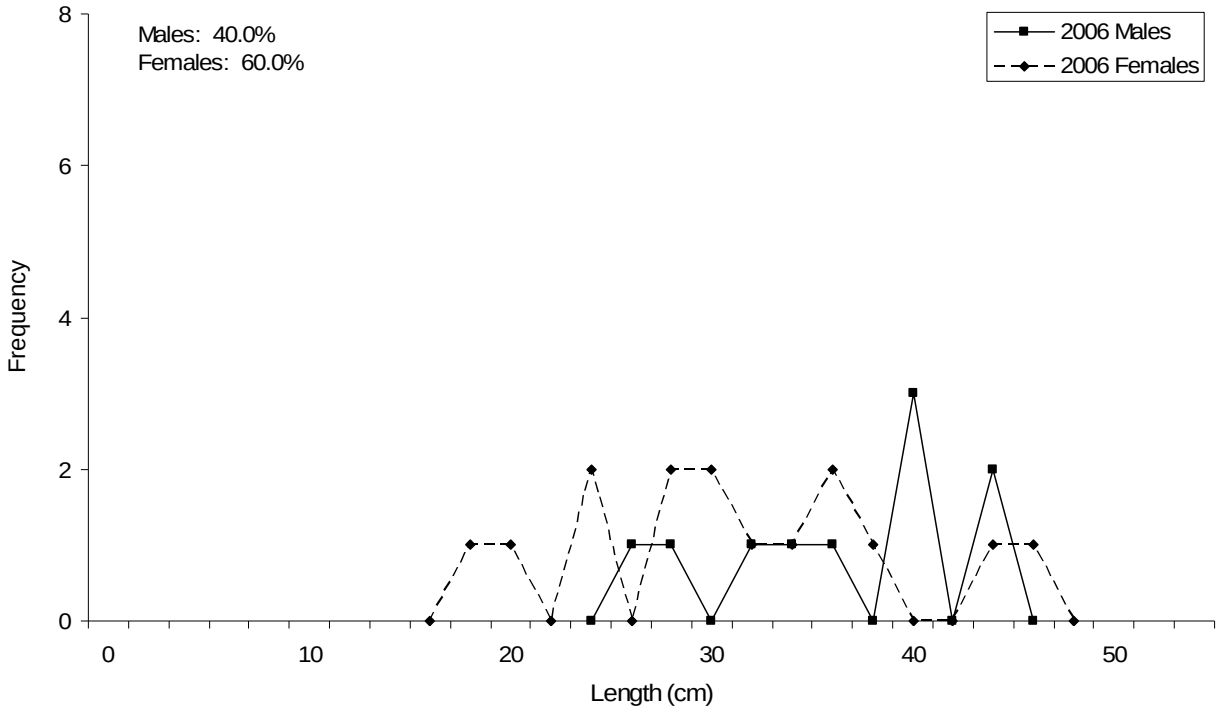

Figure 42. Length frequency distribution by sex for greenblotched rockfish for all sites sampled, 2006.

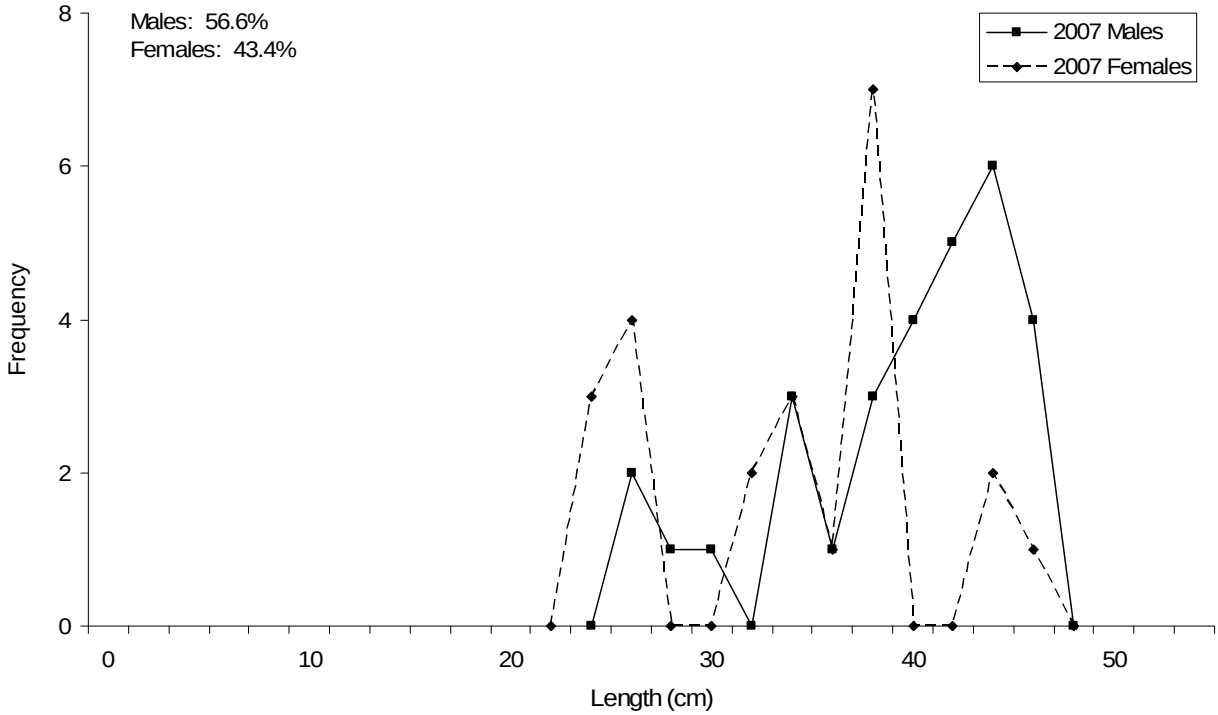

Figure 43. Length frequency distribution by sex for greenblotched rockfish for all sites sampled, 2007.

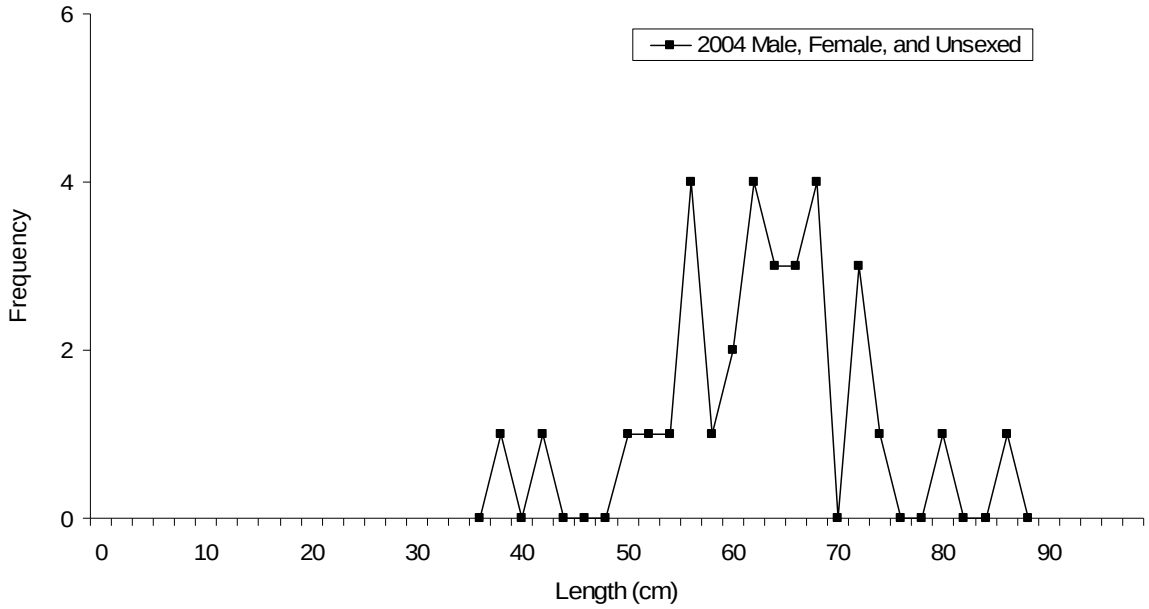

Figure 44. Length frequency distribution for lingcod for all sites sampled, 2004.

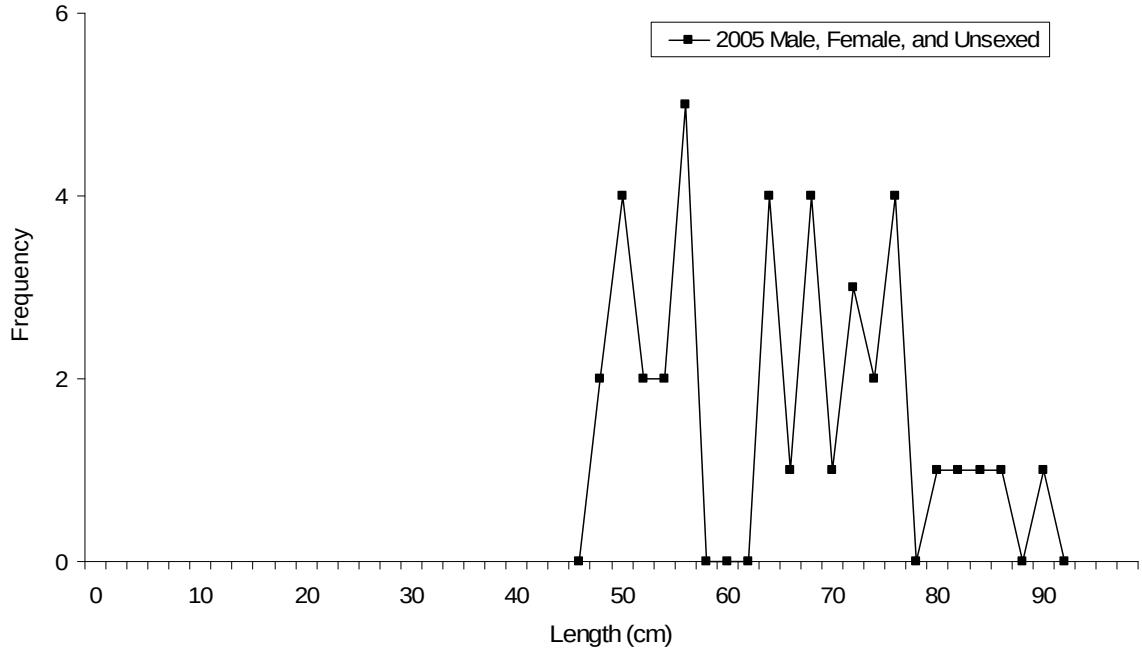

Figure 45. Length frequency distribution for lingcod for all sites sampled, 2005.

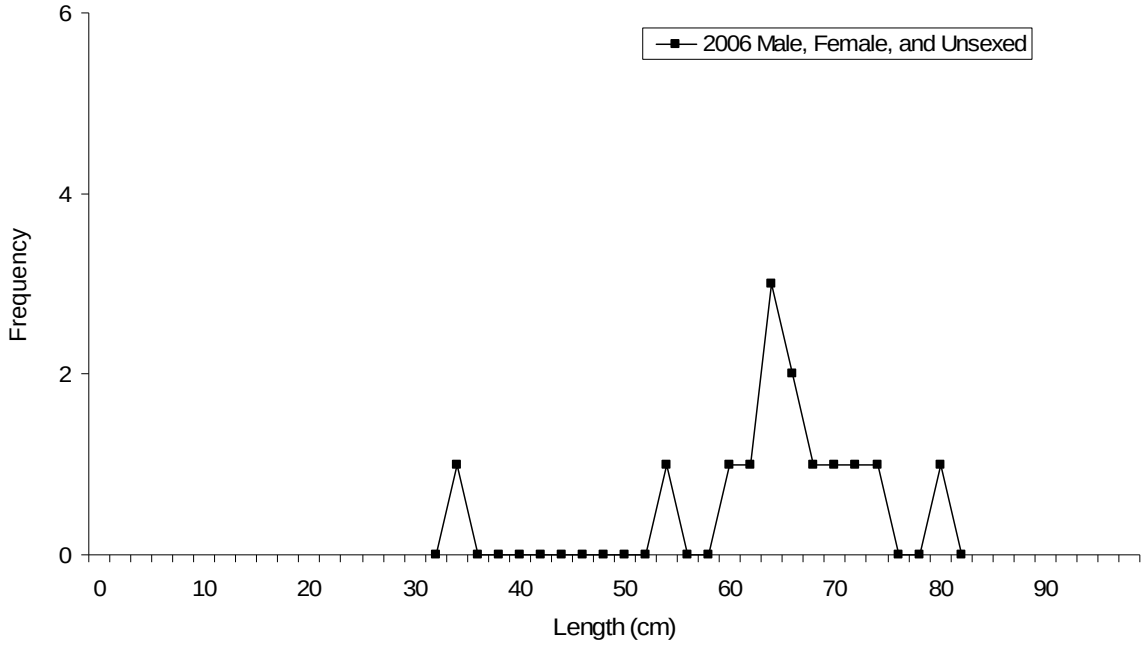

Figure 46. Length frequency distribution for lingcod for all sites sampled, 2006.

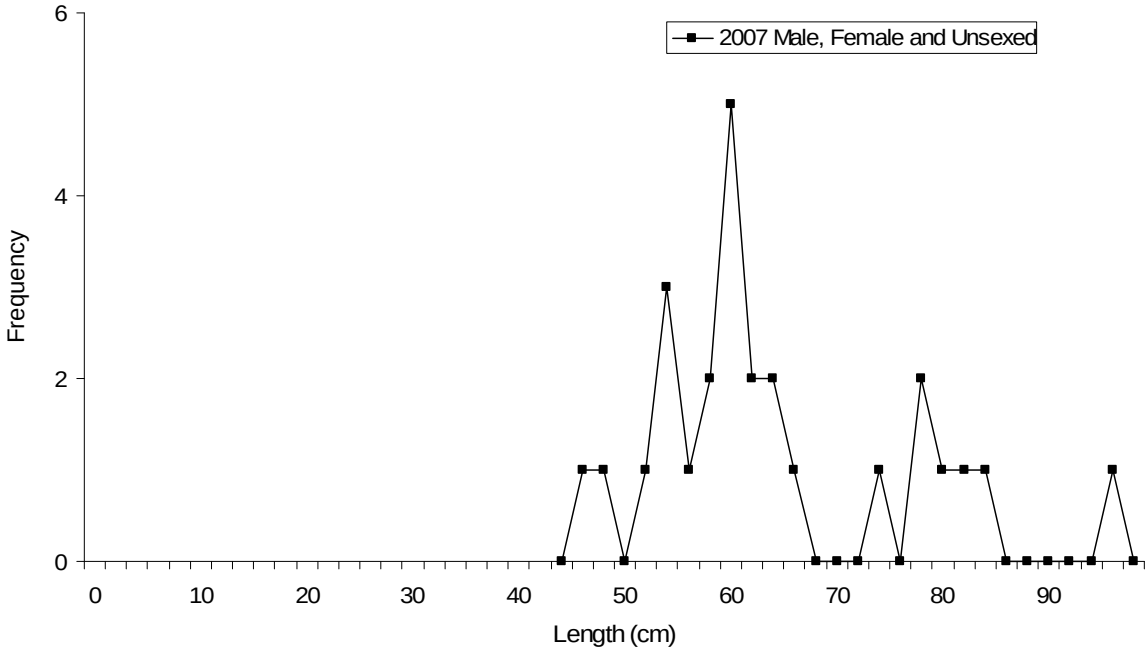

Figure 47. Length frequency distribution for lingcod for all sites sampled, 2007.

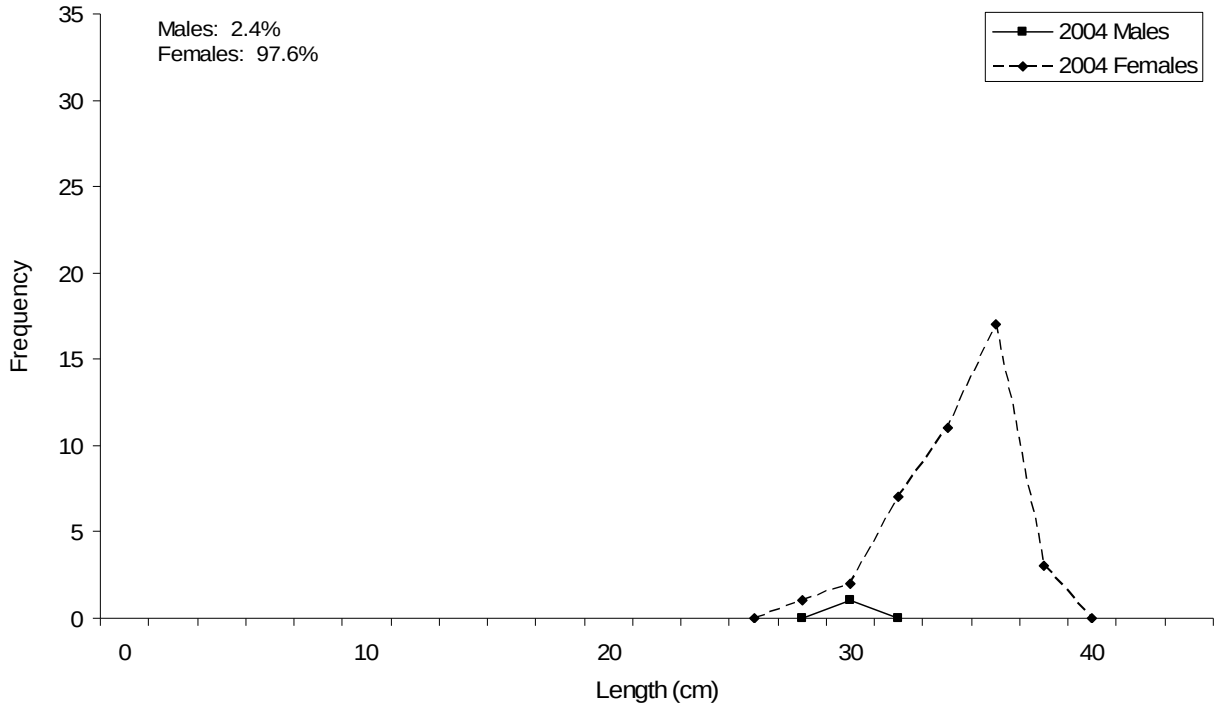

Figure 48. Length frequency distribution by sex for speckled rockfish for all sites sampled, 2004.

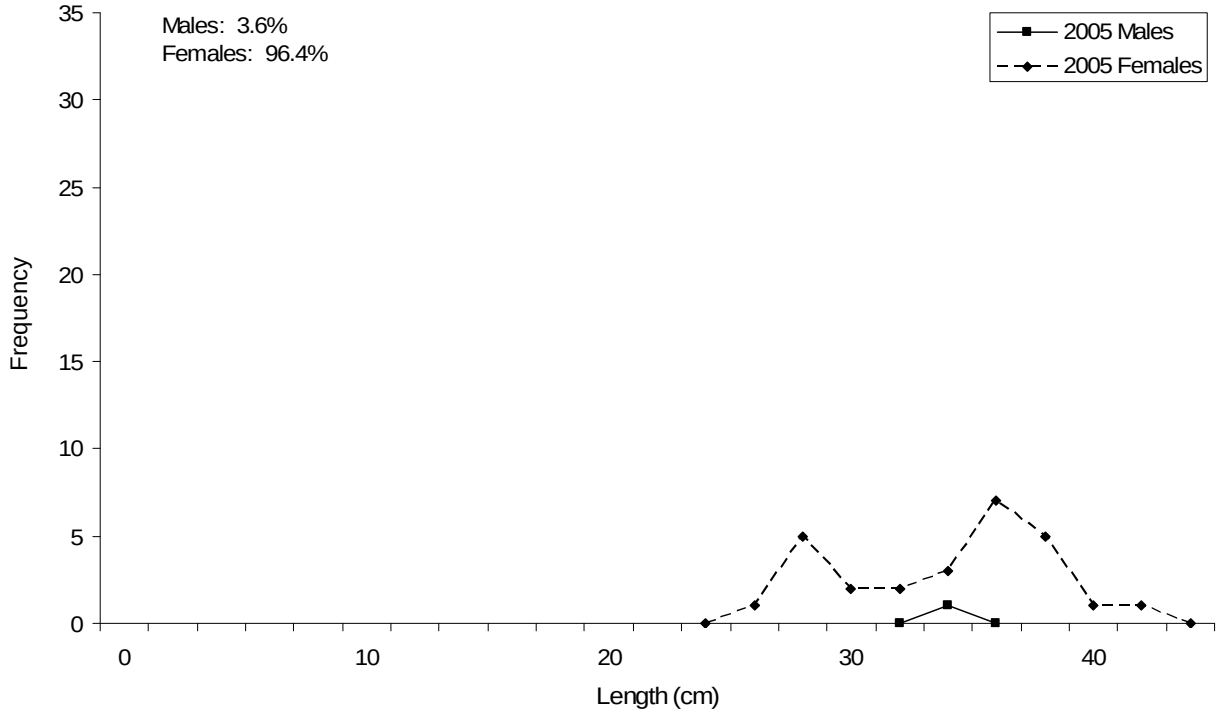

Figure 49. Length frequency distribution by sex for speckled rockfish for all sites sampled, 2005.

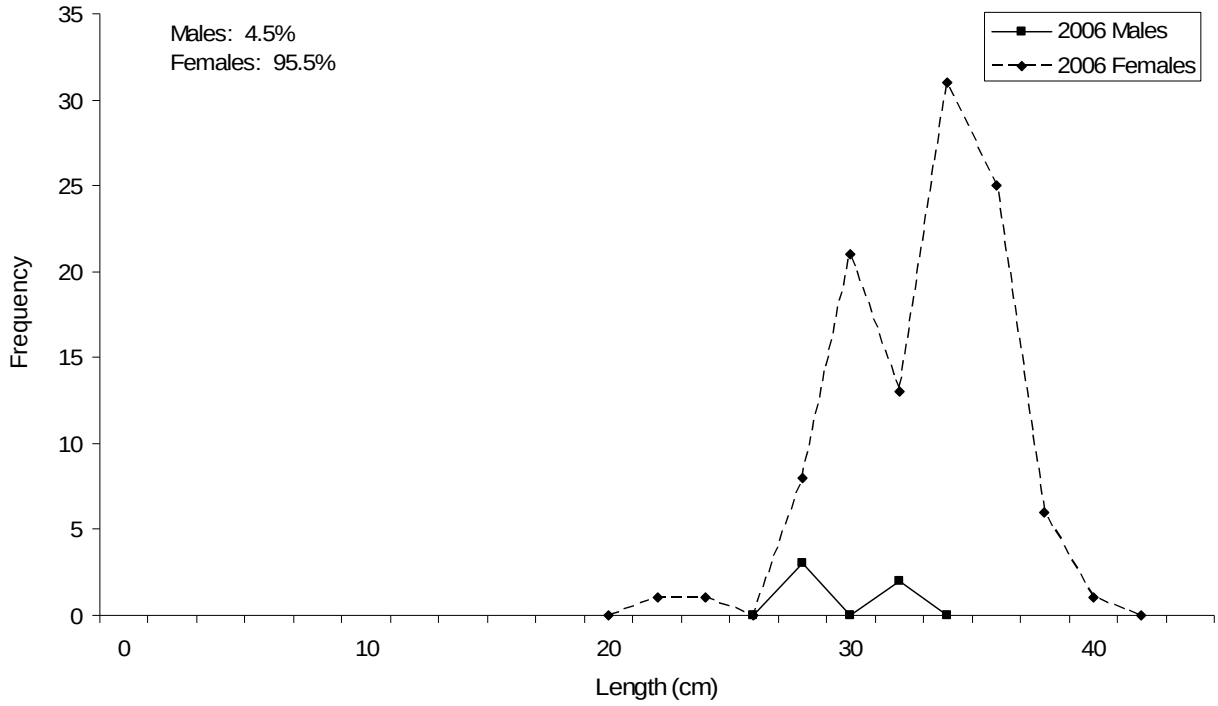

Figure 50. Length frequency distribution by sex for speckled rockfish for all sites sampled, 2006.

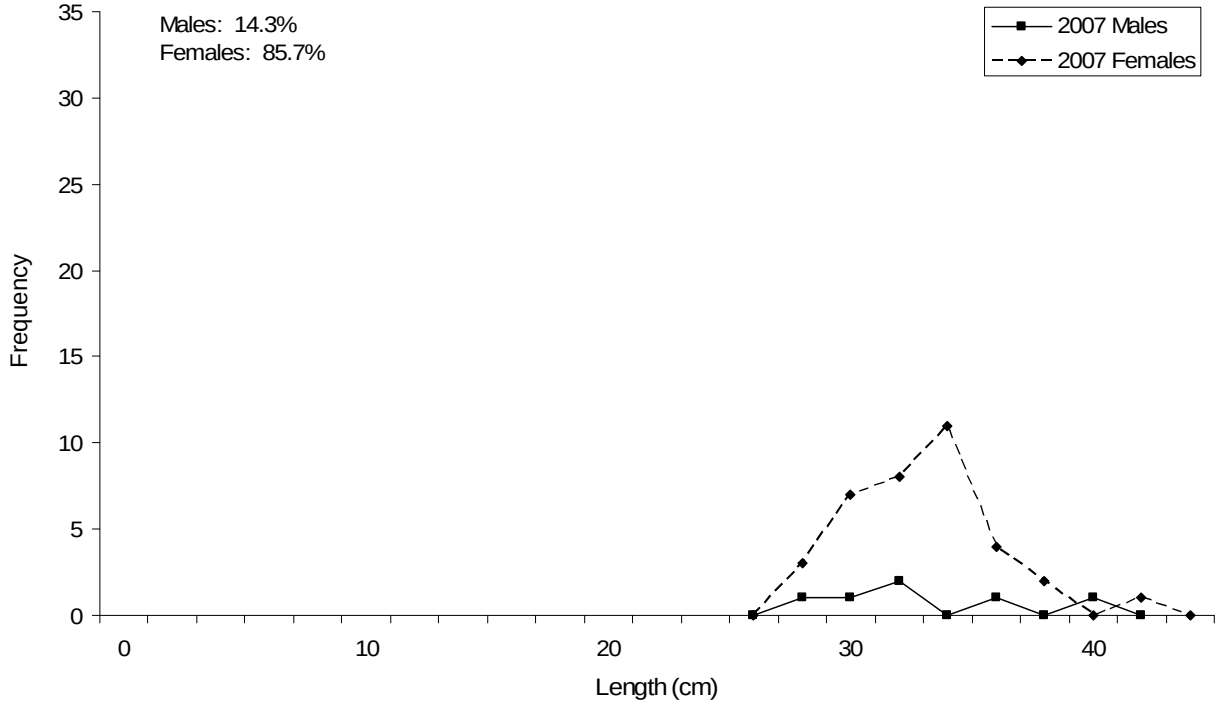

Figure 51. Length frequency distribution by sex for speckled rockfish for all sites sampled, 2007.

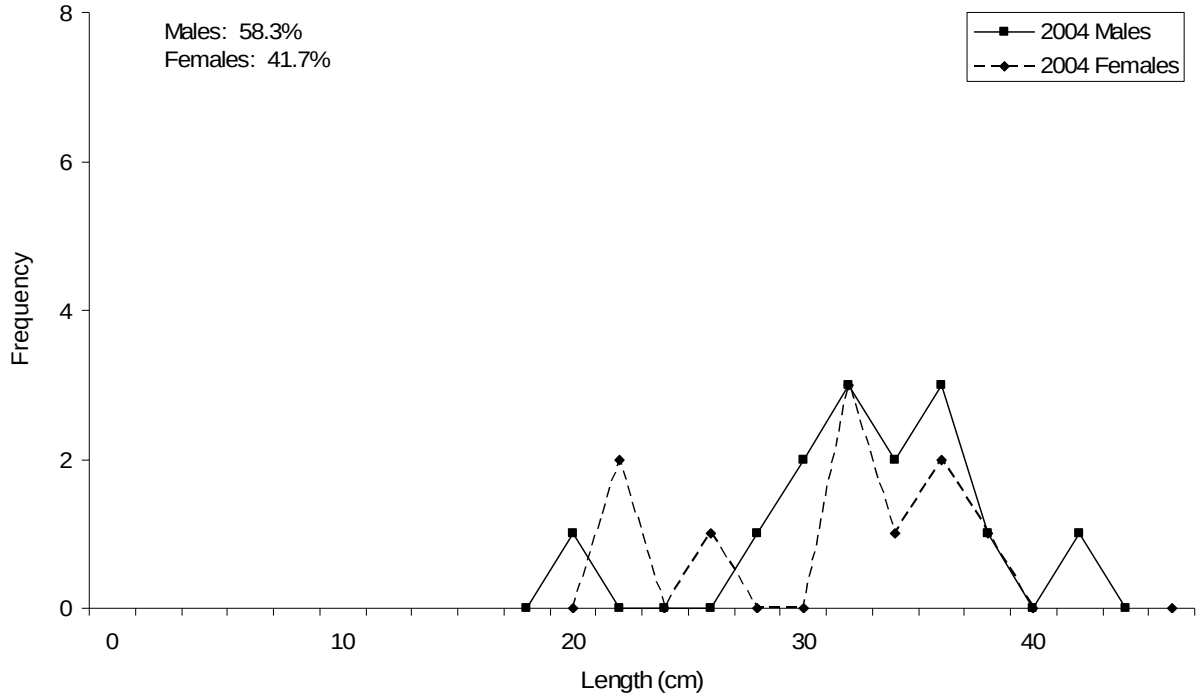

Figure 52. Length frequency distribution by sex for starry rockfish for all sites sampled, 2004.

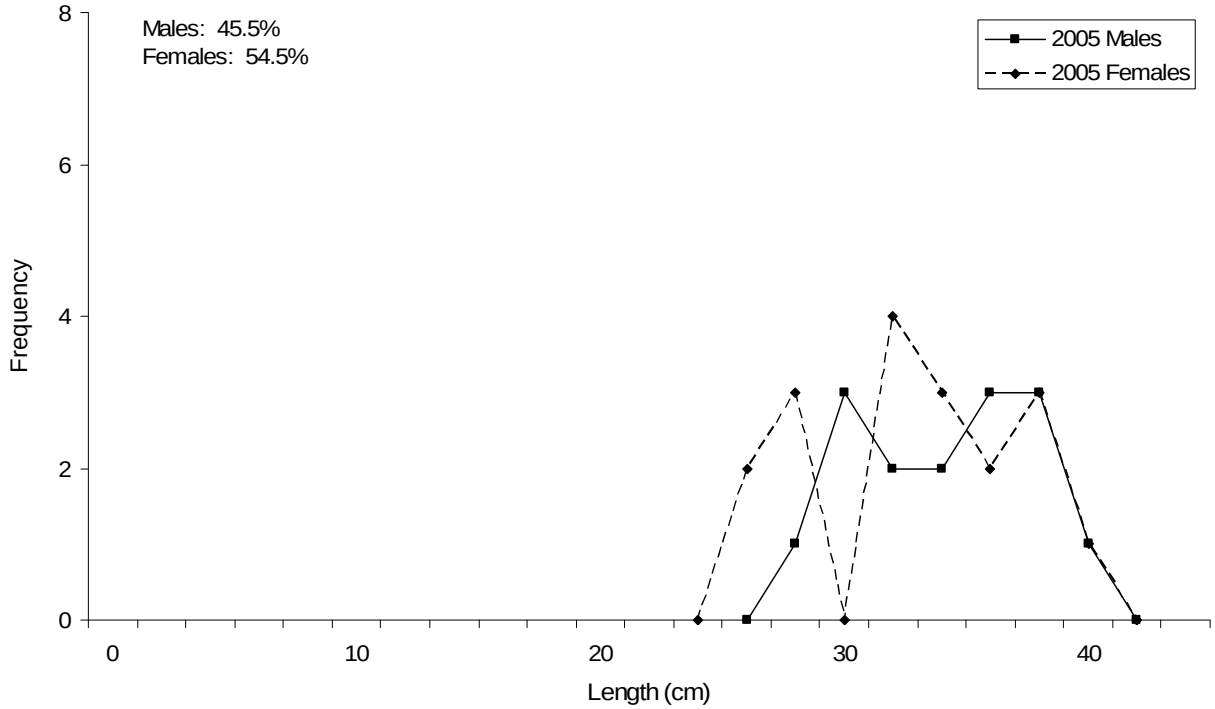

Figure 53. Length frequency distribution by sex for starry rockfish for all sites sampled, 2005.

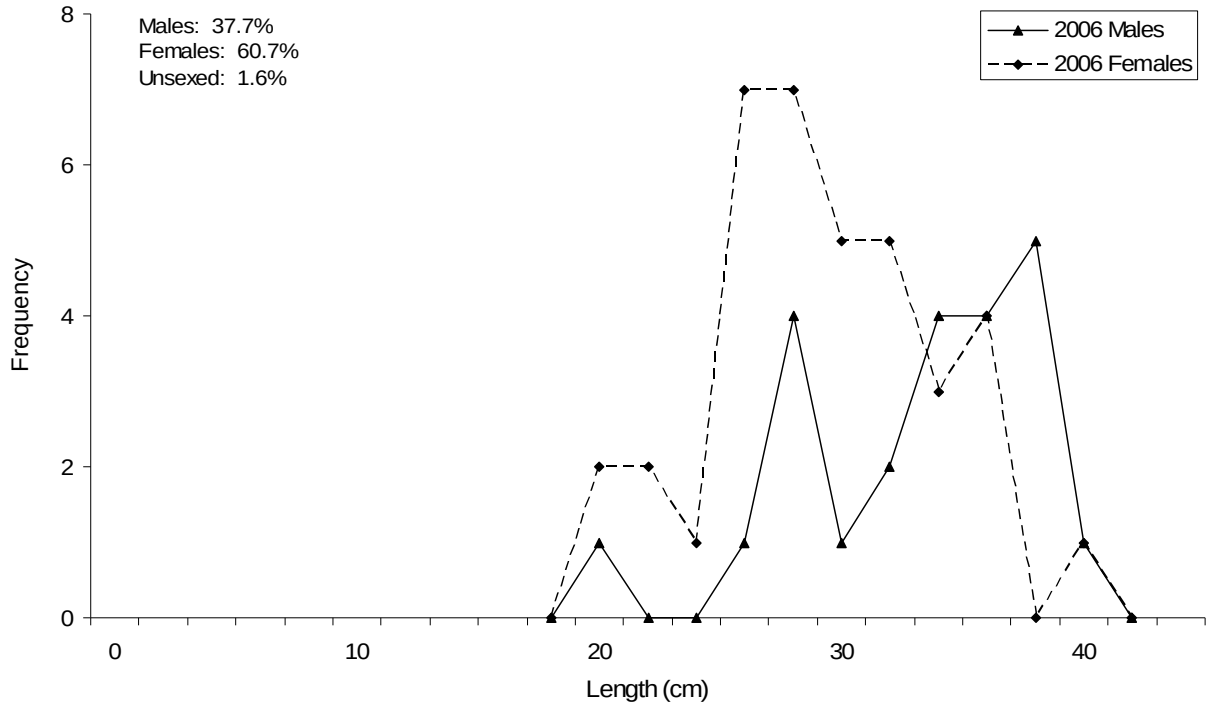

Figure 54. Length frequency distribution by sex for starry rockfish for all sites sampled, 2006.

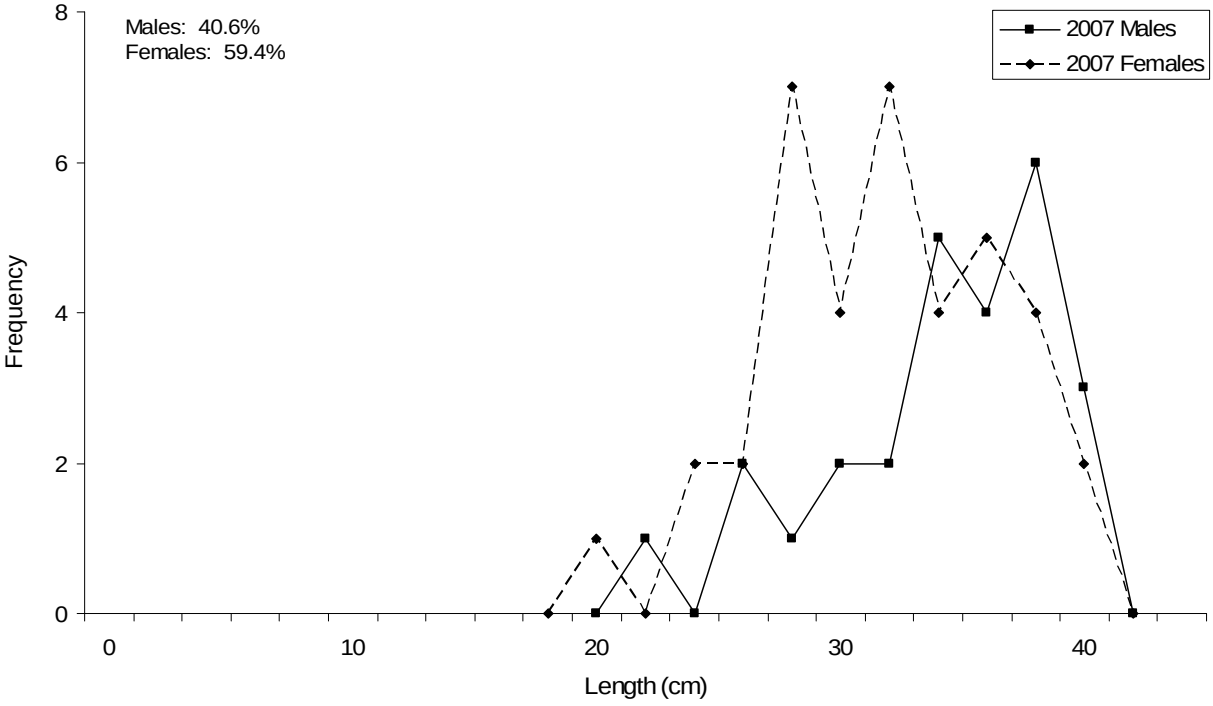

Figure 55. Length frequency distribution by sex for starry rockfish for all sites sampled, 2007.

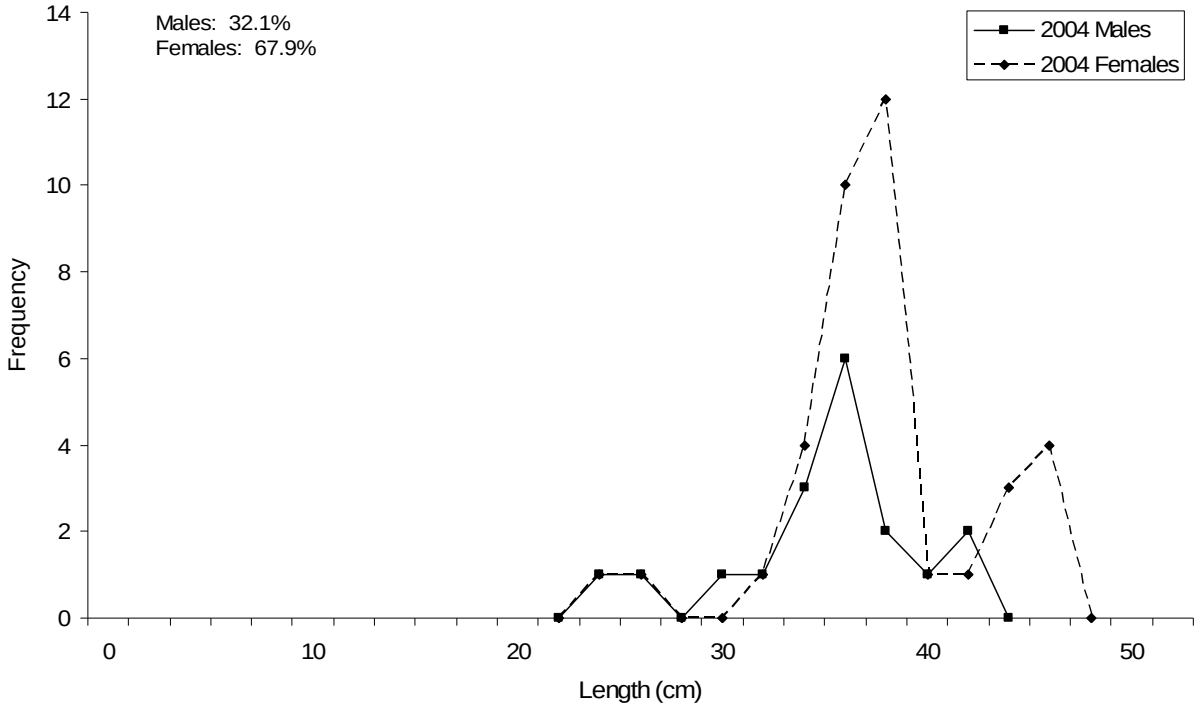

Figure 56. Length frequency distribution by sex for widow rockfish for all sites sampled, 2004.

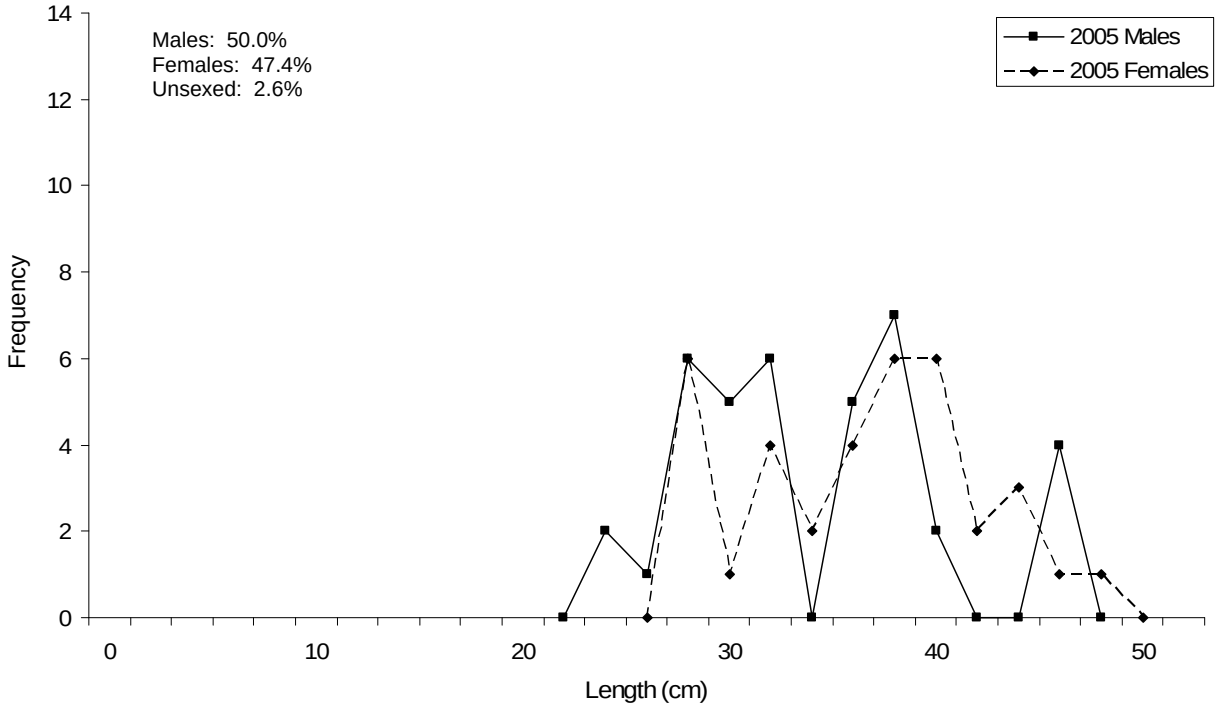

Figure 57. Length frequency distribution by sex for widow rockfish for all sites sampled, 2005.

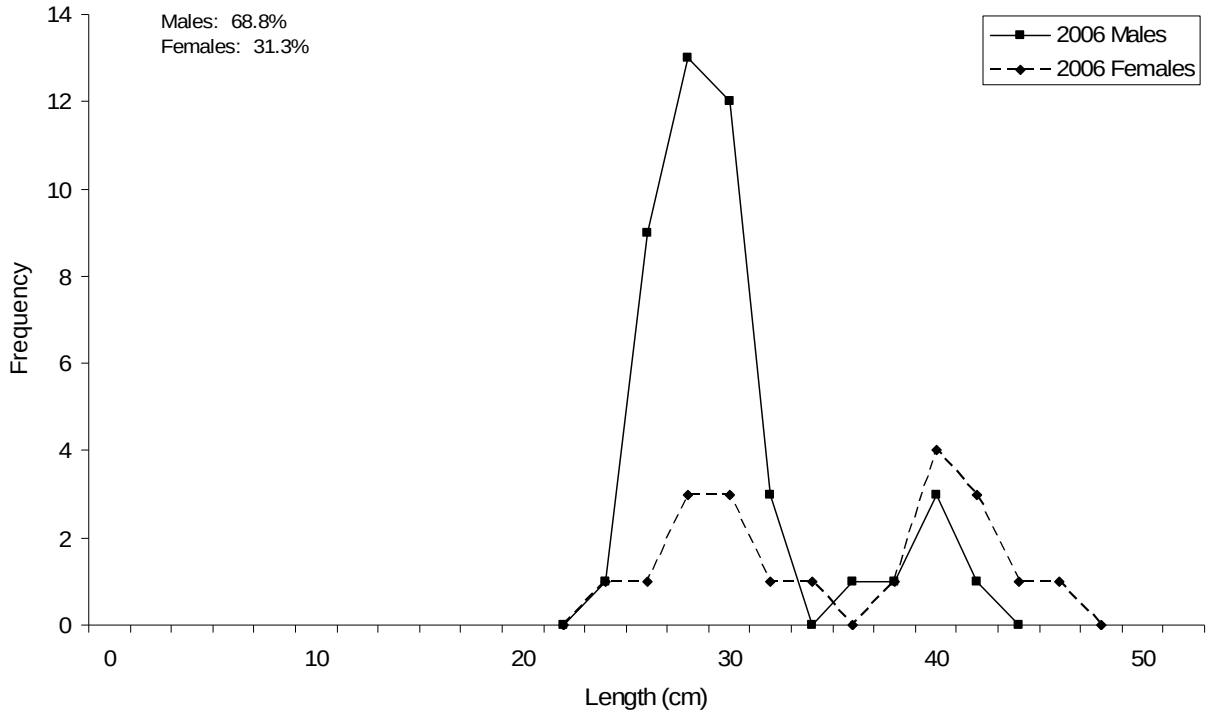

Figure 58. Length frequency distribution by sex for widow rockfish for all sites sampled, 2006.

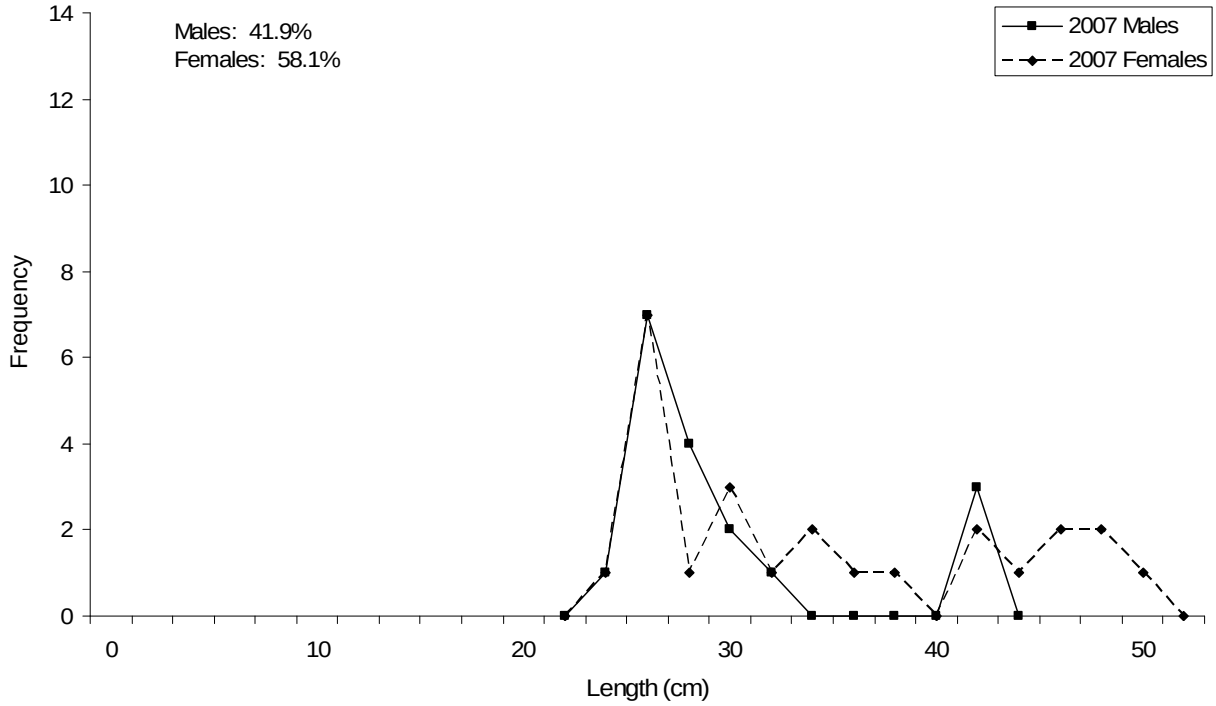

Figure 59. Length frequency distribution for by sex widow rockfish for all sites sampled, 2007.

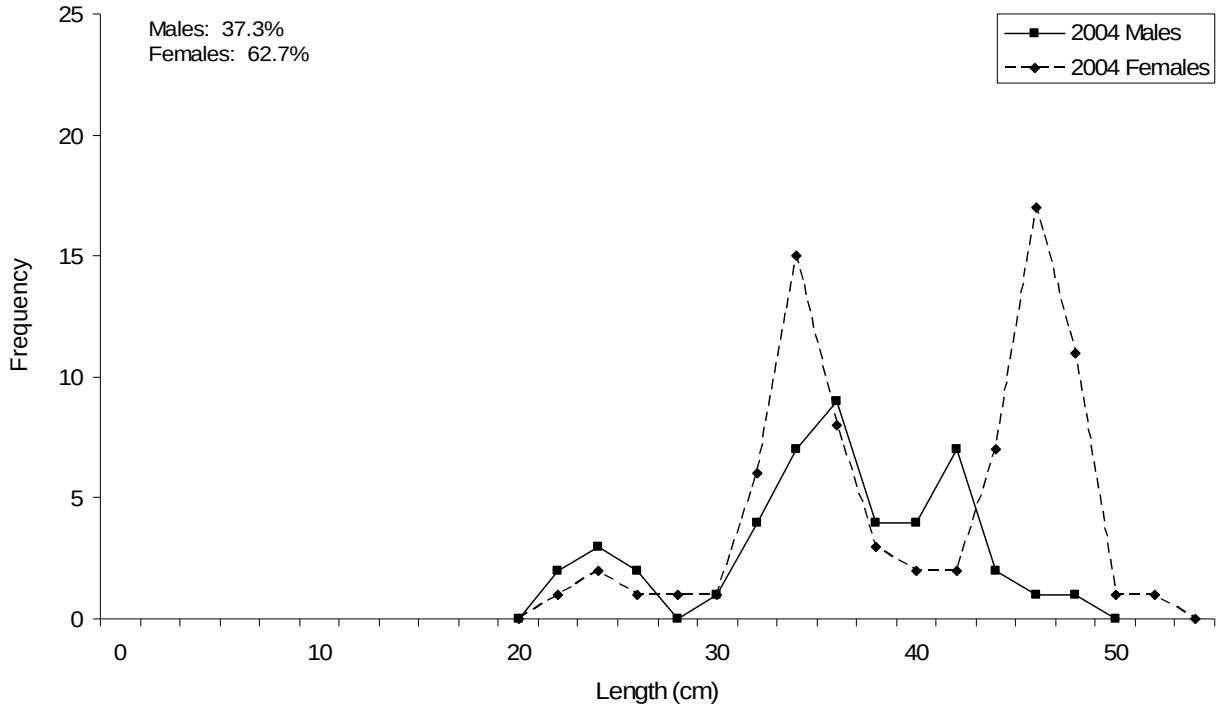

Figure 60. Length frequency distribution by sex for yellowtail rockfish for all sites sampled, 2004.

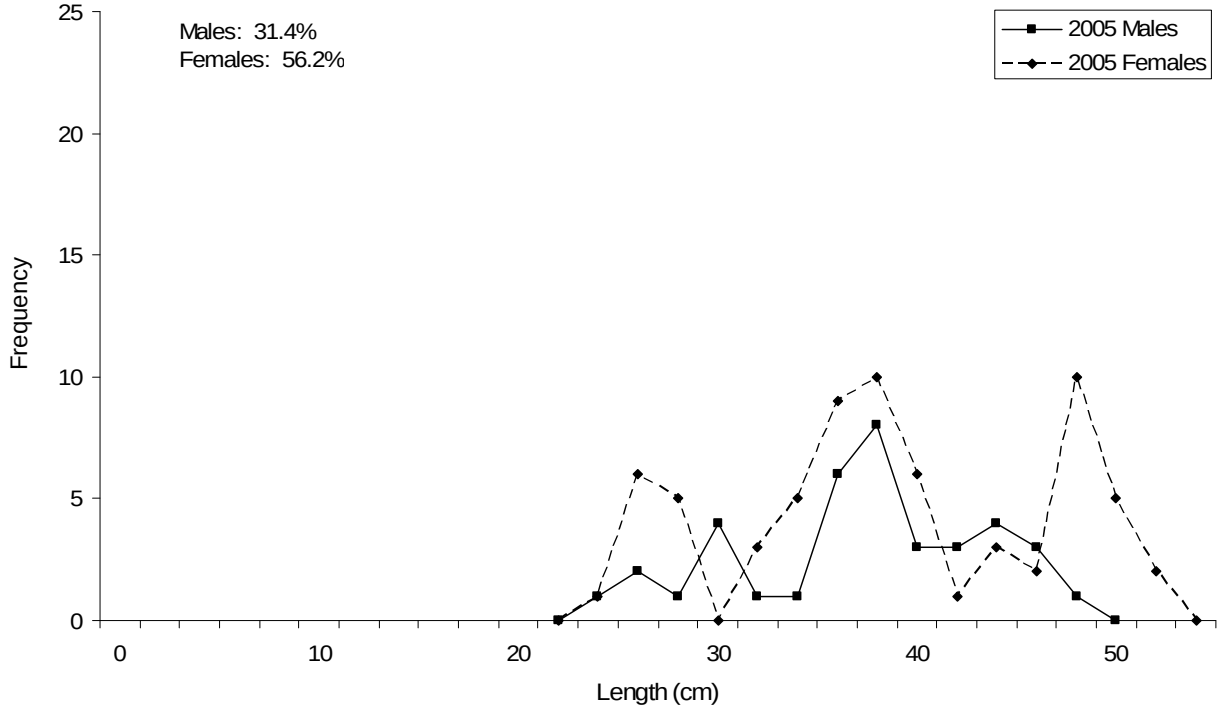

Figure 61. Length frequency distribution by sex for yellowtail rockfish for all sites sampled, 2005.

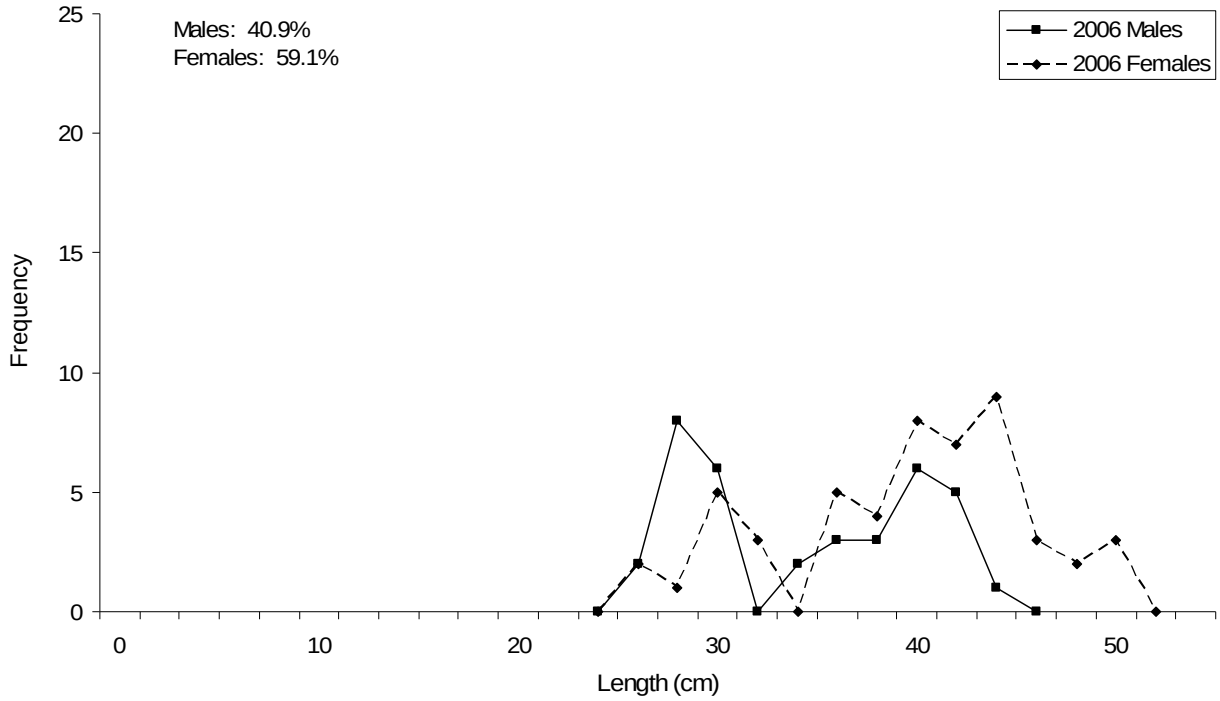

Figure 62. Length frequency distribution by sex for yellowtail rockfish for all sites sampled, 2006.

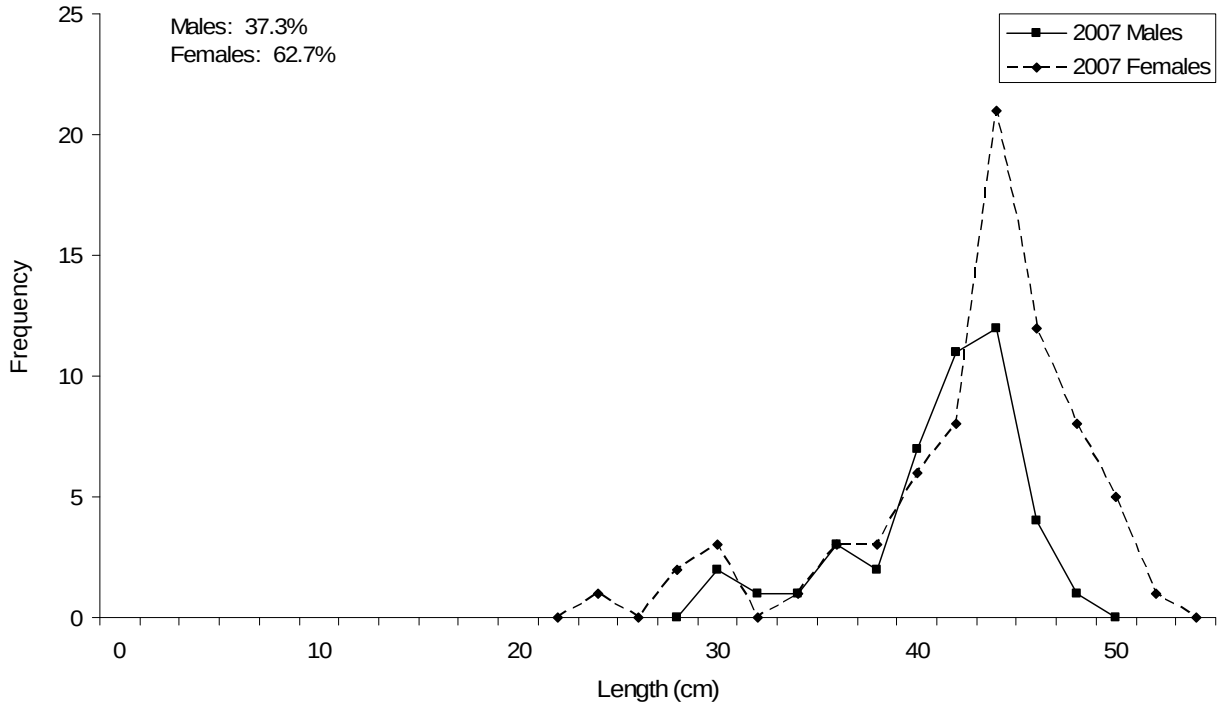

Figure 63. Length frequency distribution by sex for yellowtail rockfish for all sites sampled, 2007.

Length by Depth Strata

Figures 64 through 66 illustrate the size compositions for three key species encountered in four depth strata in each year, 2004–2007. In this section, the three most abundant species in the survey are included: bocaccio, vermilion rockfish, and greenspotted rockfish. Depth is indicated in fathoms, as this is the native unit from which the data were binned. Metric equivalents are as follows:

Fathoms	Meters
0–40	0–73
40–60	73–110
60–80	110–146
>80	>146

For all three species, larger fish are generally associated with deeper water. For bocaccio in 2006 and 2007, a clear difference in size is present between the second and third depth strata as smaller, younger fish from the 2003 and 2005 year-classes compose a larger proportion of all bocaccio encountered (Figure 64). Greenspotted rockfish are rarely caught shallower than 73 m and tend to level off in size in waters deeper than 110 m (Figure 66).

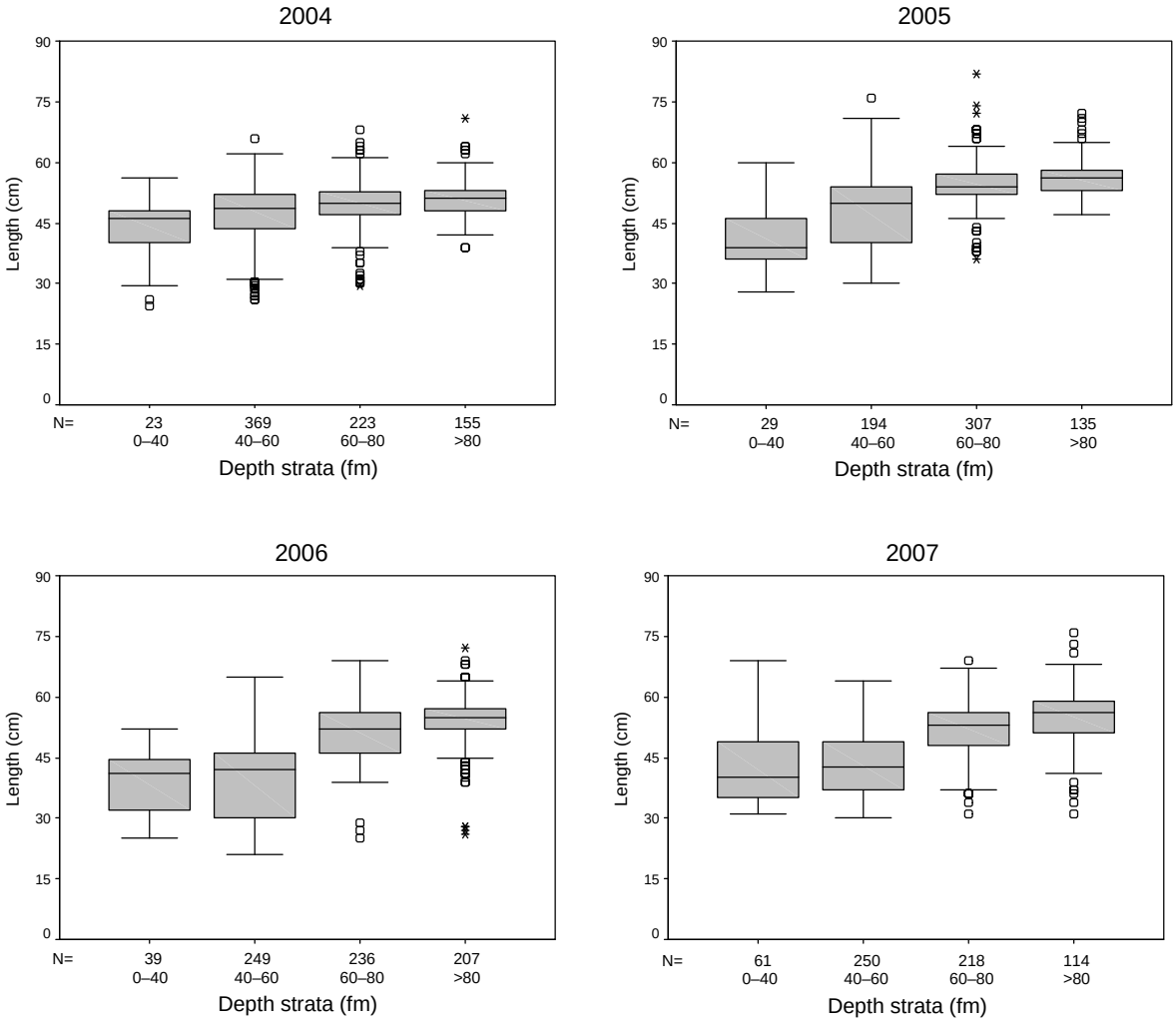

Figure 64. Bocaccio length by depth strata and year for all sites, 2004–2007. Box plots display interquartile range and median values. Outliers (1.5–3 box lengths) are shown as circles. Extreme values (>3 box lengths) are shown as asterisks.

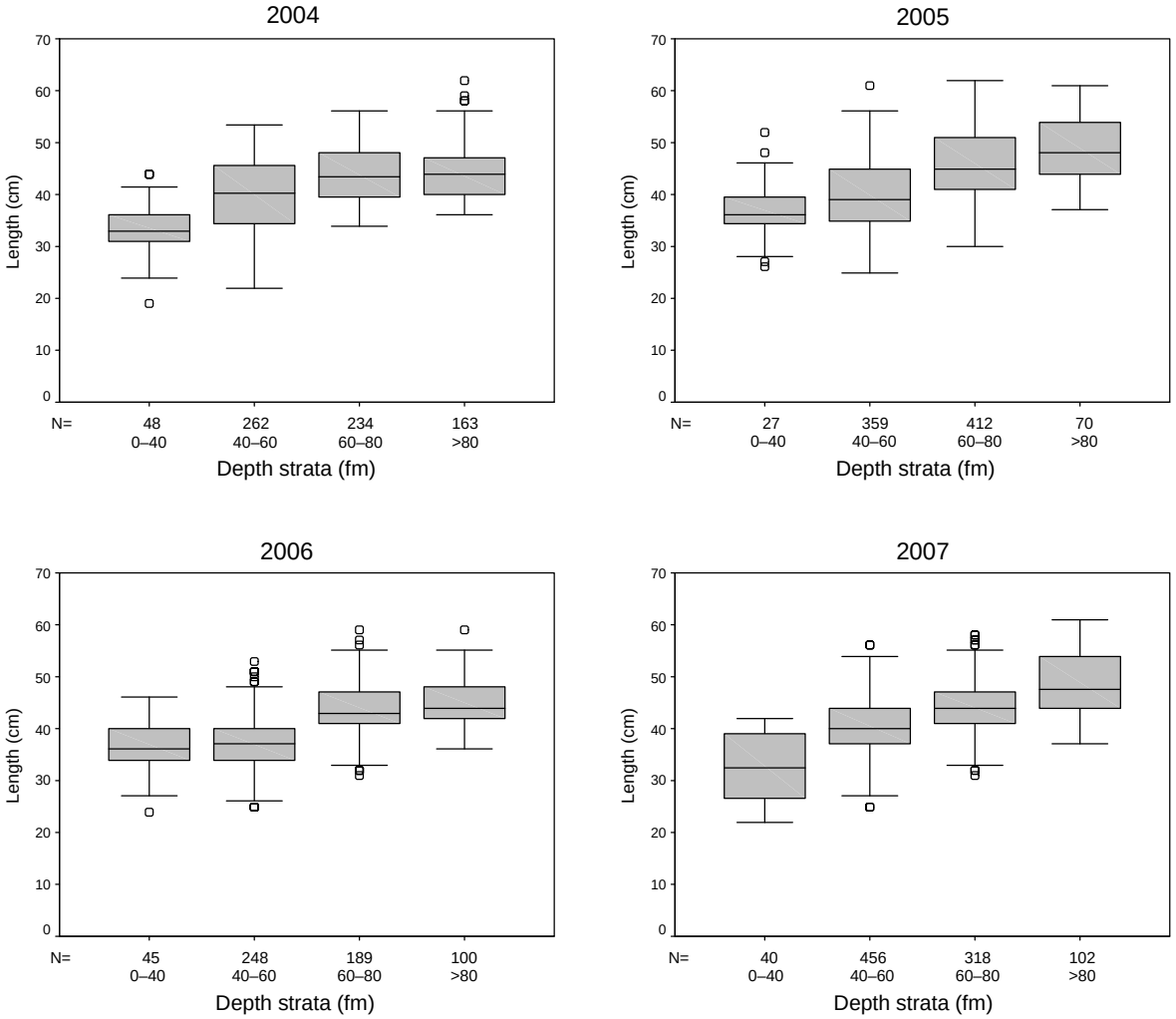

Figure 65. Vermilion rockfish length by depth strata and year for all sites, 2004–2007. Box plots display interquartile range and median values. Outliers (1.5–3 box lengths) are shown as circles.

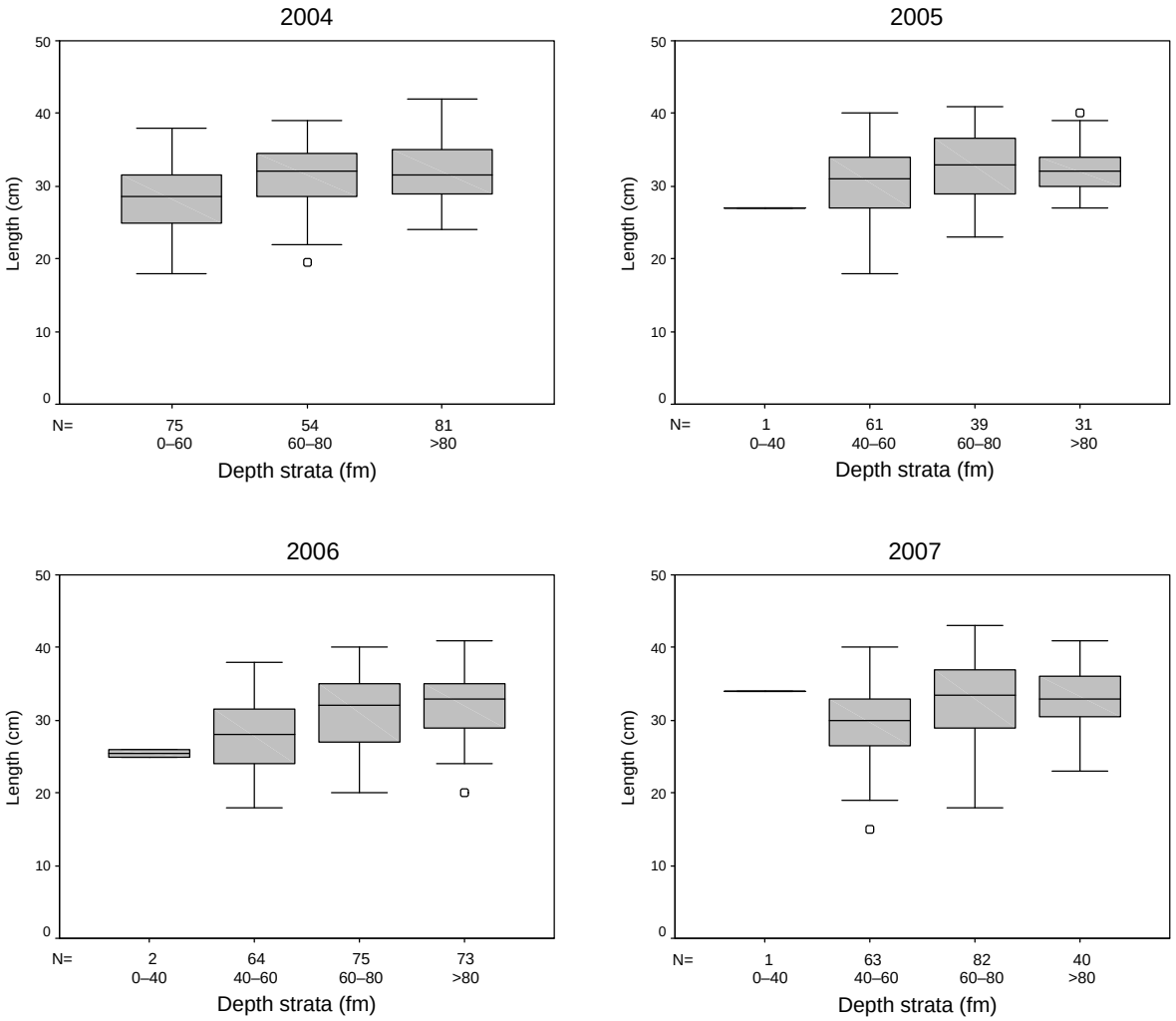

Figure 66. Greenspotted rockfish length by depth strata and year for all sites, 2004–2007. Box plots display interquartile range and median values. Outliers (1.5–3 box lengths) are shown as circles.

Relative Abundance and Distribution of Key Species

Catch Rates

For this report, catch rate is expressed as the number of individual fish hooked per site, by species, normalized for any invalid or missing drops and hooks. In this section, the three most abundant species in the survey are included: bocaccio, vermilion rockfish, and greenspotted rockfish.

Table 10 provides the mean catch rates and standard deviations for these three species in all 4 years of the survey both for all sites sampled in a year and for only those sites that have been sampled consecutively each year from 2004–2007. Mean catch rates were highest for all three species in 2004. The 2004 hook and line survey was conducted in mid-November versus the late-September start date for the 2005–2007 surveys, so seasonal changes in abundance may have influenced catch rates.

Figures 67 through 69 provide box plots of the catch rates observed for bocaccio, vermilion rockfish, and greenspotted rockfish by year. A pair of charts is included for each species. The first chart provides results from every site sampled in a particular year; the second provides results from sites that have been sampled consecutively from 2004–2007. Population trends for all three species are generally flat (Figures 67 through 69). A slight decrease in the mean and median number of vermilion rockfish caught between 2005 and 2007 at the consecutive sites is visible. However, this decreasing pattern is not observed for the set of all sites sampled in those years. As previously noted on page 23, the identification of sunset rockfish, a cryptic form of vermilion rockfish, presents additional challenges for research and management.

Figures 70 through 72 provide catch rates for bocaccio, vermilion rockfish, and greenspotted rockfish broken down by depth strata. Four strata are used: 0–40 fm (0–73 m), 40–60 fm (73–110 m), 60–80 fm (110–146 m), and greater than 80 fm (146 m). All three species are less abundant in shallow water. Bocaccio abundance levels off in waters deeper than 146 m, while vermilion rockfish abundance decreases slightly in the deepest stratum. Median abundance is generally constant for greenspotted rockfish in waters deeper than 73 m; however, several outliers suggest that the most abundant locations for this species may be in isolated areas in waters deeper than 146 m.

Table 10. Mean catch rates and standard deviations for bocaccio, vermilion rockfish, and greenspotted rockfish by year during the hook and line survey. For each year, catch rates are calculated for all sites sampled in a year and for the subset of sites that have been sampled consecutively in each of the 4 years of the survey.

	2004				2005				2006				2007			
	All sites N = 74		Cons. only N = 43*		All sites N = 89		Cons. only N = 42*		All sites N = 90		Cons. Only N = 42*		All sites N = 99		Cons. only N = 42*	
Species	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD
Bocaccio	11.0	11.0	10.9	11.8	7.7	11.0	8.9	11.0	8.5	10.5	9.9	12.2	6.6	7.3	7.3	8.2
Vermillion rockfish	10.6	12.7	9.0	11.0	9.9	13.5	9.2	12.3	6.6	9.4	7.8	10.7	9.6	13.9	7.3	12.8
Greenspotted rockfish	3.0	5.7	2.8	5.5	1.5	3.2	1.4	3.4	2.3	3.5	2.3	3.9	1.9	3.5	1.4	2.5

* One site was sampled by both vessels in 2004.

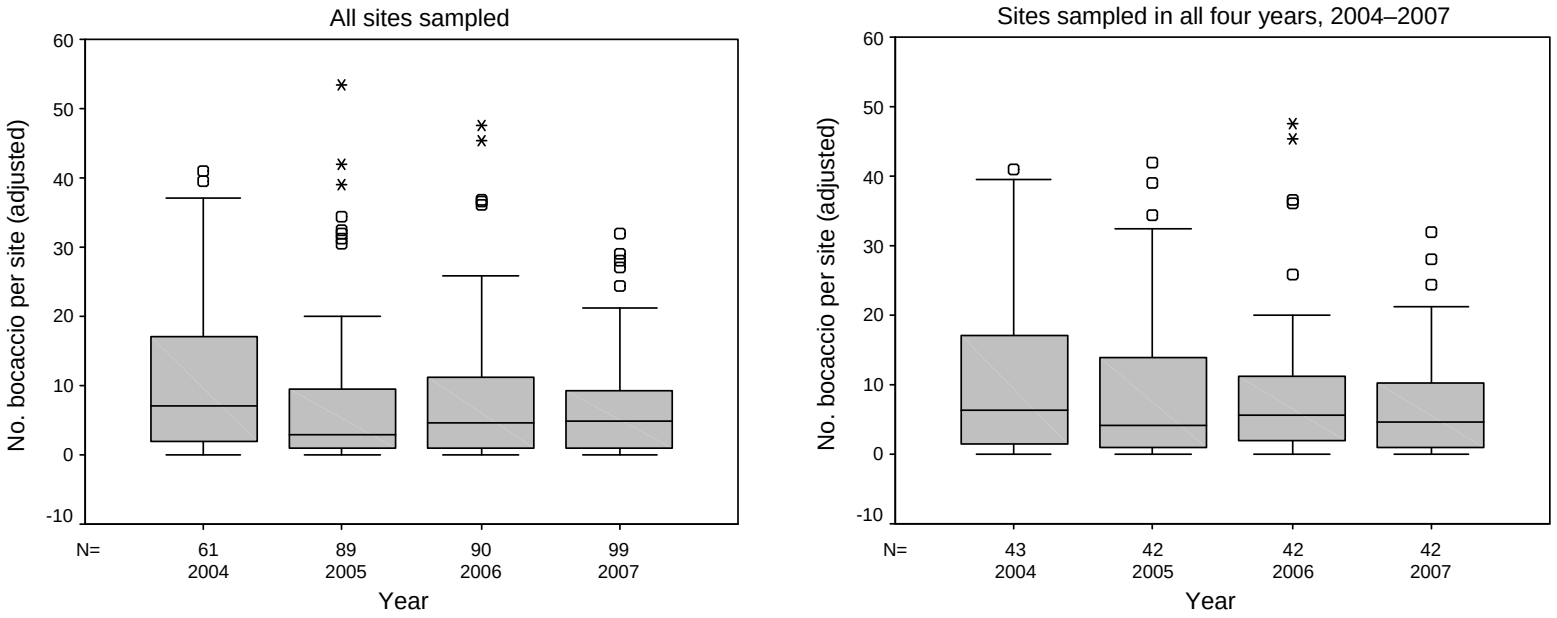

Figure 67. Catch rates for bocaccio by year during the hook and line survey, 2004–2007. Box plots display interquartile range and median values. Outliers (1.5–3 box lengths) are shown as circles. Extreme values (>3 box lengths) are shown as asterisks.

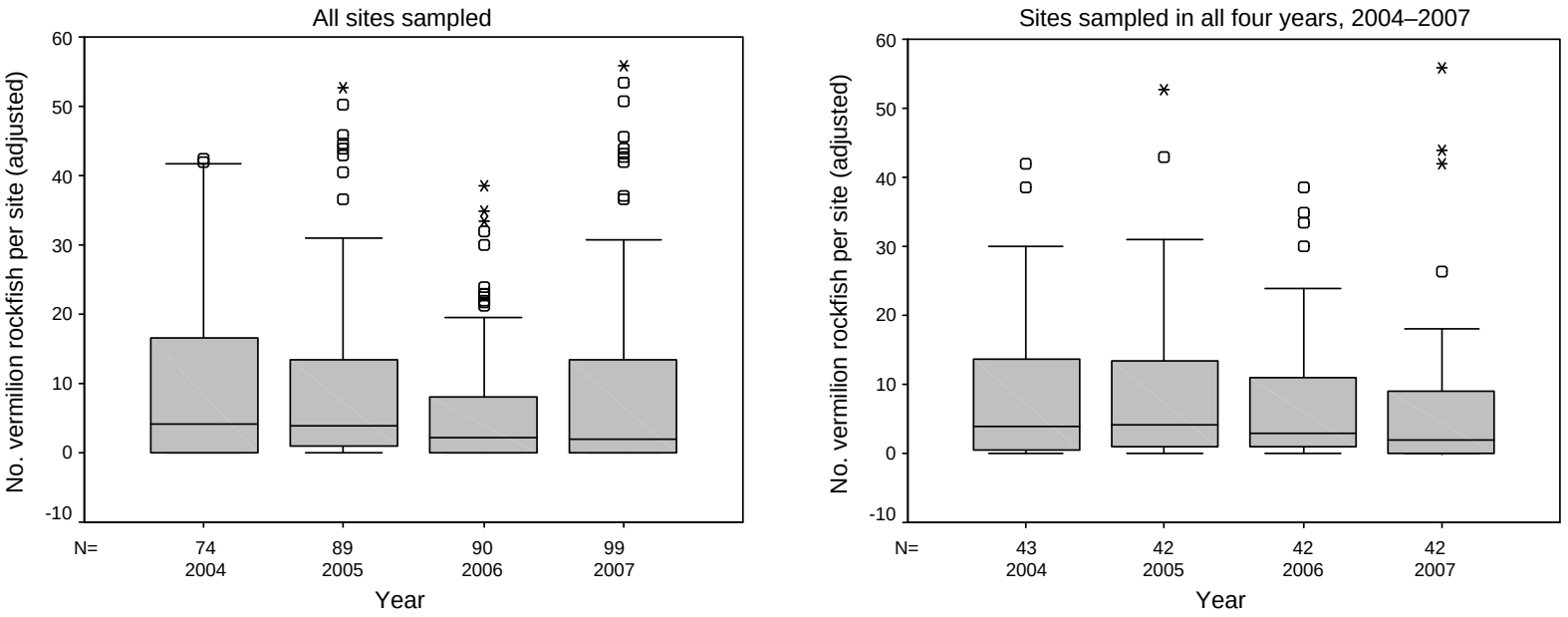

Figure 68. Catch rates for vermilion rockfish by year during the hook and line survey, 2004–2007. Box plots display interquartile range and median values. Outliers (1.5–3 box lengths) are shown as circles. Extreme values (>3 box lengths) are shown as asterisks.

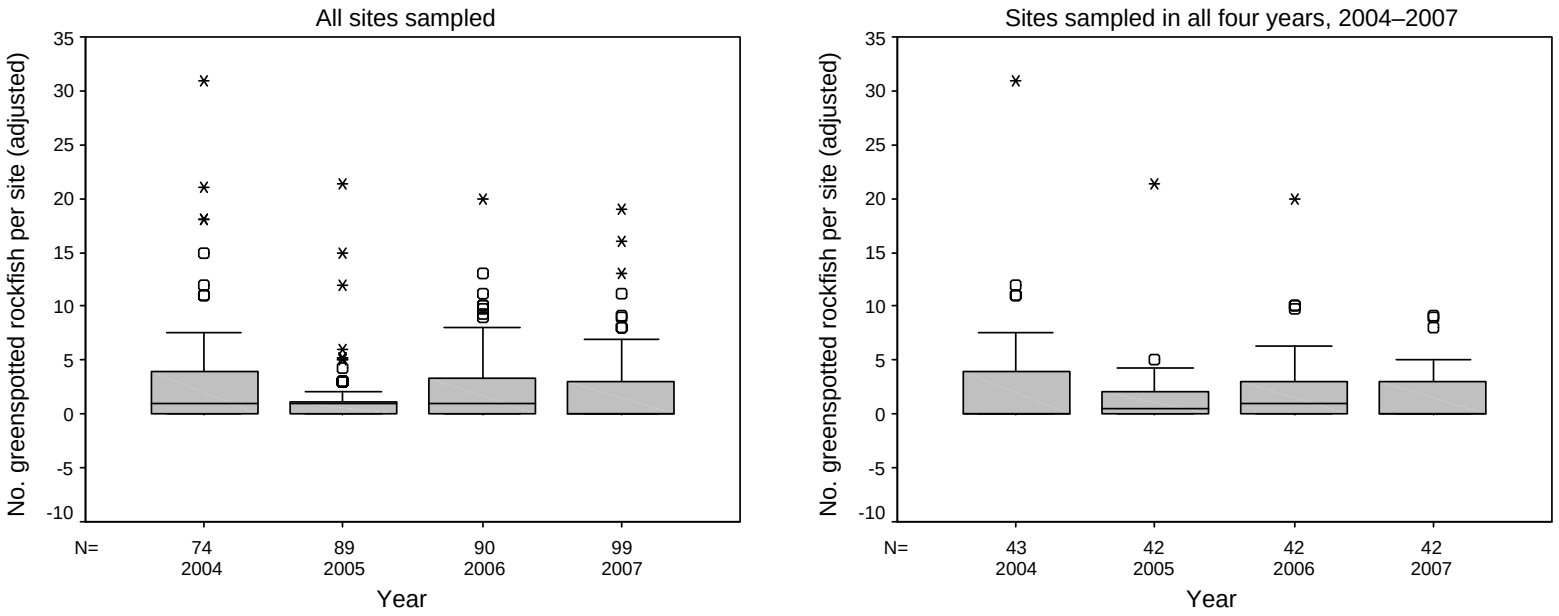

Figure 69. Catch rates for greenspotted rockfish by year during the hook and line survey, 2004–2007. Box plots display interquartile range and median values. Outliers (1.5–3 box lengths) are shown as circles. Extreme values (>3 box lengths) are shown as asterisks.

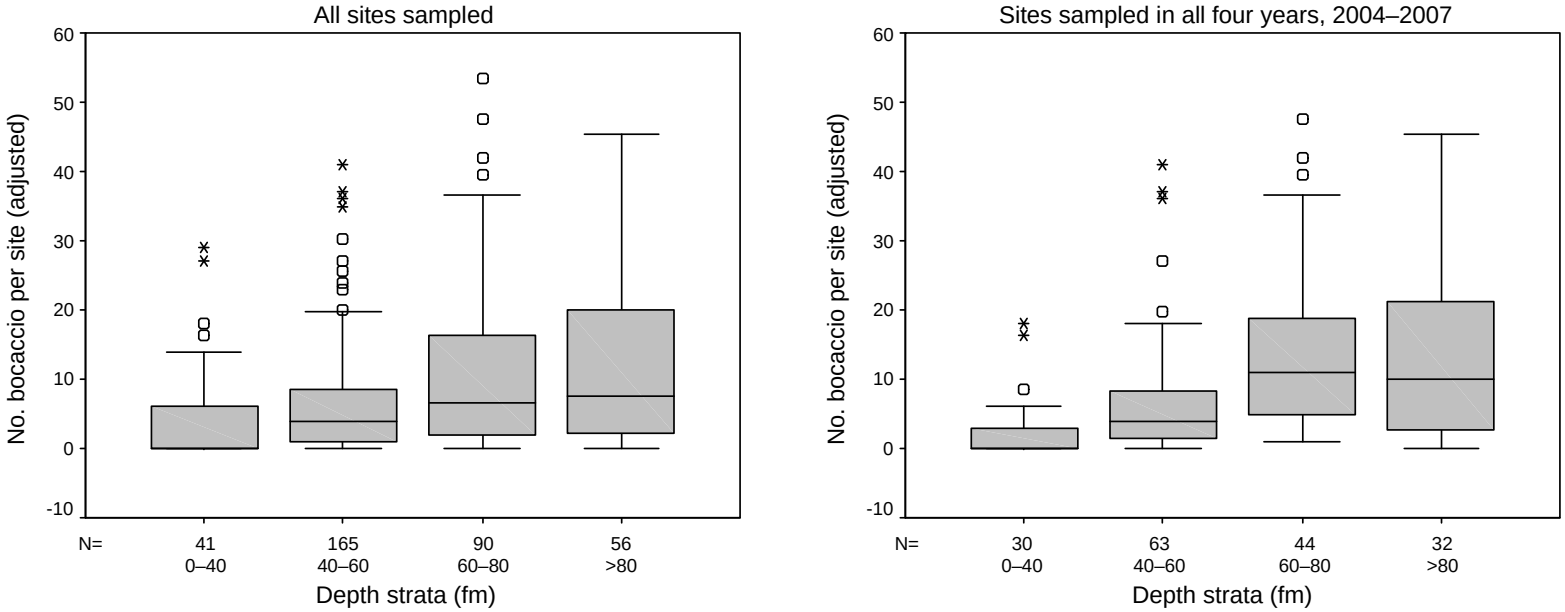

Figure 70. Catch rates for bocaccio by depth strata during the hook and line survey, 2004–2007. Box plots display interquartile range and median values. Outliers (1.5–3 box lengths) are shown as circles. Extreme values (>3 box lengths) are shown as asterisks.

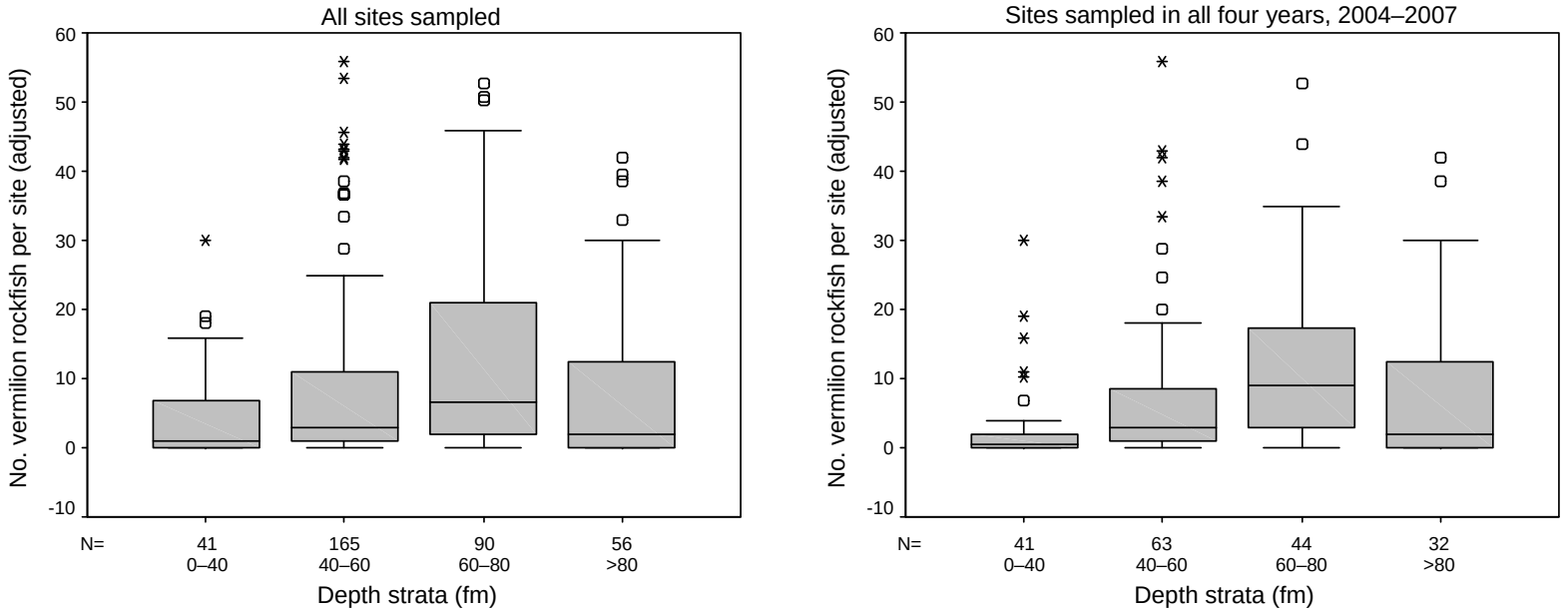

Figure 71. Catch rates for vermilion rockfish by depth strata during the hook and line survey, 2004–2007. Box plots display interquartile range and median values. Outliers (1.5–3 box lengths) are shown as circles. Extreme values (> 3 box lengths) are shown as asterisks.

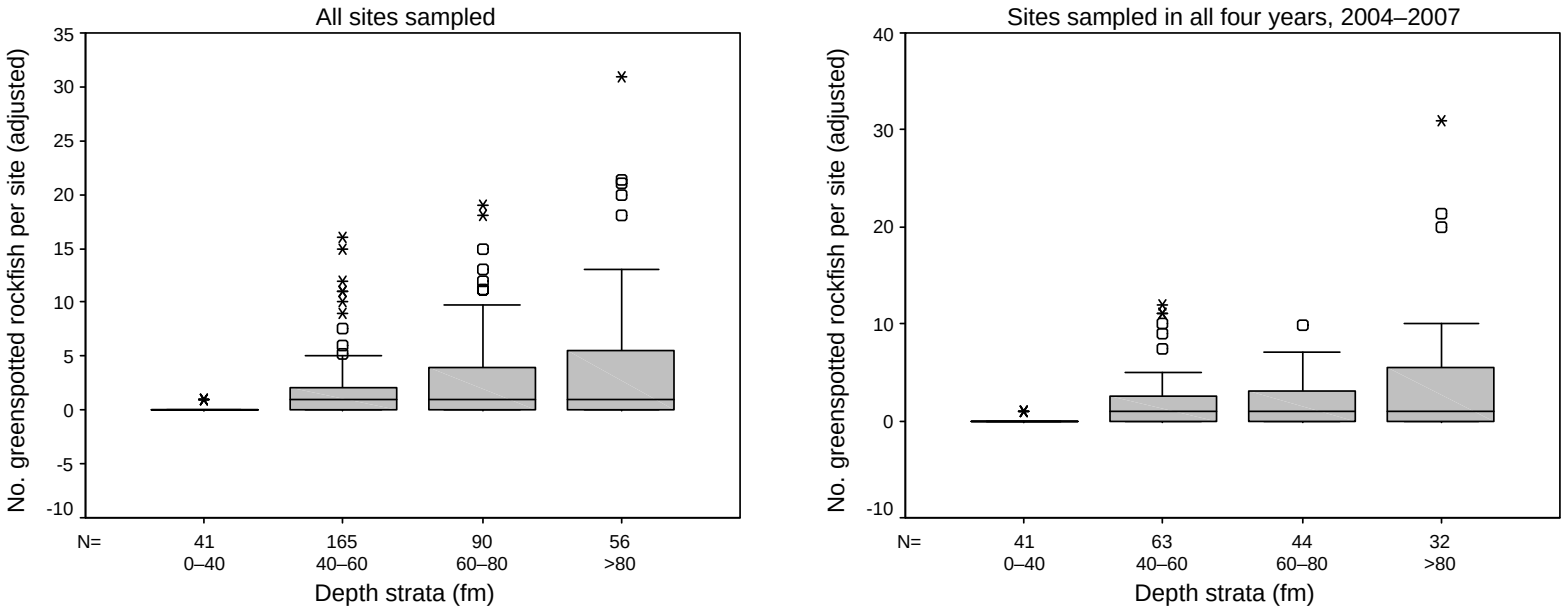

Figure 72. Catch rates for greenspotted rockfish by depth strata during the hook and line survey, 2004–2007. Box plots display interquartile range and median values. Outliers (1.5–3 box lengths) are shown as circles. Extreme values (>3 box lengths) are shown as asterisks.

Distribution

Figures 73 through 84 illustrate catch rates for bocaccio, vermilion rockfish, and greenspotted rockfish as distributed in the 19 sampling area subdivisions described in Figure 1. These figures include data from all sites sampled in a particular year. The bubble plots illustrate differences in relative abundance of a species with regard to its mean in a particular year and, therefore, should not be used to directly compare one species to another or 1 year to another without noting the corresponding changes in symbol definitions.

Although catch rates fluctuate from year to year, the highest relative abundances for both bocaccio and vermilion rockfish are generally observed at the more remote areas including Point Conception, San Miguel Island, Santa Rosa Flats, and 60 Mile Bank (Figures 73 through 80). There are some exceptions, however, where less distant locations can produce high catch rates (e.g., Santa Rosa Island in 2005–2007 for vermilion rockfish, Catalina and San Clemente islands in 2007 for bocaccio, and Nine Mile Bank in most years for both bocaccio and vermilion rockfish).

More remote locations may yield larger catches as they impose a higher fuel and logistical cost on potential anglers and thus have been subjected to less historical and current fishing pressure relative to sites closer to major ports. The inshore sites from San Diego north to Long Beach have generally yielded lower catch rates for all bocaccio, vermilion rockfish, and greenspotted rockfish. The more remote locations also tend to be deeper, and deeper waters are correlated with higher catch rates as seen previously in Figures 70 through 72.

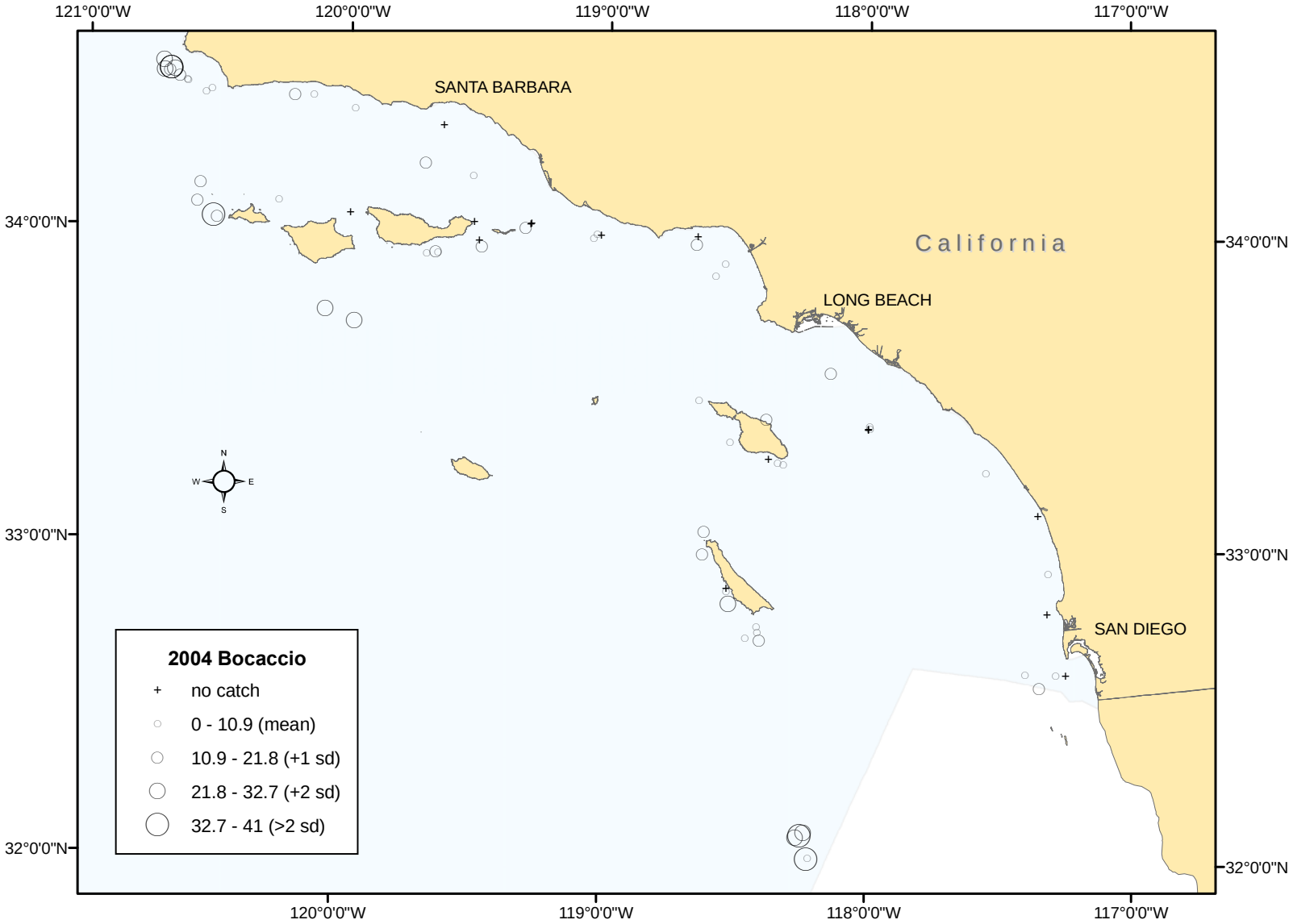

Figure 73. Distribution and relative abundance (number of individuals per site) for bocaccio during the 2004 hook and line survey.

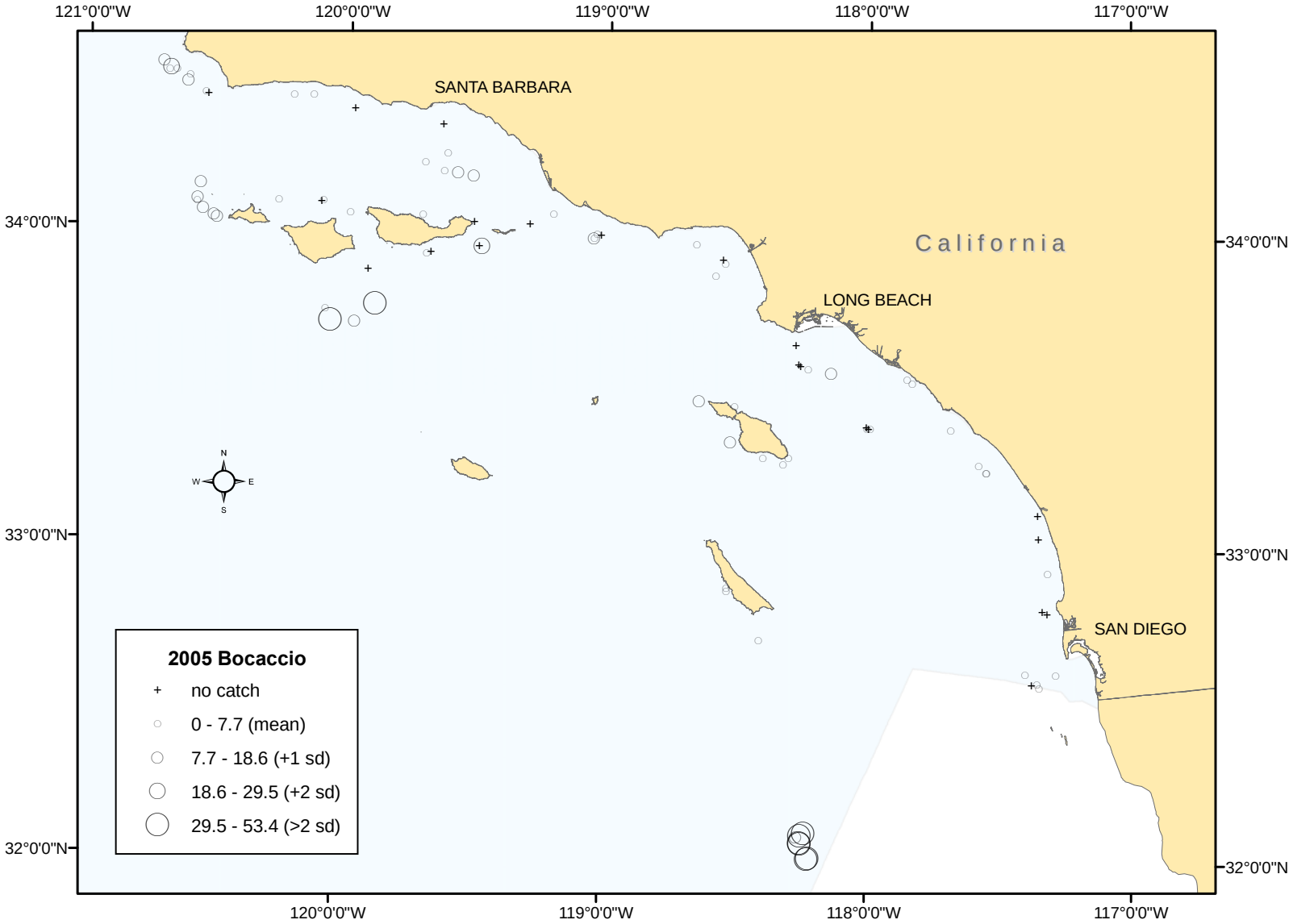

Figure 74. Distribution and relative abundance (number of individuals per site) for bocaccio during the 2005 hook and line survey.

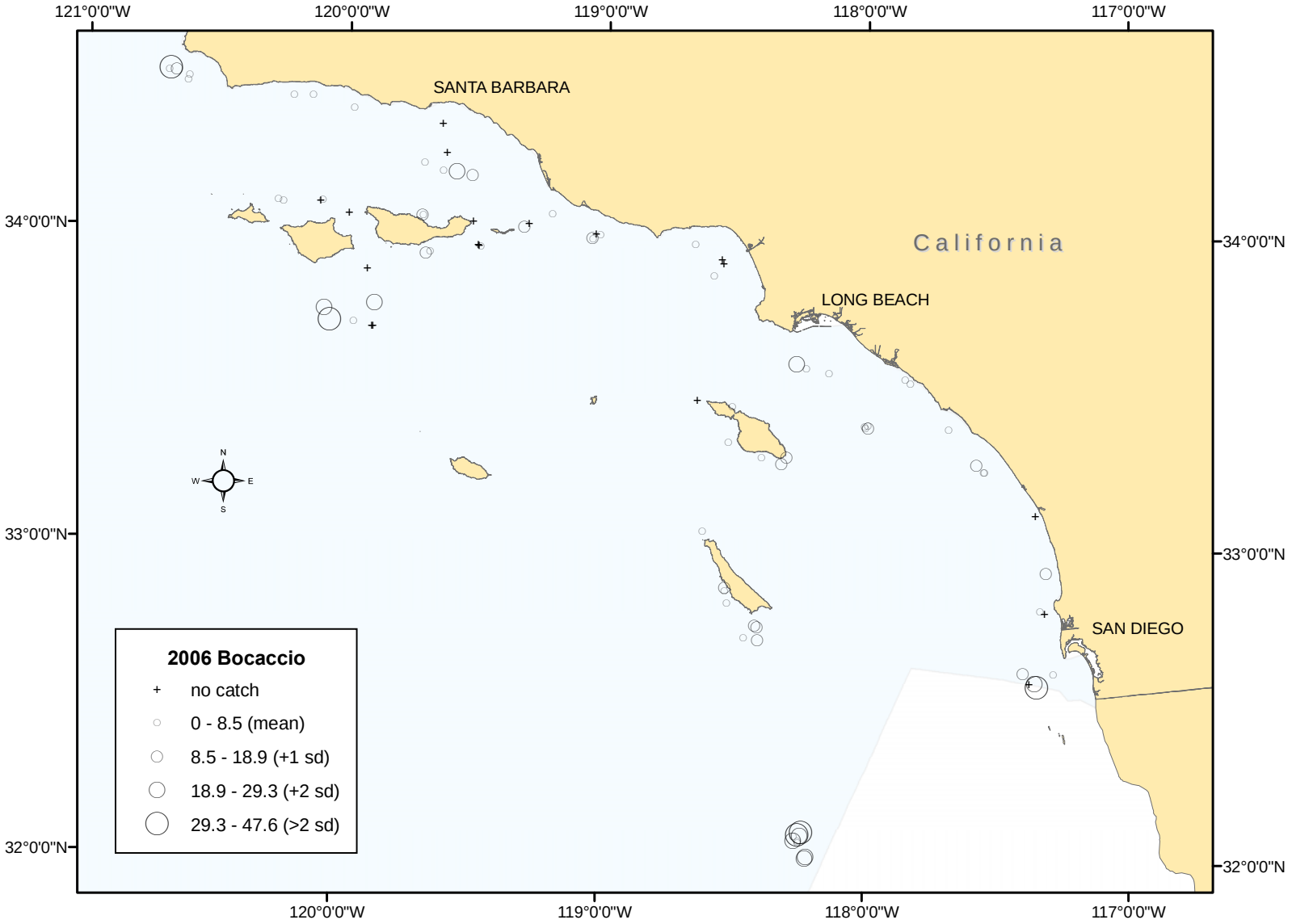

Figure 75. Distribution and relative abundance (number of individuals per site) for bocaccio during the 2006 hook and line survey.

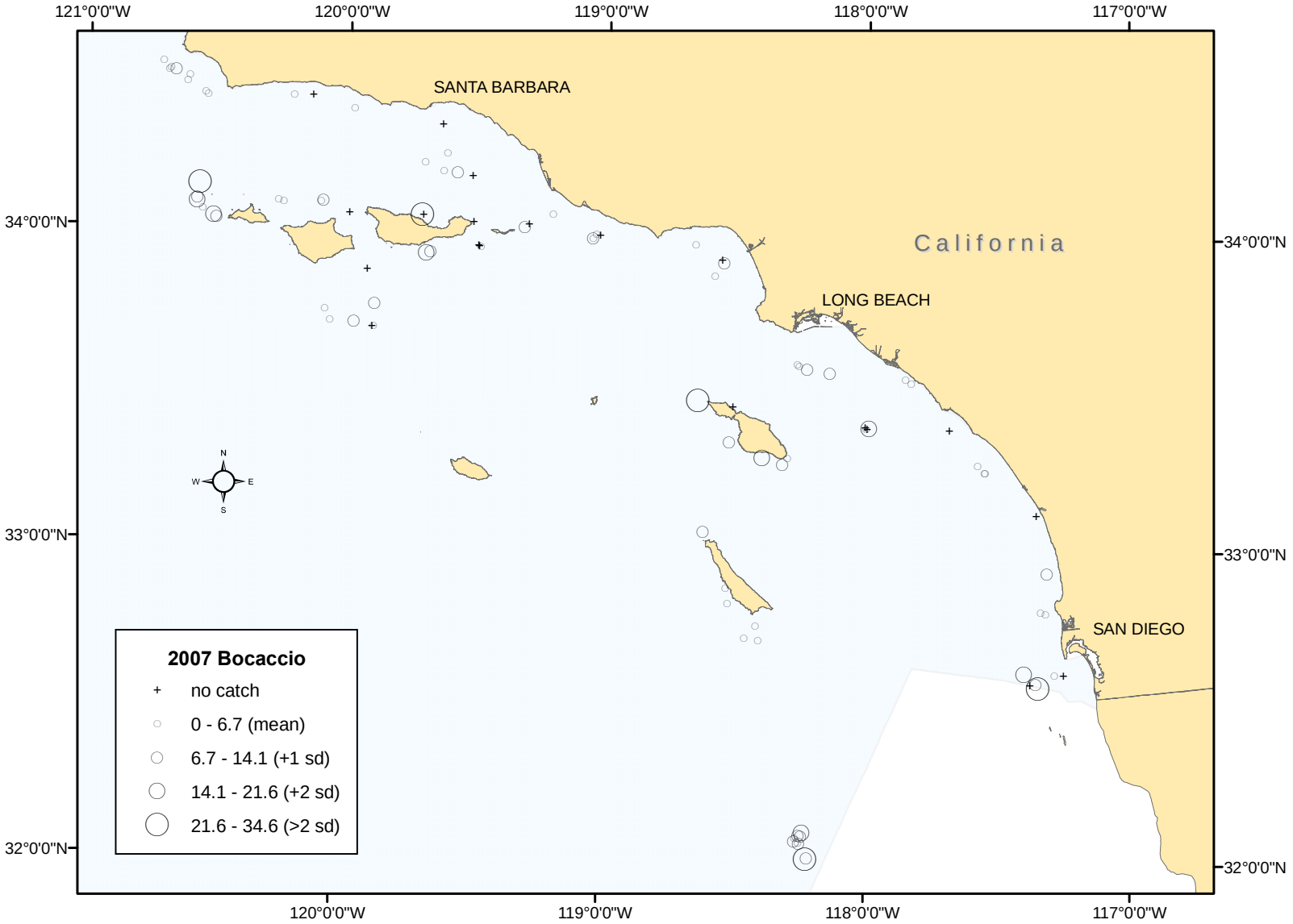

Figure 76. Distribution and relative abundance (number of individuals per site) for bocaccio during the 2007 hook and line survey.

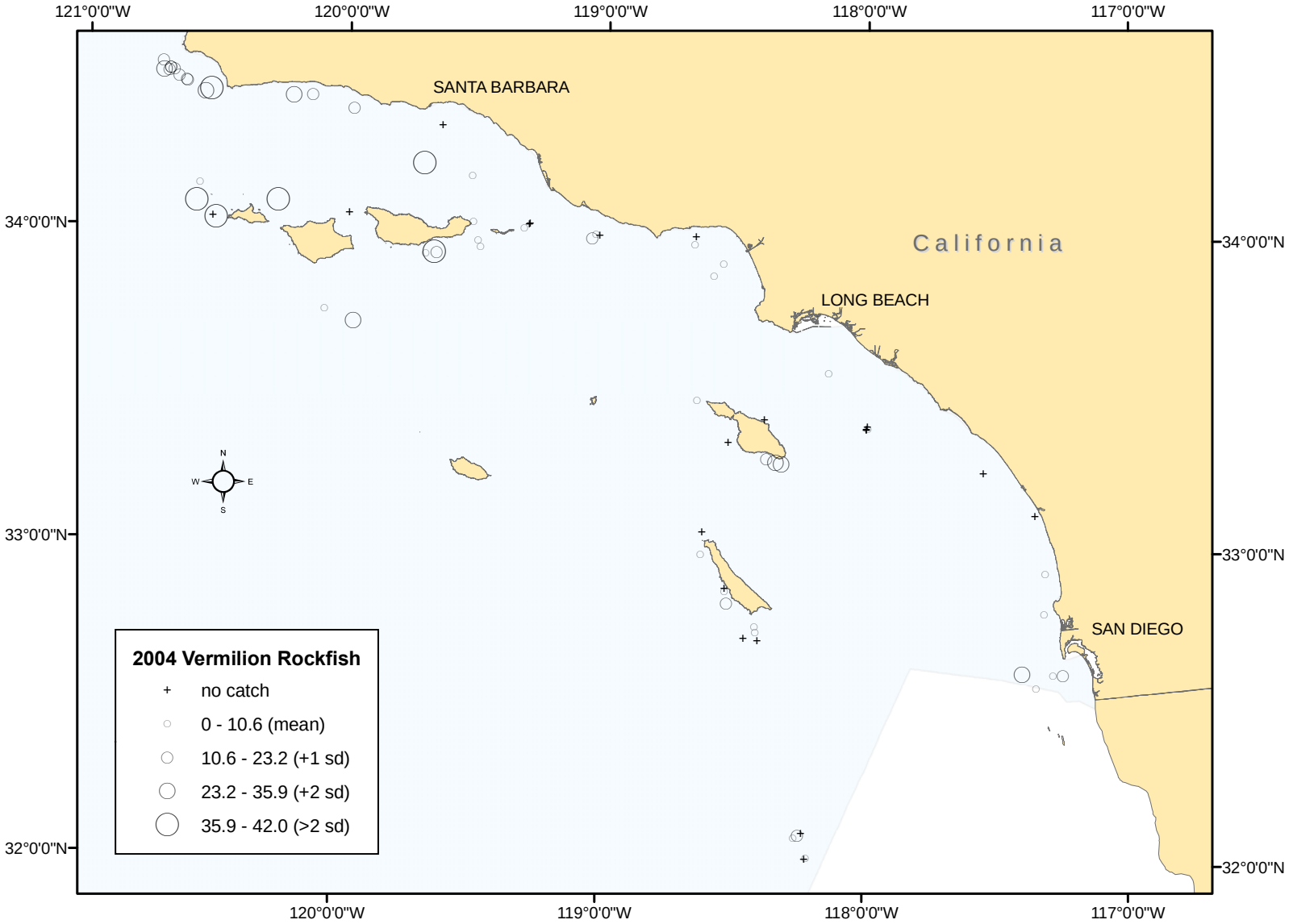

Figure 77. Distribution and relative abundance (number of individuals per site) for vermilion rockfish during the 2004 hook and line survey.

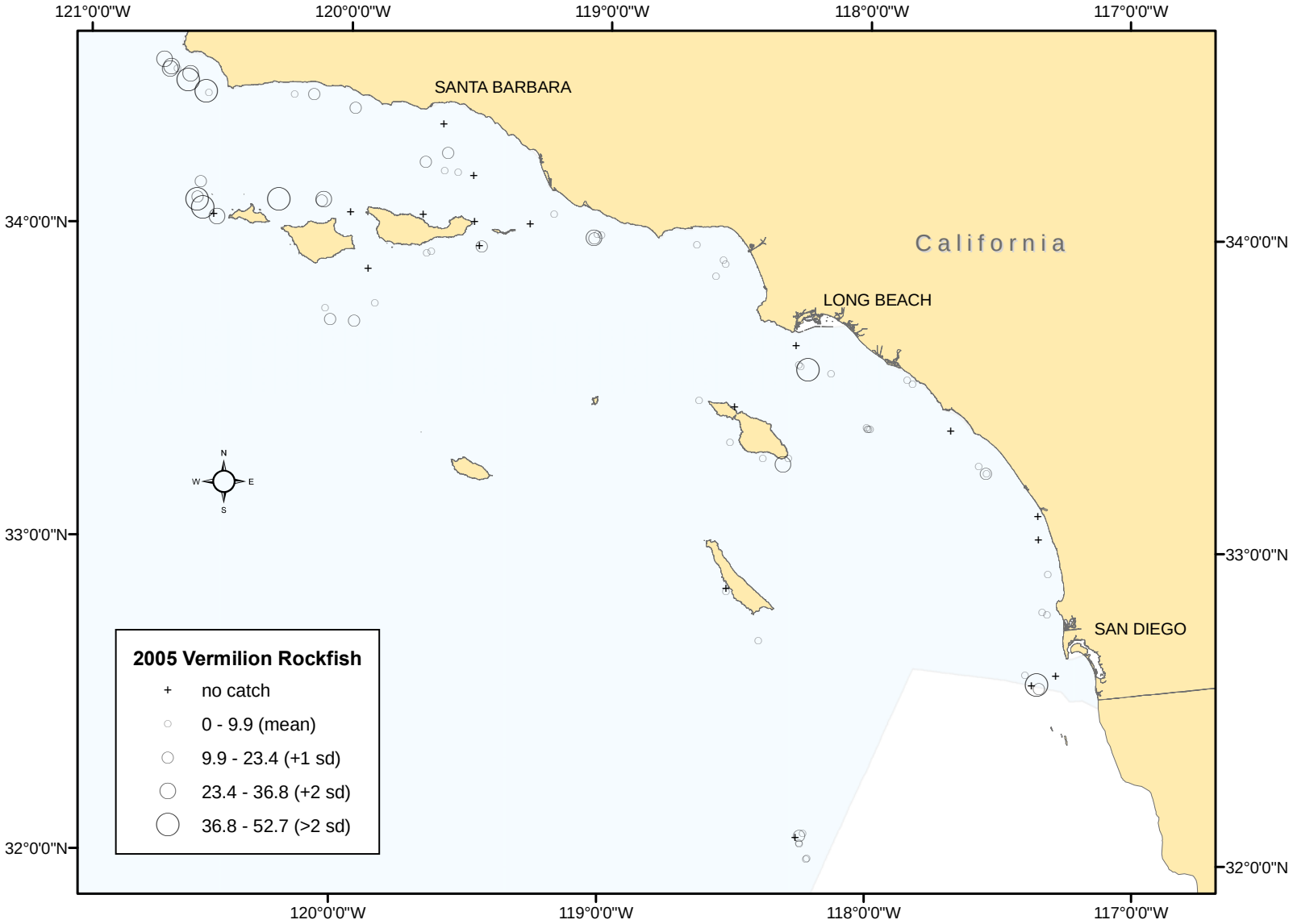

Figure 78. Distribution and relative abundance (number of individuals per site) for vermilion rockfish during the 2005 hook and line survey.

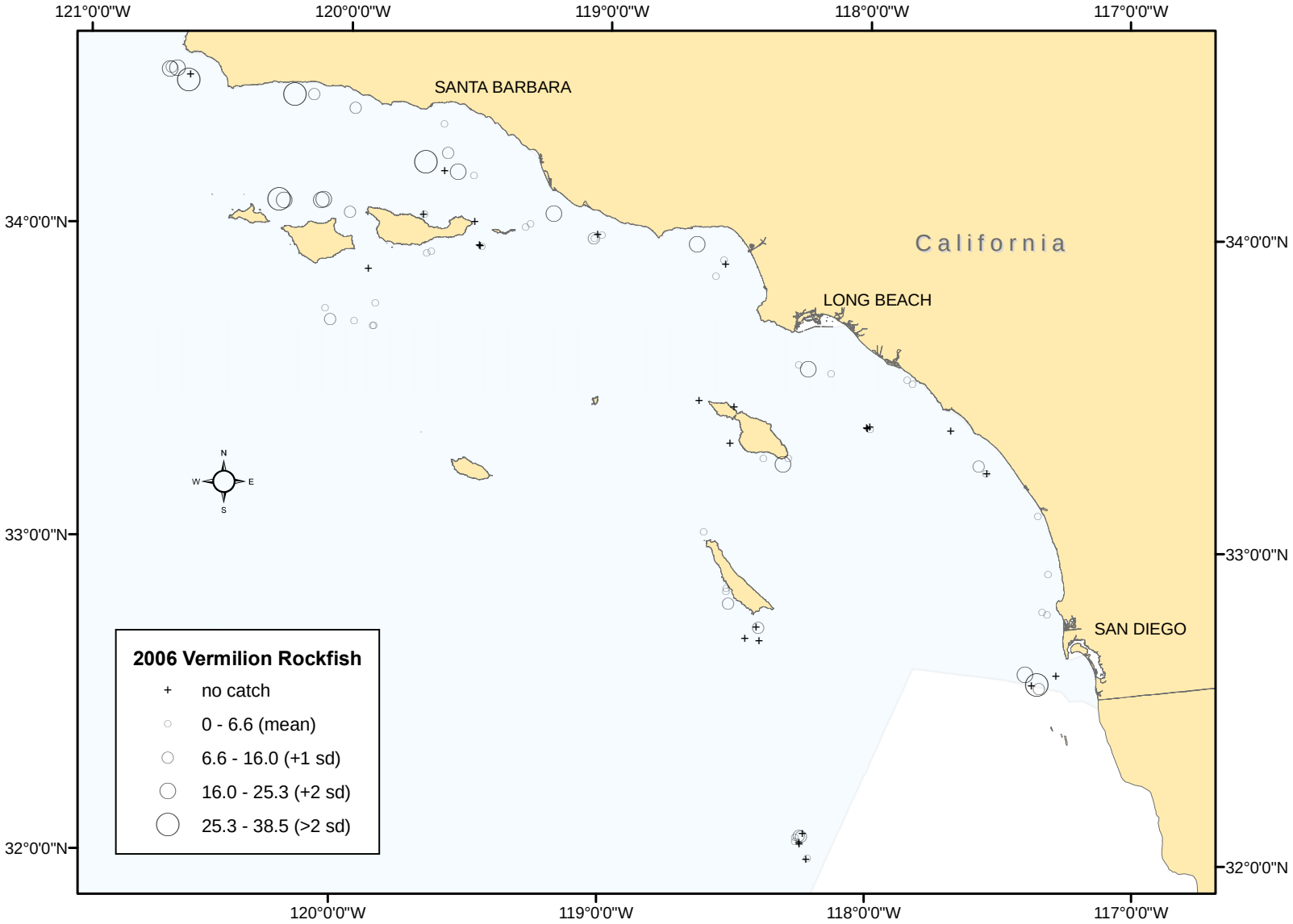

Figure 79. Distribution and relative abundance (number of individuals per site) for vermilion rockfish during the 2006 hook and line survey.

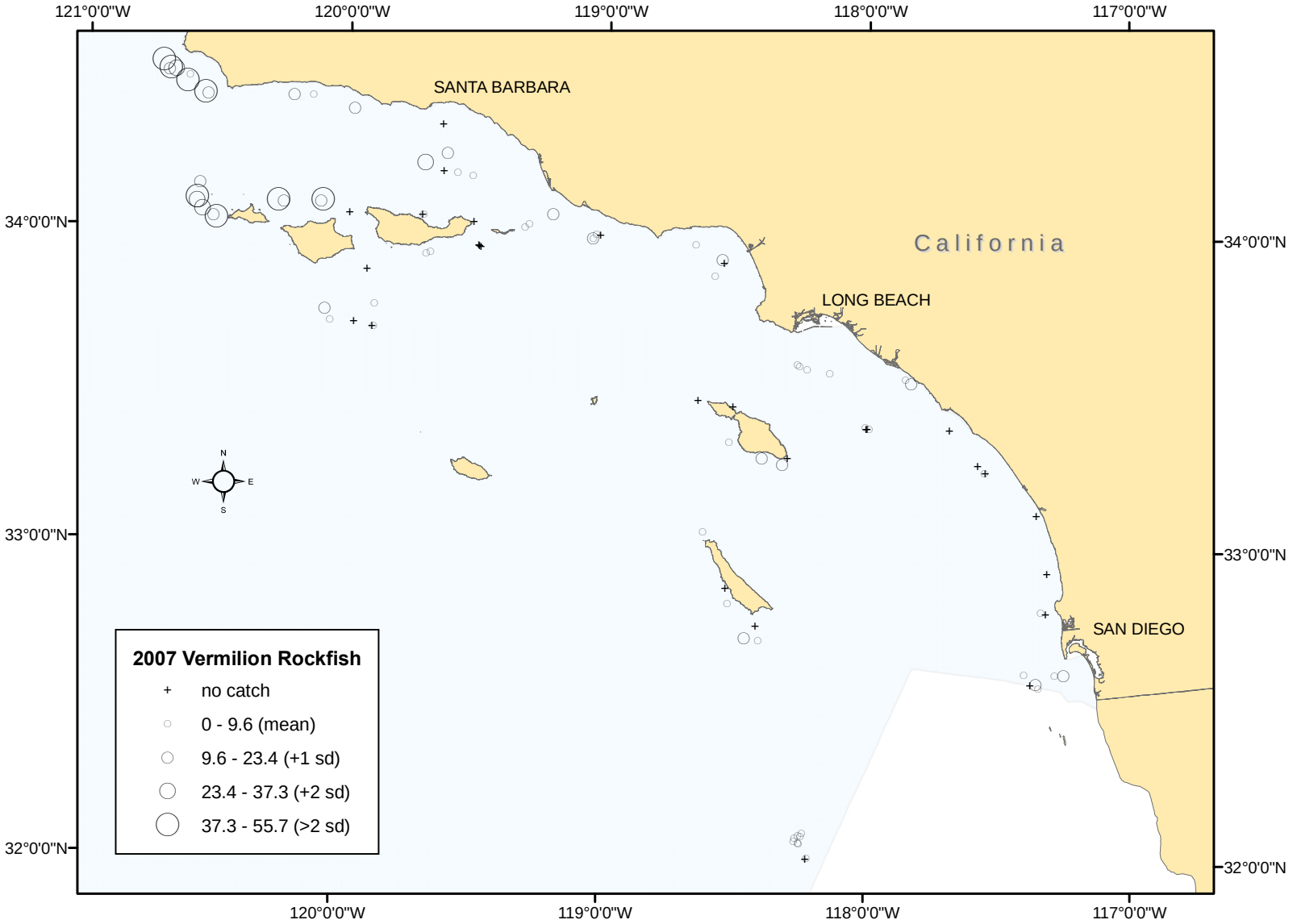

Figure 80. Distribution and relative abundance (number of individuals per site) for vermilion rockfish during the 2007 hook and line survey.

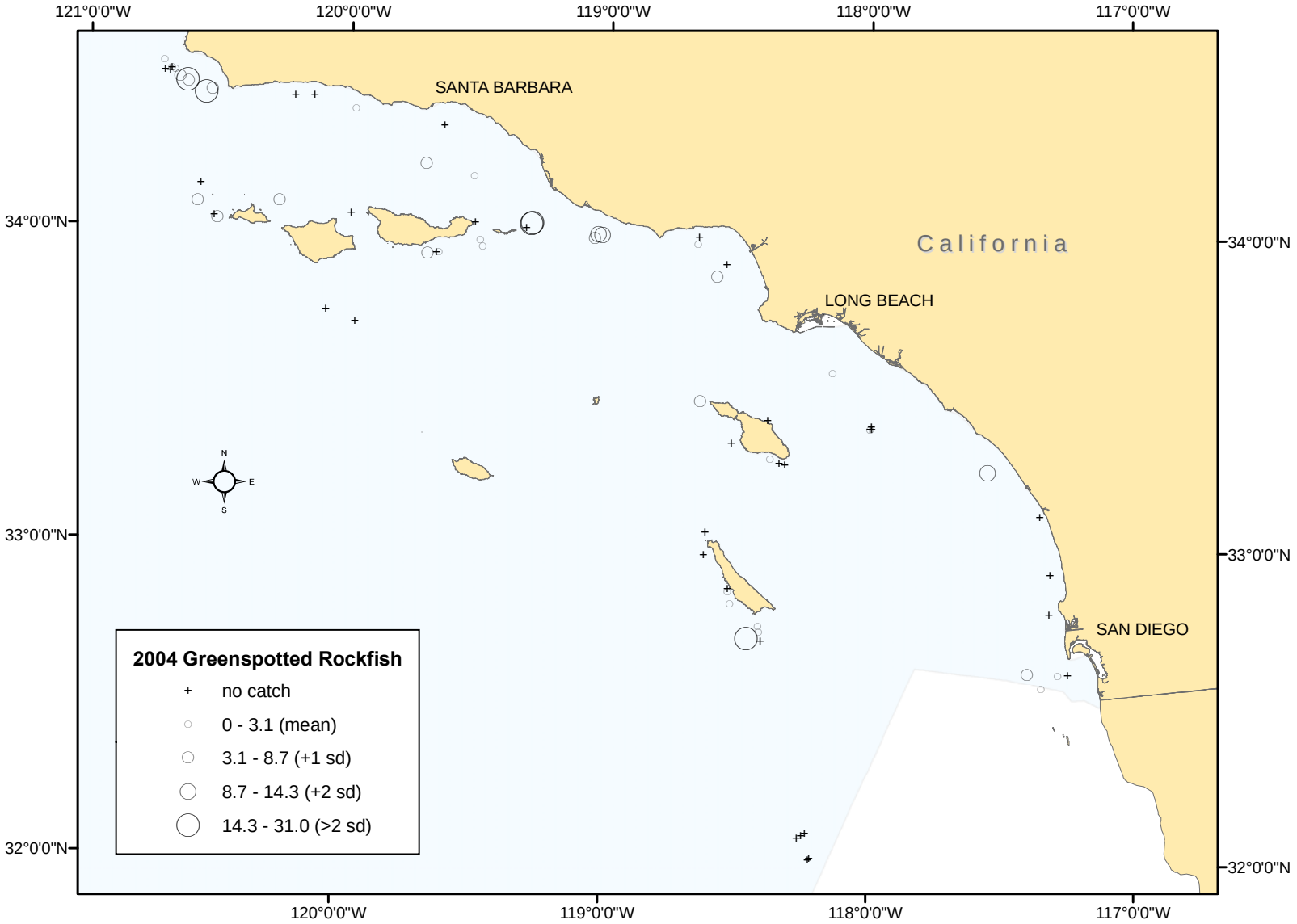

Figure 81. Distribution and relative abundance (number of individuals per site) for greenspotted rockfish during the 2004 hook and line survey.

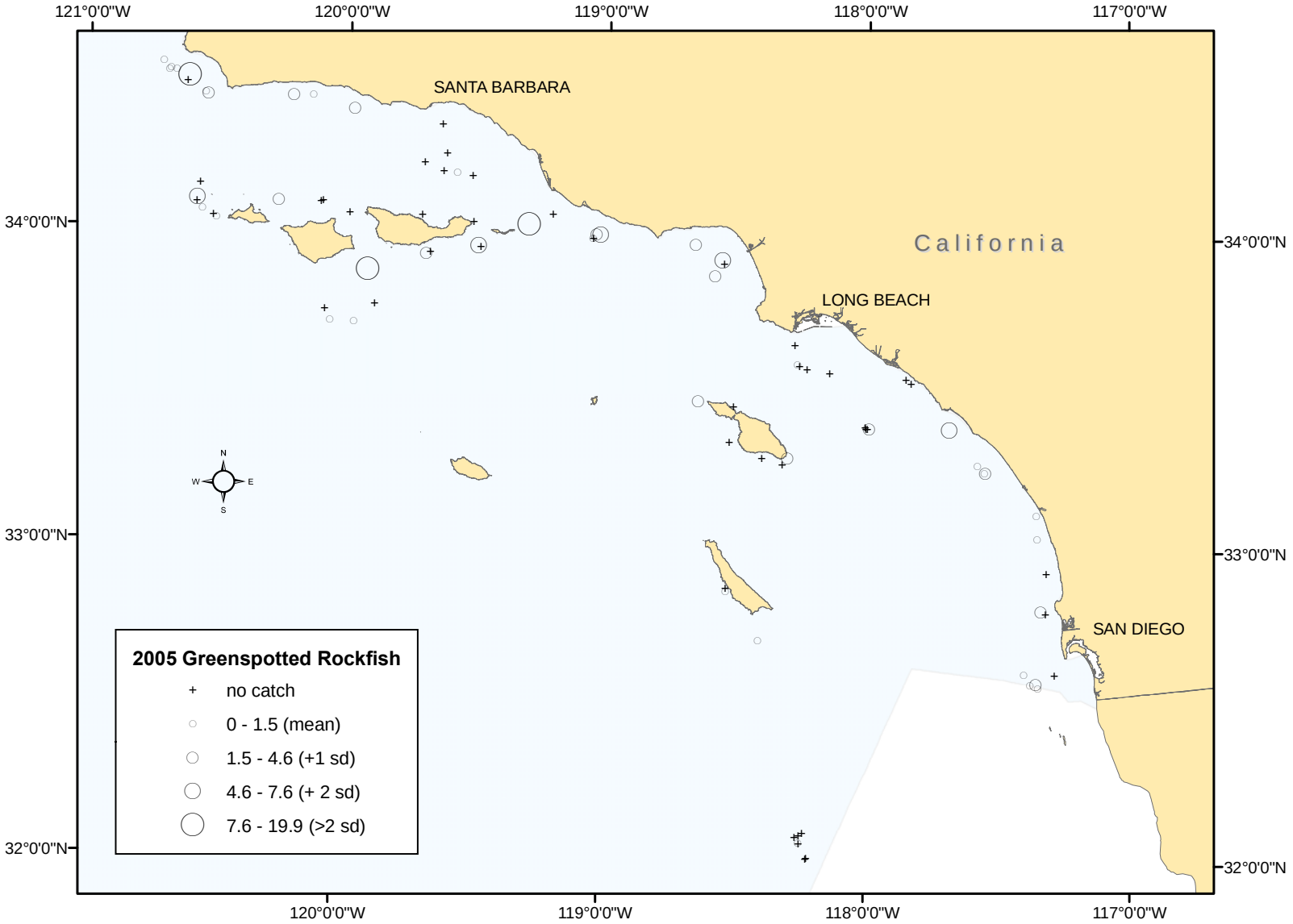

Figure 82. Distribution and relative abundance (number of individuals per site) for greenspotted rockfish during the 2005 hook and line survey.

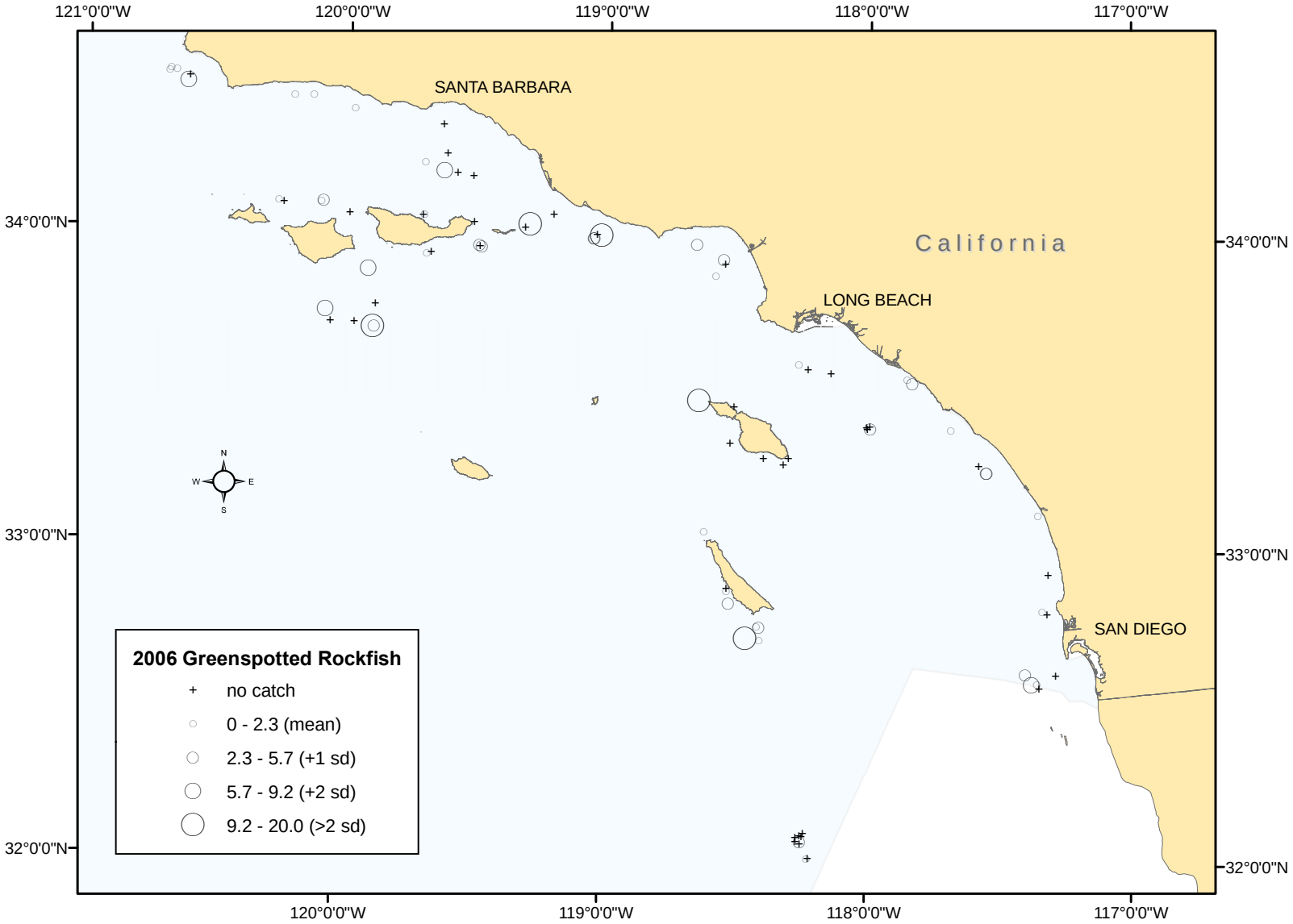

Figure 83. Distribution and relative abundance (number of individuals per site) for greenspotted rockfish during the 2006 hook and line survey.

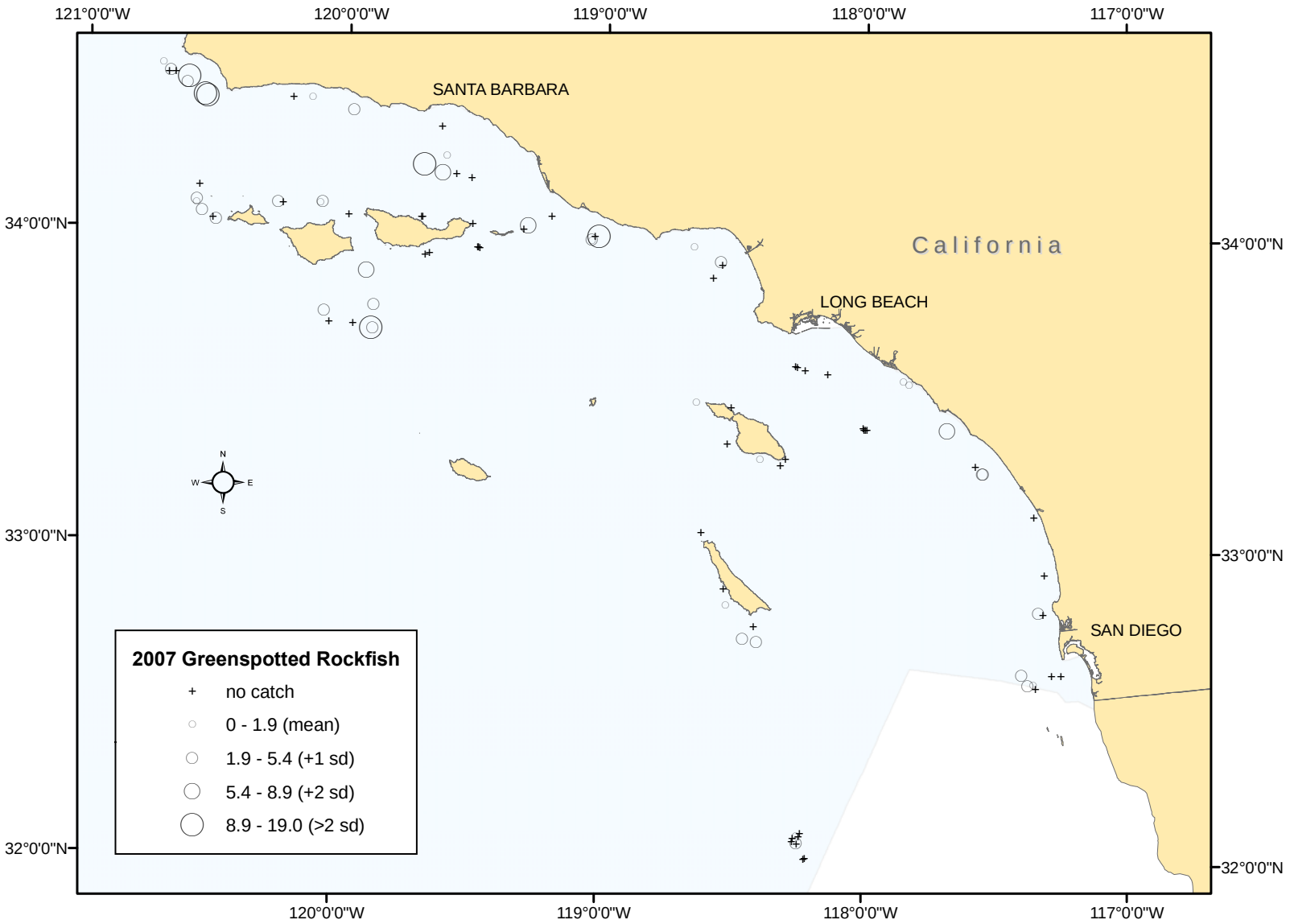

Figure 84. Distribution and relative abundance (number of individuals per site) for greenspotted rockfish during the 2007 hook and line survey.

Catch Modeling

We have developed a method for modeling the catch of species of interest as described in the manuscript, "A fishery-independent estimate of recent population trend for an overfished West Coast groundfish species, bocaccio rockfish (*Sebastes paucispinis*)" (Harms et al. in prep.). In this method, catch is modeled directly at the hook level. Any hook deployed in the survey either captured the species of interest or did not. A Generalized Linear Model (GLM) is used to standardize catch rates of bocaccio to account for important parameters including hook position, angler position, drop number, survey vessel, depth, ocean conditions, site effects, and fishing time. Modeling catch and including effort (in this case, fishing time) in the model as a covariate is a simpler approach than modeling catch rate directly, as the former approach does not presuppose the proportionality of the components of catch rate metrics as is implied in combined measures such as hook-hour or angler-hour (Maunder and Punt 2004, Xiao 2004).

The GLM generated coefficients for each of the covariates including year effect, which is the primary value of interest. These values, computed by the model in logit space, were back-transformed into a yearly index of relative abundance expressed as the probability of a survey hook catching a bocaccio in a particular survey year. The trend demonstrated in the year effect coefficients and the back-transformed index values was similar to that illustrated in the raw catch rates (Figure 67).

Analytic calculation of the variance of the standardized index is not straightforward; therefore, we employ two commonly used numerical procedures: Bayesian integration via Markov chain Monte Carlo and the jackknife. We apply the Bayesian approach for its elegance in propagating the variance of model parameters into the back-transformed index (the quantity of interest). The jackknife method is presented for comparison, mainly because of its frequent application to fishery catch per unit effort data. Confidence intervals around the index values were comparable, if not superior, in precision to those of other indices in the most recent bocaccio assessment (MacCall 2007) in the case of the Bayesian approach, and considerably more precise in the case of the jackknife.

The methods described here are applicable for developing abundance indices for several other species of rockfish in the region including vermilion rockfish,[*] greenspotted rockfish, speckled rockfish, and starry rockfish. These species' highest abundances occur within the SCB, are commonly encountered during the hook and line survey, and are subject to the same fishery-independent data limitations as bocaccio. Although the general method developed here is likely to remain unchanged, the process of variable selection will be revisited for each species. Further, a model-based index for any species using this approach must be recalculated as each new year of data is added, updating the results of the entire time series. Because estimates of coefficients may change, the year-specific values as well as the variance of the index are subject to change.

[*] As previously stated on page 23, the recent delineation of the sunset rockfish, a cryptic form of vermilion rockfish, provides additional complexity for research and management. However, tissue samples from all specimens hooked during the survey have been retained for genetic analyses, providing the ability to generate separate indices for both species.

Gear Saturation

A primary assumption underlying fishery-independent biomass surveys is that observed catch rates vary in proportion to a species' abundance (Somerton and Kikkawa 1995). However, in situations where local abundance exceeds the capacity of a sampling method to accommodate additional catch (e.g., as a net or trap fills to capacity or as fish occupy all the available hooks on a longline), this assumption of proportionality is no longer valid. These instances of gear saturation can make site-to-site and year-to-year catch rate comparisons problematic.

During the 2003 pilot cruise aboard the two sportfishing vessels, each of the three anglers attempted only three drops per site using lines outfitted with three hooks each, allowing for a maximum possible catch per site of 27 fish. A review of the data from the pilot cruises suggested that by increasing the number of drops per angler to five and the number of hooks per line to five to bring the maximum catch per site to 75 fish, the frequency of sites returning saturated gear could be reduced.

Figure 85 provides an overview of which of the survey's 19 sampling areas are most prone to gear saturation. The highest rates of saturated gear were observed at Point Conception, San Miguel Island, Nine Mile Bank, Santa Rosa Island, and Santa Rosa Flats, where fish were caught on at least 50% of the available hooks in at least two of the four sampling years, 2004–2007. The percentage of hooks yielding fish tends to increase with depth, and then level off in the deepest stratum of sites (Figure 86). Figure 87 indicates the frequency with which anglers catch zero through five fish on a particular drop. Zero, one, or two fish were encountered on at least 60% of all angler-drops in all years and on about 70% of all angler-drops since 2005. Angler-drops yielding larger numbers of fish were increasingly infrequent, with a slight upturn in frequency for angler-drops that yielded five fish.

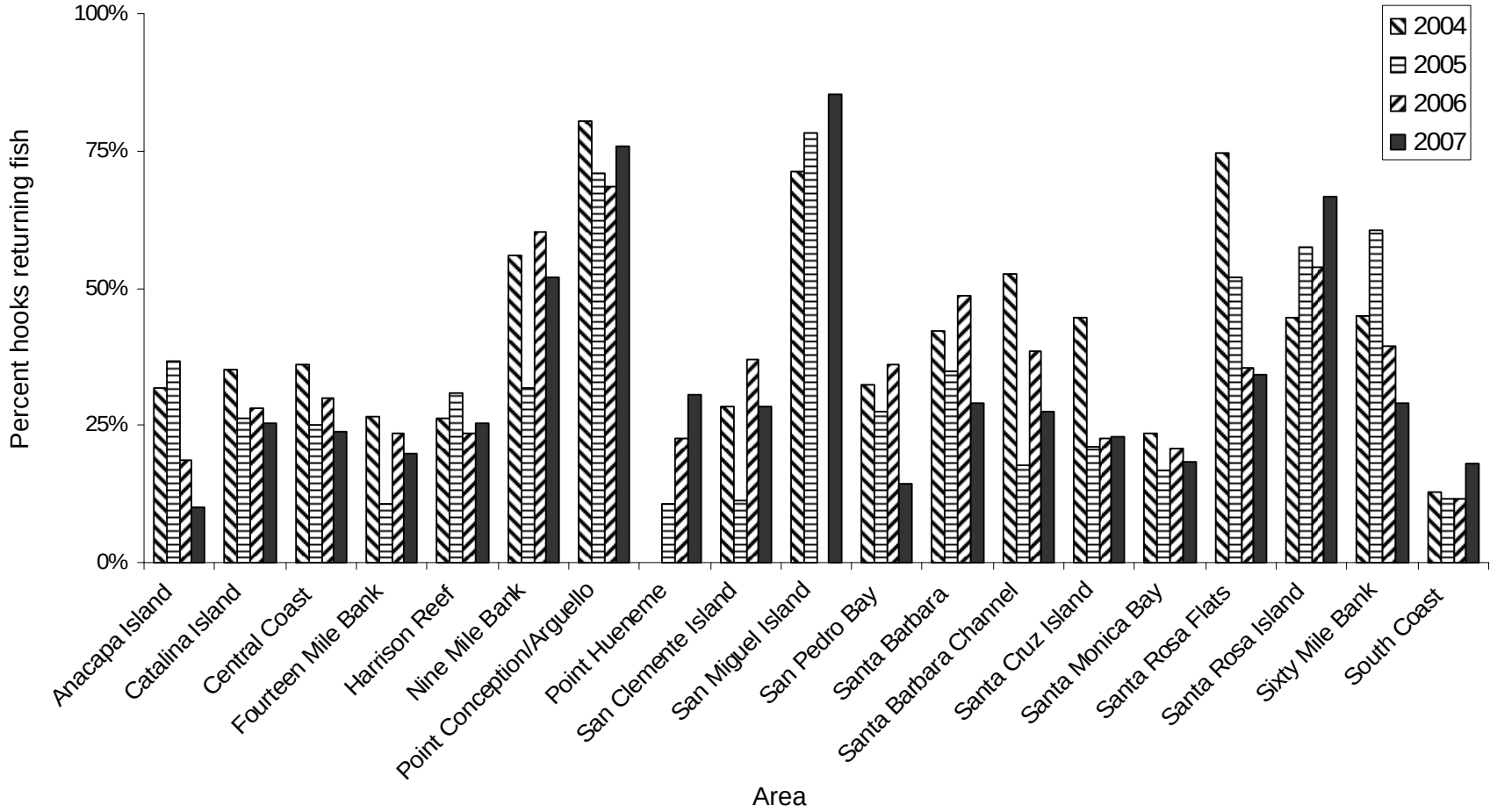

Figure 85. Percentage of total hooks deployed within each of the 19 sampling areas that caught a fish during the hook and line survey, 2004–2007. Point Hueneme has no information for 2004 because it was not sampled that year and, as noted earlier, weather prevented sampling at San Miguel Island in 2006.

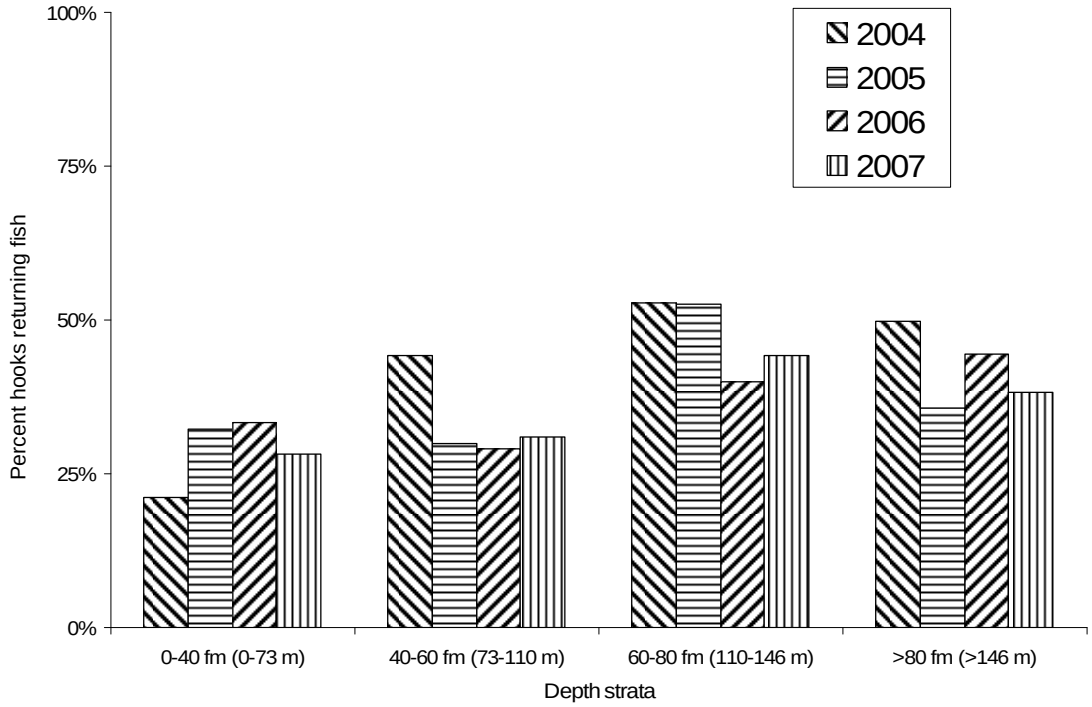

Figure 86. Percentage of total hooks deployed within each of four depth strata that caught a fish during the hook and line survey, 2004–2007.

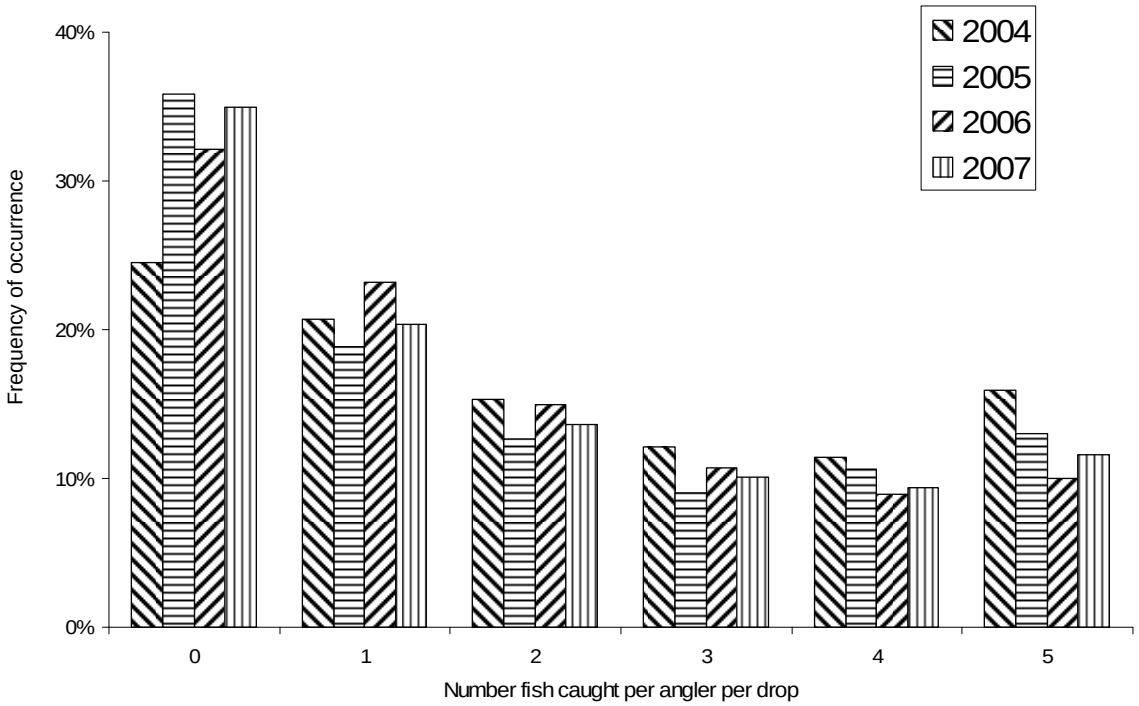

Figure 87. Frequency of occurrence of the number of fish caught per angler per drop during the hook and line survey, 2004–2007. All angler-drops with missing or otherwise invalid hooks were excluded from this analysis.

Glossary

angler. Refers to any of the three deckhands during the act of sampling. Each angler is assigned to one of three positions: bow, midship, or stern.

angler-drop. Refers to the gangion of five hooks used by an individual angler each time it is deployed for sampling. Angler-drop can refer to the actual sampling event in time or be used as a unit of fishing effort.

area. One of 19 geographical subdivisions into which the Southern California Bight is partitioned to ensure sampling coverage throughout the region. Figure 1 provides a detailed illustration of the locations of each area and the sites that are contained therein.

CPFV. For *Commercial Passenger Fishing Vessel.* A vessel that participates in the commercial passenger fishing vessel industry. See also *sportfishing vessel*.

drop. One of five coordinated deployments of the sampling rig during the sampling of a site. A drop begins when all three anglers simultaneously release their sinkers over the side on the captain's command.

dropper loop. A type of knot used during the construction of a sampling rig. A dropper loop cut at its midpoint forms the leader to which a shrimp fly is affixed.

gangion. The entire sampling rig from the first swivel to the sinker. A gangion is a section of 60 lb monofilament fishing line and is comprised of five shrimp flies each attached to a leader, a lead sinker, and a section of 20 lb or 30 lb monofilament that attaches the sinker to the rest of the gangion. Figure 3 provides a schematic of a gangion's components.

kirbed. A hook whose point is slightly offset to one side relative to the hook's shank.

leader (or tippet). An approximately 6 inch length of monofilament to which a shrimp fly is affixed. Each gangion includes five leaders and shrimp flies.

shrimp fly. A hook that includes colored bristles usually attached through the hook's eye that extend down its shank and partially obscure the bend and point of the hook and may also serve to mimic the appearance of potential prey items. Shrimp flies are also baited with squid strips during hook and line survey operations.

sinker (or weight). Lead cast into a cuboid shape with rounded corners to provide the ballast necessary to quickly sink the gangion to the seafloor. The sinkers used in the hook and line survey weigh from 1 to 5 lb in 1-lb increments.

site. Any of the approximately 100 fixed stations that are scheduled to be sampled annually during the hook and line survey. A site's location is defined by GPS coordinates and a 100-yard radius around that position is provided inside which all five sampling drops must be initiated.

SCB. For *Southern California Bight*. A region from Point Conception in the north to the U.S.-Mexico border in the south. It includes coastal southern California, the Channel Islands, Catalina and San Clemente islands, and the local portion of the Pacific Ocean.

sportfishing vessel. Also called a "party boat." Any vessel of the CPFV industry that specializes in transporting groups of 10–40 people to fishing grounds for relatively short trips (1–5 days). These vessels are typically of fiberglass or wood construction, 50–90 feet in length, and often have limited galley capacity and other amenities characteristic of longer-endurance vessels.

References

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Appendix A: Site Summary

Table A-1 provides detail on specific habitat characteristics of all sites visited during the hook and line survey, 2004–2007. This information is compiled to ensure that the survey is targeting a range of hard-bottom habitats that represent the variety of seafloor types.

The locations for the majority of sample sites were provided through communication with sport and commercial fishermen throughout the region. There have been instances where, due to clerical or other errors, reported sites have not been successfully located by the survey vessels or no target habitat was found at the reported site's coordinates. Some sites have been removed during the course of the survey when habitat observations or other indications suggest the site contains very little or no hard-bottom habitat.

The following information will be useful in interpreting Table A-1. "Gen. area" in the table refers to the 19 general sampling areas illustrated in Figure 1. They are abbreviated as follows:

14MB = Fourteen Mile Bank
60MB = Sixty Mile Bank
9MB = Nine Mile Bank
Ana = Anacapa Island
Cat = Catalina Island
CenCo = Central Coast
Clem = San Clemente Island
Conc = Point Conception
Harr = Harrison Reef
Hue = Point Hueneme
Miguel = San Miguel Island
SB = Santa Barbara
SBC = Santa Barbara Channel
SC = Santa Cruz Island
SMBay = Santa Monica Bay
SoCo = South Coast
SPBay = San Pedro Bay
SR = Santa Rosa Island
SRFlats = Santa Rosa Flats

The "Habitat notes" columns of Table A-1 provide observations on the type of habitat present at each site from the captain's interpretation of the vessel's echosounder readings as well as the initials of the vessel (AG = FV *Aggressor*, MI = FV *Mirage*) that sampled the site. The low and high depths of any drop made at a site (in the depth range columns) provide a de facto depth range for a site. The difference in meters between those two observations (in the Δ column) provides a proxy for the site's bathymetric relief. The distance of the site to the nearest mainland fishing port (Santa Barbara, Ventura, Oxnard, Port Hueneme, San Pedro, Long Beach, Newport Beach, Dana Point, Mission Beach, or San Diego) is included as a proxy for current and historical fishing pressure with the assumption that sites closer to ports are more likely to be targeted by the half-day, three-fourth-day, and full-day sportfishing charter fleets.

The mean distance of each drop to the calculated centroid of all drops that have been conducted at a site is a proxy for the amount of area of prime habitat within a site's 100-yard radius. If vessel captains consistently target a relatively small area within the site's radius, the distance of each drop to the centroid of all drops in all years at that site will remain small. However, if captains are targeting multiple discrete areas of the seafloor or if there is a large amount of prime habitat throughout the radius, the distance of each drop to the centroid of all drops will tend to be larger.

The table also indicates in how many years the site has been sampled and whether the survey's underwater video sled collected habitat footage. This camera system was developed to collect real-time video imagery of the habitat and fish aggregations at survey sites for positive identification of habitat types and eventual analyses to correlate species catch rates with specific habitat types. During the survey, hook and line sampling takes priority and camera sled drops are conducted on an ad hoc basis, generally after daylight sampling hours have concluded. At the conclusion of the 2007 survey, the sled had been dropped at approximately 31 sites.

The final column "Notes" in Table A-1 indicates whether a site is active, inactive, or has been removed due to lack of target habitat. This column also provides information on instances when a site was not sampled due to weather or other reasons.

Table A-1. Summary of habitat and other information for all sites sampled during the hook and line survey, 2004–2007.

Site name	Gen. area	Habitat notes				Depth range of all drops (m)			Nearest port (km)	Mean dist. (m) to centroid	Years sam-pled	Camera drop?	Notes
		2004	2005	2006	2007	Low	High	Δ					
2	14MB	Bump that comes up to 128 m, good rocky area (MI)	No comments	No comments	No comments	128.1	131.8	3.7	23.9	52.2	4	Y	Active fixed site
5	14MB	Edge of wall of high spot (MI)	Not sampled	Not sampled	Not sampled	126.3	146.4	20.1	26.5	46.7	1	N	Inactive site
6	14MB	Hard spot/shelf on the edge (MI)	Not sampled	No comments	Not sampled	170.2	183.7	13.5	22.9	34.1	2	N	Active alternate site
11	14MB	Not sampled	Rock on edge of high spot (MI)	Large rocky area (AG)	No comments	106.1	122.2	16.1	23.9	39.8	3	N	Active fixed site
15	14MB	Not sampled	Hard, med. size rock (MI)	No comments	No comments	119.0	125.9	6.9	24.2	41.5	3	N	Active fixed site
16	14MB	High spot on bank, up and down high spot (MI)	One of the bank's high spots (MI)	Not sampled	No comments	98.8	106.1	7.3	24.1	40.1	3	N	Active fixed site
17	60MB	Steep drop off (AG)	Steep ledge (AG)	No comments	Big rock on the edge (MI)	157.4	197.6	40.2	114.0	33.7	4	N	Active fixed site
18	60MB	Big pile of rocks, no pinnacles (AG)	≈11 m pinnacle on the edge (MI)	Big rock (MI)	No comments	133.2	143.7	10.5	115.4	37.1	4	Y	Active fixed site
21	60MB	Not sampled	Not sampled	Big rock (MI)	Big rock (MI)	129.6	141.5	11.9	115.1	32.3	2	N	Active alternate site
22	60MB	Flat, featureless rocky bottom (AG)	Rocky (AG)	Fairly level, some rocks; rocky area (AG)	Rocky bottom, flat and level (AG)	98.3	117.7	19.4	117.1	51.4	4	Y	Active fixed site
24	60MB	Not sampled	Not sampled	No comments	Sheer, hard edge (MI)	159.2	194.2	35.0	118.0	42.3	2	N	Active fixed site
27	60MB	Not sampled	Rocky (AG)	Not sampled	Rocky and level (AG)	123.3	130.7	7.4	116.9	30.3	3	Y	Active fixed site

Table A-1 continued. Summary of habitat and other information for all sites sampled during the hook and line survey, 2004–2007.

Site name	Gen. area	Habitat notes 2004	2005	2006	2007	Depth range of all drops (m) Low	High	Δ	Nearest port (km)	Mean dist. (m) to centroid	Years sam-pled	Camera drop?	Notes
29	60MB	Giant rock pinnacle (AG)	Edge of the high spot (MI)	No comments	Hard slope (AG)	119.0	159.9	40.9	117.8	52.8	4	Y	Active fixed site
31	60MB	Steep edge (AG)	Rocky ledge (AG)	No comments	Rocky edge (MI)	137.3	154.6	17.3	118.4	31.7	4	N	Active fixed site
33	9MB	Big rock w/ hard bottom around; reefy area w/big rock (MI)	Big rock and rocky area (AG)	No comments	Rock on the edge (MI)	128.1	133.6	5.5	18.1	26.7	4	N	Active fixed site
35	9MB	Not sampled	Rocky hard slope (AG)	No comments	Hard slope (AG)	138.2	148.4	10.2	16.3	20.1	3	N	Active fixed site
36	9MB	Reef ≈ 1/8 mi long w/some rocks that stick up	Big rock, not much else (AG)	Big rock (MI)	Big pile of rocks (AG)	116.8	129.4	12.6	16.7	33.9	4	N	Active fixed site
40	Ana	Hard slope, but not necessarily rocky, rock outcropping ≈75 m from mark (AG)	Not sampled	Not sampled	Not sampled	161.0	168.4	7.4	14.4	35.6	1	N	Inactive site
43	Ana	Rocky slope (MI)	Rocky edge (MI)	No comments	No comments	162.9	173.9	11.0	14.2	52.2	4	N	Active fixed site
45	Ana	Large, rocky area, good habitat (AG)	Not sampled	No comments	Rocky, complex bottom (AG)	94.4	103.9	9.5	16.3	42.3	3	N	Active fixed site
48	Ana	No comments	Big rocks, reef (MI)	Rocky slope (AG)	No comments	125.7	138.0	12.3	32.6	33.7	4	N	Active fixed site
52	Cat	Big rock (AG)	Very big rock, huge pinnacle 18–27 m off bottom (AG)	Big pinnacle (AG)	Very big rock (AG)	173.9	194.0	20.1	44.6	26.5	4	Y	Active fixed site

Table A-1 continued. Summary of habitat and other information for all sites sampled during the hook and line survey, 2004–2007.

Site name	Gen. area	Habitat notes				Depth range of all drops (m)			Nearest port (km)	Mean dist. (m) to centroid	Years sam-pled	Camera drop?	Notes
		2004	2005	2006	2007	Low	High	Δ					
54	Cat	Not sampled	Big rock that comes up (AG)	No comments	Rock pile (AG)	55.8	76.9	21.1	36.4	50.5	3	Y	Active fixed site
59	Cat	One big pinnacle that comes up to 71 m (MI)	Not sampled	Not sampled	Not sampled	73.2	78.7	5.5	34.4	25.1	1	N	Active alternate site
62	Cat	Jagged hard bottom	Extremely rocky (AG)	No comments	Very rocky (AG)	59.8	74.8	15.0	72.5	45.6	4	N	Active fixed site
66	Cat	Not sampled	Big rock (MI)	No comments	Rocky (AG)	75.8	98.8	23.0	50.5	33.9	3	N	Active fixed site
68	Cat	Not sampled	Big reef, rocky (MI)	Small rock (AG)	Little patch of hard bottom (AG)	75.8	81.6	5.8	59.6	48.8	3	N	Active fixed site
71	Cat	No comments	Not sampled	Not sampled	Not sampled	63.1	77.6	14.5	59.6	22.9	1	Y	Inactive site
77	Cat	Hard edge (MI)	Not sampled	Not sampled	Not sampled	142.7	142.7	0.0	54.6	9.4	1	N	Active alternate site
79	Cat	Hard, steep slope (AG)	Hard edge, steep edge or canyon (MI)	Steep wall, edge (MI)	No comments	147.3	165.1	17.8	53.3	34.6	4	N	Active fixed site
84	CenCo	Not sampled	Hard slope (AG)	Hard edge (MI)	Hard slope (AG)	93.3	107.2	13.9	6.8	37.5	3	N	Active fixed site
89	CenCo	Some rocks, hard spots on edge of canyon, may be mud surrounding (MI)	Removed	Removed	Removed	194.0	201.3	7.3	n/a	n/a	1	N	Removed after 2004 due to nontarget habitat
91	CenCo	No habitat found; removed	Removed	Removed	Removed	n/a	n/a	n/a	n/a	n/a	0	N	Removed in 2004 due to nontarget habitat
92	CenCo	Hard spot on the edge (MI)	No comments	Hard slope, no real structure (AG)	Hard bottom, slope (AG)	85.5	103.0	17.5	14.8	45.0	4	N	Active fixed site

Table A-1 continued. Summary of habitat and other information for all sites sampled during the hook and line survey, 2004–2007.

Site name	Gen. area	Habitat notes 2004	2005	2006	2007	Depth range of all drops (m) Low	High	Δ	Nearest port (km)	Mean dist. (m) to centroid	Years sam-pled	Camera drop?	Notes
97	Clem	Big area of rock (AG)	Not sampled	Rocky area (AG)	No comments	70.1	86.9	16.8	90.1	37.4	2	N	Active fixed site
101	Clem	Flat and rocky (AG)	Not sampled	Not sampled	Not sampled	63.9	84.5	20.6	99.7	49.6	1	N	Inactive site
109	Clem	Shallow (AG)	Rocks (AG)	No comments	No comments	41.7	45.8	4.1	111.6	52.4	4	Y	Active fixed site
114	Clem	One big rock ≈5 m high in middle of mud (AG)	Rock and mud (AG)	No comments	Not sampled	79.6	86.9	7.3	112.5	21.3	3	N	Active fixed site
119	Clem	Rocky ledge (AG)	Not sampled	Rocky reef, bigger rocky area at 2:00, 25–75 m; small rock at 8:00 75 m (MI)	No comments	97.2	109.4	12.2	117.1	56.8	3	Y	Active fixed site
130	Clem	Big pile of rock (AG)	Not sampled	Very rocky (AG)	Big rock (MI)	76.9	86.2	9.3	111.2	36.2	3	Y	Active fixed site
133	Clem	Rocky bottom (AG)	Not sampled	Not sampled	Not sampled	91.7	101.4	9.7	108.2	29.6	1	N	Inactive site
136	Clem	Big hard dome surrounded by deep water (AG)	Not sampled	No comments	Big mound (MI)	166.9	174.6	7.7	116.0	56.5	3	N	Active fixed site
137	Clem	Big, rocky pinnacle (AG)	Big pinnacle, mountain (MI)	Rocky bottom (AG)	No comments	146.4	162.9	16.5	111.2	55.7	4	Y	Active fixed site
139	Conc	Large, rocky shoulder (AG)	No comments	Not sampled	Rocky bottom w/drop off (AG)	97.0	105.6	8.6	97.9	28.1	3	N	Active fixed site
140	Conc	Big rock (MI)	Rock throughout the area (AG)	No comments	No comments	97.0	104.9	7.9	94.5	27.9	4	Y	Active fixed site

Table A-1continued. Summary of habitat and other information for all sites sampled during the hook and line survey, 2004–2007.

Site name	Gen. area	Habitat notes 2004	2005	2006	2007	Depth range of all drops (m) Low	High	Δ	Nearest port (km)	Mean dist. (m) to centroid	Years sam-pled	Camera drop?	Notes
145	Conc	Hard bottom on slope (AG)	Not sampled	Not sampled	Not sampled	156.6	160.1	3.5	96.6	13.0	1	Y	Active alternate site
146	Conc	Big reef area (MI)	Not sampled	Not sampled	Not sampled	97.9	98.8	0.9	96.2	15.6	1	N	Inactive site
147	Conc	Big rock (AG)	Big rock (AG)	No comments	Very rocky, big rock (AG)	113.5	123.9	10.4	94.7	18.1	4	N	Active fixed site
148	Conc	Rocky (MI)	Not sampled	Not sampled	Not sampled	107.1	109.8	2.7	93.8	38.1	1	N	Inactive site
149	Conc	Rock (AG)	Not sampled	Not sampled	Not sampled	113.5	113.8	0.3	90.8	34.6	1	Y	Inactive site
151	Conc	Small ledge (AG)	No comments	No comments	One pile of rocks (AG)	111.6	116.2	4.6	87.3	18.9	4	Y	Active fixed site
152	Conc	Flat rocky reef (MI)	Not sampled	Not sampled	Not sampled	82.4	84.2	1.8	78.4	51.9	1	N	Active alternate site
154	Conc	Hard edge w/ rocks (MI)	Not much habitat seen, found spot on D3 (AG)	Only habitat is 75 m NNW of mark (AG), drop-off (MI)	No comments	128.1	139.1	11.0	78.4	20.7	3	N	Active fixed site; not sampled in 2006 due to weather
157	Harr	Small rock (AG)	Top of bank, hard cobble bottom (MI)	Cobble bottom (MI)	Flat hard bottom (MI)	85.6	88.2	2.6	23.1	44.1	4	N	Active fixed site
162	Harr	Hard bottom, small rocks on top of bank (MI)	Rocky reefy area (MI)	All rocky (AG)	No comments	78.3	89.1	10.8	22.0	36.2	4	N	Active fixed site
167	Harr	Hard slope (AG)	Rock/hard spot on the W edge of bank (MI)	Hard slope (MI)	Hard slope (AG)	108.0	129.2	21.2	22.2	24.9	4	N	Active fixed site
168	Harr	Not sampled	Big rock on edge (MI)	Hard slope w/ a few small rocks around (AG)	Hard slope (AG)	106.1	121.7	15.6	22.4	25.8	3	N	Active fixed site

Table A-1 continued. Summary of habitat and other information for all sites sampled during the hook and line survey, 2004–2007.

Site name	Gen. area	Habitat notes				Depth range of all drops (m)			Nearest port (km)	Mean dist. (m) to centroid	Years sam-pled	Camera drop?	Notes
		2004	2005	2006	2007	Low	High	Δ					
180	Miguel	Very rocky (AG)	Large rocky area w/ undulations (AG)	Not sampled	Really rocky (AG)	62.2	73.7	11.5	86.6	32.0	3	Y	Active fixed site; not sampled in 2005 due to weather
181	Miguel	No comments	Big rock that comes up to 117 m (AG)	Not sampled	No comments	117.1	119.0	1.9	88.6	15.1	3	N	Active fixed site; not sampled in 2006 due to weather
182	Miguel	Hard edge, hard bottom (MI)	No comments	Not sampled	Rock in area (AG)	125.4	131.0	5.7	89.4	17.9	3	Y	Active fixed site; not sampled in 2006 due to weather
184	Miguel	Not sampled	Area of flat rocky bottom, no one big rock; 5–7 m ledge to N of drops (AG)	Not sampled	Big area of rocks (AG)	122.6	125.7	3.1	88.6	16.4	2	Y	Active fixed site; not sampled in 2006 due to weather
185	Miguel	Edge of rocky reef area (MI)	No comments	Not sampled	Big reef (MI)	86.7	91.5	4.8	86.0	21.6	3	N	Active fixed site; not sampled in 2006 due to weather
186	Miguel	Not sampled	Hard bottom (MI)	Not sampled	No comments	94.2	96.1	1.9	85.7	24.4	3	N	Active fixed site; not sampled in 2006 due to weather
187	SB	One small area of rocks (MI)	Big rock (AG)	No comments	Little rocky bump (AG)	67.7	70.8	3.1	42.7	20.5	4	Y	Active fixed site
189	SB	Bumps (AG)	Rock (AG)	Several bumps in the area (AG)	Hard bottom (AG)	76.9	83.3	6.4	27.8	20.7	4	N	Active fixed site

Table A-1 continued. Summary of habitat and other information for all sites sampled during the hook and line survey, 2004–2007.

Site name	Gen. area	Habitat notes 2004	2005	2006	2007	Depth range of all drops (m) Low	High	Δ	Nearest port (km)	Mean dist. (m) to centroid	Years sam-pled	Camera drop?	Notes
190	SB	Not sampled	No habitat found, removed	Removed	Removed	n/a	n/a	n/a	n/a	n/a	0	N	Removed in 2005 due to nontarget habitat
192	SB	Not sampled	Not sampled	Not sampled	Mud	77.6	77.6	0.0	n/a	n/a	0	N	Removed in 2007 due to nontarget habitat
193	SB	Rocky reef area (MI)	No comments	No comments	No comments	40.3	60.9	20.6	7.8	35.2	4	N	Active fixed site
196	SB	All soft bottom (AG)	Removed	Removed	Removed	n/a	n/a	n/a	n/a	n/a	0	N	Removed in 2004 due to nontarget habitat
197	SB	Big rock (AG)	Big rock (AG)	Big rock (AG)	Big rock (AG)	70.3	78.7	8.4	49.6	18.3	4	Y	Active fixed site
200	SBC	Not sampled	Hard, cobble bottom (MI)	Big ledge, fish migrate around on it (MI)	No comments	104.1	106.0	1.9	17.8	38.4	3	N	Active fixed site
205	SBC	Rocky (MI)	Small rock (AG)	Small rock (AG)	No comments	149.1	153.0	3.9	20.4	27.1	4	N	Active fixed site
209	SBC	Not sampled	Big rock (MI)	Big rock (AG)	Rocky, also large rock in area (AG)	159.9	179.3	19.4	23.5	28.1	3	N	Active fixed site
215	SBC	Not sampled	Drop-off or ledge (MI)	No comments	Drop-off or slope, hard bottom (AG)	157.4	160.1	2.7	25.3	23.1	3	N	Active fixed site
217	SBC	Hard bottom, no real rock (AG)	No comments	Somewhat bumpy, slightly rocky (AG)	Hard bottom (MI)	99.7	106.3	6.6	23.5	61.4	4	N	Active fixed site
226	SC	No comments	Big rock, hard reefy area (MI)	No comments	No comments	56.7	64.1	7.4	29.2	31.6	4	N	Active fixed site

Table A-1 continued. Summary of habitat and other information for all sites sampled during the hook and line survey, 2004–2007.

Site name	Gen. area	Habitat notes 2004	2005	2006	2007	Depth range of all drops (m) Low	High	Δ	Nearest port (km)	Mean dist. (m) to centroid	Years sam-pled	Camera drop?	Notes
228	Ana	Rock slope, hard bottom (AG)	Not sampled	Not sampled	Not sampled	80.5	122.6	42.1	32.0	49.7	1	N	Inactive site
229	Ana	Not sampled	Rocky, pinnacles (MI)	Big rock, only real structure is 25 m W of mark (AG)	No comments	95.5	107.2	11.7	32.6	61.6	3	N	Active fixed site
231	SC	Hard slope (AG)	Not sampled	Not sampled	Not sampled	157.4	161.0	3.6	46.3	18.4	1	N	Active alternate site
232	SC	Hard, rocky edge (MI)	Not sampled	Not sampled	Not sampled	197.6	206.8	9.2	45.5	16.2		N	Active alternate site
233	SC	Large area of hard bottom w/ few small rocks (AG)	Western edge of a reef running through area (MI)	No comments	Many rocks in the area (AG)	87.8	93.3	5.5	49.2	44.7	4	N	Active fixed site
234	SMBay	One very large rock (AG)	Not sampled	Not sampled	Not sampled	39.2	54.4	15.2	19.1	26.3	1	Y	Inactive site
243	SMBay	One rock 3–5 m in size (MI)	Slope, not super hard but hard enough (AG)	Little rock on the slope, best spot ≈60 m E of mark drifting NE	One small spot here (AG)	135.4	140.4	5.0	18.9	23.3	4	Y	Active fixed site
249	SMBay	Not sampled	Hard edge (MI)	No comments	No comments	91.5	102.8	11.3	9.8	16.1	3	N	Active fixed site
252	SMBay	Rocky slope (AG)	Rocky hard bottom (MI)	Rocky, looks good (MI)	No comments	75.2	94.1	18.9	9.8	37.0	4	N	Active fixed site
277	SMBay	Best habitat ≈65 m NW of mark	Small rock (AG)	Area of hard bottom w/ small rocks in various areas (AG)	Fairly level bottom, few scattered rocks (AG)	75.9	83.1	7.2	15.0	35.0	4	Y	Active fixed site
287	SR	One rocky area (MI)	Big rock (AG)	Big rock (AG)	Rocky (AG)	86.0	91.5	5.5	63.3	21.4	4	N	Active fixed site

Table A-1continued. Summary of habitat and other information for all sites sampled during the hook and line survey, 2004–2007.

Site name	Gen. area	Habitat notes				Depth range of all drops (m)			Nearest port (km)	Mean dist. (m) to centroid	Years sam-pled	Camera drop?	Notes
		2004	2005	2006	2007	Low	High	Δ					
289	SoCo	Rock that comes up at edge of canyon (MI)	Rock (AG)	No comments	Small rock (MI)	84.5	113.5	29.0	10.9	33.5	4	N	Active fixed site
291	SoCo	Big rock that comes up ≈15 m (MI)	Big rock (AG)	No comments	Big rock (AG)	74.5	89.7	15.2	20.4	30.5	4	N	Active fixed site
292	SoCo	Not sampled	Rock (AG)	Small rock (AG)	No comments	75.0	77.8	2.8	9.4	15.2	3	N	Active fixed site
293	SoCo	Rock pile that comes up from 55 m to 50 m (MI)	Rocky (AG)	No comments	Hard bottom w/small rocks (AG)	49.4	54.4	5.0	7.6	41.3	4	N	Active fixed site
298	SoCo	Small hard spot w/no relief, may be a wreck (MI)	Hard spot, small rock (AG)	Small hard spot, may be a wreck (MI)	Small rock (AG)	76.9	79.4	2.5	9.3	15.7	4	N	Active fixed site
299	SoCo	Hard shallow area	Not sampled	Not sampled	Flat hard bottom (MI)	42.8	44.8	2.0	7.8	34.7	2	N	Active fixed site
304	SPBay	Not sampled	Small hard bump as slope goes down (AG)	Not sampled	Not sampled	60.4	82.4	22.0	7.0	40.8	1	N	Inactive site
309	SPBay	Not sampled	Soft bottom	Removed	Removed	n/a	n/a	n/a	n/a	n/a	0	N	Removed in 2005 due to nontarget habitat
315	SPBay	Not sampled	Rock (AG)	Rocky bottom (AG)	Flat reef (MI)	81.6	83.1	1.5	12.2	26.5	3	N	Active fixed site
317	SPBay	Not sampled	Hard rocky bottom on edge, flattens to plateau, drops off to south (MI)	Not sampled	Rocky area (MI)	79.1	80.7	1.6	12.6	42.0	2	N	Active fixed site

Table A-1 continued. Summary of habitat and other information for all sites sampled during the hook and line survey, 2004–2007.

Site name	Gen. area	Habitat notes 2004	2005	2006	2007	Depth range of all drops (m) Low	High	Δ	Nearest port (km)	Mean dist. (m) to centroid	Years sam-pled	Camera drop?	Notes
318	SPBay	Hard bottom w/scattered rocks (AG)	Hard sloping bottom (MI)	No comments	Smaller rock (MI)	72.7	80.7	8.0	13.9	11.6	3	N	Active fixed site, not sampled in 2004 due to weather
323	SPBay	Not sampled	Flat, may be soft bottom around, small rock found (AG)	Found no structure, all soft bottom (MI)	Removed	56.5	58.6	2.1	n/a	n/a	2	N	Removed after 2006 due to nontarget habitat
326	SPBay	Reef running through, wavy rocky area, no particular rock (MI)	Flat, hard rocky bottom (MI)	No comments	Rock (AG)	83.1	86.0	2.9	18.3	34.6	4	N	Active fixed site
331	SRFlats	Soft bottom	Removed	Removed	Removed	n/a	n/a	n/a	n/a	n/a	0	N	Removed in 2004 due to nontarget habitat
333	SRFlats	Not sampled	Rock or hard spot on the edge of bank	No comments	Hard slope (AG)	128.5	157.2	28.7	70.5	33.4	3	Y	Active fixed site
342	SRFlats	Not sampled	Rocky, reefy area (MI)	Rocky bottom (MI)	No comments	120.8	124.4	3.6	74.0	27.5	3	N	Active fixed site
346	SRFlats	Big rock on the edge, jagged bottom (MI)	Gradual drop off (MI)	No comments	No comments	157.4	166.5	9.1	82.0	39.9	4	N	Active fixed site
350	SRFlats	Not sampled	Steep edge (MI)	No comments	Hard bottom, steep hard slope (AG)	181.2	203.1	21.9	84.7	29.7	3	N	Active fixed site
352	SRFlats	Big rocky area (MI)	No comments	No comments	No comments	116.9	128.1	11.2	83.4	31.9	4	N	Active fixed site

Table A-1 continued. Summary of habitat and other information for all sites sampled during the hook and line survey, 2004–2007.

Site name	Gen. area	Habitat notes				Depth range of all drops (m)			Nearest port (km)	Mean dist. (m) to centroid	Years sam-pled	Camera drop?	Notes
		2004	2005	2006	2007	Low	High	Δ					
364	SR	Soft bottom	Removed	Removed	Removed	n/a	n/a	n/a	n/a	n/a	0	N	Removed in 2004 due to nontarget habitat
365	SR	Reef (MI)	Small rise in bottom; bottom is somewhat hard, found little dome D3– 5 (AG)	No comments	Hard bottom (AG)	51.2	58.0	6.8	47.5	53.1	4	Y	Active fixed site
367	Conc	Not sampled	Rocky (AG)	No comments	Hard slope (AG)	116.4	117.1	0.7	79.6	36.2	2	Y	Active fixed site, not sampled in 2006 due to weather
374	Conc	Not sampled	No comments	Area of hard bottom that holds fish when conditions are right (MI)	Not much prime structure (MI)	95.0	105.2	10.2	87.3	31.8	3	N	Active fixed site
375	Conc	Not sampled	No comments	No comments	No comments	94.2	97.9	3.7	92.5	71.5	3	Y	Active fixed site
377	60MB	Not sampled	Big rock or pinnacle (MI)	Big rock (MI)	Reefy area (MI)	126.3	138.3	12.1	117.1	46.7	3	N	Active fixed site
379	SoCo	Not sampled	Hard bottom, little ledge (AG)	Not sampled	Not sampled	85.1	86.0	0.9	34.6	29.8	1	N	Inactive site
380	Clem	Not sampled	Not sampled	No comments	Not sampled	99.2	115.1	15.9	111.4	32.1	1	N	Active alternate site
383	SC	Not sampled	Big rock (MI)	Reefy area w/one high spot (MI)	Several rock piles (AG)	79.6	84.2	4.6	47.5	32.6	3	Y	Active fixed site

Table A-1 continued. Summary of habitat and other information for all sites sampled during the hook and line survey, 2004–2007.

Site name	Gen. area	Habitat notes				Depth range of all drops (m)			Nearest port (km)	Mean dist. (m) to centroid	Years sampled	Camera drop?	Notes
		2004	2005	2006	2007	Low	High	Δ					
385	SRFlats	Not sampled	Not sampled	Hard bottom, flat, rocky (AG)	Big area of hard bottom, no structure (AG)	141.1	143.5	2.4	79.6	49.7	2	N	Active fixed site
389	CenCo	Not sampled	Up on the flats, not the slope; hard bottom w/no particular rocks (AG)	No comments	Not much here, small area of slightly harder bottom (MI)	79.6	84.2	4.6	14.4	36.5	3	N	Active fixed site
390	CenCo	Not sampled	Rock (AG)	No comments	Rock (AG)	76.5	78.9	2.4	17.9	26.2	3	Y	Active fixed site
391	CenCo	Not sampled	Hard slope (AG)	No comments	Edge (MI)	132.9	151.9	19.0	7.4	26.9	3	N	Active fixed site
395	CenCo	Not sampled	Hard slope (AG)	No comments	No comments	95.2	108.3	13.2	5.9	27.2	3	N	Active fixed site
396	SC	Not sampled	Big rock (MI)	No comments	Big rock (AG)	65.9	78.3	12.4	38.9	45.2	3	Y	Active fixed site
397	SC	Not sampled	Not sampled	Rocky (MI)	Small pile of rocks, not very tall (AG)	74.8	80.7	5.9	38.9	22.3	2	N	Active fixed site
398	SR	Not sampled	Not sampled	Fair sized pile of rocks (AG)	Rock on edge, also good sized pile of rocks in area (AG)	76.7	80.5	3.8	62.0	40.0	2	N	Active fixed site
399	SR	Not sampled	Big rock (AG)	Big rock (AG)	No comments	86.0	101.2	15.2	51.6	20.2	3	N	Active fixed site
402	SR	Not sampled	Small rock (AG)	No comments	Two rocks at this site (MI)	86.9	93.0	6.0	50.7	25.8	3	N	Active fixed site
404	SB	Not sampled	Not sampled	Site not found	Removed	n/a	n/a	n/a	n/a	n/a	0	N	Removed in 2006; unable to locate site
405	9MB	Not sampled	Rocky, large rock (AG)	Hard bottom near an edge (MI)	Hard mound (MI)	144.6	150.6	6.0	17.9	32.5	3	N	Active fixed site

Table A-1 continued. Summary of habitat and other information for all sites sampled during the hook and line survey, 2004–2007.

Site name	Gen. area	Habitat notes				Depth range of all drops (m)			Nearest port (km)	Mean dist. (m) to centroid	Years sampled	Camera drop?	Notes
		2004	2005	2006	2007	Low	High	Δ					
407	Hue	Not sampled	Small rocky area, small reef (MI)	No comments	Hard bottom (MI)	80.2	83.6	3.5	8.3	32.2	3	N	Active fixed site
409	Hue	Not sampled	Hard edge, appears to have silted over, removed (MI)	Removed	Removed	n/a	n/a	n/a	n/a	n/a	1	N	Removed after 2005 due to nontarget habitat
411	Hue	Not sampled	No habitat found	Removed	Removed	n/a	n/a	n/a	n/a	n/a	0	N	Removed in 2005 due to nontarget habitat
412	Hue	Not sampled	No habitat found	Removed	Removed	n/a	n/a	n/a	n/a	n/a	0	N	Removed in 2005 due to nontarget habitat
413	Ana	Not sampled	Not sampled	Just off the 86 m high spot (MI)	No comments	89.7	121.3	31.6	32.6	49.2	2	N	Active fixed site
414	SRFlats	Not sampled	No comments	Rock (AG)	Pile of rocks (AG)	138.2	142.7	4.6	79.2	37.0	2	N	Active fixed site
416	Hue	Not sampled	Not sampled	Soft bottom	Removed	132.3	186.3	54.0	n/a	n/a	0	N	Removed in 2006 due to nontarget habitat

Appendix B: Hook Matrix, Species Data Sheet, and Site Data Sheet

This appendix contains examples of the three information collection forms discussed in the Sampling Protocols subsection. Most of the terms used in the forms are self-explanatory except for the following abbreviations:

- FPC stands for field party chief. It is an informal designation for the Chief Scientist on the vessel and indicates the biological staff member in charge.

- SCS stands for scientific computer system, which is the data logging software developed by NMFS and used aboard the chartered vessels.

- Also, on the Site Data Sheet, under the upper right twin columns headed "Depth," the term "ours" refers to measurements taken by the science crew and the term "vessel" indicates measurements taken by the vessel crew. The same is true for the Sfc. Temp. cells for "Ours" and "Vessel." Double measurements usually are not taken. If the vessel equipment is not functioning properly, the science crew employs its own temperature-depth sounder.

HOOK MATRIX

Date:_____ Vessel:_____ Site Name:_____ Set ID:_____

SCS File Index No.:_____ General Area:_____ Day of Cruise:_____

FPC name: Recorded by:

ANGLER A — ANGLER NAME:_____

Drop	Hook 1 (bottom hook)	2	3	4	5 (top hook)	On Bottom	First Bite	Begin Retrieval	At Sfc	Wt. Used	Ex-clude?
1											☐
Notes											
2											☐
Notes											
3											☐
Notes											
4											☐
Notes											
5											☐
Notes											

ANGLER B — ANGLER NAME:_____

Drop	Hook 1 (bottom hook)	2	3	4	5 (top hook)	On Bottom	First Bite	Begin Retrieval	At Sfc	Wt. Used	Ex-clude?
1											☐
Notes											
2											☐
Notes											
3											☐
Notes											
4											☐
Notes											
5											☐
Notes											

ANGLER C — ANGLER NAME:_____

Drop	Hook 1 (bottom hook)	2	3	4	5 (top hook)	On Bottom	First Bite	Begin Retrieval	At Sfc	Wt. Used	Ex-clude?
1											☐
Notes											
2											☐
Notes											
3											☐
Notes											
4											☐
Notes											
5											☐
Notes											

NOTES:

KEY:
- Record times in MM:SS format
- If a fish is hooked, enter species into matrix
  - "NB" = No bait on hook
  - "BB" = Bait back on hook
  - "NH" = No hook
- Note any snags, lost sinkers, or significant tangles with other anglers in space provided

Data checked by _____ on _____.

FRAM Hook and Line Survey

SPECIES DATA SHEET

Page ___ of ___

Date:_____________ Vessel:_____________Site Name:_______________ Set ID:________________________

SCS File Index No.:________General Area:_________________________________ Day of Cruise:_________

FPC name: Recorded by:

#	Species	Angler	Drop No.	Hook No.	Weight (kg)	Length (cm)	Sex	Otolith No.*	Fin Clip No.*	Special Project	Re-leased
											☐
											☐
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* Include the first letter of the species name before the otolith, and finclip numbers and include leading zeroes when the number < 100 (e.g., "V024", "A008", etc.)

NOTES:

Data checked by _______________________ on _____________.

FRAM Hook and Line Survey

SITE DATA SHEET

Date:_____ Vessel:_____ Site Name:_____ Set ID:_____

SCS File Index No.:_____ General Area:_____ Day of Cruise:_____

FPC name: Recorded by:

Drift	On anchor
Survey	Non-survey
Primary	Alternate
Test Drop?	Y N

Event Description	Time (24 hour)	Latitude DD MM.MMM	Longitude DD MM.MMM	Depth ours fth m	Depth vessel fth m
Drop 1					
Drop 2					
Drop 3					
Drop 4					
Drop 5					

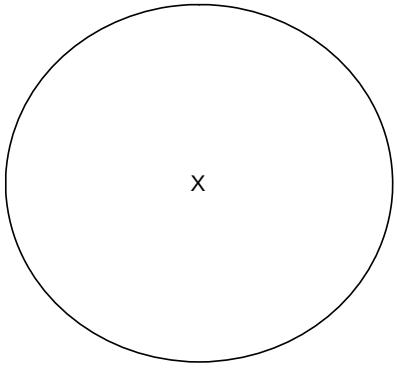
Wind		Drift		Sea state			Moon phase
spd. (kts)	dir.*	spd. (kts)	dir.*	swell ht. (ft)	dir.*	wave ht. (ft)	(phase/days until)
0-1	____°	<0.1	_____°		_____°		_____ moon
1-3		0.1 - 0.5					in _____ day(s)
4-6		0.5 - 1.0				**Sunrise**	
7-10		1.0 - 1.5		**Sfc. Temp.**		_____ am	
11-16		1.5 - 2.0		Ours:		**Sunset**	**Tide phase**
17-21		>2.0		**°C °F**		_____ pm	(height & state)
22-27				Vessel:			_____ feet
28-33				**°C °F**		**Tide Station**	ebb
34-40						_____	flood
41+						Dist. _____ nm	steady

* For wind & swell direction, enter the direction in compass degrees FROM which they originate; for drift direction, enter the direction in compass degrees TO which the boat is moving

Habitat:

Fishfinder / aggregations:

Ocean / weather:



Indicate the position of each drop using "1", "2", etc. and the direction of the drifts using arrows.

General:

Appendix C: Hook Selectivity

In 2005 an experiment was conducted to test for the presence of size selectivity in the hooks used during the hook and line survey. Although hooks used during the survey were originally selected to maximize the size range of fish that could potentially be hooked, a more rigorous assessment of this decision was warranted.

During this experiment, the gangions were equipped with three differently sized hooks. The small hook was a size 1/0 Mustad "Saltwater Circle Streamer," the medium hook was the size 5/0 hook used as shrimp flies during normal survey operations, and the large hook was a size 13/0 Mustad "EZ-Baiter." All three sizes of hook conformed to the same general shape: long shank, kirbed J-hooks (the Saltwater Circle Streamer was manually kirbed). As during survey operations, red and yellow shrimp flies were tied to each hook and baited with squid strips. The three hook sizes were distributed among the 15 angler-hook positions in a repeating small-medium-large rotation beginning with Angler 1, Hook 1 (Figure C-1). This alternating sequence allowed for all three sizes of hook to be represented at each of the gangion's five hook positions.

Among the key species of bocaccio (*Sebastes paucispinis*), vermilion rockfish (*S. miniatus*), and greenspotted rockfish (*S. chlorostictus*), length distributions caught on the three sizes of hooks were generally similar within species (Figure C-2). An analysis of variance (ANOVA) for these three species indicated the mean sizes of fish caught by the three hook sizes were not significantly different from one another (Table C-1). However, qualitative examination of the results for bocaccio and vermilion rockfish suggested the possibility of some differences in length between fish caught on the small hook versus those caught on medium and large hooks. A follow-up ANOVA for these two species to test for this possibility indicated significant differences between fish size and hook size at the 90% level for bocaccio and marginally less than the 90% level for vermilion rockfish (Table C-2). Among all other species, smaller fish were caught in disproportionate numbers on the small hooks relative to the medium and large hooks; therefore, the null hypothesis of no significant relationship between hook size and mean fish length is rejected (Table C-1).

Despite the statistically significant differences in the mean size of bocaccio and vermilion rockfish caught on small hooks versus medium and large hooks, it appears the medium hook effectively captures a wide range of fish sizes among target shelf rockfish species. The relatively small sample sizes may preclude making many definitive statements, but there appears to be little evidence suggesting that the hook that is used for sampling operations is inappropriately sized for target shelf rockfish species.

Hook selectivity experiment gangions

All specifications including line, dropper lengths, spacing, breakaways, swivels, etc., are the same as shown in Figure 2 in the body of this document. The only change is the size of shrimp fly attached to the dropper loops.

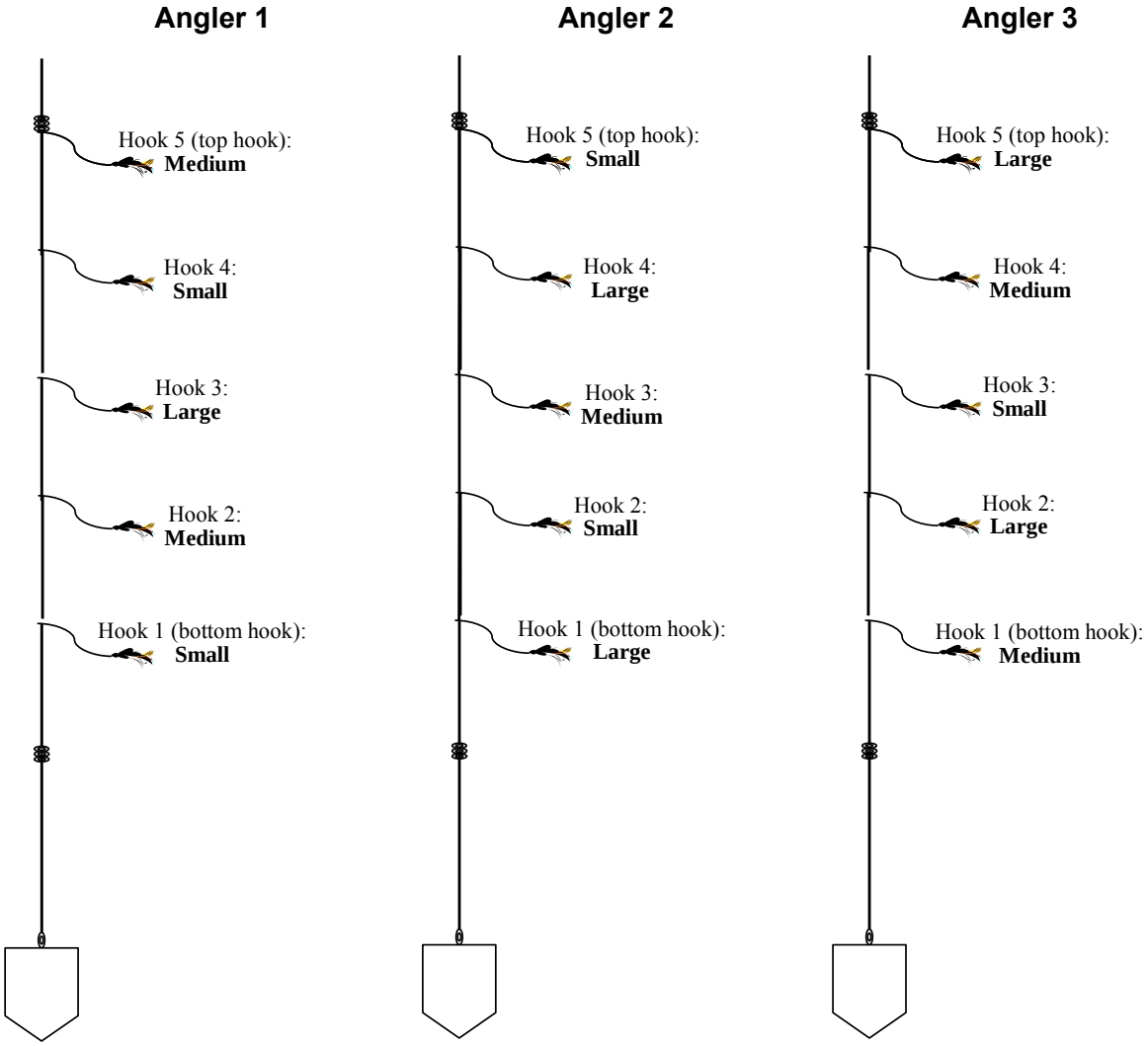


Figure C-1. Diagram showing position of differently sized hooks on gangions used during the hook selectivity experiment.

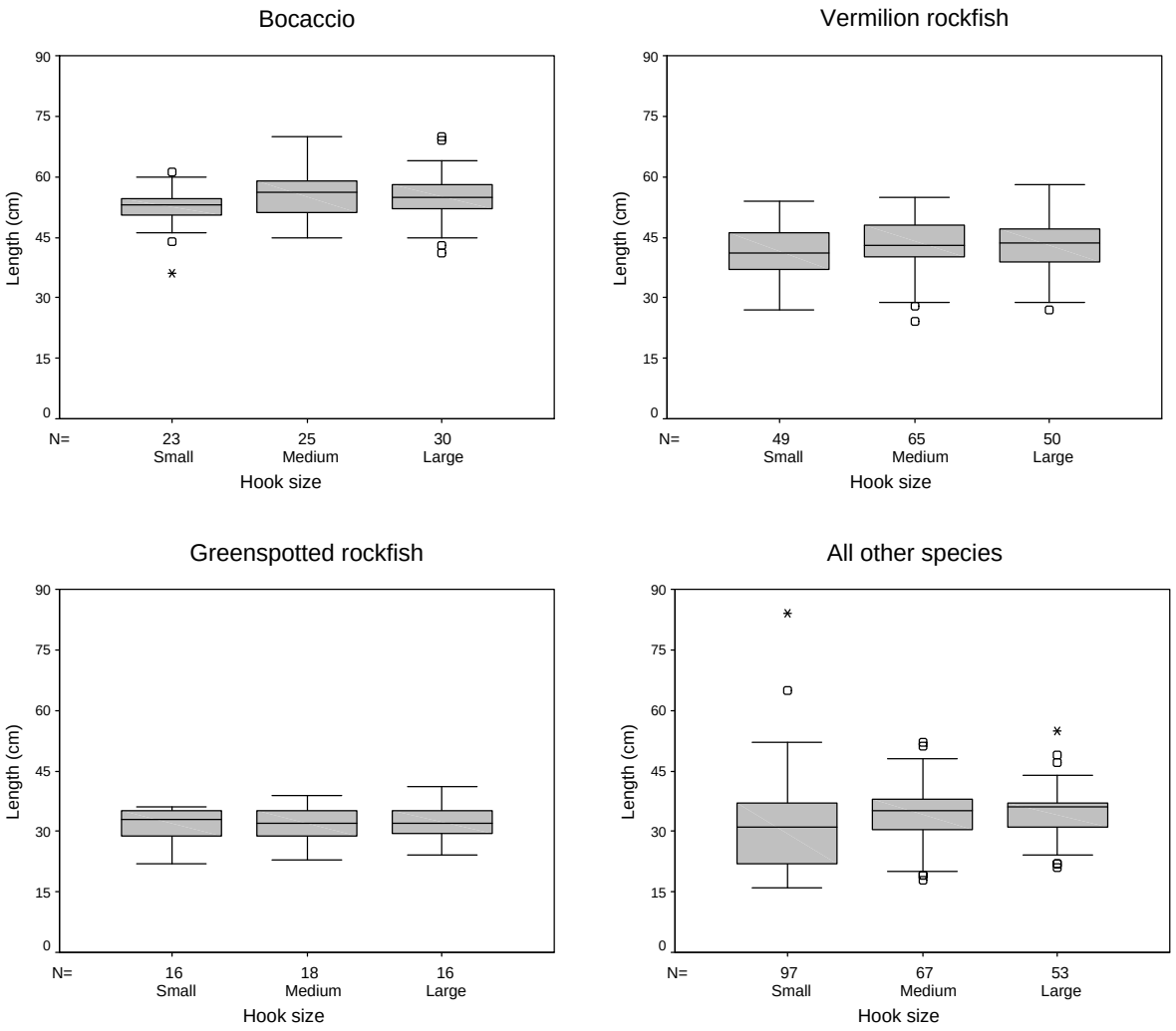


Figure C-2. Box plot of length distributions by hook size for fish caught during hook selectivity project. Box plots display interquartile range and median values. Outliers (1.5–3 box lengths) are shown as circles. Extreme values (>3 box lengths) are shown as asterisks.

Table C-1. Descriptive statistics and F and p ANOVA results for mean size difference among fish hooked on small, medium, and large hooks during a hook selectivity study.

Species	Hook size	Number	Mean length (cm)	SD	F	p
Bocaccio rockfish	Small	23	52.2	5.4	2.23	0.115
	Medium	25	55.9	6.3		
	Large	30	54.5	6.6		
Vermilion rockfish	Small	49	40.9	6.5	1.66	0.194
	Medium	65	43.1	6.8		
	Large	50	42.8	6.9		
Greenspotted rockfish	Small	16	31.6	3.9	0.26	0.772
	Medium	18	31.2	4.4		
	Large	16	32.2	4.0		
All other species	Small	97	30.9	10.5	3.55	0.030
	Medium	67	33.8	7.6		
	Large	53	34.4	6.9		

Table C-2. Descriptive statistics and follow-up F and p ANOVA results to Table C-1 for bocaccio and vermilion rockfish. Table examines mean size difference among fish hooked on small versus medium and large hooks during the hook selectivity experiment.

Species	Hook size	Number	Mean length (cm)	SD	F	p
Bocaccio	Small	23	52.2	5.4	3.75	0.056
	Medium/large	55	55.2	6.5		
Vermilion rockfish	Small	49	40.9	6.5	2.68	0.104
	Medium/large	115	42.8	7.0		

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94 **Fleischer, G.W., K.D. Cooke, P.H. Ressler, R.E. Thomas, S.K. de Blois, and L.C. Hufnagle. 2008.** The 2005 integrated acoustic and trawl survey of Pacific hake, *Merluccius productus*, in U.S. and Canadian waters off the Pacific coast. U.S. Dept. Commer., NOAA Tech. Memo. NMFS-NWFSC-94, 41 p. NTIS number pending.

93 **Keller, A.A., B.H. Horness, E.L. Fruh, V.H. Simon, V.J. Tuttle, K.L. Bosley, J.C. Buchanan, D.J. Kamikawa, and J.R. Wallace. 2008.** The 2005 U.S. West Coast bottom trawl survey of groundfish resources off Washington, Oregon, and California: Estimates of distribution, abundance, and length composition. U.S. Dept. Commer., NOAA Tech. Memo. NMFS-NWFSC-93, 136 p. NTIS number PB2008-113766.

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