NOAA Technical Memorandum NMFS-NWFSC-87

The 2004 U.S. West Coast Bottom Trawl Survey of Groundfish Resources

off Washington, Oregon, and California: Estimates of Distribution, Abundance, and Length Composition

December 2007

U.S. DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
National Marine Fisheries Service

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This document should be cited as follows:

Keller, A.A., B.H. Horness, V.H. Simon, V.J. Tuttle, J.R. Wallace, E.L. Fruh, K.L. Bosley, D.J. Kamikawa, and J.C. Buchanan. 2007. The 2004 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-87, 134 p.

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December 2007

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Executive Summary

The Northwest Fisheries Science Center's Fishery Resource Analysis and Monitoring Division (FRAM) completed the seventh in an annual series of groundfish bottom trawl surveys in 2004. The survey was conducted from 27 May to 16 October 2004 and targeted the commercial groundfish resources inhabiting depths of 55 to 1,280 m (30 to 700 fathoms) from the area off Cape Flattery, Washington (lat 48°10′N), to the U.S.-Mexico border (lat 32°30′N) using chartered West Coast commercial trawlers. This ongoing series of annual surveys, conducted by FRAM since 1998, is designed to monitor long-term trends in distribution and abundance of West Coast groundfish, especially those species of management concern. The 2004 survey represents the second year in which the depth range was expanded to include both the continental shelf (55–183 m) and continental slope (184–1,280 m) area and the second year in which a stratified-random sampling design was adopted.

In 2004 540 primary sampling sites and associated secondary sites were selected randomly prior to the start of the survey. Trawling locations were allocated according to a stratified-random sampling design that divided the region into two geographic areas north and south of Point Conception, California, and three depth zones (strata). The objective was to provide a representative sample of the various groundfish species and relative numbers in each stratum. By selecting random stations within certain depth zones, towable ground has an equal probability of being sampled during the survey. Thus the method produces unbiased estimates of relative stock size. A total of 505 successful tows were completed out of 567 attempts. Simrad Integrated Trawl Instrumentation net mensuration data, as well as global positioning system navigation data and bottom contact sensor data used to document performance (e.g., bottom tending), were obtained for most tows.

An Aberdeen-style net with a small mesh (1½″ stretched measure) liner in the codend (to retain smaller specimens) was used to sample fish biomass. Target duration of each tow was 15 minutes. Tow duration was the time between touchdown and liftoff of the trawl net from the seafloor based on readings from bottom contact sensors.

Catches were sorted to species, aggregate, or other appropriate taxonomic level then weighed using an electronic, motion-compensated scale. A total of 587 species or families were identified within the survey area. Although the biological sampling effort continues to include Dover sole (*Microstomus pacificus*), shortspine thornyhead (*Sebastolobus alascanus*), longspine thornyhead (*S. altivelis*), and sablefish (*Anoplopoma fimbria*), focus has shifted increasingly to encompass all groundfish species of management concern. Up to 100 length measurements, sex determinations, and individual weights and up to 25 age structures were collected per haul for these species.

Acknowledgments

We thank the captains and crew of the fishing vessels *Ms. Julie*, *Excalibur*, and *B.J. Thomas* for their efforts during the 2004 Northwest Fisheries Science Center's Pacific West Coast groundfish trawl survey. We also thank the biologists who participated in the survey, including Roger Clark, Chante Davis, Brook Flammang, Owen Hamel, Lisa Lysak, Stacey Miller, Natalie Reed, Suzanne Romain, Ian Stewart, Josie Thompson, Waldo Wakefield, and Keri York. Scott McEntire at the Resource Assessment and Conservation Engineering Division of the Alaska Fisheries Science Center designed the bottom contact sensors. We also express our appreciation to Brian Parker, Mary Breaker, Mary Craig, and Carol Ksycinski for their shoreside logistical support and Curt Whitmire and Julia Clemons for creating the geographic information system graphics.

Introduction

The West Coast groundfish fishery, supported by 82 commercially valuable species, spans the area from the Canadian to the Mexican borders in nearshore to offshore waters. Multiple vessel types, ranging in size from kayaks to trawlers, participate in the fishery. The fishery sectors deploy mobile and fixed gear including bottom trawls, midwater trawls, pots, longlines, and other hook and line gear; however, trawlers take the majority of landed groundfish. Active management of the fishery began in the early 1980s with the establishment of optimum yields and trip limits for several managed species. Management measures currently include landings limits, size limits, gear restrictions, and time and area closures. The management measures are designed to avoid overfishing and to rebuild overfished stocks.

The Fishery Resource Analysis and Monitoring Division of the Northwest Fisheries Science Center (NWFSC) completed the seventh in a series of annual bottom trawl surveys of groundfish resources off the U.S. West Coast. The survey operations were conducted from 27 May to 16 October 2004. The major objective of the NWFSC West Coast groundfish trawl survey (WCGTS) is to provide the fishery-independent data necessary to support the assessment of the status and trends of fish species inhabiting trawlable habitat along the U.S. West Coast's upper continental slope and shelf. The survey area extended from northern Washington (U.S.-Canada border) to southern California (U.S.-Mexico border) in waters ranging from 55 to 1,280 m (30 to 700 fathoms [fm]). Annual, coast-wide sampling cruises were undertaken by the NWFSC beginning in 1998 to establish an ongoing time series of groundfish catch, fishing effort, and individual fish measurement data (Turk et al. 2001, Builder Ramsey et al. 2002, Keller et al. 2005, 2006a, 2006b, 2007).

Although NWFSC assumed responsibility for the slope portion of the groundfish survey starting in 1998, the time series began as an annual West Coast continental slope survey conducted by the Alaska Fisheries Science Center (AFSC) in 1988. Beginning in 2003, NWFSC expanded the depth coverage to include the continental shelf (55–183 m) as well as the continental slope (184–1,280 m). Consequently, in the current sampling configuration, the WCGTS now also encompasses the area historically monitored by the continental shelf survey conducted triennially by the AFSC (from 1977 through 2001). The NWFSC's groundfish survey currently provides not only an annual snapshot of fish stock status but also an extension of two established, long-term time series from which informed management decisions can be made.

Prior to 1998, surveys conducted by the AFSC were the principal source for fishery-independent data of groundfish resources along the upper continental slope and shelf of the U.S. West Coast (Methot et al. 2000). The AFSC conducted slope surveys periodically from 1984 to 1987 and annually beginning in 1988. Shelf surveys were conducted triennially from 1977 to 2001. The AFSC slope surveys were conducted with the NOAA research vessel (RV) *Miller Freeman* while the triennial survey used chartered Alaska fishing vessels. Spatial coverage of the West Coast surveys varied between years due to constraints imposed by annual budget levels and availability of NOAA ship time (Lauth 2001).

The NWFSC groundfish survey was initially designed to cover the same depths and latitudes established with the AFSC slope survey. Beginning in 2003, the WCGTS was expanded to include the continental shelf and slope (range of depths from 55 to 1,280 m) along the entire area off the U.S. West Coast (U.S.-Canada border to U.S.-Mexico border). Since inception in 1998, the NWFSC survey has utilized chartered fishing vessels from the West Coast commercial fishing industry. This feature capitalizes on the skills of fishing captains familiar with the challenges of fishing in the waters off the West Coast and fulfills the cooperative research provisions of the Magnuson-Stevens Sustainable Fisheries Act.* The results of the surveys provide measures of the change in relative abundance, distribution, and condition of groundfish stocks over time, which is of interest to fisheries managers, fishers, and concerned citizens.

The WCGTS spans the latitude from 48°10′N to 32°30′N and is geographically subdivided into the five International North Pacific Fisheries Commission (INPFC) statistical areas: U.S-Vancouver, Columbia, Eureka, Monterey, and Conception (Figure 1). The objectives of this report are to document the operations, survey design, and initial results of the 2004 survey. Data summaries are provided for species composition, catch, distribution, relative density, biomass estimates, and size composition of selected species. The results are summarized by depth strata (55–183 m, 184–549 m, and 550–1,280 m, or 30–100 fm, 101–300 fm, and 301–700 fm) and INPFC area. Weight-length and length-at-age relationships, with age determined from otoliths, are also described for select groundfish species. In this report, we document operations and results of the 2004 groundfish survey with the intent to provide the indices of abundance necessary for subsequent stock assessment exercises.

* The mandated authority over fisheries along the West Coast of the United States, including specifically the states of California, Oregon, and Washington, resides principally with the Pacific Fishery Management Council, created in 1976 as part of the Magnuson-Stevens Fishery Conservation and Management Act. This legislation also established a 200-mile exclusive economic zone surrounding the nation's coastline.

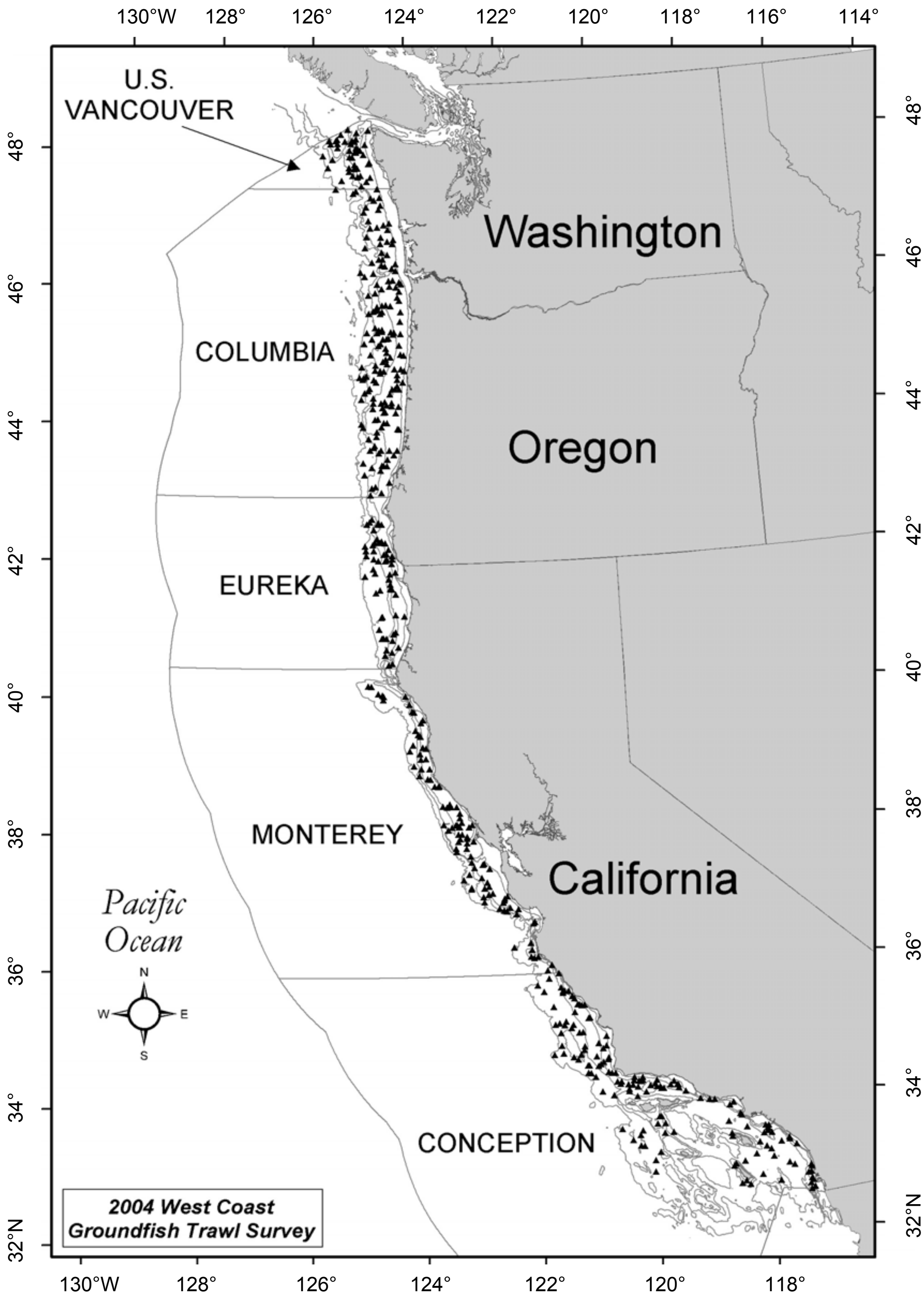


Figure 1. Map showing extent of the 2004 West Coast groundfish trawl survey and the locations of completed stations (▲).

Survey Methods

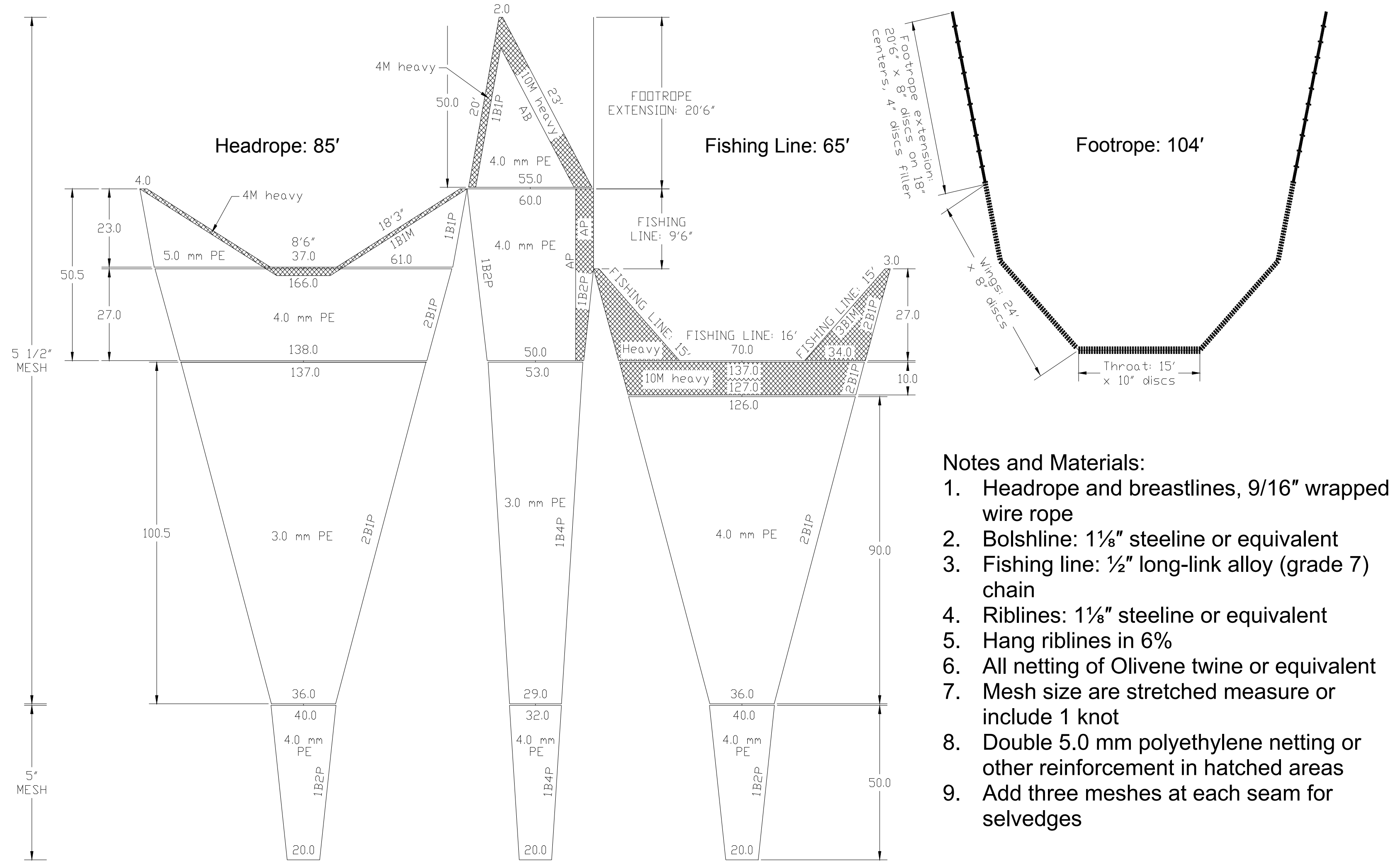
Survey Period and Sampling Area

The 2004 WCGTS was conducted in two completed cycles of operations or passes between 27 May and 16 October 2004 from the areas off Cape Flattery, Washington (lat 48°10′N), to the U.S.-Mexico border (lat 32°30′N). Three West Coast bottom trawlers were chartered through a standard competitive bid process. The fishing vessel (FV) *Ms. Julie* was used during the first survey period from 27 May to 22 July 2004 and two additional vessels, the FV *Excalibur* and the FV *B.J. Thomas*, were used during the second survey period, from 21 August to 16 October 2004. All vessels started their operations off Cape Flattery and progressed south along the coast, finishing the completed cycle south of San Diego, California. Unlike prior years, a full complement of four chartered vessels was not used in 2004 because some resources and manpower were diverted to accommodate the concurrent deployment of vessels for collection of comparable information using the technique employed by the West Coast continental shelf survey established by the AFSC.

Vessels and Sampling Gear

The three chartered fishing vessels ranged in size from 65 to 77 feet (19.8 to 23.4 m) and in power from 450 to 750 horsepower. Each vessel was rigged as a stern trawler with a rear gantry housing one or two net reels to set and retrieve trawl gear. Vessels were outfitted with split trawl winches and equipped with modern electronics including global positioning systems (GPS), multiple depth sounders, radars, and other navigational aids. Prior to the start of the survey, the NWFSC provided each vessel with two ⅝″ steel core trawl cables, each 2,288 m (1,250 fm) in length. Cables were measured side by side and marked at 25 fm increments while being spooled onto the vessel's winches. The markings provided real-time verification of the release of equal warp length from both winches while setting a tow.

All vessels were provided with two standard Aberdeen-style nets (Figures 2 and 3) built and rigged to operate within strict specifications in compliance with protocols established for bottom trawl surveys (Stauffer 2004). The Aberdeen trawl is routinely used by fishing vessels throughout the survey region and was chosen after substantial analysis of trawl performance over various towing situations. The Aberdeen trawl demonstrated relatively stable performance over the range of conditions expected during the survey (West et al. 1998). Each net was outfitted with a small-mesh liner (1½″ stretched measure, #24 twisted polypropylene) in the codend to retain smaller fish. Various aspects of the mechanical performance of the nets (e.g., spread between net wings, vertical distance from the center of the headrope to the bottom, distance from the headrope to the footrope, and clearance between the footrope and bottom) were recorded using acoustic and bottom contact instruments hung from the net during each deployment.



Notes and Materials:

1. Headrope and breastlines, 9/16″ wrapped wire rope
2. Bolshline: 1⅛″ steeline or equivalent
3. Fishing line: ½″ long-link alloy (grade 7) chain
4. Riblines: 1⅛″ steeline or equivalent
5. Hang riblines in 6%
6. All netting of Olivene twine or equivalent
7. Mesh size are stretched measure or include 1 knot
8. Double 5.0 mm polyethylene netting or other reinforcement in hatched areas
9. Add three meshes at each seam for selvedges

Figure 2. Detailed diagram of the NWFSC Aberdeen-style sampling trawl, including descriptions of dimensions, materials, mesh sizes, and mesh counts. See Figure 3 for a detail of the footrope.

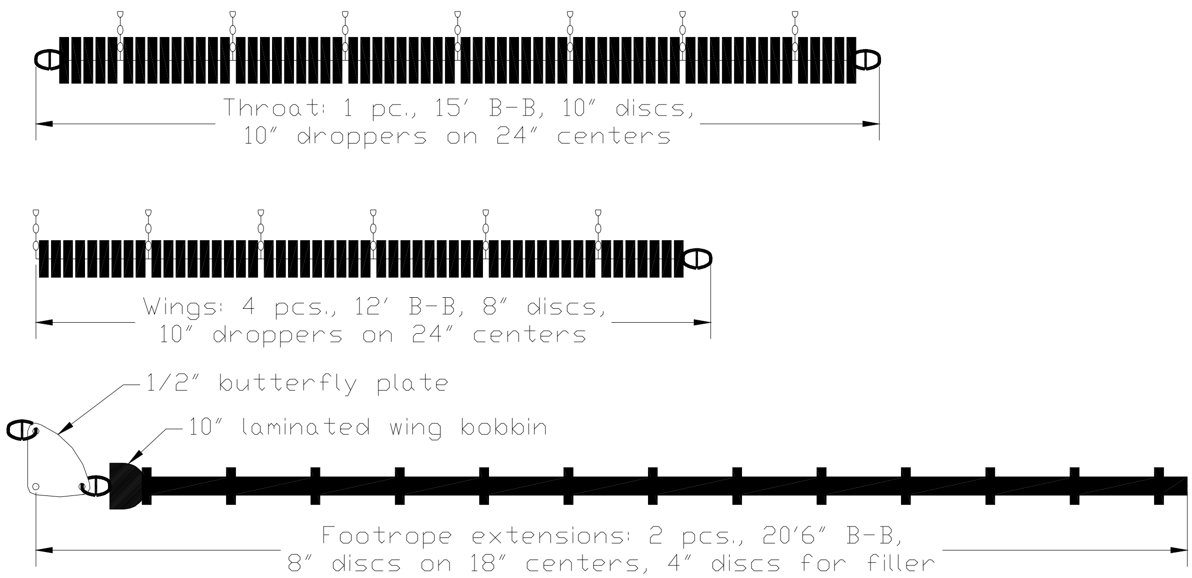


Figure 3. Footrope for the NWFSC Aberdeen-style sampling trawl composed of seven sections with an overall length of 104′. A single section of each component of the footrope is shown in the figure. Notes: Footrope composed of ½″ long-link alloy (grade 7) chain, with rubber discs (8–10″) and dropper chains (10″) strung along the length, and section lengths (measured bearing point to bearing point, B-B) connected by ½″ Campbell hammerlocks and stainless pins and spacers.

Additional information was recorded on operational conditions such as depth, amount of towing cable deployed, towing speed, tow duration, and weather conditions.

Trawl Station Allocation

From 1998 through 2002, selection of sample sites for the WCGTS was based on a fixed transect design. Following an evaluation of the transect-based survey design by assessment and survey scientists, a stratified-random sampling design was adopted in 2003. The survey area was partitioned into approximately12,000 adjacent cells of equal area (1.5 nautical miles [nm] longitude × 2.0 nm latitude, Albers Equal Area projection) with each vessel assigned a primary subset of 180 randomly selected cell sites. In 2003 sampling density was assigned to areas defined by INFPC management areas and specified depth categories. After the 2003 survey season, further review by assessment scientists indicated that a greater flexibility in the development of poststratification strategies would be gained if the geographic allocation of randomly selected sites were reduced to a simple north-south geographic division at lat 34°30′N (Point Conception, California).

Consequently, sampling locations in 2004 were allocated accordingly, with 80% of the effort allocated to the northern portion of the survey and 20% allocated to the southern range. This allocation schema was selected to maintain a comparable level of sampling effort in the area above Point Conception as sampled in prior years. The survey area was further stratified into three depth zones (55–183 m, 184–549 m, and 550–1,280 m), with the percentage of sampling stations allocated to each of the three depth ranges in the northern and southern geographic areas based roughly on the proportion of the area within each depth strata. North of Point Conception, 40% of the area is located within the shallow depth stratum (55–183 m) and 30% within each of the two remaining strata (mid depth and deep zones). South of Point Conception, 25% of the area was allocated within the shallow zone, 45% within the mid-depth zone, and the remaining 30% within the deep range.

The total number of sites targeted for the survey year, was apportioned across geographic area and depth categories, based on the above scheme, then primary stations were drawn from the survey cell pool, by strata, using a pseudorandom number generator. Each cell was sequentially assigned to an individual vessel. The process was repeated to identify two alternate sampling sites per location; additional constraints were imposed to ensure alternate sites were neither so close to an untrawlable primary site that they exhibit the same untrawlable features nor at an impractical transit distance.

In 2004 540 primary sites were selected, with each vessel assigned 180 tows (one tow per cell). A total of 505 successful tows were completed out of 567 attempts.

Trawling Protocol

Standard trawl operations were followed to minimize differences in sampling (fishing) efficiency across the range of conditions encountered during the survey and over time (Stauffer 2004). By established conventions, trawling operations were limited to the daylight period, that is, the initial tow each day began (net on seafloor) following official sunrise and the last tow of the day ended (net off seafloor) before official sunset. Once a vessel was in the preselected sampling area (1.5 by 2.0 nm cell), the captain was instructed to observe the following search rules to identify a specific tow site: 1) search within the specified depth range, 2) remain fully within the specified area, and 3) complete the search for trawlable ground within 1 hour. If no trawlable site was found within the 1-hour limit, the cell was noted in the log as untrawlable and the vessel proceeded to the secondary cell. If the secondary cell also proved untrawable, the tertiary cell was attempted. If a tow was attempted but judged unsatisfactory or if the tow was aborted, a reasonable attempt was made to redo the tow within the primary site before proceeding to alternate sites.

All fishing operations, including vessel operations and gear performance, were monitored using a suite of trawl instrumentation systems. The NMFS-supplied differential GPS navigation unit (Northstar 500, Northstar Technologies, Acton, Massachusetts) or the vessel's speed indicators were used to monitor towing speed for each survey haul (target 2.2 knots over ground). All hauls were additionally monitored using the Simrad Integrated Trawl Instrumentation (ITI, Kongsberg Simrad Mesotech Ltd., Port Coquitlam, British Columbia, Canada) system. Four sensors from the ITI trawl system were attached to the net prior to setting the gear. Two instruments were mounted on the center of the net headrope: the trawl eye provided information on the vertical opening of the trawl, distance to the seafloor, and footrope clearance above the bottom, and the temperature-depth sensor recorded ambient temperature and the depth of the trawl headrope. Paired wing units (communication sensor and remote sensor) were attached on the port and starboard wings of the net to measure wingspread.

Extreme or prolonged periods of abnormal wingspread were indicative of net performance problems. Wingspread provided an indicator of the net's contact with the bottom and whether adequate scope (amount of wire deployed) was utilized. With too little scope the gear tends bottom poorly, while too much scope may impact the proper spread of the doors. The captain, relying on past experience and judgment, determined the initial scope at the start of each tow. Guidelines for initial scope, tailored to local conditions and vessels, were provided for use at the discretion of the captain. Because the ITI trawl instruments displayed gear performance in real time, adjustments to the scope or speed were made as necessary. Scope was adjusted by deploying additional wire until the gear made stable, consistent bottom contact according to the ITI display. The Simrad ITI also provided georeferenced trawl positions relative to ship position, supplying a means to track the trawl location along the seafloor throughout each tow.

A pair of bottom contact sensors (BCSs) and a secondary temperature/depth recorder (Seabird SBE39, Sea-Bird Electronics, Bellevue, Washington) were also deployed on every haul. The BCSs were attached 4 feet from the center point of the footrope on either side of the net. The BCSs recorded the angle of incline of the net, indicating when the net landed on and lifted off bottom, and provided redundancy in the event that the ITI failed to perform adequately. The Seabird temperature/depth recorder was attached to the head rope in an ABS plastic sleeve. The BCS and Seabird temperature/depth data were reviewed following every haul to provide additional information on bottom contact and trawl performance. In addition to monitoring trawl performance, the data from the sensor systems (Simrad ITI, BCS, and Seabird) were used to calculate net dimensions (net height and net width), duration of the tow, and distance fished.

While gear was being set, vessel speeds varied from 2.2 to 5 knots. After the net made contact with the bottom, vessel speed was targeted at 2.2 knots (±0.5 knots). The haul officially began when the net was in proper fishing configuration and maintained steady contact with the bottom. The haul ended when the net lifted off the bottom after the start of haul back. Tow duration was targeted at 15 minutes. The Simrad ITI trawl eye was used to monitor real-time, ground-gear contact during a haul, but the actual bottom time was determined using data from the BCS. Position data, collected at 2-second intervals for each haul using a GPS, were used to monitor ground speed, track the vessel path, and estimate distance fished. Average net speed over ground and distance fished were calculated from the position data and the trawl's actual bottom time. All features of the trawl event (i.e., from commencement of deployment of the net to completion of retrieval of the net), including net mensuration information, GPS data, trawl location, scope, vessel depth, trawl gear depth, and sea state conditions, were logged using a customized software program called Towlogger.

Following every haul, data were reviewed to determine a performance rating for each tow. A tow was classified as unsatisfactory if gear was severely damaged during a haul because damage to the gear might affect catch composition. Moreover, if gear performance was otherwise deemed unacceptable (e.g., large quantities of mud or jellyfish, lost or abandoned fishing gear ensnared in the net, net off bottom for an extended period during the tow, etc.), the tow was also rated as unsatisfactory. Unsatisfactory hauls were not used in the following analyses.

Sampling Procedures and Biological Data Collection

Catches were sorted to species or other appropriate taxonomic levels, then weighed in aggregate using an electronic, motion-compensated scale (Marel, Reykjavik, Iceland). Subsamples of important management species were randomly selected for individual measurements (length and weights) and biological sampling (age structures and sex determinations). Up to 100 sex determinations and length measurements (to the nearest centimeter) were collected per haul from each of these species. Although fork length (or total length) was generally measured for most species, anal length was recorded for Pacific grenadier (*Coryphaenoides acrolepis*) and spotted ratfish (*Hydrolagus colliei*).

Otoliths were most commonly removed to determine age; however, exceptions to the use of otoliths included collection of fin rays from lingcod (*Ophiodon elongates*) and second dorsal spines from spiny dogfish (*Squalus acanthias*). Fish were randomly selected for ageing from the subset of fish chosen for length determination. Up to 25 individuals per species were targeted for age structure removal per haul. Individual lengths and weights were collected from all fish selected for age structure removal. For other species, only total counts and aggregate weights were recorded, except when additional information was collected for special projects (including stomach contents, tissue samples, fecundity, and toxicology). Data were logged wirelessly into a ruggedized Itronix[3] notebook computer (Itronix Corp., Spokane Valley, Washington) using the Fisheries Scientific Computing System version 1.6.

Any unidentified species were labeled, frozen, or preserved in formalin, and retained for later identification. After collecting all biological data, marketable fish were placed in the hold of the vessel, iced, then delivered to a shoreside processing facility within 5 days. Species with no commercial value or those with catch prohibitions were returned to sea as soon as possible.

Survey Analysis

Sensor Data

Instrumentation played an important role in monitoring trawl performance, with mensuration data used to facilitate detection and correction of gear malfunction and to identify deviation from standardized fishing procedures. In addition to their role in evaluating trawl performance, three sensors—BCS, ITI, and GPS—provided data used to estimate effort following the completion of the survey. Because of the occasional erratic readings inherent to acoustic data, sensor streams were reviewed prior to use. The delivery rate of new readings was at times slower than the recording rate of the computer system receiving the signals, causing some sensor readings to be erroneously repeated multiple times. These readings appeared in the data record as persistent strings of varying lengths with constant values and prompted the review of all sensor streams for spurious readings.

Since persistent strings may distort the overall signal pattern, a variety of techniques was used to remove them, including statistical trimming methods and manual removal of data points. In particular, persistent strings that originated before and extended into the time intervals used for effort estimation were routinely removed manually prior to analysis. But for the most part, the phenomena under observation varied little during the on-bottom time period of interest and the overall pattern of sensor readings was not substantially distorted by moderate periods of data repetition. Therefore, we assumed that treating the members of a persistent string as independent samples within the sample set would not substantially affect the mean estimate. However, this assumption could result in underestimation of the standard error of the mean and, accordingly, standard error estimates were not reported for mean estimates.

Since sensor readings should be consistently present during a tow, recorded values of zero were treated as missing values and filtered prior to estimation of depth, net dimensions, and temperature. Exclusion of extreme points was more difficult. Large isolated spikes in depth, net dimension, and temperature readings were frequent and assumed to be the result of acoustic or electronic noise. They were removed prior to processing. When multiple extreme points occurred in sequence, they were more difficult to evaluate because large swings in sensor data are expected during tows over sloped and irregular substrates. Trawl execution problems also produced data sets with large fluctuations in readings. Consequently, extreme values recorded where expected, either as part of a continuous variation in magnitude or during a particularly variable stretch of readings, were not excluded prior to analysis.

To ensure reliability of on-bottom readings, sensor data used to estimate depth, net width, and height were restricted to a subset of values collected from the center 80% of the tow duration. In the vast majority of tows, this criterion did not appreciably reduce the number of observations, but did effectively exclude small timing offsets between the BCS and ITI sensor systems and noise introduced by net touchdown and liftoff.

For some tows, few sensor readings (depth, net dimension, and temperature) both fell within the estimation time interval and were satisfactorily unaffected by persistent data strings. The extent to which these single or few point subsamples were representative of the entire tow was necessarily a subjective judgment. If the points seemed in alignment with the trajectory of points outside the subset time interval, they were used as the basis for estimation. Hand-recorded notations at sea during a tow provided an additional level of data checking. These notations were subsequently evaluated and potentially impacted the decision whether to accept or reject a tow.

Net Mensuration

Tow duration was determined as the simple difference between the times marking touchdown and liftoff of the trawl net. Wherever possible, these times were derived from BCS traces of tow progression from net deployment to retrieval. Gaps left by unrecorded or otherwise suspect BCS information were filled using either patterns in ITI sensor readings, Seabird temperature/depth readings, or field party chief (FPC) observations of net touchdown and lift times.

In general, mean net widths and heights were calculated from trawl sensor readings of wingspread and headrope height from bottom respectively. Although electronically recorded sensor readings provided the preferred basis for estimation, hand-recorded readings were substituted when necessary. When neither data set provided sufficient information, estimates were calculated from linear regressions based on relationships developed using data from other tows. Net height (m) was initially regressed against tow depth (m), with vessel identification incorporated as an indicator variable. Net height predictions were subsequently made using robust linear regression (S-Plus 1999). Although the interaction between vessel identification and depth proved to be significant based on analysis of variance, it neither added appreciably to the proportion of explained variation nor produced coefficients that were significantly different from zero. Therefore, it was not included in the net height predictions. Net width predictions were made using multiple linear regressions incorporating trawl depth and inverse scope.

To estimate distance fished, the period of time a net was dragged over the seafloor was split into two distinct phases. The first phase, defined as normal towing, started when the net began fishing as it settled on the seafloor and ended when net haulback was initiated. The length of the first phase is controlled by the FPC and, unless problems occur, was maintained for 15 minutes. The second phase follows sequentially and represented the time required for the net to lift off the seafloor in response to the initiation of the haulback operation. Labeled liftoff lag, the length of this phase varied by vessel, depth, current, and bottom type.

Smoothing the trackline yielded a reasonable estimate of the location of the net and an estimate of towing distance for the normal towing phase. Typically, however, the vessel was not moving forward during the liftoff lag phase, and consequently the GPS sent erroneous bearing information to the ITI. Since 2003 this problem was corrected by using a gyroscope to input the vessel bearing information into the ITI.

Visual examination was used to determine the appropriate smoothness required for each haul. A default value for the smoothing parameter was applied in a majority of cases, including but not limited to tows done in a relatively straight line with good signals from the ITI system. The percent of tows for which the default smoothing parameter worked varied by vessel, but all vessels had extreme cases for which the default value was not used. Details of this procedure can be found in Wallace (2000a, 2000b). The trigonometric method, developed for the 1998 survey analysis (Turk et al. 2001, Wallace and West 2006), was used when there was insufficient information for the above procedure. Within the database, all net configuration estimates were tagged with qualifying information indicating the estimation method employed.

Wherever possible, gear depth and bottom depth were also estimated from electronically recorded trawl sensor readings of headrope depth and headrope distance from bottom. Gear depth was taken as the headrope depth sensor reading, and bottom depth was taken as the sum of headrope depth and headrope distance from bottom. Hand-recorded data sets were substituted as needed. For cases with sufficient high quality data, mean estimates were calculated using a subsample limited to the center 80% of the tow duration to ensure only on-bottom readings were included.

In a few cases, no acceptable data existed within the center 80% of the tow duration in either the electronically or hand-recorded sets of gear depth readings. For these tows, mean gear and bottom depths were estimated from observations just outside of the center 80% of tow duration. These estimates most likely fell within the limits of net touchdown and liftoff. For some tows, few to no coincident records of headrope depth and headrope distance from bottom existed. In these cases, if gear depth and net height were available for a tow, bottom depth was estimated as the sum of these two endpoints, regardless of how the separate estimates had been derived. In cases where no reasonable observation of gear depth was recorded, bottom depth was estimated from the vessel’s navigational equipment records if available. These estimates were identified with qualifying information within the database.

Area Estimates

Area estimates were calculated using digital bathymetry points acquired from Naval Oceanographic Office DBDB-V (Digital Bathymetric Data Base-Variable resolution), Version 2.0 (Naval Oceanographic Office, no date). The input data had variable resolutions of 5.0 minutes, 1.0 minute, and 0.5 minute. The data points were gridded at 1-minute pixel resolution and contour lines for the survey depth zones were created from this grid. The contour lines were created at 30, 100, 300, and 700 fm. Contour lines were then combined with INPFC area boundaries and the maximum latitudinal extent of the survey (32.5 decimal degrees or the U.S.-Mexico border in the south, and 48.25 decimal degrees or the exclusive economic zone in the north) to make polygons of each depth zone. Bathymetry data were projected to Albers Equal Area projection, and the total area of the seafloor in three depth zones (30−100 fm, 101−300 fm, and 301−700 fm) and the five INPFC areas were calculated. Note that any areas westward of the primary 700 fm contour (e.g., seamounts) or eastward of the primary 30 fm contour were not included in the area calculations, even if they were between a 30 fm and 700 fm depth.

Temperature

Water temperature was recorded during each tow using a Simrad ITI temperature sensor (accuracy $\pm$0.2°C) and a Seabird temperature sensor (accuracy $\pm$0.002°C) mounted in the mouth of the net. The output sensor pattern indicated the Simrad sensor required the full duration of the tow to acclimate. Because the Seabird demonstrated higher accuracy and faster acclimation time than the Simrad sensor, bottom temperature was estimated as the mean of the Seabird sensor readings taken while the net was on bottom. If Seabird data were missing, bottom temperature was estimated from the Simrad sensor, based on data collected during the final 10% of the tow duration. Surface temperature was recorded using a thermometer in the surface water at the start of each tow.

Relative Density and Biomass Estimates

Relative density was calculated as catch per unit effort (CPUE) for individual species in each INPFC area and depth stratum by dividing total catch weight (kg) per species by area swept (ha) per tow,

$$\text{CPUE} = \text{C/A} \qquad (1)$$

where CPUE is catch per unit effort in kg/ha, C is catch per tow in kg for a given species, and A is area swept (ha).

Mean estimates were initially calculated for each depth stratum within an INPFC area by averaging all tows, including those with zero catch, by species. To estimate mean CPUE by species for the total area (all INPFC areas combined), depth strata (shallow and deep for all areas combined), and the individual INPFC areas (depth strata combined within areas), the initial means were weighted using the appropriate areas within each stratum. Mean biomass estimates (metric tons) were similarly calculated by multiplying the weighted mean CPUE for total area, depth strata, or INPFC region by the appropriate area of the stratum or region,

$$\hat{b} = \sum_{i=1}^{n} (\overline{CPUE_i} \times A_i)/1000 \qquad (2)$$

where $\hat{b}$ is the mean biomass estimate in metric tons, $\overline{CPUE}$ is the mean CPUE in kg/ha calculated as noted above by weighting the initial mean by area, A is area of the stratum or region in ha, and n = 3 when depth strata (shallow, mid depth, and deep) were combined within an INPFC area or n = 5 if individual INPFC areas were combined or if depth strata for all areas were combined (see above). Variance for mean biomass estimates (within and among INPFC areas and depth strata) was calculated as

$$\text{Var}\ (\hat{b}) = \sum_{i=1}^{n} (Var(\overline{CPUE}_i) \times A_i^2) \qquad (3)$$

after first adjusting for differences in units and with symbols as defined in Equation 2. Coefficients of variation (CV) were calculated for biomass estimates using the standard error (standard deviation/number sampled) divided by the mean biomass estimate.

Results

Haul, Catch, and Biological Data

The 2004 WCGTS was designed to incorporate 540 primary sampling locations, with 567 tows subsequently attempted, including failed tows, aborted tows, or tows at secondary or tertiary sites. A total of 505 tows were successfully sampled. Simard ITI net mensuration data, as well as GPS course and position data and bottom-contact sensor data, were obtained from most of the successful tows. Table 1 shows the latitudinal boundaries, depth-strata areas (km^2), and sampling densities (hauls/1,000 km^2) by INPFC statistical area based on successful tows.

Mean net widths (m) and distances fished (km) were calculated for each haul. When net mensuration data were available, the mean net width for each tow was calculated based on 80% of the tow duration, excluding the initial and final 10% of the tow time. Distances fished were calculated by estimating the length the net traveled on the seafloor from the point where it touched down to the point where it lifted off. An overall mean width of 13.80 m was calculated using data from the 505 hauls that both exhibited good trawl performance and had available net mensuration estimates. The mean net widths ranged from 10.65 m to 16.29 m with a standard deviation of 0.96 m. When the net mensuration instrumentation was not functioning properly, the mean net width per tow was calculated using multiple linear regressions as a function of trawl depth and inverse scope for the individual chartered vessel (Figure 4).

The number of lengths and age structures collected from groundfish species are summarized in Table 2. Individual length measurements were collected from 75 groundfish species, while age structures were collected from 53 species. A total of 133,303 length measurements were made and 22,366 individuals had age structures removed. The number of lengths collected ranged from 1 to 18,324 measurements per species, while the number of age structures collected ranged from 1 to 2,631 structures per species. The species with the greatest number of measurements and age structures included Dover sole (*Microstomus pacificus*), Pacific sanddab (*Citharichthys sordidus*), petrale sole (*Eopsetta jordani*), English sole (*Parophrys vetulus*), rex sole (*Glyptocephalus zachirus*), sablefish (*Anoplopoma fimbria*), longspine thornyhead (*Sebastolobus altivelis*) , shortspine thornyhead (*S. alascanus*), chilipepper rockfish (*Sebastes goodei*), splitnose rockfish (*S. diploproa*), and stripetail rockfish (*S. saxicola*).

A total of 587 unique taxa were identified over the entire survey area, with 253 species or groups of fish and the remaining invertebrates. The frequency of occurrence, depth range, mean depth, and latitudinal range for all of the identified organisms are listed in Table 3. Unidentified species or groups are referred to as “unident.” in the tables and figures following the text.

Table 1. Latitude boundaries, depth stratum areas (km^2), and sampling densities by INPFC statistical area based on successful tows during the 2004 West Coast groundfish trawl survey.

Latitude bounds	Stratum 1 (55–183 m)			Stratum 2 (184–549 m)			Stratum 3 (550–1,280 m)			All Strata 1 (55–1,280 m)		
	Area (km^2)	No. hauls	Hauls/ 1,000 km^2	Area (km^2)	No. hauls	Hauls/ 1,000 km^2	Area (km^2)	No. hauls	Hauls/ 1,000 km^2	Area (km^2)	No. hauls	Hauls/ 1,000 km^2
U.S.-Vancouver 47°30′–Border	2,318	29	12.51	2,853	8	2.80	2,286	6	3.50	7,457	46	5.77
Columbia 43°00′–47°30′	14,413	84	5.83	8,621	50	5.80	9,804	28	5.71	32,838	162	4.93
Eureka 40°30′–43°00′	4,069	20	4.92	2,034	12	5.90	6,365	25	6.44	12,467	57	4.57
Monterey 36°00′–40°30′	8,605	59	6.86	3,650	17	4.66	8,646	21	7.06	20,902	97	4.64
Conception 32°30′–36°00′	6,994	47	6.72	12,839	46	3.58	42,041	53	1.31	61,874	146	2.36
Entire survey area 32°30′–Border	36,399	239	6.57	29,997	133	4.43	69,142	133	3.20	135,538	508	3.73

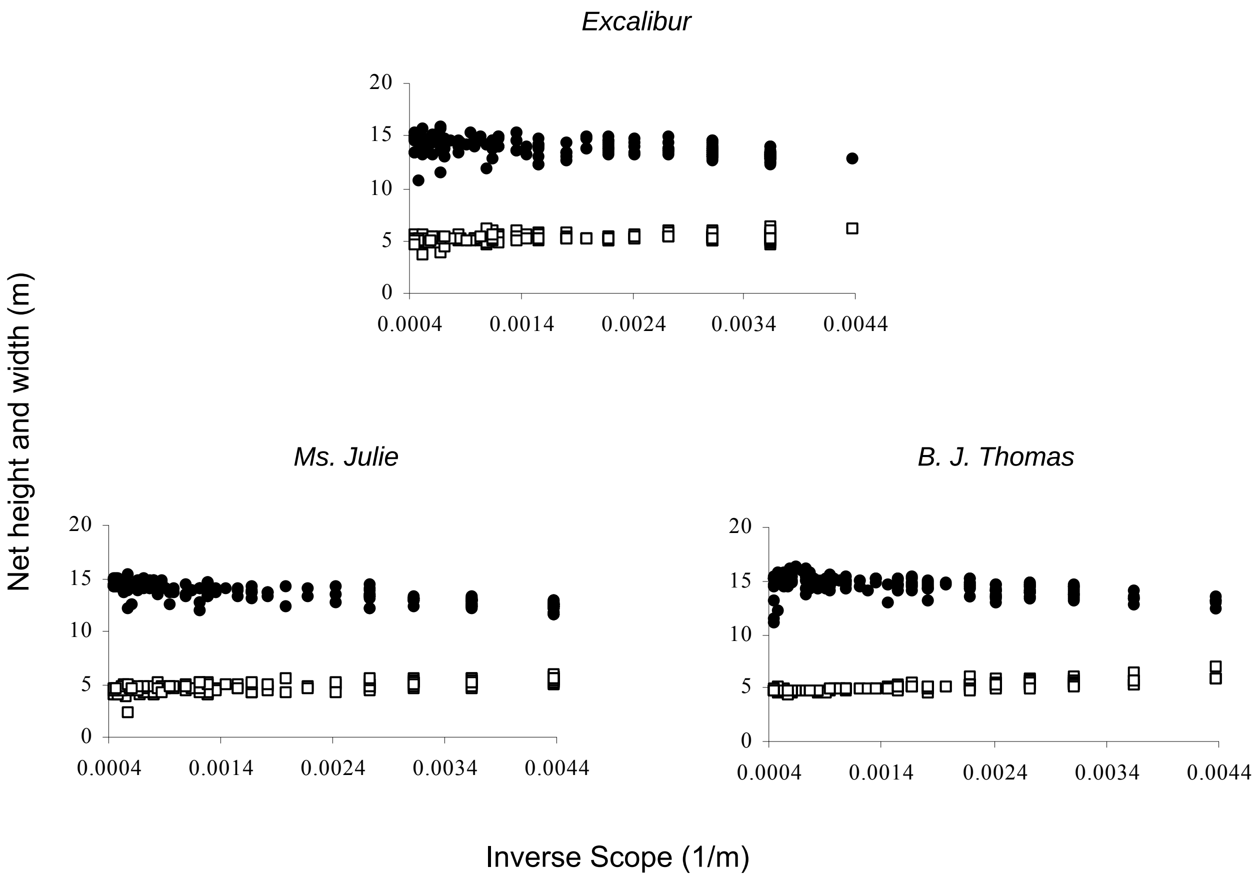


Figure 4. Mean net width (m) and height (m) for trawls conducted as part of the 2004 West Coast groundfish trawl survey. Estimates are grouped by vessel and plotted relative to net width (•) and net height (□) in meters. Prediction from multiple linear regression of width against net height and inverse scope (1/meters) and factored by vessel was used to estimate net widths for tows lacking direct width observations (FV *Excalibur*: Net width = 18.69 – 0.804 × net height – 337.5 × inverse scope; FV *Ms. Julie*: Net width = 19.31 – 1.111 × net height – 270.3 × inverse scope; FV *B.J. Thomas*: Net width = 18.44 – 0.606 × net height – 481.3 × inverse scope).

Table 2. Number of individual length measurements and age structures collected by species during the 2004 West Coast groundfish trawl survey. Note: we collected dorsal spines for spiny dogfish, dorsal finrays for lingcod, and otoliths for all other species.

Species	Lengths	Ages	Species	Lengths	Ages	Species	Lengths	Ages
Brown smoothhound	1	0	Pacific cod	304	0	Greenstriped rockfish	2,723	546
Smoothhounds	3	0	Lingcod	1,463	926	Halfbanded rockfish	1,704	450
Spiny dogfish	2,647	598	Kelp greenling	97	0	Honeycomb rockfish	16	16
Bering skate	45	0	Pacific hake	3,916	0	Mexican rockfish	1	0
Big skate	308	0	Chinook salmon	24	24	Olive rockfish	1	1
California skate	496	0	Shortspine thornyhead	6,964	1,799	Pacific ocean perch	565	219
Longnose skate	2,666	0	Longspine thornyhead	12,594	839	Pygmy rockfish	171	46
Starry skate	15	0	Aurora rockfish	1,185	366	Redbanded rockfish	159	145
Arrowtooth flounder	2,785	723	Bank rockfish	123	77	Redstripe rockfish	527	179
Butter sole	19	0	Black rockfish	1	1	Rosethorn rockfish	1,003	353
Curlfin sole	668	0	Blackgill rockfish	467	190	Rosy rockfish	3	3
Dover sole	18,324	2,631	Blue rockfish	2	2	Rougheye rockfish	115	78
English sole	9,158	1,029	Bocaccio	497	226	Sharpchin rockfish	1,176	199
Flathead sole	519	0	Brown rockfish	43	43	Shortbelly rockfish	2,920	479
Hornyhead turbot	4	0	Calico rockfish	84	84	Shortraker rockfish	8	8
Pacific sanddab	12,775	1,655	California scorpionfish	190	0	Silvergray rockfish	19	19
Pacific halibut	31	0	Canary rockfish	577	316	Splitnose rockfish	5,230	438
Petrale sole	3,547	2,011	Chilipepper rockfish	3,803	856	Squarespot rockfish	166	26
Rex sole	14,793	0	Copper rockfish	76	76	Starry rockfish	3	3
Sand sole	87	0	Cowcod	70	70	Stripetail rockfish	4,857	504
Southern rock sole	196	0	Darkblotched rockfish	1,062	595	Swordspine rockfish	330	74
Starry flounder	55	49	Flag rockfish	33	33	Vermilion rockfish	20	19
Fangtooth	1	0	Gopher rockfish	1	0	Widow rockfish	182	58
Sablefish	4,831	2,305	Greenblotched rockfish	59	59	Yelloweye rockfish	21	21
Pacific grenadier	2,497	406	Greenspotted rockfish	574	290	Yellowtail rockfish	703	203

Table 3. Frequency of occurrence, depth, and latitudinal ranges for fish and invertebrate species, grouped by family (or higher taxonomic classification), caught during the 2004 West Coast groundfish trawl survey.

Family and scientific name	Common name	Frequency of occurrence (No. hauls)	Depth (m)			Latitudinal range (dd)	
			Min.	Max.	Mean	South	North
Petromyzontidae							
Petromyzontidae	Lamprey unident.	1	99	99	99	44.30	44.30
Lampetra tridentata	Pacific lamprey	1	295	295	295	43.68	43.68
Myxinidae							
Myxinidae	Hagfish unident.	70	60	1,297	739	32.86	47.80
Eptatretus deani	Black hagfish	13	166	1,206	879	32.85	48.09
E. stoutii	Pacific hagfish	15	323	1,155	797	34.45	48.21
Chimaeridae							
Hydrolagus colliei	Spotted ratfish	267	52	711	169	32.59	48.37
Triakidae							
Triakidae	Smoothhound unident.	3	67	128	89	33.95	34.73
Galeorhinus galeus	Soupfin shark	1	82	82	82	36.25	36.25
Mustelus californicus	Gray smoothhound	8	58	91	74	32.71	38.78
M. henlei	Brown smoothhound	11	53	165	106	32.59	46.15
Scyliorhinidae							
Apristurus sp.	Cat shark unident.	2	512	571	541	34.26	34.28
A. brunneus	Brown cat shark	163	136	1,188	693	32.75	48.21
A. kampae	Longnose cat shark	6	273	1,205	920	32.63	34.63
Cephaloscyllium ventriosum	Swell shark	3	80	117	94	32.96	34.23
Parmaturus xaniurus	Filetail cat shark	43	276	792	490	32.75	36.94
Hexanchidae							
Hexanchus griseus	Sixgill shark	4	79	406	295	34.23	38.18
Somnosidae							
Somniosus pacificus	Pacific sleeper shark	2	637	1,039	838	35.73	39.60
Squalidae							
Squalidae	Dogfish shark unident.	1	1,188	1,188	1,188	33.58	33.58
Squalus acanthias	Spiny dogfish	177	52	859	155	32.67	48.37

Table 3 continued. Frequency of occurrence, depth, and latitudinal ranges for fish and invertebrate species, grouped by family (or higher taxonomic classification), caught during the 2004 West Coast groundfish trawl survey.

Family and scientific name	Common name	Frequency of occurrence (No. hauls)	Depth (m)			Latitudinal range (dd)	
			Min.	Max.	Mean	South	North
Squatinidae							
Squatina californica	Pacific angel shark	2	63	80	71	32.96	34.32
Etmopteridae							
Centroscyllium nigrum	Combtooth dogfish	1	1,186	1,186	1,186	33.08	33.08
Shark egg cases							
Shark egg case	Shark egg case unident.	3	235	385	299	42.16	43.03
Apristurus brunneus egg case	Cat shark egg case	15	123	429	304	33.57	48.20
Torpedinidae							
Torpedo californica	Pacific electric ray	40	53	1,050	154	32.61	45.40
Rajidae							
Raja binoculata	Big skate	91	52	237	104	34.51	48.36
R. inornata	California skate	67	53	385	98	32.59	40.57
R. rhina	Longnose skate	296	52	1,162	247	32.59	48.37
R. stellulata	Starry skate	11	63	591	129	35.65	44.57
Arhynchobatidae							
Bathyraja sp.	Skate unident.	13	657	1,206	946	33.01	47.69
B. abyssicola	Deepsea skate	1	1,428	1,428	1,428	47.49	47.49
B. interrupta	Bering skate	173	52	1,114	265	32.59	48.37
B. trachura	Roughtail skate	51	246	1,428	960	32.63	48.21
Skate egg cases							
B. sp.	Skate egg case unident.	5	69	1,011	309	46.90	47.67
Raja sp.	Skate egg case unident.	21	63	1,011	186	34.32	48.00
R. binoculata	Big skate egg case	2	84	1,032	558	34.49	47.72
Rajidae	Skate egg case unident.	72	57	1,197	291	33.91	48.23
Acipenseridae							
Acipenser medirostris	Green sturgeon	1	53	53	53	44.66	44.66
Anguilliformes (order)							
Anguilliformes	Eel unident.	1	743	743	743	34.62	34.62

Table 3 continued. Frequency of occurrence, depth, and latitudinal ranges for fish and invertebrate species, grouped by family (or higher taxonomic classification), caught during the 2004 West Coast groundfish trawl survey.

Family and scientific name	Common name	Frequency of occurrence (No. hauls)	Depth (m)			Latitudinal range (dd)	
			Min.	Max.	Mean	South	North
Nemichthyidae							
Nemichthyidae	Snipe eel unident.	2	552	864	708	32.86	33.46
Avocettina infans	Blackline snipe eel	5	825	1,186	957	33.08	40.05
Nemichthys scolopaceus	Slender snipe eel	2	691	848	769	33.22	33.32
N. larseni	Pale snipe eel	1	711	711	711	47.43	47.43
Serrivomeridae							
Serrivomer sector	Sawtooth eel	6	846	1,206	1,102	33.08	39.91
Nettastomatidae							
Facciolella gilbertii	Dogface witch-eel	2	371	400	385	34.26	34.30
Clupeidae							
Alosa sapidissima	American shad	86	52	440	109	34.51	48.36
Clupea pallasii	Pacific herring	54	53	189	97	34.86	48.36
Sardinops sagax	Pacific sardine	14	53	204	97	34.23	48.23
Engraulidae							
Engraulidae	Anchovy unident.	8	53	184	97	34.27	46.13
Engraulis mordax	Northern anchovy	20	57	358	112	33.26	47.26
Argentinidae							
Argentinidae	Argentine unident.	1	96	96	96	42.09	42.09
Argentina sialis	Pacific argentine	25	60	907	198	32.59	42.63
Microstomatidae							
Nansenia candida	Bluethroat argentine	1	885	885	885	40.14	40.14
Bathylagidae							
Bathylagidae	Deepsea smelt unident.	61	568	1,279	931	32.63	47.81
Bathylagus sp.	Blacksmelt unident.	37	562	1,428	890	33.08	47.99
Pseudobathylagus milleri	Robust blacksmelt	1	957	957	957	45.67	45.67
Bathylagus pacificus	Pacific blacksmelt	1	894	894	894	33.30	33.30
Leuroglossus schmidti	Northern smoothtongue	2	397	743	570	34.36	34.62
L. stilbius	California smoothtongue	16	437	910	624	32.75	37.48

Table 3 continued. Frequency of occurrence, depth, and latitudinal ranges for fish and invertebrate species, grouped by family (or higher taxonomic classification), caught during the 2004 West Coast groundfish trawl survey.

Family and scientific name	Common name	Frequency of occurrence (No. hauls)	Depth (m)			Latitudinal range (dd)	
			Min.	Max.	Mean	South	North
Opisthoproctidae							
Opisthoproctidae	Spookfish unident.	2	698	885	792	36.88	40.14
Macropinna microstoma	Barreleye	1	828	828	828	43.32	43.32
Platytroctidae							
Platytroctidae	Tubeshoulder unident.	1	885	885	885	40.14	40.14
Sagamichthys abei	Shining tubeshoulder	2	588	589	589	32.75	42.30
Alepocephalidae							
Alepocephalus tenebrosus	California slickhead	106	506	1,279	907	32.63	47.81
Talismania bifurcata	Threadfin slickhead	30	621	1,054	840	32.86	47.72
Osmeridae							
Osmeridae	Smelt unident.	6	64	579	242	34.19	43.45
Allosmerus elongatus	Whitebait smelt	10	62	144	94	37.56	43.98
Osmerus mordax	Rainbow smelt	2	61	65	63	48.15	48.36
Spirinchus starksi	Night smelt	10	53	163	93	37.15	48.04
Thaleichthys pacificus	Eulachon	40	55	220	119	34.51	48.23
Salmonidae							
Oncorhynchus tshawytscha	Chinook salmon	15	62	157	95	37.36	48.06
Gonostomatidae							
Gonostomatidae	Bristlemouth unident.	2	1,151	1,186	1,169	33.08	41.24
Sternoptychidae							
Sternoptychidae (subfamily)	Hatchetfish unident.	4	454	969	774	33.27	43.32
Argyropelecus sp.	Hatchetfish unident.	3	569	1,205	879	32.63	34.91
A. affinis	Slender hatchetfish	3	419	792	600	32.75	35.28
Sternoptyx diaphana	Longspine hatchetfish	3	864	1,205	1,090	32.63	32.86
Stomiidae							
Chauliodontinae (subfamily)	Viperfish unident.	10	547	1,197	858	33.68	47.81
Melanostomiinae	Scaleless dragonfish unident.	2	412	664	538	43.64	47.69
Aristostomias scintillans	Shining loosejaw	8	371	1,040	689	34.30	44.97

Table 3 continued. Frequency of occurrence, depth, and latitudinal ranges for fish and invertebrate species, grouped by family (or higher taxonomic classification), caught during the 2004 West Coast groundfish trawl survey.

Family and scientific name	Common name	Frequency of occurrence (No. hauls)	Depth (m)			Latitudinal range (dd)	
			Min.	Max.	Mean	South	North
Chauliodus macouni	Pacific viperfish	51	176	1,297	818	32.96	47.75
Idiacanthus antrostomus	Pacific black dragon	13	311	969	714	32.75	40.14
Stomias atriventer	Blackbelly dragonfish	12	177	1,186	698	32.75	37.15
Tactostoma macropus	Longfin dragonfish	29	384	1,162	787	37.27	47.99
Notosudidae							
Scopelosaurus harryi	Scaly paperbone	1	667	667	667	37.07	37.07
Paralepididae							
Magnisudis atlantica	Duckbill barracudina	1	702	702	702	45.94	45.94
Synodontidae							
Synodus lucioceps	California lizardfish	9	55	79	65	32.61	34.01
Myctophidae							
Myctophidae	Lanternfish unident.	94	119	1,206	649	32.63	47.67
Diaphus theta	California headlightfish	14	157	1,151	534	39.38	47.62
Nannobrachium ritteri	Broadfin lanternfish	2	397	602	499	44.51	47.80
Lampanyctus sp.	Lanternfish unident.	65	404	1,428	861	32.63	48.21
Stenobrachius leucopsarus	Northern lampfish	6	454	1,297	772	37.15	46.42
Symbolophorus californiensis	California lanternfish	2	602	894	748	33.30	44.51
Tarletonbeania crenularis	Blue lanternfish	3	119	794	452	38.89	45.44
Ophidiidae							
Chilara taylori	Spotted cusk-eel	19	53	269	159	33.45	44.37
Lamprogrammus niger	Paperbone cusk-eel	3	878	1,184	1,077	33.01	33.67
Macrouridae							
Macrouridae	Grenadier unident.	1	388	388	388	34.37	34.37
Albatrossia pectoralis	Giant grenadier	90	506	1,428	923	32.63	47.99
Caelorinchus scaphopsis	Shoulderspot grenadier	1	166	166	166	34.51	34.51
Coryphaenoides acrolepis	Pacific grenadier	98	476	1,428	905	32.63	47.99
C. cinereus	Popeye grenadier	6	786	1,297	1,063	43.68	47.81
Nezumia liolepis	Smooth grenadier	26	432	1,188	860	32.86	35.28

Table 3 continued. Frequency of occurrence, depth, and latitudinal ranges for fish and invertebrate species, grouped by family (or higher taxonomic classification), caught during the 2004 West Coast groundfish trawl survey.

Family and scientific name	Common name	Frequency of occurrence (No. hauls)	Depth (m)			Latitudinal range (dd)	
			Min.	Max.	Mean	South	North
N. stelgidolepis	California grenadier	22	432	1,201	632	32.75	43.95
Melanonidae							
Melanonus zugmayeri	Arrowtail	1	848	848	848	33.22	33.22
Moridae							
Antimora microlepis	Pacific flatnose	112	404	1,428	887	32.63	48.21
Physiculus rastrelliger	Hundred fathom codling	2	295	358	326	33.53	33.54
Merlucciidae							
Merluccius productus	Pacific hake	330	52	1,162	260	32.59	48.37
Gadidae							
Microgadus proximus	Pacific tomcod	39	53	108	80	37.15	48.36
Gadus macrocephalus	Pacific cod	50	61	285	138	44.13	48.36
Theragra chalcogramma	Walleye pollock	1	191	191	191	48.37	48.37
Batrachoididae							
Porichthys notatus	Plainfin midshipman	81	52	240	102	32.83	46.99
Oneirodidae							
Oneirodidae	Dreamer unident.	4	691	1,188	920	33.32	45.39
Chaenophryne draco	Smooth dreamer	1	1,016	1,016	1,016	45.23	45.23
Melamphaidae							
Melamphaes lugubris	Highsnout bigscale	2	781	1,201	991	32.85	37.29
Poromitra crassiceps	Crested bigscale	24	552	1,428	956	32.75	47.81
Anoplogastridae							
Anoplogastridae	Fangtooth unident.	1	848	848	848	33.22	33.22
Anoplogaster cornuta	Fangtooth	8	803	1,201	1,011	32.85	44.06
Scorpaenidae							
Scorpaenidae	Scorpionfish, rockfish unident.	1	117	117	117	33.01	33.01
Scorpaena guttata	California scorpionfish	20	55	130	78	32.61	34.32
Sebastes sp.	Rockfish unident.	21	54	512	164	32.67	43.21
S. aleutianus	Rougheye rockfish	28	127	664	319	33.57	48.16

Table 3 continued. Frequency of occurrence, depth, and latitudinal ranges for fish and invertebrate species, grouped by family (or higher taxonomic classification), caught during the 2004 West Coast groundfish trawl survey.

Family and scientific name	Common name	Frequency of occurrence (No. hauls)	Depth (m)			Latitudinal range (dd)	
			Min.	Max.	Mean	South	North
Sebastes alutus	Pacific ocean perch	36	130	497	293	42.16	48.20
S. auriculatus	Brown rockfish	8	62	88	75	36.95	38.47
S. aurora	Aurora rockfish	57	326	645	457	32.75	46.47
S. babcocki	Redbanded rockfish	38	154	506	285	34.63	47.96
S. borealis	Shortraker rockfish	3	401	555	471	44.92	48.21
S. brevispinis	Silvergray rockfish	3	67	276	199	42.16	47.93
S. carnatus	Gopher rockfish	1	58	58	58	35.52	35.52
S. caurinus	Copper rockfish	6	64	108	91	34.13	37.12
S. chlorostictus	Greenspotted rockfish	30	72	254	133	32.59	48.23
S. constellatus	Starry rockfish	3	86	141	113	33.71	37.20
S. crameri	Darkblotched rockfish	92	100	417	220	34.63	47.80
S. dalli	Calico rockfish	11	58	86	67	32.61	37.63
S. diploproa	Splitnose rockfish	102	127	519	293	32.73	47.93
S. elongatus	Greenstriped rockfish	144	86	447	155	32.59	48.37
S. ensifer	Swordspine rockfish	3	141	196	175	33.71	33.82
S. entomelas	Widow rockfish	13	64	366	190	34.37	47.97
S. flavidus	Yellowtail rockfish	28	63	181	134	35.65	48.23
S. goodei	Chilipepper rockfish	89	60	371	149	32.67	45.73
S. helvomaculatus	Rosethorn rockfish	41	67	447	220	33.71	48.30
S. hopkinsi	Squarespot rockfish	8	59	125	91	32.61	37.20
S. jordani	Shortbelly rockfish	56	60	406	174	32.73	44.44
S. lentiginosus	Freckled rockfish	1	88	88	88	33.78	33.78
S. levis	Cowcod	23	100	273	155	33.34	38.78
S. macdonaldi	Mexican rockfish	1	269	269	269	33.91	33.91
S. melanops	Black rockfish	1	70	70	70	40.81	40.81
S. melanostomus	Blackgill rockfish	21	302	568	424	32.73	45.47
S. miniatus	Vermilion rockfish	6	58	126	78	32.61	37.12
S. mystinus	Blue rockfish	1	64	64	64	35.65	35.65

Table 3 continued. Frequency of occurrence, depth, and latitudinal ranges for fish and invertebrate species, grouped by family (or higher taxonomic classification), caught during the 2004 West Coast groundfish trawl survey.

Family and scientific name	Common name	Frequency of occurrence (No. hauls)	Depth (m)			Latitudinal range (dd)	
			Min.	Max.	Mean	South	North
Sebastes paucispinis	Bocaccio	35	60	326	150	32.59	39.88
S. pinniger	Canary rockfish	42	54	220	135	34.13	48.37
S. proriger	Redstripe rockfish	15	67	235	141	42.62	48.23
S. rosaceus	Rosy rockfish	1	292	292	292	34.75	34.75
S. rosenblatti	Greenblotched rockfish	9	63	326	190	32.59	37.27
S. ruberrimus	Yelloweye rockfish	8	111	250	168	39.88	47.97
S. rubrivinctus	Flag rockfish	11	55	196	128	32.59	36.76
S. rufus	Bank rockfish	9	141	370	258	33.71	36.26
S. saxicola	Stripetail rockfish	119	65	397	173	32.59	47.54
S. semicinctus	Halfbanded rockfish	51	57	269	108	32.59	44.37
S. serranoides	Olive rockfish	1	103	103	103	37.36	37.36
S. umbrosus	Honeycomb rockfish	1	72	72	72	32.61	32.61
S. wilsoni	Pygmy rockfish	5	67	180	120	44.28	48.20
S. zacentrus	Sharpchin rockfish	33	100	404	222	36.76	48.30
Sebastolobus alascanus	Shortspine thornyhead	238	96	1,297	630	32.63	48.37
S. altivelis	Longspine thornyhead	174	254	1,428	782	32.63	48.21
Triglidae							
Bellator xenisma	Splitnose sea robin	1	66	66	66	33.37	33.37
Prionotus stephanophrys	Lumptail sea robin	2	60	184	122	33.26	33.34
Anoplopomatidae							
Anoplopoma fimbria	Sablefish	360	52	1,428	461	32.63	48.37
Hexagrammidae							
Hexagrammos decagrammus	Kelp greenling	12	60	130	98	43.61	48.23
Ophiodon elongatus	Lingcod	188	53	327	132	32.73	48.36
Zaniolepis frenata	Shortspine combfish	11	79	269	146	32.67	36.74
Z. latipinnis	Longspine combfish	61	53	238	91	32.59	38.38
Cottidae							
Cottidae	Sculpin unident.	2	80	196	138	33.82	46.97

Table 3 continued. Frequency of occurrence, depth, and latitudinal ranges for fish and invertebrate species, grouped by family (or higher taxonomic classification), caught during the 2004 West Coast groundfish trawl survey.

Family and scientific name	Common name	Frequency of occurrence (No. hauls)	Depth (m)			Latitudinal range (dd)	
			Min.	Max.	Mean	South	North
Chitonotus pugetensis	Roughback sculpin	10	60	91	73	32.96	44.83
Enophrys bison	Buffalo sculpin	1	120	120	120	48.23	48.23
E. taurina	Bull sculpin	4	58	67	62	35.52	37.75
Gymnocanthus pistilliger	Threaded sculpin	3	115	170	143	43.55	47.86
Hemilepidotus spinosus	Brown Irish lord	1	63	63	63	38.21	38.21
Icelinus burchami	Dusky sculpin	2	235	250	243	44.67	45.73
I. filamentosus	Threadfin sculpin	32	67	375	176	33.76	48.20
I. fimbriatus	Fringed sculpin	2	180	326	253	33.82	45.79
I. tenuis	Spotfin sculpin	1	67	67	67	44.49	44.49
Leptocottus armatus	Pacific staghorn sculpin	5	52	88	65	37.56	46.99
Radulinus asprellus	Slim sculpin	3	102	157	128	38.31	41.65
Psychrolutidae							
Psychrolutes phrictus	Blob sculpin	1	1,162	1,162	1,162	42.29	42.29
Agonidae							
Agonidae	Poacher unident.	5	70	302	145	32.67	41.25
Bathyagonus nigripinnis	Blackfin poacher	23	117	957	549	35.23	48.21
B. pentacanthus	Bigeye poacher	14	53	1,197	371	37.06	47.93
Chesnonia verrucosa	Warty poacher	3	63	64	63	41.90	47.89
Xeneretmus latifrons	Blacktip poacher	14	132	475	255	32.73	47.54
Liparidae							
Liparidinae	Snailfish unident.	2	645	1,162	904	34.17	42.29
Careproctus sp.	Snailfish unident.	3	903	1,115	990	41.07	47.54
C. cypselurus	Blackfin snailfish	10	698	1,235	1,038	33.41	45.39
C. gilberti	Smalldisk snailfish	3	385	672	511	38.21	43.95
C. melanurus	Blacktail snailfish	95	163	1,054	542	32.73	48.10
Paraliparis cephalus	Swellhead snailfish	15	577	1,206	894	33.41	47.69
P. dactylosus	Red snailfish	6	596	1,097	800	33.17	47.62
Rhinoliparis barbulifer	Longnose snailfish	2	868	1,184	1,026	33.50	40.10

Table 3 continued. Frequency of occurrence, depth, and latitudinal ranges for fish and invertebrate species, grouped by family (or higher taxonomic classification), caught during the 2004 West Coast groundfish trawl survey.

Family and scientific name	Common name	Frequency of occurrence (No. hauls)	Depth (m)			Latitudinal range (dd)	
			Min.	Max.	Mean	South	North
Serranidae							
Paralabrax nebulifer	Barred sand bass	3	58	65	61	32.71	34.01
Carangidae							
Trachurus symmetricus	Jack mackerel	8	58	119	86	32.71	41.58
Sciaenidae							
Genyonemus lineatus	White croaker	48	53	130	82	32.61	38.47
Seriphus politus	Queenfish	1	66	66	66	33.37	33.37
Embiotocidae							
Embiotocidae	Surfperch unident.	3	60	91	70	34.01	36.12
Amphistichus argenteus	Barred surfperch	1	53	53	53	37.15	37.15
A. rhodoterus	Redtail surfperch	1	60	60	60	34.01	34.01
Cymatogaster aggregata	Shiner perch	29	53	102	76	32.61	41.25
Embiotoca lateralis	Striped surfperch	1	63	63	63	34.32	34.32
Hyperprosopon anale	Spotfin surfperch	6	53	74	66	34.70	37.63
Phanerodon furcatus	White surfperch	2	62	86	74	37.12	37.96
Zalembius rosaceus	Pink sea perch	82	53	184	91	32.59	39.33
Bathymasteridae							
Ronquilus jordani	Northern ronquil	1	120	120	120	48.23	48.23
Uranoscopidae							
Kathetostoma averruncus	Smooth stargazer	6	75	148	113	32.59	34.28
Zoarcidae							
Zoarcidae	Eelpout unident.	2	397	601	499	34.36	39.54
Bothrocara brunneum	Twoline eelpout	89	506	1,428	879	32.63	48.21
Eucryphycus californicus	Persimmon eelpout	1	349	349	349	34.32	34.32
Lycenchelys crotalinus	Snakehead eelpout	74	591	1,297	922	32.85	47.99
Lycodapus endemoscotus	Deepwater eelpout	5	460	1,197	726	34.28	47.81
L. fierasfer	Blackmouth eelpout	2	743	965	854	34.51	34.62
Lycodes cortezianus	Bigfin eelpout	156	57	1,162	323	32.75	47.80

Table 3 continued. Frequency of occurrence, depth, and latitudinal ranges for fish and invertebrate species, grouped by family (or higher taxonomic classification), caught during the 2004 West Coast groundfish trawl survey.

Family and scientific name	**Common name**	**Frequency of occurrence (No. hauls)**	**Depth (m)**			**Latitudinal range (dd)**	
			Min.	Max.	Mean	South	North
L. diapterus	Black eelpout	77	130	1,162	486	32.59	48.33
L. pacificus	Blackbelly eelpout	72	52	349	128	32.67	48.37
Lycodapus sp.	Eelpout unident.	1	371	371	371	34.30	34.30
Cryptacanthodidae							
Cryptacanthodes giganteus	Giant wrymouth	2	158	290	224	46.03	48.16
Anarhichadidae							
Anarrhichthys ocellatus	Wolf-eel	6	54	108	74	33.58	44.56
Chiasmodontidae							
Chiasmodontidae	Swallower unident.	1	848	848	848	33.22	33.22
Chiasmodon niger	Black swallower	3	1,097	1,186	1,156	33.08	33.50
Icosteidae							
Icosteus aenigmaticus	Ragfish	1	1,201	1,201	1,201	32.85	32.85
Trichiuridae							
Aphanopus carbo	Black scabbardfish	1	667	667	667	37.07	37.07
Lepidopus caudatus	Scabbardfish	3	163	295	237	33.50	34.42
Scombridae							
Scomber japonicus	Chub mackerel	8	63	752	182	32.59	34.27
Stromateidae							
Peprilus simillimus	Pacific butterfish	37	53	128	77	32.61	47.37
Paralichthyidae							
Citharichthys sordidus	Pacific sanddab	190	52	3025	103	32.59	48.36
C. xanthostigma	Longfin sanddab	13	58	125	72	32.61	34.32
Pleuronectidae							
Atheresthes stomias	Arrowtooth flounder	182	52	1,111	196	38.17	48.37
Embassichthys bathybius	Deepsea sole	111	276	1,428	889	32.63	47.99
Eopsetta jordani	Petrale sole	232	52	404	127	33.82	48.37
Glyptocephalus zachirus	Rex sole	328	52	695	214	32.73	48.37
Hippoglossina stomata	Bigmouth sole	29	55	252	101	32.59	35.52

Table 3 continued. Frequency of occurrence, depth, and latitudinal ranges for fish and invertebrate species, grouped by family (or higher taxonomic classification), caught during the 2004 West Coast groundfish trawl survey.

Family and scientific name	**Common name**	**Frequency of occurrence (No. hauls)**	**Depth (m)**			**Latitudinal range (dd)**	
			Min.	Max.	Mean	South	North
Hippoglossoides elassodon	Flathead sole	45	77	346	154	42.02	48.37
Hippoglossus stenolepis	Pacific halibut	29	53	273	141	38.88	48.23
Isopsetta isolepis	Butter sole	5	52	71	63	40.57	46.99
Lepidopsetta bilineata	Southern rock sole	30	52	141	92	33.05	48.20
Lyopsetta exilis	Slender sole	271	52	621	199	32.59	48.37
Microstomus pacificus	Dover sole	430	52	1,235	359	32.59	48.37
Paralichthys californicus	California halibut	6	53	67	61	33.26	37.96
Parophrys vetulus	English sole	237	52	404	123	32.59	48.37
Platichthys stellatus	Starry flounder	8	53	75	63	37.15	44.66
Pleuronichthys decurrens	Curlfin sole	68	52	302	91	32.73	47.94
P. ritteri	Spotted turbot	1	85	85	85	34.23	34.23
P. verticalis	Hornyhead turbot	23	55	121	79	32.61	37.86
Psettichthys melanostictus	Sand sole	10	52	73	61	37.15	48.36
Xystreurys liolepis	Fantail sole	2	63	67	65	33.76	34.32
Cynoglossidae							
Symphurus atricaudus	California tonguefish	1	108	108	108	34.13	34.13
Osteichthyes (superclass)	Fish unident.	11	55	1,149	637	33.40	47.87
Osteichthyes (superclass)	Fish eggs unident.	1	117	117	117	39.75	39.75
Porifera (phylum)							
Hexactinellida	Glass sponge unident.	14	130	1,097	502	33.17	47.99
Porifera unident.	Sponge unident.	102	59	1,206	510	32.59	48.21
Porifera	Soft green sponge	4	285	1,197	735	46.79	48.21
Porifera	Vase sponge	9	352	1,050	466	36.26	45.43
Porifera	White claypipe sponge	1	130	130	130	48.20	48.20
Aphrocallistes vastus	Clay pipe sponge	33	130	1,163	577	32.73	47.99
Hylonema sp.	Fiber optic sponge	15	240	1,115	807	32.75	47.99
Leucandra heathi	Spiny vase sponge	6	552	910	781	32.86	33.58
Polymastia pachymastia	Black-orange spud sponge	1	112	112	112	45.69	45.69

Table 3 continued. Frequency of occurrence, depth, and latitudinal ranges for fish and invertebrate species, grouped by family (or higher taxonomic classification), caught during the 2004 West Coast groundfish trawl survey.

Family and scientific name	Common name	Frequency of occurrence (No. hauls)	Depth (m)			Latitudinal range (dd)	
			Min.	Max.	Mean	South	North
Rhabdocalyptus sp.	Cloud sponge	4	180	1,021	558	33.56	45.79
Suberites ficus	Hermit sponge	1	130	130	130	32.67	32.67
S. sp.	Deep-sea free-living sponge	1	395	395	395	34.23	34.23
Tethya sp.	Ball sponge	1	131	131	131	45.07	45.07
Scyphozoa (class)							
Scyphozoa	Jellyfish unident.	144	53	1,428	441	32.86	48.21
Aequorea sp.		3	82	721	433	44.01	44.85
Atolla sp.	Wheel jelly	28	540	1,428	965	32.85	47.99
Aurelia labiata		48	53	1,162	317	35.73	46.69
A. sp.	Moon jelly	1	120	120	120	45.55	45.55
Chrysaora melanaster	Sunrise jelly	20	53	695	193	37.09	44.83
C. sp.	Chrysaora jellyfish	26	52	506	125	36.93	47.94
Periphylla periphylla	Purple cone jelly	14	602	1,235	939	32.63	47.72
Phacellophora camtschatica	Egg-yolk jelly	18	64	859	243	38.94	44.97
P. sp.		1	54	54	54	43.21	43.21
Anthozoa (class)							
Actiniaria	Purple striated anemone unident.	10	273	933	529	34.93	44.97
Actiniaria	Sea anemone unident.	104	54	1,197	472	32.75	48.23
Actiniaria	Red striated anemone unident.	21	602	1,197	952	33.02	47.99
Alcyonacea	Soft coral unident.	1	255	255	255	47.93	47.93
Alyconaria	Octocoral unident.	1	419	419	419	32.75	32.75
Antipatheria	Black coral unident.	11	154	1,115	570	33.46	45.47
Actinostolidae		43	273	1,235	780	32.96	46.93
Gorgonacea	Gorgonian coral unident.	10	59	1,184	434	32.61	36.39
Hormathiidae	Hormathiid anemones unident.	56	124	1,206	703	32.75	48.21
Pennatulacea	Sea pen or sea whip unident.	3	224	828	485	35.32	45.39
Scleractinia	Stony coral unident.	2	555	1,115	835	46.27	48.21
Virgularidae	Sea whip unident.	21	63	1,206	492	33.05	48.16

Table 3 continued. Frequency of occurrence, depth, and latitudinal ranges for fish and invertebrate species, grouped by family (or higher taxonomic classification), caught during the 2004 West Coast groundfish trawl survey.

Family and scientific name	Common name	Frequency of occurrence (No. hauls)	Depth (m)			Latitudinal range (dd)	
			Min.	Max.	Mean	South	North
Actinauge verrilli	Reticulated anemone	38	132	1,428	769	32.86	48.21
Actinernus sp.	Lava anemones	12	645	1,188	915	32.86	35.73
Actinoscyphia sp.	Sea whip anemone	7	63	1,206	750	32.86	37.27
Actinostola sp.		4	467	1,197	809	34.82	47.81
Anthomastus sp.	Mushroom coral	13	351	1,021	626	33.56	45.39
A. sp.	Red anthomastus	1	447	447	447	33.71	33.71
Anthoptilum grandiflorum	Fleshy sea pen	55	161	1,206	744	32.63	48.21
Antipathes sp.	Black coral	5	161	1,162	619	36.88	46.56
Bathypathes sp.	Quill black coral	1	969	969	969	47.62	47.62
Callogorgia sp.		1	820	820	820	33.58	33.58
Caryophyllia alaskensis	Alaska cup coral	1	72	72	72	32.61	32.61
Corallimorphus sp.	Club tipped anemone	6	475	969	762	32.86	45.47
Isidella sp.	Articulated bamboo coral	1	1,050	1,050	1,050	36.39	36.39
Leptogorgia caryi	Red licorice coral	1	181	181	181	47.54	47.54
Liponema brevicornis	Pom pom anemone	92	119	1,428	651	32.86	47.75
Metridium farcimen	Giant anemone	179	53	825	144	32.59	48.15
M. senile	Colonial plumose sea anemone	2	64	304	184	42.39	47.94
Ombellula sp.	Flower sea pen	11	664	1,428	977	35.24	47.47
Oractis diomedeae	Grape anemone	1	969	969	969	47.62	47.62
Paractinostola faeculenta	Rough anemone	170	235	1,428	699	32.75	47.99
Paragorgia sp.	Peppermint coral	1	711	711	711	47.43	47.43
Pennatula phosphorea	Branched sea pen	2	465	991	728	34.22	47.99
Ptilosarcus gurneyi	Orange sea pen	14	58	292	125	34.28	44.83
Stomphia coccinea	Swimming anemone	27	67	1,039	320	34.23	47.97
S. sp.		1	385	385	385	42.33	42.33
Stylatula sp.	Slender sea whip	26	63	907	279	32.74	46.94
S. gracilis	Slender sea whip	34	64	1,151	596	33.32	47.47
Swiftia sp.	Red sea fan	8	110	1,184	584	33.50	47.47

Table 3 continued. Frequency of occurrence, depth, and latitudinal ranges for fish and invertebrate species, grouped by family (or higher taxonomic classification), caught during the 2004 West Coast groundfish trawl survey.

Family and scientific name	Common name	Frequency of occurrence (No. hauls)	Depth (m)			Latitudinal range (dd)	
			Min.	Max.	Mean	South	North
Urticina felina	Painted anemone	16	69	581	146	34.86	48.00
U. sp.		25	58	364	121	33.82	48.36
Virgularia sp.	Smoothstem sea whip	1	96	96	96	42.09	42.09
Hydrozoa (class)							
Dromalia alexandri	Sea pineapple	41	148	894	539	32.59	36.94
Ctenophora (phylum)							
Ctenophora	Comb jelly unident.	5	112	571	370	33.91	45.00
Beroe sp.		1	1,235	1,235	1,235	42.60	42.60
Nemata (phylum)							
Nematoda	Nematode worm unident.	3	65	1,188	483	32.95	33.82
Gymnolaemata (class)							
Gymnolaemata	Marine bryozoan unident.	1	846	846	846	33.27	33.27
Brachiopoda (phylum)							
Brachiopoda	Lampshells unident.	6	118	1,050	373	36.39	45.00
Laqueus californianus	California lamp shell	4	91	180	120	36.74	45.79
Aplacophora (class)							
Aplacophora	Solenogaster unident.	4	74	946	569	34.23	41.00
Neomenia sp.		14	371	1,054	707	33.56	46.63
Bivalvia (class)							
Bivalvia	Bivalve unident.	10	100	1,123	545	33.01	48.16
Pectinid	Scallop unident.	1	112	112	112	48.06	48.06
Acesta sphoni	Siphons giant file clam	1	691	691	691	33.32	33.32
Calyptogena pacifica		1	458	458	458	46.47	46.47
Chlamys rubida	Reddish scallop	1	59	59	59	32.84	32.84
Delectopecten vancouverensis	Glass scallop	10	533	1,201	917	32.85	45.67
Panopea abrupta	Pacific geoduck	1	80	80	80	38.01	38.01
Parvamussium alaskense	Alaska glass scallop	10	611	1,197	936	32.96	47.81
Patinopectin caurinus	Weather vane scallop	1	92	92	92	45.06	45.06

Table 3 continued. Frequency of occurrence, depth, and latitudinal ranges for fish and invertebrate species, grouped by family (or higher taxonomic classification), caught during the 2004 West Coast groundfish trawl survey.

Family and scientific name	Common name	Frequency of occurrence (No. hauls)	Depth (m)			Latitudinal range (dd)	
			Min.	Max.	Mean	South	North
Yoldia scissurata	Criss-crossed yoldia	1	103	103	103	43.67	43.67
Cephalopoda (class)							
Cephalopoda	Cephalopod unident.	1	903	903	903	47.54	47.54
Cranchiidae	Mystery squid	2	465	1,032	748	34.27	47.72
Decabrachia	Squid unident.	10	404	1,201	658	32.75	46.47
Decabrachia	Squid eggs unident.	1	1,206	1,206	1,206	33.41	33.41
Benthoctopus leioderma	Smooth octopus unident.	8	98	1,197	565	36.88	48.04
B. sp.		40	177	1,428	713	33.56	48.21
Berryteuthis magister	Magistrate armhook squid	4	397	569	517	34.91	48.21
Chiroteuthis calyx	Glass squid	2	602	1,155	879	42.14	45.30
Dosidicus gigas	Humboldt squid, “Rojo Diablo”	16	131	743	345	39.04	47.43
Galiteuthis phyllura	Arrow squid	2	176	230	203	42.07	44.44
Gonatopsis borealis	North Pacific armhook squid	7	358	1,115	579	41.00	45.43
Gonatus onyx	Arm tooth squid	22	91	1,186	631	33.08	44.84
G. sp.		4	154	402	256	37.27	45.39
Graneledone sp.	Deep-sea octopus unident.	2	1,205	1,428	1,317	32.63	47.49
Histioteuthis heteropsis	Jewel or cock-eyed squid	19	246	1,201	555	32.75	42.07
H. hoylei	Long-armed jewel squid	4	81	745	553	36.95	45.94
Histioteuthis sp.	Jewel squid	1	1,184	1,184	1,184	33.50	33.50
Japatella heathi	Yellow ringed octopus	4	794	1,045	904	32.96	44.71
Loligo opalescens	California market squid	129	53	888	141	32.59	48.00
Moroteuthis robusta	Big squid	6	273	422	352	34.32	45.30
Octopodidae	Octopus unident.	8	73	645	289	32.83	43.98
Octopus sp.	Octopus unident.	3	273	397	321	33.54	34.63
Enteroctopus dofleini	Giant Pacific octopus	26	98	683	486	37.15	45.73
Octopoteuthis deletron	Octopus squid	68	292	1,297	763	32.63	48.21
Octopus californicus	North Pacific bigeye octopus	20	121	533	311	32.59	35.32
Opisthoteuthis californiana	Flapjack devilfish	27	311	1,050	635	34.23	47.81

Table 3 continued. Frequency of occurrence, depth, and latitudinal ranges for fish and invertebrate species, grouped by family (or higher taxonomic classification), caught during the 2004 West Coast groundfish trawl survey.

Family and scientific name	Common name	Frequency of occurrence (No. hauls)	Depth (m)			Latitudinal range (dd)	
			Min.	Max.	Mean	South	North
Rossia pacifica	Bobtail squid	46	63	1,151	168	34.36	48.04
Taonius pavo	Cone squid	1	1,155	1,155	1,155	42.14	42.14
Vampyroteuthis infernalis	Vampire squid	22	137	1,297	955	32.86	46.42
Gastropoda (class)							
Gastropod eggs	Snail eggs	21	64	1,201	863	32.85	47.72
Gastropod	Snail unident.	3	836	1,123	955	33.02	36.04
Heteropoda	Heteropod unident.	5	80	910	514	32.96	34.31
Nudibranchia	Nudibranch unident.	43	63	1,184	279	32.59	48.20
Dorididae	Dorid nudibranch unident.	4	67	92	82	44.33	46.97
Archidoris odhneri	White night doris	3	98	180	126	44.30	45.79
Armina californica	Striped tongue nudibranch	3	53	83	73	44.22	44.66
Bathybembix bairdii	Green top snail	84	285	1,235	880	32.75	47.99
Boreotrophon sp.		1	384	384	384	45.31	45.31
Buccinum sp.		1	1,134	1,134	1,134	41.26	41.26
B. sp. eggs		1	384	384	384	45.31	45.31
B. strigillatum	Striated buccinum	7	276	1,048	527	40.91	47.47
B. viridum	Green buccinum	9	906	1,297	1,081	35.92	47.99
Bulbus fragilis	Fragile moonsnail	23	71	292	145	33.58	48.04
Calinaticina oldroydii		4	133	230	165	44.44	48.04
Calliostoma platinum	Silvery top snail	1	828	828	828	43.32	43.32
Colus sp.		1	1,011	1,011	1,011	47.47	47.47
Fusitriton oregonensis	Hairy triton	12	91	408	247	44.12	47.86
Neptunea amianta	Deep-sea neptune	75	206	1,279	756	32.96	47.99
N. pribiloffensis	Pribilof neptune	2	333	683	508	44.73	44.80
N. sp.		41	304	1,201	768	32.85	48.21
N. stilesi	Stile's neptune	2	253	280	266	42.33	45.72
Pleurobranchaea californica	California sea slug	74	55	388	143	32.59	42.14
Plicifusus griseus	Common plicifusus	3	869	1,011	957	32.96	47.99

Table 3 continued. Frequency of occurrence, depth, and latitudinal ranges for fish and invertebrate species, grouped by family (or higher taxonomic classification), caught during the 2004 West Coast groundfish trawl survey.

Family and scientific name	**Common name**	**Frequency of occurrence (No. hauls)**	**Depth (m)**			**Latitudinal range (dd)**	
			Min.	Max.	Mean	South	North
Polinices sp.		1	62	62	62	37.96	37.96
Tochuina tetraquetra	Giant orange tochui	1	235	235	235	43.03	43.03
Tritonia diomedea	Rosy tritonia	132	55	1,279	371	32.74	47.99
Sipuncula (phylum)							
Sipuncula	Peanut worm unident.	3	132	385	231	42.07	42.33
Polychaeta (class)							
Aphroditidae		41	112	1,201	465	32.85	48.33
Polychaeta	Polychaete worm unident.	10	71	1,206	568	33.17	46.47
Polychaeta	Worm unident.	2	71	100	86	40.55	40.57
Polychaeta	Tube worm unident.	1	191	191	191	48.37	48.37
Aphrodita sp.	Sea mouse unident.	13	133	1,428	418	34.22	48.10
Malacostraca (class)							
Calappidae	Box crab unident.	4	134	167	147	48.04	48.23
Dendrobrachiata	Shrimp unident.	8	71	776	394	33.68	40.57
Galatheidae	Galatheid crab unident.	7	141	1,188	675	33.11	35.76
Isopoda	Sea cockroach unident.	6	53	1,134	600	36.12	46.93
Mysidacea	Red mysid unident.	7	846	1,186	992	32.86	47.47
Paguridae	Hermit crab unident.	33	72	1,206	500	32.59	47.80
Pandalidae	Pandalid shrimp unident.	1	109	109	109	46.79	46.79
Thoracica	Barnacle unident.	1	60	60	60	36.12	36.12
Pleocyemata	Crab unident.	3	65	238	123	32.95	34.05
Acanthephyra curtirostris	Peaked shrimp	4	851	1,134	963	39.30	46.22
A. sp.		1	1,186	1,186	1,186	33.08	33.08
Acantholithodes hispidus	Fuzzy crab	2	235	250	243	44.67	45.73
Cancer anthonyi	Yellow rock crab	11	55	204	92	32.59	38.21
C. branneri	Furrowed rock crab	1	54	54	54	43.21	43.21
C. gracilis	Graceful rock crab	3	64	700	278	47.50	47.94
C. magister	Dungeness crab	160	52	835	123	34.70	47.94

Table 3 continued. Frequency of occurrence, depth, and latitudinal ranges for fish and invertebrate species, grouped by family (or higher taxonomic classification), caught during the 2004 West Coast groundfish trawl survey.

Family and scientific name	**Common name**	**Frequency of occurrence (No. hauls)**	**Depth (m)**			**Latitudinal range (dd)**	
			Min.	Max.	Mean	South	North
C. productus	Red rock crab	16	63	437	164	34.16	39.03
C. sp.	Cancer crab unident.	1	108	108	108	34.13	34.13
Chionoecetes angulatus	Triangle tanner crab	1	1,428	1,428	1,428	47.49	47.49
C. bairdi	Baird's tanner crab	7	154	878	356	33.01	48.09
C. sp.	Tanner crab unident.	45	280	1,197	763	33.63	48.21
C. tanneri	Grooved tanner crab	93	273	1,428	818	32.63	48.09
Chirostylus sp.	Spiny pinch bug	1	1,170	1,170	1,170	33.67	33.67
Chorilia longipes	Longhorned decorator crab	47	67	1,206	584	32.75	48.20
Crangon communis	Two-spine crangon	5	132	202	158	41.28	43.55
C. septemspinosa	Sand shrimp	3	117	141	131	38.47	42.33
C. sp.		6	88	188	129	38.47	46.79
Eualus macrophthalmus	Big eyed eualid	29	340	1,197	566	33.34	48.21
E. sp.	Eualid unident.	1	446	446	446	44.97	44.97
Glyptolithodes cristatipes	Deep-sea rock crab	2	269	533	401	33.47	33.91
Neognathophausia gigas		3	885	1,205	1,011	32.63	40.14
Hemisquilla ensigra californiensis	Mantis shrimp	4	63	79	72	32.61	33.05
Lithodes aequispina	Golden king crab	1	301	301	301	34.37	34.37
L. couesi	Scarlet king crab	26	711	1,188	953	32.86	47.99
Lopholithodes foraminatus	Brown box crab	26	67	519	202	32.73	48.37
Loxorhynchus grandis	Sheep crab	4	55	60	57	32.71	35.04
Munida quadrispina	Pinch bug	7	250	864	577	32.75	45.31
Munidopsis sp.	Thorny pinch bug	6	752	1,201	970	32.85	33.68
Mursia gaudichaudii	Shame faced crab	31	57	252	115	32.67	39.18
Neognathophausia ingens	Giant red mysid	6	741	1,184	876	33.27	40.25
Neolithodes diomedeae	Spiky king crab	3	1,054	1,170	1,128	33.18	34.80
Notostomus japonicus	Spinyridge shrimp	3	663	1,159	982	33.02	42.67
Oregonia gracilis	Graceful decorator crab	2	67	91	79	44.33	44.49
Paguristes turgidus	Hermit crab sp.	5	103	304	205	41.72	47.80

Table 3 continued. Frequency of occurrence, depth, and latitudinal ranges for fish and invertebrate species, grouped by family (or higher taxonomic classification), caught during the 2004 West Coast groundfish trawl survey.

Family and scientific name	Common name	Frequency of occurrence (No. hauls)	Depth (m)			Latitudinal range (dd)	
			Min.	Max.	Mean	South	North
Pagurus aleuticus	Aleutian hermit crab	2	254	273	264	41.66	41.72
P. confragosus	Knobbyhand hermit	1	254	254	254	41.66	41.66
P. rathbuni	Longfinger hermit	2	180	385	283	42.33	47.23
P. sp.		1	384	384	384	45.31	45.31
P. tanneri	Tanner's hermit crab	2	273	1,184	728	33.50	41.72
Pandalopsis ampla	Smooth shrimp	19	848	1,279	1,079	32.63	36.39
P. dispar	Sidestripe shrimp	12	246	1,184	516	33.50	46.56
Pandalus hypsinotus	Coonstripe shrimp	2	53	54	53	37.15	43.21
P. jordani	Southern pink shrimp	89	95	672	208	32.75	48.37
P. platyceros	Spot prawn	37	117	327	220	32.73	47.97
P. sp.		2	111	166	139	34.51	44.12
P. tridens	Yellowleg pandalid	1	250	250	250	44.67	44.67
Paralithodes californiensis	California king crab	10	181	302	255	32.73	38.17
P. rathbuni	Spiny king crab	6	148	1,184	449	32.59	37.27
Paralomis multispina	Hair crab	17	1,021	1,297	1,143	32.63	46.42
P. sp.		6	846	1,206	1,111	33.08	33.50
Pasiphaea pacifica	Glass shrimp	60	301	1,149	528	32.75	48.21
P. tarda	Crimson pasiphaeid	59	577	1,206	916	32.85	47.75
Polycheles sculptus	Deep-sea lobster	8	869	1,201	1,086	32.85	41.84
Pugettia sp.	Kelp crab	2	130	184	157	33.34	44.28
Rhinolithodes wosnessenskii	Rhinoceros crab	1	112	112	112	37.20	37.20
Sergestes sp.		31	118	890	490	32.96	48.09
Sicyonia ingentis	Razor-back prawn	18	55	1,039	195	32.61	35.73
Asteroidea (class)							
Asteroidea	Sea star unident.	19	85	1,123	467	32.59	48.20
Ampheraster marianus	Pink star	25	280	1,184	746	32.75	47.99
A. sp.		2	725	803	764	37.48	40.25
Anteliaster sp.	Soft star	7	447	1,188	844	32.86	45.30

Table 3 continued. Frequency of occurrence, depth, and latitudinal ranges for fish and invertebrate species, grouped by family (or higher taxonomic classification), caught during the 2004 West Coast groundfish trawl survey.

Family and scientific name	Common name	Frequency of occurrence (No. hauls)	Depth (m)			Latitudinal range (dd)	
			Min.	Max.	Mean	South	North
Asterina miniata	Bat star	4	58	65	62	35.52	38.21
Asthenactis fisheri	Slimy deep-sea sun star	1	1,184	1,184	1,184	33.50	33.50
Astropecten californicus	California sand star	18	67	923	231	32.92	43.39
Brisingella exilis	Lacy-armed star	7	537	707	628	38.21	43.75
B. sp.		4	568	781	689	36.88	37.29
Ceramaster leptoceramus	California cookie star	22	533	1,188	720	32.75	41.89
C. patagonicus	Orange cookie star	1	752	752	752	33.34	33.34
C. sp.		2	672	707	690	38.21	42.10
Cheiraster dawsoni	Fragile star	14	92	903	386	38.89	47.54
Cryptopeltaster lepidonotus	Grainy star	4	103	1,021	564	33.56	36.88
Ctenodiscus crispatus	Mud star	8	255	1,111	448	43.88	46.93
C. sp.		3	295	1,123	731	33.02	43.68
Dermasterias imbricata	Leather star	12	53	132	90	35.65	48.36
Diplopteraster multipes	Pincushion sea star	16	252	1,103	455	33.63	45.77
Dipsacaster borealis	Northern sand star	3	637	1,123	894	33.02	39.60
D. eximius	Broad sand star	33	64	1,188	751	32.75	37.48
D. sp.		6	672	1,145	854	33.68	41.89
Henricia clarki	Serpent-armed henricia	2	280	846	563	33.27	42.33
H. leviuscula	Blood star	1	91	91	91	44.33	44.33
H. sp.		16	67	1,097	332	33.17	48.11
Heterozonias alternatus	Pink sun star	142	89	1,428	776	32.85	48.16
Hippasteria californica	Deep-sea spiny star	70	63	1,428	784	32.73	47.99
H. sp.		41	73	1,197	466	38.47	48.23
H. spinosa	Spiny star	56	65	1,159	345	32.96	48.20
Leptychaster arcticus	Arctic sand star	1	133	133	133	48.11	48.11
L. pacificus	Pacific sand star	1	991	991	991	47.99	47.99
Lophaster furcilliger	Pink crested star	13	497	1,428	1,138	33.18	47.49

Table 3 continued. Frequency of occurrence, depth, and latitudinal ranges for fish and invertebrate species, grouped by family (or higher taxonomic classification), caught during the 2004 West Coast groundfish trawl survey.

Family and scientific name	Common name	Frequency of occurrence (No. hauls)	Depth (m)			Latitudinal range (dd)	
			Min.	Max.	Mean	South	North
L. sp.		1	1,145	1,145	1,145	37.40	37.40
L. vexator	Crested star	3	137	969	670	39.88	47.62
Luidia foliolata	Flat mud star	254	53	820	162	32.59	48.36
L. sp.		1	65	65	65	32.95	32.95
Mediaster aequalis	Equal armed star	49	65	1,279	279	33.71	48.11
M. sp.		18	81	476	231	34.05	48.16
M. tenellus	Pale equal armed star	2	440	985	713	35.51	38.24
Myxoderma platyacanthum	Red star	70	323	1,163	616	33.32	47.80
M. sacculatum	Snakehead star	19	567	1,297	956	34.51	46.42
Nearchaster aciculosus	Deep-sea fragile star	46	547	1,428	986	32.85	47.99
Orthasterias koehleri	Rainbow star	8	60	235	110	36.12	48.20
O. sp.		1	181	181	181	47.54	47.54
Pedicellaster sp.		4	253	957	657	42.30	45.72
Pisaster brevispinus	Short-spined pink star	41	52	447	111	33.71	47.94
P. ochraceus	Purple sea star	11	53	155	100	43.45	48.06
Poraniopsis flexilis	Flexible thorny star	5	67	351	146	40.91	48.20
P. inflata	Thorny star	18	91	848	264	33.22	48.20
Pseudarchaster alascensis	Alaskan pseudarchaster	13	211	683	375	40.91	45.70
P. pusillus	Little pseudarchaster	3	371	506	454	34.30	36.97
P. sp.		5	100	566	284	32.59	43.68
Pteraster jordani	Jordan's slime star	41	235	1,428	825	32.85	47.54
P. militaris	Wrinkled slime star	11	120	1,097	601	32.96	48.23
P. sp.		6	255	1,201	947	32.85	47.93
P. tesselatus	Slimy cushion star	11	67	903	237	39.88	48.23
P. trigonodon	Triangle-toothed cushion star	3	846	1,184	1,017	33.27	33.56
Pycnopodia helianthoides	Sunflower star	75	53	454	114	34.70	48.36
Rathbunaster californicus	Deep-sea sunflower star	105	53	995	252	32.75	47.93

Table 3 continued. Frequency of occurrence, depth, and latitudinal ranges for fish and invertebrate species, grouped by family (or higher taxonomic classification), caught during the 2004 West Coast groundfish trawl survey.

Family and scientific name	Common name	Frequency of occurrence (No. hauls)	Depth (m)			Latitudinal range (dd)	
			Min.	Max.	Mean	South	North
Solaster borealis	Grooved sun star	98	108	1,428	831	32.85	48.21
S. dawsoni	Morning sun star	1	54	54	54	43.21	43.21
S. endeca	Northern sun star	3	98	346	213	44.38	48.33
S. exiguus	Deep-sea sun star	10	255	1,279	1,028	33.40	47.93
S. papposus	Rose star	12	98	34	177	44.28	48.23
S. sp.	Orange sun star	11	83	1,021	349	33.56	48.23
S. stimpsoni	Striped sun star	2	91	235	163	44.33	45.73
Stylasterias forreri	Fish-eating star	60	55	721	180	32.73	48.30
S. sp.		2	74	499	286	34.90	35.71
Thrissacanthias penicillatus	Carpet star	141	163	1,428	771	32.75	47.93
Zoroaster evermani	Slender star	77	163	1,428	912	32.85	47.99
Crinoidea (class)							
Crinoidea	Crinoid unident.	7	196	1,163	717	33.82	47.99
Florometra serratissima	Feather star	6	92	1,115	474	33.82	47.54
F. sp.		1	99	99	99	44.30	44.30
Echinoidea (class)							
Echinoidea	Sea urchin unident.	2	63	73	68	32.74	33.05
Allocentrotus fragilis	Fragile red sea urchin	195	67	1,184	409	32.59	48.37
A. sp.		1	645	645	645	34.17	34.17
Brisaster latifrons	Mud urchin	149	85	1,206	400	33.22	48.37
B. sp.		11	295	820	530	33.32	48.21
B. townsendi	Giant mud urchin	4	163	743	457	34.62	45.31
Brissopsis pacifica	Oval sea biscuit	2	311	397	354	34.23	34.36
Spatangus californicus	Giant sea biscuit	16	85	429	248	33.34	35.79
Strongylocentrotus droebachiensis	Green sea urchin	5	91	370	227	34.75	44.37
S. franciscanus	Red urchin	1	163	163	163	34.42	34.42
S. pallidus	Crowned urchin	7	65	346	174	32.95	48.20
S. sp.		3	108	146	125	48.07	48.20

Table 3 continued. Frequency of occurrence, depth, and latitudinal ranges for fish and invertebrate species, grouped by family (or higher taxonomic classification), caught during the 2004 West Coast groundfish trawl survey.

Family and scientific name	Common name	Frequency of occurrence (No. hauls)	Depth (m)			Latitudinal range (dd)	
			Min.	Max.	Mean	South	North
Holothuroidea (class)							
Holothuroidea	Sea cucumber unident.	15	80	1,205	736	32.63	44.33
Molpadia intermedia	Purple sea potato	11	72	1,123	336	33.02	47.80
Pannychia moseleyi	Sloppy cucumber	38	371	1,206	725	33.08	47.99
Parastichopus californicus	California cucumber	59	54	942	144	32.61	48.30
P. leukothele	Giant soft cucumber	105	54	1,151	238	32.75	48.36
P. sp.		2	148	1,205	677	32.59	32.63
Pseudostichopus mollis	Sandy sea cucumber	30	253	1,206	561	32.75	48.21
P. sp.		1	397	397	397	47.80	47.80
Psolus fabricii	Brown-scaled sea cucumber	1	1,050	1,050	1,050	36.39	36.39
P. squamatus	White-scaled cucumber	19	235	1,197	853	33.56	47.99
Scotoplanes globosa	Sea pig	18	985	1,428	1,165	32.85	47.81
Synallactes challengeri		7	200	1,188	750	32.83	33.58
Ophiuroidea (class)							
Ophiuroid	Brittlestar unident.	17	98	1,279	771	32.73	45.47
Amphiuridae	Brittlestar unident.	1	1,111	1,111	1,111	46.93	46.93
Amphiophiura sp.	Southern armored brittlestar	11	894	1,428	1,036	33.18	47.62
A. ponderosa	Giant armored brittlestar	12	442	1,145	770	34.93	45.44
Asteronyx longifissa	Long-slit serpent brittlestar	14	132	825	509	33.34	45.37
A. loveni	Giant serpent brittlestar	21	163	1,206	692	33.40	47.47
A. sp.		14	76	1,197	659	33.50	47.81
Gorgonocephalus eucnemis	Basket star	31	54	894	186	32.59	47.26
Ophiacantha diplasia	Lacy brittle star	8	250	910	524	32.73	45.44
O. enneactis		1	371	371	371	45.20	45.20
O. sp.		9	196	1,297	691	33.32	46.42
Ophiomusium jolliensis	Red brittlestar	2	467	752	610	33.34	45.43
O. lymani	Lyman's brittlestar	1	1,097	1,097	1,097	33.17	33.17
Ophiopholis longispina	Longspined brittle star	3	384	467	420	45.31	45.43

Table 3 continued. Frequency of occurrence, depth, and latitudinal ranges for fish and invertebrate species, grouped by family (or higher taxonomic classification), caught during the 2004 West Coast groundfish trawl survey.

Family and scientific name	**Common name**	**Frequency of occurrence (No. hauls)**	**Depth (m)**			**Latitudinal range (dd)**	
			Min.	Max.	Mean	South	North
Ophioscolex sp.		2	408	467	438	45.41	45.43
Ophiura sarsi	Notched brittlestar	36	64	923	380	38.18	48.11
O. sp.		1	985	985	985	35.51	35.51
Tunicata (subphylum)							
Ascidian	Tunicate unident.	16	67	1,188	656	33.08	45.72
Thaliacea	Salps unident.	84	53	1,201	501	32.75	48.21
Molgula grifithsii	Sea grape	8	555	1,197	911	33.11	48.21
Pyrosoma atlanticum	Sea tongue	2	126	240	183	34.67	36.23
Styela rustica	Sea potato	34	90	1,188	510	32.86	48.33
Thetys vagina	Rabbit-eared salp	9	188	786	540	42.30	44.92
Invertebrate	Invertebrate unident.	8	80	1,188	542	32.96	47.67

Tables 4–9 list the number of individual fish lengths collected by species and by depth strata for all INPFC areas combined and for the individual INPFC areas. Only the top 35 most frequently measured fish species are included in these tables.

Temperature Data

Near bottom temperatures ranged from 3.1°C to 13.5°C during the May–July 2004 portion of the survey, and from 2.6°C to 12.6°C during the August–October 2004 portion of the survey (Figure 5). The mean bottom temperature was 7.1°C. Sea surface temperatures ranged from 10.0°C to 22.2°C during the May–July 2004 portion of the survey, and from 7.8°C to 19.4°C during the August–October 2004 portion of the survey (Figure 6). The mean sea-surface temperature was 14.6°C.

Relative Density and Distribution of Species

Information on the relative density and distribution of the 20 most abundant groundfish and select crab species are reported in several ways: 1) for all depth strata and INPFC areas combined (Table 10), 2) by depth strata for all INPFC areas combined (Table 11), and 3) by depth stratum within each individual INPFC area (Tables 12–16). The top five species for all areas and depth strata combined (i.e., survey wide) included Dover sole, Pacific hake (*Merluccius productus*), longspine thornyhead, sablefish, and spiny dogfish. For all depth strata combined, Dover sole had the highest catch rate in the Eureka INPFC area and the second highest rates in the U.S.-Vancouver, Columbia, and Monterey INPFC areas. Within depth strata for all INPFC areas combined, Dover sole ranked first at mid depths (184–549 m) and second in both the shallow (55–183 m) and deep (550–1,280 m) strata (Table 11).

Pacific hake had the second highest catch rate for all INPFC area combined and the highest catch rate in the Columbia INPFC area (Table 10). Within depth strata for all INPFC areas combined, Pacific hake ranked first at shallow depths (55–183 m) and fourth in the mid depth (184–549 m) stratum (Table 11). Longspine thornyheads had the highest catch rate in the Conception INPFC area for all depth strata combined and the third highest catch rate for all INPFC areas combined (Table 10). Longspine thornyhead was the most abundant species in the deep stratum (550–1,280 m) when all INPFC areas were combined. When all INPFC areas combined were separated into depth strata, spiny dogfish had the second highest catch rate in the shallow stratum and sablefish had the second highest catch rate in the mid-depth stratum (Table 11).

Catch rates varied with depth stratum for the individual INPFC areas (Tables 12–16). Within individual INPFC areas, the dominance of Dover sole in the catch tended to decline in the southern portion of the survey (Tables 12–16). Pacific hake catch rates were highest in the shallow stratum in the Eureka and Columbia INPFC areas (Tables 14–15) while longspine thornyhead catch rates were highest in the deep water stratum in the Conception and Columbia INPFC areas (Tables 12 and 14). In the shallow stratum, spiny dogfish had the highest catch rates in the Monterey and U.S.-Vancouver INPFC areas, while halfbanded rockfish (*Sebastes semicinctus*) was the predominant species in the shallow stratum in the Conception INPFC area

Table 4. Number of length-frequency measurements collected by stratum for the most frequently sampled groundfish species during the 2004 West Coast groundfish trawl survey for all the INPFC areas combined.

Species	Stratum 1 (55-183 m)	Stratum 2 (184-549 m)	Stratum 3 (550-1,280 m)	Total
Spiny dogfish	2,135	511	1	2,647
California skate	493	3	0	496
Longnose skate	1,522	1,060	84	2,666
Pacific sanddab	12,452	323	0	12,775
Arrowtooth flounder	1,858	924	3	2,785
Flathead sole	476	43	0	519
Petrale sole	3,333	214	0	3,547
English sole	8,525	633	0	9,158
Dover sole	7,030	7,395	3,899	18,324
Rex sole	8,831	5,529	433	14,793
Curlfin sole	659	9	0	668
Sablefish	1,142	1,878	1,811	4,831
Pacific grenadier	0	26	2,471	2,497
Lingcod	1,235	228	0	1,463
Pacific hake	1,484	2,381	51	3,916
Shortspine thornyhead	35	5,149	1,780	6,964
Longspine thornyhead	0	1,654	10,940	12,594
Pacific ocean perch	87	478	0	565
Aurora rockfish	0	1,076	109	1,185
Greenspotted rockfish	531	43	0	574
Darkblotched rockfish	505	557	0	1,062
Splitnose rockfish	217	5,013	0	5,230
Greenstriped rockfish	2,218	505	0	2,723
Yellowtail rockfish	703	0	0	703
Chilipepper rockfish	2,934	869	0	3,803
Rosethorn rockfish	436	567	0	1,003
Shortbelly rockfish	1,938	982	0	2,920
Blackgill rockfish	0	466	1	467
Bocaccio	431	66	0	497
Canary rockfish	561	16	0	577
Redstripe rockfish	510	17	0	527
Stripetail rockfish	2,476	2,381	0	4,857
Halfbanded rockfish	1,692	12	0	1,704
Sharpchin rockfish	283	893	0	1,176
Swordspine rockfish	205	125	0	330

Table 5. Number of length-frequency measurements collected by stratum for the most frequently sampled groundfish species during the 2004 West Coast groundfish trawl survey for the INPFC Conception area.

Species	**Stratum 1 (55–183 m)**	**Stratum 2 (184–549 m)**	**Stratum 3 (550–1,280 m)**	**Total**
Spiny dogfish	59	38	0	97
California skate	78	3	0	81
Longnose skate	109	357	21	487
Pacific sanddab	2,371	316	0	2,687
Arrowtooth flounder	0	0	0	0
Flathead sole	0	0	0	0
Petrale sole	119	63	0	182
English sole	546	200	0	746
Dover sole	30	1,927	1,167	3,124
Rex sole	156	995	4	1,155
Curlfin sole	161	9	0	170
Sablefish	25	287	575	887
Pacific grenadier	0	0	286	286
Lingcod	67	122	0	189
Pacific hake	7	1,467	16	1,490
Shortspine thornyhead	0	698	880	1,578
Longspine thornyhead	0	491	4,107	4,598
Pacific ocean perch	0	0	0	0
Aurora rockfish	0	456	41	497
Greenspotted rockfish	121	25	0	146
Darkblotched rockfish	17	30	0	47
Splitnose rockfish	55	2,104	0	2,159
Greenstriped rockfish	87	70	0	157
Yellowtail rockfish	77	0	0	77
Chilipepper rockfish	394	312	0	706
Rosethorn rockfish	6	73	0	79
Shortbelly rockfish	417	748	0	1,165
Blackgill rockfish	0	394	0	394
Bocaccio	54	33	0	87
Canary rockfish	117	0	0	117
Redstripe rockfish	0	0	0	0
Stripetail rockfish	1,108	1,090	0	2,198
Halfbanded rockfish	1,300	8	0	1,308
Sharpchin rockfish	0	0	0	0
Swordspine rockfish	205	125	0	330

Table 6. Number of length-frequency measurements collected by stratum for the most frequently sampled groundfish species during the 2004 West Coast groundfish trawl survey for the INPFC Monterey area.

Species	Stratum 1 (55-183 m)	Stratum 2 (184-549 m)	Stratum 3 (550-1,280 m)	Total
Spiny dogfish	1,042	155	1	1,198
California skate	401	0	0	401
Longnose skate	723	267	47	1,037
Pacific sanddab	4,508	7	0	4,515
Arrowtooth flounder	10	19	0	29
Flathead sole	0	0	0	0
Petrale sole	1,243	128	0	1,371
English sole	2,888	142	0	3,030
Dover sole	863	1,796	1,208	3,867
Rex sole	1,966	1,179	84	3,229
Curlfin sole	313	0	0	313
Sablefish	166	299	378	843
Pacific grenadier	0	0	369	369
Lingcod	556	65	0	621
Pacific hake	412	600	3	1,015
Shortspine thornyhead	0	247	239	486
Longspine thornyhead	0	119	1,897	2,016
Pacific ocean perch	0	0	0	0
Aurora rockfish	0	258	67	325
Greenspotted rockfish	276	18	0	294
Darkblotched rockfish	51	131	0	182
Splitnose rockfish	0	1,095	0	1,095
Greenstriped rockfish	518	49	0	567
Yellowtail rockfish	102	0	0	102
Chilipepper rockfish	2,150	533	0	2,683
Rosethorn rockfish	17	0	0	17
Shortbelly rockfish	1,505	230	0	1,735
Blackgill rockfish	0	33	1	34
Bocaccio	377	33	0	410
Canary rockfish	103	0	0	103
Redstripe rockfish	0	0	0	0
Stripetail rockfish	957	830	0	1,787
Halfbanded rockfish	380	4	0	384
Sharpchin rockfish	1	90	0	91
Swordspine rockfish	0	0	0	0

Table 7. Number of length-frequency measurements collected by stratum for the most frequently sampled groundfish species during the 2004 West Coast groundfish trawl survey for the INPFC Eureka area.

Species	Stratum 1 (55-183 m)	Stratum 2 (184-549 m)	Stratum 3 (550-1,280 m)	Total
Spiny dogfish	39	15	0	54
California skate	14	0	0	14
Longnose skate	205	189	11	405
Pacific sanddab	1,055	0	0	1,055
Arrowtooth flounder	331	152	2	485
Flathead sole	1	0	0	1
Petrale sole	481	3	0	484
English sole	1,250	6	0	1,256
Dover sole	930	744	1,069	2,743
Rex sole	1,457	903	301	2,661
Curlfin sole	72	0	0	72
Sablefish	136	512	383	1,031
Pacific grenadier	0	0	793	793
Lingcod	112	9	0	121
Pacific hake	677	297	32	1,006
Shortspine thornyhead	3	521	290	814
Longspine thornyhead	0	0	2,214	2,214
Pacific ocean perch	0	5	0	5
Aurora rockfish	0	42	0	42
Greenspotted rockfish	0	0	0	0
Darkblotched rockfish	28	203	0	231
Splitnose rockfish	33	439	0	472
Greenstriped rockfish	175	34	0	209
Yellowtail rockfish	0	0	0	0
Chilipepper rockfish	286	0	0	286
Rosethorn rockfish	0	0	0	0
Shortbelly rockfish	16	0	0	16
Blackgill rockfish	0	0	0	0
Bocaccio	0	0	0	0
Canary rockfish	7	0	0	7
Redstripe rockfish	0	1	0	1
Stripetail rockfish	372	148	0	520
Halfbanded rockfish	0	0	0	0
Sharpchin rockfish	6	27	0	33
Swordspine rockfish	0	0	0	0

Table 8. Number of length-frequency measurements collected by stratum for the most frequently sampled groundfish species during the 2004 West Coast groundfish trawl survey for the INPFC Columbia area.

Species	Stratum 1 (55-183 m)	Stratum 2 (184-549 m)	Stratum 3 (550-1,280 m)	Total
Spiny dogfish	351	118	0	469
California skate	0	0	0	0
Longnose skate	397	194	4	595
Pacific sanddab	4,069	0	0	4,069
Arrowtooth flounder	1,112	620	0	1,732
Flathead sole	287	4	0	291
Petrale sole	1,193	17	0	1,210
English sole	3,046	240	0	3,286
Dover sole	4,018	2,565	372	6,955
Rex sole	4,402	2,313	24	6,739
Curlfin sole	112	0	0	112
Sablefish	671	596	342	1,609
Pacific grenadier	0	23	801	824
Lingcod	447	30	0	477
Pacific hake	388	17	0	405
Shortspine thornyhead	14	3,332	245	3,591
Longspine thornyhead	0	947	2,345	3,292
Pacific ocean perch	2	374	0	376
Aurora rockfish	0	320	1	321
Greenspotted rockfish	127	0	0	127
Darkblotched rockfish	310	193	0	503
Splitnose rockfish	74	1,373	0	1,447
Greenstriped rockfish	1,097	345	0	1,442
Yellowtail rockfish	137	0	0	137
Chilipepper rockfish	104	24	0	128
Rosethorn rockfish	293	394	0	687
Shortbelly rockfish	0	4	0	4
Blackgill rockfish	0	39	0	39
Bocaccio	0	0	0	0
Canary rockfish	177	14	0	191
Redstripe rockfish	385	16	0	401
Stripetail rockfish	38	313	0	351
Halfbanded rockfish	12	0	0	12
Sharpchin rockfish	147	676	0	823
Swordspine rockfish	0	0	0	0

Table 9. Number of length-frequency measurements collected by stratum for the most frequently sampled groundfish species during the 2004 West Coast groundfish trawl survey for the INPFC U.S.-Vancouver area.

Species	Stratum 1 (55-183 m)	Stratum 2 (184-549 m)	Stratum 3 (550-1,280 m)	Total
Spiny dogfish	644	185	0	829
California skate	0	0	0	0
Longnose skate	88	53	1	142
Pacific sanddab	449	0	0	449
Arrowtooth flounder	405	133	1	539
Flathead sole	188	39	0	227
Petrale sole	297	3	0	300
English sole	795	45	0	840
Dover sole	1,189	363	83	1,635
Rex sole	850	139	20	1,009
Curlfin sole	1	0	0	1
Sablefish	144	184	133	461
Pacific grenadier	0	3	222	225
Lingcod	53	2	0	55
Pacific hake	0	0	0	0
Shortspine thornyhead	18	351	126	495
Longspine thornyhead	0	97	377	474
Pacific ocean perch	85	99	0	184
Aurora rockfish	0	0	0	0
Greenspotted rockfish	7	0	0	7
Darkblotched rockfish	99	0	0	99
Splitnose rockfish	55	2	0	57
Greenstriped rockfish	341	7	0	348
Yellowtail rockfish	387	0	0	387
Chilipepper rockfish	0	0	0	0
Rosethorn rockfish	120	100	0	220
Shortbelly rockfish	0	0	0	0
Blackgill rockfish	0	0	0	0
Bocaccio	0	0	0	0
Canary rockfish	157	2	0	159
Redstripe rockfish	125	0	0	125
Stripetail rockfish	1	0	0	1
Halfbanded rockfish	0	0	0	0
Sharpchin rockfish	129	100	0	229
Swordspine rockfish	0	0	0	0

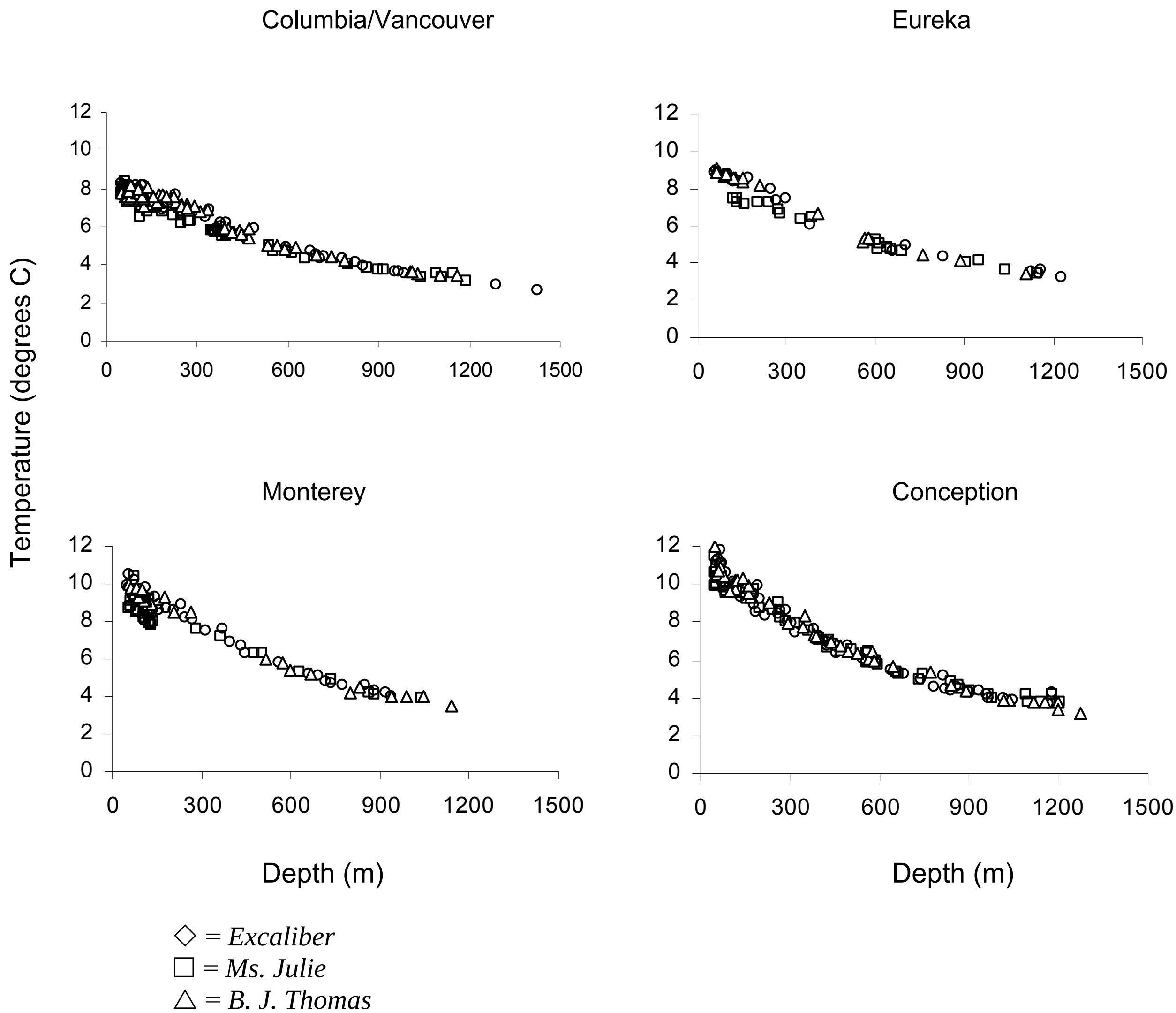


Figure 5. Near bottom temperature observed at the mouth of the net for each tow conducted during the 2004 West Coast groundfish trawl survey. Observations are grouped by INPFC area and plotted relative to haul depth.

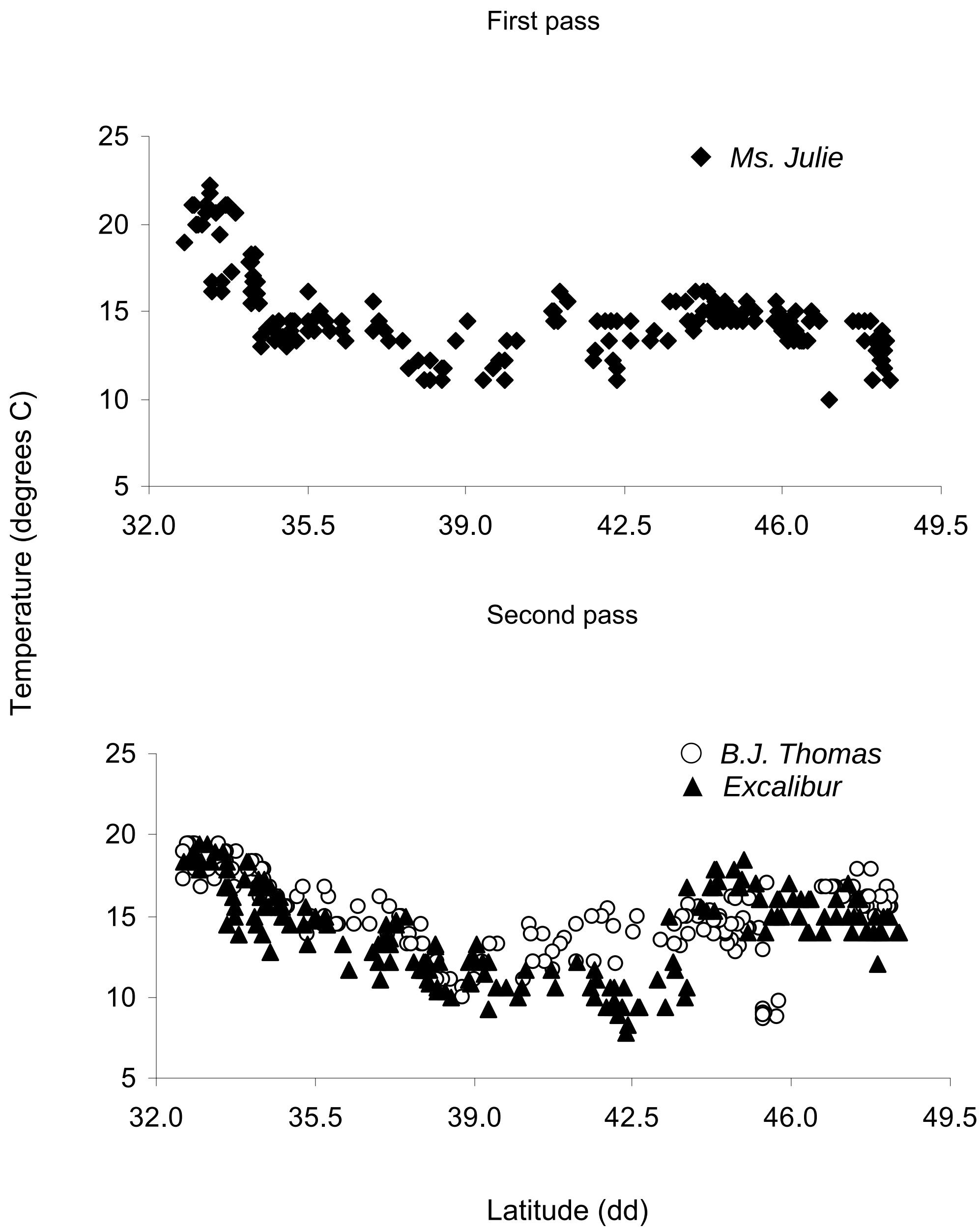


Figure 6. Sea surface temperature observed at the start of each tow during the 2004 NWFSC West Coast groundfish trawl survey. Observations are grouped by date (first pass from 27 May 2004 to 22 July 2004, second pass from 21 August 2004 to 16 October 2004).

Table 10. Mean CPUE (kg/ha) of the 20 most abundant groundfish and selected crab species caught in each of the INPFC areas for all strata (55–1,280 m) combined during the 2004 West Coast groundfish trawl survey.

All areas **Number of hauls = 505**		**U.S.-Vancouver area** **Number of hauls = 46**		**Columbia area** **Number of hauls = 162**	
Dover sole	21.12	Spiny dogfish	50.44	Pacific hake	31.05
Pacific hake	13.06	Dover sole	37.22	Dover sole	21.48
Longspine thornyhead	12.16	Sablefish	19.53	Sablefish	8.85
Sablefish	10.57	Arrowtooth flounder	18.94	Pacific sanddab	8.61
Spiny dogfish	8.17	Pacific ocean perch	11.26	Rex sole	7.83
Chilipepper rockfish	5.95	Sharpchin rockfish	9.35	Longspine thornyhead	6.79
Splitnose rockfish	4.45	Canary rockfish	8.07	Longnose skate	5.53
Pacific sanddab	4.41	Longspine thornyhead	6.61	Arrowtooth flounder	5.52
Rex sole	4.35	Yellowtail rockfish	6.52	English sole	5.37
Shortspine thornyhead	4.34	Shortspine thornyhead	6.33	Sharpchin rockfish	5.32
Longnose skate	4.00	Spotted ratfish	5.60	Shortspine thornyhead	3.87
English sole	3.26	Longnose skate	5.01	Grooved tanner crab	3.51
Shortbelly rockfish	3.15	Grooved tanner crab	4.91	Pacific grenadier	2.86
Pacific grenadier	2.73	English sole	4.46	Giant grenadier	2.44
Arrowtooth flounder	2.66	Pacific grenadier	3.65	Splitnose rockfish	2.38
Stripetail rockfish	2.27	Rex sole	3.54	Lingcod	2.19
Lingcod	21..	Redbanded rockfish	2.76	Spotted ratfish	1.82
Grooved tanner crab	2.10	Pacific hake	1.97	Yellowtail rockfish	1.66
California slickhead	2.06	Pacific cod	1.87	Petrale sole	1.61
Giant grenadier	1.92	Giant grenadier	1.87	Spiny dogfish	1.60
Eureka area **Number of hauls = 57**		**Monterey area** **Number of hauls = 97**		**Conception area** **Number of hauls = 146**	
Dover sole	39.45	Chilipepper rockfish	34.31	Longspine thornyhead	13.49
Sablefish	20.31	Dover sole	31.61	Dover sole	11.76
Pacific hake	20.06	Spiny dogfish	31.59	Sablefish	6.08
Longspine thornyhead	16.30	Sablefish	17.55	Shortspine thornyhead	5.06
Rex sole	12.51	Longspine thornyhead	16.19	California slickhead	3.93
Pacific grenadier	11.96	Pacific hake	14.53	Splitnose rockfish	3.58
English sole	9.57	Splitnose rockfish	11.30	Shortbelly rockfish	3.36
Giant grenadier	7.32	Shortbelly rockfish	10.47	Pacific hake	2.94
Longnose skate	6.45	Pacific sanddab	10.15	Longnose skate	1.51
Splitnose rockfish	5.39	Stripetail rockfish	9.80	Halfbanded rockfish	1.39
Grooved tanner crab	4.36	Grooved tanner crab	7.55	Pacific grenadier	1.22
Shortspine thornyhead	3.76	Longnose skate	7.11	Filetail cat shark	1.08
Petrale sole	3.68	Lingcod	6.13	Grooved tanner crab	1.07
Chilipepper rockfish	3.39	Rex sole	4.56	Pacific sanddab	0.90
Arrowtooth flounder	2.85	English sole	4.38	Giant grenadier	0.90
Pacific sanddab	2.80	Bocaccio	3.66	Spotted ratfish	0.90
Big skate	2.61	Petrale sole	3.49	Rex sole	0.88
Stripetail rockfish	2.40	White croaker	3.42	Stripetail rockfish	0.83
Lingcod	2.04	Big Skate	2.83	Brown cat shark	0.83
Slender sole	1.58	Shortspine thornyhead	2.60	Lingcod	0.82

Table 11. Mean CPUE (kg/ha) of the 20 most abundant groundfish and selected crab species caught by depth strata in all INPFC areas combined during the 2004 West Coast groundfish trawl survey.

Stratum 1 (55–183 m)		Stratum 2 (184–549 m)		Stratum 3 (550–1,280 m)	
Pacific Hake	34.34	Dover sole	30.60	Longspine thornyhead	23.49
Spiny dogfish	28.02	Sablefish	21.67	Dover sole	19.36
Dover sole	16.67	Splitnose rockfish	20.05	Sablefish	9.24
Pacific sanddab	15.89	Pacific hake	16.75	Grooved tanner crab	6.25
Chilipepper rockfish	14.21	Rex sole	9.70	Shortspine thornyhead	6.19
English sole	11.17	Chilipepper rockfish	9.63	Pacific grenadier	5.36
Rex sole	7.63	Shortbelly rockfish	9.29	California slickhead	4.05
Longnose skate	6.87	Longnose skate	8.48	Giant grenadier	3.76
Lingcod	5.68	Sharpchin rockfish	7.36	Brown cat shark	1.27
Petrale sole	4.73	Stripetail rockfish	7.24	Deepsea sole	1.19
Arrowtooth flounder	4.69	Arrowtooth flounder	6.30	Twoline eelpout	1.01
Shortbelly rockfish	4.08	Shortspine thornyhead	5.32	Filetail cat shark	0.77
Big skate	3.96	Pacific ocean perch	3.48	Longnose skate	0.53
Sablefish	3.95	Spiny dogfish	2.90	Pacific flatnose	0.50
Spotted ratfish	3.80	Lingcod	2.66	Roughtail skate	0.48
Yellowtail rockfish	3.06	Spotted rockfish	2.49	Bigfin eelpout	0.38
White croaker	2.71	Blackgill rockfish	1.44	Rex sole	0.30
Halfbanded rockfish	2.66	Aurora rockfish	1.43	Pacific hake	0.26
Canary rockfish	2.56	Bering skate	1.42	Snakehead eelpout	0.21
Stripetail rockfish	2.50	Bigfin eelpout	1.28	Aurora rockfish	0.17
Number of hauls	**239**	**Number of hauls**	**133**	**Number of hauls**	**133**

Table 12. Mean CPUE (kg/ha) of the 20 most abundant groundfish and selected crab species caught by depth strata in the Conception INPFC area during the 2004 West Coast groundfish trawl survey.

Stratum 1 (55–183 m)		Stratum 2 (184–549 m)		Stratum 3 (550–1,280 m)	
Halfbanded rockfish	12.30	Splitnose rockfish	17.22	Longspine thornyhead	19.57
Spotted ratfish	5.68	Shortbelly rockfish	17.12	Dover sole	13.31
Pacific sanddab	5.30	Dover sole	13.07	Sablefish	7.67
White croaker	3.88	Pacific hake	13.00	Shortspine thornyhead	6.82
Pacific butterfish	2.55	Longnose skate	5.35	California slickhead	5.79
Pink sea perch	1.82	Sable fish	4.17	Pacific grenadier	1.79
English sole	1.21	Rex sole	4.13	Grooved tanner crab	1.74
Spiny dogfish	1.18	Stripetail rockfish	3.52	Giant grenadier	1.32
California scorpionfish	0.92	Lingcod	3.52	Filetail cat shark	1.25
Stripetail rockfish	0.92	Blackgill rockfish	2.76	Brown cat shark	1.08
California skate	0.91	Chilipepper rockfish	2.17	Twoline eelpout	0.69
Pacific hake	0.85	Shortspine thornyhead	2.06	Deepsea sole	0.67
Lingcod	0.82	Aurora rockfish	1.71	Roughtail skate	0.49
Petrale sole	0.78	Pacific sanddab	1.47	Longnose skate	0.49
Bocaccio	0.76	Spotted ratfish	1.23	Bigfin eelpout	0.43
Canary rockfish	0.75	Filetail cat shark	1.09	Pacific flatnose	0.37
Greenspotted rockfish	0.67	English sole	1.03	Pacific hake	0.22
Longnose skate	0.60	Longspine thornyhead	0.95	Aurora rockfish	0.18
Big skate	0.55	Swordspine rockfish	0.92	Deepsea skate unident.	0.16
Copper rockfish	0.43	Slender sole	0.91	Pacific sleeper shark	0.11
Number of hauls	**47**	**Number of hauls**	**46**	**Number of hauls**	**53**

Table 13. Mean CPUE (kg/ha) of the 20 most abundant groundfish and selected crab species caught by depth strata in the Monterey INPFC area during the 2004 West Coast groundfish trawl survey.

Stratum 1 (55–183 m)		**Stratum 2 (184–549 m)**		**Stratum 3 (550–1,280 m)**	
Spiny dogfish	75.09	Chilipepper rockfish	71.23	Dover sole	48.51
Chilipepper rockfish	53.13	Sablefish	68.86	Longspine thornyhead	39.09
Pacific sanddab	24.62	Splitnose rockfish	64.71	Grooved tanner crab	18.25
Pacific hake	17.73	Dover sole	51.65	Sablefish	9.93
Shortbelly rockfish	17.10	Pacific hake	40.94	Shortspine thornyhead	5.37
Lingcod	12.44	Stripetail rockfish	40.26	Pacific grenadier	2.88
English sole	9.87	Shortbelly rockfish	19.64	Brown cat shark	2.52
Longnose skate	9.32	Rex sole	17.47	Deepsea sole	2.36
White croaker	8.31	Longnose skate	15.49	California slickhead	2.31
Bocaccio	7.89	Lingcod	5.78	Giant grenadier	2.23
Petrale sole	6.90	Spiny dogfish	3.84	Longnose skate	1.38
Stripetail rockfish	6.73	Petrale sole	3.73	Twoline eelpout	1.00
Big skate	6.45	Spotted ratfish	3.47	Aurora rockfish	0.45
Dover sole	6.14	Darkblotched rockfish	2.79	Rex sole	0.39
Spotted ratfish	3.55	Bering skate	2.49	Bigfin eelpout	0.38
California skate	3.48	Sharpchin rockfish	2.41	Snakehead eelpout	0.36
Sablefish	3.45	Boccacio	2.37	Pacific flatnose	0.23
Rex Sole	3.27	Shortspine thornyhead	2.18	Pacific hake	0.20
Plainfin midshipman	1.43	Bigfin eelpout	2.17	Bering skate	0.19
Greenstriped rockfish	1.27	Aurora rockfish	1.95	Roughtail skate	0.18
Number of hauls	**59**	**Number of hauls**	**17**	**Number of hauls**	**21**

Table 14. Mean CPUE (kg/ha) of the 20 most abundant groundfish and selected crab species caught by depth strata in the Eureka INPFC area during the 2004 West Coast groundfish trawl survey.

Stratum 1 (55–183 m)		**Stratum 2 (184–549 m)**		**Stratum 3 (550–1,280 m)**	
Pacific hake	43.70	Sablefish	71.55	Dover sole	39.07
English sole	29.28	Dover sole	67.64	Longspine thornyhead	31.92
Dover sole	25.95	Pacific hake	33.37	Pacific grenadier	23.43
Rex sole	20.67	Splitnose rockfish	33.00	Giant grenadier	14.33
Petrale sole	11.22	Rex sole	28.19	Sablefish	13.84
Chilipepper rockfish	10.40	Longnose skate	18.67	Grooved tanner crab	8.54
Longnose skate	9.77	Arrowtooth flounder	6.31	Shortspine thornyhead	6.34
Pacific sanddab	8.58	Bigfin eelpout	5.42	Rex sole	2.28
Big skate	7.99	Darkblotched rockfish	5.27	Deepsea sole	2.27
Stripetail rockfish	6.42	Bering skate	4.92	California slickhead	1.42
Lingcod	5.53	Shortspine thornyhead	3.21	Pacific flatnose	1.25
Arrowtooth flounder	5.49	Stripetail rockfish	1.85	Brown cat shark	1.20
Sablefish	4.82	Brown cat shark	1.48	Bigfin eelpout	0.76
Slender sole	4.27	Lingcod	1.42	Black eelpout	0.76
Spotted ratfish	2.53	Spotted ratfish	1.41	Pacific hake	0.69
Greenstriped rockfish	1.07	Slender sole	1.15	Roughtail skate	0.69
Northern anchovy	1.02	Black eelpout	0.90	Twoline eelpout	0.64
Pacific tomcod	0.92	Aurora rockfish	0.74	Snakehead eelpout	0.61
Starry flounder	0.77	Spiny dogfish	0.51	Longnose skate	0.42
California skate	0.66	Redbanded rockfish	0.39	Deepsea skate unident.	0.15
Number of hauls	**20**	**Number of hauls**	**12**	**Number of hauls**	**25**

Table 15. Mean CPUE (kg/ha) of the 20 most abundant groundfish and selected crab species caught by depth strata in the Columbia INPFC area during the 2004 West Coast groundfish trawl survey.

Stratum 1 (55–183 m)		**Stratum 2 (184–549 m)**		**Stratum 3 (550–1,280 m)**	
Pacific hake	62.81	Dover sole	30.16	Longspine thornyhead	21.61
Dover sole	27.16	sharpchin rockfish	16.60	Grooved tanner crab	11.59
Pacific sanddab	19.61	Sablefish	13.36	Sablefish	9.61
English sole	11.43	Pacific hake	13.04	Pacific grenadier	9.59
Rex sole	10.82	Rex sole	11.64	Giant grenadier	8.17
Longnose skate	7.99	Shortspine thornyhead	10.90	Dover sole	5.52
Arrowtooth flounder	6.60	Arrowtooth flounder	9.99	Shortspine thornyhead	3.30
Sablefish	5.64	Splitnose rockfish	8.95	Twoline eelpout	1.58
Lingcod	4.48	Longnose skate	7.54	Deepsea sole	1.45
Yellowtail rockfish	3.78	Pacific ocean perch	2.48	Brown cat shark	1.03
Petrale sole	3.60	Stripetail rockfish	2.45	Pacific flatnose	0.80
Spotted ratfish	3.38	Rougheye rockfish	2.44	California slickhead	0.67
Big skate	3.10	Aurora rockfish	1.42	Roughtail skate	0.51
Spiny dogfish	2.98	Slender sole	1.39	Snakehead eelpout	0.37
Greenstriped rockfish	2.91	Bering skate	1.38	Deepsea skate	0.36
Pacific cod	2.23	English sole	1.33	Pacific hake	0.20
Redstripe rockfish	2.22	Longspine thornyhead	1.29	Deepsea skate unident.	0.17
Sharpchin rockfish	2.19	Spotted ratfish	1.25	Bering skate	0.15
Darkblotched rockfish	1.99	Darkblotched rockfish	1.24	Longnose skate	0.15
Slender sole	1.47	Bigfin eelpout	1.21	Rex sole	0.07
Number of hauls	**84**	**Number of hauls**	**50**	**Number of hauls**	**28**

Table 16. Mean CPUE (kg/ha) of the 20 most abundant groundfish and selected crab species caught by depth strata in the U.S.-Vancouver INPFC area during the 2004 West Coast groundfish survey.

Stratum 1 (55–183 m)		**Stratum 2 (184–549 m)**		**Stratum 3 (550–1,280 m)**	
Spiny dogfish	138.39	Dover sole	57.49	Dover sole	24.85
Canary rockfish	25.59	Arrowtooth flounder	30.91	Sablefish	21.18
Dover sole	24.46	Sablefish	29.57	Longspine thornyhead	21.17
Arrowtooth flounder	22.83	Pacific ocean perch	29.05	Grooved tanner crab	14.73
Yellowtail rockfish	20.97	Sharpchin rockfish	23.97	Pacific grenadier	11.89
English sole	12.66	Spiny dogfish	19.38	Shortspine thornyhead	9.79
Greenstriped rockfish	5.58	Spotted ratfish	11.45	Giant grenadier	5.99
Sablefish	5.55	Longnose skate	9.18	Twoline eelpout	5.55
Pacific cod	5.35	Shortspine thornyhead	8.60	Deapsea sole	2.31
Pacific sanddab	5.15	Redbanded rockfish	7.03	Shortraker rockfish	1.49
Longnose skate	4.65	Rex sole	5.81	Brown cat shark	1.32
Petrale sole	4.27	Rosethorn rockfish	2.60	Black eelpout	1.00
Spotted ratfish	3.92	Pacific hake	2.07	Roughtail skate	0.65
Rex sole	3.68	Bering skate	1.98	Pacific flatnose	0.62
Pacific hake	3.57	Rougheye rockfish	1.44	Rex sole	0.58
Big skate	3.23	English sole	1.37	Deepsea skate unident.	0.44
Lingcod	3.06	Lingcod	1.09	California slickhead	0.34
Pacific halibut	2.60	Grooved tanner crab	1.02	Snakehead eelpout	0.31
Slender sole	1.51	Slender sole	0.95	Pacific hake	0.21
Rosethorn rockfish	1.14	Flathead sole	0.76	Longnose skate	0.17
Number of hauls	**29**	**Number of hauls**	**8**	**Number of hauls**	**6**

(Tables 12–16). For the deep stratum, longspine thornyhead was the dominant species in the Conception and Columbia INPFC areas, while Dover sole was the dominant species in the Monterey, Eureka, and U.S.-Vancouver INPFC areas. Dover sole was also the dominant species in the mid-water stratum in the Columbia and U.S.-Vancouver INPFC areas while splitnose rockfish, chilipepper rockfish, and sablefish were most abundant at mid depths in the Conception, Monterey, and Eureka INPFC areas.

Figures 7–35 (created with ArcGIS Software, Environmental Systems Research Institute Inc., Redlands, California) are maps showing the geographical distributions and relative abundances of select groundfish species. These maps show the location points of the hauls where the species were caught. Catch rates were categorized as follows: 1) no catch, 2) greater than zero but less than or equal to the mean CPUE, 3) greater than the mean CPUE but less than or equal to one standard deviation from the mean, 4) between one and two standard deviations greater than the mean CPUE, and 5) more than two standard deviations greater than the mean CPUE.

Biomass and Population Estimates

Abundance estimates of biomass in metric tons (mt) along with associated CVs are presented for the 20 most abundant groundfish and crab species (Tables 17–22) based on all areas combined by depth strata and INPFC areas. Dover sole had the highest biomass in the mid-depth stratum and in all depth strata for the combined INPFC areas (Table 17). Pacific hake, longspine thornyhead, sablefish, spiny dogfish, chilipepper, and splitnose rockfish followed Dover sole in decreasing order of biomass in all strata for the combined INPFC areas. Unlike Dover sole, Pacific hake and spiny dogfish exhibited higher biomass in the shallow stratum while longspine thornyheads had the highest biomass in the deep stratum (Table 17). Other species with elevated biomass in the deep stratum include shortspine thornyhead, grooved tanner crab, Pacific grenadier, California slickhead and giant grenadier. Sablefish had moderately high levels of biomass in both the mid-depth and deep strata while chilipepper biomass was elevated in the shallow and mid-depth strata. Splitnose rockfish were concentrated in the mid-depth stratum, where they ranked third overall for all INPFC areas combined.

When depth strata are combined Dover sole biomass ranked first or second in all INPFC areas (Tables 18–22). For combined depth strata, longspine thornyhead biomass was greater than Dover sole in the Conception area, Pacific hake biomass was higher in the Columbia area and spiny dogfish biomass was higher in the U.S.-Vancouver area. The depth distributions described above for biomass estimates of dominant species in the combined INPFC area were generally reflected in the individual areas (Tables 18–22). Dover sole and longspine thornyhead dominated the deep stratum in the Conception, Monterey, Eureka, and U.S.-Vancouver areas. In the Columbia area, grooved tanner crab biomass was elevated in the deep stratum. In the northern portion of the survey, Dover sole and sablefish biomass were elevated in the mid-depth stratum, while splitnose rockfish, shortbelly rockfish, and chilipepper biomass were higher in the south. Generally, either Pacific hake or spiny dogfish biomass was highest in the shallow stratum from the Monterey INPFC area to the U.S.-Vancouver INPFC area. In the INPFC Conception area, biomass of halfbanded rockfish (data not shown) was the highest observed in the shallow stratum.

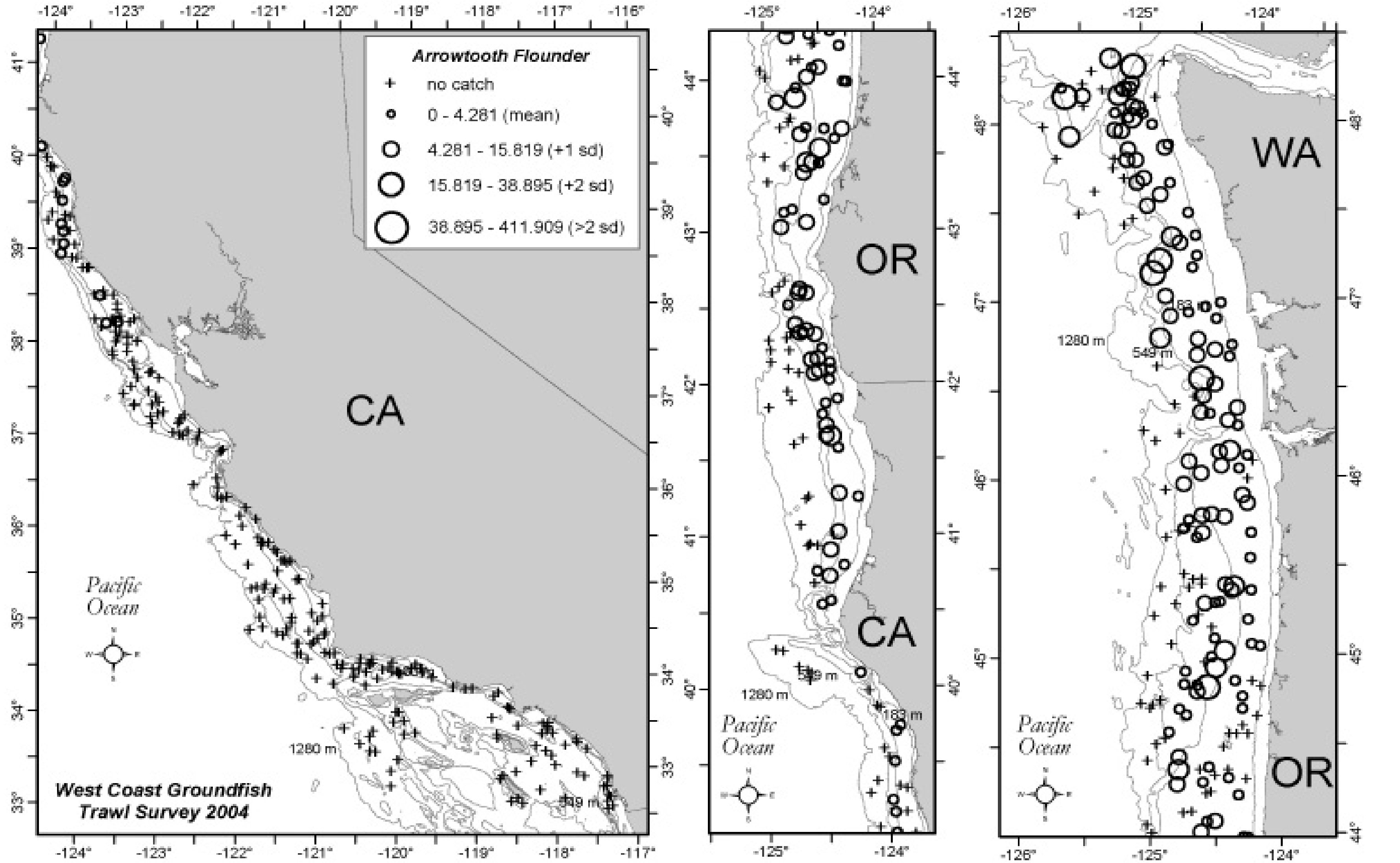


Figure 7. Arrowtooth flounder distribution and relative abundance (kg/ha) from the 2004 West Coast groundfish trawl survey.

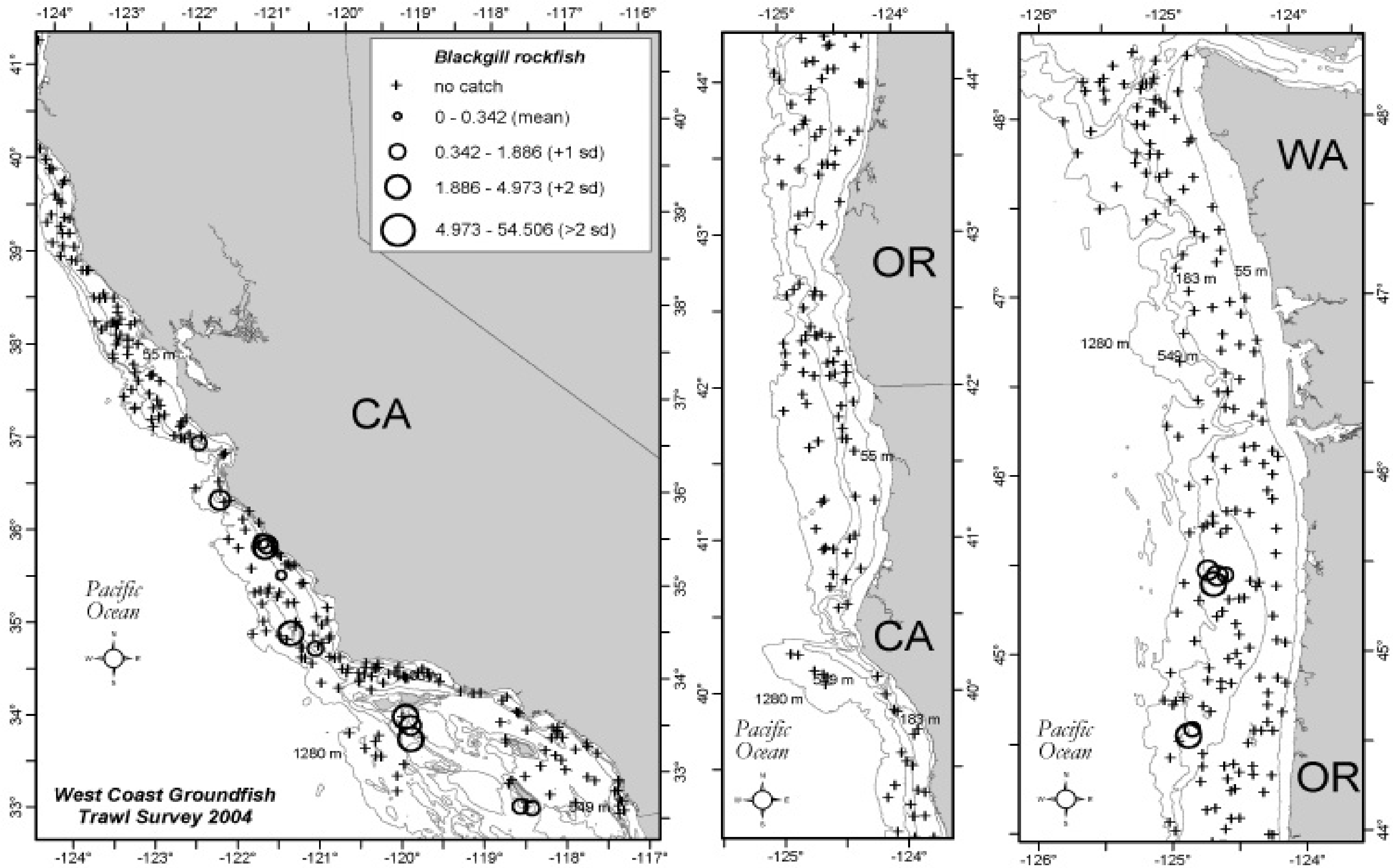


Figure 8. Blackgill rockfish distribution and relative abundance (kg/ha) from the 2004 West Coast groundfish trawl survey.

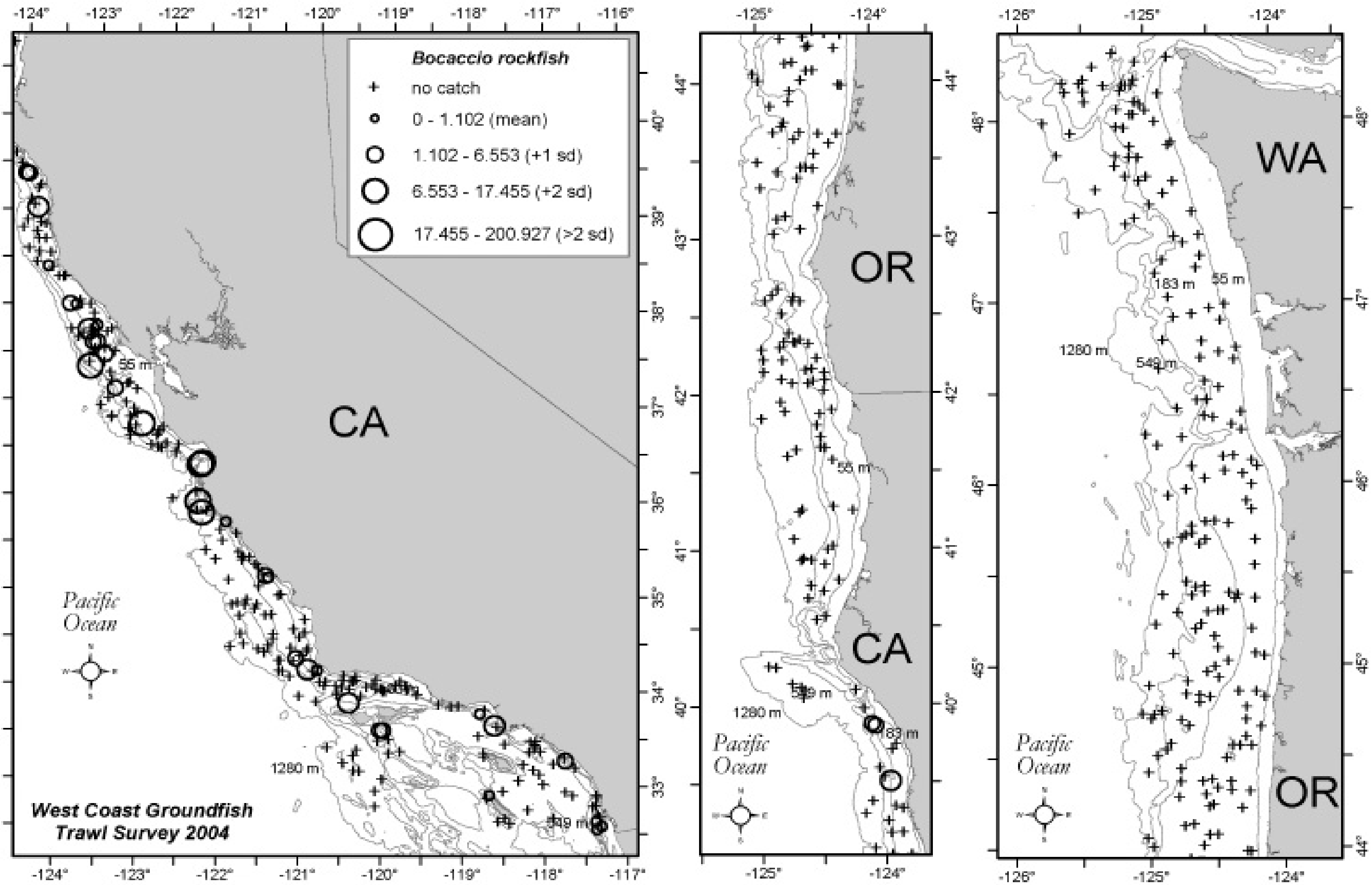


Figure 9. Bocaccio distribution and relative abundance (kg/ha) from the 2004 West Coast groundfish trawl survey.

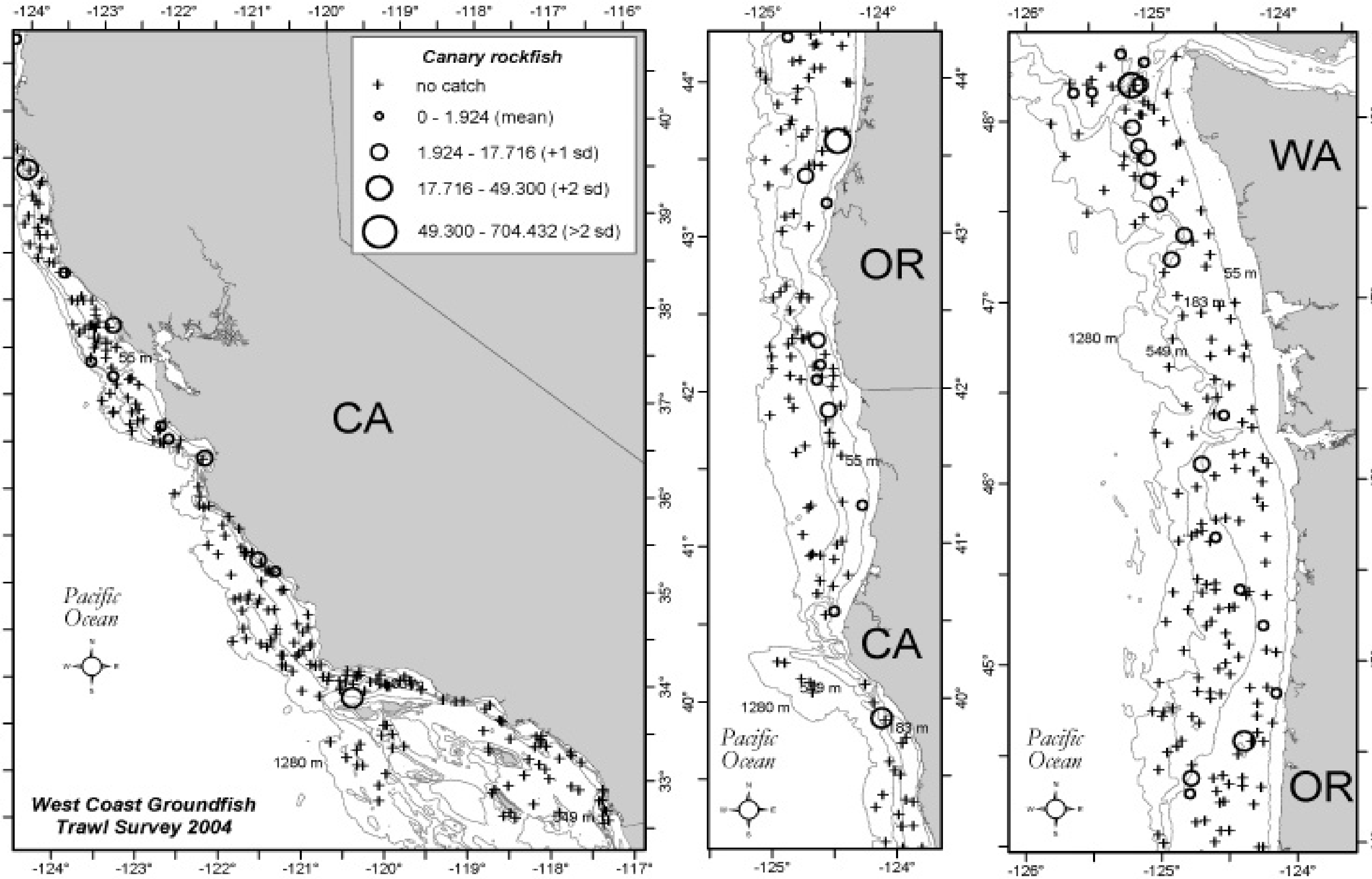


Figure 10. Canary rockfish distribution and relative abundance (kg/ha) from the 2004 West Coast groundfish trawl survey.

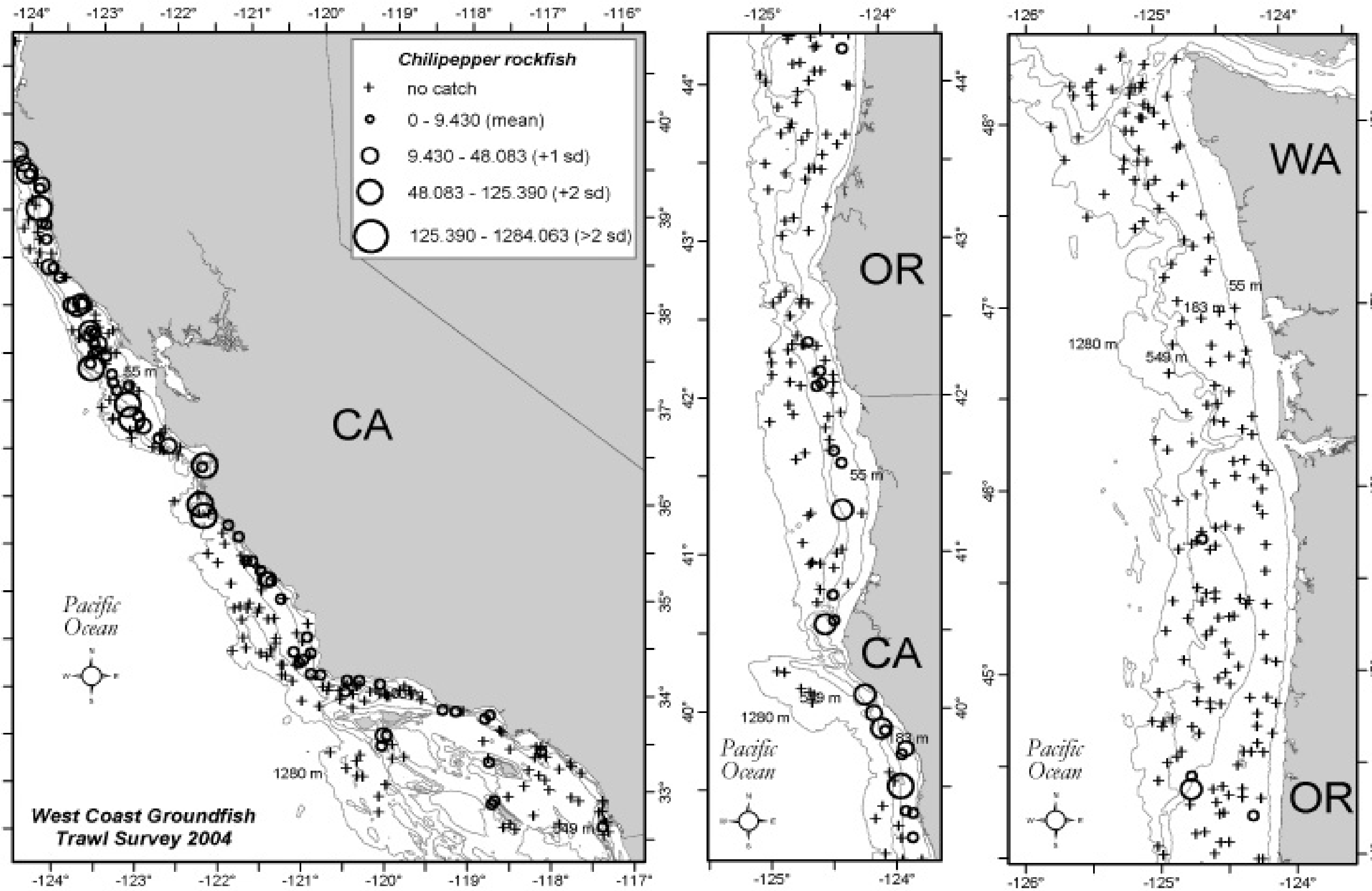


Figure 11. Chilipepper rockfish distribution and relative abundance (kg/ha) from the 2004 West Coast groundfish trawl survey.

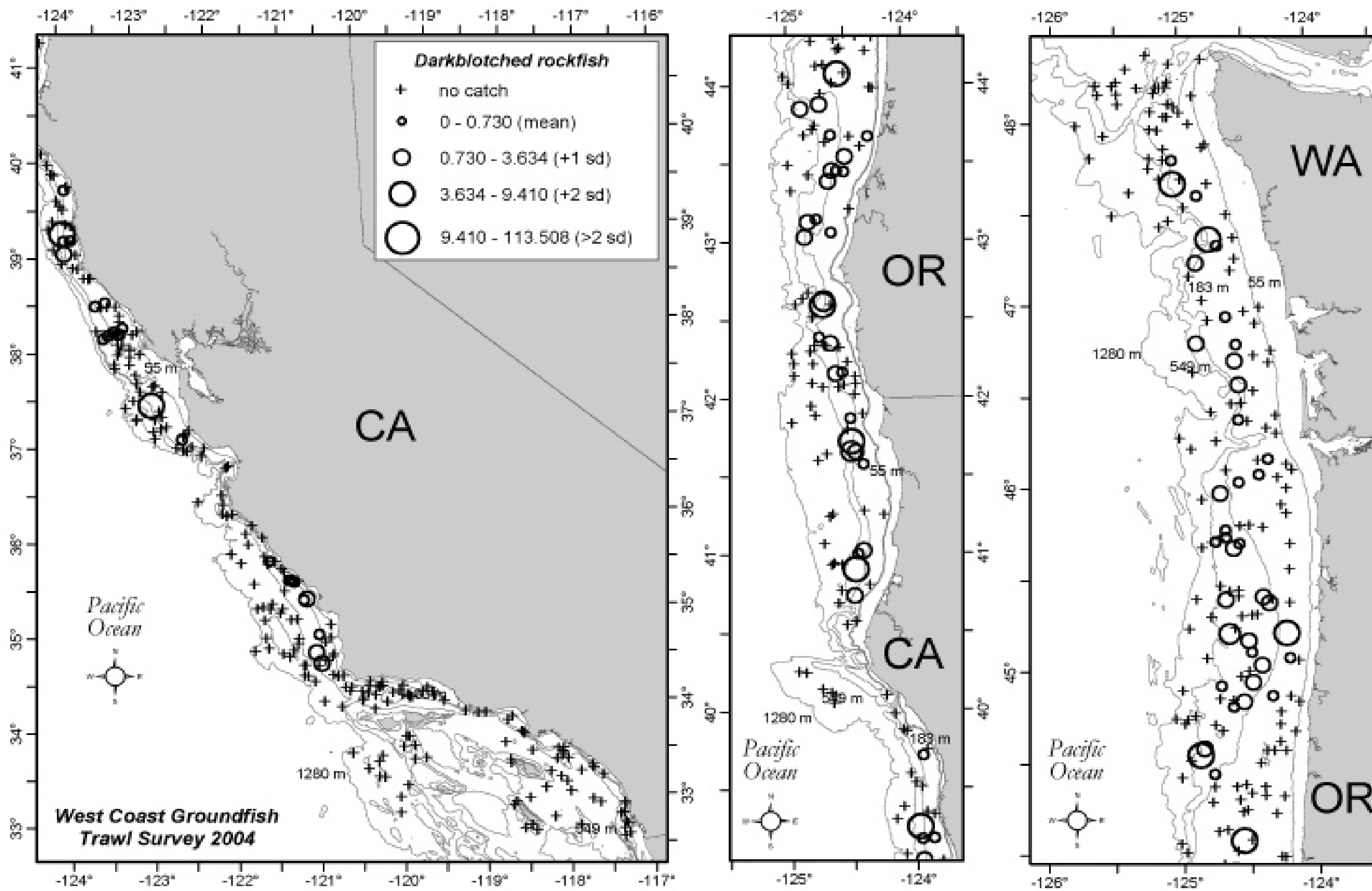


Figure 12. Darkblotched rockfish distribution and relative abundance (kg/ha) from the 2004 West Coast groundfish trawl survey.

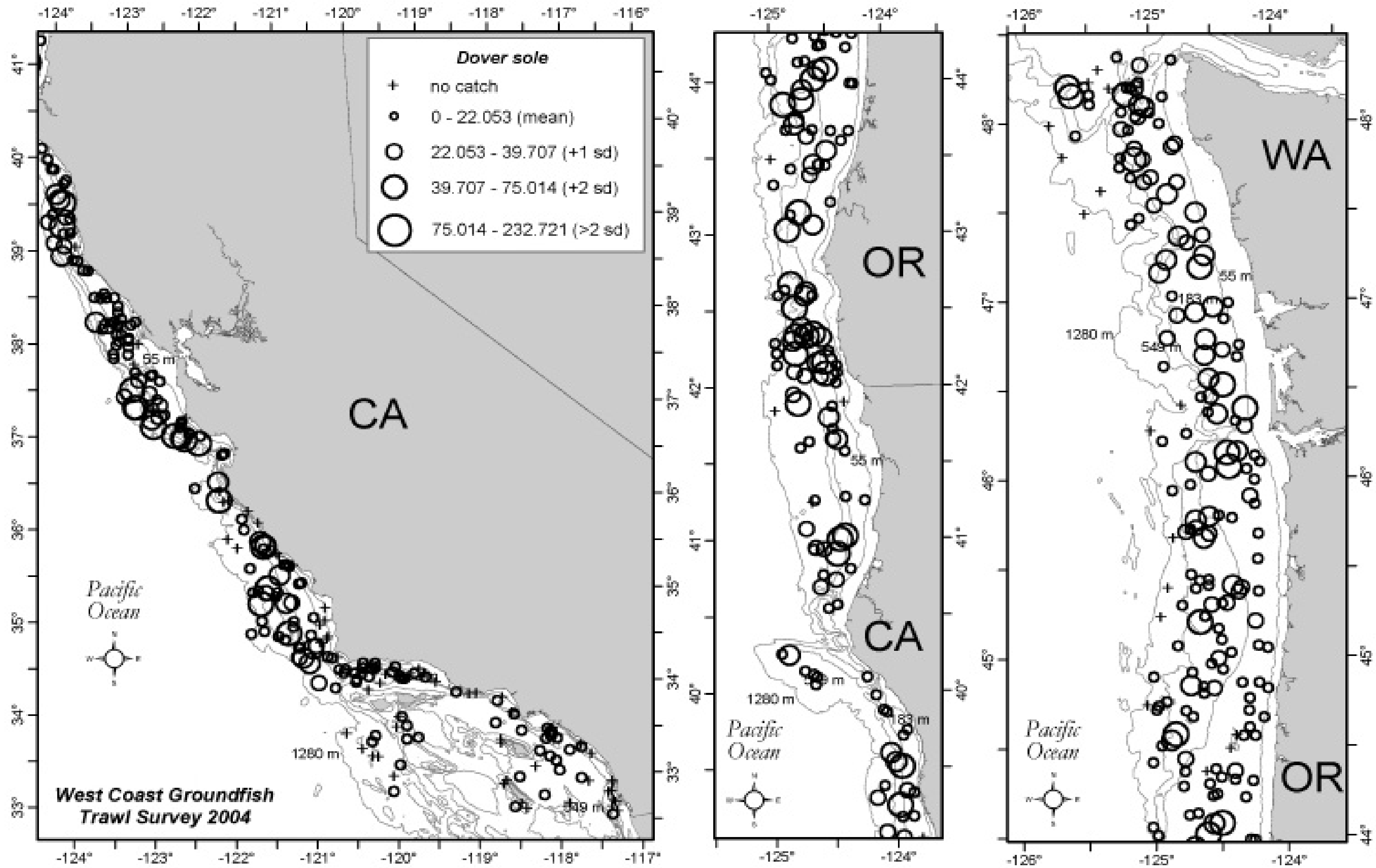


Figure 13. Dover sole distribution and relative abundance (kg/ha) from the 2004 West Coast groundfish trawl survey.

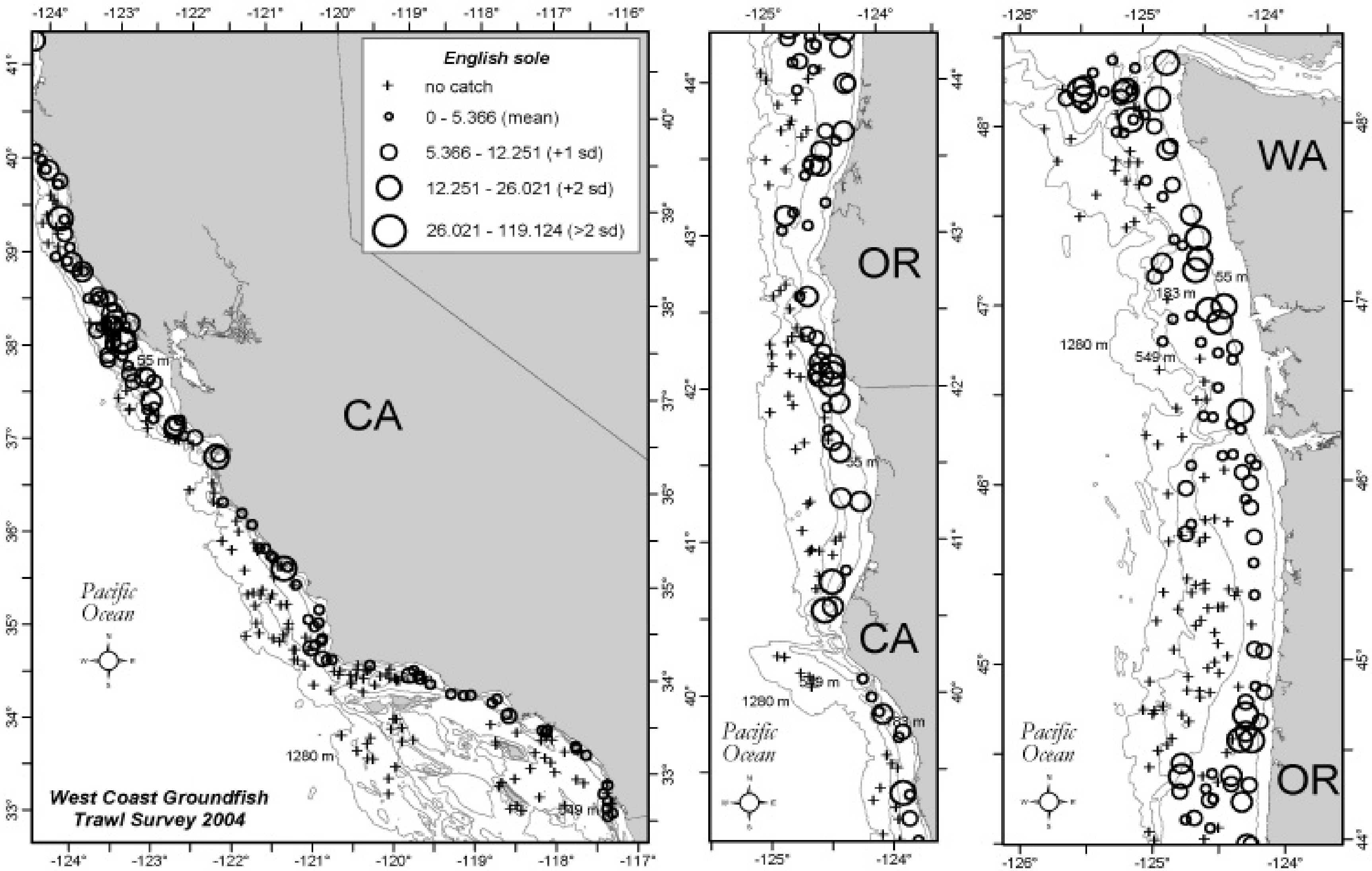


Figure 14. English sole distribution and relative abundance (kg/ha) from the 2004 West Coast groundfish trawl survey.

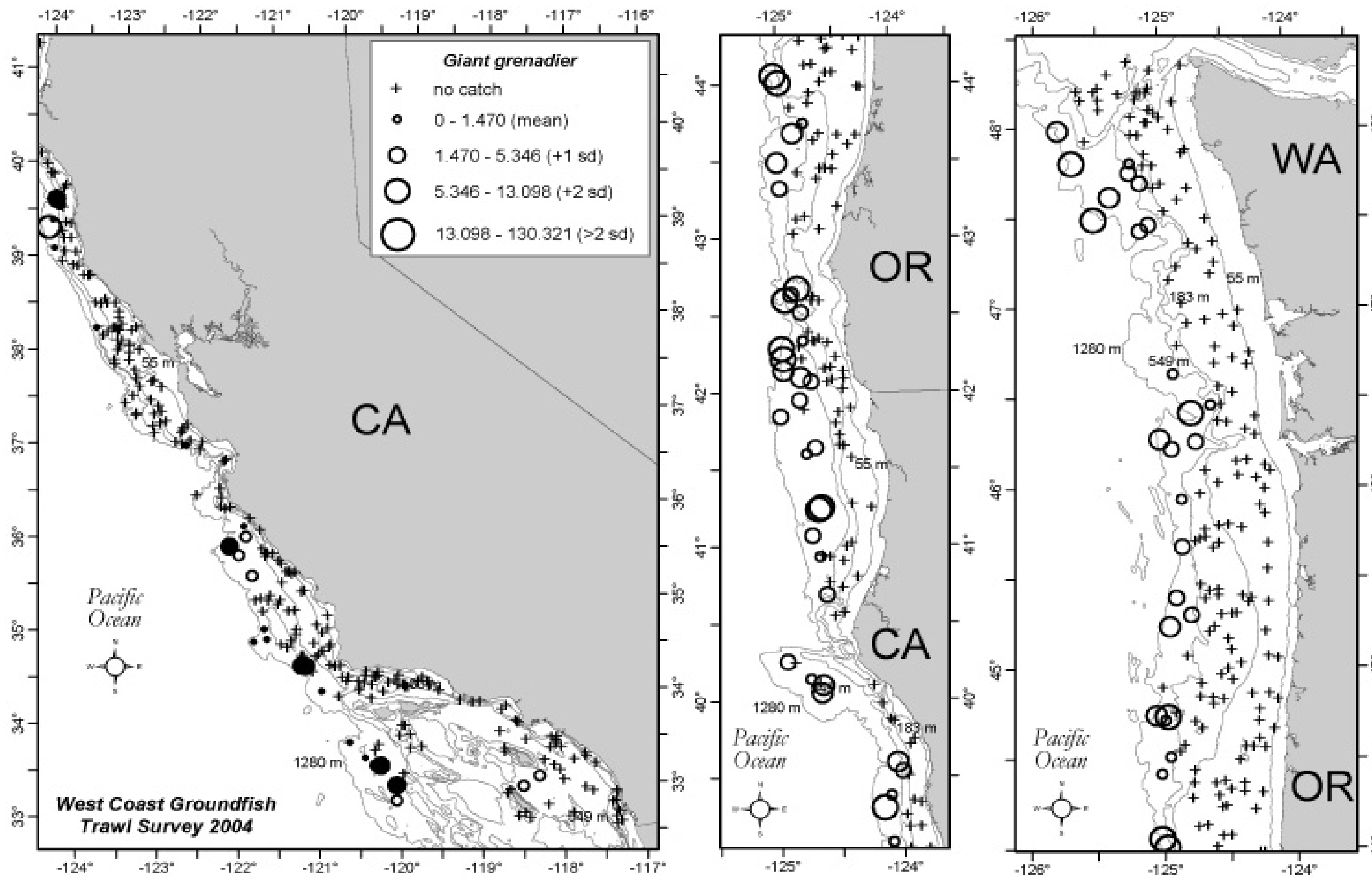


Figure 15. Giant grenadier distribution and relative abundance (kg/ha) from the 2004 West Coast groundfish trawl survey.

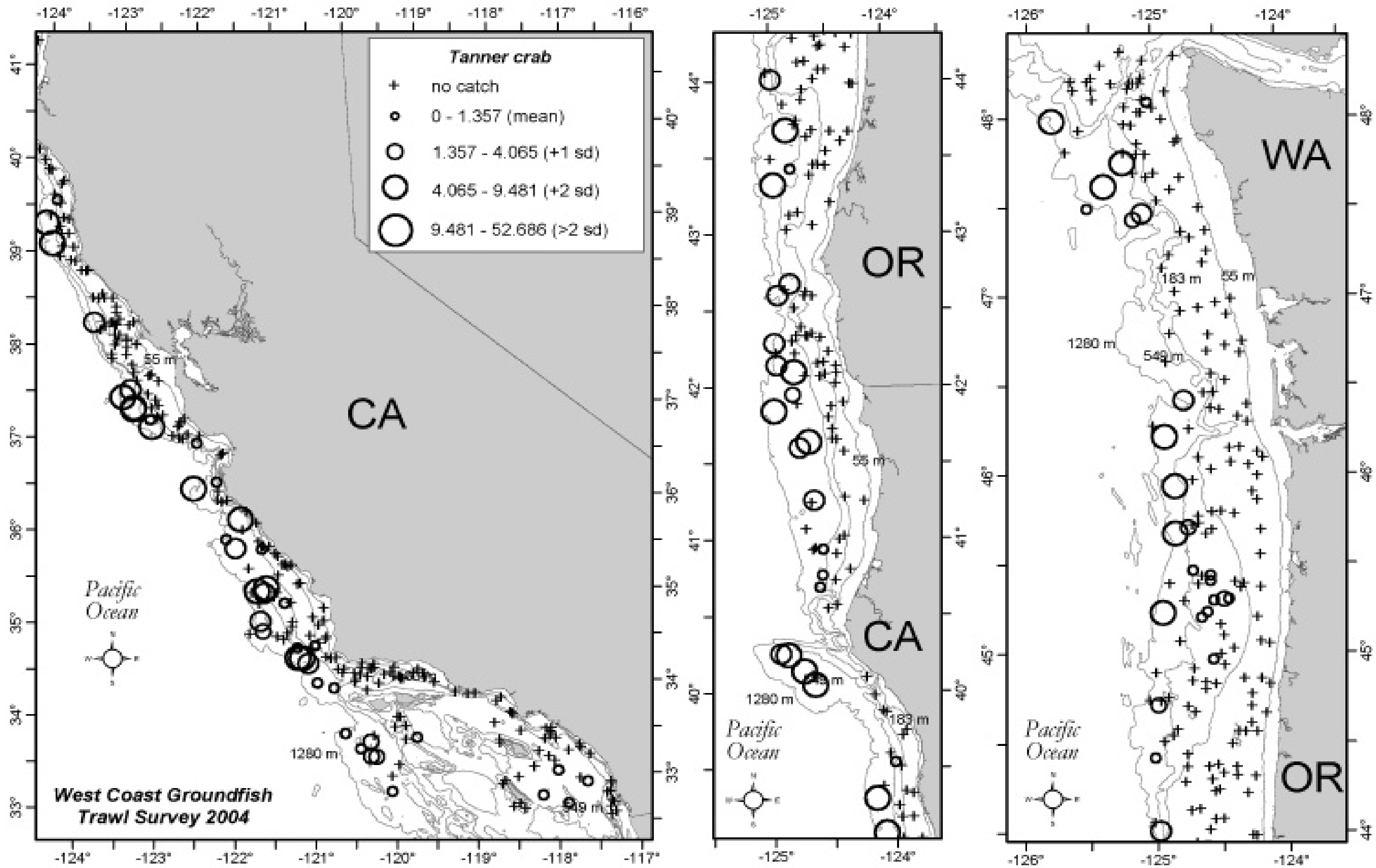


Figure 16. Grooved tanner crab distribution and relative abundance (kg/ha) from the 2004 West Coast groundfish trawl survey.

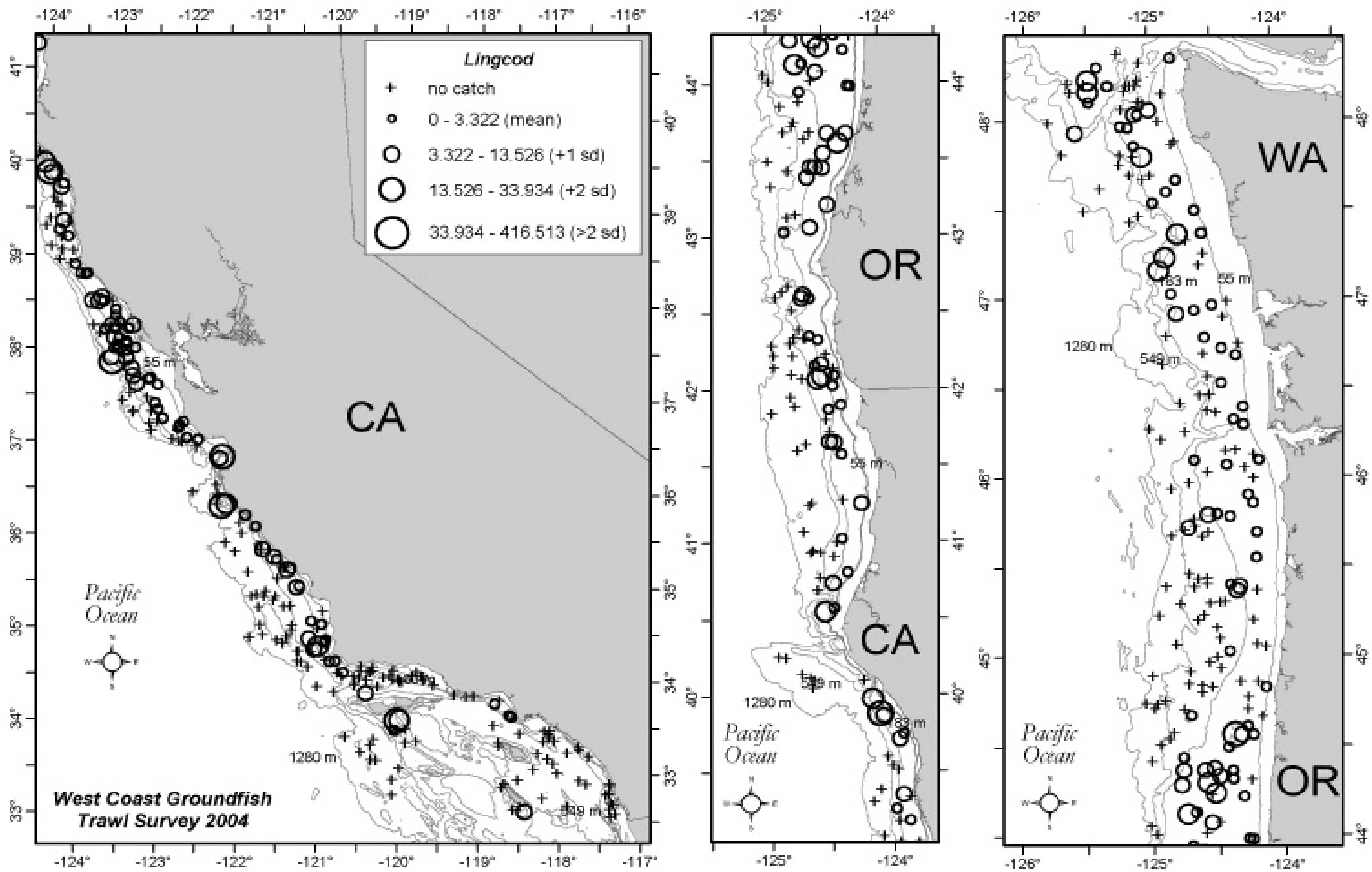


Figure 17. Lingcod distribution and relative abundance (kg/ha) from the 2004 West Coast groundfish trawl survey.

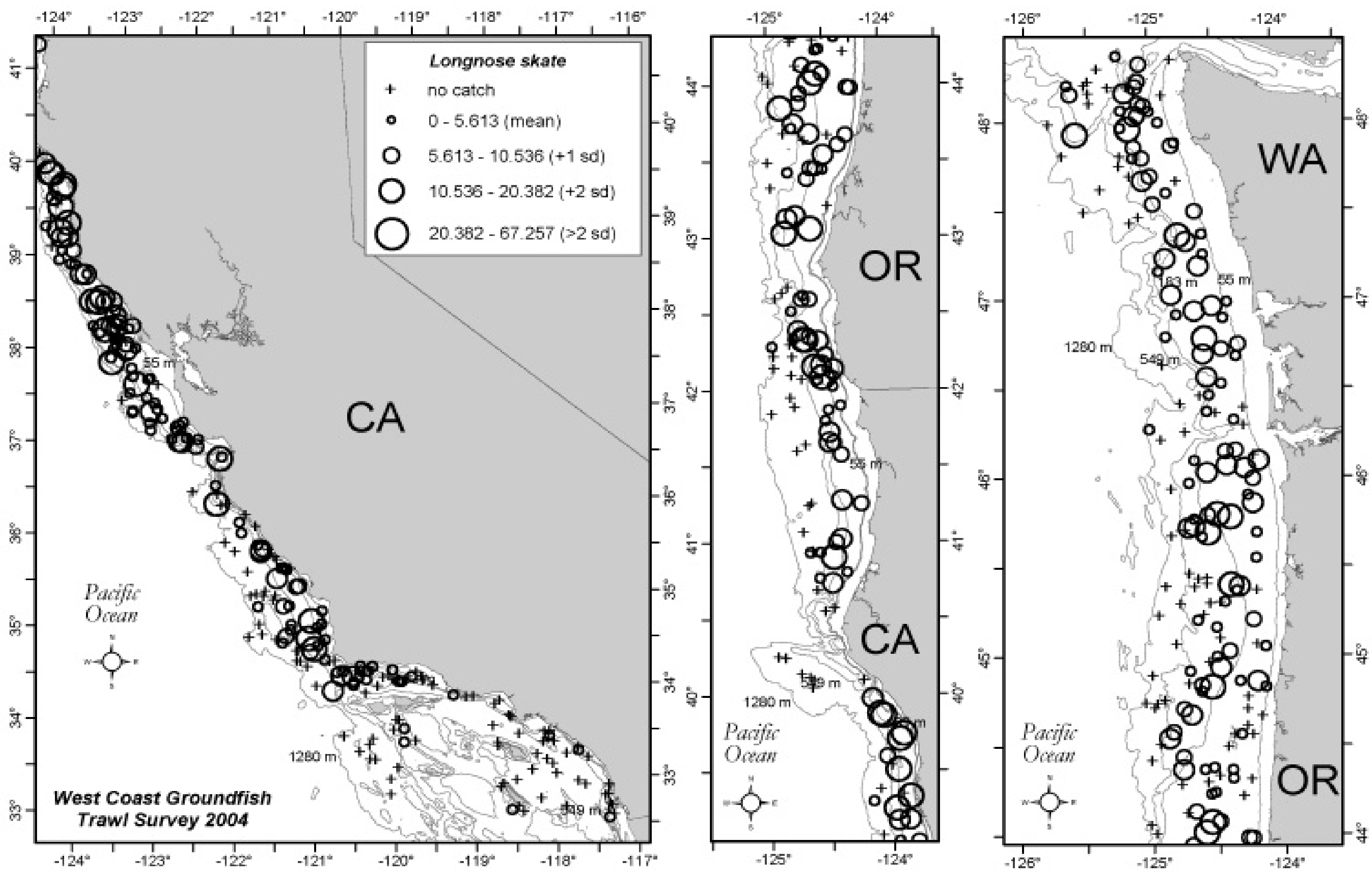


Figure 18. Longnose skate distribution and relative abundance (kg/ha) from the 2004 West Coast groundfish trawl survey.

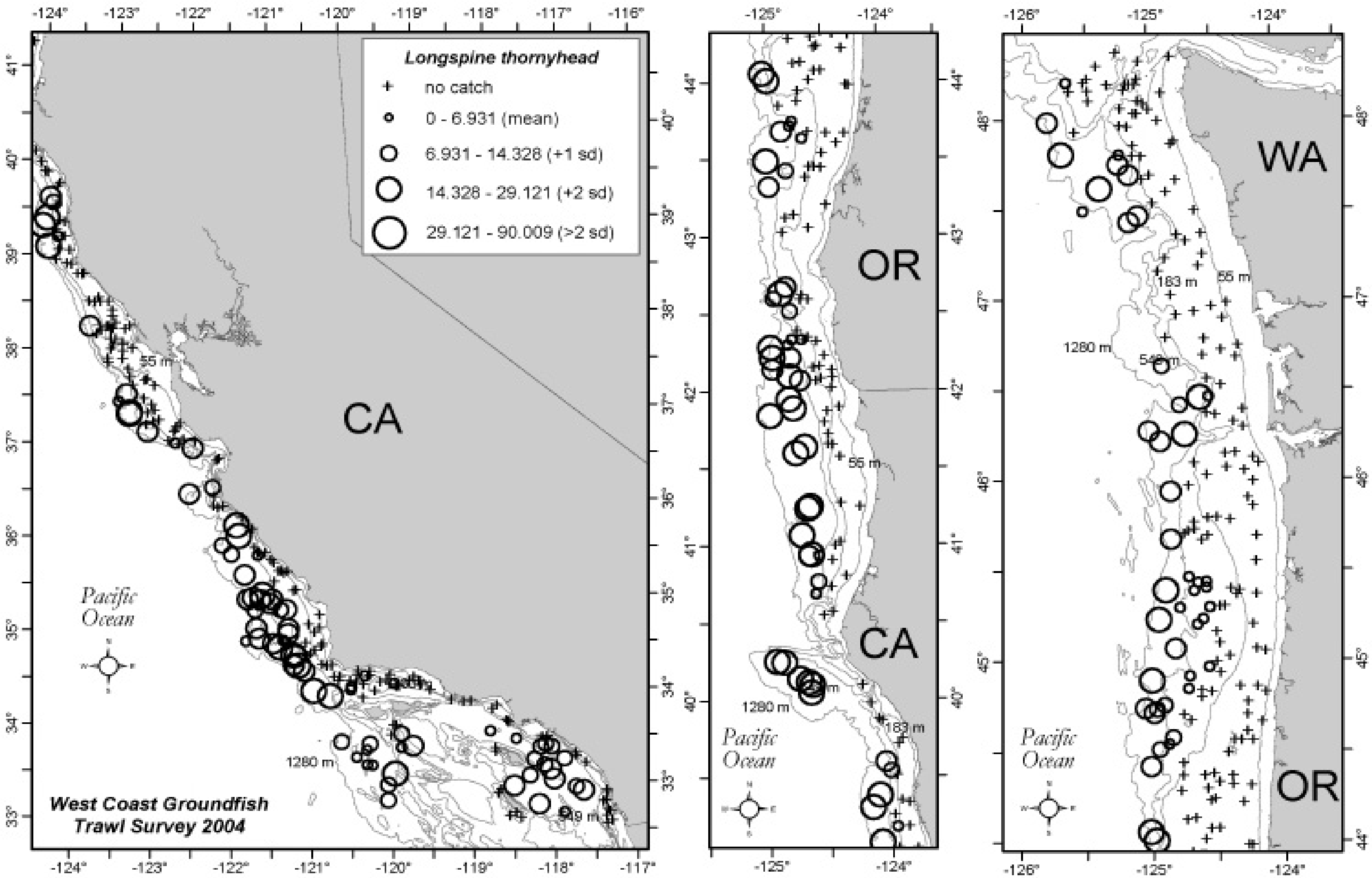


Figure 19. Longspine thornyhead distribution and relative abundance (kg/ha) from the 2004 West Coast groundfish trawl survey.

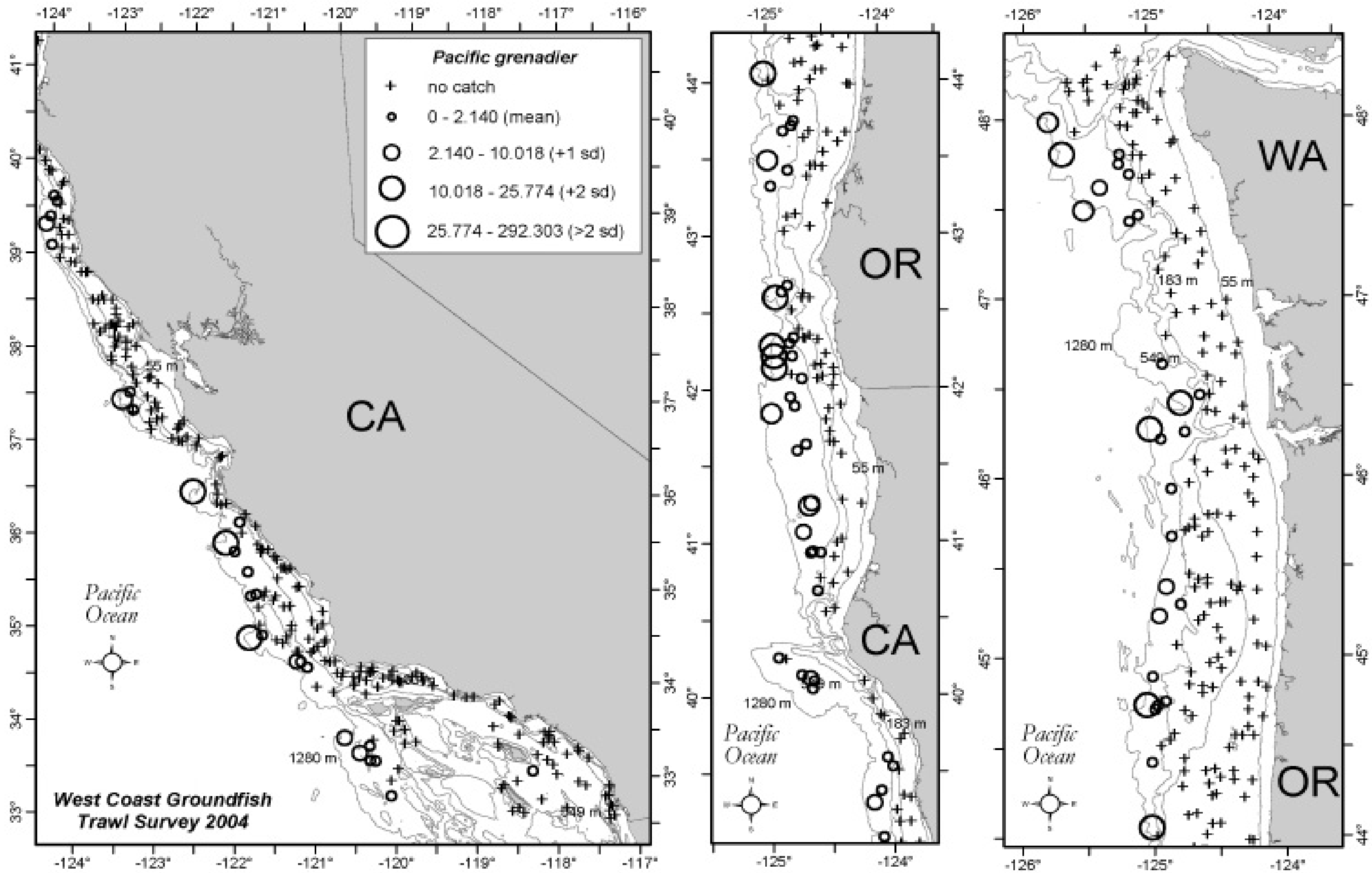


Figure 20. Pacific grenadier distribution and relative abundance (kg/ha) from the 2004 West Coast groundfish trawl survey.

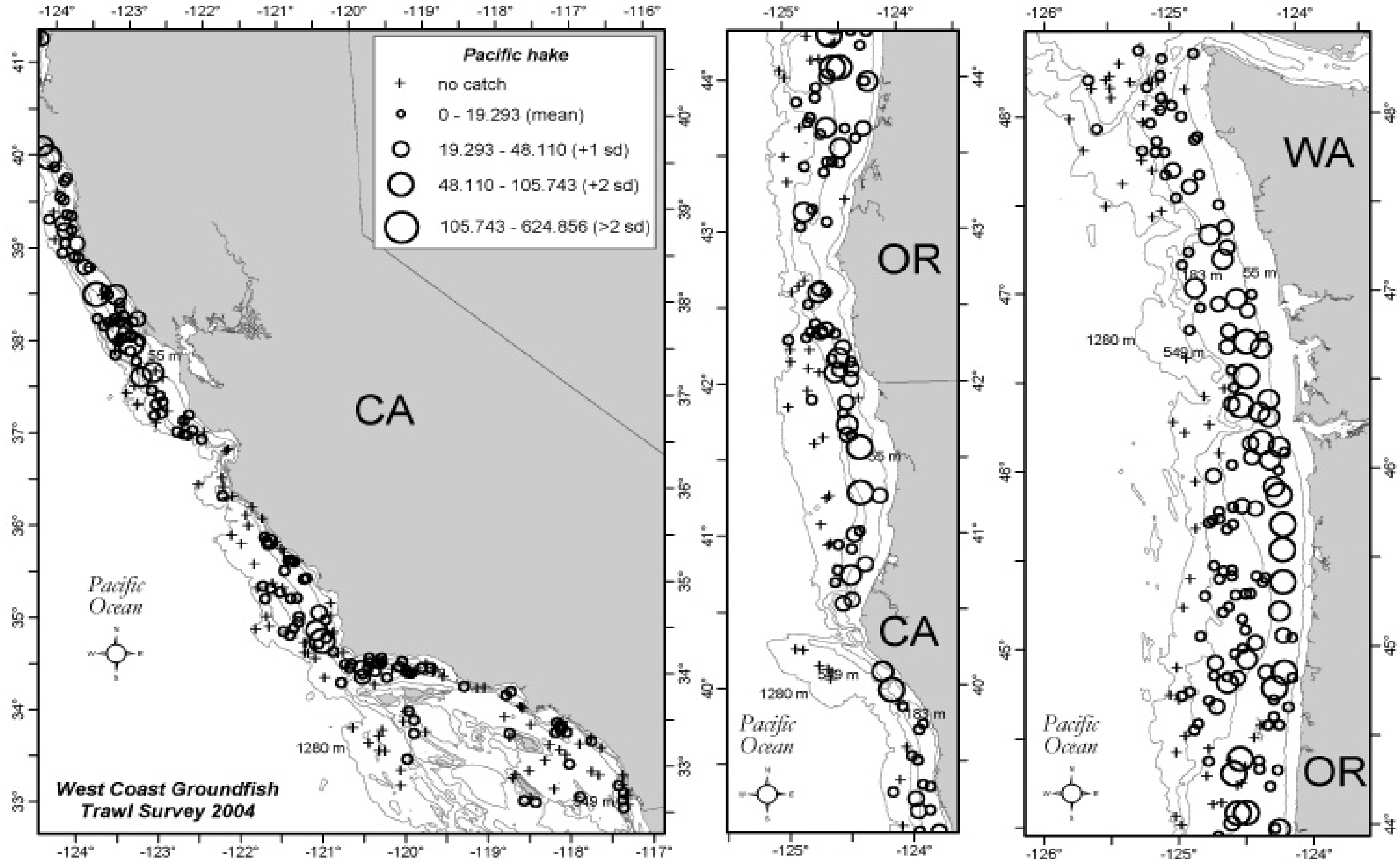


Figure 21. Pacific hake distribution and relative abundance (kg/ha) from the 2004 West Coast groundfish trawl survey.

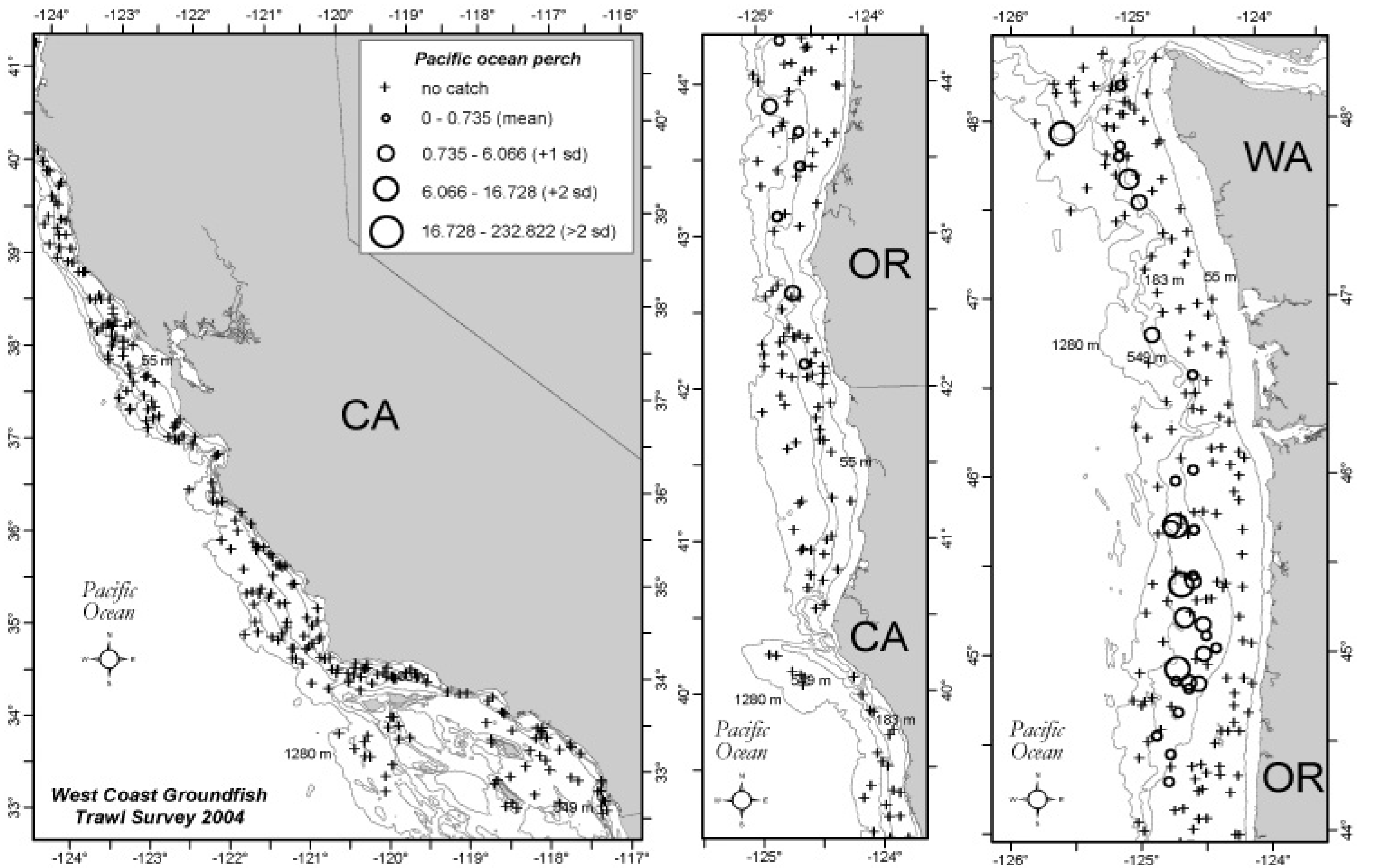


Figure 22. Pacific ocean perch distribution and relative abundance (kg/ha) from the 2004 West Coast groundfish trawl survey.

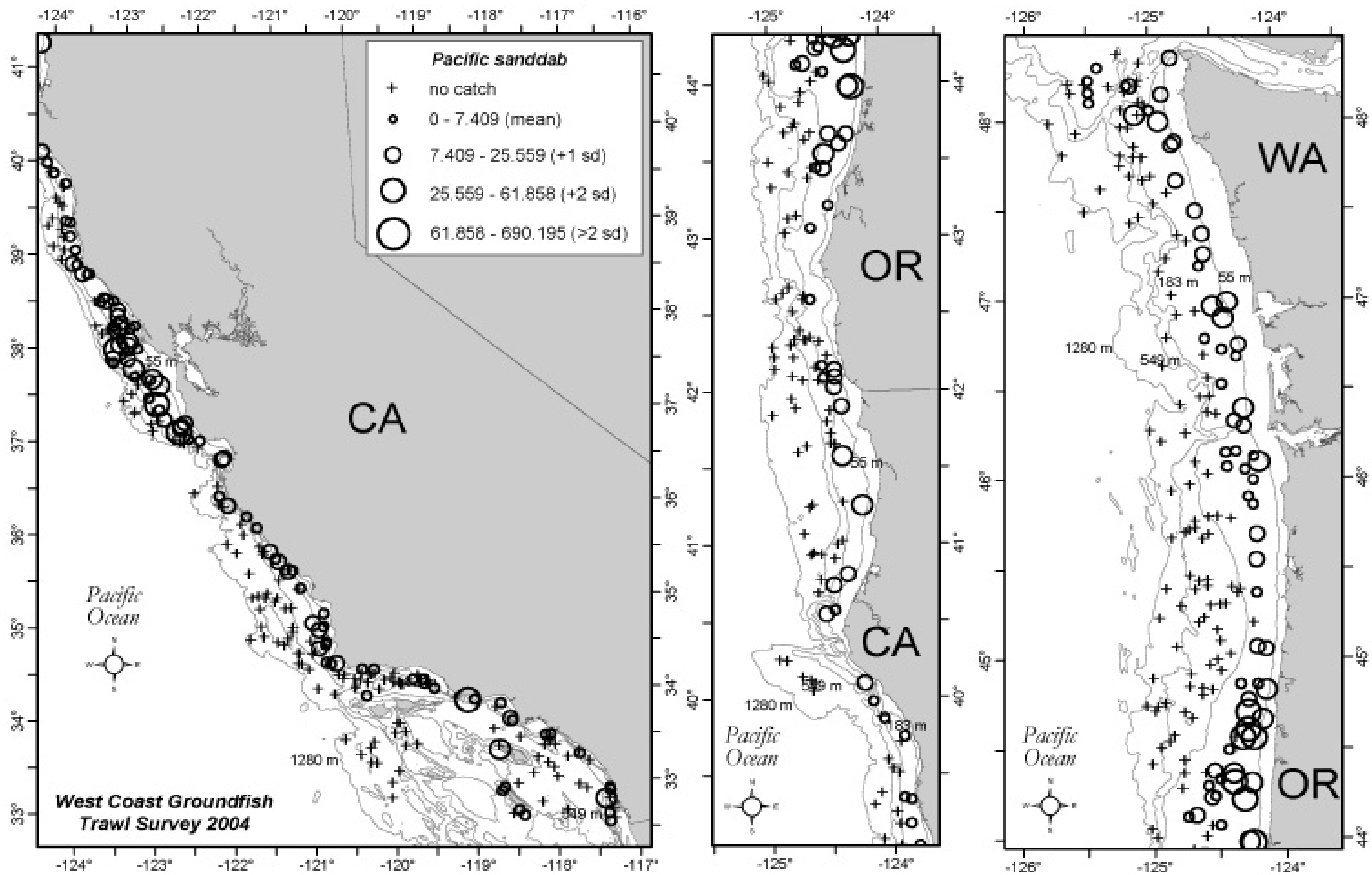


Figure 23. Pacific sanddab distribution and relative abundance (kg/ha) from the 2004 West Coast groundfish trawl survey.

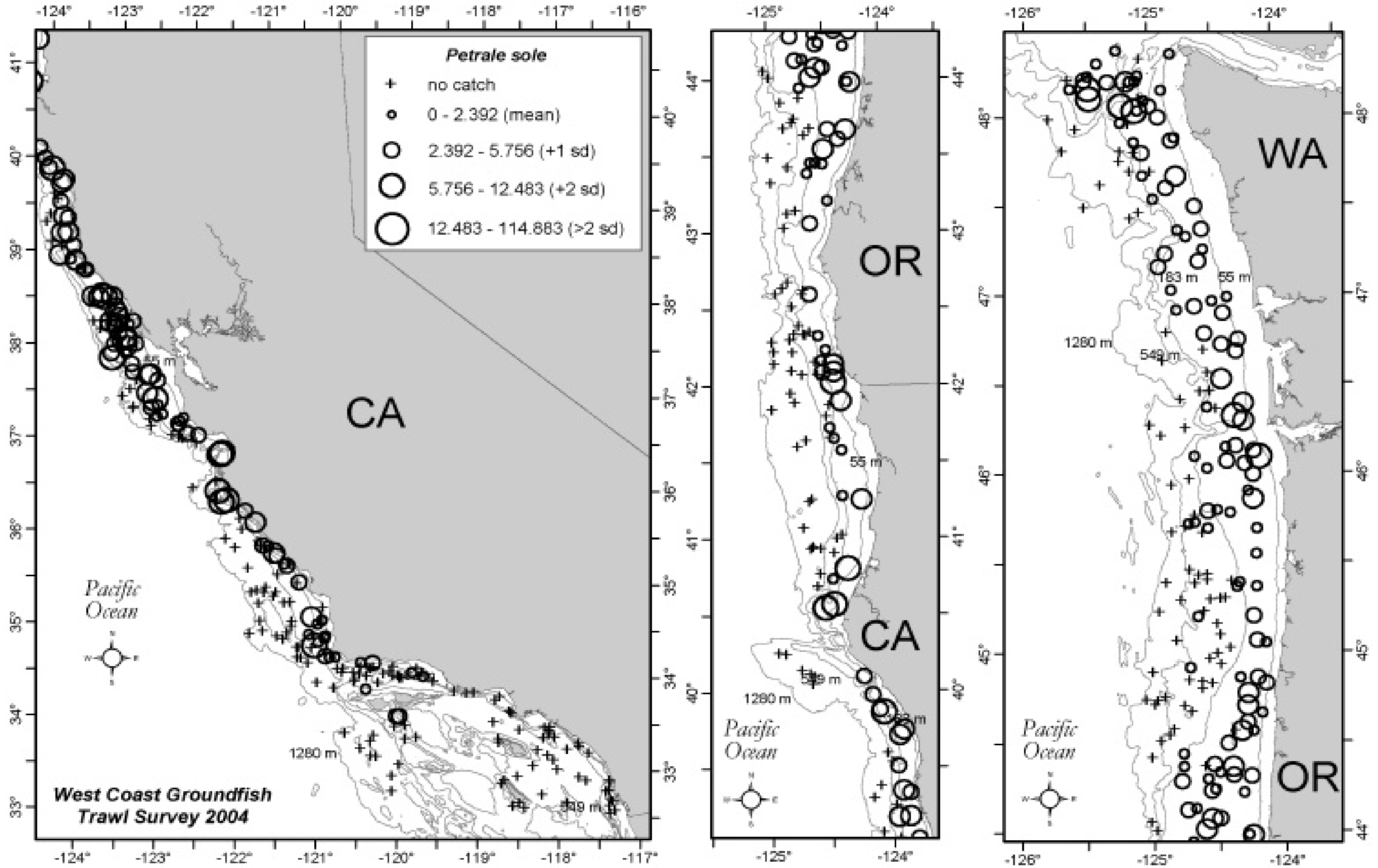


Figure 24. Petrale sole distribution and relative abundance (kg/ha) from the 2004 West Coast groundfish trawl survey.

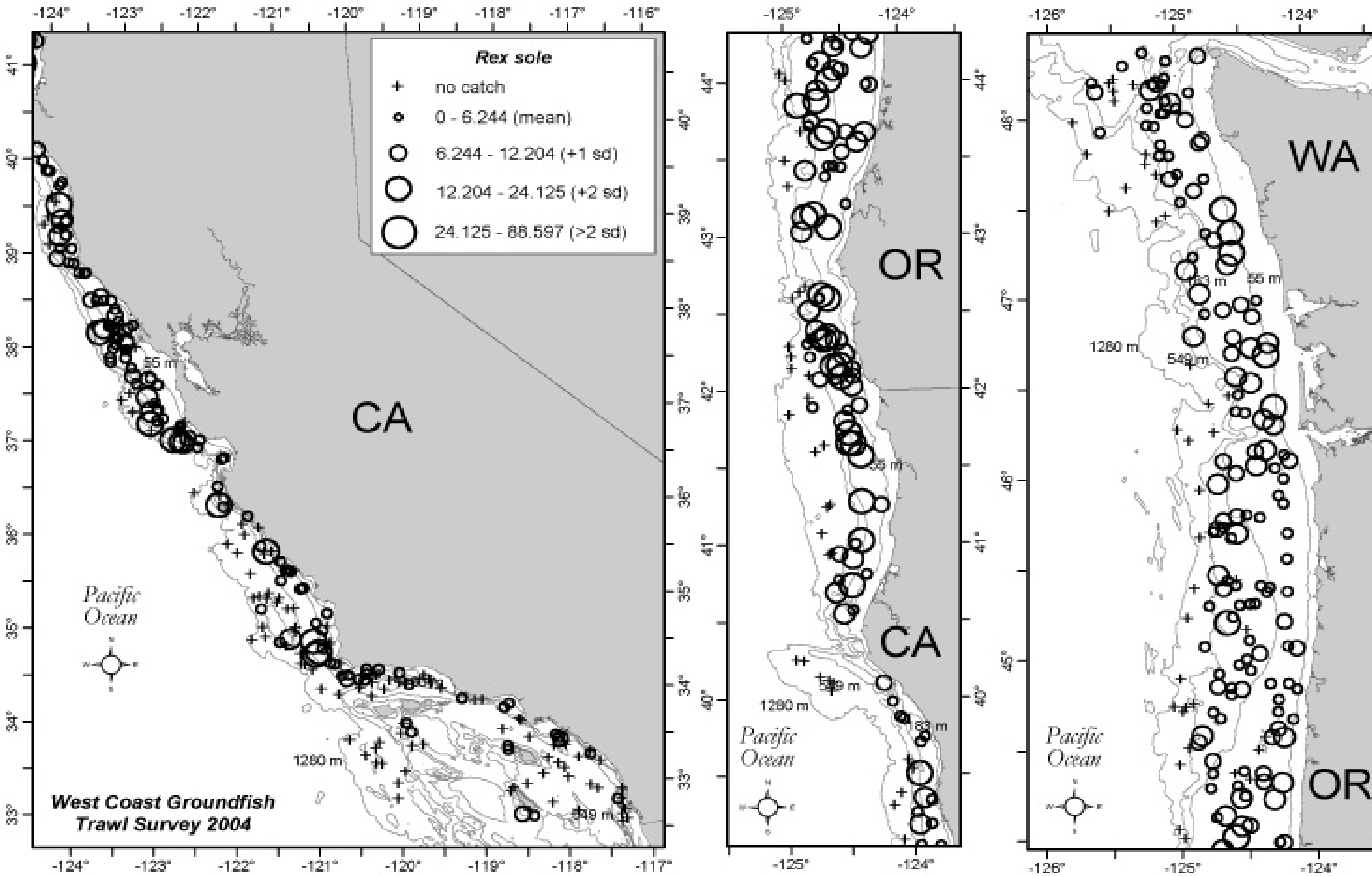


Figure 25. Rex sole distribution and relative abundance (kg/ha) from the 2004 West Coast groundfish trawl survey.

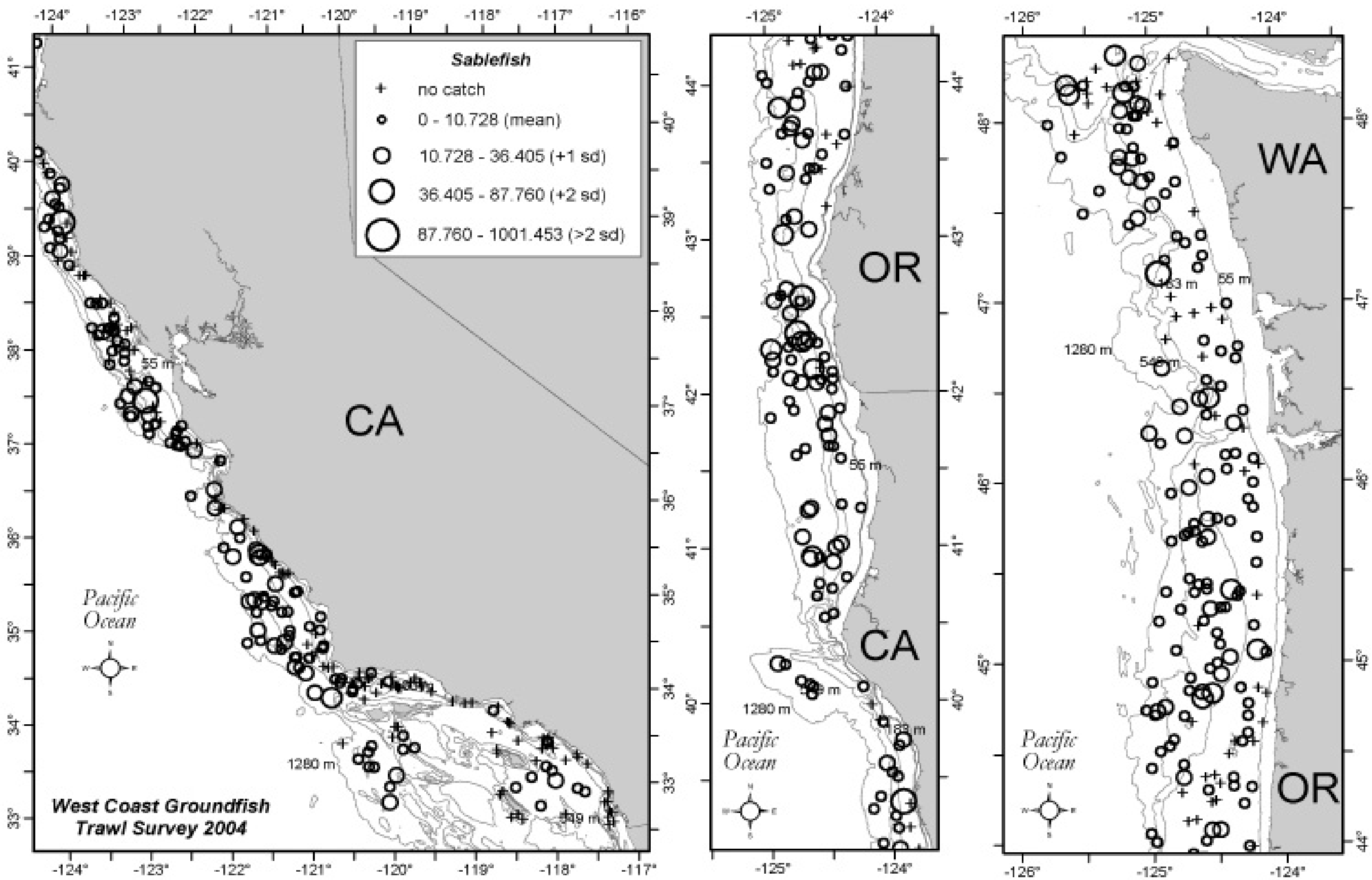


Figure 26. Sablefish distribution and relative abundance (kg/ha) from the 2004 West Coast groundfish trawl survey.

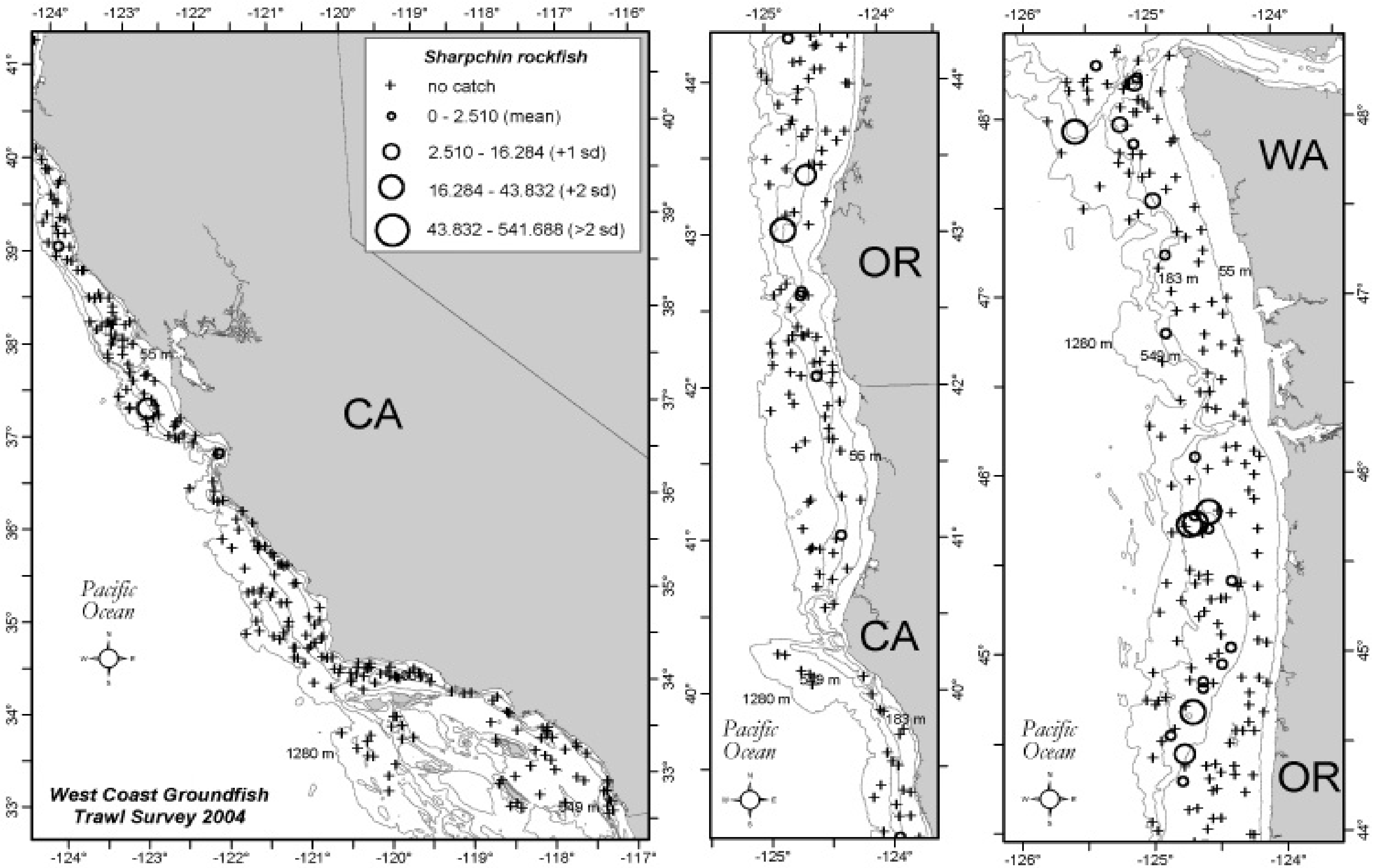


Figure 27. Sharpchin rockfish distribution and relative abundance (kg/ha) from the 2004 West Coast groundfish trawl survey.

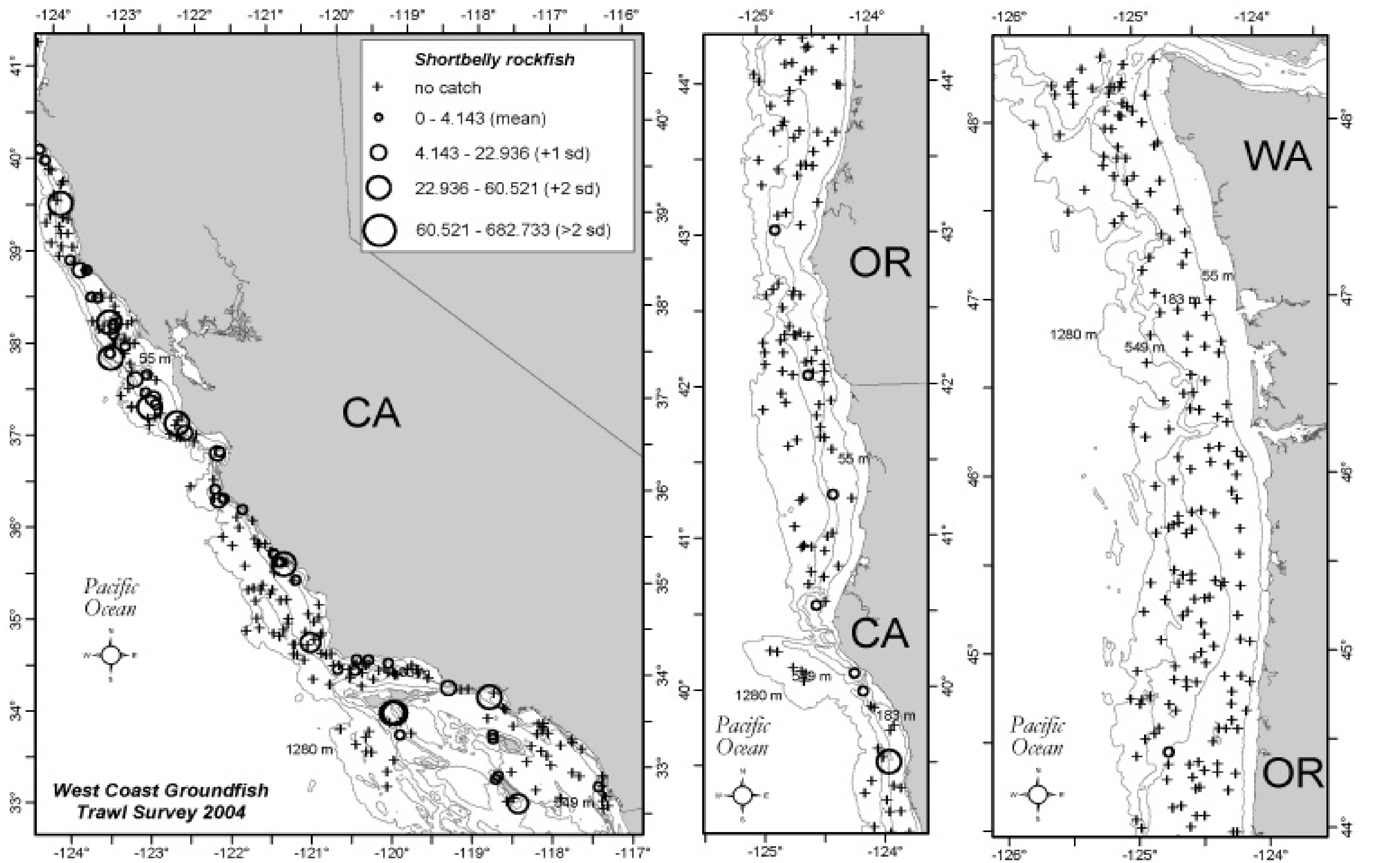


Figure 28. Shortbelly rockfish distribution and relative abundance (kg/ha) from the 2004 West Coast groundfish trawl survey.

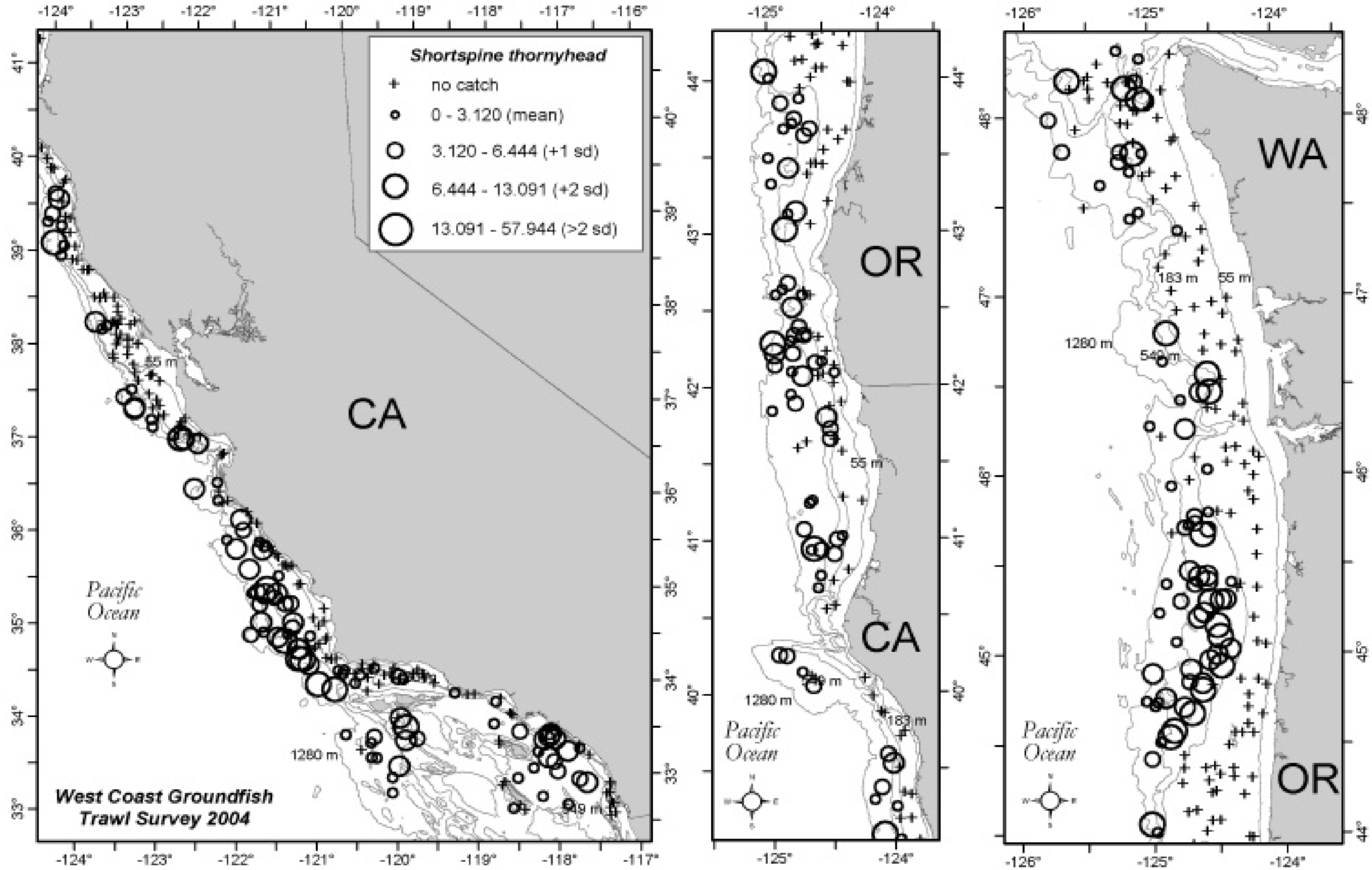


Figure 29. Shortspine thornyhead distribution and relative abundance (kg/ha) from the 2004 West Coast groundfish trawl survey.

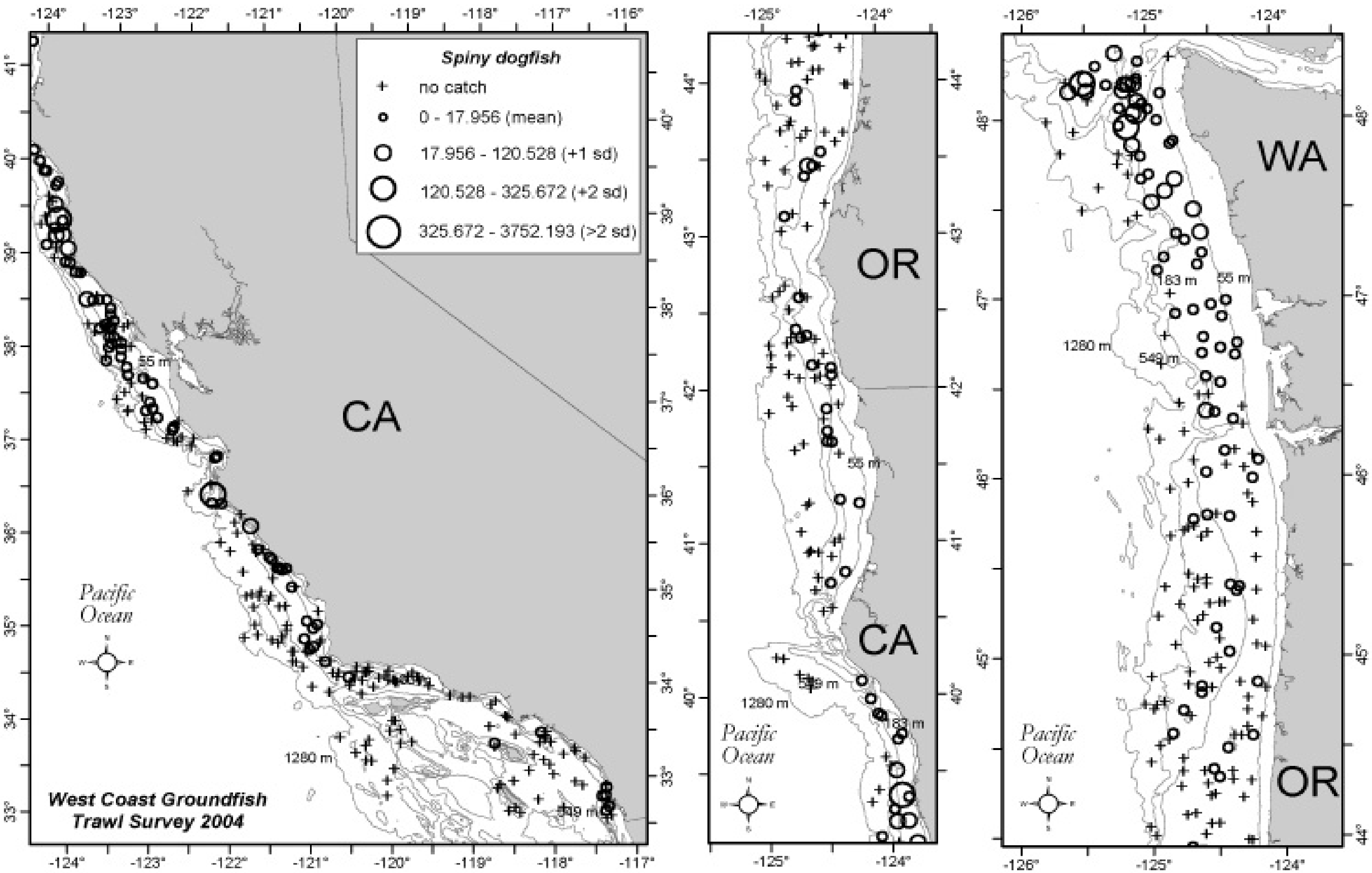


Figure 30. Spiny dogfish distribution and relative abundance (kg/ha) from the 2004 West Coast groundfish trawl survey.

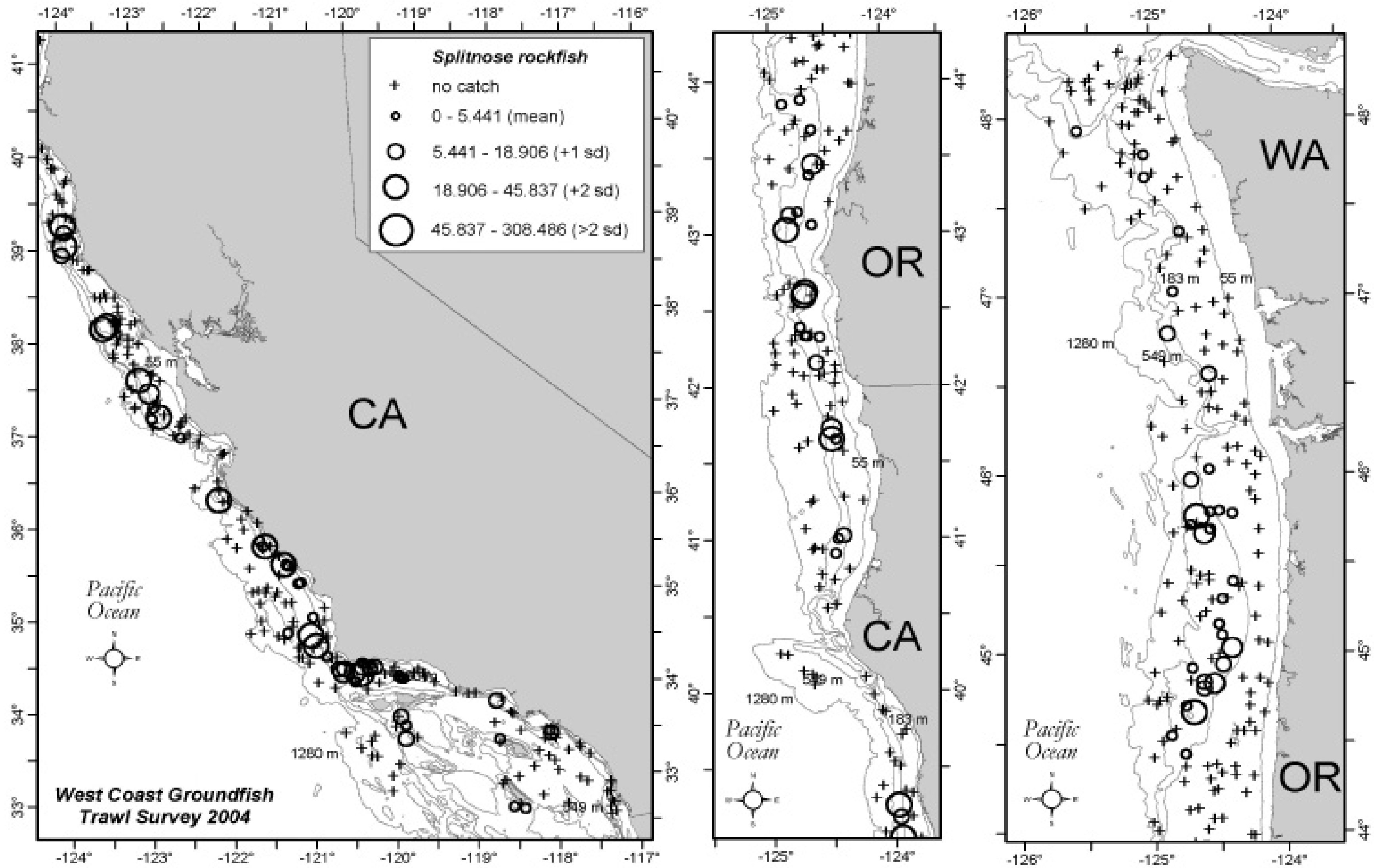


Figure 31. Splitnose rockfish distribution and relative abundance (kg/ha) from the 2004 West Coast groundfish trawl survey.

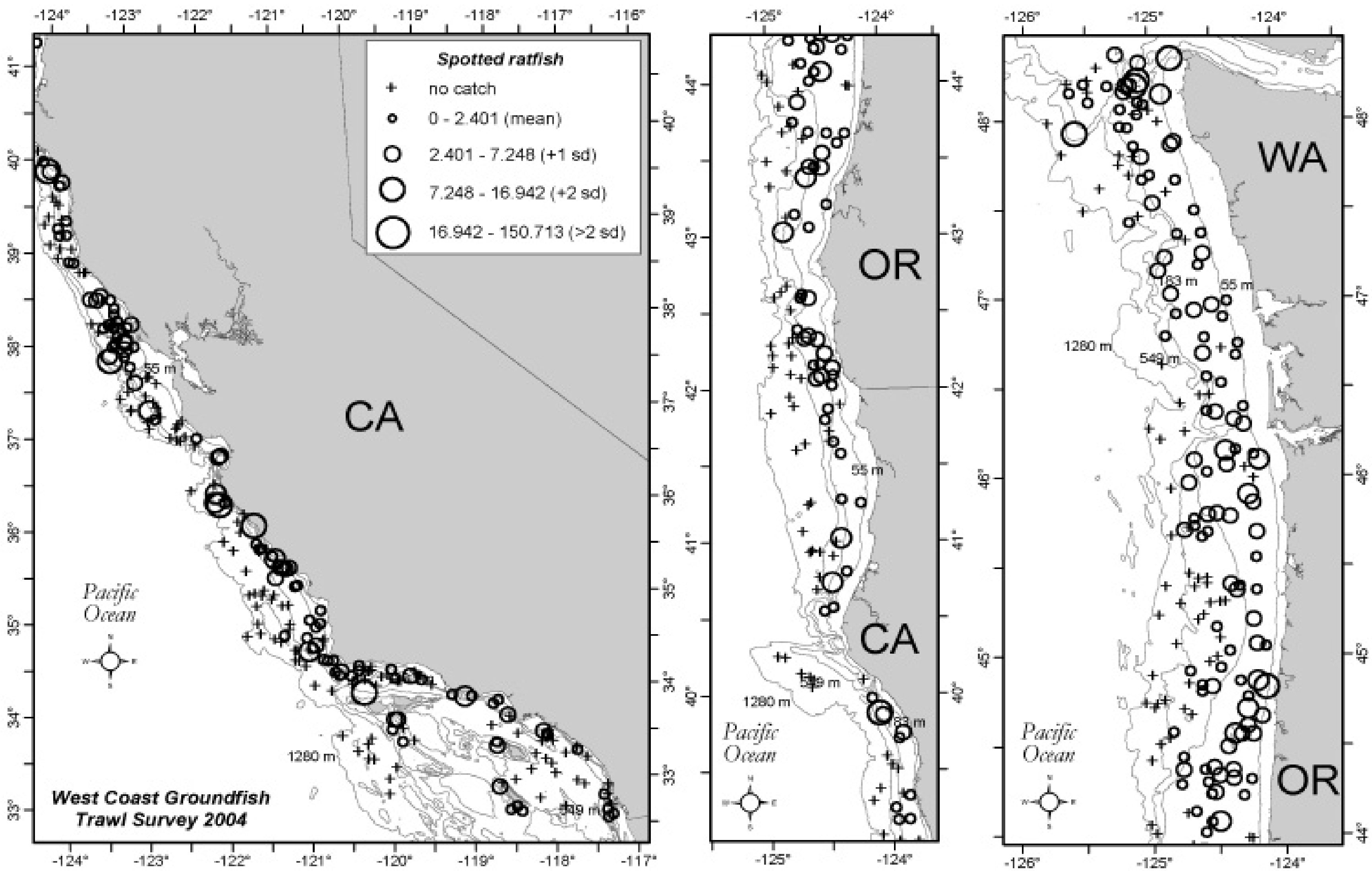


Figure 32. Spotted ratfish distribution and relative abundance (kg/ha) from the 2004 West Coast groundfish trawl survey.

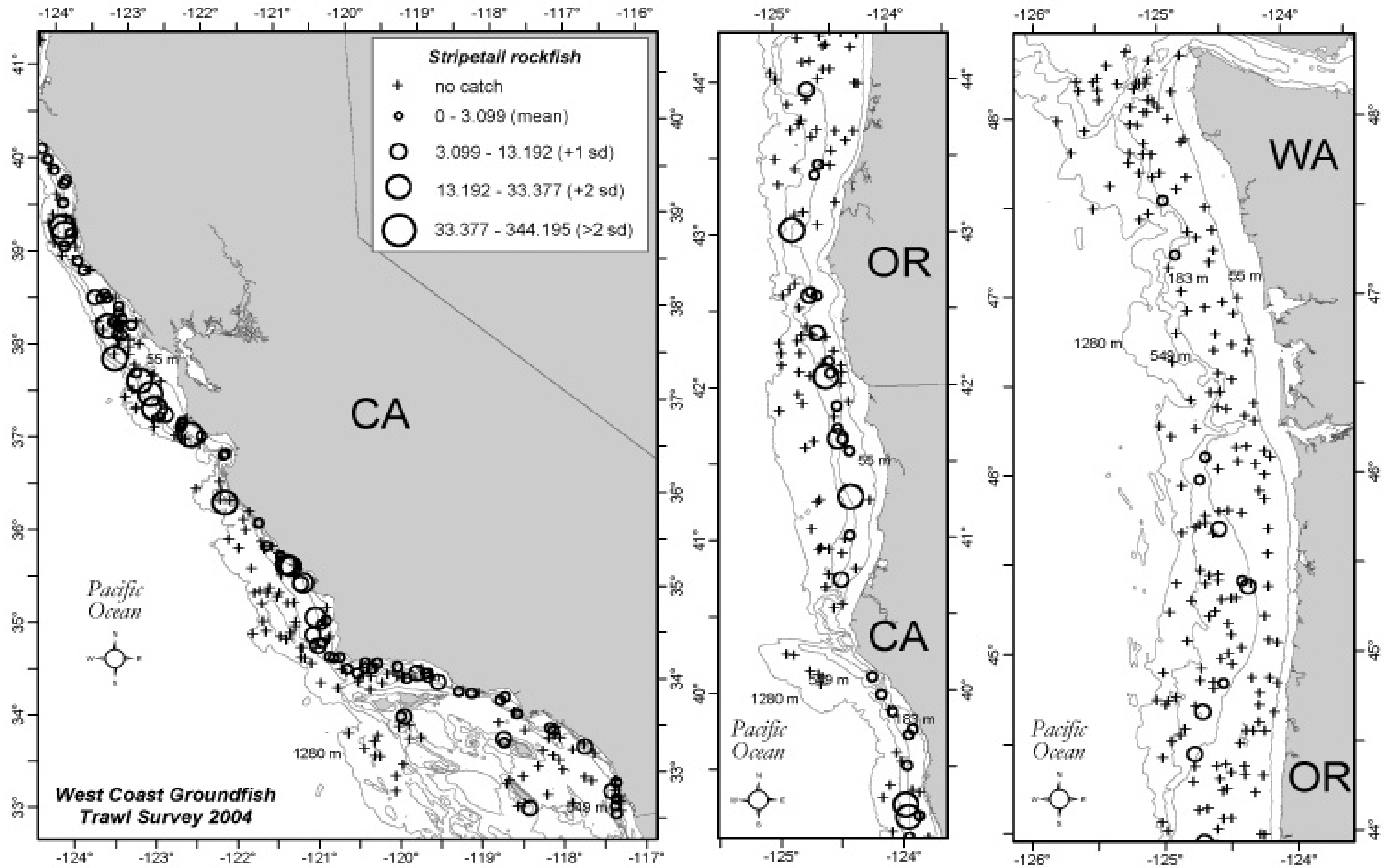


Figure 33. Stripetail rockfish distribution and relative abundance (kg/ha) from the 2004 West Coast groundfish trawl survey.

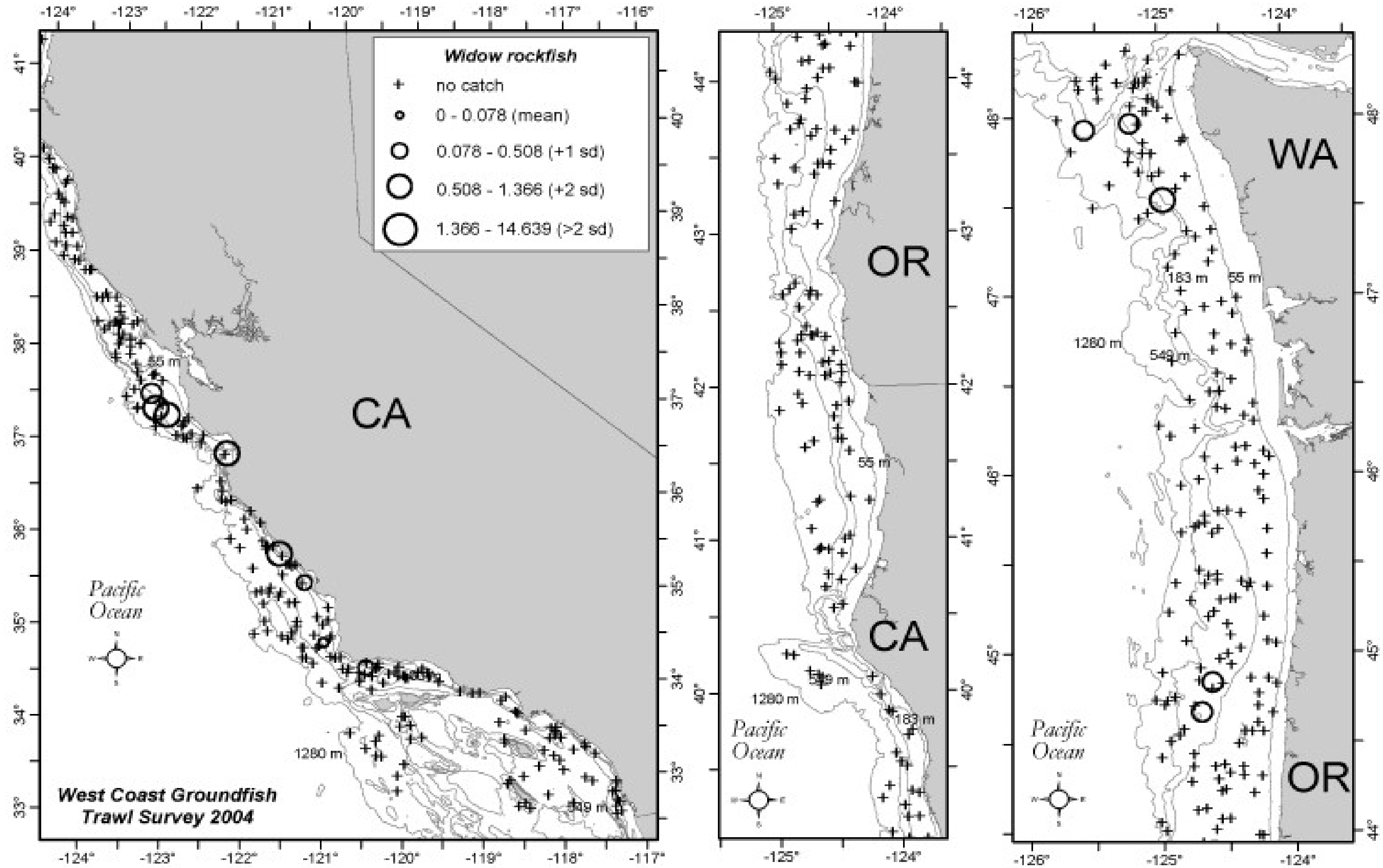


Figure 34. Widow rockfish distribution and relative abundance (kg/ha) from the 2004 West Coast groundfish trawl survey.

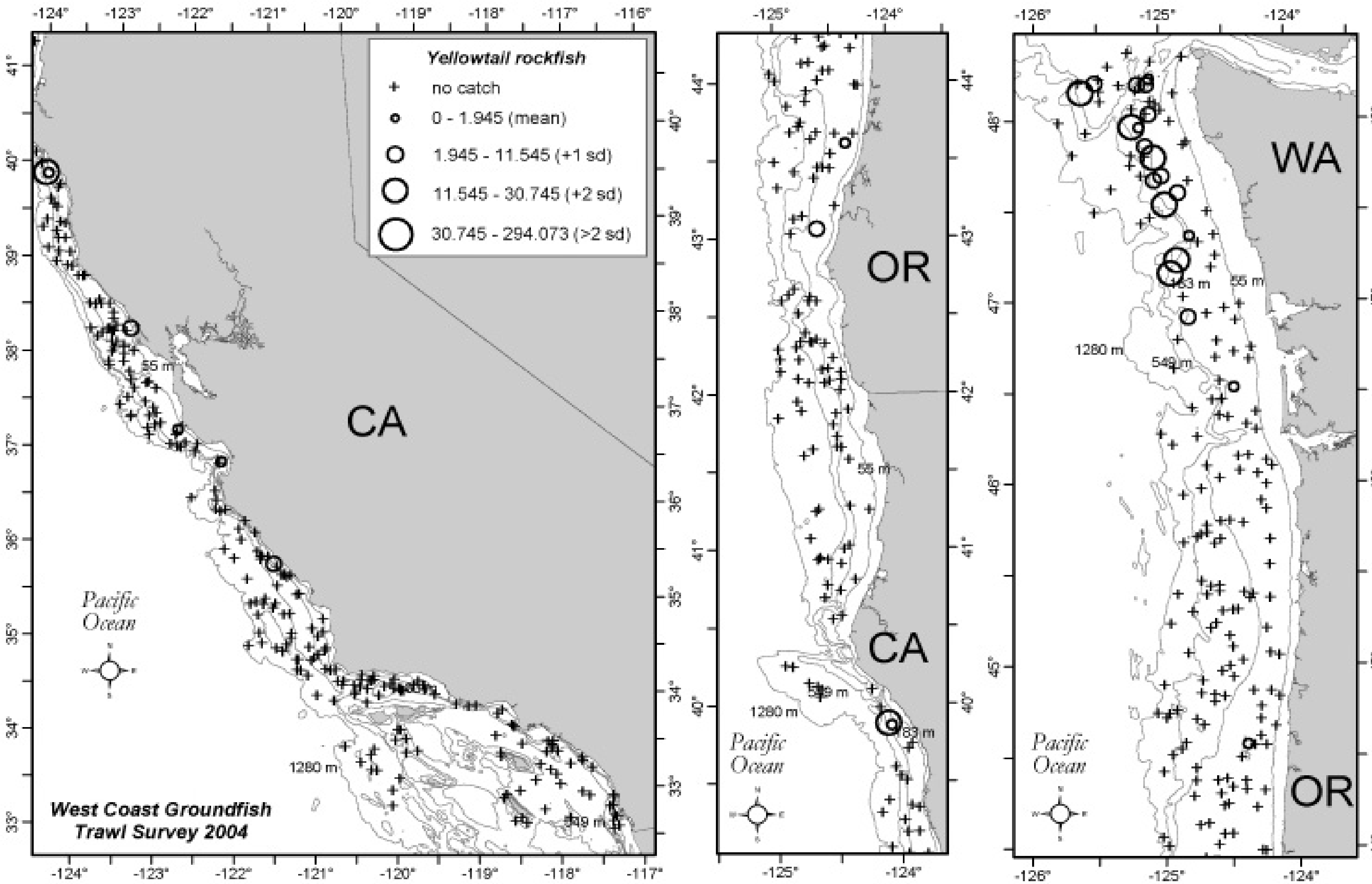


Figure 35. Yellowtail rockfish distribution and relative abundance (kg/ha) from the 2004 West Coast groundfish trawl survey.

Table 17. Estimates of fish biomass (metric tons) and coefficients of variation (CV) by stratum for the combined INPFC areas (U.S.-Vancouver, Columbia, Eureka, Monterey, and Conception) from the 2004 West Coast groundfish trawl survey.

	Stratum 1 55–183 m		Stratum 2 184–549 m		Stratum 3 550–1,280 m		All strata 55–1,280 m	
Species	Biomass (mt)	CV (%)	Biomass (mt)	CV (%)	Biomass (mt)	CV (%)	Biomass (mt)	CV (%)
Dover sole	60,687	26	91,788	28	133,835	42	286,310	32
Pacific hake	124,987	24	50,257	62	1,785	65	177,029	60
Longspine thornyhead	0	–	2,449	44	162,408	15	164,858	15
Sablefish	14,384	51	64,990	111	63,898	30	143,271	118
Spiny dogfish	101,989	159	8,695	68	16	318	110,700	375
Chilipepper rockfish	51,709	93	28,880	150	0	–	80,589	196
Splitnose rockfish	180	122	60,158	50	0	–	60,339	115
Pacific sanddab	57,847	41	1,921	83	0	–	59,768	102
Rex Sole	27,765	21	29,103	28	2,042	164	58,910	42
Shortspine thornyhead	102	182	15,950	27	42,821	29	58,873	27
Longnose skate	25,018	20	25,446	28	3,699	52	54,162	39
English sole	40,661	26	3,551	61	0	–	44,212	61
Grooved tanner crab	0	–	527	120	43,248	42	43,775	42
Shortbelly rockfish	14,845	144	27,870	87	0	–	42,714	183
Pacific grenadier	0	–	6	178	37,047	112	37,053	112
Arrowtooth flounder	17,074	109	18,892	77	52	300	36,017	162
Stripetail rockfish	9,116	124	21,707	66	0	–	30,823	143
Lingcod	20,692	64	7,974	86	0	–	28,666	131
California slickhead	0	–	1	294	27,975	19	27,976	19
Giant grenadier	0	–	55	156	25,999	73	26,053	73

Table 18. Estimates of fish biomass (metric tons) and coefficients of variation (CV) by stratum for the INPFC Conception area from the 2004 West Coast groundfish trawl survey.

	Stratum 1 55–183 m		Stratum 2 184–549 m		Stratum 3 550–1,280 m		All strata 55–1,280 m	
Species	Biomass (mt)	CV (%)	Biomass (mt)	CV (%)	Biomass (mt)	CV (%)	Biomass (mt)	CV (%)
Dover sole	31	48	16,777	22	55,937	24	72,745	22
Pacific hake	593	40	16,693	28	925	32	18,211	69
Longspine thornyhead	0	–	1,215	44	82,269	12	83,484	10
Sablefish	36	50	5,348	38	32,248	16	37,633	19
Spiny dogfish	825	52	703	31	0	–	1,528	146
Chilipepper rockfish	222	39	2,786	50	0	–	3,008	127
Splitnose rockfish	62	99	22,109	42	0	–	22,171	112
Pacific sanddab	3,710	32	1,882	62	0	–	5,592	121
Rex Sole	92	48	5,298	33	59	74	5,449	87
Shortspine thornyhead	0	–	2,650	26	28,679	13	31,329	12
Longnose skate	419	44	6,872	28	2,061	51	9,352	57
English sole	846	21	1,325	68	0	–	2,171	119
Grooved tanner crab	0	–	39	94	7,310	28	7,348	25
Shortbelly rockfish	111	53	20,691	46	0	–	20,802	123
Pacific grenadier	0	–	0	–	7,531	49	7,531	43
Arrowtooth flounder	0	–	0	–	0	–	0	–
Stripetail rockfish	645	47	4,521	31	0	–	5,166	80
Lingcod	575	49	4,516	66	0	–	5,091	162
California slickhead	0	–	0	–	24,337	17	24,337	15
Giant grenadier	0	–	0	–	5,569	28	5,569	25

Table 19. Estimates of fish biomass (metric tons) and coefficients of variation (CV) by stratum for the INPFC Monterey area from the 2004 West Coast groundfish trawl survey.

	Stratum 1 55–183 m		Stratum 2 184–549 m		Stratum 3 550–1,280 m		All strata 55–1,280 m	
Species	**Biomass (mt)**	**CV (%)**	**Biomass (mt)**	**CV (%)**	**Biomass (mt)**	**CV (%)**	**Biomass (mt)**	**CV (%)**
Dover sole	5,284	65	18,853	22	41,941	21	66,078	23
Pacific hake	15,254	37	14,943	66	176	57	30,373	86
Longspine thornyhead	0	–	31	87	33,801	13	33,833	15
Sablefish	2,968	73	25,136	85	8,585	19	36,689	140
Spiny dogfish	64,612	85	1,401	57	16	100	66,028	157
Chilipepper rockfish	45,714	49	26,001	57	0	–	71,715	77
Splitnose rockfish	0	–	23,620	33	0	–	23,620	78
Pacific sanddab	21,185	48	39	100	0	–	21,224	91
Rex Sole	2,810	18	6,378	23	334	69	9,521	38
Shortspine thornyhead	0	–	796	57	4,639	17	5,435	26
Longnose skate	8,022	17	5,656	26	1,190	37	14,868	30
English sole	8,495	18	664	46	0	–	9,159	32
Grooved tanner crab	0	–	9	72	15,779	21	15,788	24
Shortbelly rockfish	14,710	69	7,170	96	0	–	21,881	116
Pacific grenadier	0	–	0	–	2,490	62	2,490	70
Arrowtooth flounder	27	52	174	56	0	–	201	117
Stripetail rockfish	5,789	87	14,698	32	0	–	20,487	72
Lingcod	10,705	57	2,108	86	0	–	12,814	97
California slickhead	0	–	1	100	2,000	31	2,001	35
Giant grenadier	0	–	17	100	1,930	37	1,947	41

Table 20. Estimates of fish biomass (metric tons) and coefficients of variation (CV) by stratum for the INPFC Eureka area from the 2004 West Coast groundfish trawl survey.

	Stratum 1 55–183 m		Stratum 2 184–549 m		Stratum 3 550–1,280 m		All strata 55–1,280 m	
Species	**Biomass (mt)**	**CV (%)**	**Biomass (mt)**	**CV (%)**	**Biomass (mt)**	**CV (%)**	**Biomass (mt)**	**CV (%)**
Dover sole	10,560	31	13,756	19	24,866	27	49,182	26
Pacific hake	17,779	23	6,787	28	439	47	25,005	37
Longspine thornyhead	0	–	3	100	20,315	13	20,317	17
Sablefish	1,962	38	14,551	53	8,806	17	24,320	87
Spiny dogfish	180	43	103	42	0	–	283	66
Chilipepper rockfish	4,232	67	0	–	0	–	4,232	121
Splitnose rockfish	9	97	6,712	48	0	–	6,721	134
Pacific sanddab	3,493	29	0	–	0	–	3,493	52
Rex Sole	8,404	22	5,732	19	1,450	46	15,591	30
Shortspine thornyhead	5	69	653	23	4,035	32	4,694	36
Longnose skate	3,976	30	3,798	20	267	44	8,040	38
English sole	11,913	25	22	87	0	–	11,935	45
Grooved tanner crab	0	–	4	100	5,435	32	5,440	41
Shortbelly rockfish	23	92	0	–	0	–	23	167
Pacific grenadier	0	–	0	–	14,911	54	14,911	70
Arrowtooth flounder	2,235	21	1,282	18	40	72	3,558	30
Stripetail rockfish	2,613	59	377	78	0	–	2,990	98
Lingcod	2,251	36	289	42	0	–	2,539	60
California slickhead	0	–	0	–	902	47	903	61
Giant grenadier	0	–	0	–	9,121	40	9,121	52

Table 21. Estimates of fish biomass (metric tons) and coefficients of variation (CV) by stratum for the INPFC Columbia area from the 2004 West Coast groundfish trawl survey.

	Stratum 1 55–183 m		Stratum 2 184–549 m		Stratum 3 550–1,280 m		All strata 55–1,280 m	
Species	**Biomass (mt)**	**CV (%)**	**Biomass (mt)**	**CV (%)**	**Biomass (mt)**	**CV (%)**	**Biomass (mt)**	**CV (%)**
Dover sole	39,142	13	25,998	13	5,441	31	70,550	16
Pacific hake	90,534	19	11,241	18	198	49	101,973	28
Longspine thornyhead	0	–	1,113	31	21,184	9	22,297	12
Sablefish	8,132	34	11,517	17	9,417	17	29,066	22
Spiny dogfish	4,291	32	957	52	0	–	5,249	48
Chilipepper rockfish	1,541	100	93	94	0	–	1,634	154
Splitnose rockfish	86	88	7,717	30	0	–	7,803	63
Pacific sanddab	28,265	21	0	–	0	–	28,265	35
Rex Sole	15,602	14	10,039	18	67	82	25,708	20
Shortspine thornyhead	64	70	9,398	15	3,231	27	12,693	26
Longnose skate	11,523	15	6,501	17	142	86	18,166	20
English sole	16,472	17	1,150	48	0	–	17,623	28
Grooved tanner crab	0	–	183	36	11,358	24	11,541	32
Shortbelly rockfish	0	–	8	72	0	–	8	153
Pacific grenadier	0	–	2	72	9,397	39	9,399	54
Arrowtooth flounder	9,519	25	8,614	41	0	–	18,133	47
Stripetail rockfish	68	90	2,112	73	0	–	2,180	150
Lingcod	6,452	21	750	39	0	–	7,202	33
California slickhead	0	–	0	–	658	31	658	43
Giant grenadier	0	–	13	100	8,010	27	8,023	38

Table 22. Estimates of fish biomass (metric tons) and coefficients of variation (CV) by stratum for the INPFC U.S.-Vancouver area from the 2004 West Coast groundfish trawl survey.

	Stratum 1 55–183 m		Stratum 2 184–549 m		Stratum 3 550–1,280 m		All strata 55–1,280 m	
Species	**Biomass (mt)**	**CV (%)**	**Biomass (mt)**	**CV (%)**	**Biomass (mt)**	**CV (%)**	**Biomass (mt)**	**CV (%)**
Dover sole	5,670	27	16,405	40	5,680	93	27,755	38
Pacific hake	827	37	592	32	47	100	1,466	57
Longspine thornyhead	0	–	87	10	4,839	29	4,926	35
Sablefish	1,285	52	8,438	31	4,841	49	14,564	31
Spiny dogfish	32,081	65	5,530	38	0	–	37,611	147
Chilipepper rockfish	0	–	0	–	0	–	0	–
Splitnose rockfish	22	100	1	100	0	–	23	252
Pacific sanddab	1,195	34	0	–	0	–	1,195	89
Rex Sole	852	19	1,657	49	132	100	2,641	39
Shortspine thornyhead	33	96	2,453	36	2,237	66	4,723	44
Longnose skate	1,078	23	2,620	37	38	100	3,736	34
English sole	2,934	28	390	98	0	–	3,324	66
Grooved tanner crab	0	–	292	82	3,366	39	3,658	45
Shortbelly rockfish	0	–	0	–	0	–	0	–
Pacific grenadier	0	–	4	100	2,717	63	2,721	76
Arrowtooth flounder	5,292	63	8,821	54	12	100	14,125	73
Stripetail rockfish	0	100	0	–	0	–	0	264
Lingcod	710	35	311	100	0	–	1,020	73
California slickhead	0	–	0	–	78	94	78	115
Giant grenadier	0	–	25	100	1,368	42	1,393	50

The calculated biomass estimates presented are not considered absolute estimates. Herding caused by doors and bridles, as well as escapement from underneath the trawl footrope, around the net opening, and through the net mesh, may affect the trawl effectiveness (Gunderson 1993). Abundance calculations are based on the assumption that all of the fish that are in front of the trawl and between the wingtips have an equal chance of being caught. The ability of a fish to avoid the net will depend on the species, fish shape, size, speed, and its reaction to the part of the net it encounters (Lauth 1999). Furthermore, the survey does not cover the entire geographic range of many of the species caught.

The total number of hauls by depth strata, where weight, number of fish, and lengths were collected for the 30 most abundant groundfish and selected invertebrate species, are shown in Tables 23–28 by stratum and INPFC area for each species.

Size Compositions

Figures 36–61 show the estimated population length-frequencies for Dover sole, longspine thornyhead, sablefish, and shortspine thornyhead presented by depth stratum for all INPFC areas combined, and for individual INPFC areas. Figures 62–64 show the length frequency distributions by sex (male, female, and undetermined) for additional important management species in all INPFC areas combined for all depths (55–1,280 m).

In general Figures 62–64 include species with greater than 500 length measurements taken throughout the survey period: spiny dogfish, California skate, longnose skate, arrowtooth flounder, curlfin sole, English sole, Pacific sanddab, petrale sole, rex sole, Pacific grenadier, lingcod, Pacific hake, aurora rockfish, bocaccio, canary rockfish, chilipepper rockfish, darkblotched rockfish, greenspotted rockfish, greenstriped rockfish, halfbanded rockfish, Pacific ocean perch, rosethorn rockfish, sharpchin rockfish, shortbelly rockfish, splitnose rockfish, stripetail rockfish, and yellowtail rockfish. If sex could not be determined for greater than 2% of the individuals measured for a given species (e.g., Pacific grenadier), then a separate category (unsexed) was included in the plot. Note that the length-frequencies are the sum of all measured fish and are not adjusted for subsampling, area swept, or stratum size.

Table 23. Number of hauls by depth strata where weight (Wt.), number of fish (No.), and lengths (Len.) were collected for the 30 most abundant groundfish and selected invertebrate species in the INPFC U.S.-Vancouver, Columbia, Eureka, Monterey, and Conception areas from the 2004 West Coast groundfish trawl survey.

	Stratum 1 55–183 m Total hauls = 239 Hauls with:			**Stratum 2 184–549 m Total hauls = 133 Hauls with:**			**Stratum 3 550–1,280 m Total hauls = 133 Hauls with:**		
Species	**Wt.**	**No.**	**Len.**	**Wt.**	**No.**	**Len.**	**Wt.**	**No.**	**Len.**
Dover sole	183	183	181	127	127	126	108	108	107
Pacific hake	156	156	34	124	124	33	32	32	7
Longspine thornyhead	0	0	0	30	30	29	131	131	130
Sablefish	120	120	118	100	100	100	124	124	123
Spiny dogfish	129	129	126	41	41	41	1	1	1
Chilipepper rockfish	68	68	68	20	20	20	0	0	0
Splitnose rockfish	14	14	14	86	86	86	0	0	0
Pacific sanddab	176	176	174	7	7	7	0	0	0
Rex sole	187	187	183	114	114	113	17	17	16
Shortspine thornyhead	7	7	7	96	96	95	123	123	122
Longnose skate	158	158	153	103	103	102	27	27	27
English sole	199	199	196	32	32	31	0	0	0
Grooved tanner crab	0	0	0	24	24	0	100	100	0
Shortbelly rockfish	33	33	33	21	21	21	0	0	0
Pacific grenadier	0	0	0	3	3	3	84	84	81
Arrowtooth flounder	111	111	109	59	59	59	3	3	3
Stripetail rockfish	71	71	70	47	47	46	0	0	0
Lingcod	108	153	149	32	32	32	0	0	0
California slickhead	0	0	0	1	1	0	94	94	0
Giant grenadier	0	0	0	3	3	0	77	77	0
Sharpchin rockfish	11	11	11	22	22	22	0	0	0
Spotted ratfish	175	175	0	79	79	0	1	1	0
Petrale sole	197	197	194	29	29	29	0	0	0
Big skate	84	84	82	4	4	4	0	0	0
Yellowtail rockfish	28	28	27	0	0	0	0	0	0
Pacific ocean perch	6	6	6	29	29	28	0	0	0
Brown cat shark	3	3	0	42	42	0	107	107	0
White croaker	29	47	0	0	0	0	0	0	0
Canary rockfish	35	35	35	6	6	6	0	0	0
Halfbanded rockfish	45	45	45	3	3	3	0	0	0

Table 24. Number of hauls by depth strata where weight (Wt.), number of fish (No.), and lengths (Len.) were collected for the 30 most abundant groundfish and selected invertebrate species in the INPFC U.S.-Vancouver area from the 2004 West Coast groundfish trawl survey.

	Stratum 1 55–183 m Total hauls = 29 Hauls with:			**Stratum 2 184–549 m Total hauls = 8 Hauls with:**			**Stratum 3 550–1,280 m Total hauls = 6 Hauls with:**		
Species	**Wt.**	**No.**	**Len.**	**Wt.**	**No.**	**Len.**	**Wt.**	**No.**	**Len.**
Dover sole	26	26	25	8	8	8	3	3	3
Pacific hake	15	15	0	7	7	0	1	1	0
Longspine thornyhead	0	0	0	1	1	1	6	6	6
Sablefish	17	17	16	7	7	7	6	6	6
Spiny dogfish	26	26	26	5	5	5	0	0	0
Chilipepper rockfish	0	0	0	0	0	0	0	0	0
Splitnose rockfish	2	2	2	1	1	1	0	0	0
Pacific sanddab	14	14	13	0	0	0	0	0	0
Rex sole	24	24	23	6	6	6	1	1	1
Shortspine thornyhead	2	2	2	7	7	7	6	6	6
Longnose skate	18	18	18	7	7	7	1	1	1
English sole	23	23	22	3	3	3	0	0	0
Grooved tanner crab	0	0	0	3	3	0	6	6	6
Shortbelly rockfish	0	0	0	0	0	0	0	0	0
Pacific grenadier	0	0	0	1	1	1	5	5	5
Arrowtooth flounder	23	23	22	7	7	7	1	1	1
Stripetail rockfish	1	1	1	0	0	0	0	0	0
Lingcod	16	16	15	1	1	1	0	0	0
California slickhead	0	0	0	0	0	0	1	1	0
Giant grenadier	0	0	0	1	1	0	5	5	0
Sharpchin rockfish	6	6	6	1	1	1	0	0	0
Spotted ratfish	20	20	0	5	5	0	0	0	0
Petrale sole	27	27	26	2	2	2	0	0	0
Big skate	9	9	9	0	0	0	0	0	0
Yellowtail rockfish	14	14	14	0	0	0	0	0	0
Pacific ocean perch	4	4	4	2	2	2	0	0	0
Brown cat shark	0	0	0	3	3	0	4	4	0
White croaker	0	0	0	0	0	0	0	0	0
Canary rockfish	9	9	9	2	2	2	0	0	0
Halfbanded rockfish	0	0	0	0	0	0	0	0	0

Table 25. Number of hauls by depth strata where weight (Wt.), number of fish (No.), and lengths (Len.) were collected for the 30 most abundant groundfish and selected invertebrate species in the INPFC Columbia area from the 2004 West Coast groundfish trawl survey.

	Stratum 1 55–183 m Total hauls = 84 Hauls with:			**Stratum 2 184–549 m Total hauls = 50 Hauls with:**			**Stratum 3 550–1,280 m Total hauls = 28 Hauls with:**		
Species	**Wt.**	**No.**	**Len.**	**Wt.**	**No.**	**Len.**	**Wt.**	**No.**	**Len.**
Dover sole	76	76	75	50	50	49	20	20	20
Pacific hake	69	69	9	48	48	2	5	5	0
Longspine thornyhead	0	0	0	16	16	16	28	28	28
Sablefish	51	51	50	45	45	45	28	28	28
Spiny dogfish	35	35	33	14	14	13	0	0	0
Chilipepper rockfish	2	2	2	2	2	2	0	0	0
Splitnose rockfish	7	7	7	28	28	28	0	0	0
Pacific sanddab	57	57	56	0	0	0	0	0	0
Rex sole	75	75	73	48	48	47	3	3	3
Shortspine thornyhead	3	3	3	43	43	42	25	25	25
Longnose skate	61	61	57	37	37	36	2	2	2
English sole	64	64	62	11	11	11	0	0	0
Grooved tanner crab	0	0	0	16	16	0	20	20	0
Shortbelly rockfish	0	0	0	2	2	2	0	0	0
Pacific grenadier	0	0	0	2	2	2	25	25	25
Arrowtooth flounder	62	62	61	36	36	36	0	0	0
Stripetail rockfish	2	2	2	10	10	9	0	0	0
Lingcod	55	55	52	10	10	10	0	0	0
California slickhead	0	0	0	0	0	0	16	16	0
Giant grenadier	0	0	0	1	1	0	24	24	0
Sharpchin rockfish	3	3	3	16	16	16	0	0	0
Spotted ratfish	70	70	0	27	27	0	1	1	0
Petrale sole	76	76	74	10	10	10	0	0	0
Big skate	34	34	32	2	2	2	0	0	0
Yellowtail rockfish	8	8	7	0	0	0	0	0	0
Pacific ocean perch	2	2	2	25	25	24	0	0	0
Brown cat shark	0	0	0	11	11	0	22	22	0
White croaker	0	0	0	0	0	0	0	0	0
Canary rockfish	9	9	9	4	4	4	0	0	0
Halfbanded rockfish	2	2	2	0	0	0	0	0	0

Table 26. Number of hauls by depth strata where weight (Wt.), number of fish (No.), and lengths (Len.) were collected for the 30 most abundant groundfish and selected invertebrate species in the INPFC Eureka area from the 2004 West Coast groundfish trawl survey.

	Stratum 1 55–183 m Total hauls = 20 Hauls with:			**Stratum 2 184–549 m Total hauls = 12 Hauls with:**			**Stratum 3 550–1,280 m Total hauls = 25 Hauls with:**		
Species	**Wt.**	**No.**	**Len.**	**Wt.**	**No.**	**Len.**	**Wt.**	**No.**	**Len.**
Dover sole	19	19	19	12	12	12	23	23	23
Pacific hake	18	6	6	12	12	4	7	7	2
Longspine thornyhead	0	0	0	1	1	0	25	25	25
Sablefish	18	18	18	12	12	12	25	25	25
Spiny dogfish	9	9	9	6	6	6	0	0	0
Chilipepper rockfish	10	10	10	0	0	0	0	0	0
Splitnose rockfish	2	2	2	11	11	11	0	0	0
Pacific sanddab	13	13	13	0	0	0	0	0	0
Rex sole	20	20	20	12	12	12	9	9	8
Shortspine thornyhead	2	2	2	11	11	11	23	23	23
Longnose skate	18	18	18	12	12	12	6	6	6
English sole	20	20	20	2	2	1	0	0	0
Grooved tanner crab	0	0	0	1	1	0	22	22	0
Shortbelly rockfish	3	3	3	0	0	0	0	0	0
Pacific grenadier	0	0	0	0	0	0	22	22	20
Arrowtooth flounder	20	20	20	11	11	11	2	2	2
Stripetail rockfish	10	10	10	5	5	5	0	0	0
Lingcod	17	17	17	5	5	5	0	0	0
California slickhead	0	0	0	0	0	0	18	18	0
Giant grenadier	0	0	0	0	0	0	19	19	0
Sharpchin rockfish	1	1	1	3	3	3	0	0	0
Spotted ratfish	19	0	0	7	7	0	0	0	0
Petrale sole	17	17	17	1	1	1	0	0	0
Big skate	13	13	13	0	0	0	0	0	0
Yellowtail rockfish	0	0	0	0	0	0	0	0	0
Pacific ocean perch	0	0	0	2	2	2	0	0	0
Brown cat shark	2	0	0	8	8	0	21	21	0
White croaker	0	0	0	0	0	0	0	0	0
Canary rockfish	6	6	6	0	0	0	0	0	0
Halfbanded rockfish	0	0	0	0	0	0	0	0	0

Table 27. Number of hauls by depth strata where weight (Wt.), number of fish (No.), and lengths (Len.) were collected for the 30 most abundant groundfish and selected invertebrate species in the INPFC Monterey area from the 2004 West Coast groundfish trawl survey.

	Stratum 1 55–183 m Total hauls = 59 Hauls with:			Stratum 2 184–549 m Total hauls = 17 Hauls with:			Stratum 3 550–1,280 m Total hauls = 21 Hauls with:		
Species	**Wt.**	**No.**	**Len.**	**Wt.**	**No.**	**Len.**	**Wt.**	**No.**	**Len.**
Dover sole	51	51	51	16	16	16	21	21	21
Pacific hake	42	42	16	15	15	8	3	3	1
Longspine thornyhead	0	0	0	2	2	2	21	21	21
Sablefish	27	27	27	15	15	15	21	21	21
Spiny dogfish	46	46	45	5	5	6	1	1	1
Chilipepper rockfish	38	38	38	5	5	5	0	0	0
Splitnose rockfish	0	0	0	13	13	13	0	0	0
Pacific sanddab	54	54	54	1	1	1	0	0	0
Rex sole	55	55	54	17	17	17	2	2	2
Shortspine thornyhead	0	0	0	10	10	10	19	19	19
Longnose skate	49	49	48	15	15	15	10	10	10
English sole	56	56	56	7	7	7	0	0	0
Grooved tanner crab	0	0	0	2	2	0	21	21	0
Shortbelly rockfish	22	22	22	5	5	5	0	0	0
Pacific grenadier	0	0	0	0	0	0	15	15	15
Arrowtooth flounder	6	6	6	5	5	5	0	0	0
Stripetail rockfish	32	32	31	10	10	10	0	0	0
Lingcod	5	50	50	5	5	5	0	0	0
California slickhead	0	0	0	1	1	0	17	17	0
Giant grenadier	0	0	0	1	1	0	11	11	0
Sharpchin rockfish	1	1	1	2	2	2	0	0	0
Spotted ratfish	37	37	0	9	9	0	0	0	0
Petrale sole	59	59	59	8	8	8	0	0	0
Big skate	25	25	25	2	2	2	0	0	0
Yellowtail rockfish	5	5	5	0	0	0	0	0	0
Pacific ocean perch	0	0	0	0	0	0	0	0	0
Brown cat shark	1	1	0	5	5	0	20	20	0
White croaker	2	20	0	0	0	0	0	0	0
Canary rockfish	8	8	8	0	0	0	0	0	0
Halfbanded rockfish	11	11	11	1	1	1	0	0	0

Table 28. Number of hauls by depth strata where weight (Wt.), number of fish (No.), and lengths (Len.) were collected for the 30 most abundant groundfish and selected invertebrate species in the INPFC Conception area from the 2004 West Coast groundfish trawl survey.

	Stratum 1 55–183 m Total hauls = 47 Hauls with:			**Stratum 2 184–549 m Total hauls = 46 Hauls with:**			**Stratum 3 550–1,280 m Total hauls = 53 Hauls with:**		
Species	**Wt.**	**No.**	**Len.**	**Wt.**	**No.**	**Len.**	**Wt.**	**No.**	**Len.**
Dover sole	11	11	11	41	41	41	41	41	40
Pacific hake	12	12	3	42	42	19	16	16	4
Longspine thornyhead	0	0	0	10	10	10	51	51	50
Sablefish	7	7	7	21	21	21	44	44	43
Spiny dogfish	13	13	13	11	11	11	0	0	0
Chilipepper rockfish	18	18	18	13	13	13	0	0	0
Splitnose rockfish	3	3	3	33	33	33	0	0	0
Pacific sanddab	38	38	38	6	6	6	0	0	0
Rex sole	13	13	13	31	31	31	2	2	2
Shortspine thornyhead	0	0	0	25	25	25	50	50	49
Longnose skate	12	12	12	32	32	32	8	8	8
English sole	36	36	36	9	9	9	0	0	0
Grooved tanner crab	0	0	0	2	2	0	31	31	0
Shortbelly rockfish	8	8	8	14	14	14	0	0	0
Pacific grenadier	0	0	0	0	0	0	17	17	16
Arrowtooth flounder	0	0	0	0	0	0	0	0	0
Stripetail rockfish	26	26	26	22	22	22	0	0	0
Lingcod	15	15	15	11	11	11	0	0	0
California slickhead	0	0	0	0	0	0	42	42	0
Giant grenadier	0	0	0	0	0	0	18	18	0
Sharpchin rockfish	0	0	0	0	0	0	0	0	0
Spotted ratfish	29	29	0	31	31	0	0	0	0
Petrale sole	18	18	18	8	8	8	0	0	0
Big skate	3	3	3	0	0	0	0	0	0
Yellowtail rockfish	1	1	1	0	0	0	0	0	0
Pacific ocean perch	0	0	0	0	0	0	0	0	0
Brown cat shark	0	0	0	15	15	0	40	40	0
White croaker	27	27	0	0	0	0	0	0	0
Canary rockfish	3	3	3	0	0	0	0	0	0
Halfbanded rockfish	32	32	32	2	2	2	0	0	0

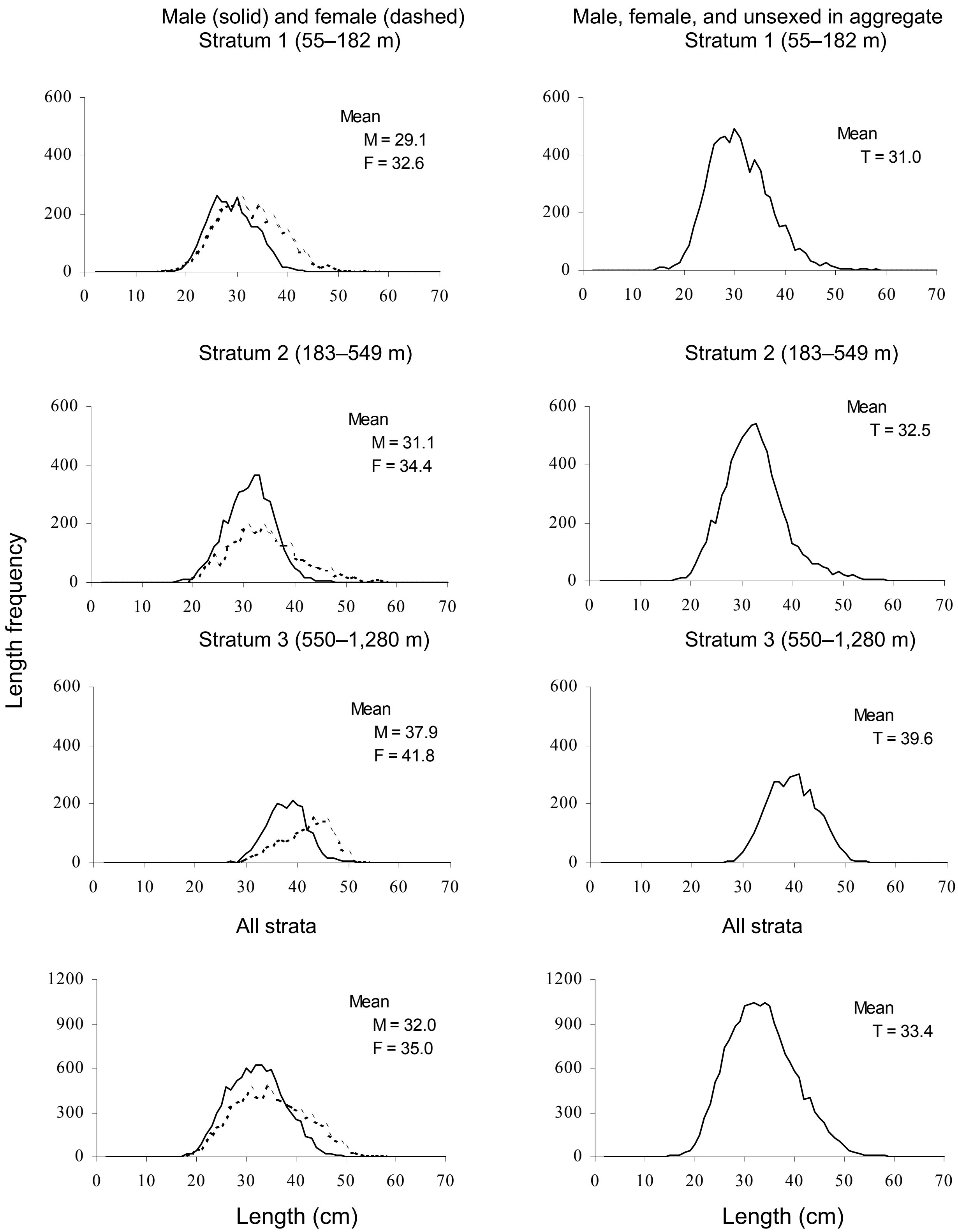


Figure 36. Unweighted length-frequency data and mean lengths of Dover sole by depth stratum and by sex (M = male, F = female, and T = males, females, and unsexed in aggregate) for all INPFC areas sampled from the 2004 West Coast groundfish trawl survey.

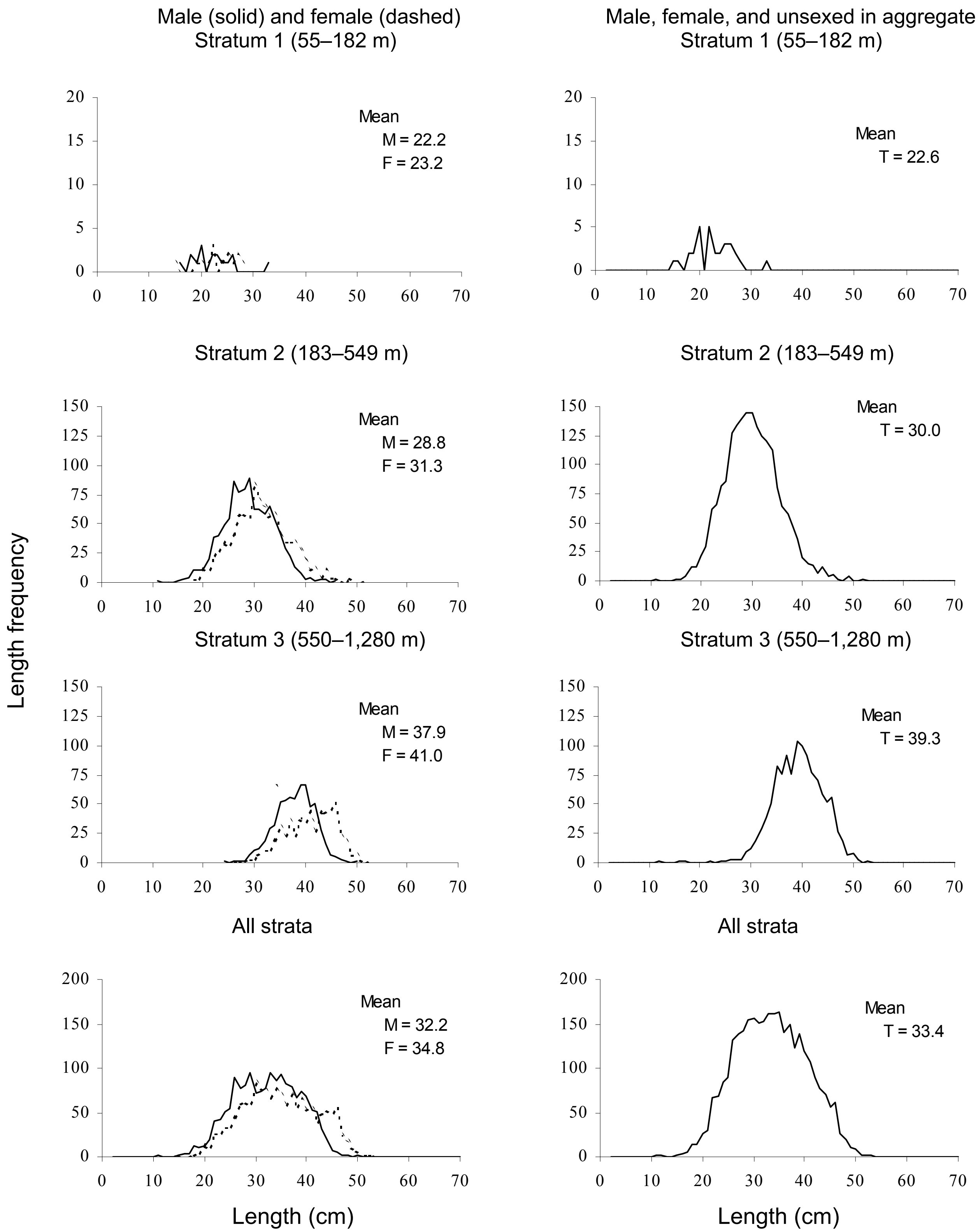


Figure 37. Unweighted length-frequency data and mean lengths of Dover sole by depth stratum and by sex (M = male, F = female, and T = males, females, and unsexed) for the INPFC Conception area from the 2004 West Coast groundfish trawl survey.

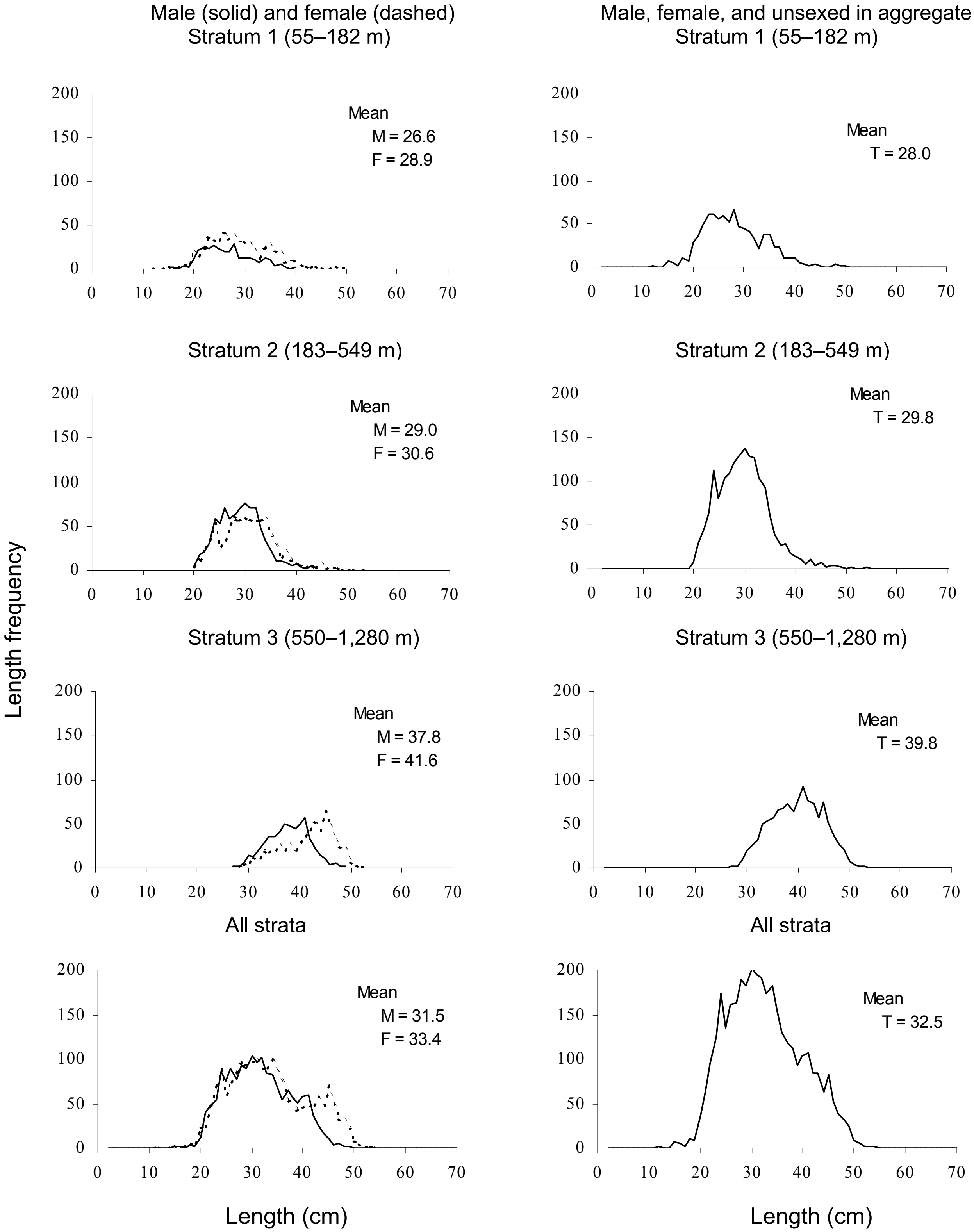


Figure 38. Unweighted length-frequency data and mean lengths of Dover sole by depth stratum and by sex (M = male, F = female, and T = males, females, and unsexed) for the INPFC Monterey area from the 2004 West Coast groundfish trawl survey.

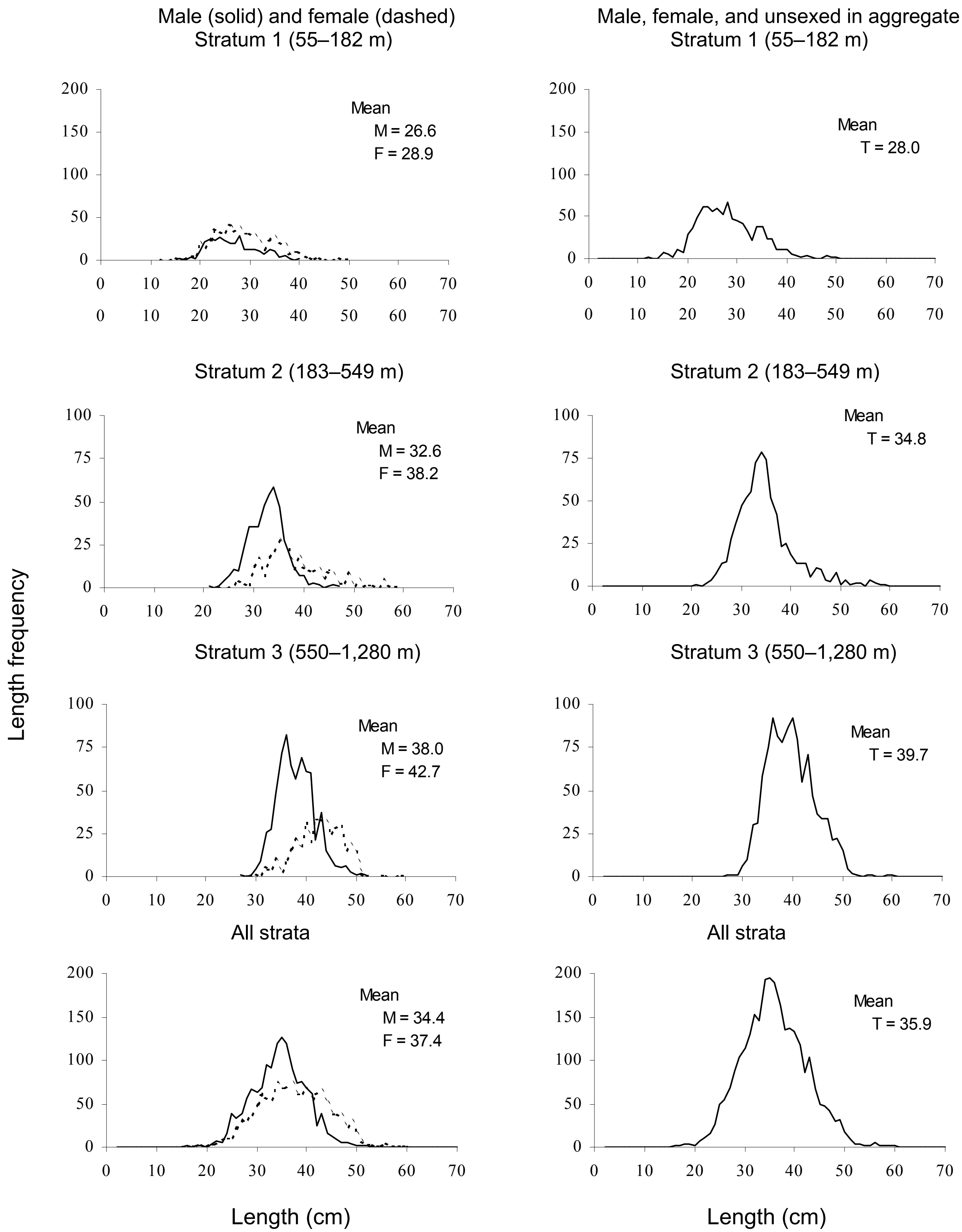


Figure 39. Unweighted length-frequency data and mean lengths of Dover sole by depth stratum and by sex (M = male, F = female, and T = males, females, and unsexed) for the INPFC Eureka area from the 2004 West Coast groundfish trawl survey.

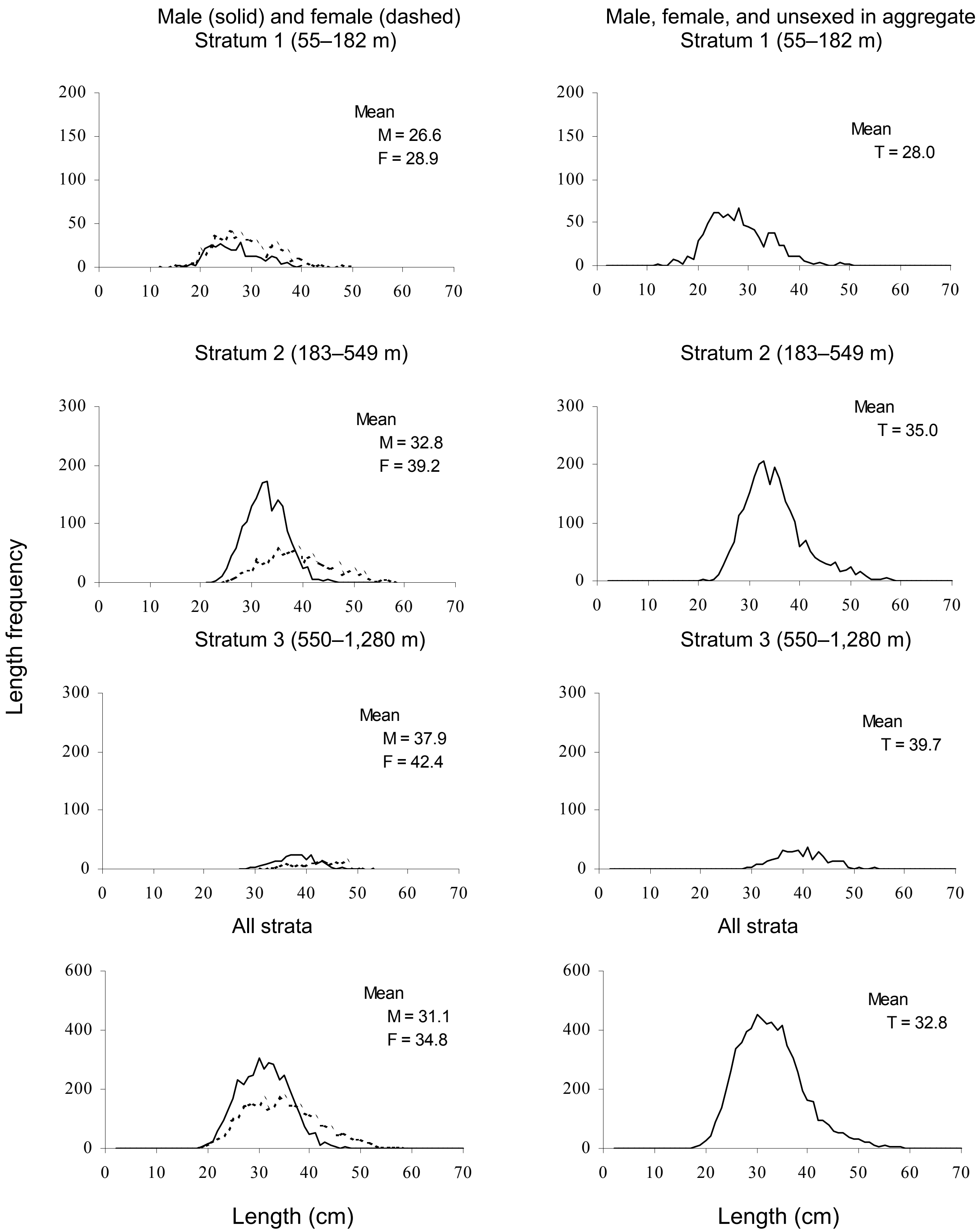


Figure 40. Unweighted length-frequency data and mean lengths of Dover sole by depth stratum and by sex (M = male, F = female, and T = males, females, and unsexed) for the INPFC Columbia area from the 2004 West Coast groundfish trawl survey.

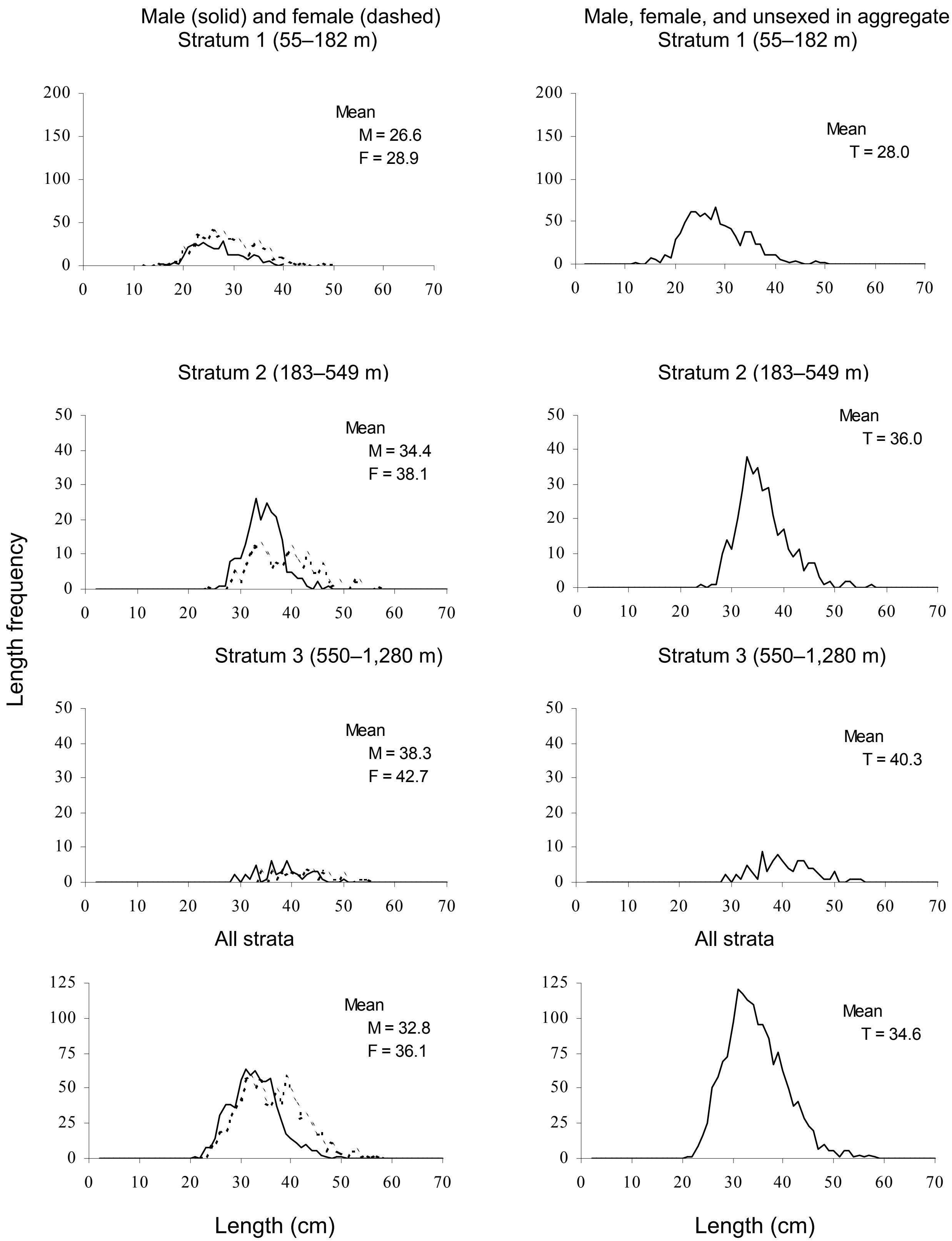


Figure 41. Unweighted length-frequency data and mean lengths of Dover sole by depth stratum and by sex (M = male, F = female, and T = males, females, and unsexed) for the INPFC U.S.-Vancouver area from the 2004 West Coast groundfish trawl survey.

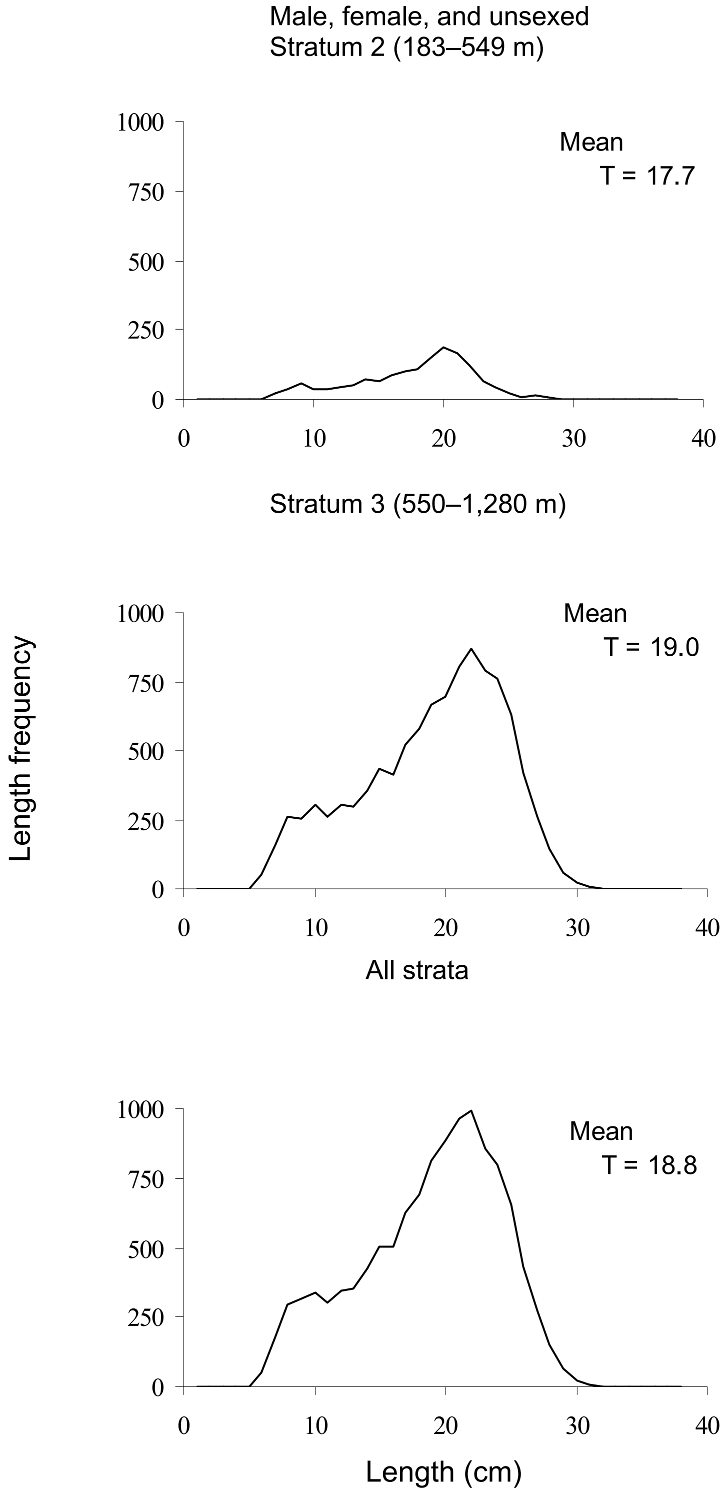


Figure 42. Unweighted length-frequency data and mean lengths of longspine thornyhead by depth stratum for all INPFC areas sampled during the 2004 West Coast groundfish trawl survey (T = males, females, and unsexed).

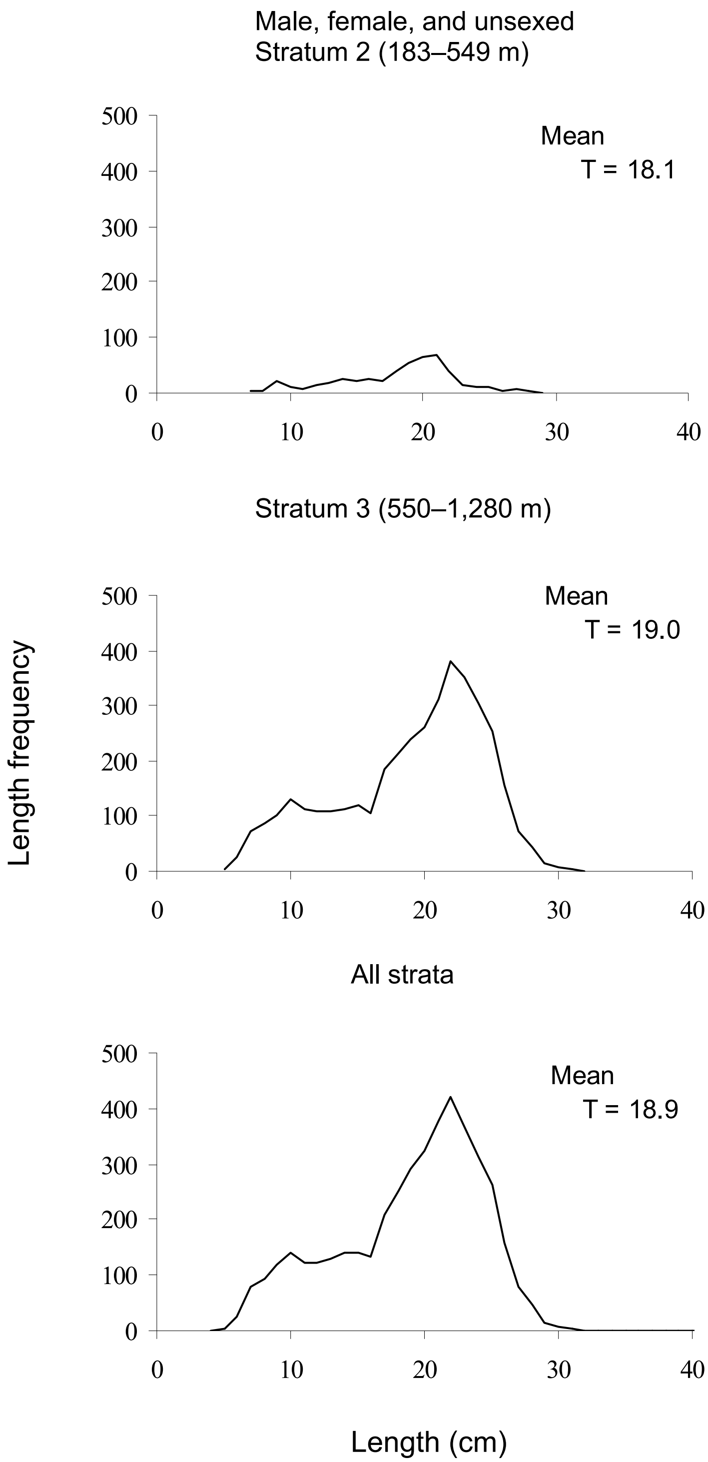


Figure 43. Unweighted length-frequency data and mean lengths of longspine thornyhead by depth stratum for the Conception INPFC area from the 2004 West Coast groundfish trawl survey (T = males, females, and unsexed).

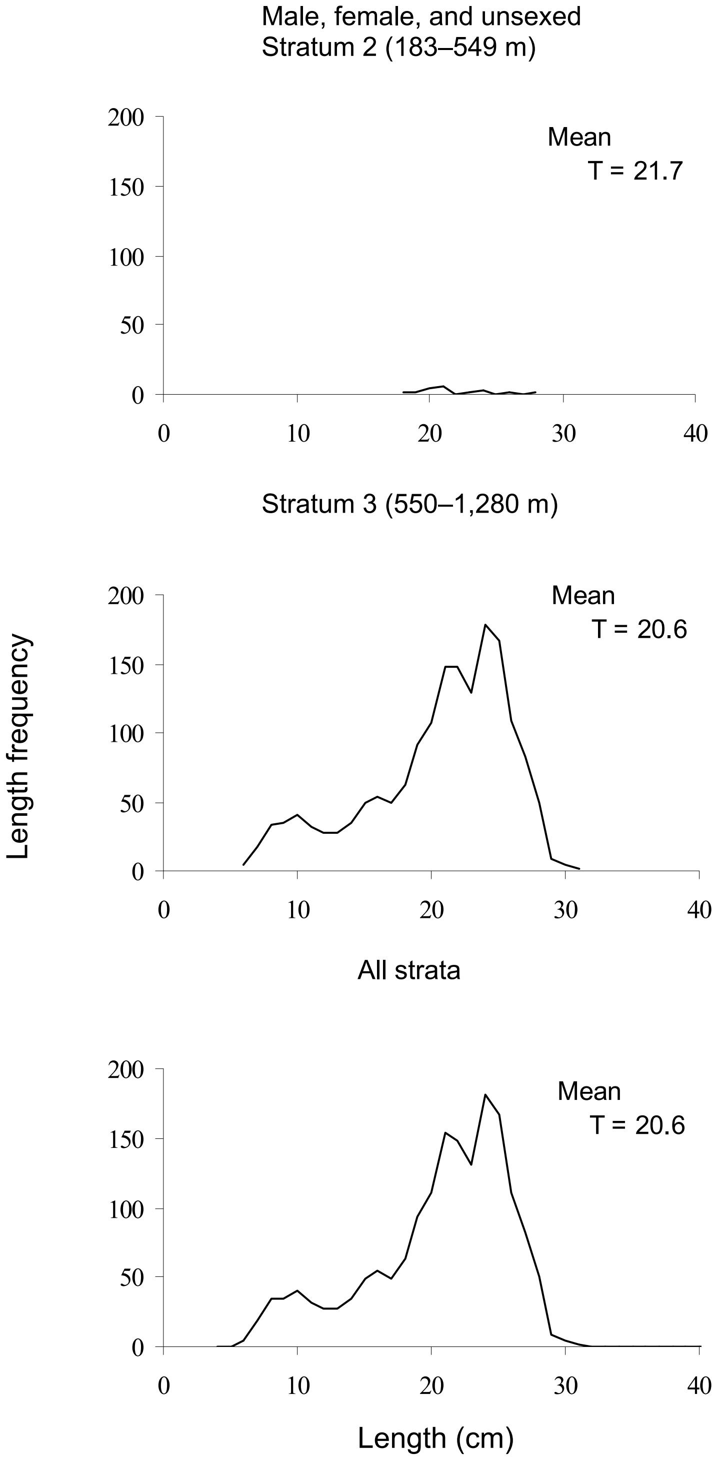


Figure 44. Unweighted length-frequency data and mean lengths of longspine thornyhead by depth stratum for the Monterey INPFC area from the 2004 West Coast groundfish trawl survey (T = males, females, and unsexed).

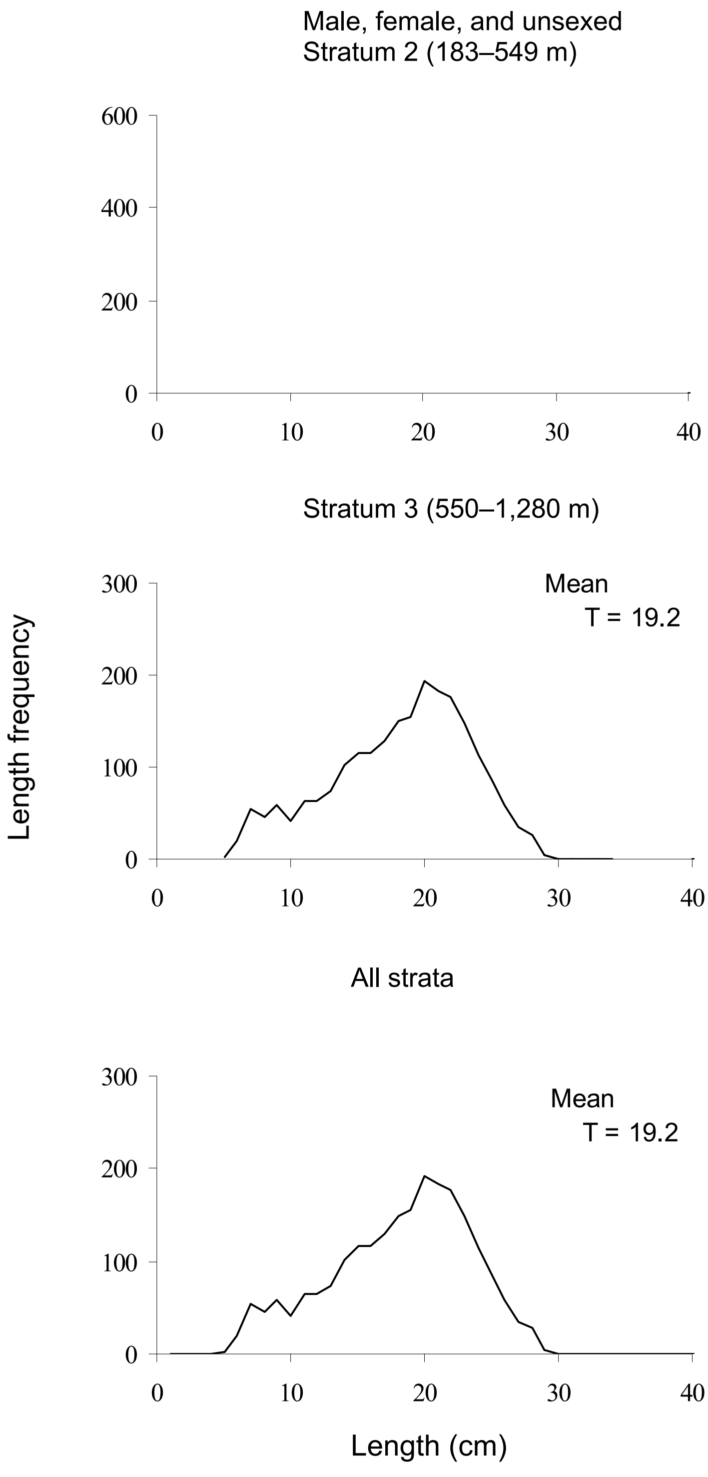


Figure 45. Unweighted length-frequency data and mean lengths of longspine thornyhead by depth stratum for the Eureka INPFC area from the 2004 West Coast groundfish trawl survey (T = males, females, and unsexed).

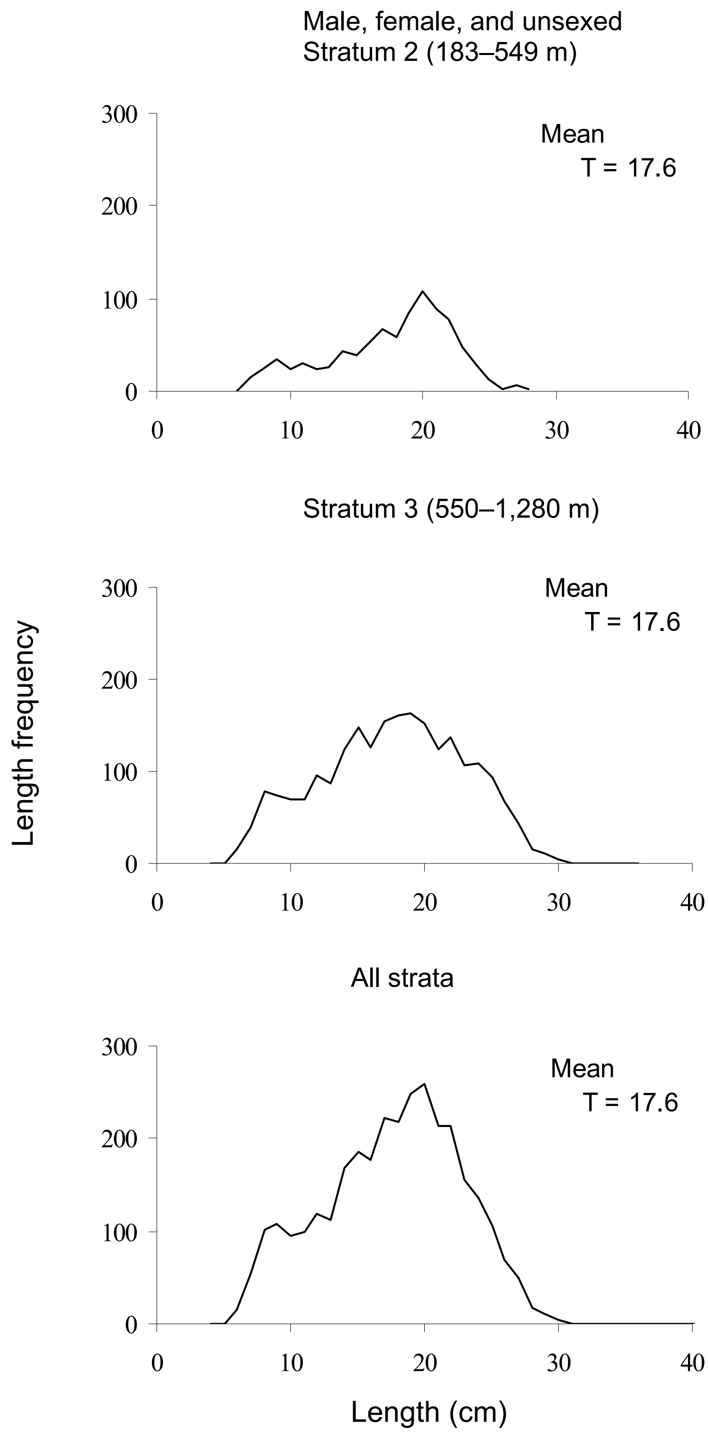


Figure 46. Unweighted length-frequency data and mean lengths of longspine thornyhead by depth stratum for the Columbia INPFC area from the 2004 West Coast groundfish trawl survey (T = males, females, and unsexed).

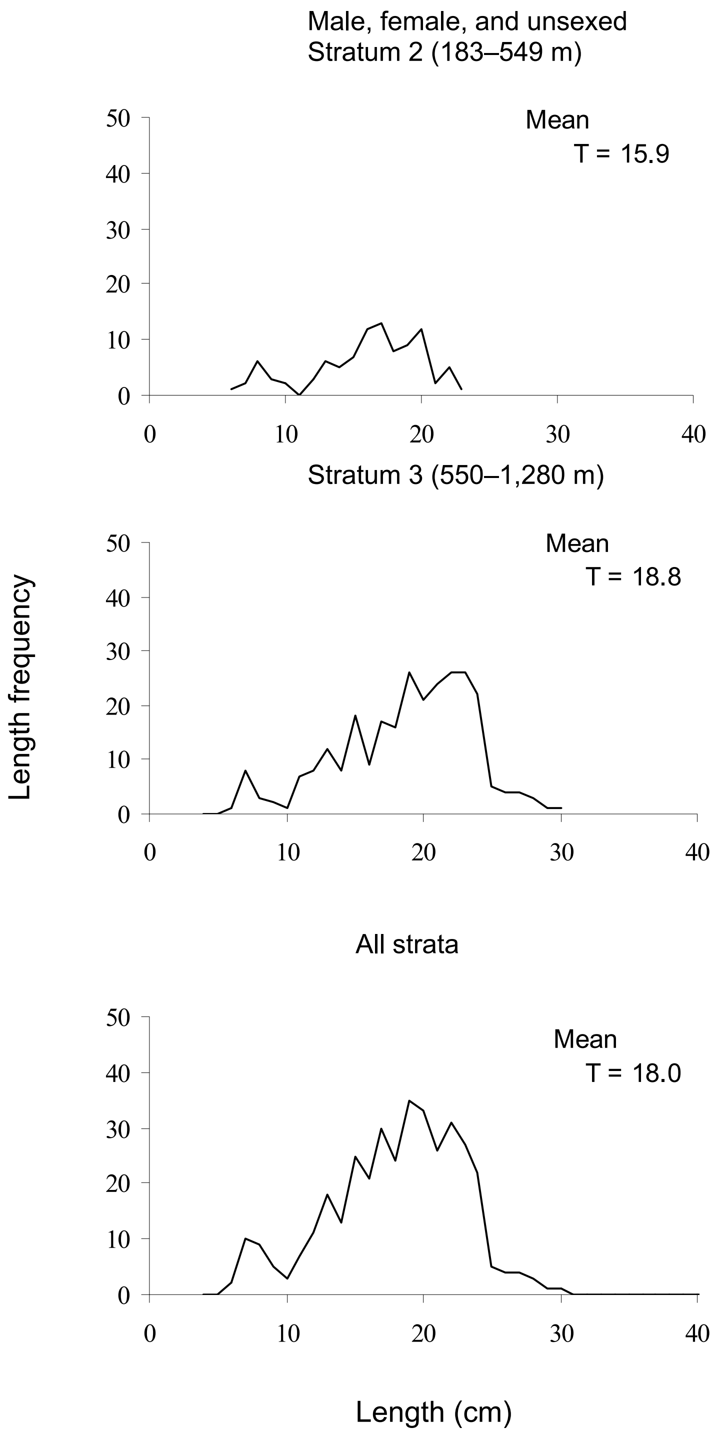


Figure 47. Unweighted length-frequency data and mean lengths of longspine thornyhead by depth stratum for the U.S.-Vancouver INPFC area from the 2004 West Coast groundfish trawl survey (T = males, females, and unsexed).

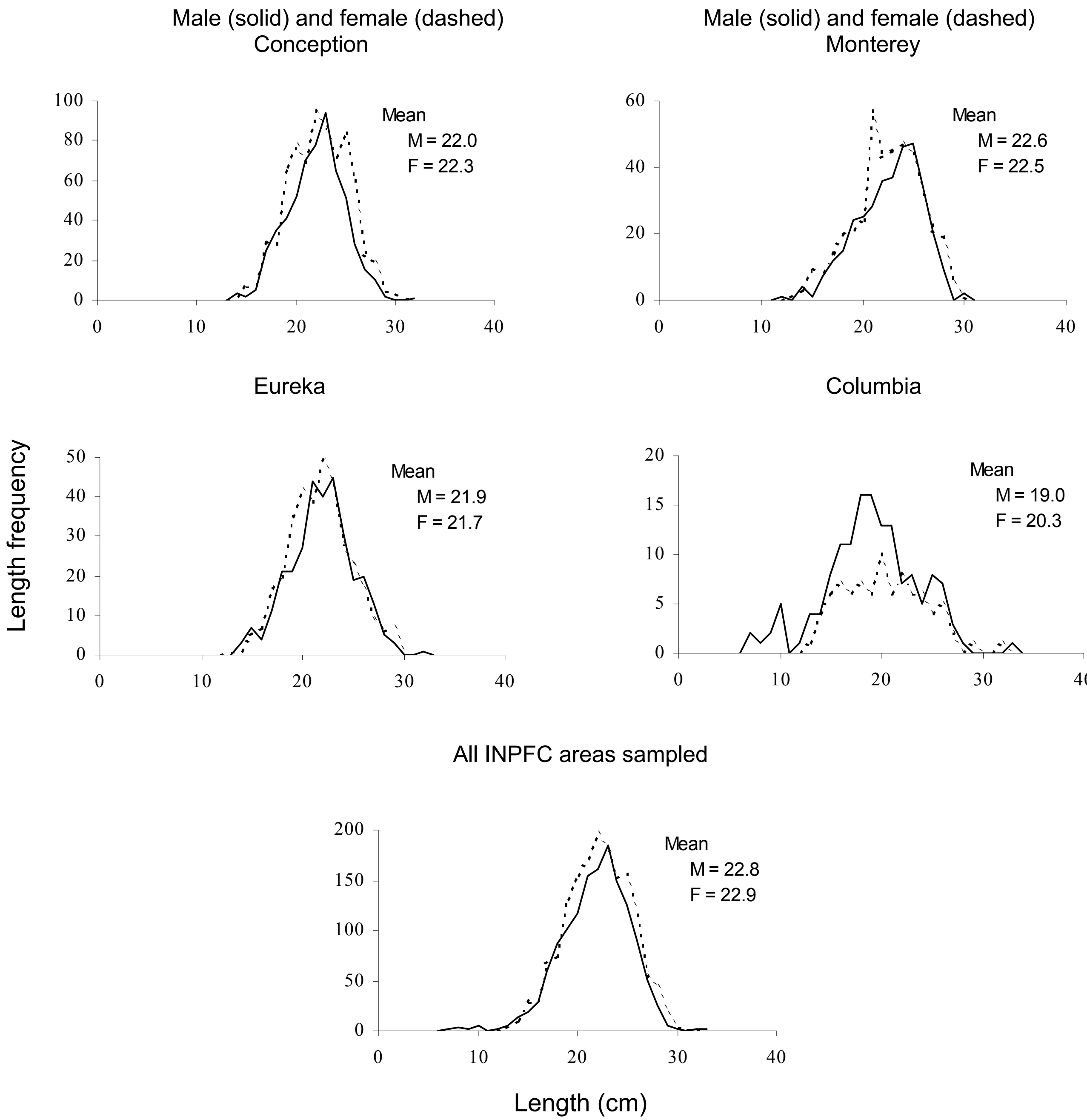


Figure 48. Unweighted length-frequency data and mean lengths of sexed longspine thornyhead (M = male, F = female) from stratum 3 (550–1,280 m) by INPFC area during the 2004 West Coast groundfish trawl survey.

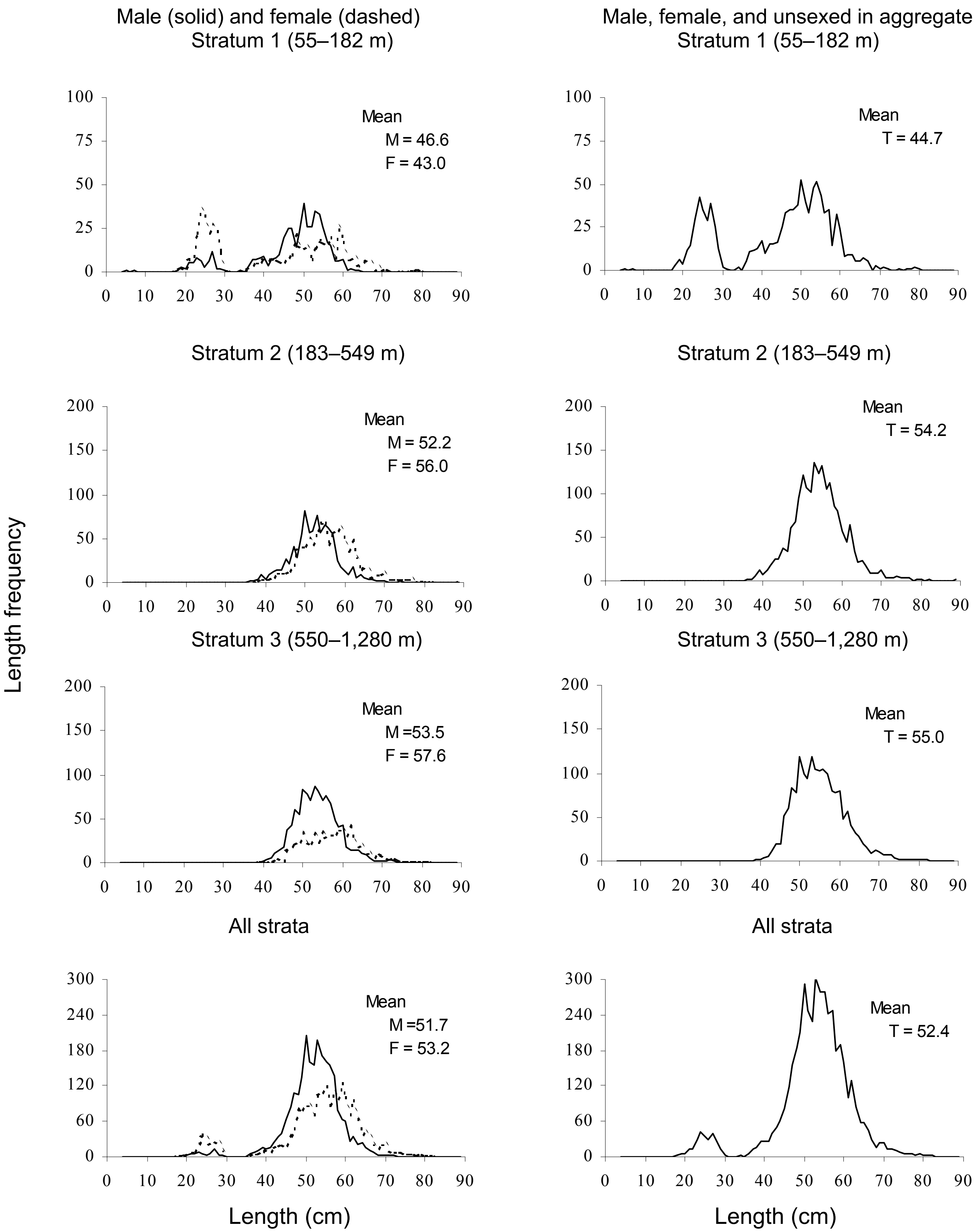


Figure 49. Unweighted length-frequency data and mean lengths of sablefish by depth stratum and by sex (M = male, F = female, and T = males, females, and unsexed in aggregate) for all INPFC areas sampled from the 2004 West Coast groundfish trawl survey.

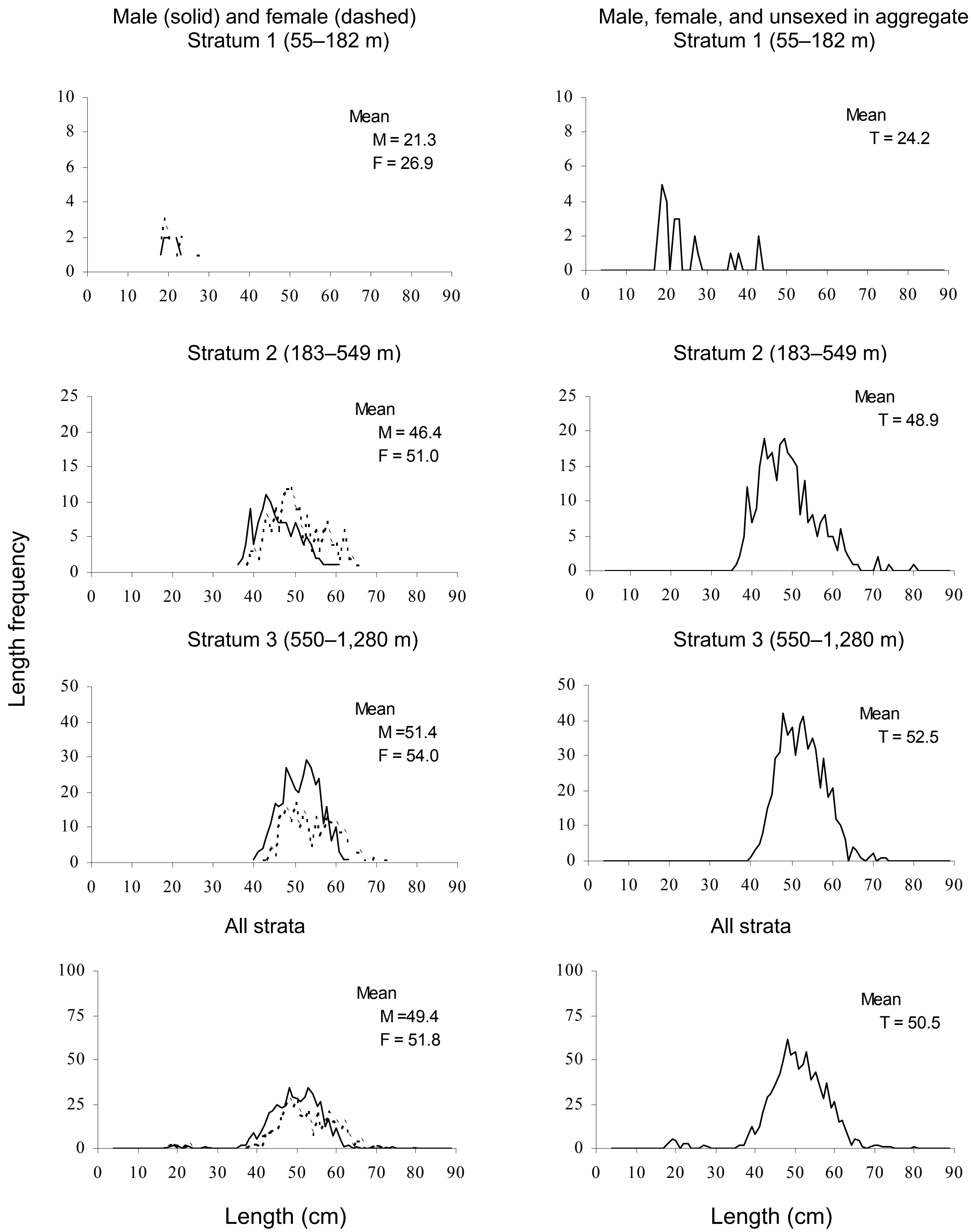


Figure 50. Unweighted length-frequency data and mean lengths of sablefish by depth stratum and by sex (M = male, F = female, and T = males, females, and unsexed in aggregate) for the INPFC Conception area from the 2004 West Coast groundfish trawl survey.

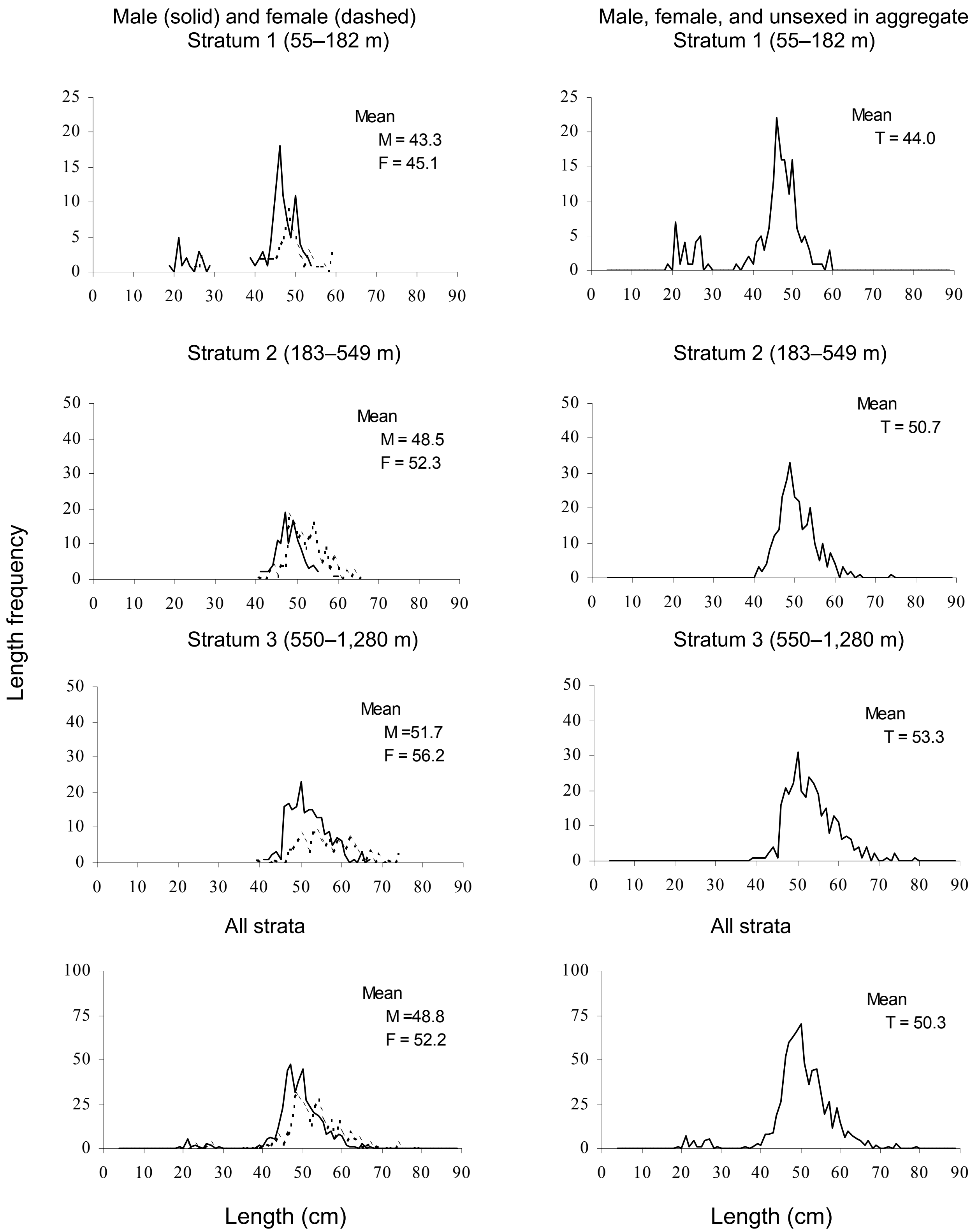


Figure 51. Unweighted length-frequency data and mean lengths of sablefish by depth stratum and by sex (M = male, F = female, and T = males, females, and unsexed in aggregate) for the INPFC Monterey area from the 2004 West Coast groundfish trawl survey.

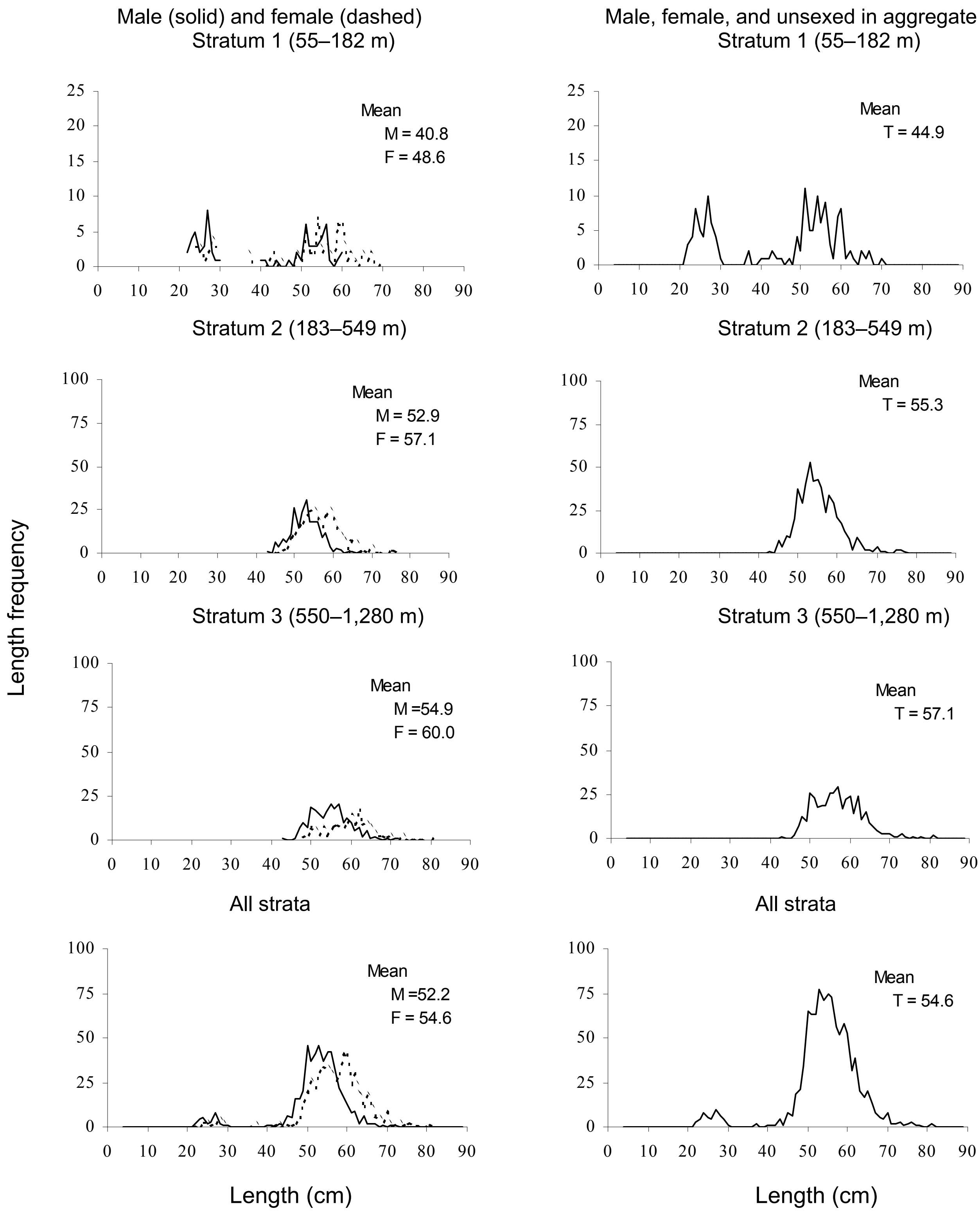


Figure 52. Unweighted length-frequency data and mean lengths of sablefish by depth stratum and by sex (M = male, F = female, and T = males, females, and unsexed in aggregate) for the INPFC Eureka area from the 2004 West Coast groundfish trawl survey.

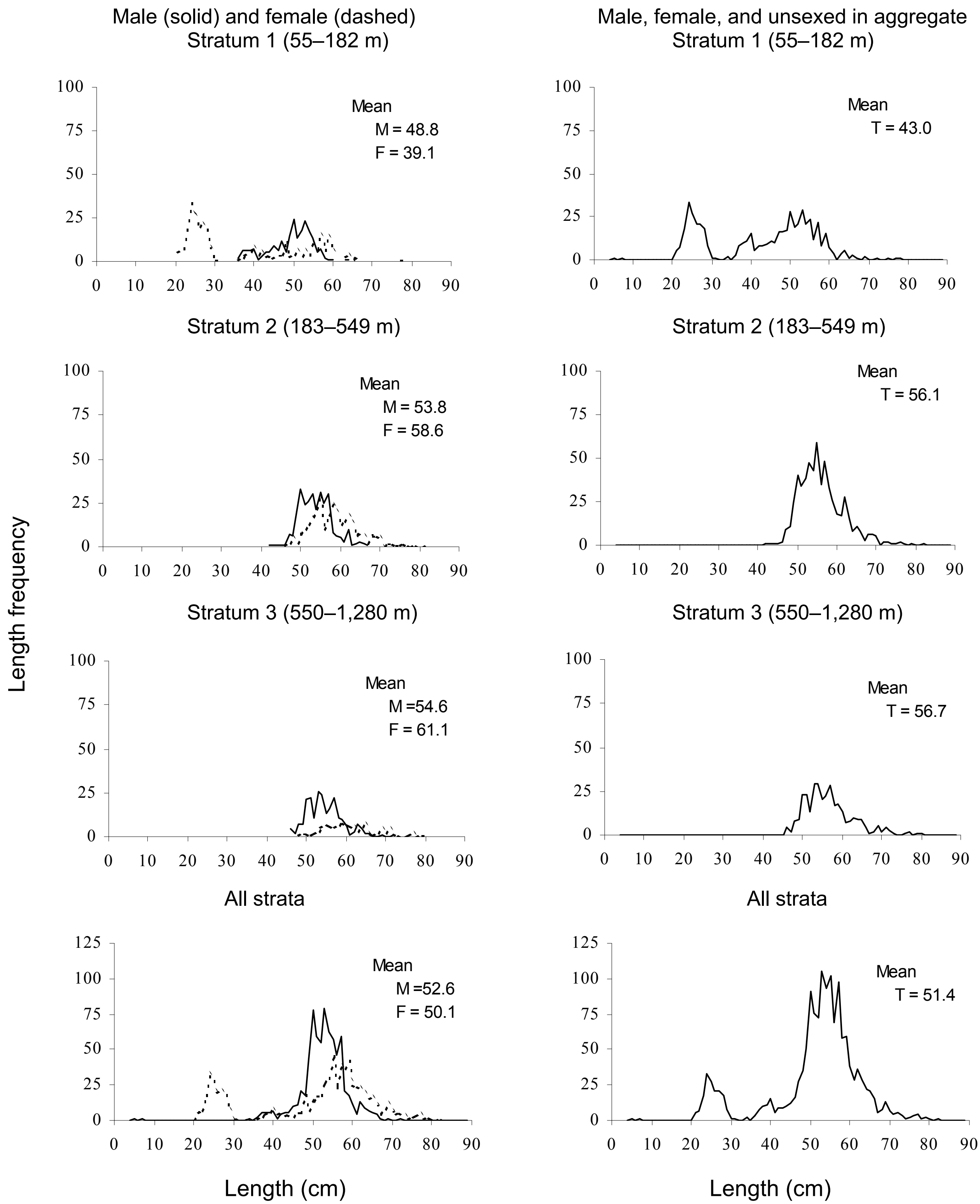


Figure 53. Unweighted length-frequency data and mean lengths of sablefish by depth stratum and by sex (M = male, F = female, and T = males, females, and unsexed in aggregate) for the INPFC Columbia area from the 2004 West Coast groundfish trawl survey.

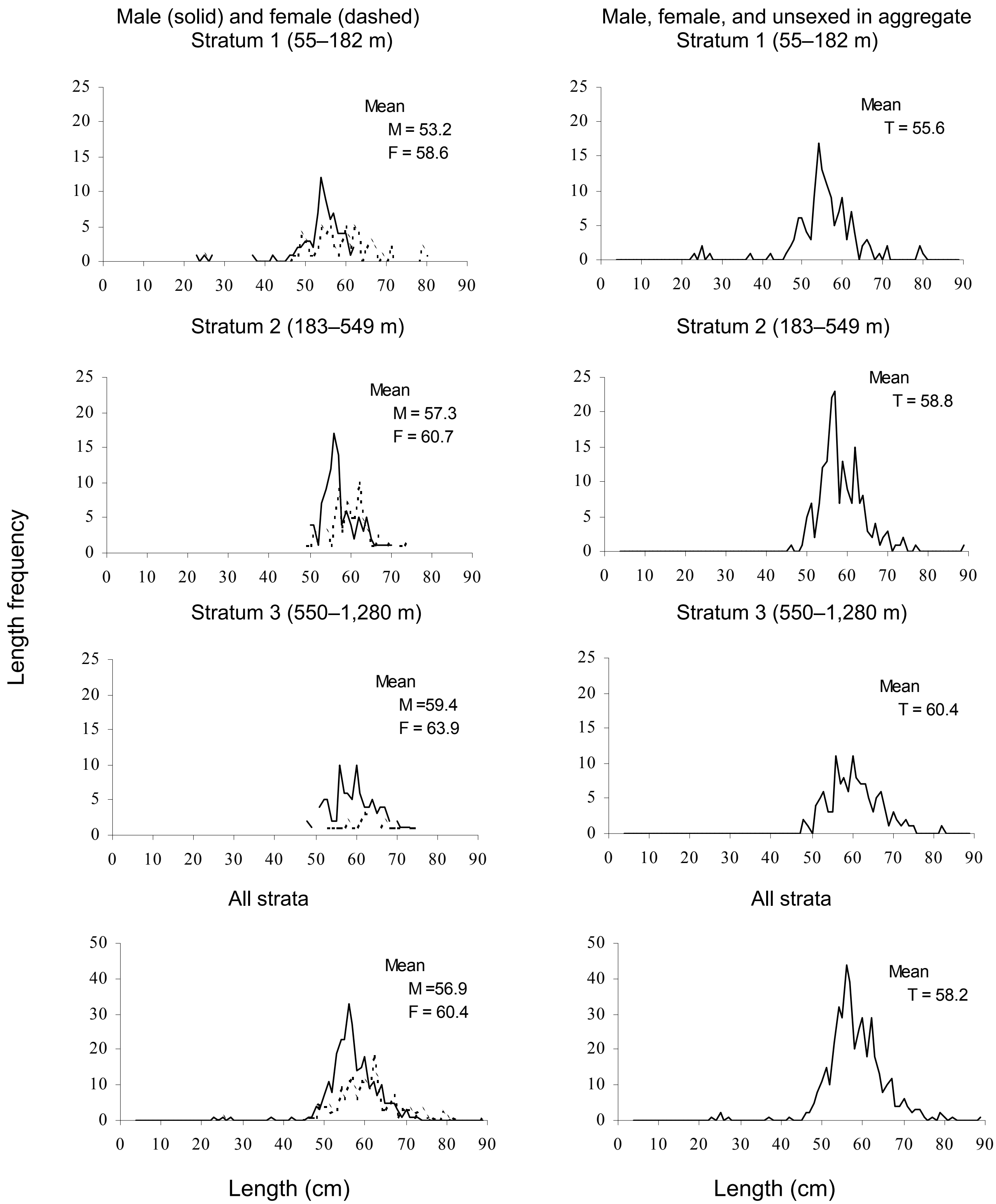


Figure 54. Unweighted length-frequency data and mean lengths of sablefish by depth stratum and by sex (M = male, F = female, and T = males, females, and unsexed in aggregate) for the INPFC U.S.-Vancouver area from the 2004 West Coast groundfish trawl survey.

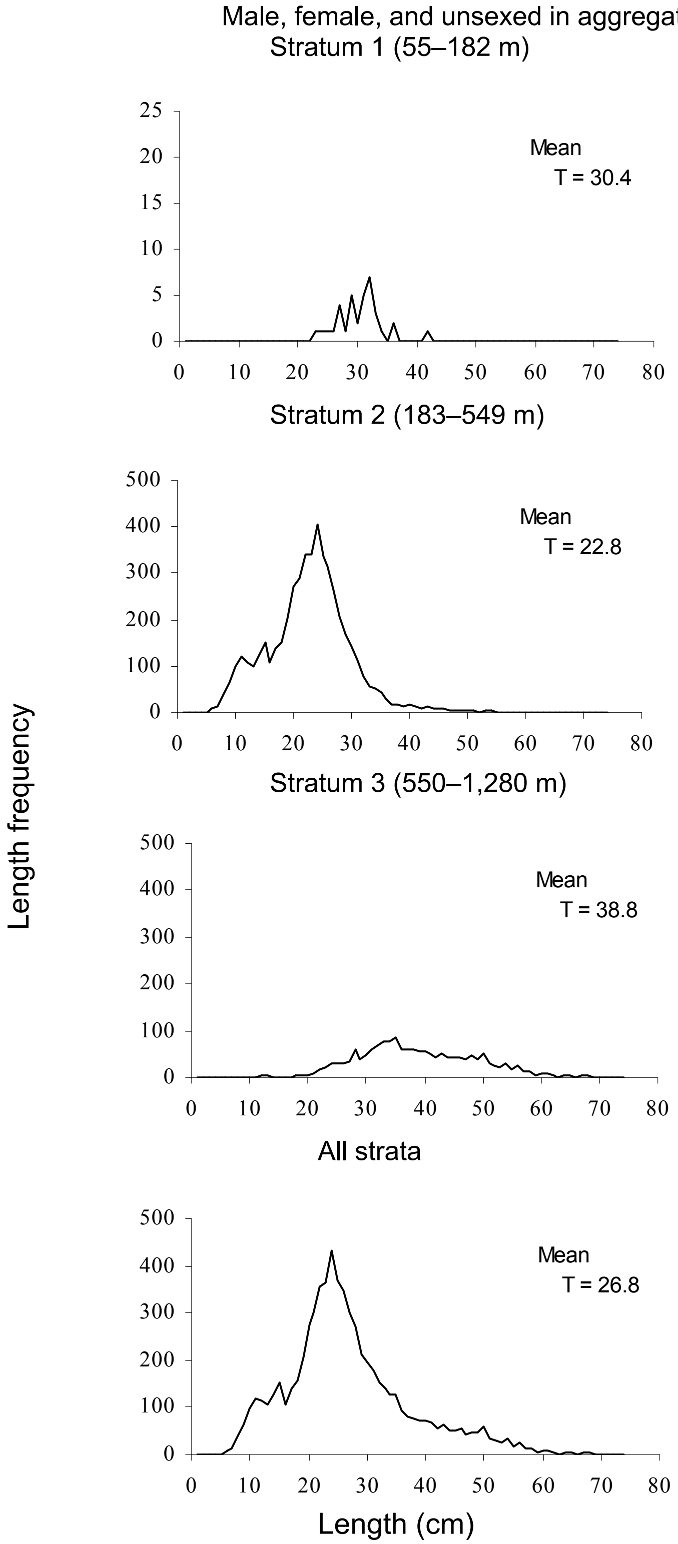


Figure 55. Unweighted length-frequency data and mean lengths of shortspine thornyhead by depth stratum for all INPFC areas sampled during the 2004 West Coast groundfish trawl survey (T = males, females, and unsexed).

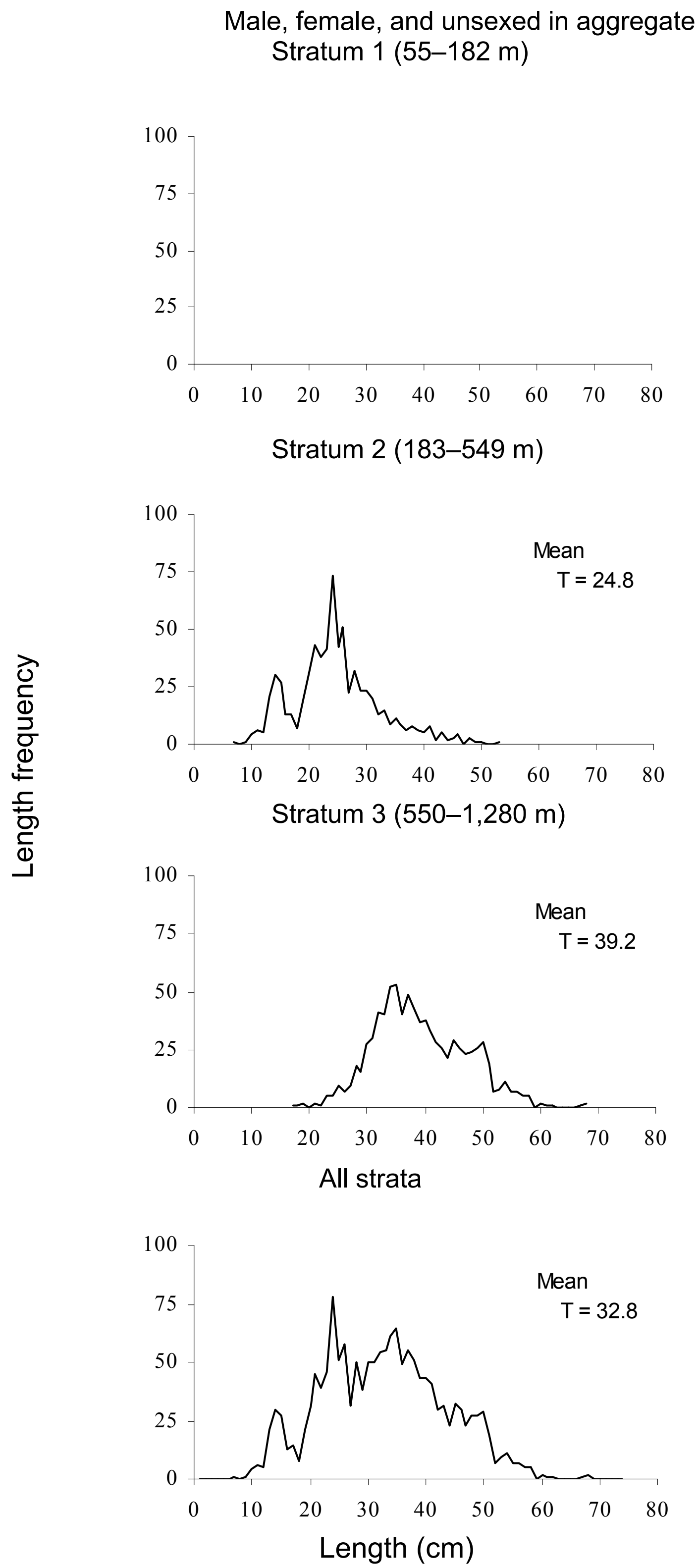


Figure 56. Unweighted length-frequency data and mean lengths of shortspine thornyhead by depth stratum for the INPFC Conception area from the 2004 West Coast groundfish trawl survey (T = males, females, and unsexed).

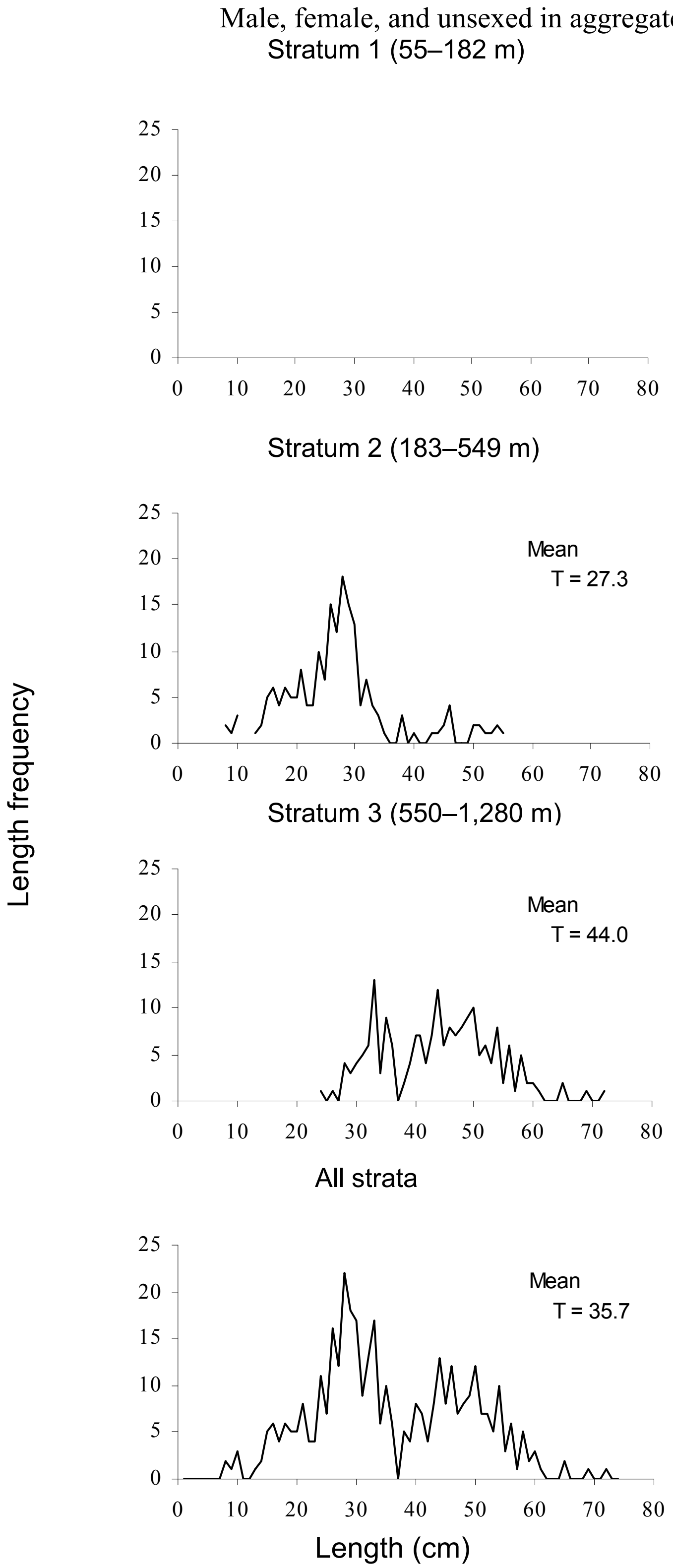


Figure 57. Unweighted length-frequency data and mean lengths of shortspine thornyhead by depth stratum for the INPFC Monterey area from the 2004 West Coast groundfish trawl survey (T = males, females, and unsexed).

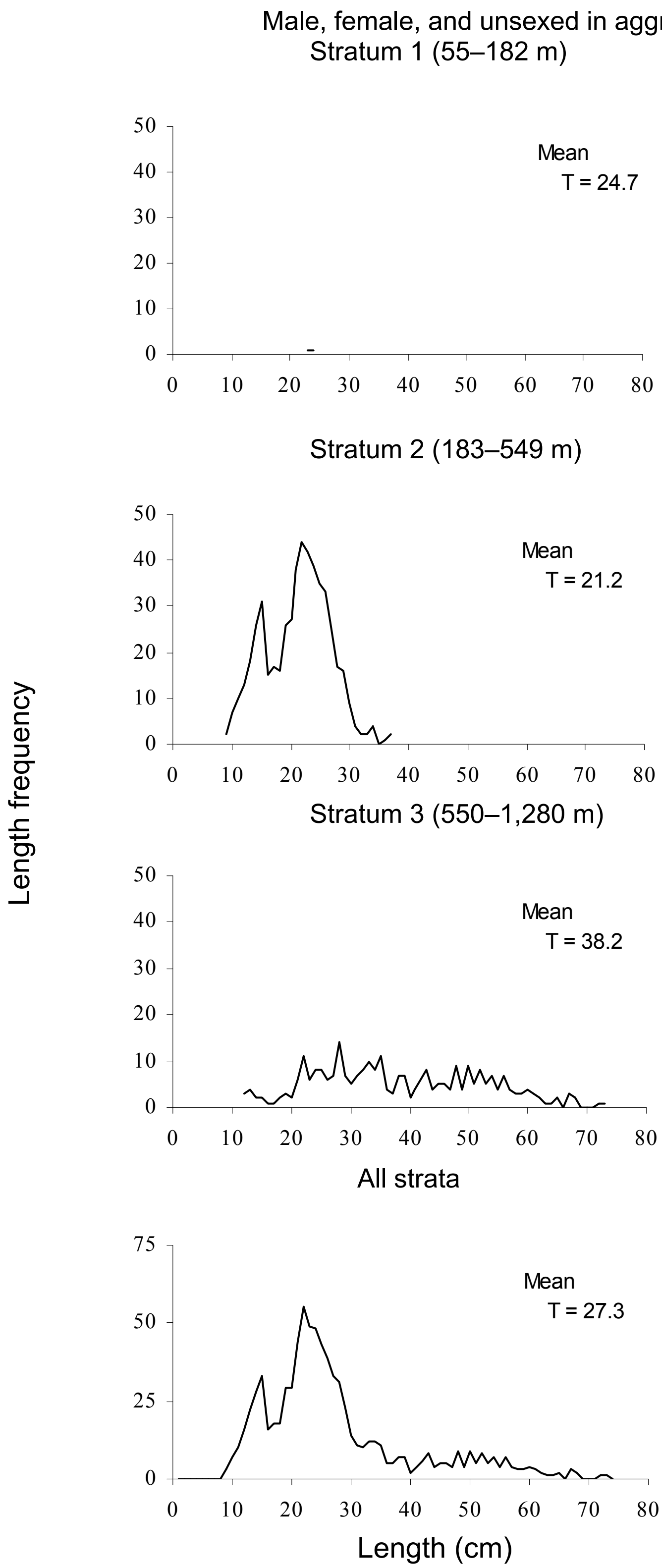


Figure 58. Unweighted length-frequency data and mean lengths of shortspine thornyhead by depth stratum for the INPFC Eureka area from the 2004 West Coast groundfish trawl survey (T = males, females, and unsexed).

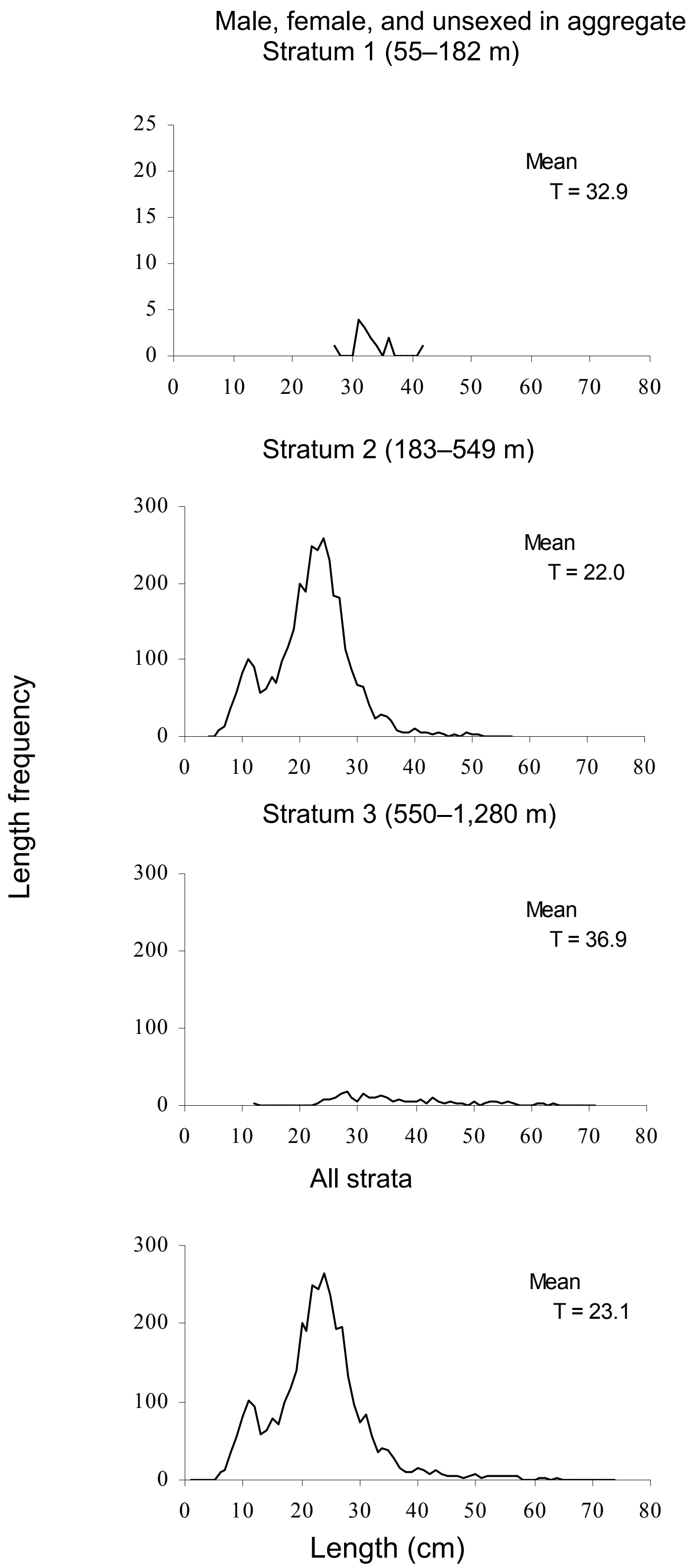


Figure 59. Unweighted length-frequency data and mean lengths of shortspine thornyhead by depth stratum for the INPFC Columbia area from the 2004 West Coast groundfish trawl survey (T = males, females, and unsexed).

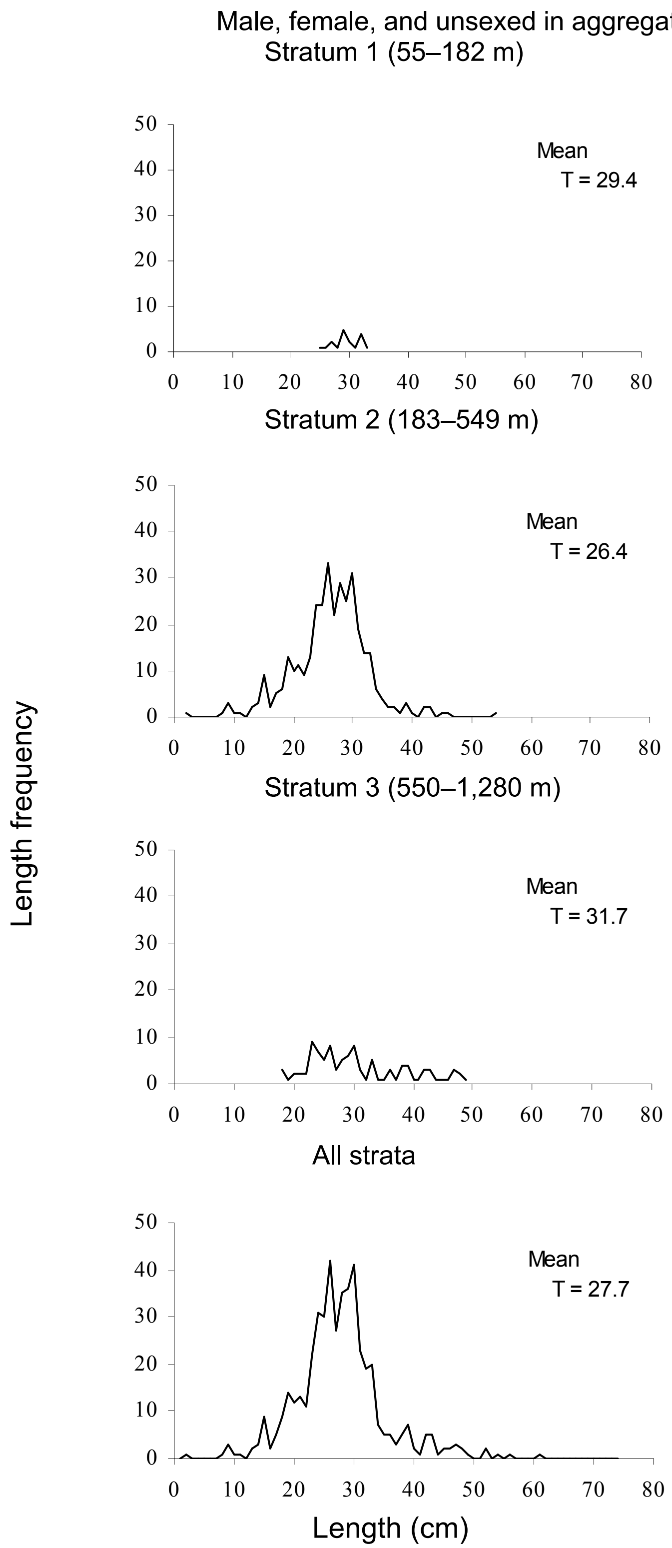


Figure 60. Unweighted length-frequency data and mean lengths of shortspine thornyhead by depth stratum for the INPFC U.S.-Vancouver area from the 2004 West Coast groundfish trawl survey (T = males, females, and unsexed).

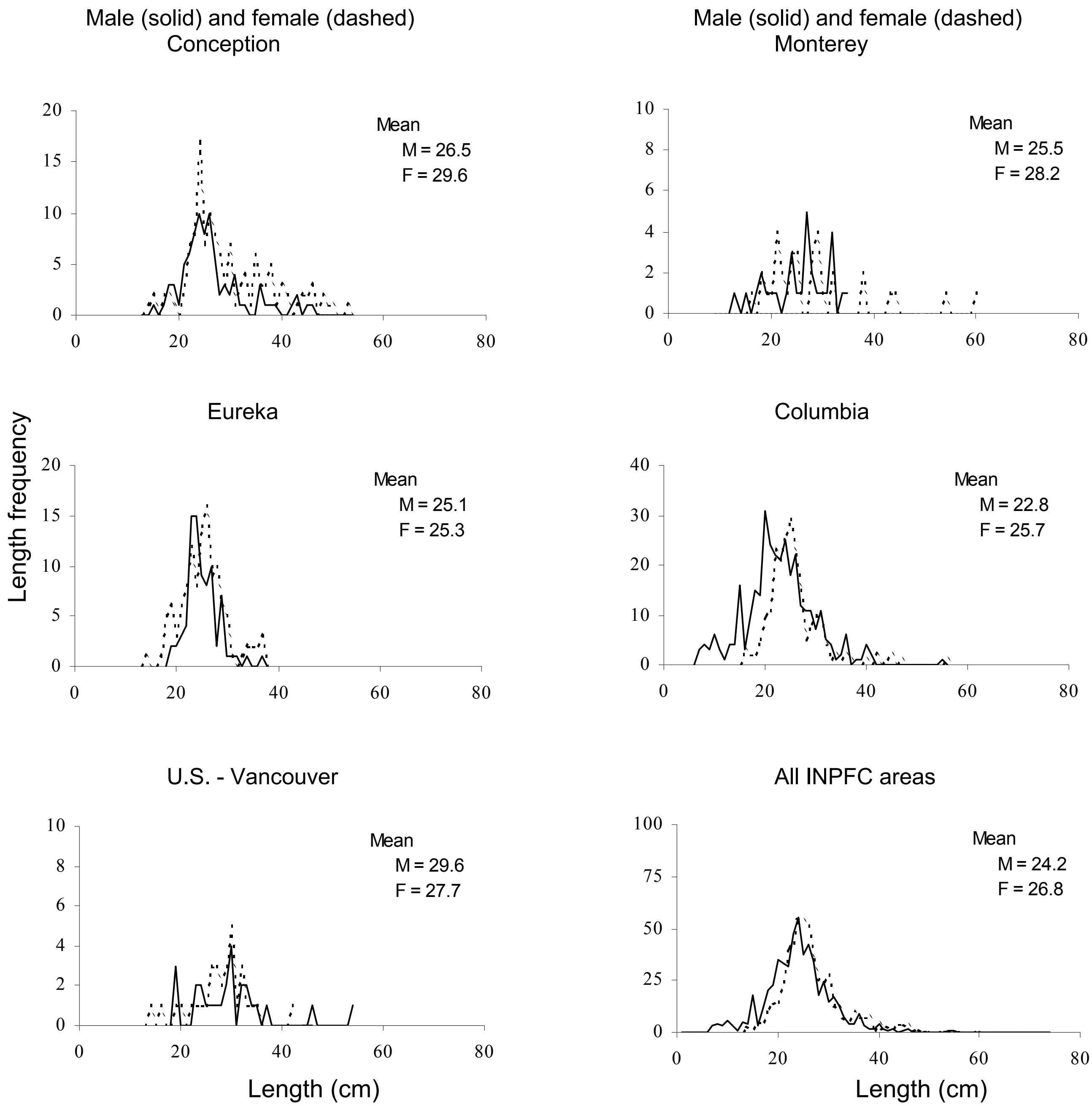


Figure 61. Unweighted length-frequency data and mean lengths of sexed shortspine thornyhead (M = male, F = female) from stratum 2 (183–549 m) by INPFC area during the 2004 West Coast groundfish trawl survey.

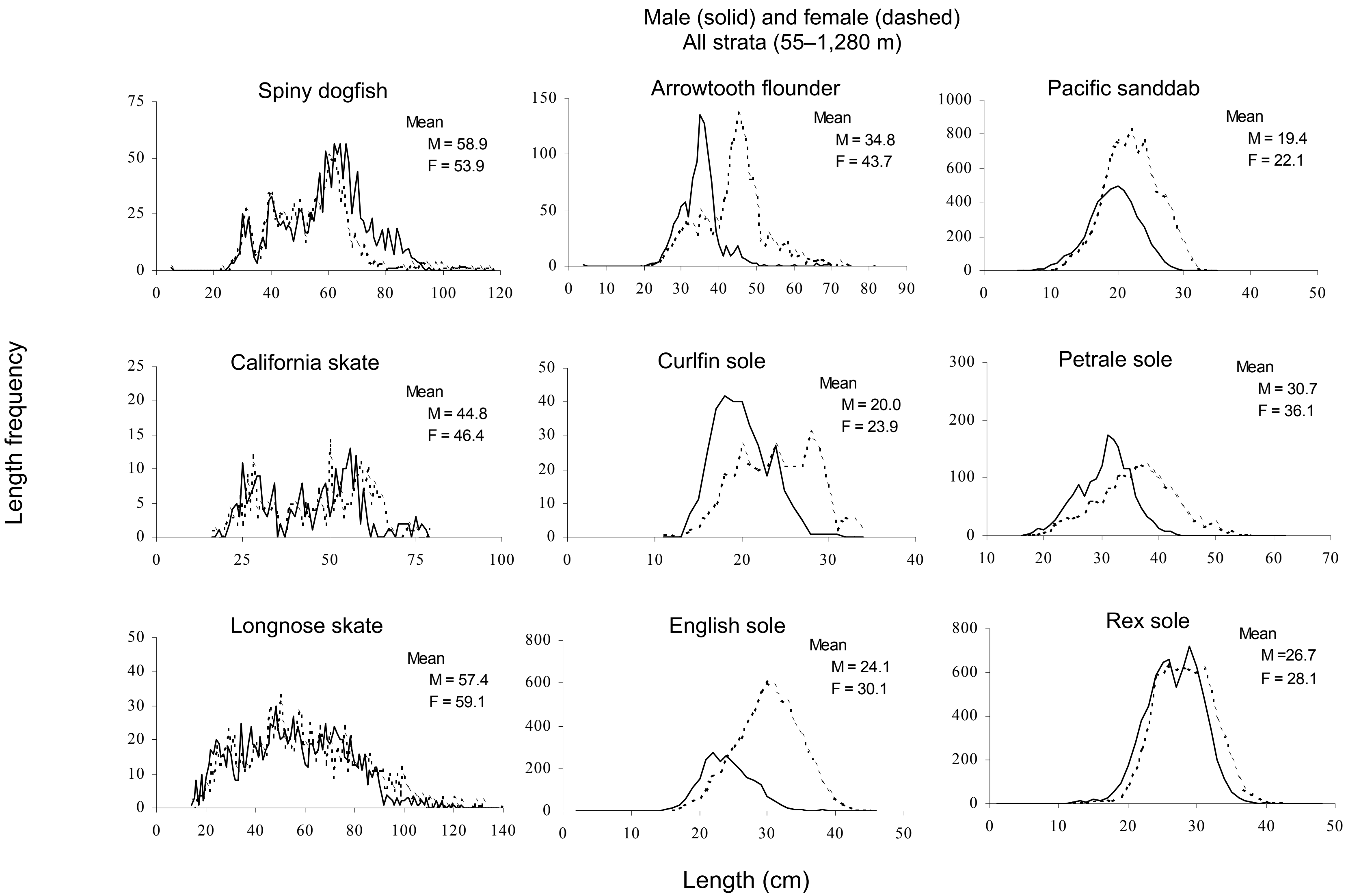


Figure 62. Unweighted length-frequency data and mean lengths of spiny dogfish, arrowtouth flounder, Pacific sanddab, California skate, curlfin sole, petrale sole, longnose skate, English sole, and rex sole by sex (M = males, F = females) for all depths (55–1,280 m) and all INPFC areas sampled from the 2004 West Coast groundfish trawl survey.

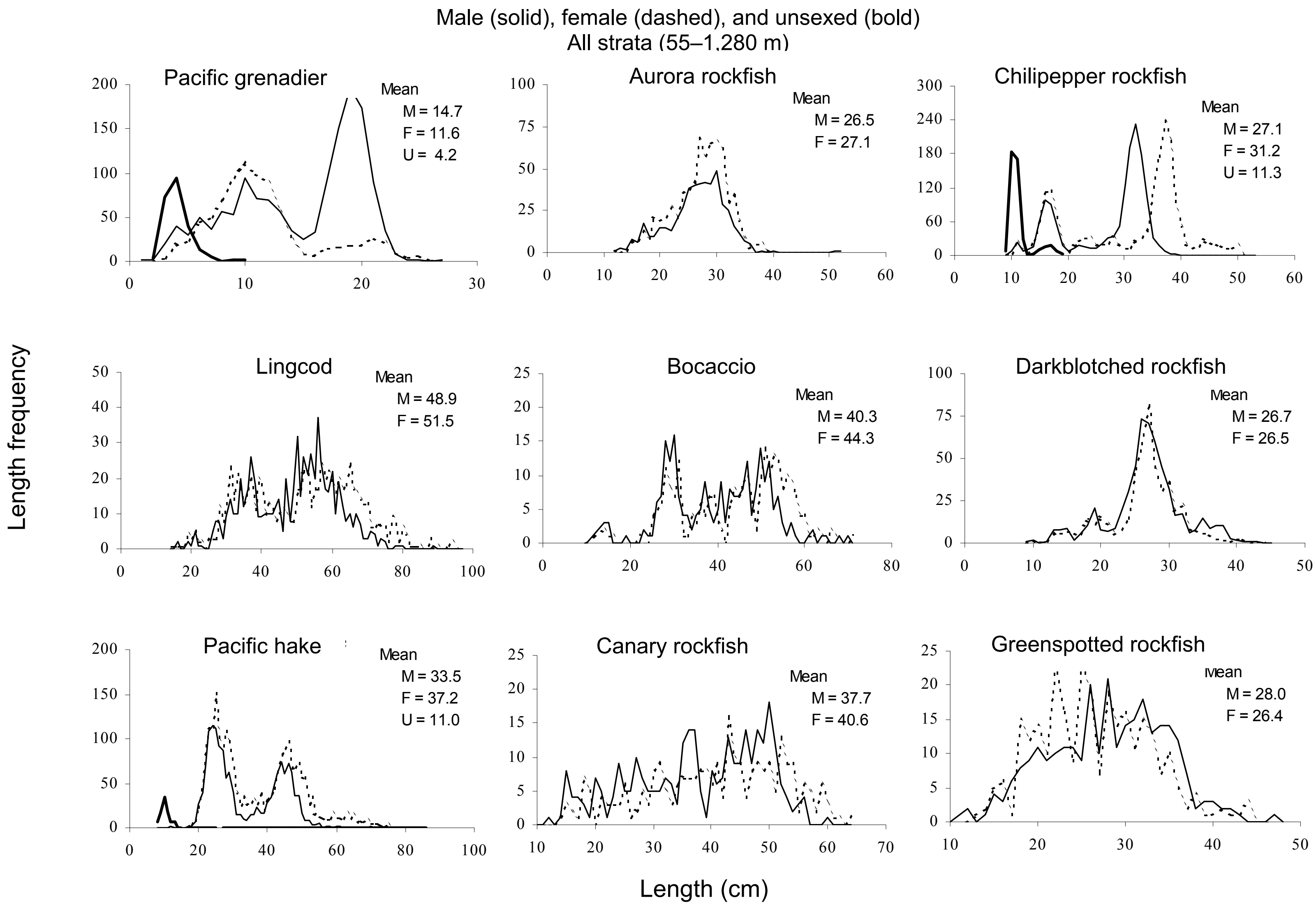


Figure 63. Unweighted length-frequency data and mean lengths of Pacific grenadier, aurora rockfish, chilipepper rockfish, lingcod, bocaccio, darkblotched rockfish, Pacific hake, canary rockfish, and greenspotted rockfish by sex (M = males, F = females, U = unsexed) for all depths (55–1,280 m) and all INPFC areas sampled from the 2004 West Coast groundfish trawl survey.

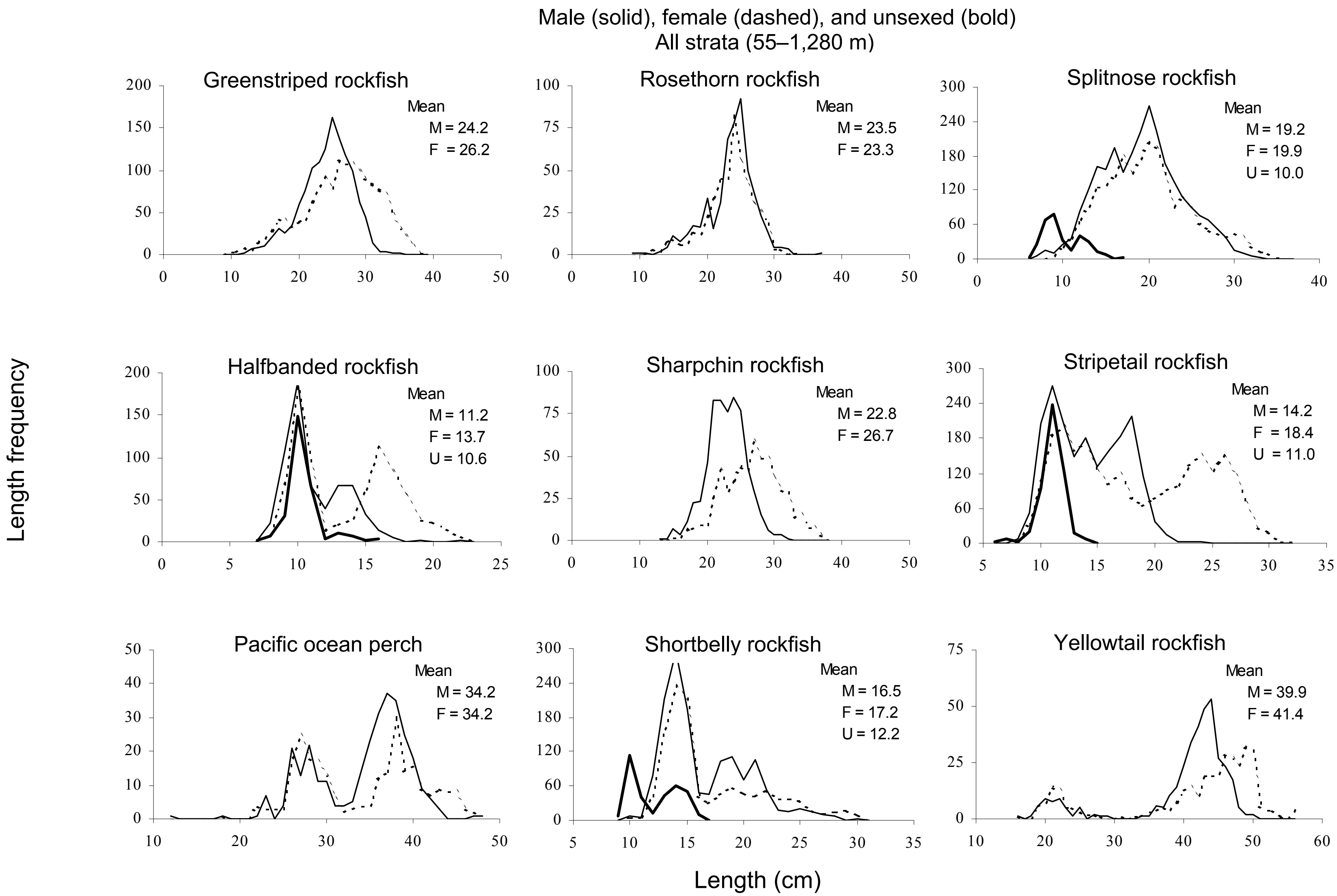


Figure 64. Unweighted length-frequency data and mean lengths of greenstriped rockfish, rosethorn rockfish, splitnose rockfish, halfbanded rockfish, sharpchin rockfish, stripetail rockfish, Pacific ocean perch, shortbelly rockfish, and yellowtail rockfish by sex (M = males, F = females, U = unsexed) for all depths (55–1,280 m) and all INPFC areas sampled from the 2004 West Coast groundfish trawl survey.

Weight-length Relationships

Individual measurements of weight (g) and length (cm) were collected for 49 groundfish species during the 2004 West Coast trawl survey. These data were fit to the following weight-length relationship using a nonlinear least squares fit,

$$W = a \times L^{b} \qquad (4)$$

where W is fish weight in grams, L in fish length in centimeters, and a and b are constants. As previously noted, fork length (or total length) was measured for most species; however, anal length was recorded for Pacific grenadier. Results of these analyses, including number sampled and the coefficient of determination (r^2) are reported in Table 29.

Length-age Relations

Otoliths, dorsal fin rays, or dorsal spines were collected from specimens of 53 groundfish species (Table 2) to determine ages. To date, ages have been determined for age structures collected from Dover sole, petrale sole, lingcod, sablefish, Pacific ocean perch, darkblotched rockfish, yellowtail rockfish, and canary rockfish. For this report, each species is treated as a single homogeneous stock and all age data collected during the 2004 survey are used to estimate the species length-age relationship. Growth was described by the von Bertalanffy growth model (von Bertalanffy 1938),

$$L_t = L_\infty (1 - e^{-k(t - t_0)}) \qquad (5)$$

where L_t is fork length (cm) at age t in years, L_∞ is theoretical maximum fork length (cm), k is growth rate (per year), and t_0 is the theoretical age (years) when the fish was length zero. Growth equation constants for the von Bertalanffy growth model were calculated from length-at-age data for each species by using the least squares, nonlinear regression (SAS Institute Inc. 1999). The von Bertalanffy growth model parameters were estimated for males and females separately to account for possible sex-specific growth rates and for both sexes combined (Table 30).

Growth curves were compared by using the extra sum of square principle (Draper and Smith 1981). Growth between the sexes was significantly different ($P<0.05$), with females growing slower but reaching a larger maximum size than males (Figure 65). Age composition of management species are reported in greater geographic detail in stock assessment documents published by the Pacific Fishery Management Council.

Table 29. The weight-length relationships from the 2004 West Coast groundfish trawl survey using a nonlinear least squares fit for Equation 4.

Species	Number sampled	Weight-length coefficients a	b	r^2
Spiny dogfish	490	0.002869	3.0773	0.99
Pacific sanddab	1,514	0.005336	3.1859	0.91
Arrowtooth flounder	567	0.002440	3.3632	0.98
Petrale sole	1,828	0.001866	3.5026	0.97
English sole	940	0.007278	3.0598	0.95
Dover sole	2,370	0.002397	3.3935	0.97
Starry flounder	49	0.005390	3.2406	0.99
Sablefish	2,083	0.003016	3.3023	0.99
Pacific grenadier	382	0.247072	2.6943	0.96
Lingcod	860	0.001920	3.3911	0.99
Chinook salmon	24	0.003118	3.3641	0.94
Aurora rockfish	375	0.008487	3.1913	0.98
Bank rockfish	77	0.006761	3.2225	0.97
Blackgill rockfish	186	0.009322	3.1360	0.99
Bocaccio	226	0.005958	3.1744	0.99
Brown rockfish	43	0.004243	3.3732	0.96
Calico rockfish	84	0.007570	3.2030	0.89
Canary rockfish	291	0.008965	3.1677	0.99
Chilipepper rockfish	856	0.006086	3.2320	0.99
Copper rockfish	76	0.006190	3.2847	0.98
Cowcod	71	0.006677	3.2639	0.99
Darkblotched rockfish	569	0.012250	3.1099	0.98
Flag rockfish	33	0.005680	3.3168	0.98
Greenblotched rockfish	59	0.005665	3.3042	0.99
Greenspotted rockfish	290	0.005149	3.3381	0.98
Greenstriped rockfish	486	0.006336	3.2149	0.97
Halfbanded rockfish	449	0.026115	2.7227	0.78
Honeycomb rockfish	16	0.005202	3.3331	0.97
Longspine thornyhead	793	0.019046	2.8422	0.94
Pacific ocean perch	163	0.017119	2.9412	0.98
Pygmy rockfish	46	0.162557	2.1334	0.81
Redbanded rockfish	129	0.004649	3.3768	0.99
Redstripe rockfish	167	0.016584	2.9364	0.96
Rosethorn rockfish	316	0.008728	3.1419	0.92
Rougheye rockfish	63	0.004522	3.3137	0.99
Sharpchin rockfish	172	0.016740	2.9364	0.94
Shortbelly rockfish	478	0.004577	3.2716	0.92
Shortraker rockfish	8	0.006157	3.2252	0.99
Shortspine thornyhead	1,675	0.005347	3.2284	0.99
Silvergray rockfish	19	0.020869	2.8899	0.96
Splitnose rockfish	417	0.019477	2.9318	0.96
Squarespot rockfish	26	0.004855	3.3666	0.97
Starry rockfish	3	0.004763	3.3357	0.99
Stripetail rockfish	497	0.023853	2.8192	0.94
Swordspine rockfish	74	0.009795	3.0796	0.79
Vermilion rockfish	19	0.007243	3.2334	0.98
Widow rockfish	63	0.004009	3.3749	0.99
Yelloweye rockfish	18	0.003873	3.4155	0.99
Yellowtail rockfish	172	0.009790	3.1646	0.99

Table 30. Fitted parameters for the von Bertalanffy growth curve model for selected fish species sampled during the 2004 West Coast Groundfish trawl survey relating length (fork length, cm) to age (years) for males, females, and both sexes combined. Coefficients were determined using a nonlinear least squares fit for Equation 5, with L_t as fork length (cm) at age t in years, L_∞ as theoretical maximum length (cm), k as growth rate (per year), and t_0 the theoretical age (years) when the fish was length zero.

Species	Number sampled	Coefficients		
		L_∞	k	t_0
Dover sole				
Female	475	47.077	0.131	–2.34
Male	524	40.681	0.156	–2.34
Combined	999	46.200	0.099	–4.91
Petrale sole				
Female	279	62.589	0.126	–1.16
Male	256	44.104	0.234	–0.53
Combined	535	65.107	0.106	–1.62
Lingcod				
Female	496	96.864	0.190	–0.95
Male	384	83.139	0.217	–1.08
Combined	880	92.062	0.195	–1.03
Sablefish				
Female	291	62.557	0.338	–2.38
Male	353	56.566	0.317	–2.97
Combined	644	58.595	0.408	–1.81
Canary rockfish				
Female	140	56.073	0.175	0.064
Male	171	52.200	0.197	0.089
Combined	311	53.350	0.194	0.144
Darkblotched rockfish				
Female	264	41.442	0.228	–0.73
Male	323	38.091	0.253	–0.77
Combined	587	39.017	0.250	–0.72
Pacific ocean perch				
Female	100	40.521	0.254	–0.59
Male	103	37.617	0.260	–2.92
Combined	203	39.573	0.169	–3.86
Yellowtail rockfish				
Female	107	52.187	0.171	–0.16
Male	95	46.044	0.229	0.09
Combined	202	49.133	0.192	–0.09

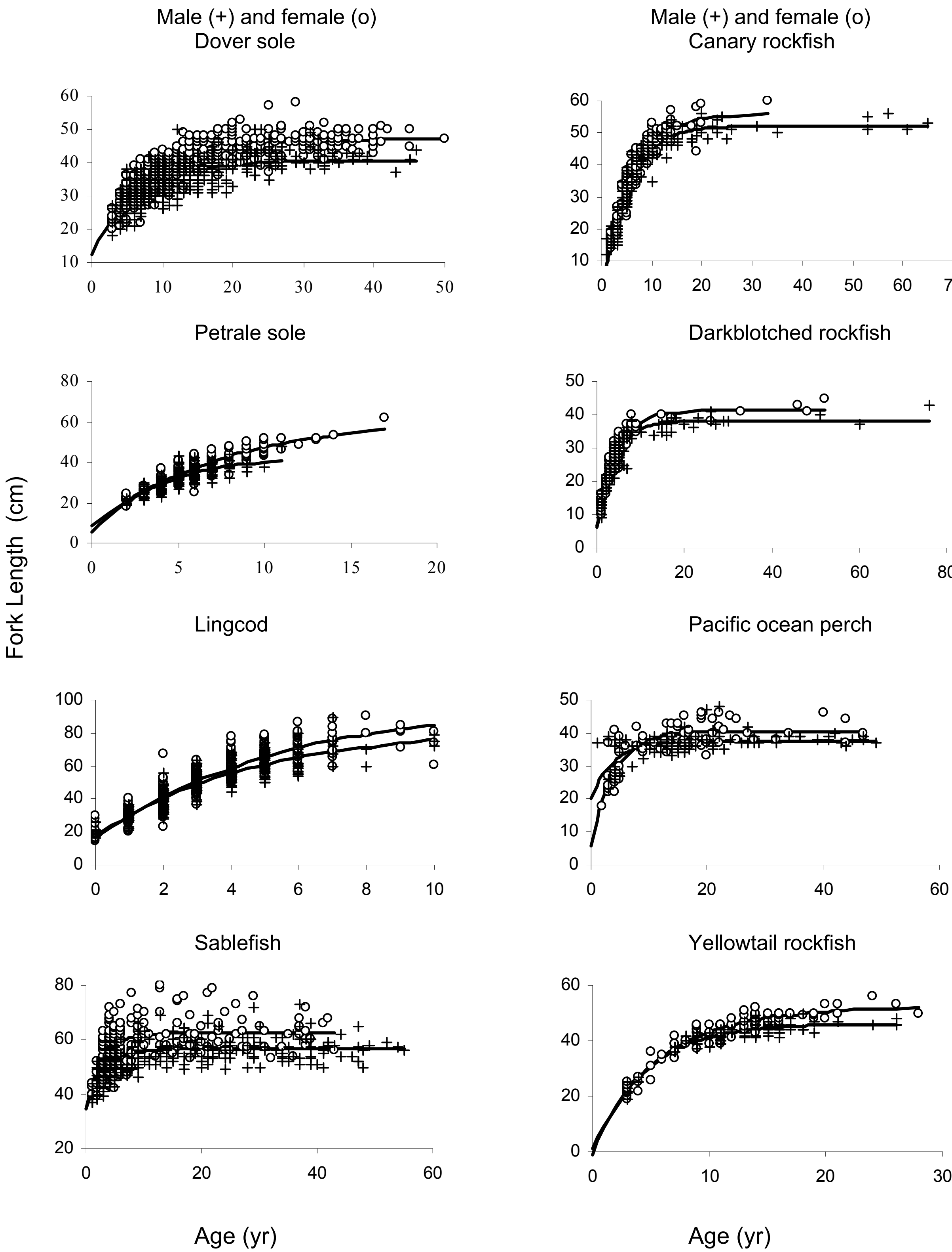


Figure 65. Von Bertalanffy growth models for male and female Dover sole, canary rockfish, petrale sole, darkblotched rockfish, lingcod, Pacific ocean perch, sablefish, and yellowtail rockfish from the 2004 West Coast groundfish trawl survey.

Analysis Approach and Data Requests

Population parameters in this document were estimated using statistical procedures similar to those used by Lauth (1999) for surveys conducted on the RV *Miller Freeman*. This approach does not consider possible differences between vessels, treating each tow as both independent and random. A statistical analysis that explicitly considers vessel effects, the probability distribution of catch per tow, and alternative stratifications is under development (Helser et al. 2004). The results from this analysis will lead to a better understanding of the survey data and may require updating the results and analysis presented in this document at a later date.

This document only includes information for key species. For information on other species that are not listed here or more detailed information, contact the senior author (telephone 206-860-3460 or e-mail aimee.keller@noaa.gov).

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