NOAA Technical Memorandum NMFS-NWFSC-86

The 2003 U.S. West Coast Bottom Trawl Survey of Groundfish Resources

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

November 2007

U.S. DEPARTMENT OF COMMERCE
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Executive Summary

The Northwest Fisheries Science Center's Fishery Resource Analysis and Monitoring Division (FRAM) in 2003 completed the sixth in an annual series of groundfish bottom trawl surveys. The survey was conducted 24 June to 23 October 2003 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 for those species of management concern. The 2003 survey represents the first 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 first year in which a stratified-random sampling design was adopted.

In 2003 620 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 five geographic areas defined by the International North Pacific Fisheries Commission that extended from northern Washington (U.S.-Canada border) to southern California (U.S.-Mexico border and three depth 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, all towable areas have an equal probability of being sampled during the survey. Thus the method produces unbiased estimates of the relative stock size. In 2003 a total of 574 successful tows were completed out of 643 attempts. Simrad ITI (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 517 species or families (fish and invertebrates) 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*), the focus of the survey has increasingly shifted 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*, *Captain Jack*, and *Blue Horizon* for their effort during the 2003 Northwest Fisheries Science Center's Pacific West Coast groundfish trawl survey, as well as the biologists who participated in the survey, including Chante Davis, Eric Eisenhardt, Brook Flammang, Jennifer Gilden, Chad Keith, Marion Mann, Josie Thompson, Tonya Wick, 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 Todd Bridgeman, 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 U.S. 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 sixth in a series of annual bottom trawl surveys of groundfish resources off the U.S. West Coast, conducting survey operations from 24 June to 23 October 2003. 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 m to 1,280 m (30–700 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). 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 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, as well as shelf surveys 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 (depth range 55 m to 1,280 m) along the entire U.S. West Coast (U.S.-Canada border to U.S.-Mexico border). Since inception in 1998, the NWFSC survey has used 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, fishermen, 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 2003 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 INPFC area and 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). 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 2003 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.

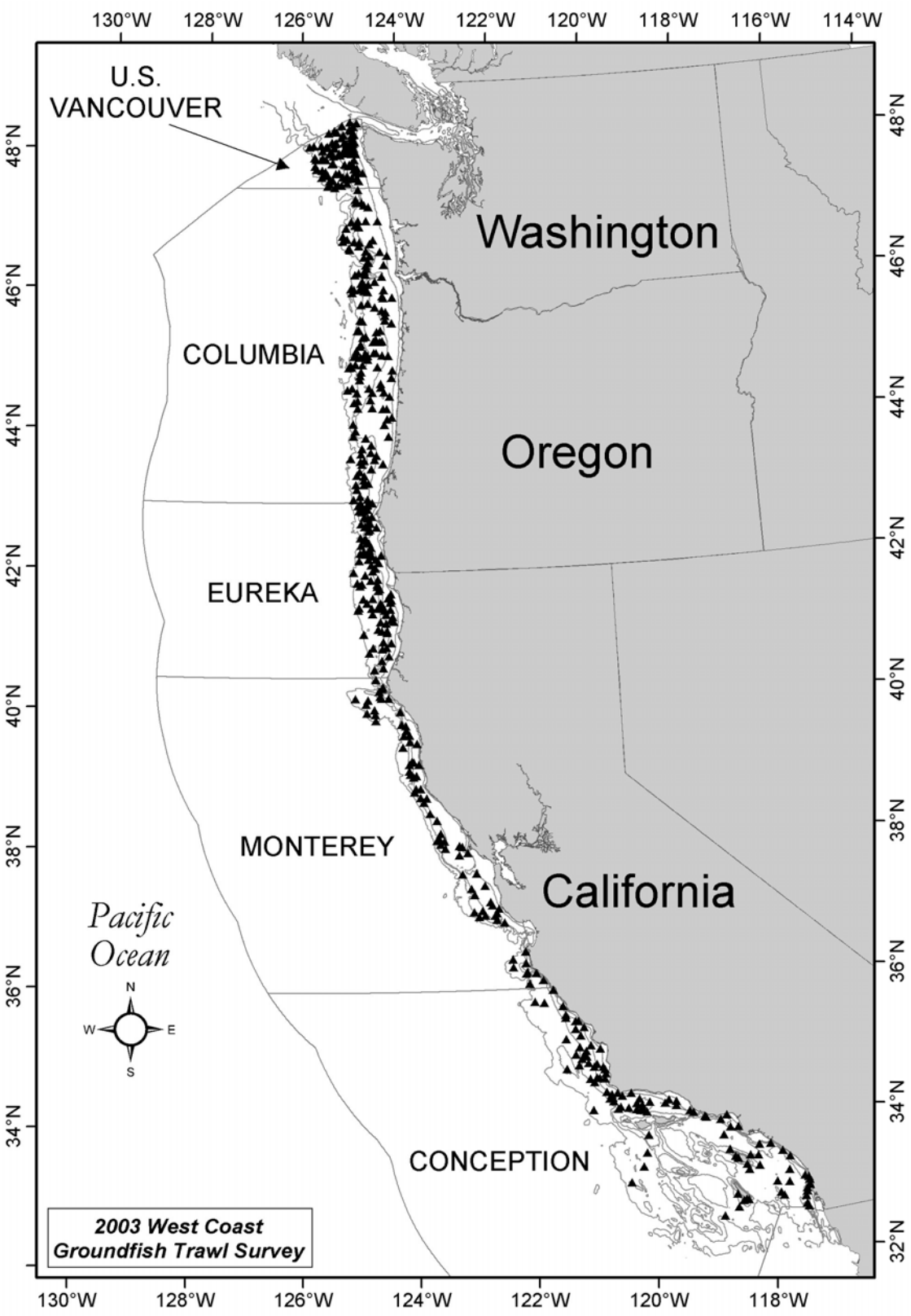


Figure 1. Map showing extent of the 2003 West Coast groundfish trawl survey and location of completed stations (▲).

Survey Methods

Survey Period and Sampling Area

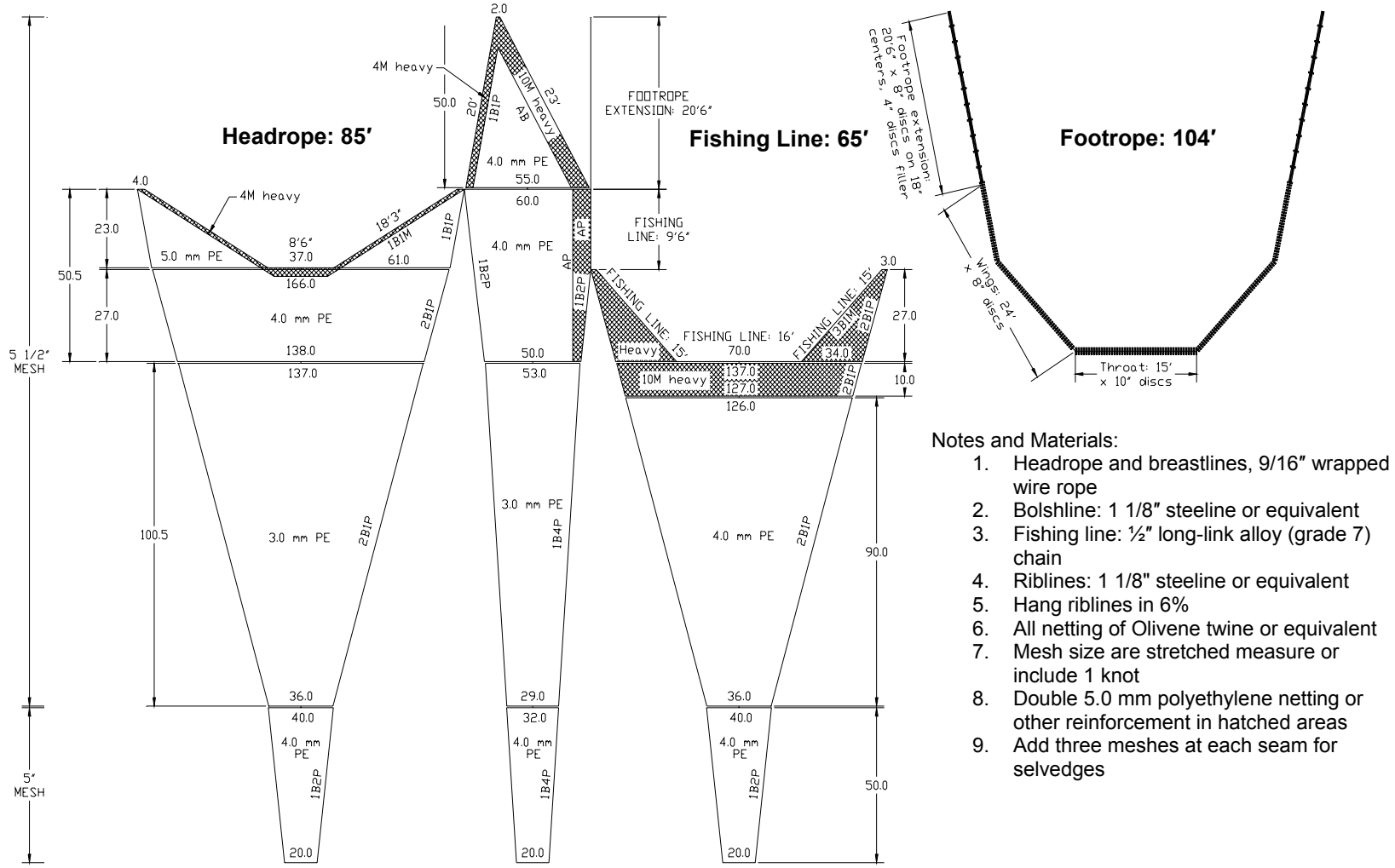
The 2003 WCGTS was conducted in two completed cycles of operations, or passes, between 24 June 2003 and 23 October 2003 from the areas off Cape Flattery, Washington (lat 48°10′N) to the U.S.-Mexico border (lat 32°30′N). Four West Coast bottom trawlers were chartered through a standard competitive bid process. The fishing vessels (FVs) *Ms. Julie* and *Captain Jack* were used during the first survey period from 24 June 2003 to 13 August 2003, and two additional vessels, the FV *Excalibur* and the FV *Blue Horizon*, were used during the second survey period from 31 August 2003 to 23 October 2003. All vessels started their operations off Cape Flattery, then progressed south along the coast, finishing the completed cycle south of San Diego, California.

Vessels and Sampling Gear

The four chartered fishing vessels ranged in size from 65 to 92 feet (19.8 to 28.0 m) and in engine size from 450 to 775 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 5/8″ 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. Additional information was recorded on operational conditions, such as depth, amount of towing cable deployed, towing speed, tow duration, and weather conditions.



Notes and Materials:

1. Headrope and breastlines, 9/16″ wrapped wire rope
2. Bolshline: 1 1/8″ steeline or equivalent
3. Fishing line: ½″ long-link alloy (grade 7) chain
4. Riblines: 1 1/8" 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.

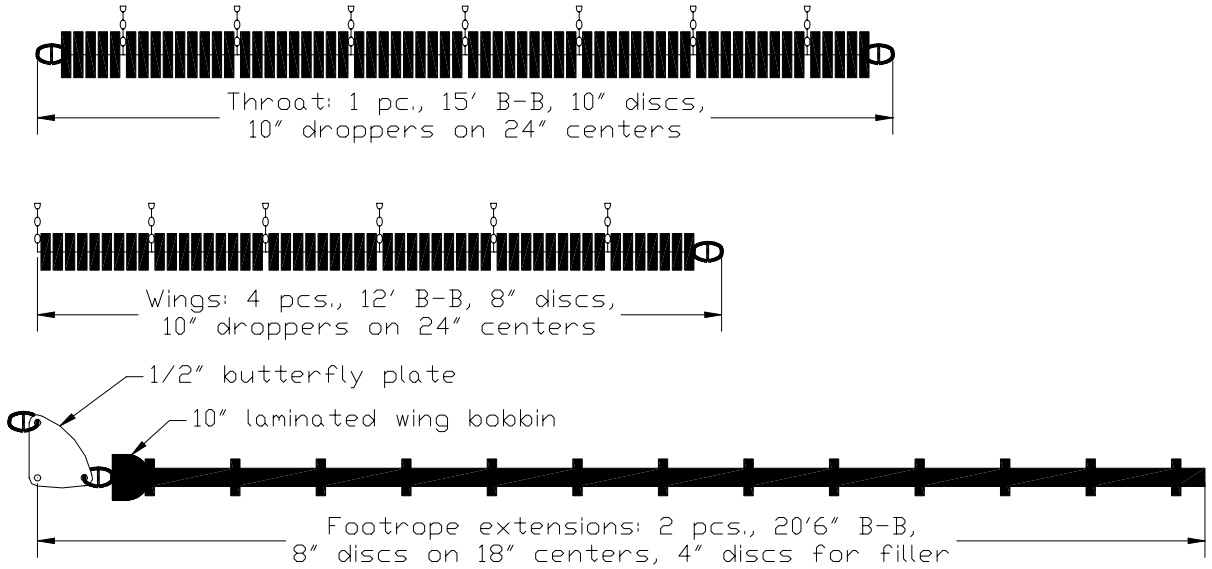


Figure 3. Footrope for the NWFSC Aberdeen-style sampling trawl composed of seven sections with an overall length of 104 feet (31.7 m). A single section of each component of the footrope is shown in the figure. Notes: Footrope composed of ½″ long-link alloy (grade 7) chain, with rubber discs (8–10″) and 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.

Trawl Station Allocation

From 1998 through 2002, a fixed transect design served as the selection basis of sample sites for the WCGTS. 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 approximately 12,000 adjacent cells of equal area (1.5 nautical miles [nm] longitude by 2.0 nm latitude, Albers Equal Area projection), with each vessel assigned a primary subset of 155 randomly selected cell sites. In 2003, sampling density was assigned to areas defined by INPFC management areas and specified depth categories. Sampling locations were allocated by assigning 16–25% of the effort within each INPFC area. This allocation scheme was adopted to maintain a level of sampling effort in the slope area (184–1,280 m) comparable to prior years. The survey area was further stratified into three depth zones (55–183 m, 184–549 m, and 550–1,280 m).

Emphasis was placed on continuing a level of effort in the 184–549 m and 550–1,280 m depth strata similar to past surveys while maintaining a minimum of 30 tows per strata. 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 2003 we selected 620 primary sites with each vessel assigned 155 tows (one tow per cell). A total of 574 successful tows were completed out of 643 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. 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 untrawlable, a trawl of 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 global positioning system (DGPS) 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, BC, 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 used. 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. Since the ITI trawl instruments displayed gear performance in real-time, adjustments to the scope were made if necessary. Scope was adjusted by deploying additional wire until the gear made stable and consistent bottom contact according to the ITI

display. The Simrad ITI system 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 Inc., 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 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 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 DGPS, were used to monitor ground speed, track the vessel path, and estimate distance fished. Average vessel 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 since 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 otolith (or other 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 collection of 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.

Persistent strings may distort the overall signal pattern; therefore, 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. For the most part, however, the sensor data varied little during the on-bottom time period of interest and the overall pattern 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 the depth, net dimension, and temperature readings were frequent and assumed to be the result of acoustic or electronic noise and were removed prior to processing. When multiple extreme points occurred in sequence, they were more difficult to evaluate since 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) 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. Notations, hand recorded 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 liftoff 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 occurred, was maintained for 15 minutes. The second phase followed 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). We used the trigonometric method, developed for the 1998 survey analysis (Turk et al. 2001, Wallace and West 2006), 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, we estimated gear depth and bottom depth 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, we calculated mean estimates 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, we estimated mean gear and bottom depths 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 existed of headrope depth and headrope distance from bottom. 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 with 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 ±0.2°C) and a Seabird temperature sensor (accuracy ±0.002°C) mounted in the net mouth. 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, we estimated bottom temperature 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 in kilograms (kg) per species by area swept in hectares (ha) per tow,

$$\text{CPUE} = \text{C} / \text{A} \tag{1}$$

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, mid depth, and deep for all areas combined), 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,

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

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

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

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 2003 WCGTS was designed to incorporate 620 primary sampling locations, with 643 tows subsequently attempted, including failed tows, aborted tows, or tows at secondary or tertiary sites. A total of 574 tows were successfully sampled. Simrad 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 that 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 13.77 m was calculated using data from the 574 hauls that both exhibited good trawl performance and had available net mensuration estimates. The mean net widths ranged from 10.11 m to 15.84 m with a standard deviation of 0.90 m. When the net mensuration instrumentation did not function 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 77 groundfish species, while age structures were collected from 34 species. A total of 158,033 length measurements were made and 25,834 individuals had age structures removed. The number of lengths collected ranged from 1 to 23,616 measurements per species, while the number of age structures collected ranged from 4 to 3,071 structures per species. The species with the greatest number of measurements and age structures included Dover sole (*Microstomus pacificus*), Pacific sanddab (*Citharichthys sordidus*), English sole (*Parophrys vetulus*), rex sole (*Glyptocephalus zachirus*), sablefish (A*noplopoma fimbria*), Pacific hake (*Merluccius productus*), longspine thornyhead (*Sebastolobus altivelis*), shortspine thornyhead (*S. alascanus*), splitnose rockfish (*Sebastes diploproa*), and stripetail rockfish (*S. saxicola*).

A total of 517 unique taxa were identified over the entire survey area, with 257 species or groups of fish and 260 species or groups of invertebrates. The frequency of occurrence, depth range, mean depth, and the 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. 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.

Table 1. Latitude boundaries, depth stratum areas (km^2), and sampling densities by INPFC statistical area based on successful tows during the 2003 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)**		
Latitude bounds	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	48	20.71	2,853	16	5.61	2,286	23	10.06	7,457	87	11.67
Columbia 43°00′–47°30′	14,413	47	3.26	8,621	40	4.64	9,804	61	6.22	32,838	148	4.51
Eureka 40°30′–43°00′	4,069	35	8.60	2,034	36	17.70	6,365	33	5.18	12,467	104	8.34
Monterey 36°00′–40°30′	8,605	45	5.23	3,650	30	8.22	8,646	26	3.01	20,902	101	4.83
Conception 32°30′–36°00′	6,994	52	7.43	12,839	54	4.21	42,041	28	0.67	61,874	134	2.17
Entire survey area 32°30′–border	36,399	227	6.24	29,997	176	5.87	69,142	171	2.47	135,538	574	4.23

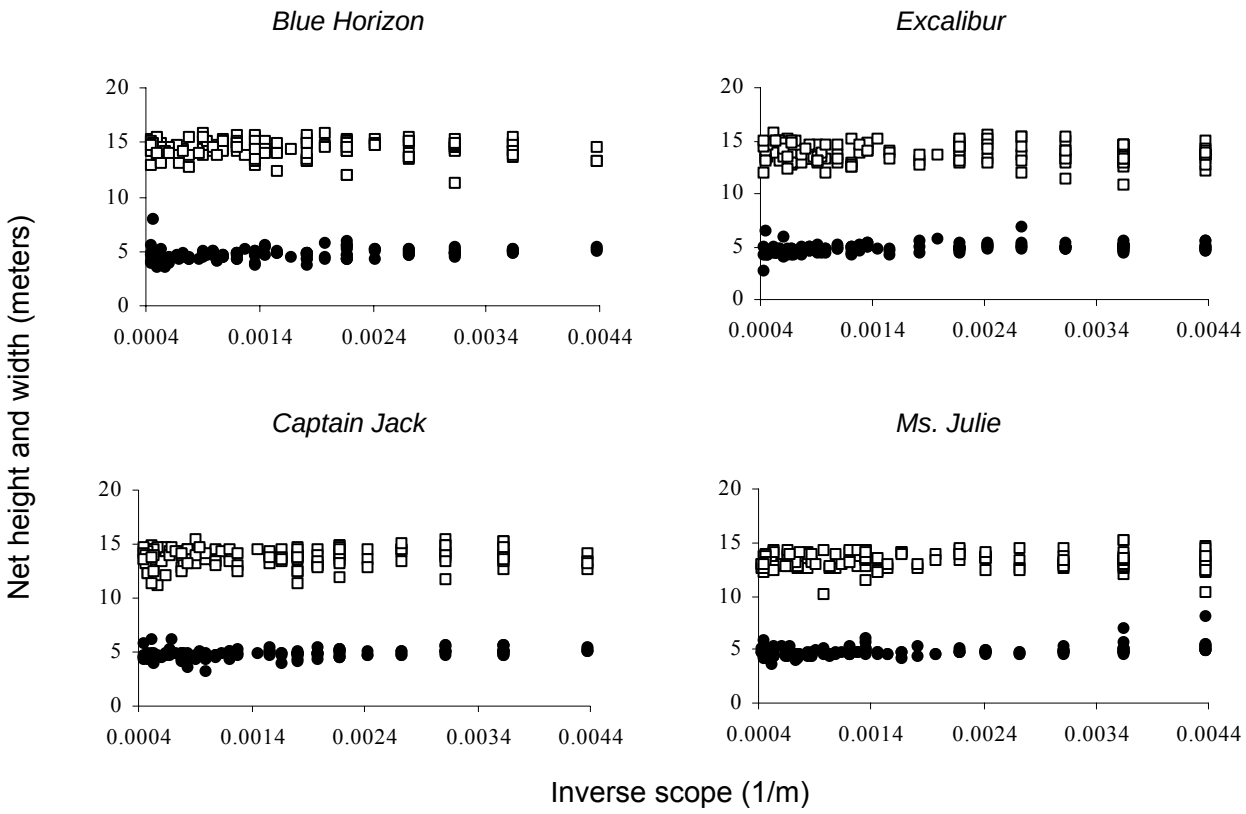


Figure 4. Mean net width (m) and height (m) for trawls conducted as part of the 2003 West Coast groundfish trawl survey. Estimates are grouped by vessel with net width (□) and net height (•) in meters plotted relative to inverse scope (1/meters). Multiple linear regressions of width versus net height and inverse scope (factored by vessel) were used to estimate net widths for tows lacking direct width observations. (FV *Blue Horizon*: Net width = 19.68 – 1.019 × net height – 308.1 × inverse scope; FV *Excalibur*: Net width = 19.62 – 1.098 × net height – 324.0 × inverse scope; FV *Captain Jack*: Net width = 18.24 – 0.781 × net height – 335.5 × inverse scope; FV *Ms. Julie*: Net width = 17.30 – 0.727 × net height – 274.1 × inverse scope).

Table 2. Number of individual length measurements and age structures collected by species during the 2003 West Coast groundfish trawl survey. Note: dorsal spines were collected for spiny dogfish, dorsal finrays were collected for lingcod, and otoliths were collected for all other species.

Species	Lengths	Ages	Species	Lengths	Ages	Species	Lengths	Ages
Pacific sleeper shark	1	0	Cabezon	1	0	Greenspotted rockfish	424	0
Soupfin shark	1	0	Blob sculpin	1	0	Greenstriped rockfish	3,649	625
Spiny dogfish	4,017	700	Pacific cod	787	0	Honeycomb rockfish	1	0
Big skate	217	0	Pacific flatnose	2,138	0	Pacific ocean perch	1,427	435
California skate	310	0	Lingcod	1,431	969	Pink rockfish	1	0
Longnose skate	2,685	0	Kelp greenling	64	0	Quillback rockfish	4	0
Skate egg case	1	0	Pacific hake	6,050	1,729	Redbanded rockfish	325	194
Starry skate	24	0	Chinook salmon	4	0	Redstripe rockfish	1,072	250
Spotted ratfish	5,034	0	Shortspine thornyhead	7,790	1,308	Rosethorn rockfish	1,768	427
Arrowtooth flounder	4,593	1,406	Longspine thornyhead	16,252	1,021	Rosy rockfish	21	0
Butter sole	90	0	Aurora rockfish	1,176	575	Rougheye rockfish	112	56
Curlfin sole	806	0	Bank rockfish	36	4	Sharpchin rockfish	2,400	585
Dover sole	23,616	3,071	Blackgill rockfish	244	119	Shortbelly rockfish	2,320	666
English sole	8,605	1,924	Blue rockfish	19	0	Shortraker rockfish	3	0
Flathead sole	1,524	0	Bocaccio	125	125	Silvergray rockfish	34	34
Pacific halibut	63	0	Brown rockfish	56	0	Splitnose rockfish	6,696	1,083
Pacific sanddab	10,770	896	Calico rockfish	12	0	Squarespot rockfish	30	0
Petrale sole	2,920	1,661	California scorpionfish	197	0	Starry rockfish	1	0
Rex sole	11,084	0	Canary rockfish	567	319	Stripetail rockfish	5,959	0
Rock sole unident.	323	0	Chilipepper rockfish	2,687	738	Tiger rockfish	2	0
Sand sole	88	0	Copper rockfish	29	0	Vermilion rockfish	63	0
Sanddab unident.	295	0	Cowcod	13	13	Widow rockfish	218	12
Southern rock sole	25	0	Darkblotched rockfish	2,401	787	Yelloweye rockfish	78	78
Starry flounder	6	0	Flag rockfish	78	0	Yellowmouth rockfish	141	34
Sablefish	6,038	2,445	Gopher rockfish	3	0	Yellowtail rockfish	1,093	323
Pacific grenadier	4,851	1,222	Greenblotched rockfish	43	0			

Table 3. Frequency of occurrence, depth, and latitudinal ranges for fish and invertebrate species, grouped by family (or higher taxonomic classification), caught during the 2003 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							
Lampetra tridentata	Pacific lamprey	1	171	171	171	41.20	41.20
Myxinidae							
Myxinidae	Hagfish unident.	128	79	1,209	773	32.69	48.09
Eptatretus sp.		1	986	986	986	47.56	47.56
E. stoutii	Pacific hagfish	4	763	1,079	945	32.83	45.47
Chimaeridae							
Hydrolagus colliei	Spotted ratfish	274	44	723	184	32.62	48.45
Elasmobranchii (subclass)							
Elasmobranch	Shark unident.	1	641	641	641	33.41	33.41
Triakidae							
Galeorhinus galeus	Soupfin shark	3	69	141	95	34.44	39.01
Mustelus henlei	Brown smoothhound	7	35	196	106	32.77	34.39
M. californicus	Gray smoothhound	9	27	149	67	32.92	35.09
Scyliorhinidae							
Scyliorhinidae	Cat shark unident.	4	335	1,209	737	33.36	39.71
Apristurus brunneus	Brown cat shark	223	82	1,196	668	32.57	48.11
A. kampae	Longnose cat shark	5	230	932	624	32.69	47.61
Cephaloscyllium ventriosum	Swell shark	4	64	97	86	34.03	34.67
Parmaturus xaniurus	Filetail cat shark	38	265	792	468	33.52	37.14
Somniosidae							
Somniosus pacificus	Pacific sleeper shark	3	96	1,064	600	44.35	47.01
Squalidae							
Squalus acanthias	Spiny dogfish	190	36	451	180	32.83	48.45
Squatinidae							
Squatina californica	Pacific angel shark	5	27	104	71	33.29	35.09
Etmopteridae							
Centroscyllium nigrum	Combtooth dogfish	2	1,072	1,157	1,115	32.85	33.21

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 2003 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
Elasmobranch egg cases							
Elasmobranch egg case	Shark egg case unident.	3	84	338	192	34.97	45.74
Apristurus brunneus egg case	Cat shark egg case	3	95	575	369	33.11	45.30
Torpedinidae							
Torpedo californica	Pacific electric ray	34	27	362	126	32.77	42.24
Rajidae							
Rajidae	Skate unident.	1	313	313	313	48.44	48.44
Raja binoculata	Big skate	69	36	262	104	34.21	48.16
R. inornata	California skate	66	24	792	122	32.66	41.36
R. rhina	Longnose skate	304	43	992	256	32.66	48.45
R. stellulata	Starry skate	5	64	328	136	33.59	38.04
Arhynchobatidae							
Bathyraja abyssicola	Deepsea skate	1	1,168	1,168	1,168	40.32	40.32
B. aleutica	Aleutian skate	1	206	206	206	36.96	36.96
B. interrupta	Bering skate	237	57	1,162	292	32.62	48.45
B. trachura	Roughtail skate	75	177	1,341	933	32.69	47.76
Rhinobatidae							
Rhinobatidae	Guitarfish unident.	1	174	174	174	34.32	34.32
Rhionbatos productus	Shovelnose guitarfish	1	27	27	27	34.02	34.02
Myliobatidae							
Myliobatis californicus	Bat ray	4	27	62	46	32.77	34.02
Rajiformes (order) egg cases							
Rajiformes	Skate egg case unident.	57	35	1,213	349	33.26	48.45
Raja sp.	Skate egg case unident.	1	60	60	60	41.36	41.36
Nemichthyidae							
Nemichthyidae	Snipe eel unident.	3	196	911	632	32.99	33.97
Avocettina infans	Blackline snipe eel	9	107	1,181	920	32.80	47.77
Nemichthys scolopaceus	Slender snipe eel	1	1,096	1,096	1,096	32.80	32.80

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 2003 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
Serrivomeridae							
Serrivomer sector	Sawtooth eel	2	1,178	1,181	1,180	36.07	47.66
Clupeidae							
Alosa sapidissima	American shad	59	53	319	122	37.06	48.33
Clupea pallasii	Pacific herring	44	55	207	97	34.66	48.40
Sardinops sagax	Pacific sardine	7	35	104	63	33.26	35.09
Engraulidae							
Engraulis mordax	Northern anchovy	21	35	543	124	33.26	46.53
Argentinidae							
Argentinidae	Argentine unident.	1	847	847	847	41.84	41.84
Argentina sialis	Pacific argentine	11	117	273	198	32.62	38.45
Bathylagidae							
Bathylagidae	Deepsea smelt unident.	114	563	1,341	914	32.57	48.10
Bathylagus sp.	Blacksmelt unident.	13	606	1,253	919	40.78	47.94
Leuroglossus schmidti	Northern smoothtongue	6	468	763	562	33.27	34.86
L. stilbius	California smoothtongue	5	471	623	548	34.17	43.44
Opisthoproctidae							
Opisthoproctidae	Spookfish unident.	1	431	431	431	33.52	33.52
Macropinna microstoma	Barreleye	8	279	1,201	838	32.57	47.71
Platytroctidae							
Maulisia mauli		3	723	984	849	40.78	47.71
Sagamichthys abei	Shining tubeshoulder	4	528	937	667	34.86	46.64
Alepocephalidae							
Alepocephalus tenebrosus	California slickhead	128	566	1,240	903	32.57	48.10
Bajacalifornia burragei	Sharpchin slickhead	1	932	932	932	32.69	32.69
B. erimoensis		1	814	814	814	33.01	33.01
Talismania bifurcata	Threadfin slickhead	45	708	1,341	909	32.57	48.10
Osmeridae							
Osmeridae	Smelt unident.	29	57	507	147	34.19	48.27

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 2003 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
Allosmerus elongatus	Whitebait smelt	13	53	104	78	38.06	46.53
Spirinchus starksi	Night smelt	7	62	594	182	34.02	48.08
S. thaleichthys	Longfin smelt	3	61	64	62	33.91	37.97
Thaleichthys pacificus	Eulachon	29	51	237	126	33.97	48.40
Salmonidae							
Oncorhynchus tshawytscha	Chinook salmon	10	64	171	107	34.87	48.27
O. kisutch	Coho salmon	1	101	101	101	38.54	38.54
Gonostomatidae							
Gonostomatidae	Bristlemouth unident.	4	566	1,095	877	35.34	47.88
Sternoptychidae							
Sternoptychidae	Hatchetfish unident.	3	575	1,007	783	32.57	42.17
Argyropelecus sp.	Hatchetfish unident.	2	395	1,157	776	33.21	33.53
Sternoptyx sp.	Hatchetfish unident.	3	543	986	792	33.15	47.56
Argyropelecus affinis	Slender hatchetfish	3	449	984	680	35.05	43.63
S. diaphana	Longspine hatchetfish	7	328	1,037	689	32.99	39.97
Stomiidae							
Melanostomiinae (subfamily)	Scaleless dragonfish unident.	1	763	763	763	33.27	33.27
Aristostomias scintillans	Shining loosejaw	14	398	1,007	727	40.18	47.86
Borostomias panamensis		1	666	666	666	37.13	37.13
Chauliodus macouni	Pacific viperfish	77	411	1,240	823	33.15	47.91
Idiacanthus antrostomus	Pacific blackdragon	5	492	1,240	785	32.83	40.97
Stomias atriventer	Blackbelly dragonfish	2	575	1,072	823	32.85	33.11
Tactostoma macropus	Longfin dragonfish	54	290	1,341	831	32.80	48.10
Scopelarchidae							
Benthalbella dentata	Northern pearleye	3	847	1,159	1,021	35.81	41.84
Paralepididae							
Magnisudis atlantica	Duckbill barracudina	1	783	783	783	47.55	47.55
Synodontidae							
Synodus lucioceps	California lizardfish	11	24	104	61	32.77	34.02

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 2003 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
Myctophidae							
Myctophidae	Lanternfish unident.	115	132	1,264	713	32.69	48.14
Diaphus theta	California headlightfish	20	166	1,141	615	36.96	47.66
Lampanyctus sp.	Lanternfish unident.	97	323	1,253	823	32.83	48.10
Tarletonbeania crenularis	Blue lanternfish	14	134	1,095	532	36.37	47.68
Ophidiidae							
Ophidiidae	Cusk-eel unident.	1	117	117	117	48.38	48.38
Chilara taylori	Spotted cusk-eel	32	27	273	160	32.78	47.78
Dicrolene filamentosa	Threadfin cusk-eel	1	879	879	879	37.05	37.05
Bythitidae							
Cataetyx rubrirostris	Rubynose brotula	1	670	670	670	41.50	41.50
Brosmophycis marginata	Red brotula	1	190	190	190	32.62	32.62
Macrouridae							
Macrouridae	Grenadier unident.	1	565	565	565	46.10	46.10
Albatrossia pectoralis	Giant grenadier	136	499	1,341	910	32.80	48.10
Coryphaenoides acrolepis	Pacific grenadier	140	313	1,341	900	33.21	48.10
C. cinereus	Popeye grenadier	20	395	1,213	989	33.53	47.91
C. filifer	Filamented grenadier	1	1,196	1,196	1,196	40.00	40.00
Nezumia liolepis	Smooth grenadier	13	641	1,157	883	32.57	34.60
N. stelgidolepis	California grenadier	25	441	1,096	618	32.80	39.16
Moridae							
Antimora microlepis	Pacific flatnose	153	262	1,341	846	32.57	48.11
Physiculus rastrelliger	Hundred fathom codling	5	241	338	280	32.66	34.38
Merlucciidae							
Merluccius productus	Pacific hake	352	53	1,213	274	32.62	48.44
Gadidae							
Gadus macrocephalus	Pacific cod	72	53	267	139	39.17	48.45
Microgadus proximus	Pacific tomcod	36	53	116	74	35.09	48.27
Theragra chalcogramma	Walleye pollock	18	82	270	140	47.65	48.45

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 2003 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
Batrachoididae							
Porichthys notatus	Plainfin midshipman	65	24	464	104	32.79	47.02
Oneirodidae							
Oneirodidae	Dreamer unident.	1	1,096	1,096	1,096	32.80	32.80
Oneirodes sp.	Dreamer unident.	4	847	1,213	964	41.62	47.76
Melanocetidae							
Melanocetus johnsonii	Common blackdevil	1	797	797	797	45.17	45.17
Melamphaidae							
Melamphaes lugubris	Highsnout bigscale	1	763	763	763	33.27	33.27
Poromitra crassiceps	Crested bigscale	19	571	1,253	1,017	32.80	47.88
Anoplogastridae							
Anoplogaster cornuta	Fangtooth	10	641	1,240	946	32.80	46.35
Scorpaenidae							
Scorpaenidae	Scorpionfish, rockfish unident.	2	27	104	66	33.42	34.02
Scorpaena guttata	California scorpionfish	18	24	190	72	32.62	34.39
Sebastolobus alascanus	Shortspine thornyhead	311	88	1,341	605	32.57	48.44
S. altivelis	Longspine thornyhead	214	328	1,341	802	32.57	48.10
Sebastes sp.	Rockfish unidentified	3	59	129	92	32.77	48.10
S. aleutianus	Rougheye rockfish	34	141	798	286	42.79	48.34
S. alutus	Pacific ocean perch	48	123	436	270	40.23	48.34
S. auriculatus	Brown rockfish	9	58	80	65	32.77	40.81
S. aurora	Aurora rockfish	68	129	581	432	33.11	48.11
S. babcocki	Redbanded rockfish	64	141	415	270	34.38	48.31
S. borealis	Shortraker rockfish	2	418	428	423	34.99	48.11
S. brevispinis	Silvergray rockfish	9	86	255	174	42.94	48.09
S. carnatus	Gopher rockfish	1	74	74	74	34.44	34.44
S. caurinus	Copper rockfish	10	36	174	87	32.77	37.38
S. chlorostictus	Greenspotted rockfish	37	83	280	174	32.62	48.38
S. constellatus	Starry rockfish	1	64	64	64	37.38	37.38

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 2003 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 crameri	Darkblotched rockfish	102	104	411	238	33.56	48.40
S. dalli	Calico rockfish	4	59	80	69	32.77	37.38
S. diploproa	Splitnose rockfish	137	68	478	274	32.66	48.23
S. elongatus	Greenstriped rockfish	137	70	296	164	32.62	48.45
S. emphaeus	Puget Sound rockfish	3	36	173	94	34.44	47.01
S. entomelas	Widow rockfish	21	64	362	168	37.14	48.38
S. eos	Pink rockfish	1	324	324	324	35.56	35.56
S. flavidus	Yellowtail rockfish	39	36	215	136	34.97	48.40
S. goodei	Chilipepper rockfish	98	36	464	177	32.77	43.61
S. helvomaculatus	Rosethorn rockfish	68	70	411	207	32.77	48.45
S. hopkinsi	Squarespot rockfish	4	62	114	88	33.39	37.38
S. jordani	Shortbelly rockfish	56	26	323	168	32.78	48.33
S. levis	Cowcod	7	147	253	196	33.84	42.06
S. maliger	Quillback rockfish	3	70	125	94	44.64	48.03
S. melanostomus	Blackgill rockfish	24	247	543	375	32.77	45.13
S. miniatus	Vermilion rockfish	7	59	478	142	32.77	37.38
S. mystinus	Blue rockfish	2	64	132	98	35.97	37.38
S. nigrocinctus	Tiger rockfish	2	114	178	146	38.21	48.33
S. paucispinis	Bocaccio	44	56	299	155	32.79	48.29
S. pinniger	Canary rockfish	53	58	219	145	32.62	48.39
S. proriger	Redstripe rockfish	26	70	255	150	39.01	48.39
S. reedi	Yellowmouth rockfish	5	114	313	226	44.63	48.33
S. rosaceus	Rosy rockfish	1	328	328	328	33.59	33.59
S. rosenblatti	Greenblotched rockfish	6	190	323	252	32.62	36.24
S. ruberrimus	Yelloweye rockfish	21	86	242	155	39.09	48.39
S. rubrivinctus	Flag rockfish	8	81	219	134	32.62	34.40
S. rufus	Bank rockfish	6	203	360	280	33.59	45.09
S. saxicola	Stripetail rockfish	122	36	431	184	32.62	48.26
S. semicinctus	Halfbanded rockfish	26	60	395	120	32.77	44.57

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 2003 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 umbrosus	Honeycomb rockfish	1	241	241	241	33.56	33.56
S. wilsoni	Pygmy rockfish	17	64	191	134	33.81	48.39
S. zacentrus	Sharpchin rockfish	57	86	391	197	38.10	48.45
Triglidae							
Prionotus stephanophrys	Lumptail sea robin	2	60	85	73	32.92	33.36
Anoplopomatidae							
Anoplopoma fimbria	Sablefish	439	26	1,341	481	32.57	48.45
Hexagrammidae							
Hexagrammos decagrammus	Kelp greenling	13	64	129	92	37.38	48.39
H. lagocephalus	Rock greenling	1	27	27	27	34.02	34.02
Ophiodon elongatus	Lingcod	206	26	360	140	32.62	48.45
Zaniolepis frenata	Shortspine combfish	16	85	264	144	32.62	34.68
Z. latipinnis	Longspine combfish	51	26	203	79	32.77	44.19
Cottidae							
Cottidae	Sculpin unident.	4	73	110	97	38.01	42.99
Chitonotus pugetensis	Roughback sculpin	3	61	128	98	32.88	34.83
Enophrys bison	Buffalo sculpin	5	56	194	97	34.40	40.81
E. taurina	Bull sculpin	3	74	83	78	34.39	35.50
Hemilepidotus hemilepidotus	Red Irish lord	5	70	137	110	42.42	48.39
H. spinosus	Brown Irish lord	1	123	123	123	48.26	48.26
Icelinus burchami	Dusky sculpin	2	360	435	398	40.23	44.12
I. filamentosus	Threadfin sculpin	58	81	414	170	34.21	48.45
I. fimbriatus	Fringed sculpin	2	114	242	178	33.81	44.63
I. sp.	Sculpin unident.	1	150	150	150	42.48	42.48
Leptocottus armatus	Pacific staghorn sculpin	7	53	335	107	33.39	48.16
Radulinus asprellus	Slim sculpin	5	83	132	107	35.97	45.92
Scorpaenichthys marmoratus	Cabezon	1	27	27	27	34.02	34.02
Triglops macellus	Roughspine sculpin	3	113	117	115	48.16	48.39

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 2003 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
Hemitripteridae							
Nautichthys oculofasciatus	Sailfin sculpin	1	58	58	58	37.80	37.80
Psychrolutidae							
Dasycottus setiger	Spinyhead sculpin	2	58	169	114	37.80	48.40
Malacocottus kincaidi	Blackfin sculpin	2	296	313	304	45.13	47.91
Psychrolutes phrictus	Blob sculpin	5	988	1,341	1,210	42.25	47.82
Agonidae							
Agonidae	Poacher unident.	2	136	161	148	48.14	48.33
Agonopsis vulsa	Northern spearnose poacher	4	74	187	137	34.44	48.16
Bathyagonus nigripinnis	Blackfin poacher	33	172	991	587	41.49	48.31
B. pentacanthus	Bigeye poacher	7	183	411	303	35.30	47.91
Chesnonia verrucosa	Warty poacher	1	53	53	53	46.53	46.53
Podothecus accipenserinus	Sturgeon poacher	2	65	88	77	48.15	48.16
Xeneretmus latifrons	Blacktip poacher	17	154	940	265	34.62	48.14
Liparidae							
Liparidinae	Snailfish unident.	1	790	790	790	33.16	33.16
Careproctus sp.		1	959	959	959	47.85	47.85
C. melanurus	Blacktail snailfish	169	199	1,095	567	33.56	48.23
C. cypselurus	Blackfin snailfish	19	403	1,341	1,002	40.15	47.82
C. gilberti	Smalldisk snailfish	7	328	492	417	40.20	42.95
Elassodiscus caudatus	Humpback snailfish	4	451	879	645	37.05	40.77
Paraliparis dactylosus	Red snailfish	4	571	1,162	840	35.02	46.13
P. rosaceus	Rosy snailfish	1	1,080	1,080	1,080	46.15	46.15
P. cephalus	Swellhead snailfish	9	606	1,285	954	40.30	47.77
P. pectoralis	Broadfin snailfish	1	1,096	1,096	1,096	47.68	47.68
Rhinoliparis barbulifer	Longnose snailfish	1	927	927	927	36.32	36.32
Serranidae							
Paralabrax nebulifer	Barred sand bass	13	24	101	54	32.77	34.09
Carangidae							
Trachurus symmetricus	Jack mackerel	9	27	394	113	32.83	42.95

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 2003 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
Sciaenidae							
Genyonemus lineatus	White croaker	39	27	124	74	32.77	38.08
Seriphus politus	Queenfish	1	35	35	35	33.26	33.26
Embiotocidae							
Embiotocidae	Surfperch unident.	2	31	62	46	33.39	33.45
Amphistichus rhodoterus	Redtail surfperch	1	73	73	73	39.17	39.17
Cymatogaster aggregata	Shiner perch	22	26	96	61	33.00	41.69
Embiotoca lateralis	Striped surfperch	1	64	64	64	34.27	34.27
Hyperprosopon anale	Spotfin surfperch	7	36	64	54	34.66	37.38
Zalembius rosaceus	Pink sea perch	68	26	276	82	32.77	39.25
Bathymasteridae							
Ronquilus jordani	Northern ronquil	4	114	174	146	47.84	48.33
Zoarcidae							
Zoarcidae	Eelpout unident.	2	104	512	308	33.42	34.34
Bothrocara brunneum	Twoline eelpout	119	455	1,285	891	32.69	48.10
B. molle	Soft eelpout	2	803	1,341	1,072	46.06	46.59
Lycenchelys camchatica	Kamchatka eelpout	6	723	988	881	35.79	46.59
L. crotalinus	Snakehead eelpout	120	313	1,285	909	32.99	48.10
L. endemoscotus	Deepwater eelpout	2	441	543	492	34.37	35.13
L. fierasfer	Blackmouth eelpout	2	803	814	808	33.01	46.59
L. mandibularis	Pallid eelpout	7	563	1,096	861	32.80	46.15
Lycodes cortezianus	Bigfin eelpout	187	57	607	315	32.87	48.23
L. diapterus	Black eelpout	108	82	1,021	459	33.97	48.34
L. pacificus	Blackbelly eelpout	87	58	587	173	32.66	48.40
L. palearis	Wattled eelpout	2	111	187	149	47.63	47.86
Cryptacanthodidae							
Cryptacanthodes giganteus	Giant wrymouth	2	124	174	149	45.79	47.84
Stichaeidae							
Poroclinus rothrocki	Whitebarred prickleback	1	163	163	163	43.04	43.04

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 2003 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
Anarhichadidae							
Anarrhichthys ocellatus	Wolf-eel	2	36	70	53	36.81	44.57
Chiasmodontidae							
Chiasmodon niger	Black swallower	1	911	911	911	32.99	32.99
Ammodytidae							
Ammodytes hexapterus	Pacific sand lance	1	64	64	64	42.80	42.80
Trichiuridae							
Lepidopus xantusi	Scabbardfish	4	196	276	247	32.66	33.97
Sphyraenidae							
Sphyraena argentea	California barracuda	1	35	35	35	33.26	33.26
Centrolophidae							
Icichthys lockingtoni	Medusafish	5	164	775	474	39.58	46.50
Stromateidae							
Peprilus simillimus	Pacific butterfish	43	26	149	73	32.77	37.94
Paralichthyidae							
Citharichthys sp.	Sanddab unident.	3	58	135	93	34.97	37.80
C. sordidus	Pacific sanddab	157	24	251	103	32.77	48.33
C. stigmaeus	Speckled sanddab	1	35	35	35	33.26	33.26
C. xanthostigma	Longfin sanddab	7	26	85	47	32.92	34.73
Pleuronectidae							
Atheresthes stomias	Arrowtooth flounder	199	53	680	205	38.14	48.45
Embassichthys bathybius	Deepsea sole	157	391	1,341	874	32.69	48.11
Eopsetta jordani	Petrale sole	209	36	418	144	34.17	48.39
Glyptocephalus zachirus	Rex sole	364	47	715	245	32.66	48.45
Hippoglossina stomata	Bigmouth sole	33	24	478	103	32.77	34.44
Hippoglossoides elassodon	Flathead sole	54	69	345	143	43.55	48.40
Hippoglossus stenolepis	Pacific halibut	46	57	345	166	39.09	48.33
Isopsetta isolepis	Butter sole	7	53	178	89	40.20	46.53
Lepidopsetta bilineata	Southern rock sole	10	61	128	100	32.77	44.51
L. sp.	Rock sole unident.	13	36	141	87	36.81	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 2003 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
Lyopsetta exilis	Slender sole	289	53	680	213	32.62	48.45
Microstomus pacificus	Dover sole	463	53	1,196	392	32.57	48.45
Paralichthys californicus	California halibut	14	24	218	60	33.00	42.06
Parophrys vetulus	English sole	242	24	396	142	32.62	48.45
Platichthys stellatus	Starry flounder	6	36	95	69	36.81	44.33
Pleuronichthys decurrens	Curlfin sole	73	26	219	86	32.77	48.16
P. ritteri	Spotted turbot	20	26	219	86	32.78	37.67
P. verticalis	Hornyhead turbot	13	24	124	68	32.77	34.97
Psettichthys melanostictus	Sand sole	10	36	76	60	36.81	48.16
Xystreurys liolepis	Fantail sole	15	24	104	51	33.00	34.79
Osteichthyes (superclass)	Fish unident.	1	241	241	241	33.56	33.56
Porifera (phylum)							
Aphrocallistes vastus	Clay pipe sponge	17	114	1,141	614	33.81	45.14
Porifera	Vase sponge	1	180	180	180	48.04	48.04
Porifera	Mushroom sponge	2	528	889	708	35.34	46.30
Porifera	Sponge unident.	136	60	1,285	544	32.57	48.45
Hexactinellida	Glass sponge unident.	2	114	129	122	33.73	33.81
Hylonema sp.	Fiberoptic sponge	18	35	1,285	808	33.01	47.76
Mycale sp.		1	477	477	477	34.82	34.82
Rhabdocalyptus sp.	Cloud sponge	4	129	492	357	33.59	40.97
Scyphozoa (class)							
Scyphozoa	Jellyfish unident.	214	26	1,264	481	32.66	48.34
Aurelia sp.	Moon jelly	5	56	451	273	35.09	40.34
Periphylla periphylla	Purple cone jelly	1	943	943	943	40.04	40.04
Anthozoa (class)							
Actiniaria	Sea anemone unident.	357	36	1,341	475	32.57	48.39
Actiniaria	Striated sea anemone unident.	3	414	480	438	39.58	40.91
Actiniaria	Red striated anemone unident.	4	107	948	735	38.90	42.00
Alcyonacea	Soft coral unident.	6	181	982	581	40.36	44.63
Alyconaria	Octocoral unident.	1	915	915	915	45.09	45.09

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 2003 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
Antipatharia	Black coral unident.	12	103	1,285	692	33.21	48.11
Actinostolidae		9	414	1,159	811	32.99	41.49
Gorgonacea	Gorgonian coral unident.	8	589	1,142	886	32.99	45.83
Hormathiidae	Hormathiid anemones unident.	4	360	446	410	39.11	40.91
Pennatulacea	Sea pen or sea whip unident.	36	61	1,264	575	32.66	47.91
Scleractinia	Stony coral unident.	3	242	979	516	33.59	44.93
Virgularidae	Sea whip unident.	31	72	1,325	569	32.83	48.14
Actinernus sp.		5	790	1,096	905	32.80	34.22
Amphilaphis sp.		1	114	114	114	33.81	33.81
Anthomastus sp.	Mushroom coral	6	360	1,094	673	32.57	44.93
Anthoptilum grandiflorum	Fleshy sea pen	5	103	1,094	663	44.63	45.17
Antipathes sp.	Black coral	18	82	1,054	554	40.47	46.04
Bathypathes sp.	Quill black coral	1	982	982	982	44.63	44.63
Corallimorphus sp.		1	904	904	904	34.22	34.22
Keratoisis sp.	Bamboo coral	2	1,094	1,285	1,190	44.93	47.53
Leptogorgia cari	Red licorice coral	2	315	398	356	42.79	45.34
Lillipathes sp.	Long-stemmed black coral	1	1,094	1,094	1,094	44.93	44.93
Liponema brevicornis	Tentacle-shedding sea anemone	29	312	1,209	641	32.99	44.35
Metridium farcimen	Gigantic sea anemone	45	64	944	214	32.62	44.47
M. sp.		1	64	64	64	42.80	42.80
Ombellula sp.	Flower sea pen	1	893	893	893	41.47	41.57
Paractinostola faeculenta	Rough purple sea anemone	56	249	1,178	652	32.99	44.35
Paragorgia sp.	Peppermint coral	1	790	790	790	33.16	33.16
Ptilosarcus gurneyi	Orange sea pen	6	64	798	343	42.80	46.81
Stomphia coccinea	Swimming sea anemone	19	107	1,209	552	33.36	42.06
S. sp.		2	92	207	150	34.40	34.84
Stylatula gracilis	Roughstem sea whip	1	680	680	680	42.66	42.66
S. sp.	Slender sea whip	3	449	544	489	34.94	35.16
Swiftia sp.	Red sea fan	2	337	893	615	41.57	44.87

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 2003 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
Hydrozoa (class)							
Dromalia alexandri	Sea pineapple	32	196	904	505	32.66	36.22
Ctenophora (phylum)							
Ctenophora	Comb jelly unident.	2	135	734	435	37.54	44.43
Nemata (phylum)							
Nematoda	Nematode worm unident.	2	798	1,095	946	46.81	47.68
Brachiopoda (phylum)							
Brachiopod	Lampshells unident.	1	251	251	251	36.24	36.24
Laqueus californianus	California lamp shell	1	104	104	104	33.42	33.42
Aplacophora (class)							
Aplacophora	Solenogaster unident.	5	415	897	578	39.11	48.10
Neomenia sp.		14	337	1,264	683	33.27	48.11
Bivalvia (class)							
Pectinid	Scallop unident.	3	70	1,154	664	33.22	46.39
Acharax johnsoni		1	991	991	991	46.43	46.43
Cyclopecten davidsoni	Salmon glass-scallop	1	743	743	743	44.97	44.97
Delectopecten vancouverensis	Vancouver scallop	6	790	1,129	982	32.80	47.77
Parvamussium alaskense	Alaska glass-scallop	1	1,095	1,095	1,095	47.68	47.68
Pleurobranchaea californica	California sea slug	48	56	1,209	222	32.62	41.63
Plicifusus griseus	Gray whelk	1	906	906	906	40.18	40.18
Solariella nuda	Naked solarelle	1	906	906	906	40.18	40.18
Tochuina tetraquetra	Giant orange tochui	1	95	95	95	34.02	34.02
Cephalopoda (class)							
Decabrachia	Squid unident.	4	84	911	513	32.99	43.70
Benthoctopus sp.		98	70	1,264	514	33.97	48.19
Berryteuthis magister	Magistrate armhook squid	5	313	595	467	46.67	48.44
Chiroteuthis calyx	Glass squid	10	262	1,154	715	33.52	46.52
Cranchia scabra	Sandpaper squid	2	455	984	719	33.97	40.12
Dosidicus gigas	Humboldt squid	16	71	763	367	33.27	45.13
Galiteuthis phyllura	Arrow squid	2	623	798	711	43.44	46.81

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 2003 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
Gonatopsis borealis	Boreopacific armhook squid	12	280	1,142	639	34.37	47.61
Gonatus onyx	Clawed armhook squid	32	171	983	583	33.16	47.91
Gonatus sp.		4	564	919	702	38.43	41.24
Graneledone boreopacifica	Ghost octopus	2	1,253	1,285	1,269	47.51	47.53
Graneledone sp.	Deep-sea octopus	1	1,325	1,325	1,325	47.82	47.82
Histioteuthis heteropsis	Jewel or cock-eyed squid	18	106	1,196	624	32.83	42.88
Japetella heathi	Yellowring octopus	27	581	1,285	956	33.16	48.10
Loligo opalescens	California market squid	101	26	572	126	32.62	48.00
Moroteuthis robusta	Robust clubhook squid	2	319	381	350	39.28	41.14
Octopodidae	Octopus unident.	10	43	1,285	531	33.00	47.76
Octopus sp.		1	59	59	59	32.77	32.77
Enteroctopus dofleini	Giant octopus	44	35	734	309	32.79	48.40
Octopoteuthis deletron	Octopus squid	119	411	1,285	781	33.01	48.10
Octopus californicus	North Pacific bigeye octopus	29	104	524	319	32.62	35.97
O. rubescens	Red octopus	2	61	80	70	37.67	38.08
Onychoteuthis borealijaponicus	Boreal clubhook squid	2	414	948	681	39.58	41.49
Opisthoteuthis californiana	Flapjack devilfish	64	84	1,196	669	34.17	48.11
Rossia pacifica	Eastern Pacific bobtail	25	56	1,079	184	32.83	47.29
Taonius pavo	Cone squid	15	360	1,096	807	41.38	47.68
Vampyroteuthis infernalis	Vampire squid	26	94	1,240	873	32.83	47.55
Gastropoda (class)							
Gastropod eggs	Snail eggs unident.	15	60	1,063	667	33.01	47.71
Gastropod	Snail unident.	206	48	1,325	604	32.69	48.40
Carinariidae	Heteropod unident.	1	890	890	890	35.79	35.79
Dorididae	Dorid nudibranch unident.	2	86	337	212	44.64	44.87
Mollusca	Limpet unident.	1	70	70	70	44.57	44.57
Nudibranchia	Nudibranch unident.	154	26	1,325	376	32.66	48.40
Bathybembix bairdii	Green top snail	34	446	1,209	851	32.80	45.17
Bivalvia unidentified	Bivalve unident.	5	194	1,178	771	33.41	46.59
Buccinum viridum	Turban whelk	1	906	906	906	40.18	40.18

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 2003 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
Bulbus fragilis	Fragile moonsnail	22	82	337	145	32.62	48.00
Calinaticina oldroydii		1	207	207	207	34.84	34.84
Colus aphelus	Oblique whelk	1	906	906	906	40.18	40.18
C. sp.		5	218	948	561	40.91	42.06
Fusitriton oregonensis	Oregon triton	2	137	383	260	42.42	45.29
Neptunea amianta	Deep-sea neptune	8	371	911	669	32.99	40.34
N. sp.		42	312	1,178	744	32.80	45.17
N. tabulata	Tabled whelk	1	124	124	124	34.21	34.21
Tritonia diomedea	Rosy tritonia	35	60	1,037	397	32.57	48.15
T. sp.		1	1,094	1,094	1,094	44.93	44.93
Sipuncula (phylum)							
Sipuncula	Peanut worm unident.	2	183	264	224	33.06	47.29
Polychaeta (class)							
Aphroditidae		85	95	1,201	326	34.02	48.40
Polychaeta	Worm unident.	3	145	454	299	36.12	44.02
Aphrodita sp.	Sea mouse unident.	1	593	593	593	43.77	43.77
Malacostraca (class)							
Dendrobranchiata	Shrimp unident.	7	24	1,096	445	33.00	47.68
Galatheidae	Galatheid crab unident.	1	133	133	133	48.15	48.15
Isopoda	Isopod unident.	14	48	1,253	706	34.79	47.77
Lithodidae	Stone crab unident.	2	455	823	639	33.26	33.97
Majidae	Spider crab unident.	1	48	48	48	34.79	34.79
Mysidacea	Mysid unident.	2	606	1,121	863	36.43	45.59
Paguridae	Hermit crab unident.	73	61	1,201	502	34.17	48.40
Pandalidae	Pandalid shrimp unident.	2	108	136	122	47.78	48.14
Pasiphaeidae	Pasiphaeid shrimp unident.	2	451	507	479	34.15	34.19
Pleocyemata	Crab unident.	13	24	328	100	32.62	34.43
Sergestidae	Sergestid shrimp unident.	2	431	639	535	33.52	45.07
Thoracica	Barnacle unident.	1	73	73	73	39.17	39.17
Acanthephyra curtirostris	Peaked shrimp	5	740	1,156	948	32.85	47.91

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 2003 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
Acantholithodes hispidus	Fuzzy crab	5	114	502	230	33.81	48.38
Callianassa sp.	Ghost shrimp	4	454	1,095	754	36.12	47.94
Cancer anthonyi	Yellow rock crab	1	27	27	27	34.02	34.02
C. gracilis	Graceful rock crab	11	26	97	59	34.09	35.09
C. magister	Dungeness crab	96	36	581	131	34.53	47.48
C. productus	Red rock crab	29	31	330	98	32.79	37.67
C. sp.	Cancer crab unident.	10	24	455	137	33.03	34.53
Chionoecetes bairdi	Bairdi tanner crab	6	169	345	270	44.93	48.44
C. sp.	Tanner crab unident.	19	337	1,057	737	40.97	46.04
C. tanneri	Grooved tanner crab	179	82	1,341	774	32.69	48.23
Chorilia longipes	Long horned decorator crab	49	35	1,157	621	32.57	48.40
Crangon communis	Two-spine crangon	1	53	53	53	46.53	46.53
C. sp.		4	93	196	123	34.26	42.65
Eualus biunguis	Two-clawed eualid	5	743	1,341	1,112	44.97	47.77
E. macropthalmus	Bigeye eualid	25	399	1,285	631	39.83	48.01
Hemisquilla californiensis	Mantis shrimp	1	27	27	27	34.02	34.02
Hyas lyratus	Pacific lyre crab	6	117	777	582	43.19	48.38
Lithodes couesi	Scarlet king crab	36	715	1,201	961	32.69	47.77
Lopholithodes foraminatus	Brown box crab	17	106	345	188	32.77	48.34
L. sp.	Box crab unident.	10	64	206	139	36.96	48.31
Loxorhynchus crispatus	Moss crab	1	35	35	35	33.26	33.26
L. grandis	Sheep crab	1	27	27	27	34.02	34.02
Munida quadrispina	Pinchbug	8	190	1,079	639	32.62	46.04
Munidopsis sp.	Thorny pinch bug	2	431	848	640	33.42	33.52
Mursia gaudichaudii	Armored box crab	35	24	219	96	32.77	44.47
Neognathophausia ingens	Giant red mysid	7	573	1,209	962	32.69	40.00
Neolithodes diomedeae	Spiky king crab	1	1,209	1,209	1,209	33.36	33.36
Notostomus japonicus	Spinyridge shrimp	2	808	1,201	1,004	39.94	41.63
Pagurus sp.		2	145	393	269	39.73	40.47
Pandalopsis ampla	Smooth shrimp	20	230	1,341	885	32.57	46.06

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 2003 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
Pandalopsis dispar	Sidestripe shrimp	13	169	345	249	41.16	48.40
Pandalus hypsinotus	Coonstripe shrimp	1	64	64	64	37.97	37.97
P. jordani	Ocean shrimp	84	88	351	177	34.38	48.40
P. platyceros	Spot shrimp	63	78	345	212	32.77	48.39
Panulirus interruptus	California spiny lobster	1	27	27	27	34.02	34.02
Paralithodes californiensis	California king crab	15	83	345	219	32.62	35.50
P. rathbuni	Spiny king crab	14	178	362	256	32.62	38.70
Paralomis multispina	Hair crab	23	206	1,341	1,078	32.80	47.82
P. sp.		1	1,079	1,079	1,079	32.83	32.83
Pasiphaea pacifica	Pacific glass shrimp	86	84	1,156	561	33.42	48.44
P. tarda	Crimson pasiphaeid	76	328	1,341	918	32.69	47.88
Polycheles sculptus	Deep sea lobster	8	251	1,341	436	32.57	48.45
Sergestes sp.		33	298	1,129	551	33.56	47.88
Sicyonia ingentis	Ridgeback rock shrimp	14	60	264	134	32.62	34.97
Asteroidea (class)							
Asteroidea	Sea star unident.	436	26	1,341	436	32.57	48.45
Zoroasteridae		1	484	484	484	41.83	41.83
Ampheraster sp.		5	607	944	834	37.05	42.00
Anteliaster sp.	Soft star	2	480	944	712	39.83	42.00
Asterina miniata	Bat star	1	77	77	77	36.22	36.22
Astropecten verrilli	California sand star	2	64	411	237	34.27	43.25
Ceramaster leptoceramus	California cookie star	4	104	769	469	33.22	42.26
C. patagonicus	Orange cookie star	1	395	395	395	33.53	33.53
C. sp.		1	769	769	769	33.22	33.22
Cryptopeltaster lepidonotus	Grainy star	2	477	911	694	32.99	34.82
Ctenodiscus crispatus	Common mud star	1	312	312	312	43.82	43.82
Dermasterias imbricata	Leather sea star	3	55	98	72	34.66	42.80
Diplopteraster multipes	Pincushion sea star	1	872	872	872	33.56	33.56
Diplocaster sp.		2	95	906	500	40.18	40.20
Dipsacaster eximius	Broad sand star	12	174	1,096	664	32.57	41.96

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 2003 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
Dipsacaster sp.		6	60	879	521	33.11	39.73
Henricia sp.		3	145	911	543	32.99	42.26
Heterozonias alternatus	Pink sun star	41	137	1,209	641	32.80	44.63
Hippasteria californica	Deep-sea spiny star	40	82	1,209	582	32.57	44.63
H. sp.		3	60	872	337	33.56	44.21
H. spinosa	Spiny star	20	62	982	508	32.57	44.63
Lophaster furcilliger	Pink crested sea star	1	477	477	477	34.82	34.82
L. sp.		1	1,159	1,159	1,159	35.81	35.81
Luidia foliolata	Flat mud star	70	48	782	259	33.42	44.21
L. sp.		2	92	507	300	34.19	34.40
Mediaster aequalis	Equal armed star	7	77	1,159	564	32.57	38.45
M. sp.		4	84	414	268	34.97	42.95
M. tenellus	Pale equal armed star	1	477	477	477	34.82	34.82
Myxoderma platyacanthum	Red star	29	84	1,178	464	33.42	43.82
M. sacculatum	Snakehead star	5	360	1,209	837	32.80	40.23
Nearchaster aciculosus	Deep-sea fragile star	13	323	1,209	845	32.80	44.63
N. sp.		3	477	911	719	32.57	34.82
Orthasterias sp.		1	60	60	60	44.21	44.21
Peribolaster biserialis		1	477	477	477	34.82	34.82
Pisaster brevispinus	Short-spined pink star	8	24	326	111	33.36	42.80
P. sp.		3	60	312	224	43.82	44.21
Poraniopsis flexilius	Flexible thorny star	2	769	944	856	32.57	42.00
P. inflata	Thorny star	3	145	769	464	32.57	40.47
Pseudarchaster dissonus	Deep-sea pseudarchaster	1	563	563	563	34.86	34.86
P. parelii	Scarlet sea star	3	95	371	204	40.20	40.47
P. pusillus	Little pseudarchaster	2	338	478	408	34.24	34.38
P. sp.		15	68	751	326	39.25	43.82
Pteraster jordani	Jordan's slime star	11	395	1,209	849	32.57	42.00
P. sp.		6	182	982	646	32.57	44.63
Pycnopodia helianthoides	Sunflower sea star	25	48	1,159	230	34.19	44.11

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 2003 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
Rathbunaster californicus	Deep-sea sunflower star	32	64	507	231	33.59	44.02
Solaster borealis	Grooved sea star	30	82	1,178	698	32.57	44.63
S. exiguus	Deep-sea sun star	2	982	1,209	1,096	33.36	44.63
S. papposus	Rose sea star	2	328	371	349	33.59	40.34
S. sp.	Orange sun star	2	60	82	71	33.36	44.34
Stylasterias forreri	Fish-eating star	13	68	451	214	32.78	42.72
Thrissacanthias penicillatus	Carpet star	57	60	1,209	579	32.80	44.63
Zoroaster evermani	Slender star	22	182	1,178	830	32.57	44.63
Crinoidea (class)							
Crinoidea	Crinoid unident.	7	86	1,096	710	33.81	47.68
Florometra serratissima	Featherstar crinoid	3	104	790	418	33.16	40.23
Psathyrometra fragilis	Fragile crinoid						
Echinoidea (class)							
Echinoidea	Sea urchin unident.	238	70	1,157	362	32.66	48.45
Allocentrotus fragilis	Fragile red sea urchin	71	62	927	381	32.57	44.64
A. sp.		2	328	641	485	33.58	33.59
Brisaster latifrons	Mud urchin	34	98	1,178	480	33.56	44.35
B. sp.		4	177	715	463	34.99	43.67
Brissopsis pacifica	Oval sea biscuit	8	104	911	470	32.99	34.96
Spatangus californicus	Giant sea biscuit	6	239	338	291	32.77	34.62
Strongylocentrotus pallidus	White sea urchin	1	62	62	62	33.39	33.39
Holothuroidea (class)							
Holothuroidea	Sea cucumber unident.	186	35	1,285	384	32.57	48.45
Molpadia intermedia	Purple sea potato	4	145	1,025	521	35.02	48.09
Pannychia moseleyi	Sloppy cucumber	10	446	1,025	615	33.58	42.26
Parastichopus californicus	California cucumber	26	43	1,178	258	32.83	42.42
P. leukothele	Giant soft cucumber	24	110	721	281	33.06	43.82
P. sp.		3	190	1,096	700	32.62	33.01
Pseudostichopus mollis	Sandy sea cucumber	3	477	1,096	815	32.80	34.82
Psolus squamatus	Whitescaled sea cucumber	9	371	1,094	708	32.57	46.04

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 2003 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
Scotoplanes globosa	Sea pig	18	1,037	1,285	1,153	33.36	47.76
Ophiuroidea (class)		1	769	769	769	32.57	32.57
Ophiuroid	Brittlestarfish unident.	43	35	1,201	547	32.80	48.38
Amphiophiura ponderosa	Giant armored brittlestar	5	598	944	833	33.56	44.47
Asteronyx longifissus	Long-slit serpent brittlestar	2	478	524	501	34.24	34.96
A. loveni	Giant serpent brittlestar	3	790	1,063	964	33.16	40.20
A. sp.		12	84	848	507	33.11	37.07
Gorgonocephalus eucnemis	Basketstar	17	64	782	278	33.97	45.36
Ophiacantha sp.		1	848	848	848	33.42	33.42
Ophiomusium jolliensis	Red brittlestar	1	948	948	948	41.49	41.49
Ophiopholis aculeata	Ubiquitous brittle star	1	1,095	1,095	1,095	47.68	47.68
O. longispina	Longspined brittlestar	5	114	948	600	33.81	42.29
Ophiura sarsi	Notched brittlestar	9	68	782	390	38.45	42.23
O. sp.		1	411	411	411	43.25	43.25
Tunicata (subphylum)							
Ascidia	Tunicate unident.	2	790	911	851	32.99	33.16
Thaliacea	Salps unident.	160	79	1,253	547	33.52	48.38
Halocynthia sp.	Sea peach unident.	1	36	36	36	36.81	36.81
Molgula griffithsii	Sea grape	4	740	1,181	915	41.57	47.91
Styela rustica	Sea potato	24	59	992	363	32.77	48.34
Thetys vagina	Common salp	7	129	1,181	539	34.82	48.17
Animalia (kingdom)							
Animalia	Invertebrate unident.	5	70	179	117	36.22	46.12
Animalia	Unsorted shab	5	258	1,325	848	33.16	47.82

Table 4. Number of length-frequency measurements collected by stratum for the most frequently sampled groundfish species during the 2003 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	2,976	1,041	0	4,017
Longnose skate	1,364	1,276	54	2,694
Spotted ratfish	3,455	1,575	4	5,034
Pacific sanddab	10,638	132	0	10,770
Arrowtooth flounder	3,780	812	6	4,592
Flathead sole	1,328	196	0	1,524
Petrale sole	2,654	266	0	2,920
English sole	7,655	950	0	8,605
Dover sole	12,176	8,531	4,263	24,970
Rex sole	7,101	3,753	284	11,138
Rock sole unident.	323	0	0	323
Curlfin sole	802	4	0	806
Sablefish	3,342	1,604	1,814	6,760
Pacific grenadier	1,808	2	4,847	6,657
Pacific cod	690	97	0	787
Pacific flatnose	760	51	2,069	2,120
Lingcod	1,229	202	0	1,431
Pacific hake	4,187	1,858	23	6,068
Shortspine thornyhead	3,328	3,283	1,771	8,382
Longspine thornyhead	4,926	1,159	14,859	20,944
Pacific ocean perch	808	619	0	1,427
Aurora rockfish	67	1,023	89	1,179
Greenspotted rockfish	338	86	0	424
Darkblotched rockfish	1,579	822	0	2,401
Splitnose rockfish	1,743	4,953	0	6,696
Greenstriped rockfish	3,055	594	0	3,649
Yellowtail rockfish	1,068	25	0	1,093
Chilipepper rockfish	1,886	801	0	2,687
Rosethorn rockfish	1,454	314	0	1,768
Cowcod	4	9	0	13
Canary rockfish	561	6	0	567
Redstripe rockfish	1,055	17	0	1,072
Redbanded rockfish	135	190	0	325
Stripetail rockfish	2,915	3,044	0	5,959
Sharpchin rockfish	1,913	487	0	2,400

Table 5. Number of length-frequency measurements collected by stratum for the most frequently sampled groundfish species during the 2003 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	35	313	0	348
Longnose skate	31	583	12	626
Spotted ratfish	448	393	0	841
Pacific sanddab	3,615	126	0	3,741
Arrowtooth flounder	0	0	0	0
Flathead sole	0	0	0	0
Petrale sole	110	101	0	211
English sole	750	224	0	974
Dover sole	13	2,054	512	2,579
Rex sole	27	889	0	916
Rock sole unident.	0	0	0	0
Curlfin sole	275	4	0	279
Sablefish	99	325	149	573
Pacific grenadier	0	0	69	69
Pacific cod	0	0	0	0
Pacific flatnose	0	0	130	130
Lingcod	211	39	0	250
Pacific hake	150	895	1	1,046
Shortspine thornyhead	0	585	430	1,015
Longspine thornyhead	0	782	2,792	3,574
Pacific ocean perch	0	0	0	0
Aurora rockfish	3	635	43	681
Greenspotted rockfish	69	84	0	153
Darkblotched rockfish	1	6	0	7
Splitnose rockfish	7	2,326	0	2,333
Greenstriped rockfish	9	64	0	73
Yellowtail rockfish	2	0	0	2
Chilipepper rockfish	391	287	0	678
Rosethorn rockfish	17	66	0	83
Cowcod	1	7	0	8
Canary rockfish	1	2	0	3
Redstripe rockfish	0	0	0	0
Redbanded rockfish	0	2	0	2
Stripetail rockfish	990	1,365	0	2,355
Sharpchin rockfish	0	0	0	0

Table 6. Number of length-frequency measurements collected by stratum for the most frequently sampled groundfish species during the 2003 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	303	201	0	504
Longnose skate	315	213	25	553
Spotted ratfish	283	487	0	770
Pacific sanddab	2,334	6	0	2,340
Arrowtooth flounder	4	102	0	106
Flathead sole	0	0	0	0
Petrale sole	767	99	0	866
English sole	2,224	463	0	2,687
Dover sole	490	2,293	883	3,666
Rex sole	891	849	76	1,816
Rock sole unident.	174	0	0	174
Curlfin sole	367	0	0	367
Sablefish	140	462	362	964
Pacific grenadier	0	0	1,177	1,177
Pacific cod	5	0	0	5
Pacific flatnose	0	12	531	543
Lingcod	263	54	0	317
Pacific hake	467	426	1	894
Shortspine thornyhead	1	478	319	798
Longspine thornyhead	0	129	2,493	2,622
Pacific ocean perch	0	6	0	6
Aurora rockfish	0	180	43	223
Greenspotted rockfish	138	1	0	139
Darkblotched rockfish	36	226	0	262
Splitnose rockfish	15	1,322	0	1,337
Greenstriped rockfish	556	33	0	589
Yellowtail rockfish	164	0	0	164
Chilipepper rockfish	1,145	463	0	1,608
Rosethorn rockfish	8	46	0	54
Cowcod	3	1	0	4
Canary rockfish	92	0	0	92
Redstripe rockfish	2	0	0	2
Redbanded rockfish	1	30	0	31
Stripetail rockfish	1,067	1,007	0	2,074
Sharpchin rockfish	4	1	0	5

Table 7. Number of length-frequency measurements collected by stratum for the most frequently sampled groundfish species during the 2003 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	79	265	0	344
Longnose skate	244	341	7	592
Spotted ratfish	457	296	4	757
Pacific sanddab	1,370	0	0	1,370
Arrowtooth flounder	381	356	1	738
Flathead sole	0	0	0	0
Petrale sole	491	21	0	512
English sole	1,763	237	0	2,000
Dover sole	1,807	3,185	1,397	6,389
Rex sole	1,473	1,875	154	3,502
Rock sole unident.	48	0	0	48
Curlfin sole	69	0	0	69
Sablefish	376	680	474	1,530
Pacific grenadier	0	1	945	946
Pacific cod	25	3	0	28
Pacific flatnose	0	33	413	446
Lingcod	238	63	0	301
Pacific hake	880	511	2	1,393
Shortspine thornyhead	2	1,347	278	1,627
Longspine thornyhead	0	243	3,201	3,444
Pacific ocean perch	12	17	0	29
Aurora rockfish	0	202	0	202
Greenspotted rockfish	123	1	0	124
Darkblotched rockfish	374	406	0	780
Splitnose rockfish	329	1,163	0	1,492
Greenstriped rockfish	836	245	0	1,081
Yellowtail rockfish	32	0	0	32
Chilipepper rockfish	349	51	0	400
Rosethorn rockfish	241	54	0	295
Cowcod	0	1	0	1
Canary rockfish	63	4	0	67
Redstripe rockfish	170	1	0	171
Redbanded rockfish	2	103	0	105
Stripetail rockfish	624	671	0	1,295
Sharpchin rockfish	657	273	0	930

Table 8. Number of length-frequency measurements collected by stratum for the most frequently sampled groundfish species during the 2003 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	466	214	0	680
Longnose skate	302	172	9	483
Spotted ratfish	704	186	0	890
Pacific sanddab	1,943	0	0	1,943
Arrowtooth flounder	1,094	539	5	1,638
Flathead sole	423	17	0	440
Petrale sole	555	23	0	578
English sole	1,462	56	0	1,518
Dover sole	2,843	2,350	1,354	6,547
Rex sole	2,308	971	54	3,333
Rock sole unident.	39	0	0	39
Curlfin sole	84	0	0	84
Sablefish	486	712	722	1,920
Pacific grenadier	0	2	1,806	1,808
Pacific cod	86	24	0	110
Pacific flatnose	0	18	742	760
Lingcod	246	63	0	309
Pacific hake	1,193	700	18	1,911
Shortspine thornyhead	90	2,573	592	3,255
Longspine thornyhead	0	234	4,692	4,926
Pacific ocean perch	5	749	0	754
Aurora rockfish	0	61	3	64
Greenspotted rockfish	4	1	0	5
Darkblotched rockfish	108	946	0	1,054
Splitnose rockfish	262	1,087	0	1,349
Greenstriped rockfish	517	245	0	762
Yellowtail rockfish	223	15	0	238
Chilipepper rockfish		1	0	1
Rosethorn rockfish	185	493	0	678
Cowcod	0	0	0	0
Canary rockfish	97	9	0	106
Redstripe rockfish	422	133	0	555
Redbanded rockfish	17	114	0	131
Stripetail rockfish	47	175	0	222
Sharpchin rockfish	229	672	0	901

Table 9. Number of length-frequency measurements collected by stratum for the most frequently sampled groundfish species during the 2003 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	1,879	262	0	2,141
Longnose skate	291	139	1	431
Spotted ratfish	1,377	399	0	1,776
Pacific sanddab	1,376	0	0	1,376
Arrowtooth flounder	1,757	354	0	2,111
Flathead sole	888	196	0	1,084
Petrale sole	708	45	0	753
English sole	1,400	26	0	1,426
Dover sole	3,319	999	117	4,435
Rex sole	1,377	140	0	1,517
Rock sole unident.	62	0	0	62
Curlfin sole	7	0	0	7
Sablefish	807	137	107	1,051
Pacific grenadier	0	1	850	851
Pacific cod	550	94	0	644
Pacific flatnose	0	6	253	259
Lingcod	208	46	0	254
Pacific hake	779	26	1	806
Shortspine thornyhead	70	873	152	1,095
Longspine thornyhead	0	5	1,681	1,686
Pacific ocean perch	42	596	0	638
Aurora rockfish		6	0	6
Greenspotted rockfish	3	0	0	3
Darkblotched rockfish	114	184	0	298
Splitnose rockfish	43	142	0	185
Greenstriped rockfish	892	252	0	1,144
Yellowtail rockfish	632	25	0	657
Chilipepper rockfish	0	0	0	0
Rosethorn rockfish	510	148	0	658
Cowcod	0	0	0	0
Canary rockfish	299	0	0	299
Redstripe rockfish	328	16	0	344
Redbanded rockfish	1	55	0	56
Stripetail rockfish	12	1	0	13
Sharpchin rockfish	351	213	0	564

Temperature Data

Near bottom temperatures ranged from 2.7°C to 11.6°C during the June–August 2003 portion of the survey, and from 3.1°C to 14.7°C during the late August–October 2003 portion of the survey (Figure 5). The mean bottom temperature was 6.7°C. Sea surface temperatures ranged from 10.0°C to 23.3°C during the June–August 2003 portion of the survey, and from 8.9°C to 22.2°C during the late August–October 2003 portion of the survey (Figure 6). The mean sea surface temperature was 14.7°C.

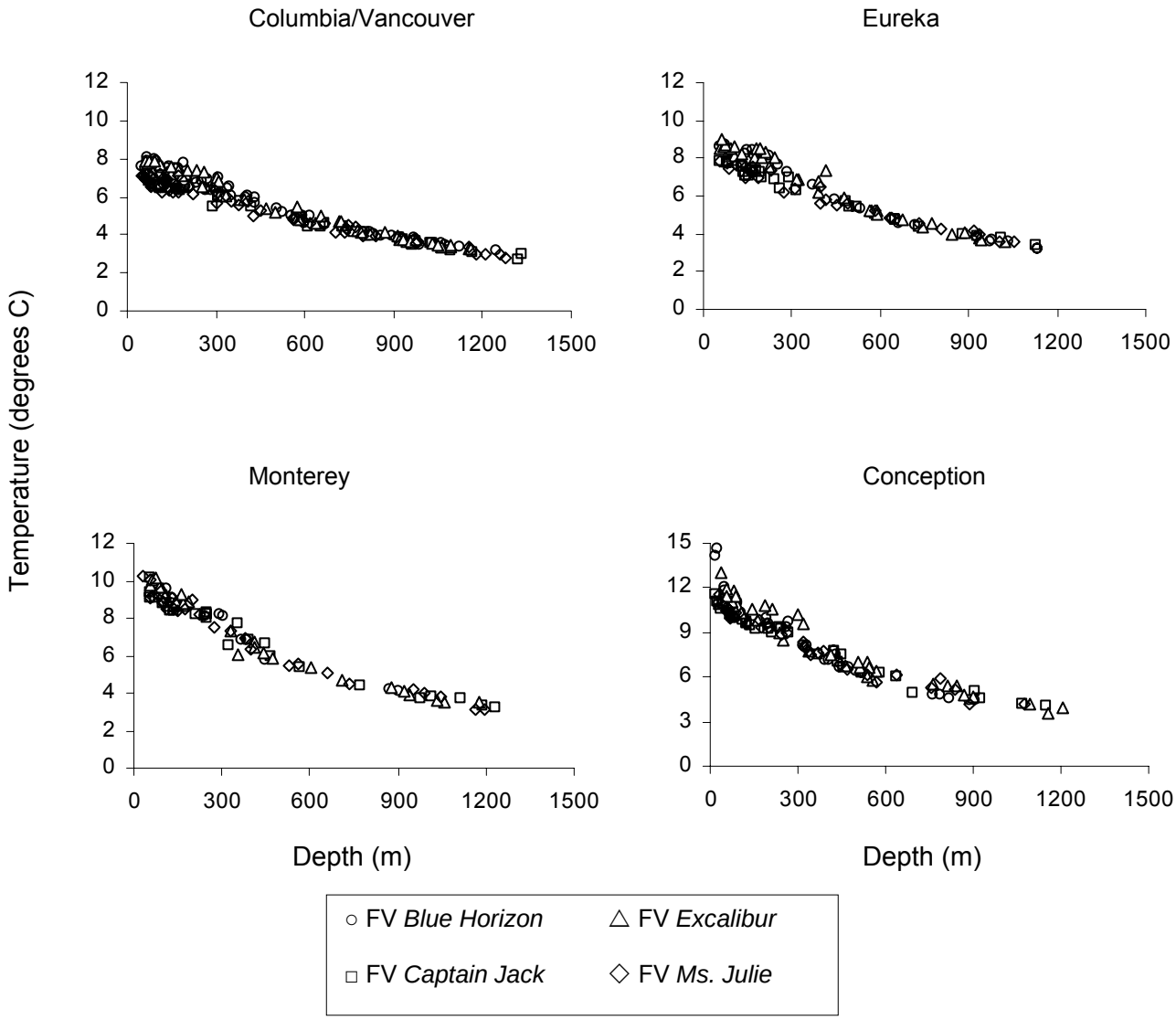


Figure 5. Near bottom temperature observed at the mouth of the net for each tow conducted during the 2003 West Coast groundfish trawl survey. Observations are grouped by INPFC area and plotted relative to haul depth.

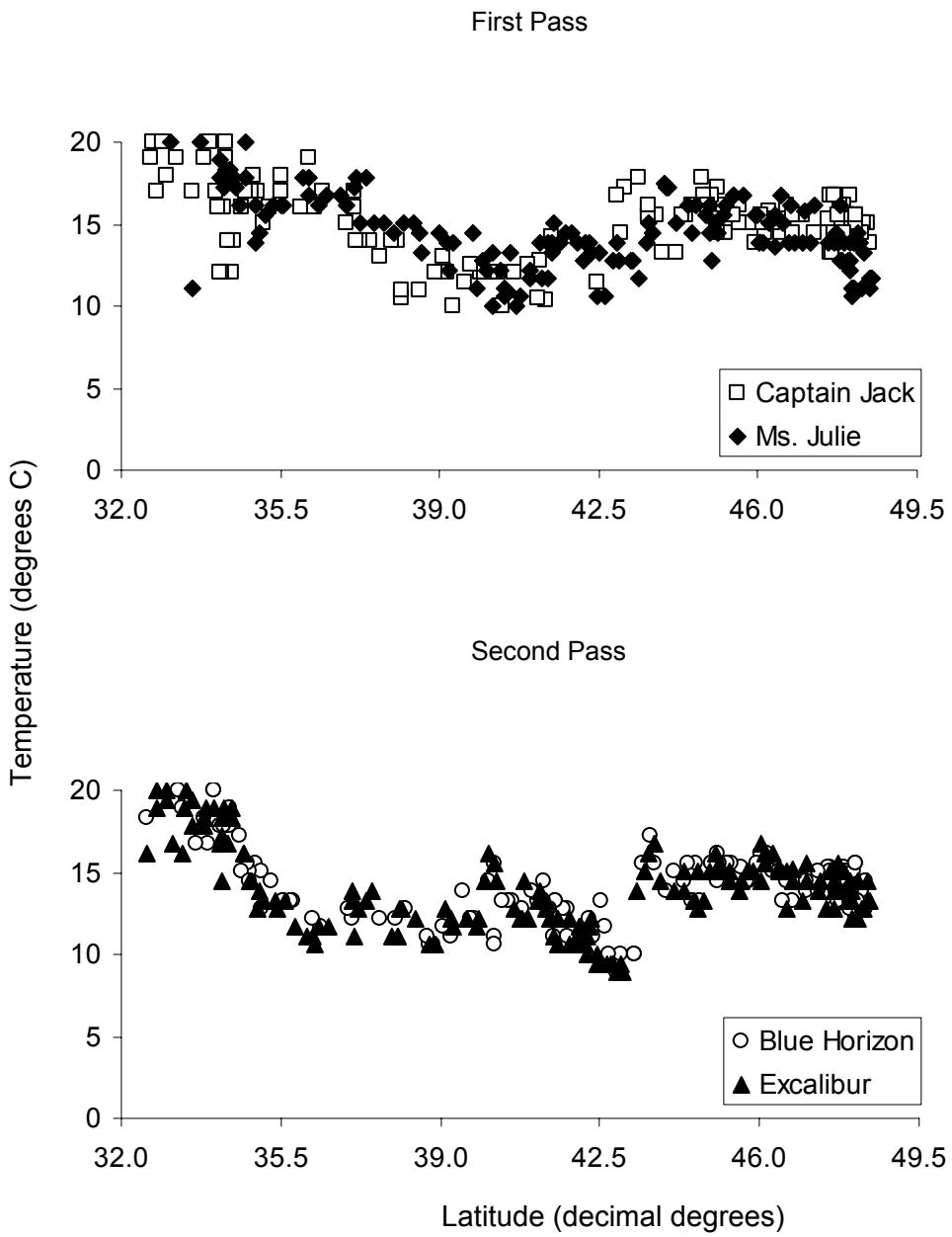


Figure 6. Sea surface temperature observed at the start of each tow during the 2003 NWFSC West Coast groundfish trawl survey. Observations are grouped by date (first pass from 24 June 2003 to 13 August 2003, second pass from 13 August 2003 to 23 October 2003), and plotted relative to latitude.

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, spiny dogfish, longspine thornyhead, and sablefish. For all depth strata combined, Dover sole had the second highest rates in all INPFC areas. Within depth strata for all INPFC areas combined, Dover sole ranked first at mid depths (184–549 m), second in deep (550–1,280 m), and fifth in the shallow (55–183 m) depth 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 second in the mid-depth (184–549 m) stratum (Table 11). Spiny dogfish had the highest catch rate in the U.S.-Vancouver INPFC area (Table 10) and was the second most abundant species in the shallow depth stratum in all INPFC areas combined (Table 11). When all INPFC areas combined were separated into depth strata, spiny dogfish also had the third highest catch rate in the mid-depth stratum and sablefish had the third highest catch rate in the deep stratum (Table 11). Longspine thornyheads had the highest catch rate in the Conception INPFC area for all depth strata combined and the fourth highest catch rate for all INPFC areas combined (Table 10). Longspine thornyhead was the most abundant species in the deep depth stratum (550–1,280 m) when all INPFC areas were combined. Sharpchin rockfish was the most abundant species in the Eureka INPFC area when all depth strata were combined and chilipepper rockfish similarly held the first position in the Monterey area (Table 10).

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 was similar throughout the survey area (Tables 12–16). Pacific hake catch rates were highest in the shallow depth stratum in the Columbia INPFC area and second highest in the shallow depth stratum in the Eureka and U.S.-Vancouver INPFC areas (Tables 14–16). Longspine thornyhead catch rates were highest in the deep stratum in all INPFC areas except Monterey (Tables 12–14). Spiny dogfish had the highest catch rates in the shallow and mid-depth strata in the U.S.-Vancouver INPFC areas.

In the shallow depth stratum, Pacific sanddab was the predominant species in the Conception INPFC area, chilipepper rockfish was most abundant in the Monterey INPFC area, and sharpchin rockfish was most abundant in the Eureka INPFC area (Tables 12–14). For the deep stratum, Dover sole was the dominant species in the Monterey area, while elsewhere longspine thornyhead was the dominant species. Dover sole was also the dominant species in the mid stratum in the Conception, Eureka, and Columbia INPFC areas, while shortbelly rockfish and spiny dogfish were most abundant at mid depths in the Monterey and U.S.-Vancouver INPFC areas.

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 2003 West Coast groundfish trawl survey.

All areas Total hauls = 574		**U.S.-Vancouver area Total hauls = 87**		**Columbia area Total hauls = 148**	
Dover sole	20.88	Spiny dogfish	163.91	Pacific hake	46.60
Pacific hake	19.13	Dover sole	34.74	Dover sole	26.06
Spiny dogfish	14.43	Pacific hake	29.70	Sablefish	16.90
Longspine thornyhead	11.18	Sablefish	20.42	Pacific sanddab	13.52
Sablefish	9.67	Arrowtooth flounder	17.88	Sharpchin rockfish	8.54
Pacific sanddab	9.56	Pacific ocean perch	15.15	Rex sole	8.20
Sharpchin rockfish	8.96	Longspine thornyhead	7.93	Arrowtooth flounder	8.12
Chilipepper rockfish	8.82	Spotted ratfish	7.75	Longspine thornyhead	7.93
Shortspine thornyhead	4.38	Longnose skate	7.41	Darkblotched rockfish	7.24
Rex sole	4.29	Rex sole	5.54	Pacific ocean perch	6.63
Shortbelly rockfish	3.72	Shortspine thornyhead	5.30	Yellowtail rockfish	6.25
Longnose skate	3.67	Yellowtail rockfish	4.80	Longnose skate	6.17
Pacific grenadier	3.40	Greenstriped rockfish	4.73	Spiny dogfish	4.86
Arrowtooth flounder	3.13	Pacific cod	3.92	English sole	3.93
Grooved tanner crab	3.03	Lingcod	3.57	Shortspine thornyhead	3.55
English sole	2.60	Flathead sole	3.28	Grooved tanner crab	3.52
Pacific ocean perch	2.45	Redstripe rockfish	3.24	Pacific grenadier	2.92
Darkblotched rockfish	2.33	Pacific sanddab	3.14	Lingcod	2.74
Splitnose rockfish	2.32	Giant grenadier	3.05	Spotted ratfish	2.18
Giant grenadier	2.32	English sole	2.97	Giant grenadier	2.05
Eureka area Total hauls = 104		**Monterey area Total hauls = 101**		**Conception area Total hauls = 134**	
Sharpchin rockfish	73.63	Chilipepper rockfish	49.92	Longspine thornyhead	11.54
Dover sole	38.15	Dover sole	31.89	Dover sole	9.26
Pacific hake	35.64	Pacific sanddab	31.42	Shortspine thornyhead	5.11
Longspine thornyhead	18.33	Spiny dogfish	25.33	Sablefish	3.60
Redstripe rockfish	17.23	Shortbelly rockfish	19.67	California slickhead	3.32
Sablefish	15.17	Pacific grenadier	13.64	Pacific hake	2.35
Lingcod	11.24	Longspine thornyhead	12.11	Splitnose rockfish	2.23
Rex sole	9.25	Pacific hake	12.06	Chilipepper rockfish	2.16
Giant grenadier	6.62	Sablefish	9.17	Longnose skate	1.76
Pacific sanddab	6.58	Grooved tanner crab	8.51	Shortbelly rockfish	1.50
Grooved tanner crab	5.26	English sole	5.76	Pacific sanddab	1.45
English sole	5.13	Giant grenadier	5.11	Brown cat shark	1.12
Longnose skate	4.81	Spotted ratfish	4.51	Rex sole	1.06
Stripetail rockfish	3.35	Rex sole	4.30	Aurora rockfish	0.73
Shortspine thornyhead	3.18	Stripetail rockfish	4.03	Stripetail rockfish	0.63
Pacific grenadier	3.09	Shortspine thornyhead	3.94	Giant grenadier	0.56
Greenstriped rockfish	2.27	White croaker	3.79	Spotted ratfish	0.53
Spotted ratfish	2.17	Splitnose rockfish	3.41	Grooved tanner crab	0.50
Splitnose rockfish	1.66	Longnose skate	3.35	Spiny dogfish	0.48
Chilipepper rockfish	1.49	Petrale sole	2.25	Pacific grenadier	0.45

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 2003 West Coast groundfish trawl survey.

Stratum 1 (55–183 m)		Stratum 2 (184–549 m)		Stratum 3 (550–1,280 m)	
Pacific hake	55.5	Dover sole	37.81	Longspine thornyhead	21.31
Spiny dogfish	39.4	Pacific hake	17.56	Dover sole	15.21
Pacific sanddab	35.5	Spiny dogfish	17.37	Sablefish	8.03
Chilipepper rockfish	27.6	Shortbelly rockfish	15.39	Pacific grenadier	6.67
Sharpchin rockfish	25.2	Sablefish	11.44	Shortspine thornyhead	6.20
Dover sole	17.6	Pacific ocean perch	11.03	Grooved tanner crab	5.84
Sablefish	11.3	Rex sole	10.10	Giant grenadier	4.53
English sole	8.82	Splitnose rockfish	10.03	California slickhead	3.76
Rex sole	7.17	Darkblotched rockfish	10.01	Brown cat shark	1.57
Yellowtail rockfish	7.15	Sharpchin rockfish	9.84	Deepsea sole	1.09
Redstripe rockfish	7.12	Longnose skate	8.15	Pacific hake	0.64
Lingcod	6.96	Arrowtooth flounder	7.74	Pacific flatnose	0.58
Longnose skate	6.00	Chilipepper rockfish	6.35	Longnose skate	0.50
Arrowtooth flounder	5.27	Shortspine thornyhead	5.39	Roughtail skate	0.48
Spotted ratfish	3.98	Spotted ratfish	4.63	Twoline eelpout	0.43
Petrale sole	3.41	Stripetail rockfish	3.40	Aurora rockfish	0.33
White croaker	2.59	Bering skate	1.78	Rex sole	0.25
Greenstriped	2.58	Lingcod	1.63	Snakehead eelpout	0.23
Big skate	2.00	Pacific halibut	1.52	Black eelpout	0.17
Stripetail rockfish	1.85	Longspine thornyhead	1.38	California grenadier	0.13
Number of hauls	**227**	**Number of hauls**	**176**	**Number of hauls**	**171**

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 2003 West Coast groundfish trawl survey.

Stratum 1 (55–183 m)		Stratum 2 (184–549 m)		Stratum 3 (550–1,280 m)	
Pacific sanddab	12.46	Dover sole	11.05	Longspine thornyhead	16.29
White croaker	2.15	Splitnose rockfish	10.72	Dover sole	10.25
Pacific butterfish	1.99	Chilipepper rockfish	9.48	Shortspine thornyhead	6.89
Spotted ratfish	1.87	Pacific hake	9.11	California slickhead	4.89
Chilipepper rockfish	1.70	Shortbelly rockfish	7.19	Sablefish	4.38
English sole	1.38	Longnose skate	6.41	Brown cat shark	1.40
Barred sand bass	1.33	Rex sole	4.95	Giant grenadier	0.82
Pink sea perch	1.28	Sablefish	2.85	Grooved tanner crab	0.74
Pacific electric ray	0.84	Stripetail rockfish	2.77	Pacific grenadier	0.66
California skate	0.81	Longspine thornyhead	2.25	Pacific hake	0.65
Northern anchovy	0.75	Aurora rockfish	2.06	Longnose skate	0.60
Petrale sole	0.70	Shortspine thornyhead	2.06	Aurora rockfish	0.43
Calif. scorpionfish	0.70	Spiny dogfish	2.03	Deepsea sole	0.35
Halfbanded rockfish	0.60	Spotted ratfish	1.55	Roughtail skate	0.30
Plainfin midshipman	0.60	Filetail cat shark	1.46	Pacific flatnose	0.30
Lingcod	0.59	Bering skate	0.93	Twoline eelpout	0.25
Spiny dogfish	0.48	Slender sole	0.81	California grenadier	0.21
Stripetail rockfish	0.47	Brown cat shark	0.81	Smooth grenadier	0.16
Big skate	0.45	Bigfin eelpout	0.64	Threadfin slickhead	0.10
Soupfin shark	0.44	Petrale sole	0.62	Deepsea smelt unident.	0.08
Number of hauls	**52**	**Number of hauls**	**54**	**Number of hauls**	**28**

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 2003 West Coast groundfish trawl survey.

Stratum 1 (55–183 m)		Stratum 2 (184–549 m)		Stratum 3 (550–1,280 m)	
Chilipepper rockfish	113.3	Shortbelly rockfish	101.1	Dover sole	42.57
Pacific sanddab	76.30	Dover sole	79.40	Pacific grenadier	32.96
Spiny dogfish	59.22	Spotted ratfish	20.74	Longspine thornyhead	28.87
Pacific hake	21.03	Splitnose rockfish	19.50	Grooved tanner crab	20.40
English sole	12.20	Chilipepper rockfish	18.73	Sablefish	16.45
White croaker	9.22	Pacific hake	17.92	Giant grenadier	12.33
Stripetail rockfish	4.99	Rex sole	15.99	Shortspine thornyhead	7.70
Shortbelly rockfish	4.87	Darkblotched rockfish	12.44	California slickhead	4.60
Petrale sole	4.86	Stripetail rockfish	11.30	Deepsea sole	2.75
Longnose skate	4.51	Sablefish	9.90	Brown cat shark	2.73
Rex sole	3.29	Longnose skate	6.98	Pacific flatnose	1.48
Grnstrpd rockfish	3.11	Spiny dogfish	5.45	Roughtail skate	0.75
Lingcod	2.84	Shortspine thornyhead	4.29	Bigfin eelpout	0.70
Spotted ratfish	2.15	English sole	4.22	Longnose skate	0.67
Big skate	1.85	Lingcod	2.56	Pacific hake	0.65
California skate	1.75	Bering skate	2.14	Aurora rockfish	0.49
Rock sole unident.	1.66	Bigfin eelpout	1.83	Snakehead eelpout	0.48
Sablefish	1.55	Arrowtooth flounder	1.55	Twoline eelpout	0.43
Yellowtail rockfish	1.24	Aurora rockfish	1.46	Deepsea skate	0.40
Plainfin midshipman	1.02	Petrale sole	1.43	Rex sole	0.37
Number of hauls	**45**	**Number of hauls**	**30**	**Number of hauls**	**26**

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 2003 West Coast groundfish trawl survey.

Stratum 1 (55–183 m)		Stratum 2 (184–549 m)		Stratum 3 (550–1,280 m)	
Sharpchin rockfish	215.85	Dover sole	94.20	Longspine thornyhead	35.72
Pacific hake	96.70	Rex sole	25.49	Dover sole	22.88
Redstripe rockfish	52.79	Pacific hake	22.27	Sablefish	18.49
Dover sole	34.02	Sharpchin rockfish	19.51	Giant grenadier	12.97
Lingcod	32.56	Sablefish	18.04	Grooved tanner crab	10.22
Pacific sanddab	20.17	Longnose skate	14.86	Pacific grenadier	6.05
English sole	14.62	Stripetail rockfish	10.50	Shortspine thornyhead	5.07
Rex sole	13.32	Splitnose rockfish	9.00	Brown cat shark	2.35
Sablefish	8.54	Spiny dogfish	5.69	Deepsea sole	2.25
Longnose skate	7.22	Lingcod	3.79	Rex sole	1.46
Grnstrpd rockfish	6.28	Darkblotched rockfish	3.65	California slickhead	1.24
Spotted ratfish	5.24	Shortspine thornyhead	3.65	Black eelpout	1.03
Stripetail rockfish	5.02	Arrowtooth flounder	3.43	Pacific hake	0.87
Chilipepper rockfish	4.43	Bigfin eelpout	3.15	Snakehead eelpout	0.81
Petrale sole	3.78	Spotted ratfish	2.74	Roughtail skate	0.73
Yellowtail rockfish	3.54	Bering skate	2.39	Pacific flatnose	0.62
Arrowtooth flounder	2.82	English sole	2.24	Twoline eelpout	0.50
Big skate	2.77	Black eelpout	1.95	Hagfish unident.	0.16
Drkbltchd rockfish	2.55	Slender sole	1.54	Blacktail snailfish	0.13
Rosethorn rockfish	2.11	Greenstriped rockfish	1.36	Deepsea smelt unident.	0.08
Number of hauls	**35**	**Number of hauls**	**36**	**Number of hauls**	**33**

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 2003 West Coast groundfish trawl survey.

Stratum 1 (55–183 m)		Stratum 2 (184–549 m)		Stratum 3 (550–1,280 m)	
Pacific hake	86.06	Dover sole	38.11	Longspine thornyhead	25.80
Pacific sanddab	30.81	Pacific hake	32.97	Grooved tanner crab	11.33
Dover sole	29.43	Sharpchin rockfish	28.03	Dover sole	10.52
Sablefish	16.88	Darkblotched rockfish	27.15	Sablefish	10.31
Yellowtail rockfish	14.06	Pacific ocean perch	25.25	Pacific grenadier	9.77
Rex sole	11.04	Sablefish	24.41	Giant grenadier	6.84
Longnose skate	9.08	Arrowtooth flounder	19.34	Shortspine thornyhead	3.51
English sole	8.73	Rex sole	12.40	Deepsea sole	1.82
Arrowtooth flounder	6.90	Spiny dogfish	9.52	Brown cat shark	1.11
Spiny dogfish	5.37	Shortspine thornyhead	9.16	Pacific flatnose	0.86
Lingcod	4.97	Longnose skate	8.02	Roughtail skate	0.77
Spotted ratfish	4.12	Splitnose rockfish	6.39	Twoline eelpout	0.70
Petrale sole	3.35	Redstripe rockfish	4.06	California slickhead	0.62
Slender sole	2.77	Pacific halibut	3.98	Pacific hake	0.56
Big skate	2.70	Rosethorn rockfish	2.91	Snakehead eelpout	0.44
Sharpchin rockfish	2.70	Lingcod	2.12	Black eelpout	0.34
Pacific halibut	1.91	Bering skate	1.79	Rex sole	0.32
Redstripe rockfish	1.46	Slender sole	1.68	Longnose skate	0.28
Grnstrpd rockfish	1.36	Bigfin eelpout	1.61	Bering skate	0.21
Flathead sole	1.29	Spotted ratfish	1.43	Blacktail snailfish	0.18
Number of hauls	**47**	**Number of hauls**	**40**	**Number of hauls**	**61**

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 2003 West Coast groundfish survey.

Stratum 1 (55–183 m)		Stratum 2 (184–549 m)		Stratum 3 (550–1,280 m)	
Spiny dogfish	362.75	Spiny dogfish	133.66	Longspine thornyhead	25.73
Pacific hake	89.07	Dover sole	63.95	Giant grenadier	9.94
Sablefish	51.29	Pacific ocean perch	39.54	Grooved tanner crab	8.93
Arrowtooth flounder	34.79	Arrowtooth flounder	18.48	Pacific grenadier	6.06
Dover sole	31.31	Longnose skate	13.11	Sablefish	4.39
Yellowtail rockfish	14.00	Shortspine thornyhead	11.57	Shortspine thornyhead	2.62
Spotted ratfish	13.98	Spotted ratfish	8.89	Twoline eelpout	2.24
Pacific sanddab	10.11	Sablefish	8.18	Deepsea sole	2.13
Redstripe rockfish	10.09	Rex sole	7.83	Dover sole	1.75
Grnstrpd rockfish	9.51	Splitnose rockfish	6.52	Roughtail skate	0.85
English sole	9.11	Flathead sole	6.44	Pacific flatnose	0.84
Lingcod	9.00	Pacific hake	5.16	Black eelpout	0.58
Pacific cod	8.49	Sharpchin rockfish	4.89	Snakehead eelpout	0.47
Rex sole	8.19	Bering skate	4.73	California slickhead	0.26
Longnose skate	7.59	Greenstriped rockfish	4.64	Blacktail snailfish	0.22
Petrale sole	5.88	Darkblotched rockfish	4.61	Brown cat shark	0.16
Canary rockfish	4.71	Pacific cod	3.34	Hagfish unident.	0.16
Slender sole	4.00	Pacific halibut	2.70	Pacific hake	0.14
Pacific halibut	3.44	Slender sole	2.02	Blob sculpin	0.13
Flathead sole	2.62	Lingcod	2.02	Longnose skate	0.11
Number of hauls	**48**	**Number of hauls**	**16**	**Number of hauls**	**23**

Figures 7–35 show the geographical distributions and relative abundances of select groundfish species (created with ArcGIS Software, Environmental Systems Research Institute Inc., Redlands, California). 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) over two standard deviations greater than the mean CPUE.

Biomass and Population Estimates

Abundance estimates of biomass in metric tons (mt) along with associated CV 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 rockfish, 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 rockfish 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 rockfish 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. For the INPFC Conception area, halfbanded rockfish (data not shown) exhibited the highest observed biomass for fish within the shallow stratum.

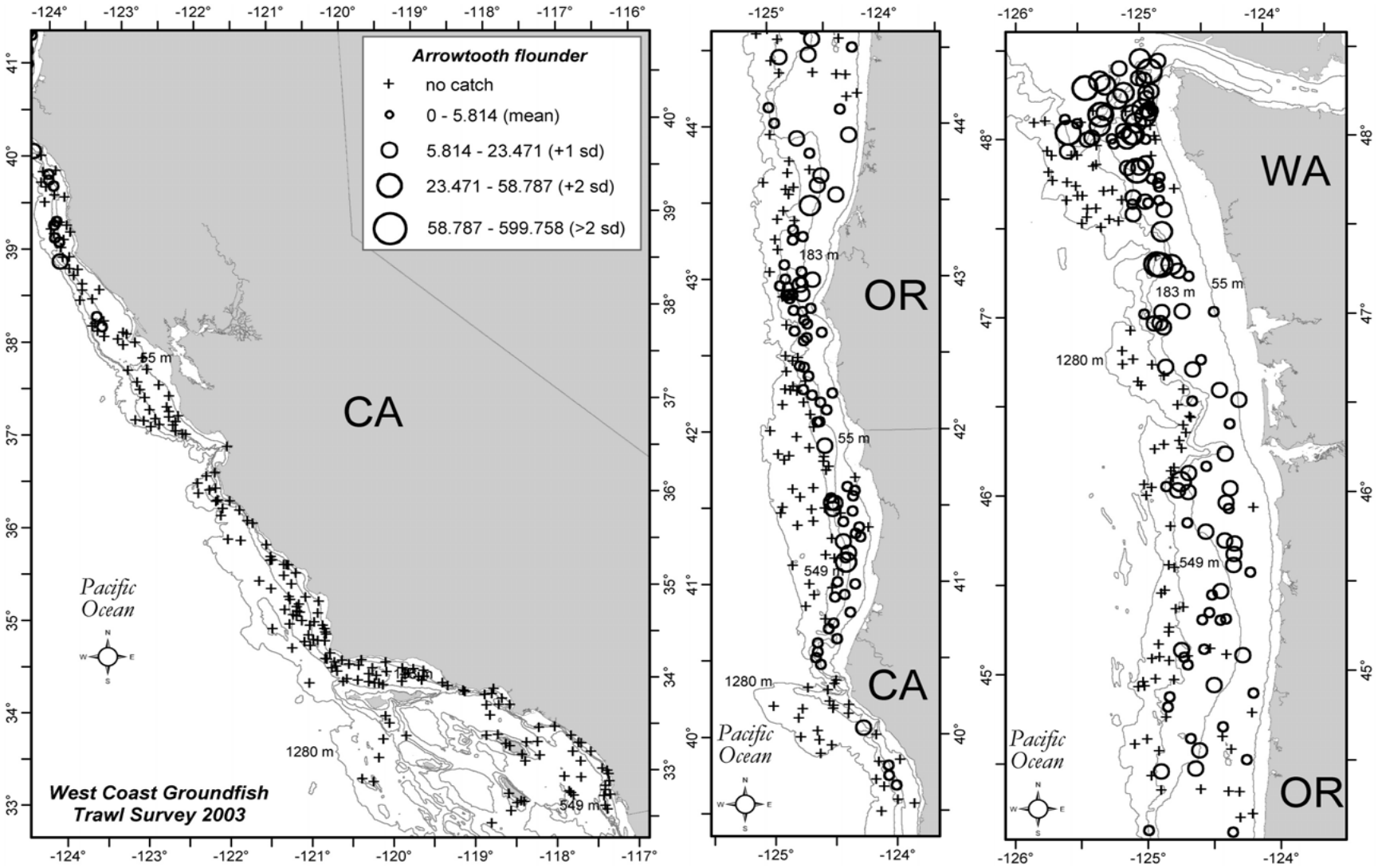


Figure 7. Arrowtooth flounder distribution and relative abundance (kg/ha) from the 2003 West Coast groundfish trawl survey.

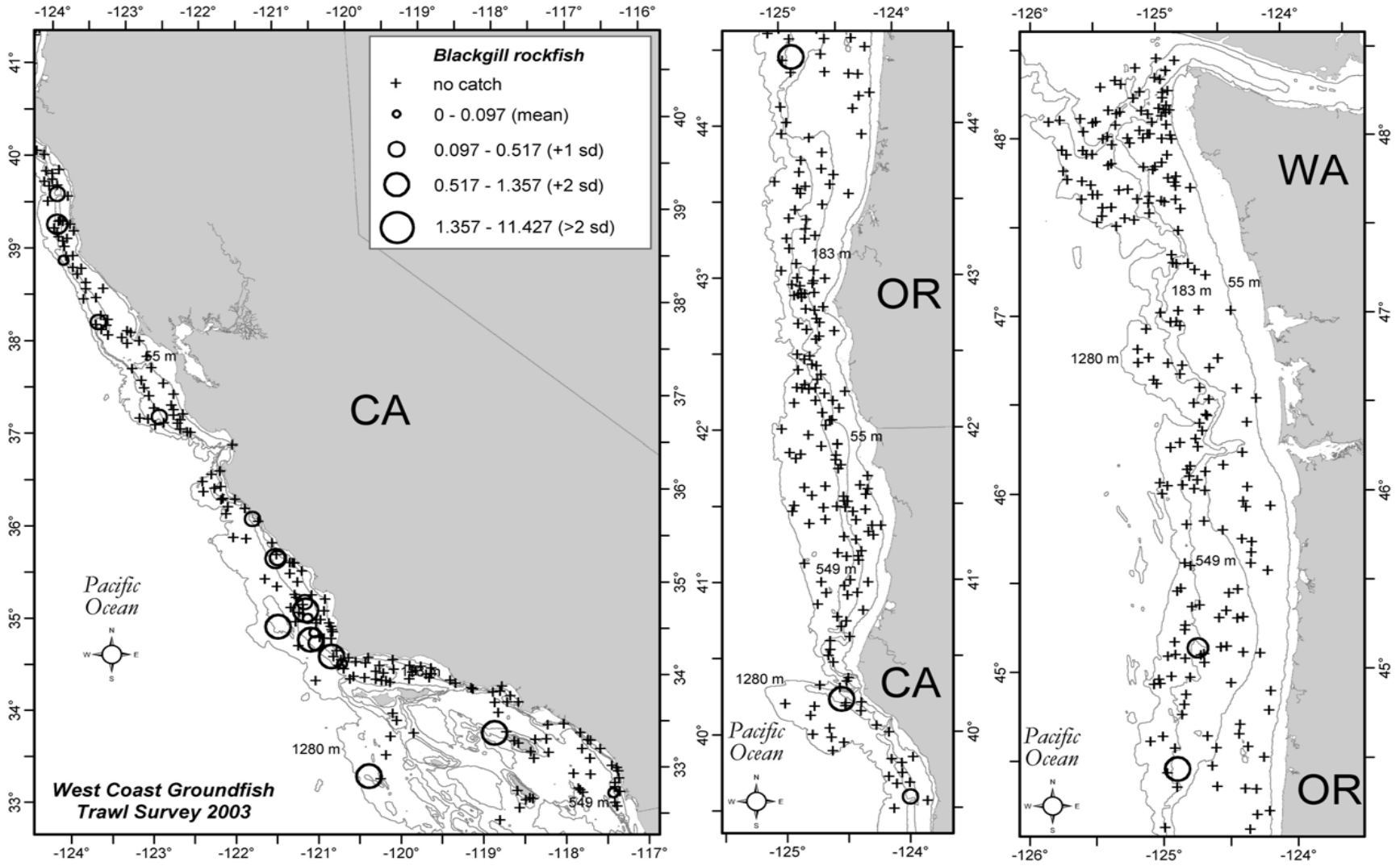


Figure 8. Blackgill rockfish distribution and relative abundance (kg/ha) from the 2003 West Coast groundfish trawl survey.

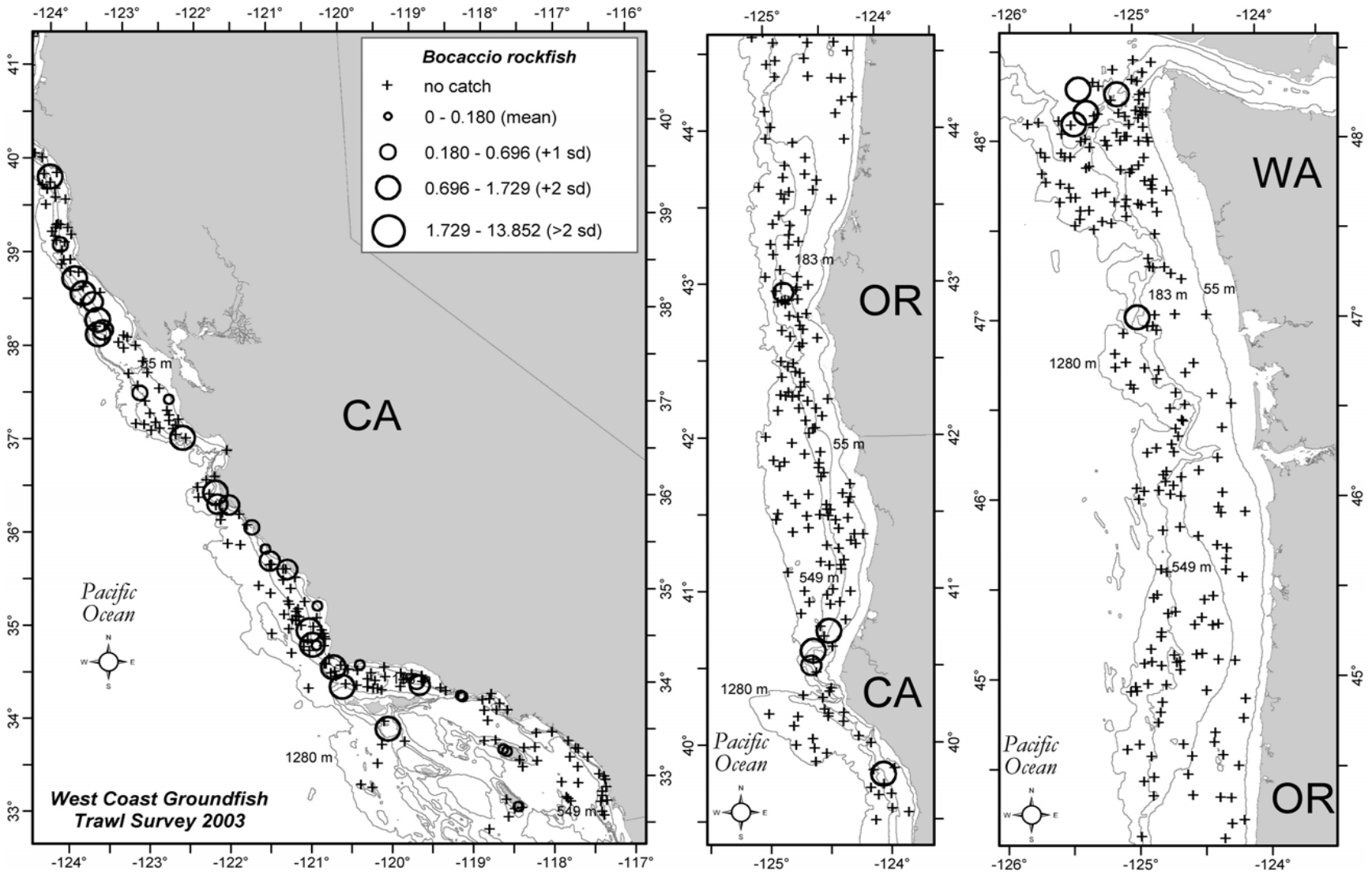


Figure 9. Bocaccio distribution and relative abundance (kg/ha) from the 2003 West Coast groundfish trawl survey.

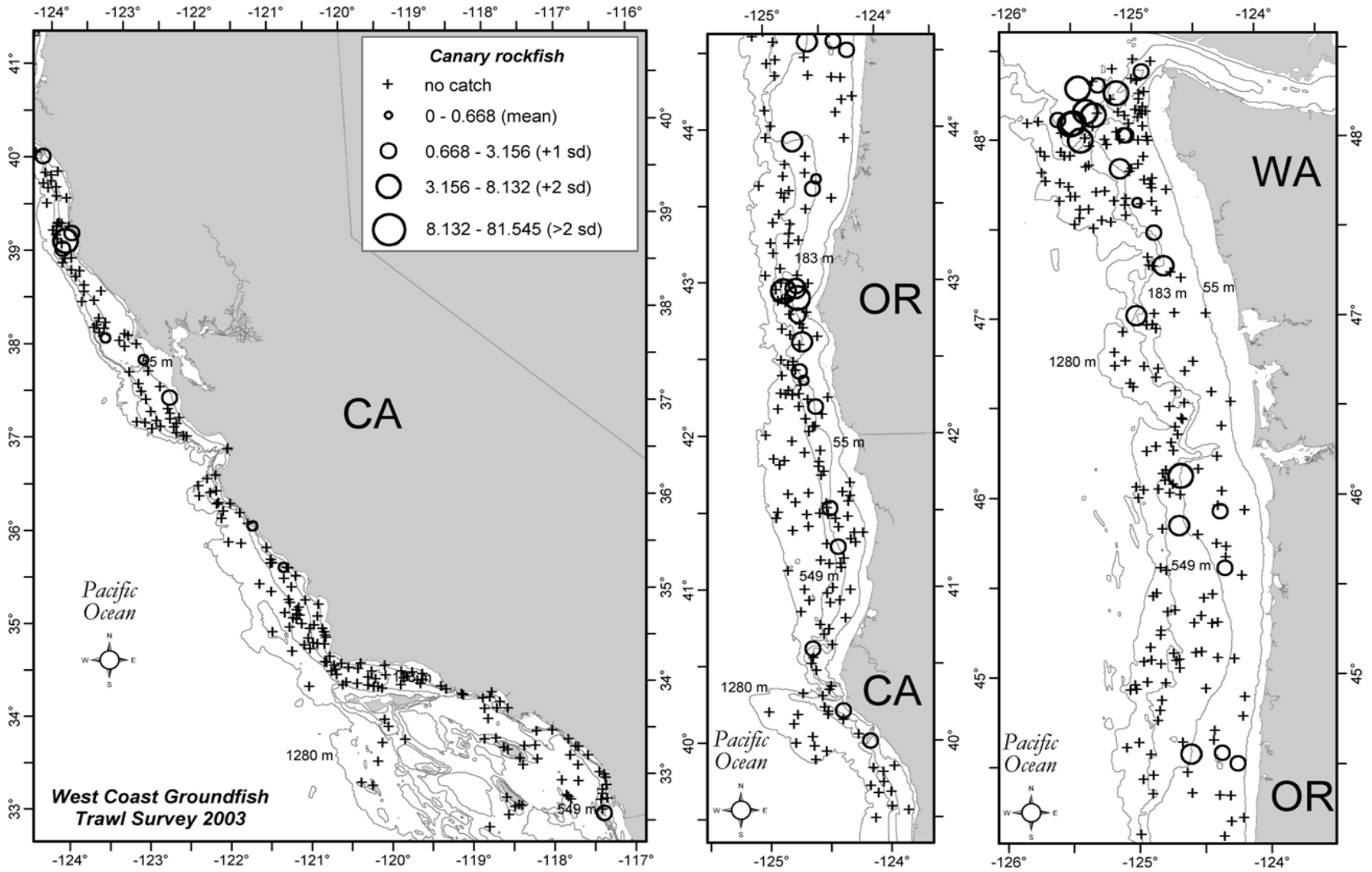


Figure 10. Canary rockfish distribution and relative abundance (kg/ha) from the 2003 West Coast groundfish trawl survey.

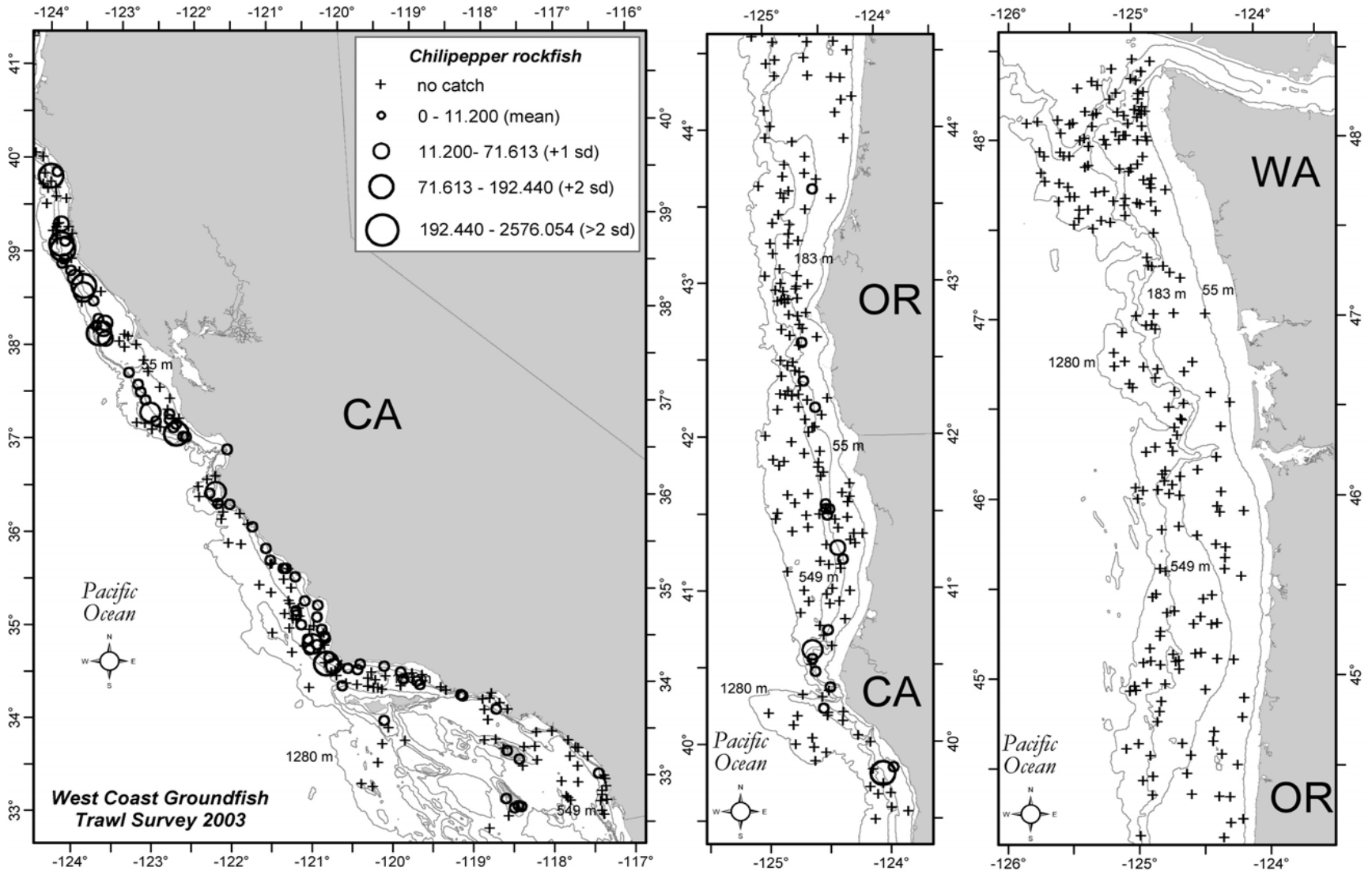


Figure 11. Chilipepper rockfish distribution and relative abundance (kg/ha) from the 2003 West Coast groundfish trawl survey.

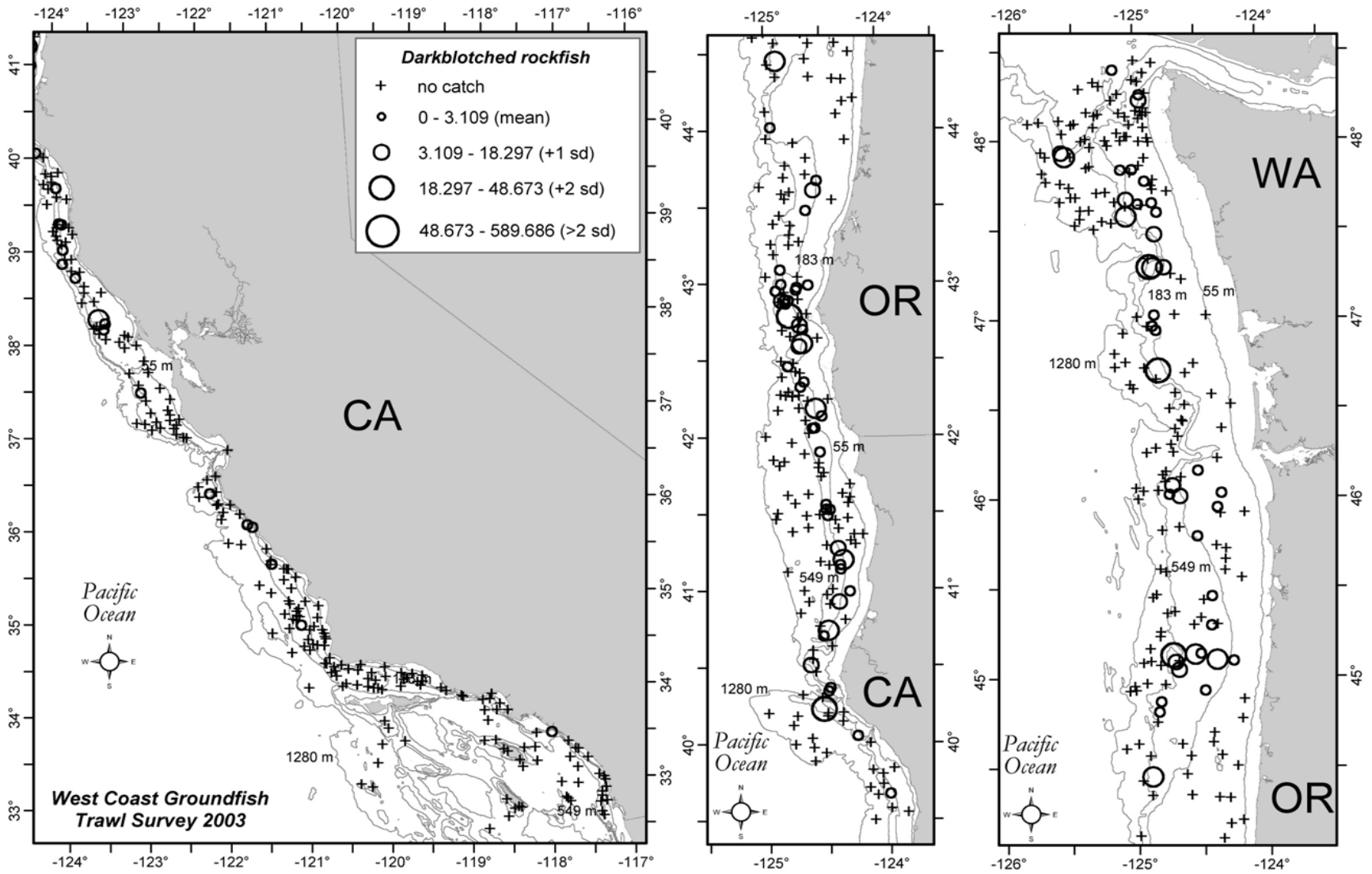


Figure 12. Darkblotched rockfish distribution and relative abundance (kg/ha) from the 2003 West Coast groundfish trawl survey.

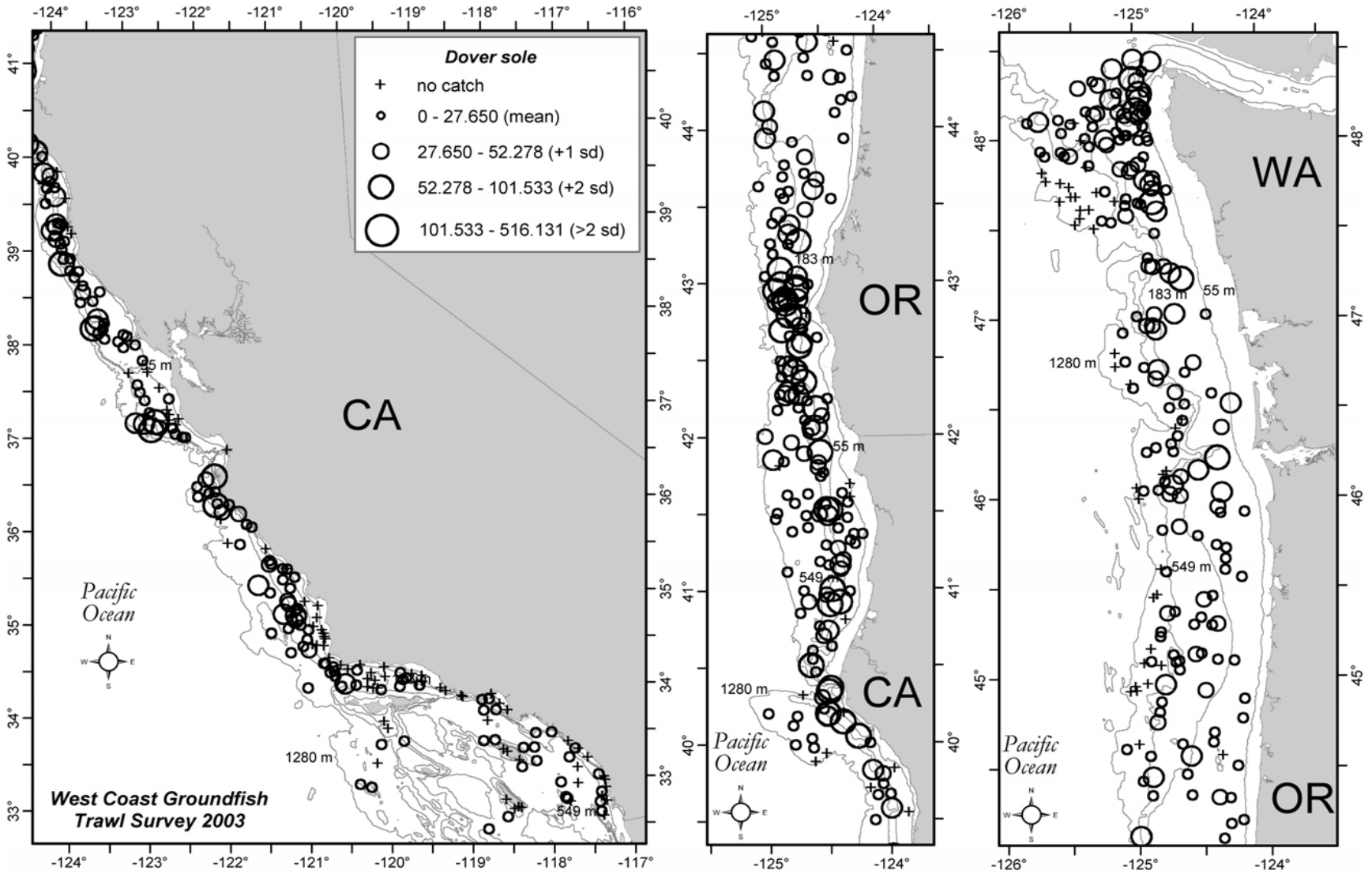


Figure 13. Dover sole distribution and relative abundance (kg/ha) from the 2003 West Coast groundfish trawl survey.

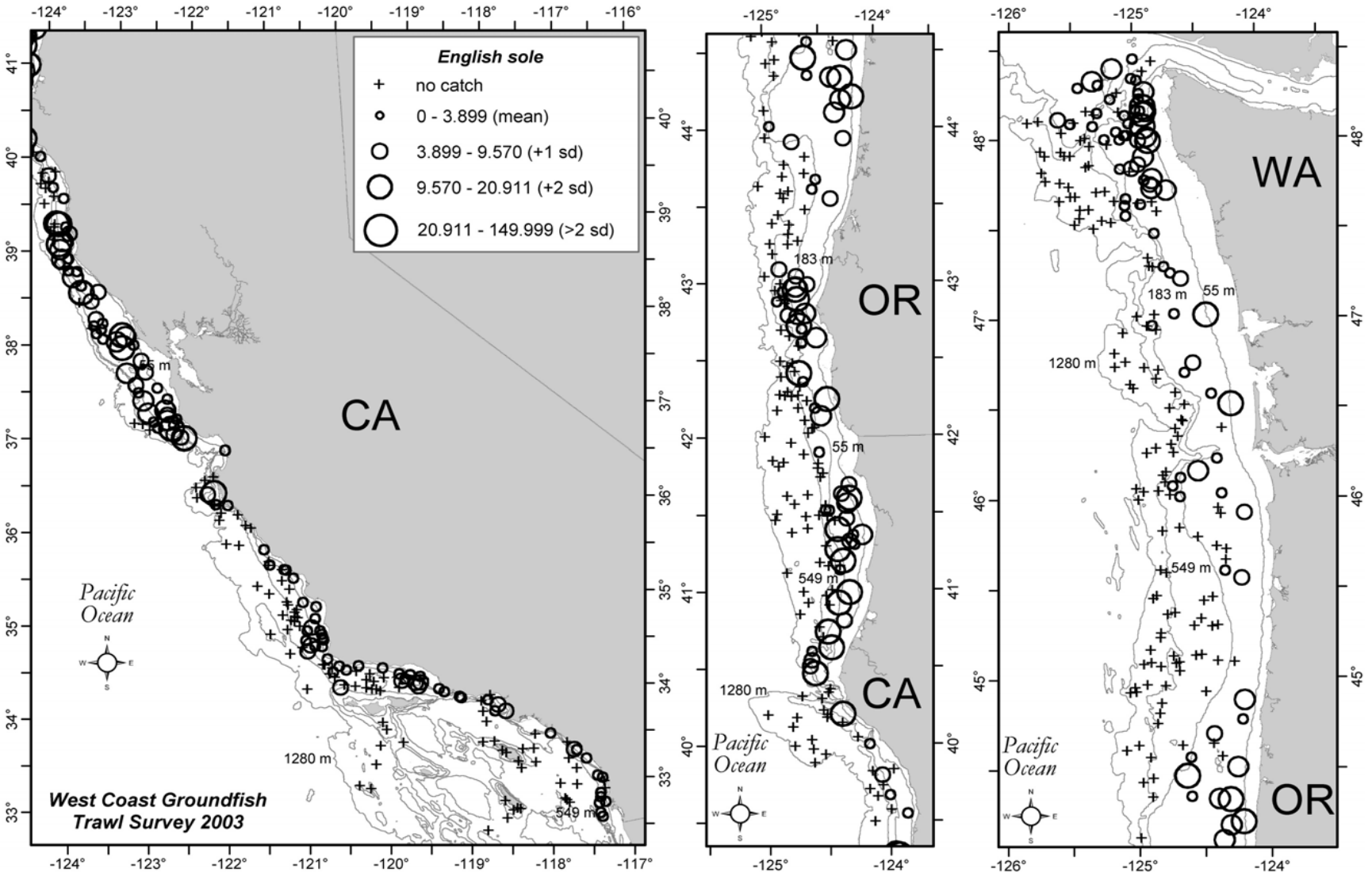


Figure 14. English sole distribution and relative abundance (kg/ha) from the 2003 West Coast groundfish trawl survey.

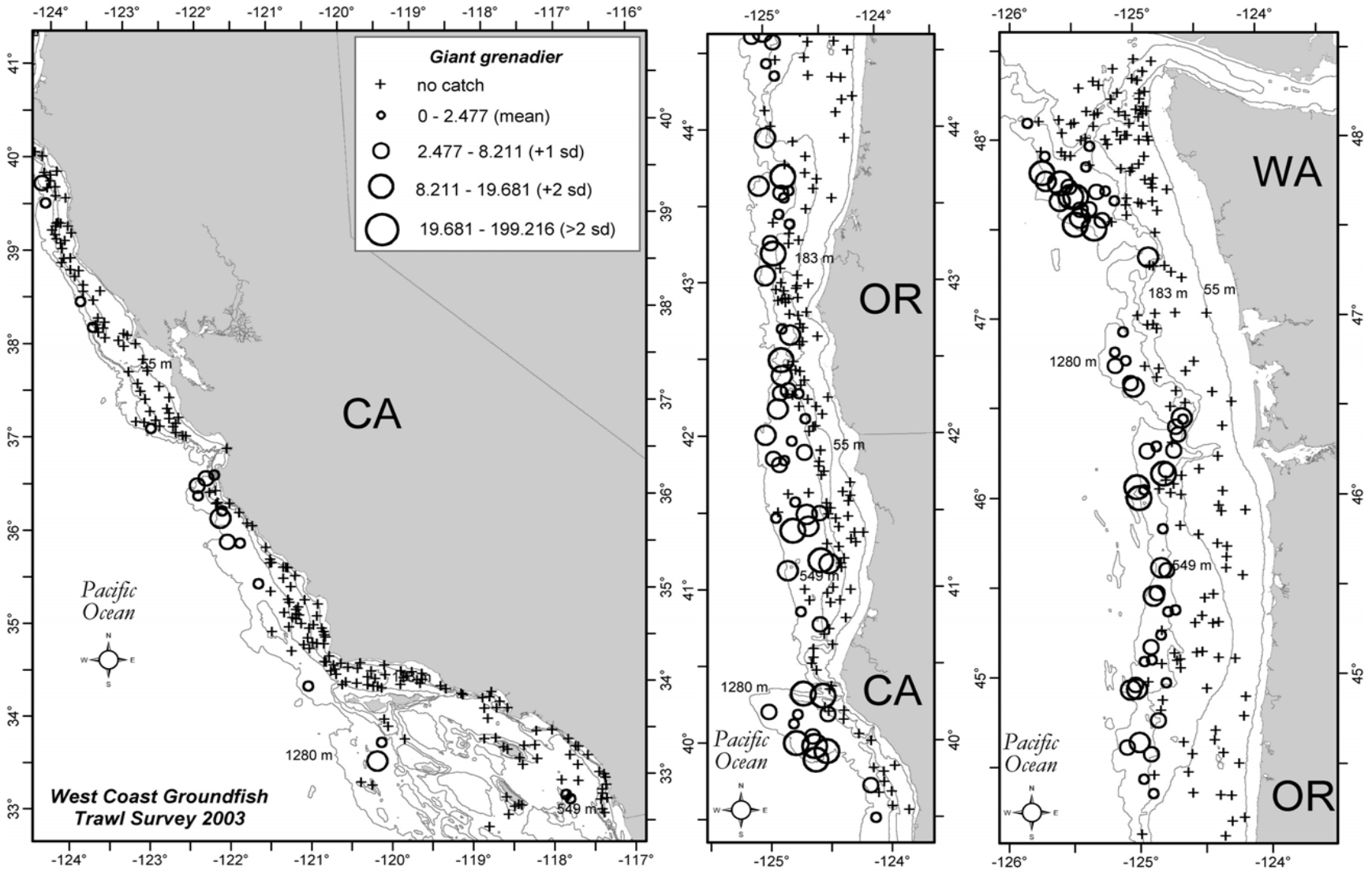


Figure 15. Giant grenadier distribution and relative abundance (kg/ha) from the 2003 West Coast groundfish trawl survey.

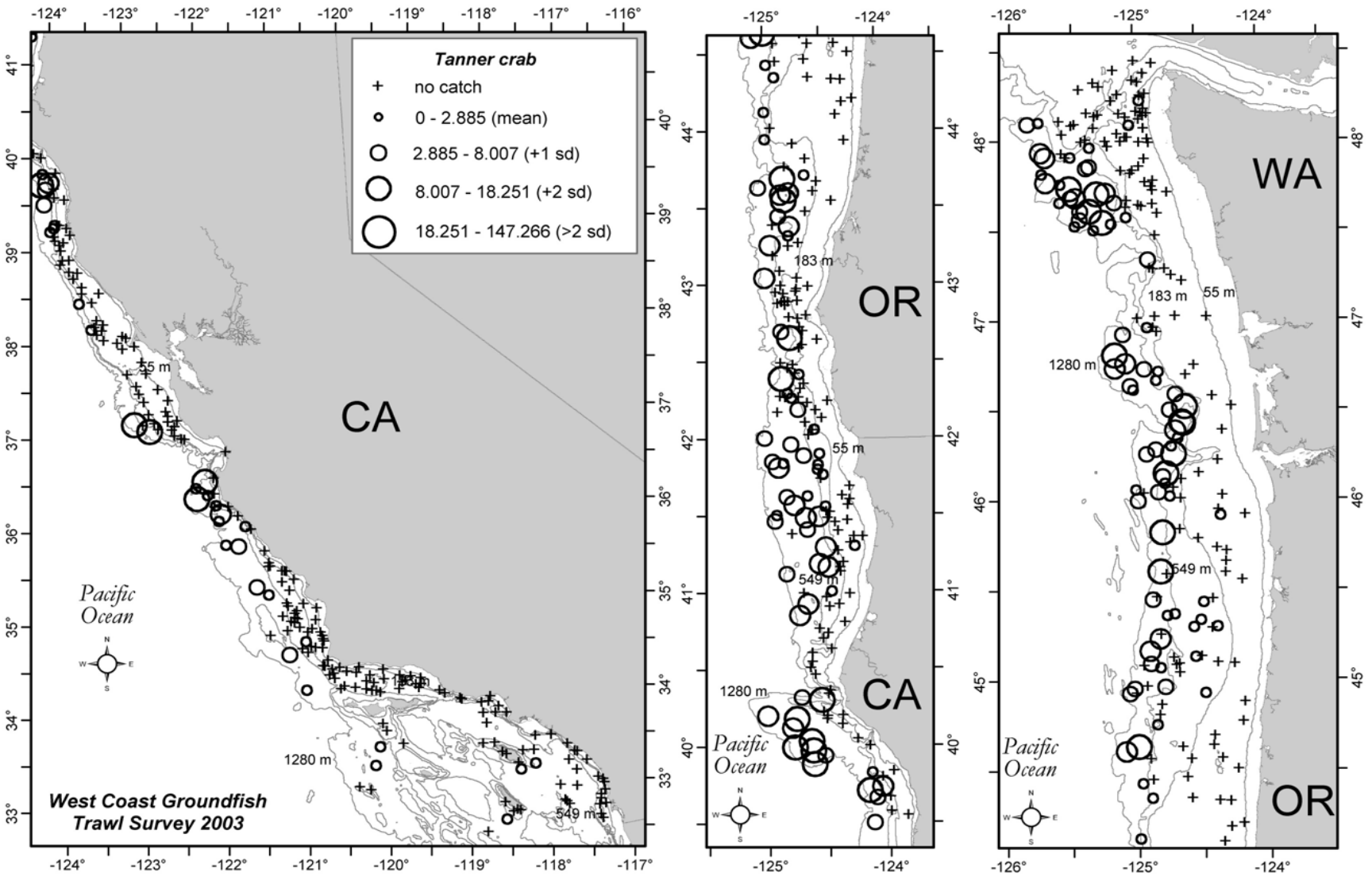


Figure 16. Grooved tanner crab distribution and relative abundance (kg/ha) from the 2003 West Coast groundfish trawl survey.

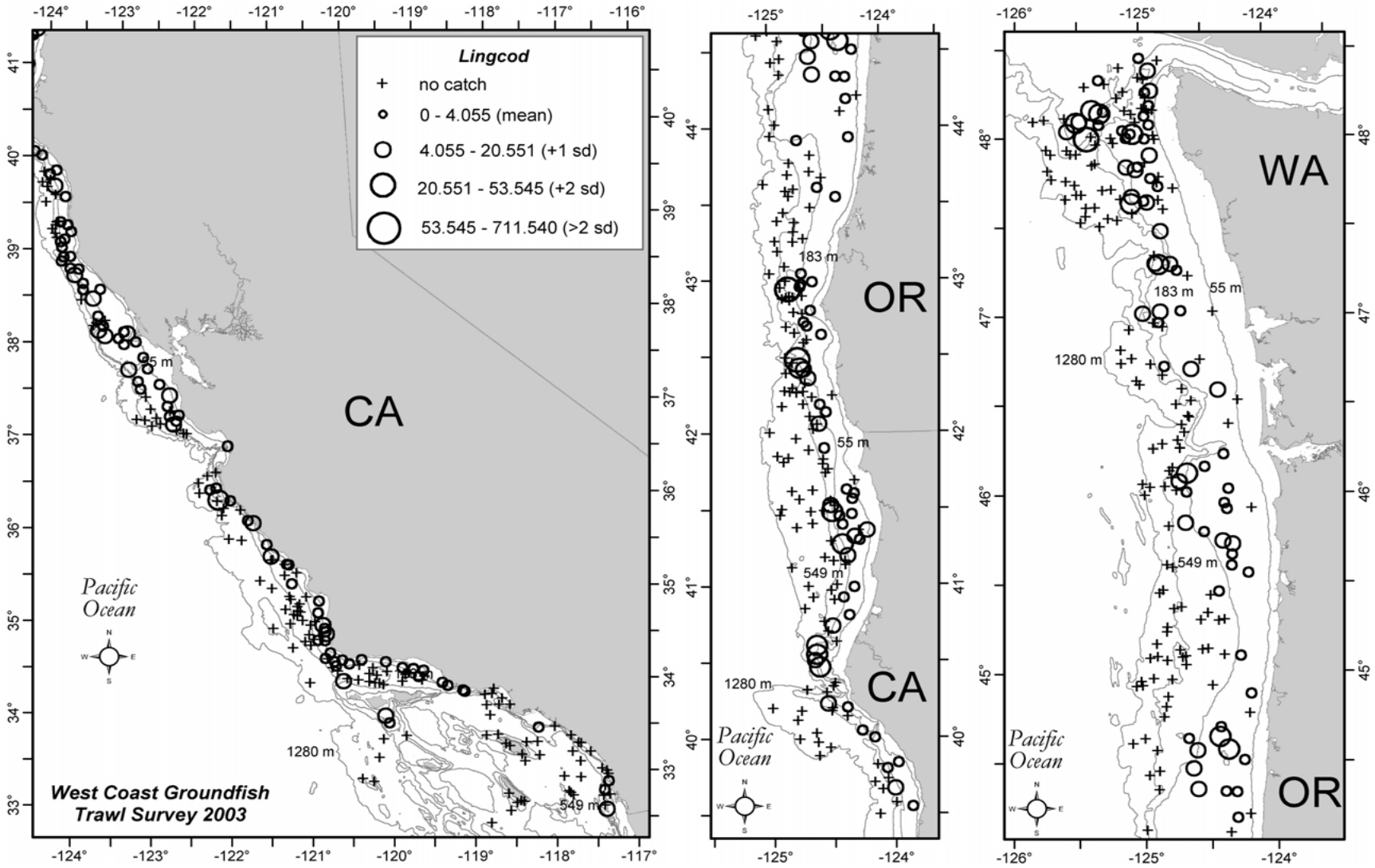


Figure 17. Lingcod distribution and relative abundance (kg/ha) from the 2003 West Coast groundfish trawl survey.

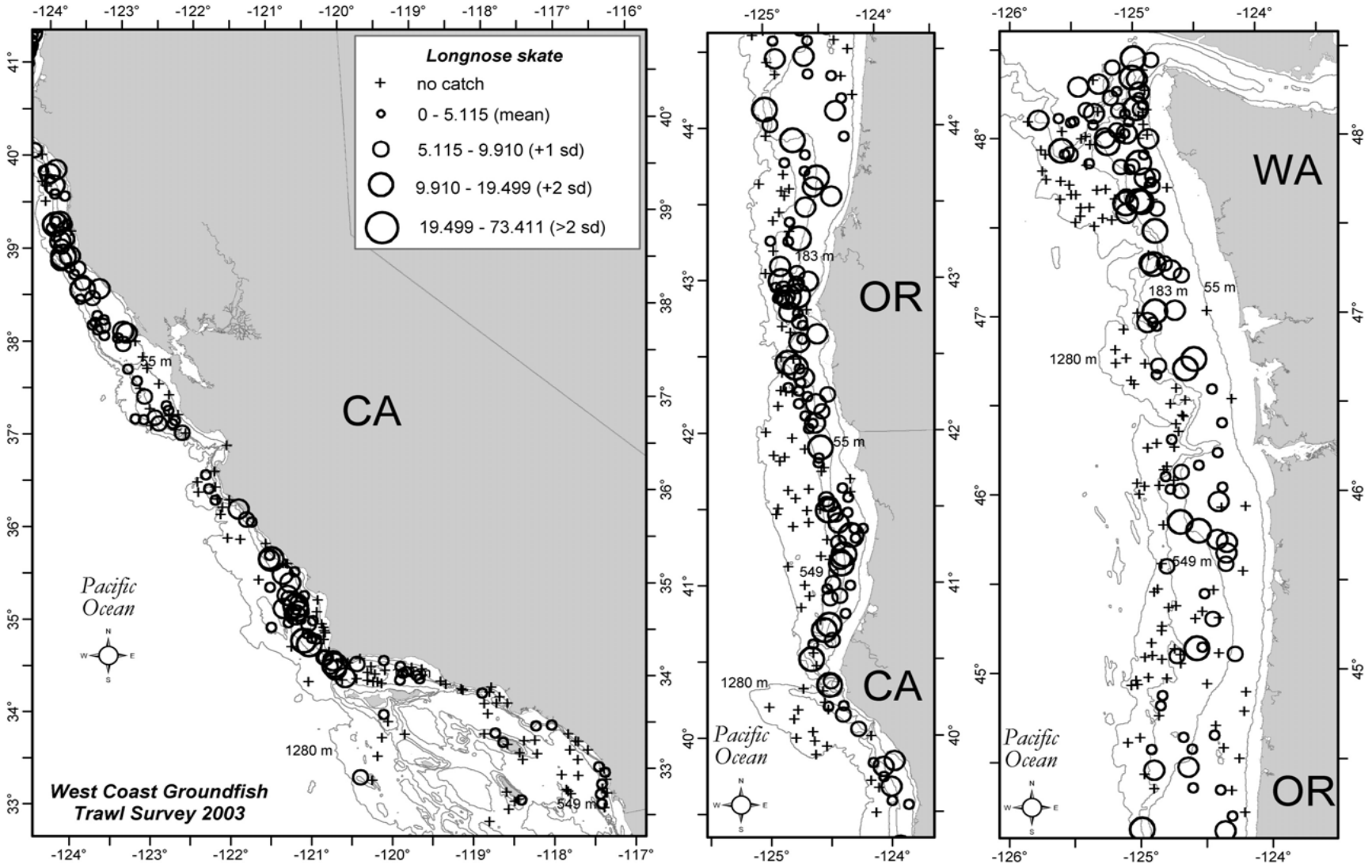


Figure 18. Longnose skate distribution and relative abundance (kg/ha) from the 2003 West Coast groundfish trawl survey.

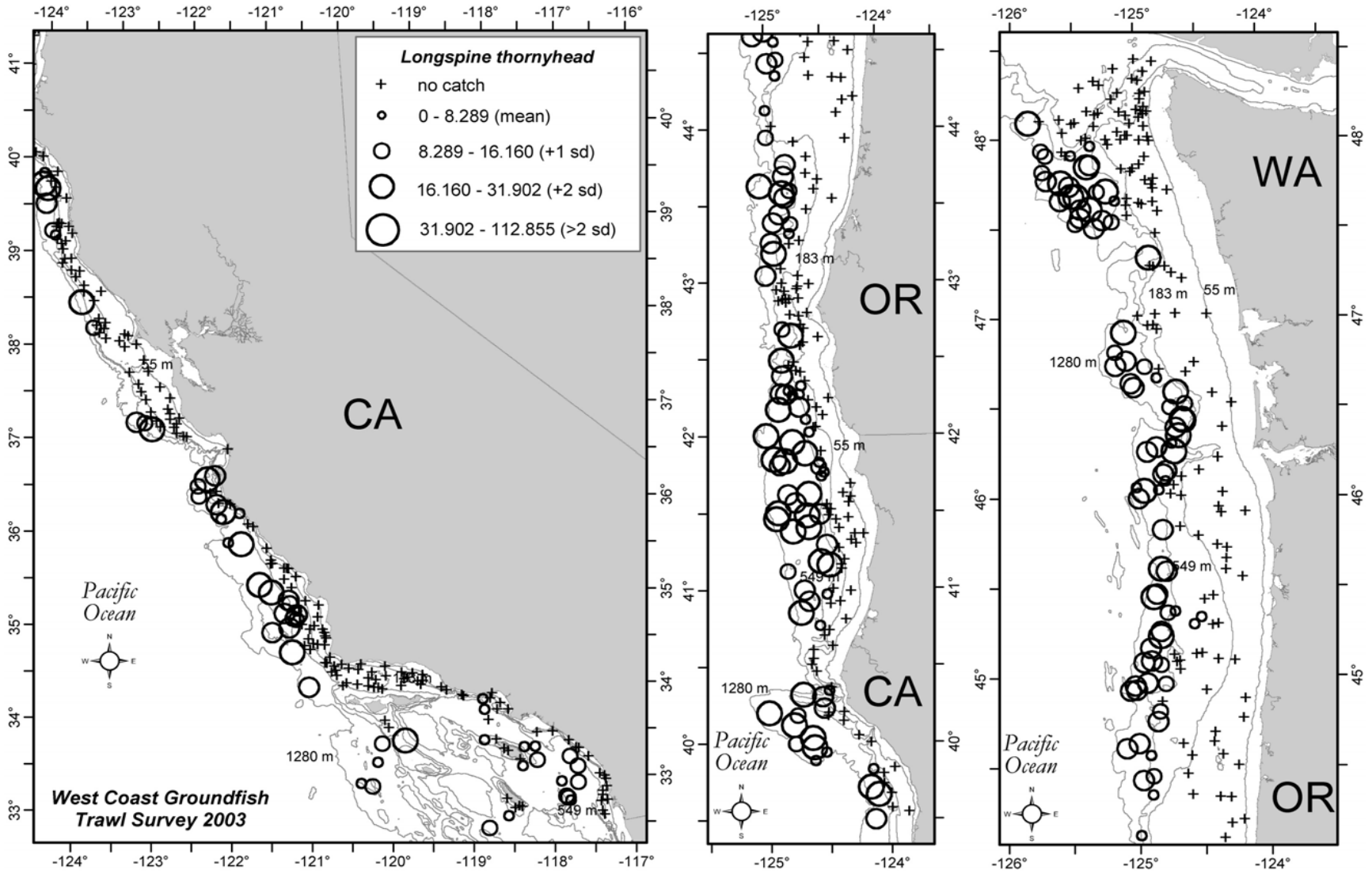


Figure 19. Longspine thornyhead distribution and relative abundance (kg/ha) from the 2003 West Coast groundfish trawl survey.

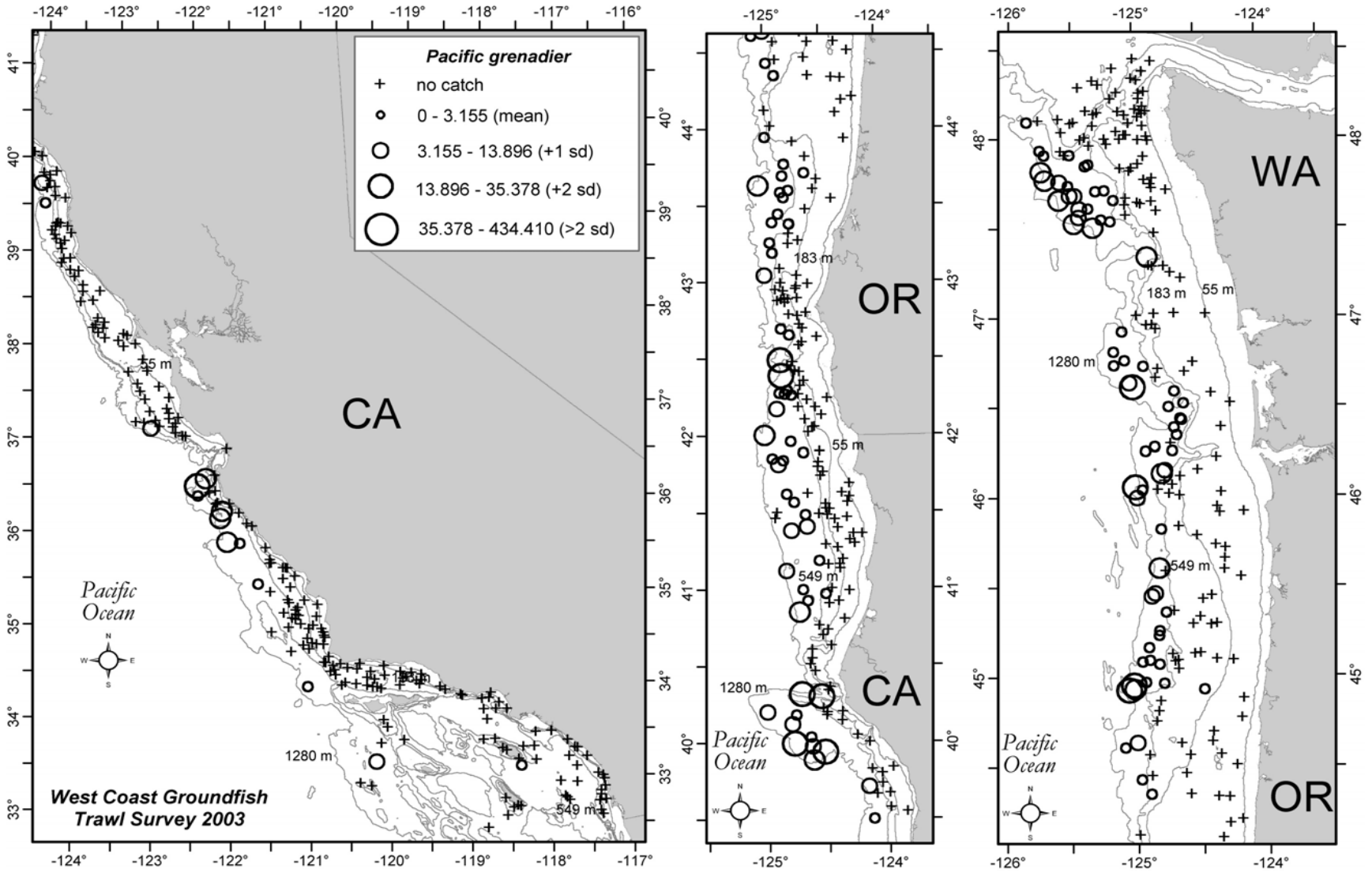


Figure 20. Pacific grenadier distribution and relative abundance (kg/ha) from the 2003 West Coast groundfish trawl survey.

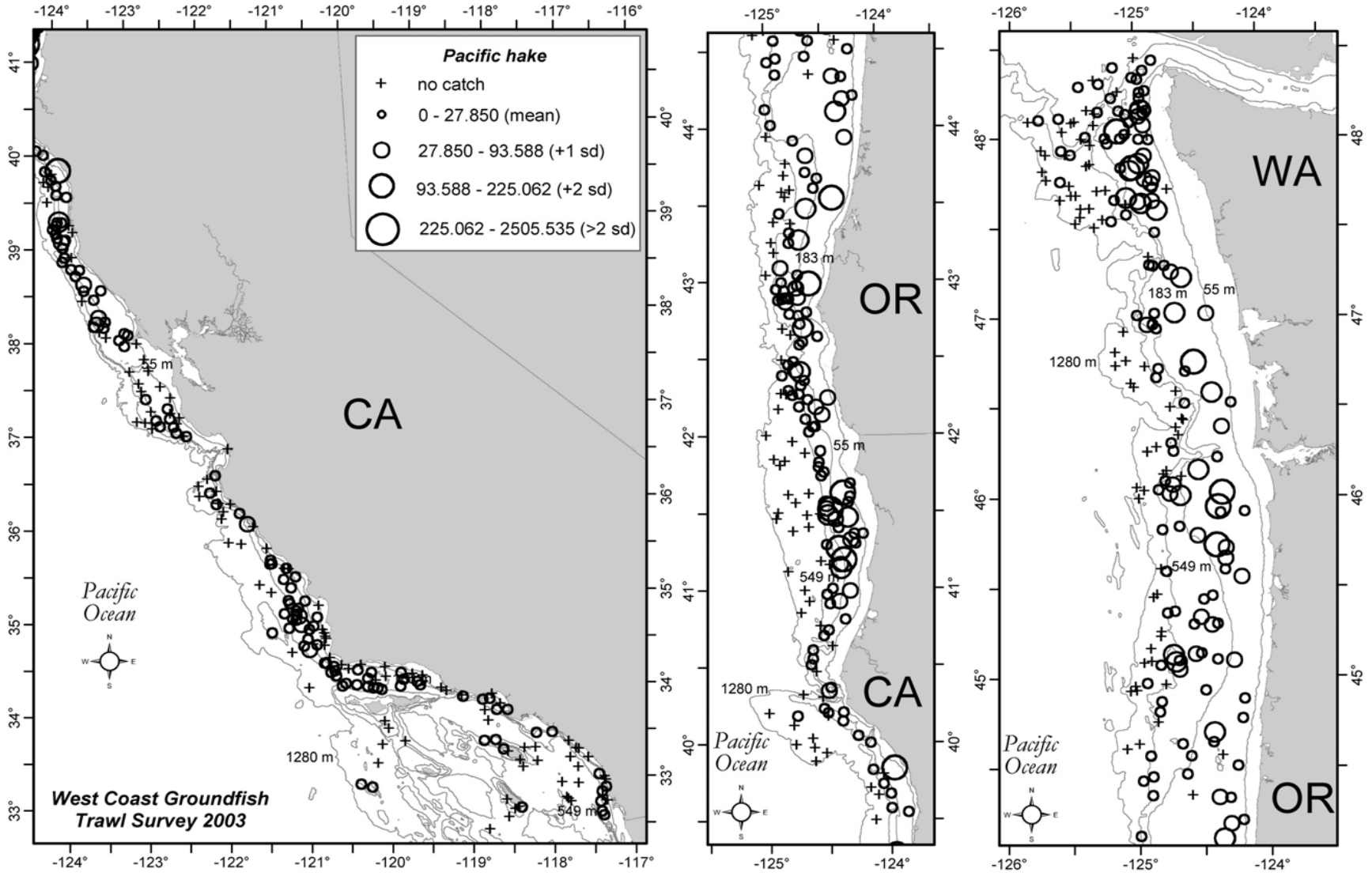


Figure 21. Pacific hake distribution and relative abundance (kg/ha) from the 2003 West Coast groundfish trawl survey.

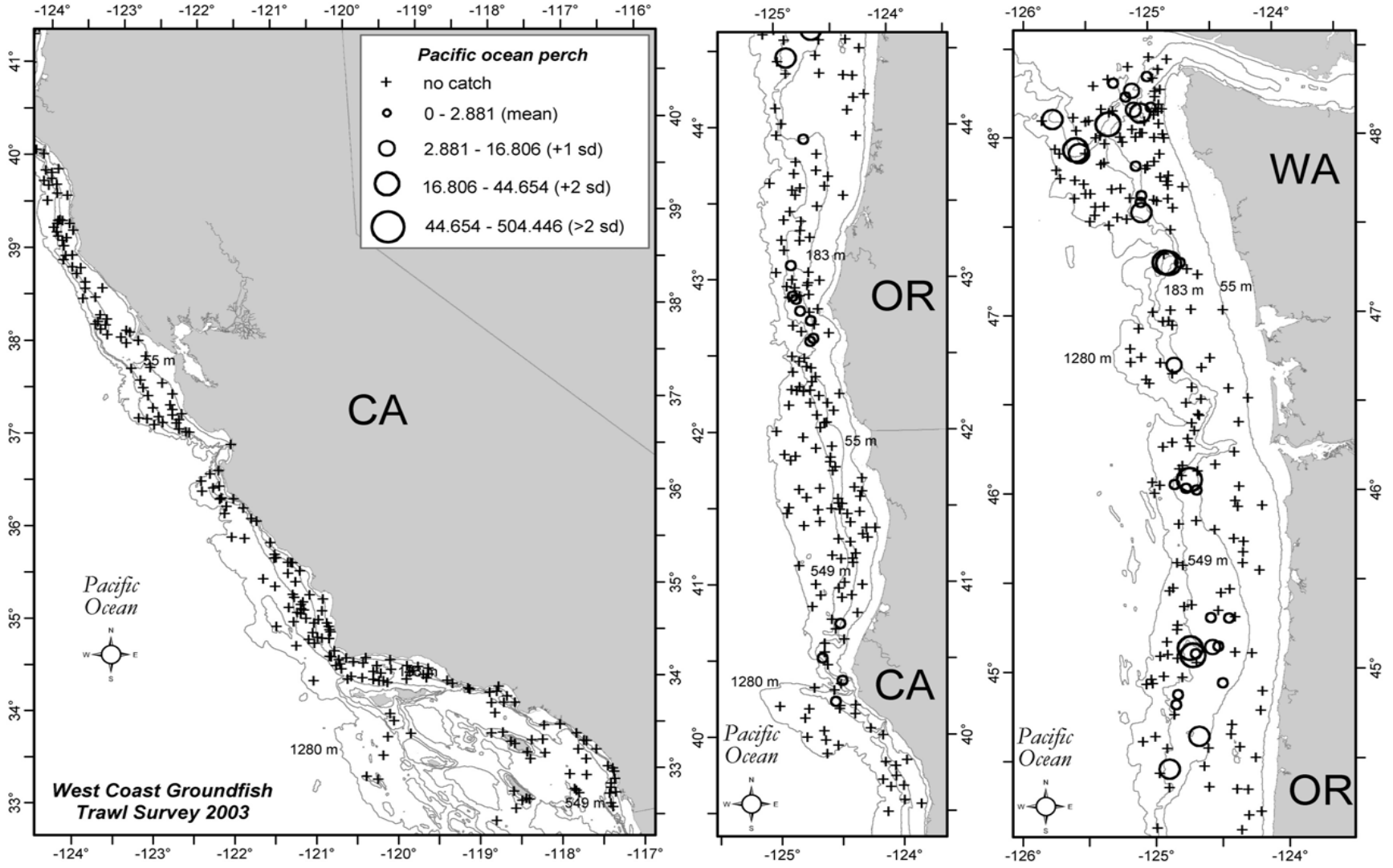


Figure 22. Pacific ocean perch distribution and relative abundance (kg/ha) from the 2003 West Coast groundfish trawl survey.

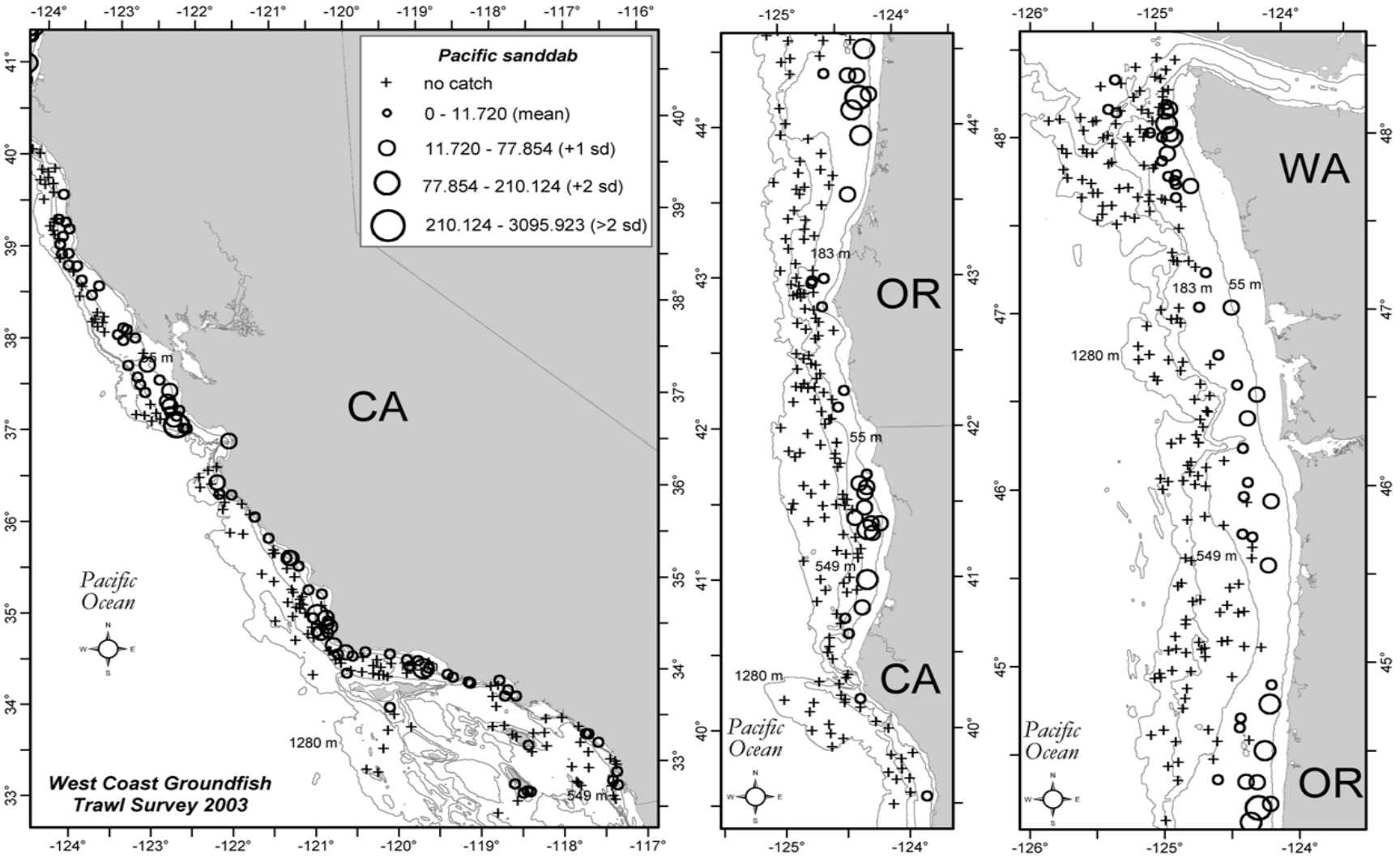


Figure 23. Pacific sanddab distribution and relative abundance (kg/ha) from the 2003 West Coast groundfish trawl survey.

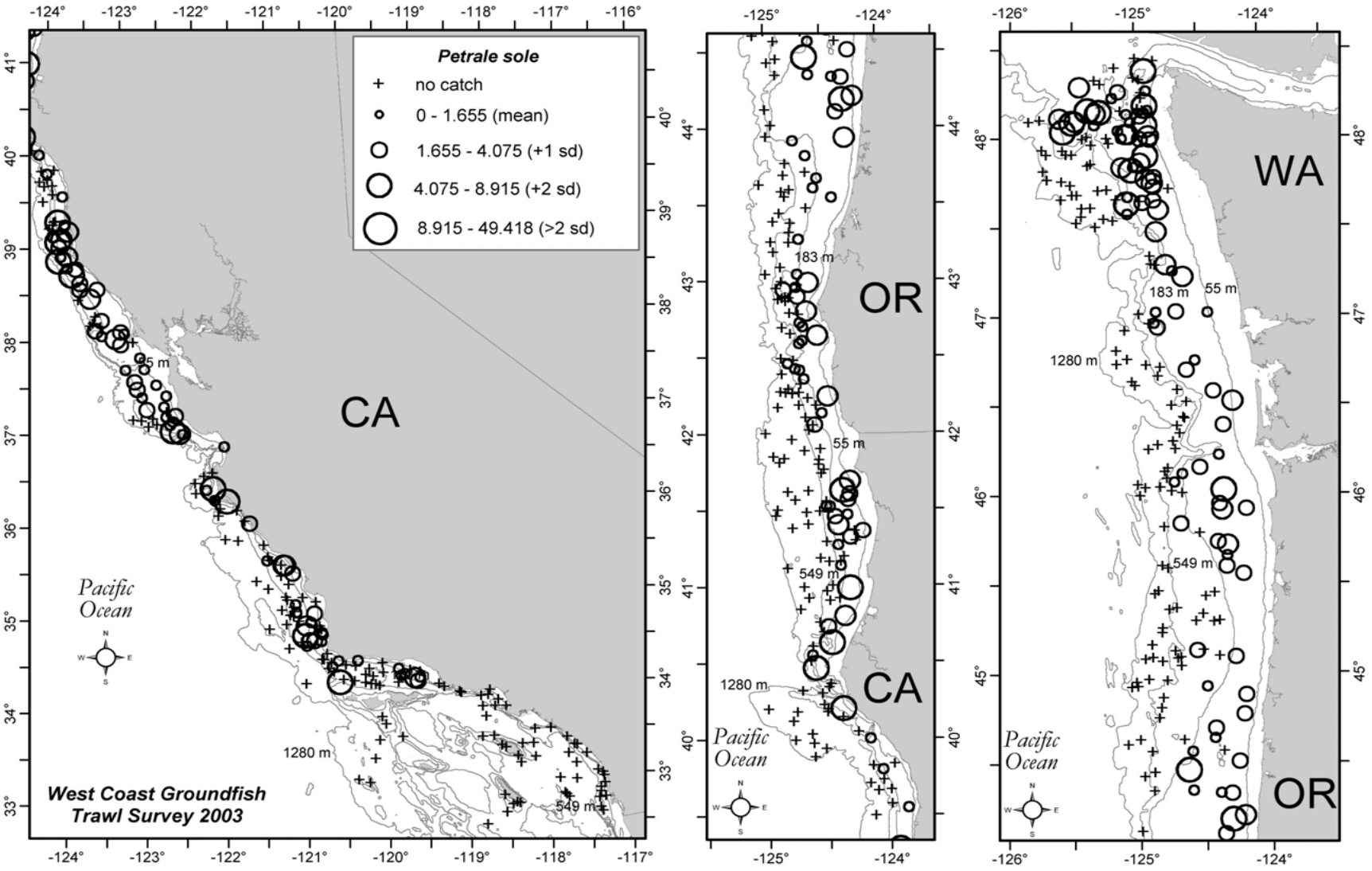


Figure 24. Petrale sole distribution and relative abundance (kg/ha) from the 2003 West Coast groundfish trawl survey.

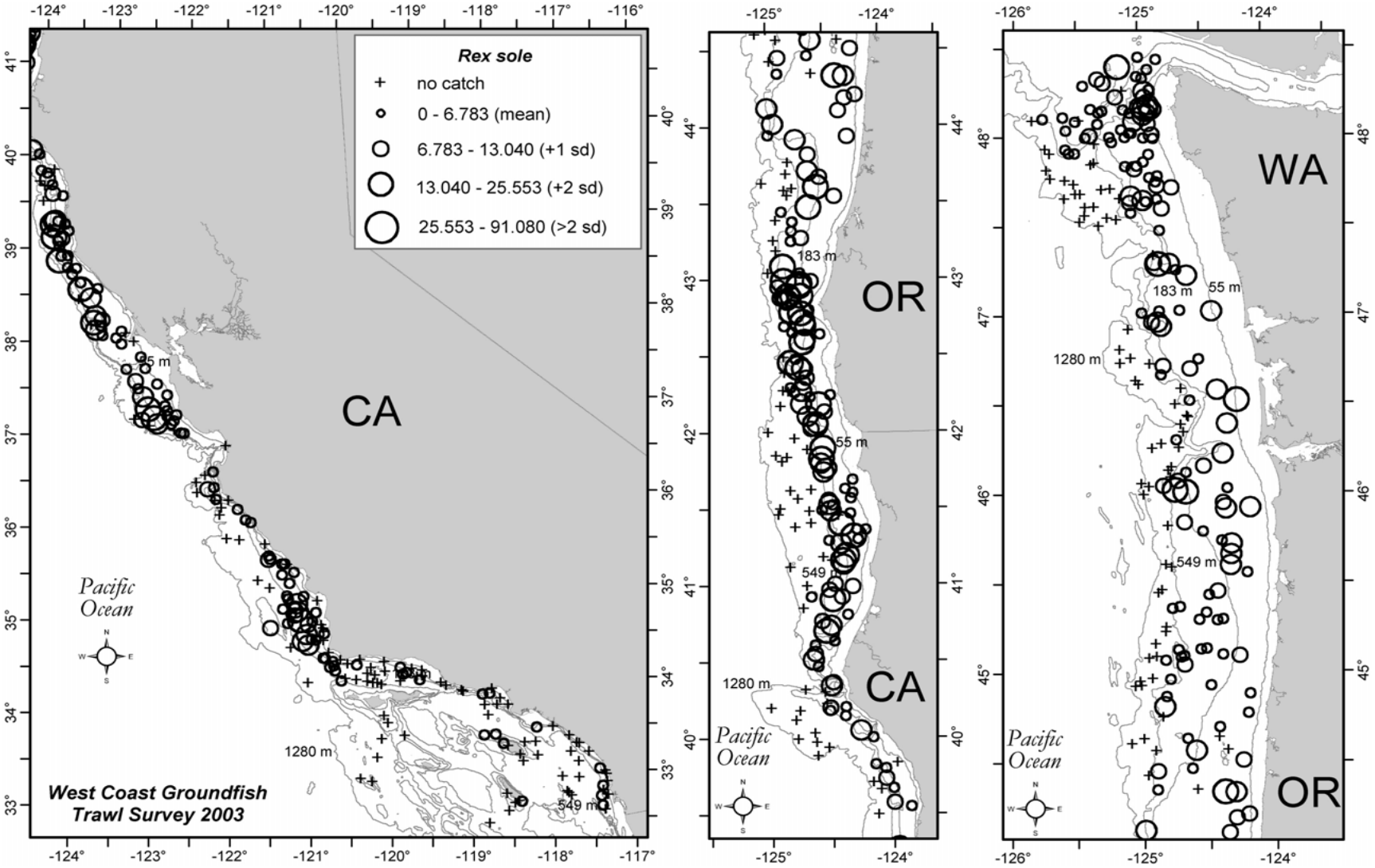


Figure 25. Rex sole distribution and relative abundance (kg/ha) from the 2003 West Coast groundfish trawl survey.

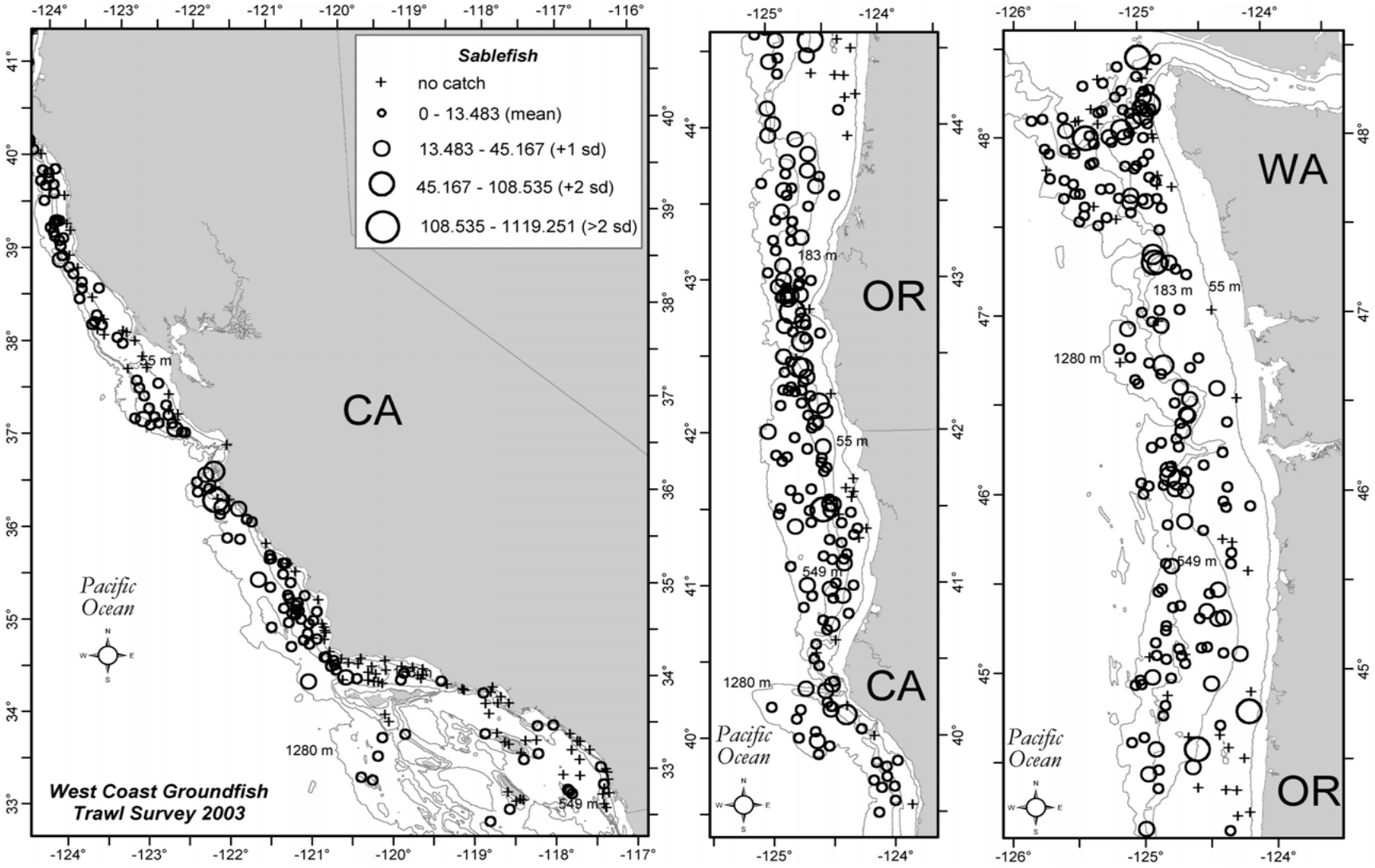


Figure 26. Sablefish distribution and relative abundance (kg/ha) from the 2003 West Coast groundfish trawl survey.

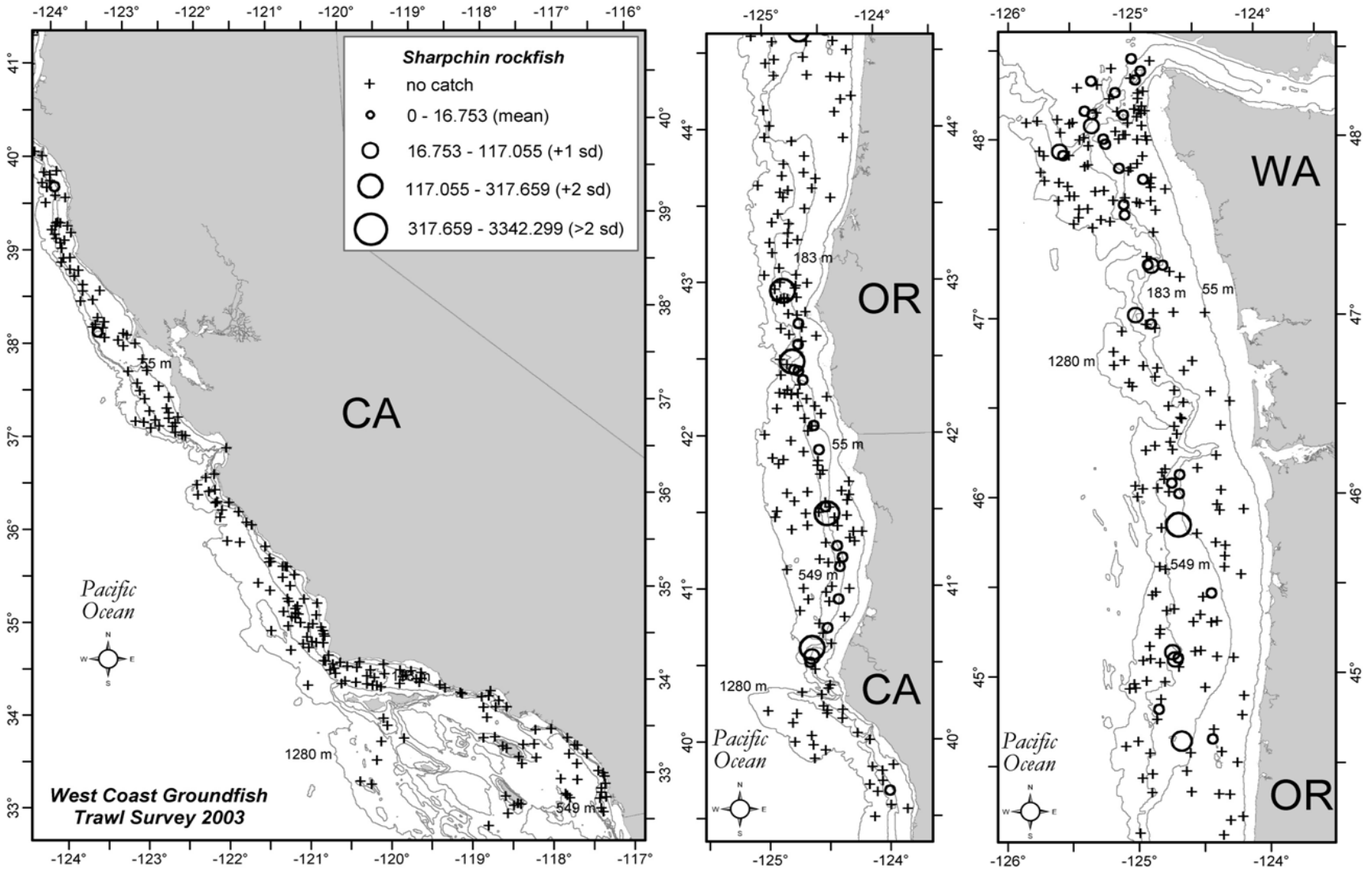


Figure 27. Sharpchin rockfish distribution and relative abundance (kg/ha) from the 2003 West Coast groundfish trawl survey.

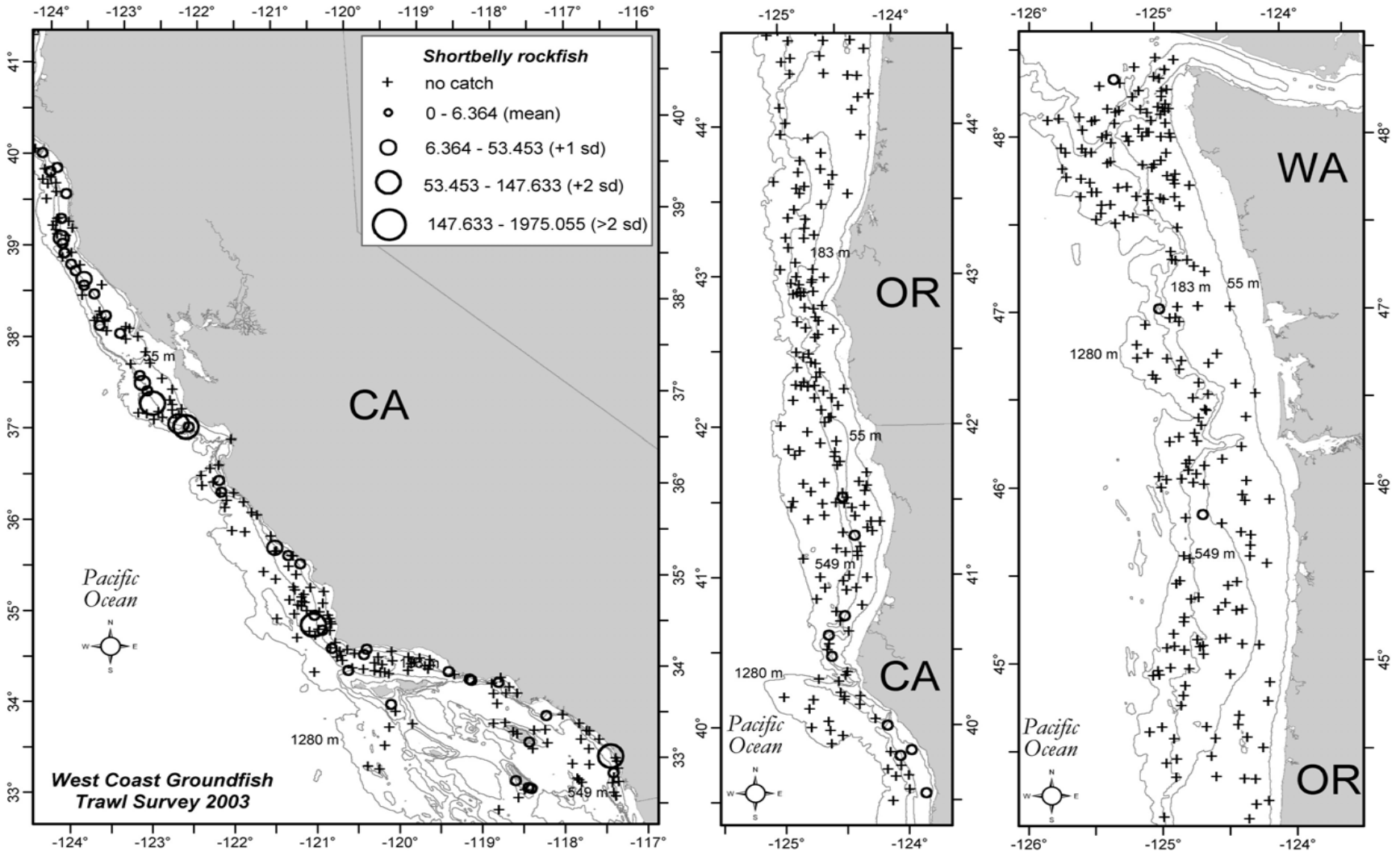


Figure 28. Shortbelly rockfish distribution and relative abundance (kg/ha) from the 2003 West Coast groundfish trawl survey.

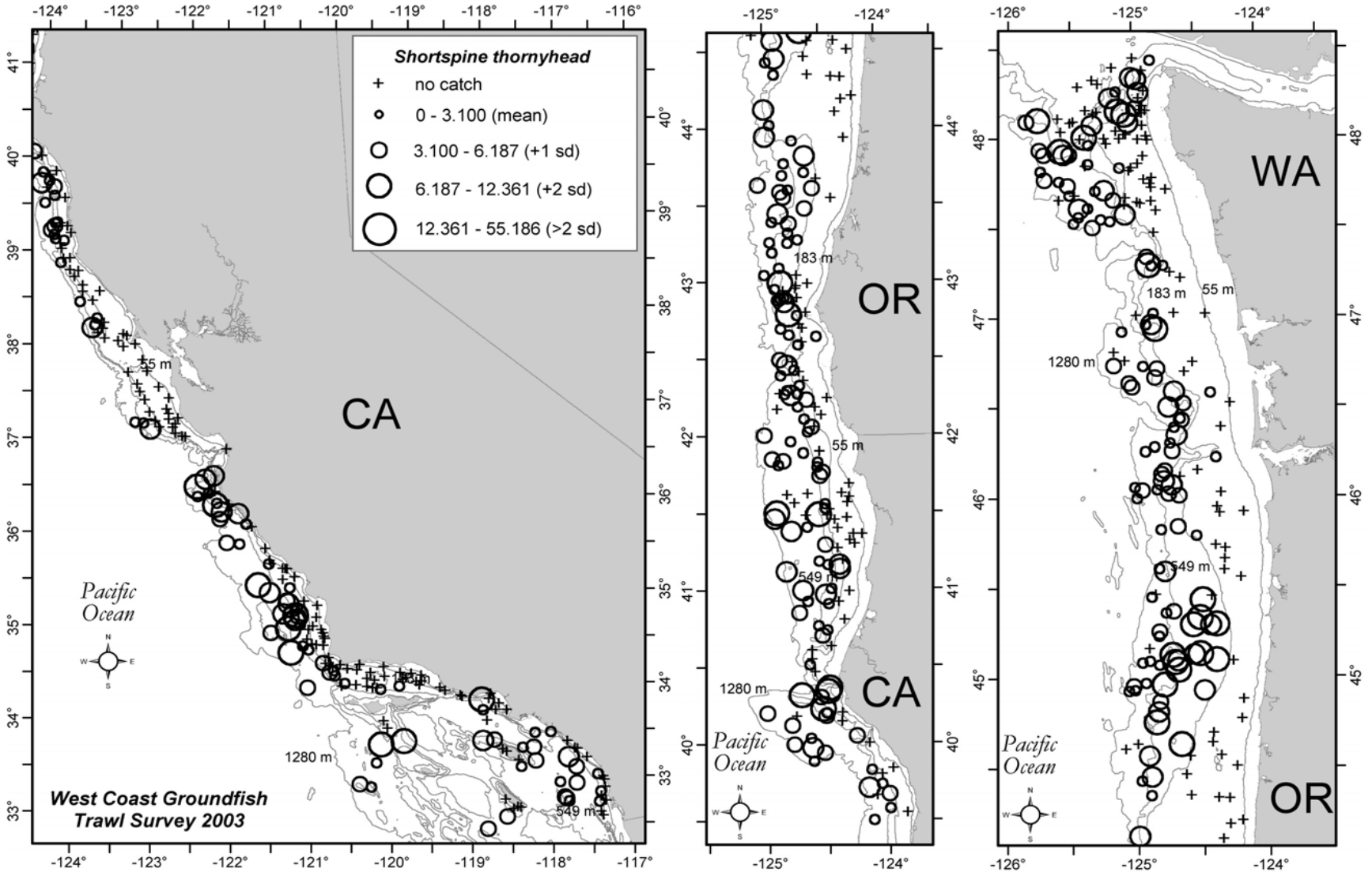


Figure 29. Shortspine thornyhead distribution and relative abundance (kg/ha) from the 2003 West Coast groundfish trawl survey.

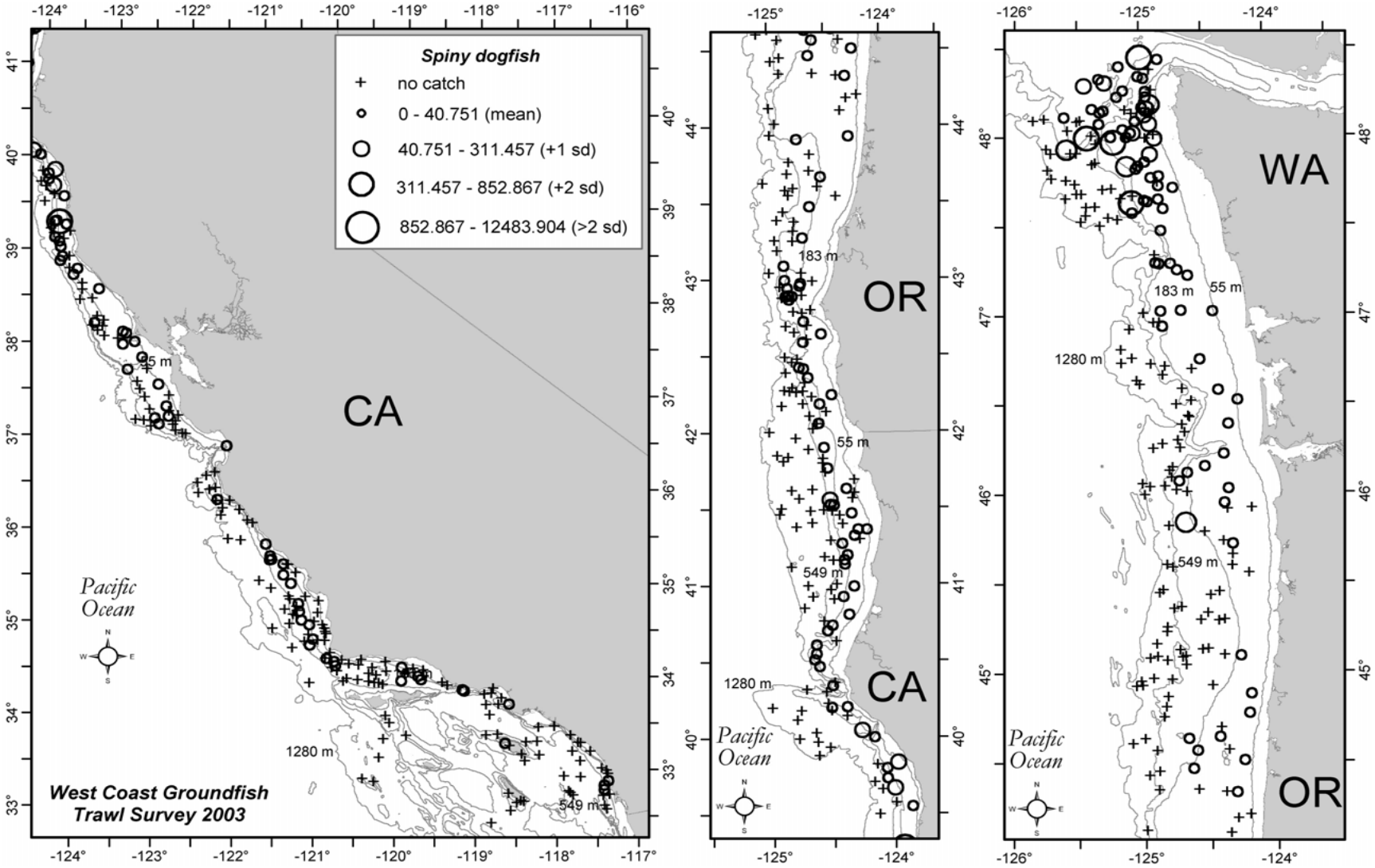


Figure 30. Spiny dogfish distribution and relative abundance (kg/ha) from the 2003 West Coast groundfish trawl survey.

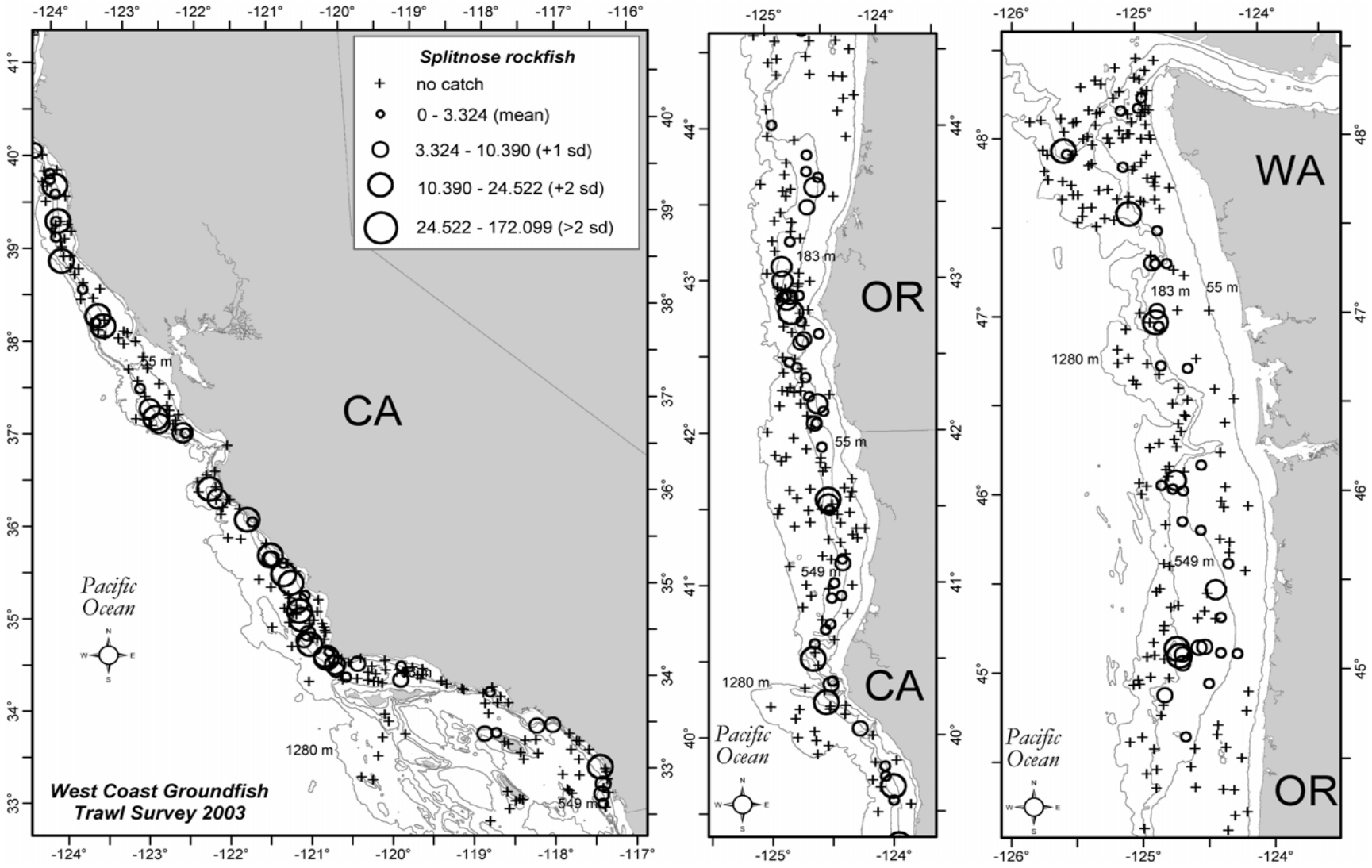


Figure 31. Splitnose rockfish distribution and relative abundance (kg/ha) from the 2003 West Coast groundfish trawl survey.

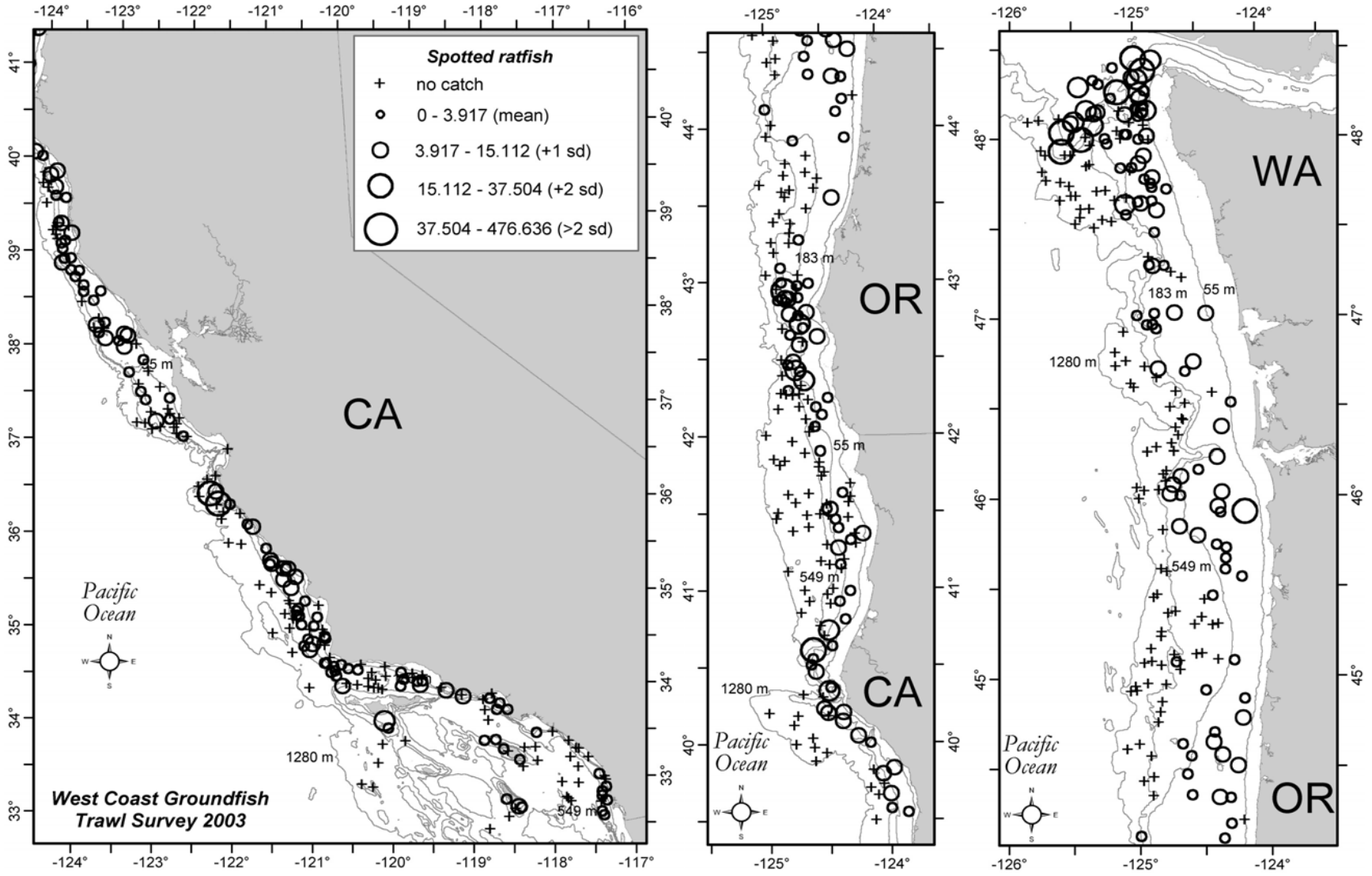


Figure 32. Spotted ratfish distribution and relative abundance (kg/ha) from the 2003 West Coast groundfish trawl survey.

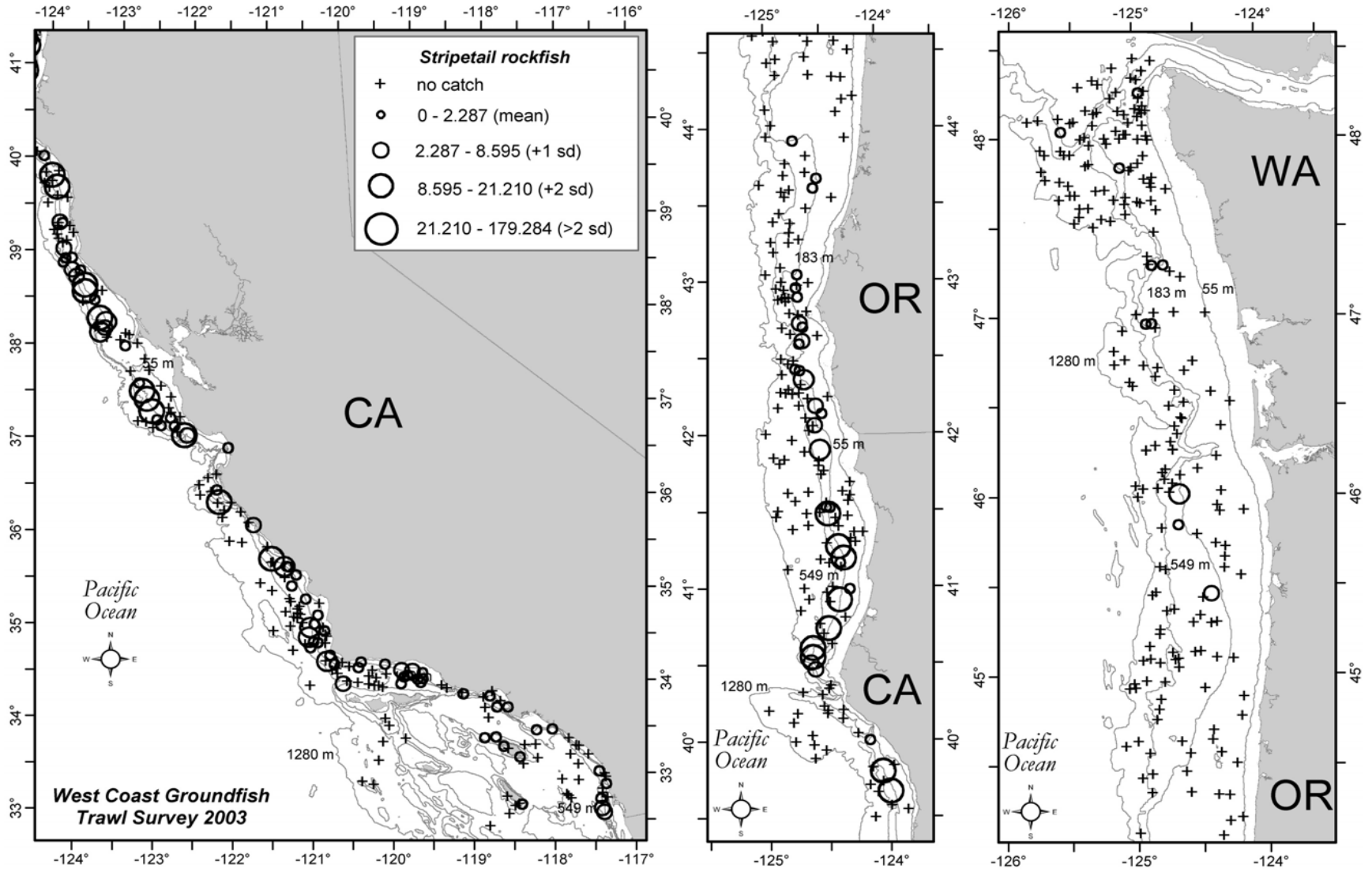


Figure 33. Stripetail rockfish distribution and relative abundance (kg/ha) from the 2003 West Coast groundfish trawl survey.

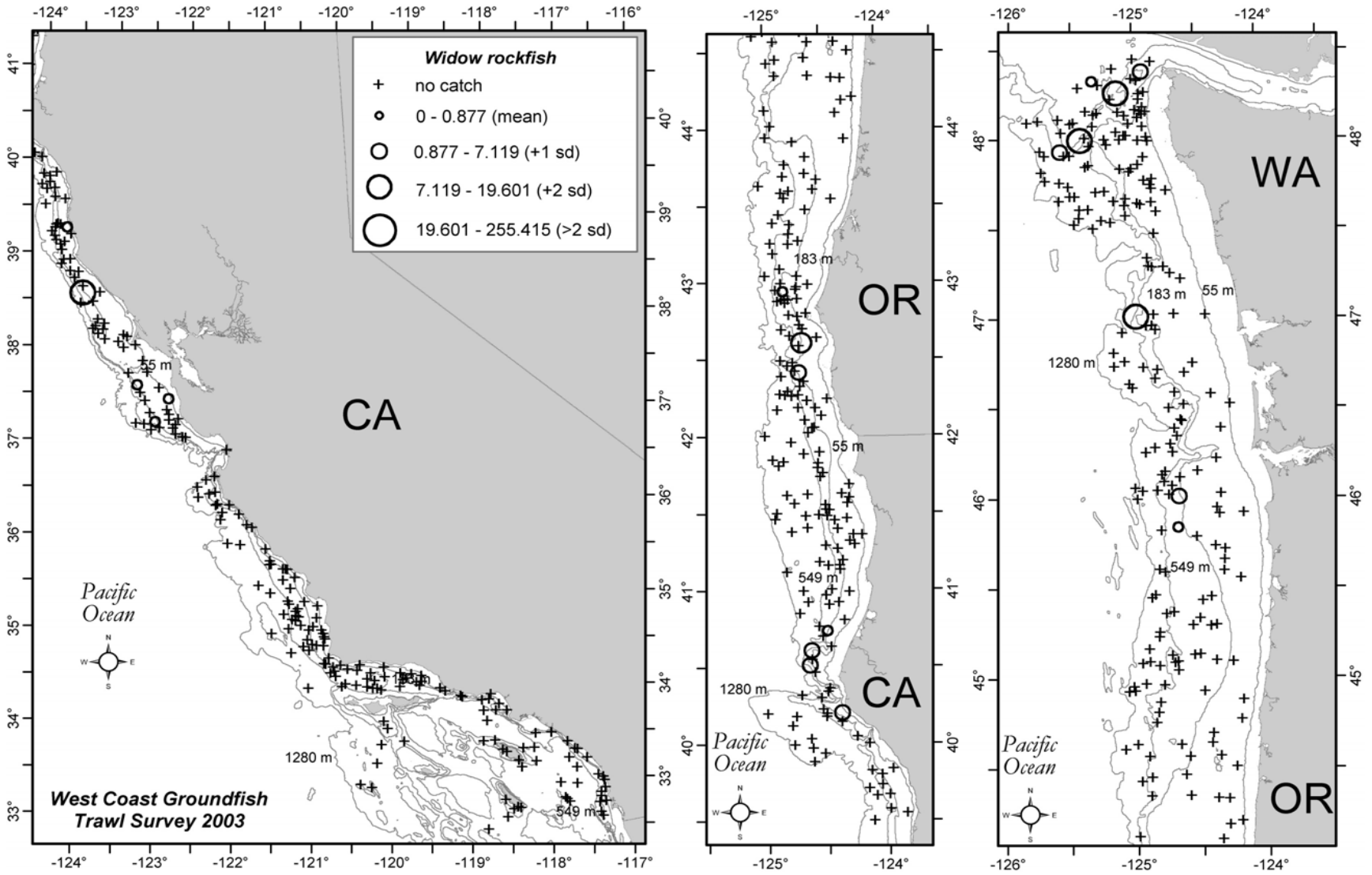


Figure 34. Widow rockfish distribution and relative abundance (kg/ha) from the 2003 West Coast groundfish trawl survey.

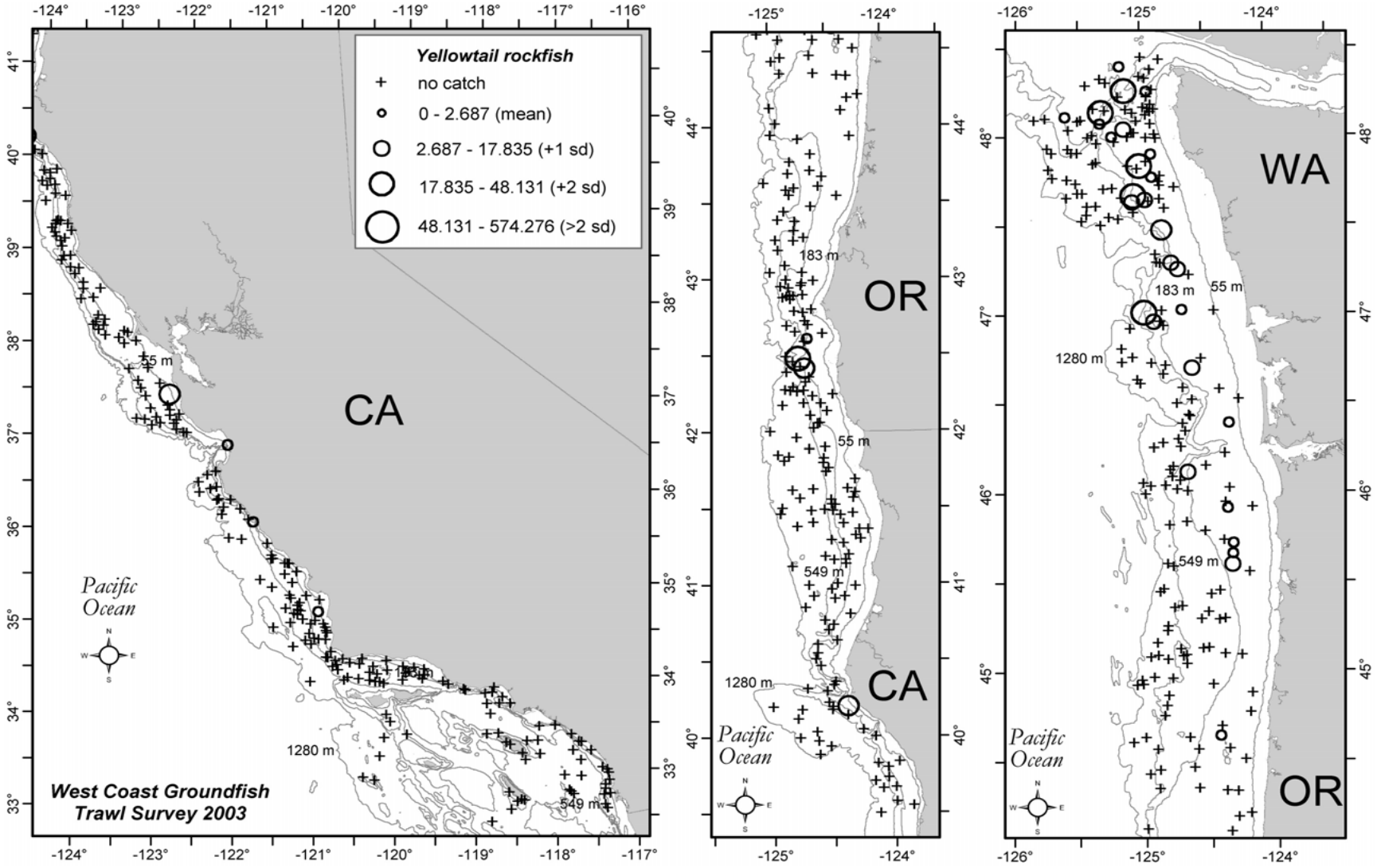


Figure 35. Yellowtail rockfish distribution and relative abundance (kg/ha) from the 2003 West Coast groundfish trawl survey.

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 2003 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	64,393	24	113,425	29	105,179	43	282,997	36
Pacific hake	202,246	54	52,664	29	4,404	62	259,314	99
Spiny dogfish	143,479	311	52,098	169	0	–	195,577	545
Longspine thornyhead	0	–	4,130	41	147,369	14	151,498	15
Sablefish	41,241	119	34,328	39	55,519	64	131,088	96
Pacific sanddab	129,328	88	280	100	0	–	129,608	206
Sharpchin rockfish	91,866	204	29,526	131	0	–	121,392	370
Chilipepper rockfish	100,482	100	19,061	94	0	–	119,543	200
Shortspine thornyhead	373	122	16,158	23	42,898	20	59,428	22
Rex sole	26,094	22	30,304	24	1,698	131	58,095	39
Shortbelly rockfish	4,319	103	46,159	198	0	–	50,478	454
Longnose skate	21,833	21	24,454	26	3,428	48	49,714	38
Pacific grenadier	0	–	10	132	46,087	105	46,098	112
Arrowtooth flounder	19,176	121	23,204	75	62	285	42,443	164
Grooved tanner crab	66	106	636	71	40,391	51	41,094	54
English sole	32,110	27	3,150	79	0	–	35,260	60
Pacific ocean perch	40	306	33,101	83	0	–	33,141	207
Darkblotched rockfish	1,553	117	30,032	89	0	–	31,585	211
Splitnose rockfish	1,410	84	30,088	41	0	–	31,498	98
Giant grenadier	0	–	49	231	31,351	77	31,400	82

Table 18. Estimates of fish biomass (metric tons) and coefficients of variation (CV) by stratum for the INPFC Conception area from the 2003 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	15	45	14,187	20	43,092	39	57,295	25
Pacific hake	113	36	11,698	21	2,713	69	14,524	52
Spiny dogfish	335	38	2,606	38	0	–	2,942	105
Longspine thornyhead	0	–	2,889	33	69,494	18	71,383	13
Sablefish	208	65	3,661	19	18,415	29	22,284	19
Pacific sanddab	8,715	37	258	81	0	–	8,974	199
Sharpchin rockfish	0	–	0	–	0	–	0	–
Chilipepper rockfish	1,186	93	12,168	92	0	–	13,354	259
Shortspine thornyhead	0	–	2,648	24	28,980	21	31,628	14
Rex sole	28	38	6,361	34	140	94	6,530	102
Shortbelly rockfish	81	59	9,225	69	0	–	9,306	210
Longnose skate	176	41	8,230	18	2,513	83	10,918	42
Pacific grenadier	0	–	0	–	2,771	78	2,771	53
Arrowtooth flounder	0	–	0	–	0	–	0	–
Grooved tanner crab	0	–	7	77	3,095	44	3,102	29
English sole	965	21	746	35	0	–	1,712	79
Pacific ocean perch	0	–	0	–	0	–	0	–
Darkblotched rockfish	0	100	23	56	0	–	24	168
Splitnose rockfish	0	53	13,770	27	0	–	13,770	84
Giant grenadier	0	–	0	–	3,459	54	3,459	36

Table 19. Estimates of fish biomass (metric tons) and coefficients of variation (CV) by stratum for the INPFC Monterey area from the 2003 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	864	27	28,982	25	36,806	35	66,651	41
Pacific hake	18,100	85	6,540	41	559	91	25,198	104
Spiny dogfish	50,955	91	1,989	63	0	–	52,944	142
Longspine thornyhead	0	–	342	81	24,962	12	25,304	15
Sablefish	1,337	35	3,615	19	14,221	34	19,173	33
Pacific sanddab	65,657	90	21	98	0	–	65,678	146
Sharpchin rockfish	5	100	0	100	0	–	5	156
Chilipepper rockfish	97,493	54	6,839	46	0	–	104,332	83
Shortspine thornyhead	8	100	1,566	40	6,654	24	8,228	33
Rex sole	2,829	19	5,837	21	318	99	8,985	43
Shortbelly rockfish	4,192	57	36,926	73	0	–	41,118	204
Longnose skate	3,881	18	2,547	18	581	37	7,009	26
Pacific grenadier	0	–	0	–	28,502	51	28,502	63
Arrowtooth flounder	20	74	564	46	0	–	585	139
Grooved tanner crab	0	–	150	77	17,635	32	17,786	39
English sole	10,498	19	1,542	36	0	–	12,040	31
Pacific ocean perch	0	–	27	87	0	–	27	271
Darkblotched rockfish	74	64	4,541	92	0	–	4,615	281
Splitnose rockfish	2	100	7,119	33	0	–	7,121	104
Giant grenadier	0	–	33	100	10,658	38	10,691	46

Table 20. Estimates of fish biomass (metric tons) and coefficients of variation (CV) by stratum for the INPFC Eureka area from the 2003 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	13,841	25	19,157	12	14,563	20	47,561	22
Pacific hake	39,344	31	4,529	19	555	54	44,428	50
Spiny dogfish	349	21	1,158	69	0	–	1,507	192
Longspine thornyhead	0	–	116	46	22,736	10	22,852	11
Sablefish	3,473	31	3,668	21	11,769	56	18,911	43
Pacific sanddab	8,206	31	1	100	0	–	8,207	55
Sharpchin rockfish	87,827	61	3,967	97	0	–	91,794	104
Chilipepper rockfish	1,803	68	49	75	0	–	1,852	119
Shortspine thornyhead	1	100	742	21	3,226	34	3,969	33
Rex sole	5,421	17	5,184	11	930	43	11,543	24
Shortbelly rockfish	45	90	0	71	0	–	45	159
Longnose skate	2,936	23	3,022	20	33	98	5,991	42
Pacific grenadier	0	–	1	100	3,848	36	3,849	39
Arrowtooth flounder	1,149	18	698	30	2	100	1,850	45
Grooved tanner crab	11	93	38	43	6,502	26	6,552	28
English sole	5,947	18	455	50	0	–	6,401	32
Pacific ocean perch	14	73	24	47	0	–	38	117
Darkblotched rockfish	1,036	49	743	51	0	–	1,779	92
Splitnose rockfish	238	67	1,831	45	0	–	2,069	143
Giant grenadier	0	–	3	72	8,254	48	8,258	53

Table 21. Estimates of fish biomass (metric tons) and coefficients of variation (CV) by stratum for the INPFC Columbia area from the 2003 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	42,414	15	32,851	19	10,318	23	85,582	18
Pacific hake	124,042	25	28,426	22	545	51	153,012	28
Spiny dogfish	7,747	27	8,207	84	0	–	15,953	87
Longspine thornyhead	0	–	752	42	25,296	8	26,049	18
Sablefish	24,333	60	21,048	34	10,112	12	55,493	42
Pacific sanddab	44,404	37	0	–	0	–	44,404	48
Sharpchin rockfish	3,886	88	24,165	72	0	–	28,050	124
Chilipepper rockfish	0	–	5	100	0	–	5	198
Shortspine thornyhead	309	88	7,901	13	3,439	15	11,649	21
Rex sole	15,917	18	10,688	18	310	41	26,914	20
Shortbelly rockfish	1	100	8	100	0	–	8	183
Longnose skate	13,082	19	6,915	26	276	43	20,272	24
Pacific grenadier	0	–	8	83	9,581	35	9,590	76
Arrowtooth flounder	9,942	14	16,669	61	60	70	26,671	76
Grooved tanner crab	55	97	394	28	11,106	12	11,555	26
English sole	12,588	27	307	53	0	–	12,895	34
Pacific ocean perch	7	100	21,768	54	0	–	21,775	107
Darkblotched rockfish	376	46	23,409	57	0	–	23,785	112
Splitnose rockfish	1,165	78	5,507	38	0	–	6,672	65
Giant grenadier	0	–	13	100	6,707	20	6,720	43

Table 22. Estimates of fish biomass (metric tons) and coefficients of variation (CV) by stratum for the INPFC U.S.-Vancouver area from the 2003 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	7,259	12	18,249	20	400	52	25,907	18
Pacific hake	20,647	59	1,472	32	31	63	22,151	132
Spiny dogfish	84,092	72	38,139	72	0	–	122,231	121
Longspine thornyhead	0	–	30	100	5,880	12	5,911	21
Sablefish	11,890	53	2,336	30	1,003	16	15,228	100
Pacific sanddab	2,345	45	0	–	0	–	2,345	108
Sharpchin rockfish	149	51	1,394	57	0	–	1,543	59
Chilipepper rockfish	0	–	0	–	0	–	0	–
Shortspine thornyhead	54	85	3,301	21	600	18	3,955	20
Rex sole	1,899	22	2,233	25	0	–	4,132	28
Shortbelly rockfish	0	100	0	–	0	–	0	239
Longnose skate	1,759	19	3,740	24	25	100	5,524	23
Pacific grenadier	0	–	1	100	1,385	26	1,386	43
Arrowtooth flounder	8,064	40	5,273	24	0	–	13,337	58
Grooved tanner crab	1	100	47	56	2,041	20	2,090	34
English sole	2,112	36	101	29	0	–	2,213	83
Pacific ocean perch	19	85	11,281	54	0	–	11,300	61
Darkblotched rockfish	67	64	1,315	66	0	–	1,382	71
Splitnose rockfish	5	80	1,861	76	0	–	1,866	85
Giant grenadier	0	–	0	–	2,273	23	2,273	39

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, where weight, abundance, and lengths were collected for the most abundant fish species and tanner crab are shown in Tables 23–28 by stratum and INPFC area.

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 combined INPFC areas (U.S.-Vancouver, Columbia, Eureka, Monterey, and Conception) from the 2003 West Coast groundfish trawl survey.

	Stratum 1 55–183 m Total hauls = 227 Hauls with:			Stratum 2 184–549 m Total hauls = 176 Hauls with:			Stratum 3 550–1,280 m Total hauls = 171 Hauls with:		
Species	**Wt.**	**No.**	**Len.**	**Wt.**	**No.**	**Len.**	**Wt.**	**No.**	**Len.**
Dover sole	160	159	159	168	167	165	115	115	115
Pacific hake	153	151	82	165	165	70	26	26	10
Spiny dogfish	117	115	114	70	70	70	0	0	0
Longspine thornyhead	0	0	0	34	34	33	148	148	148
Sablefish	119	119	119	153	153	151	138	138	138
Pacific sanddab	146	146	145	9	9	8	0	0	0
Sharpchin rockfish	25	24	23	29	28	28	0	0	0
Chilipepper rockfish	62	62	62	33	32	32	0	0	0
Shortspine thornyhead	12	12	12	138	138	135	134	134	134
Rex sole	175	173	92	162	160	73	22	22	9
Shortbelly rockfish	34	34	34	21	21	19	0	0	0
Longnose skate	140	139	138	143	142	140	18	18	17
Pacific grenadier	0	0	0	4	4	4	107	106	107
Arrowtooth flounder	112	112	111	81	81	80	3	3	3
Grooved tanner crab	5	5	0	38	39	0	124	123	0
English sole	186	185	185	54	53	53	0	0	0
Pacific ocean perch	7	6	6	40	40	40	0	0	0
Darkblotched rockfish	36	36	36	65	64	64	0	0	0
Splitnose rockfish	25	25	24	110	110	110	0	0	0
Giant grenadier	0	0	0	4	4	0	105	103	0
Lingcod	161	157	155	41	40	40	0	0	0
Redstripe rockfish	20	20	19	5	5	5	0	0	0
Spotted ratfish	171	168	167	96	95	93	2	2	2
Yellowtail rockfish	32	32	32	4	4	4	0	0	0
California slickhead	0	0	0	0	0	0	111	111	0
Stripetail rockfish	68	66	65	53	53	52	0	0	0
Petrale sole	166	166	166	41	40	40	0	0	0
Brown cat shark	3	3	0	74	72	0	128	128	0
Greenstriped rockfish	95	95	94	39	39	39	0	0	0
Slender sole	153	153	0	131	131	0	2	2	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 2003 West Coast groundfish trawl survey.

	Stratum 1 55–183 m Total hauls = 227 Hauls with:			**Stratum 2 184–549 m Total hauls = 176 Hauls with:**			**Stratum 3 550–1,280 m Total hauls = 171 Hauls with:**		
Species	**Wt.**	**No.**	**Len.**	**Wt.**	**No.**	**Len.**	**Wt.**	**No.**	**Len.**
Dover sole	46	46	46	16	16	15	0	0	0
Pacific hake	36	36	19	13	13	3	0	0	0
Spiny dogfish	37	36	35	10	10	10	0	0	0
Longspine thornyhead	0	0	0	1	1	1	2	2	2
Sablefish	36	36	36	14	14	13	1	1	1
Pacific sanddab	19	19	19	0	0	0	0	0	0
Sharpchin rockfish	11	10	10	6	6	6	0	0	0
Chilipepper rockfish	0	0	0	0	0	0	0	0	0
Shortspine thornyhead	3	3	3	15	15	13	2	2	2
Rex sole	46	45	25	16	16	4	0	0	0
Shortbelly rockfish	1	1	1	0	0	0	0	0	0
Longnose skate	34	34	33	15	14	13	0	0	0
Pacific grenadier	0	0	0	1	1	1	2	1	2
Arrowtooth flounder	41	41	40	12	12	11	0	0	0
Grooved tanner crab	1	1	0	4	4	0	2	2	0
English sole	36	36	36	9	9	9	0	0	0
Pacific ocean perch	4	3	3	11	11	11	0	0	0
Darkblotched rockfish	9	9	9	4	4	4	0	0	0
Splitnose rockfish	2	2	2	5	5	5	0	0	0
Giant grenadier	0	0	0	0	0	0	2	2	0
Lingcod	28	28	28	3	3	3	0	0	0
Redstripe rockfish	9	9	8	3	3	3	0	0	0
Spotted ratfish	41	41	40	10	10	10	0	0	0
Yellowtail rockfish	11	11	11	3	3	3	0	0	0
California slickhead	0	0	0	0	0	0	0	0	0
Stripetail rockfish	2	2	2	1	1	1	0	0	0
Petrale sole	36	36	36	6	6	6	0	0	0
Brown cat shark	0	0	0	5	5	0	0	0	0
Greenstriped rockfish	27	27	27	8	8	8	0	0	0
Slender sole	43	43	0	13	13	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 2003 West Coast groundfish trawl survey.

	Stratum 1 55–183 m Total hauls = 227 Hauls with:			Stratum 2 184–549 m Total hauls = 176 Hauls with:			Stratum 3 550–1,280 m Total hauls = 171 Hauls with:		
Species	**Wt.**	**No.**	**Len.**	**Wt.**	**No.**	**Len.**	**Wt.**	**No.**	**Len.**
Dover sole	46	46	46	40	40	39	41	41	41
Pacific hake	44	44	24	40	40	15	13	13	7
Spiny dogfish	27	27	27	10	10	10	0	0	0
Longspine thornyhead	0	0	0	9	9	8	61	61	61
Sablefish	31	31	31	37	37	36	59	59	59
Pacific sanddab	27	27	27	0	0	0	0	0	0
Sharpchin rockfish	4	4	3	12	12	12	0	0	0
Chilipepper rockfish	0	0	0	1	1	1	0	0	0
Shortspine thornyhead	7	7	7	39	39	38	55	55	55
Rex sole	44	44	23	40	39	15	9	9	4
Shortbelly rockfish	1	1	1	1	1	1	0	0	0
Longnose skate	34	34	34	28	28	27	6	6	5
Pacific grenadier	0	0	0	2	2	2	56	56	56
Arrowtooth flounder	38	38	38	33	33	33	2	2	2
Grooved tanner crab	2	2	0	18	18	0	57	57	0
English sole	34	33	33	6	6	6	0	0	0
Pacific ocean perch	1	1	1	21	21	21	0	0	0
Darkblotched rockfish	9	9	9	24	24	24	0	0	0
Splitnose rockfish	9	9	9	29	29	29	0	0	0
Giant grenadier	0	0	0	1	1	0	50	48	0
Lingcod	36	35	35	10	10	10	0	0	0
Redstripe rockfish	4	4	4	1	1	1	0	0	0
Spotted ratfish	41	40	40	16	16	16	0	0	0
Yellowtail rockfish	13	13	13	1	1	1	0	0	0
California slickhead	0	0	0	0	0	0	40	40	0
Stripetail rockfish	5	5	5	6	6	6	0	0	0
Petrale sole	43	43	43	9	9	9	0	0	0
Brown cat shark	1	1	0	14	14	0	53	53	0
Greenstriped rockfish	25	25	24	9	9	9	0	0	0
Slender sole	41	41	0	35	35	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 2003 West Coast groundfish trawl survey.

	Stratum 1 55–183 m Total hauls = 227 Hauls with:			Stratum 2 184–549 m Total hauls = 176 Hauls with:			Stratum 3 550–1,280 m Total hauls = 171 Hauls with:		
Species	**Wt.**	**No.**	**Len.**	**Wt.**	**No.**	**Len.**	**Wt.**	**No.**	**Len.**
Dover sole	30	30	30	36	35	35	32	32	32
Pacific hake	34	32	17	36	36	19	5	5	1
Spiny dogfish	21	20	20	18	18	18	0	0	0
Longspine thornyhead	0	0	0	9	9	9	33	33	33
Sablefish	23	23	23	36	36	36	33	33	33
Pacific sanddab	19	19	19	1	1	0	0	0	0
Sharpchin rockfish	9	9	9	10	9	9	0	0	0
Chilipepper rockfish	8	8	8	4	3	3	0	0	0
Shortspine thornyhead	1	1	1	32	32	32	27	27	27
Rex sole	34	34	17	36	36	19	9	9	4
Shortbelly rockfish	2	2	2	2	2	1	0	0	0
Longnose skate	30	30	30	34	34	34	2	2	2
Pacific grenadier	0	0	0	1	1	1	25	25	25
Arrowtooth flounder	31	31	31	26	26	26	1	1	1
Grooved tanner crab	2	2	0	9	9	0	31	31	0
English sole	33	33	33	9	8	8	0	0	0
Pacific ocean perch	2	2	2	6	6	6	0	0	0
Darkblotched rockfish	13	13	13	22	21	21	0	0	0
Splitnose rockfish	8	8	7	24	24	24	0	0	0
Giant grenadier	0	0	0	2	2	0	24	24	0
Lingcod	28	28	26	8	7	7	0	0	0
Redstripe rockfish	6	6	6	1	1	1	0	0	0
Spotted ratfish	26	26	25	18	17	17	2	2	2
Yellowtail rockfish	3	3	3	0	0	0	0	0	0
California slickhead	0	0	0	0	0	0	25	25	0
Stripetail rockfish	15	15	15	10	10	10	0	0	0
Petrale sole	28	28	28	7	6	6	0	0	0
Brown cat shark	1	1	0	23	22	0	31	31	0
Greenstriped rockfish	20	20	20	10	10	10	0	0	0
Slender sole	32	32	0	29	29	0	2	2	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 2003 West Coast groundfish trawl survey.

	Stratum 1 55–183 m Total hauls = 227 Hauls with:			Stratum 2 184–549 m Total hauls = 176 Hauls with:			Stratum 3 550–1,280 m Total hauls = 171 Hauls with:		
Species	**Wt.**	**No.**	**Len.**	**Wt.**	**No.**	**Len.**	**Wt.**	**No.**	**Len.**
Dover sole	31	30	30	30	30	30	21	21	21
Pacific hake	25	25	13	25	25	12	5	5	1
Spiny dogfish	22	22	22	15	15	15	0	0	0
Longspine thornyhead	0	0	0	5	5	5	26	26	26
Sablefish	21	21	21	29	29	29	26	26	26
Pacific sanddab	37	37	36	2	2	2	0	0	0
Sharpchin rockfish	1	1	1	1	1	1	0	0	0
Chilipepper rockfish	26	26	26	14	14	14	0	0	0
Shortspine thornyhead	1	1	1	21	21	21	24	24	24
Rex sole	39	39	20	29	28	15	2	2	1
Shortbelly rockfish	20	20	20	6	6	6	0	0	0
Longnose skate	29	29	29	25	25	25	7	7	7
Pacific grenadier	0	0	0	0	0	0	18	18	18
Arrowtooth flounder	2	2	2	10	10	10	0	0	0
Grooved tanner crab	0	0	0	6	6	0	23	23	0
English sole	44	44	44	15	15	15	0	0	0
Pacific ocean perch	0	0	0	2	2	2	0	0	0
Darkblotched rockfish	4	4	4	11	11	11	0	0	0
Splitnose rockfish	2	2	2	22	22	22	0	0	0
Giant grenadier	0	0	0	1	1	0	21	21	0
Lingcod	40	39	39	11	11	11	0	0	0
Redstripe rockfish	1	1	1	0	0	0	0	0	0
Spotted ratfish	32	32	32	18	18	18	0	0	0
Yellowtail rockfish	3	3	3	0	0	0	0	0	0
California slickhead	0	0	0	0	0	0	23	23	0
Stripetail rockfish	21	21	20	13	13	13	0	0	0
Petrale sole	42	42	42	9	9	9	0	0	0
Brown cat shark	1	1	0	13	13	0	21	21	0
Greenstriped rockfish	19	19	19	7	7	7	0	0	0
Slender sole	33	33	0	22	22	0	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 2003 West Coast groundfish trawl survey.

	Stratum 1 55–183 m Total hauls = 227 Hauls with:			Stratum 2 184–549 m Total hauls = 176 Hauls with:			Stratum 3 550–1,280 m Total hauls = 171 Hauls with:		
Species	**Wt.**	**No.**	**Len.**	**Wt.**	**No.**	**Len.**	**Wt.**	**No.**	**Len.**
Dover sole	7	7	7	46	46	46	21	21	21
Pacific hake	14	14	9	51	51	21	3	3	1
Spiny dogfish	10	10	10	17	17	17	0	0	0
Longspine thornyhead	0	0	0	10	10	10	26	26	26
Sablefish	8	8	8	37	37	37	19	19	19
Pacific sanddab	44	44	44	6	6	6	0	0	0
Sharpchin rockfish	0	0	0	0	0	0	0	0	0
Chilipepper rockfish	28	28	28	14	14	14	0	0	0
Shortspine thornyhead	0	0	0	31	31	31	26	26	26
Rex sole	12	11	7	41	41	20	2	2	0
Shortbelly rockfish	10	10	10	12	12	11	0	0	0
Longnose skate	13	12	12	41	41	41	3	3	3
Pacific grenadier	0	0	0	0	0	0	6	6	6
Arrowtooth flounder	0	0	0	0	0	0	0	0	0
Grooved tanner crab	0	0	0	2	2	0	11	10	0
English sole	39	39	39	15	15	15	0	0	0
Pacific ocean perch	0	0	0	0	0	0	0	0	0
Darkblotched rockfish	1	1	1	4	4	4	0	0	0
Splitnose rockfish	4	4	4	30	30	30	0	0	0
Giant grenadier	0	0	0	0	0	0	8	8	0
Lingcod	29	27	27	9	9	9	0	0	0
Redstripe rockfish	0	0	0	0	0	0	0	0	0
Spotted ratfish	31	30	30	34	34	32	0	0	0
Yellowtail rockfish	2	2	2	0	0	0	0	0	0
California slickhead	0	0	0	0	0	0	23	23	0
Stripetail rockfish	25	23	23	23	23	22	0	0	0
Petrale sole	17	17	17	10	10	10	0	0	0
Brown cat shark	0	0	0	19	18	0	23	23	0
Greenstriped rockfish	4	4	4	5	5	5	0	0	0
Slender sole	4	4	0	32	32	0	0	0	0

Size Compositions

Figures 36–59 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 60–62 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 60–62 include species with greater than 500 length measurements taken throughout the survey period: spiny dogfish, longnose skate, spotted ratfish, arrowtooth flounder, curlfin sole, English sole, flathead sole, Pacific sanddab, petrale sole, rex sole, Pacific grenadier, Pacific flatnose, lingcod, Pacific hake, aurora rockfish, canary rockfish, chilipepper rockfish, darkblotched rockfish, greenstriped rockfish, Pacific ocean perch, redstriped rockfish, 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.

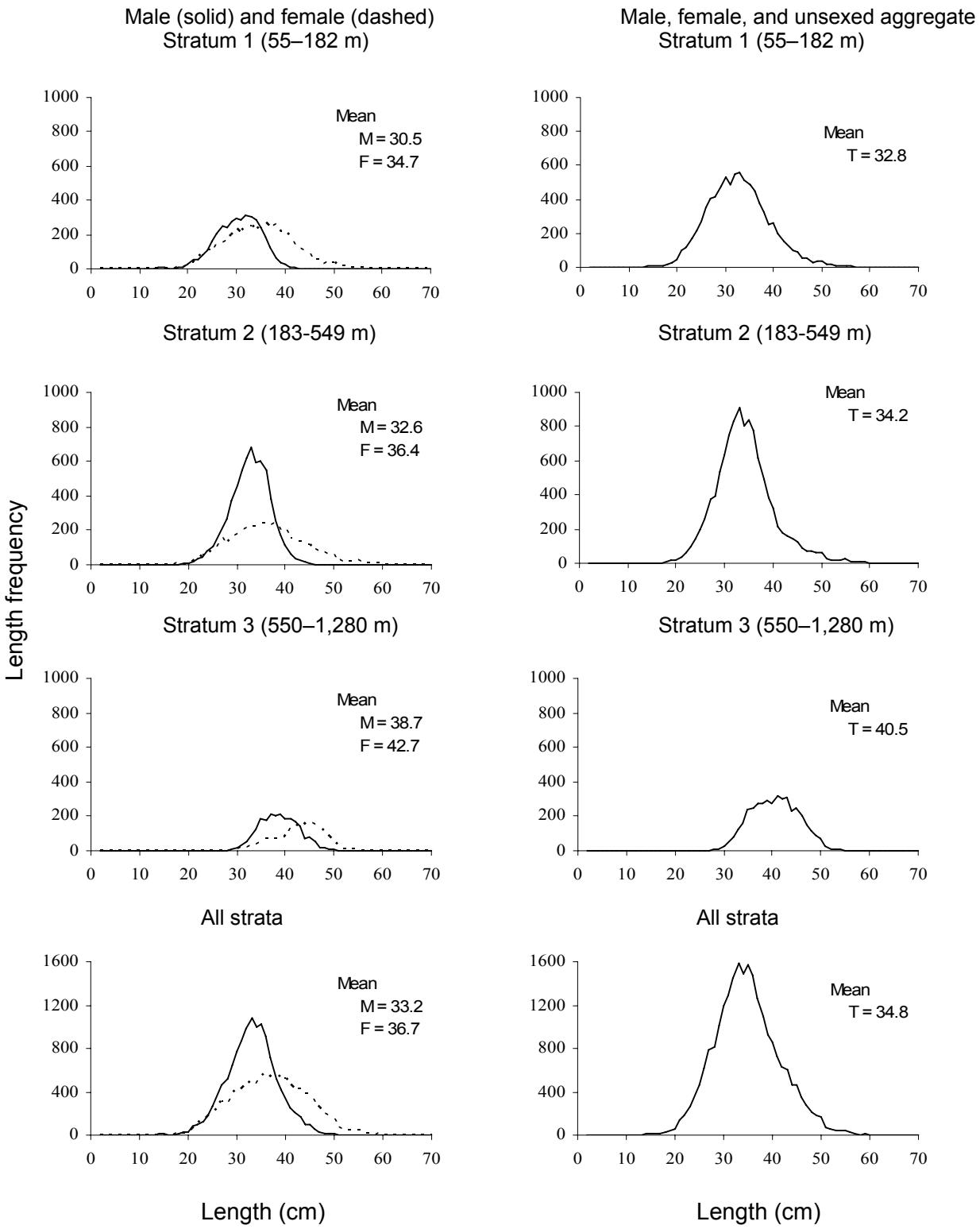


Figure 36. Unweighted length-frequency data and mean lengths (cm) of Dover sole by depth stratum (depth in m) and by sex (M = male, F = female, and T = males, females, and unsexed in aggregate) for all INPFC areas sampled from the 2003 West Coast groundfish trawl survey.

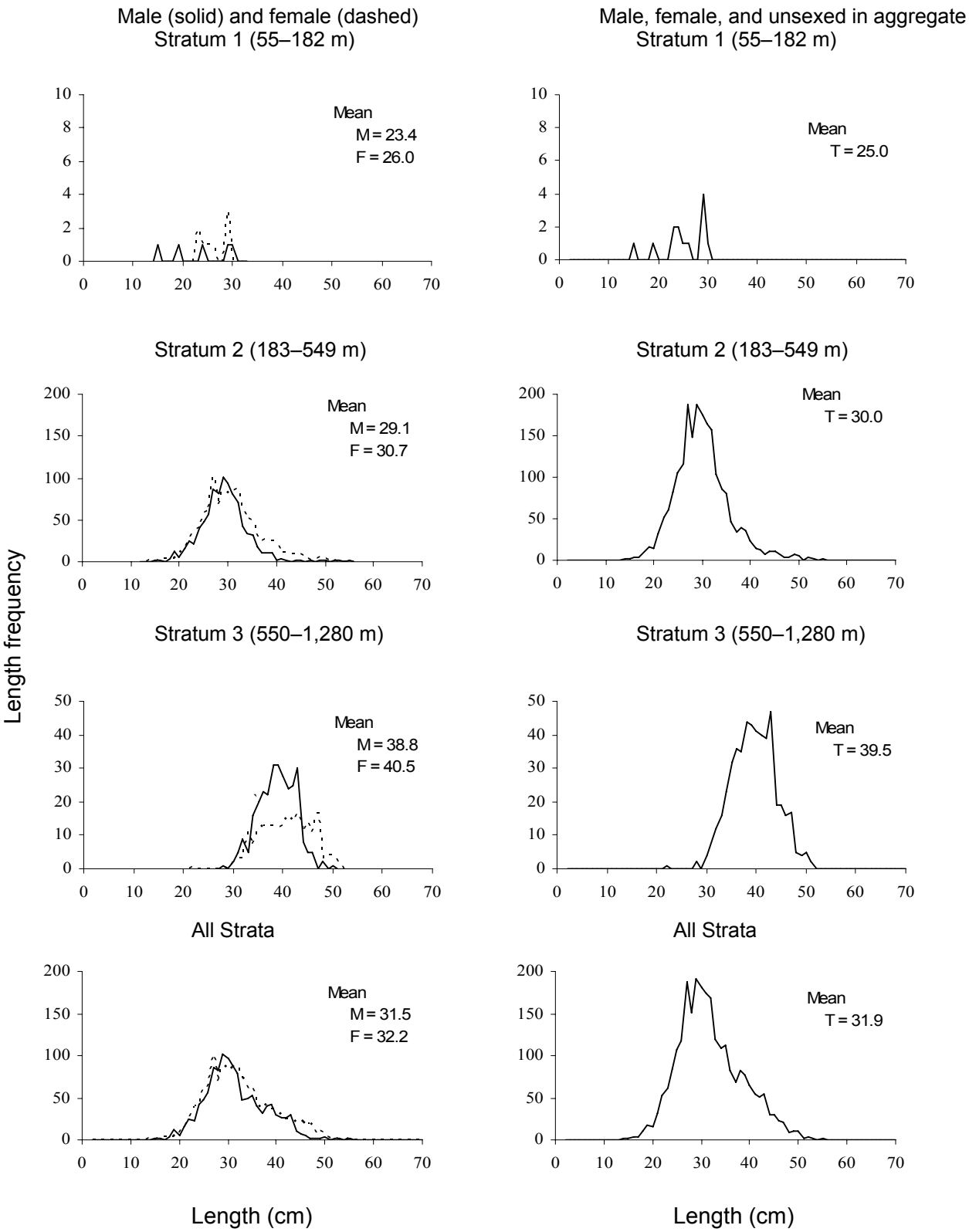


Figure 37. Unweighted length-frequency data and mean lengths (cm) of Dover sole by depth stratum (depth in m) and by sex (M = male, F = female, and T = males, females, and unsexed) for the INPFC Conception area from the 2003 West Coast groundfish trawl survey.

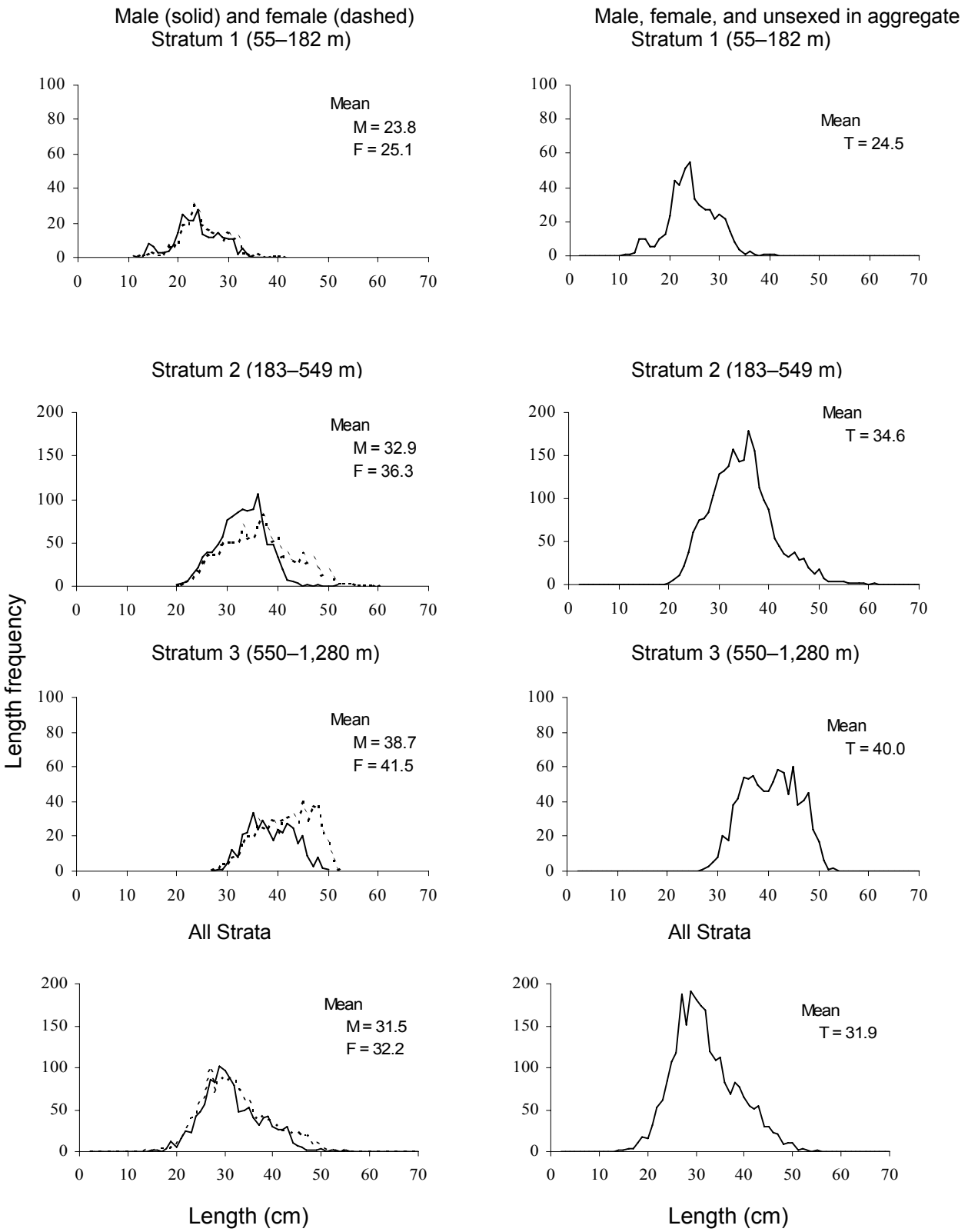


Figure 38. Unweighted length-frequency data and mean lengths (cm) of Dover sole by depth stratum (depth in m) and by sex (M = male, F = female, and T = males, females, and unsexed) for the INPFC Monterey area from the 2003 West Coast groundfish trawl survey.

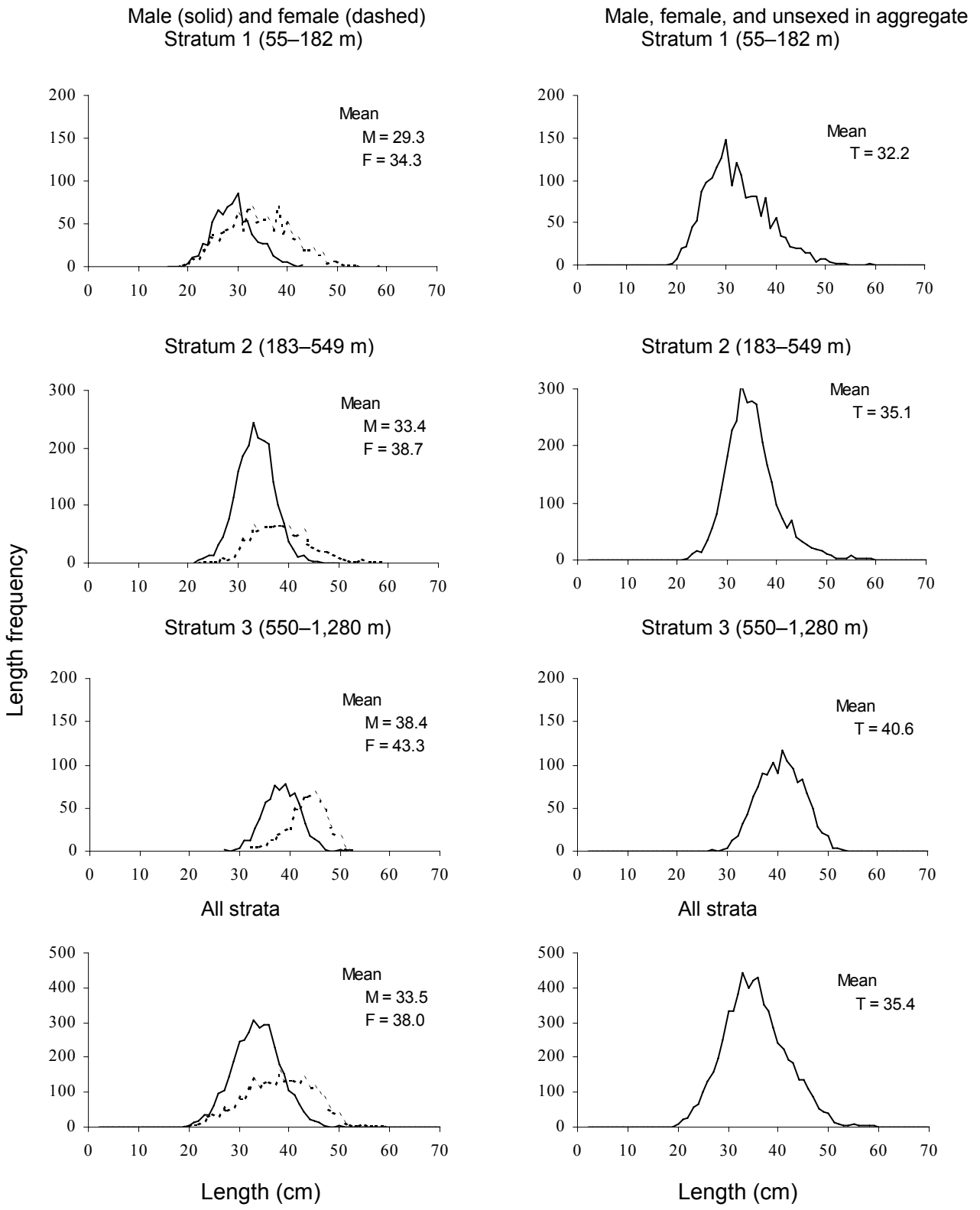


Figure 39. Unweighted length-frequency data and mean lengths (cm) of Dover sole by depth stratum (depth in m) and by sex (M = male, F = female, and T = males, females, and unsexed) for the INPFC Eureka area from the 2003 West Coast groundfish trawl survey.

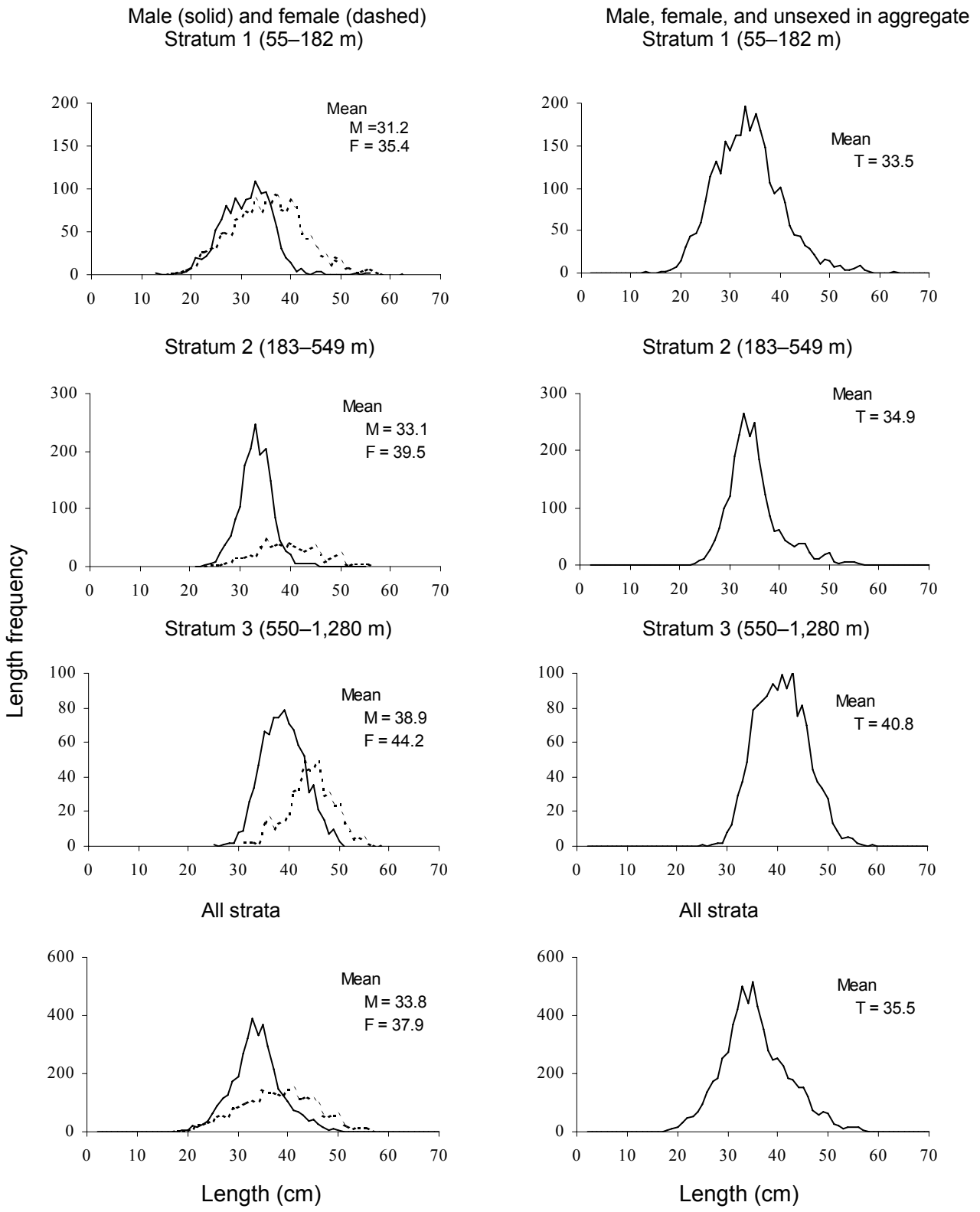


Figure 40. Unweighted length-frequency data and mean lengths (cm) of Dover sole by depth stratum (depth in m) and by sex (M = male, F = female, and T = males, females, and unsexed) for the INPFC Columbia area from the 2003 West Coast groundfish trawl survey.

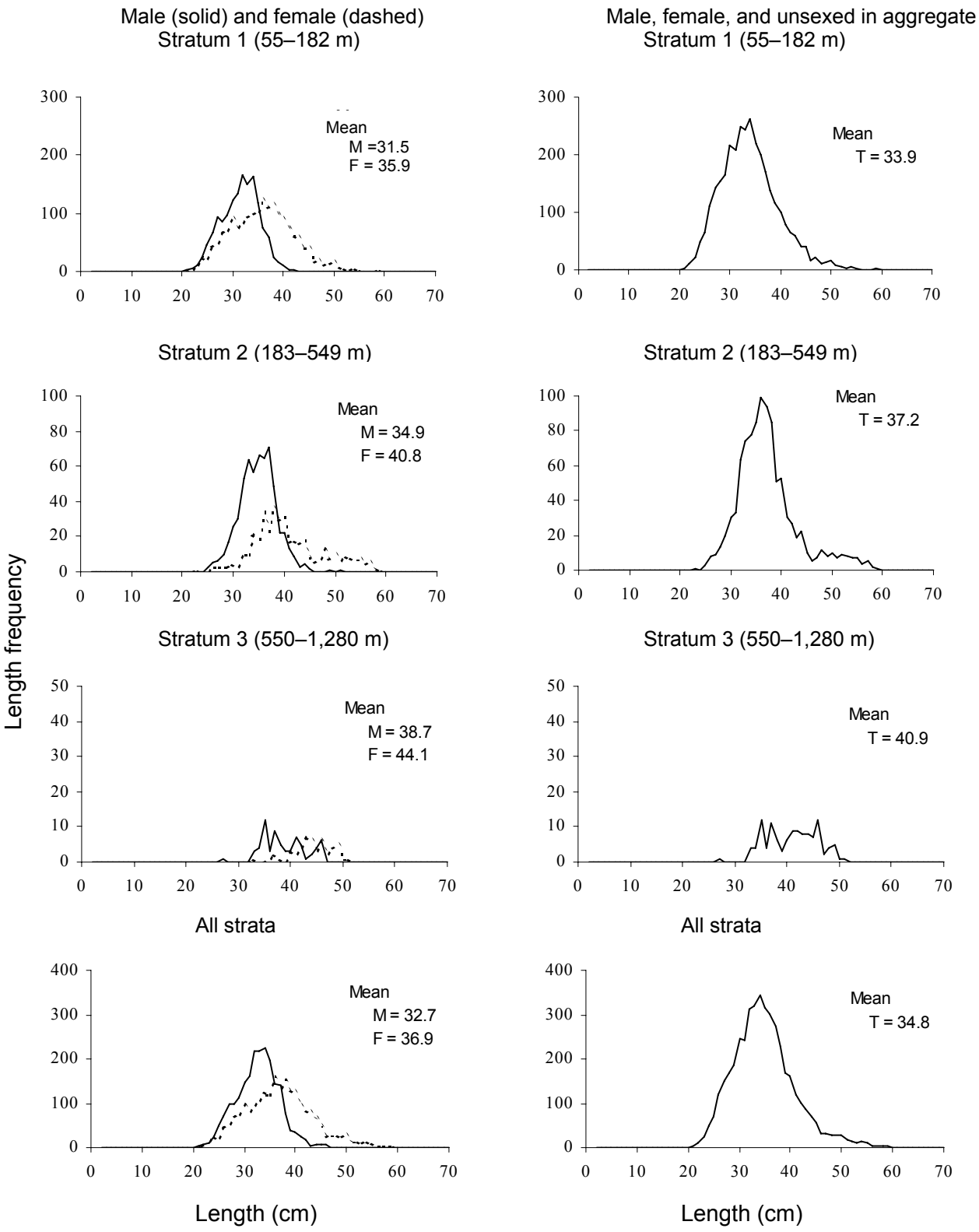


Figure 41. Unweighted length-frequency data and mean lengths (cm) of Dover sole by depth stratum (depth in m) and by sex (M = male, F = female, and T = males, females, and unsexed) for the INPFC U.S.-Vancouver area from the 2003 West Coast groundfish trawl survey.

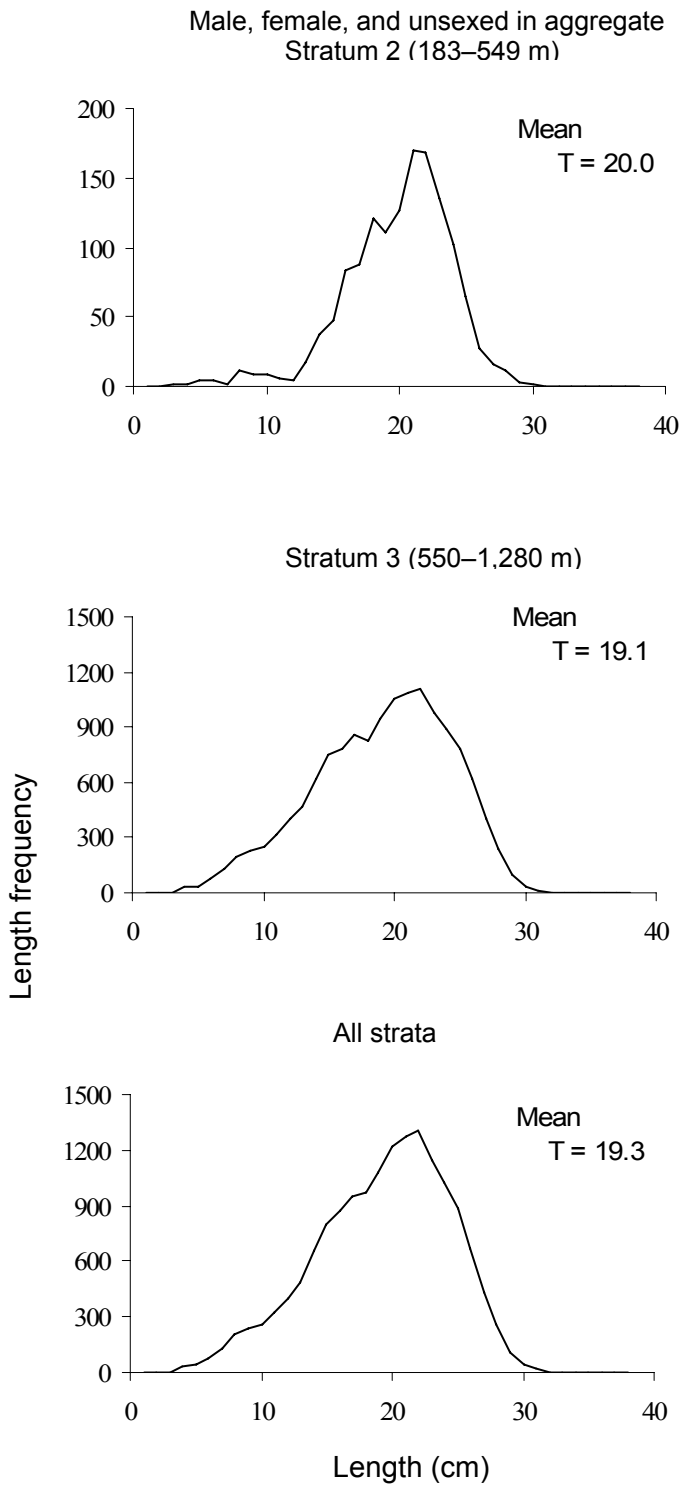


Figure 42. Unweighted length-frequency data and mean lengths (cm) of longspine thornyhead by depth stratum (depth in m) for all INPFC areas sampled during the 2003 West Coast groundfish trawl survey (T = males, females, and unsexed in aggregate).

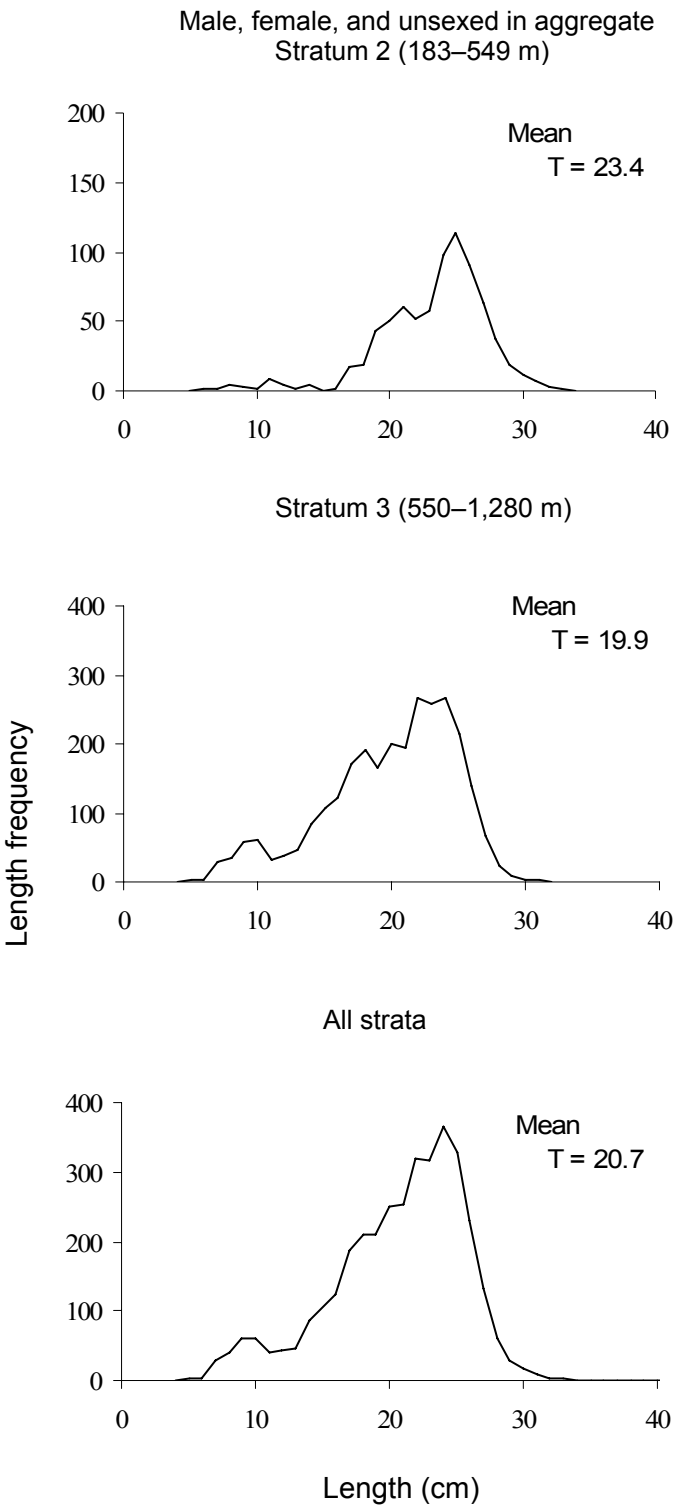


Figure 43. Unweighted length-frequency data and mean lengths (cm) of longspine thornyhead by depth stratum (depth in m) for the Conception INPFC area from the 2003 West Coast groundfish trawl survey (T = males, females, and unsexed in aggregate).

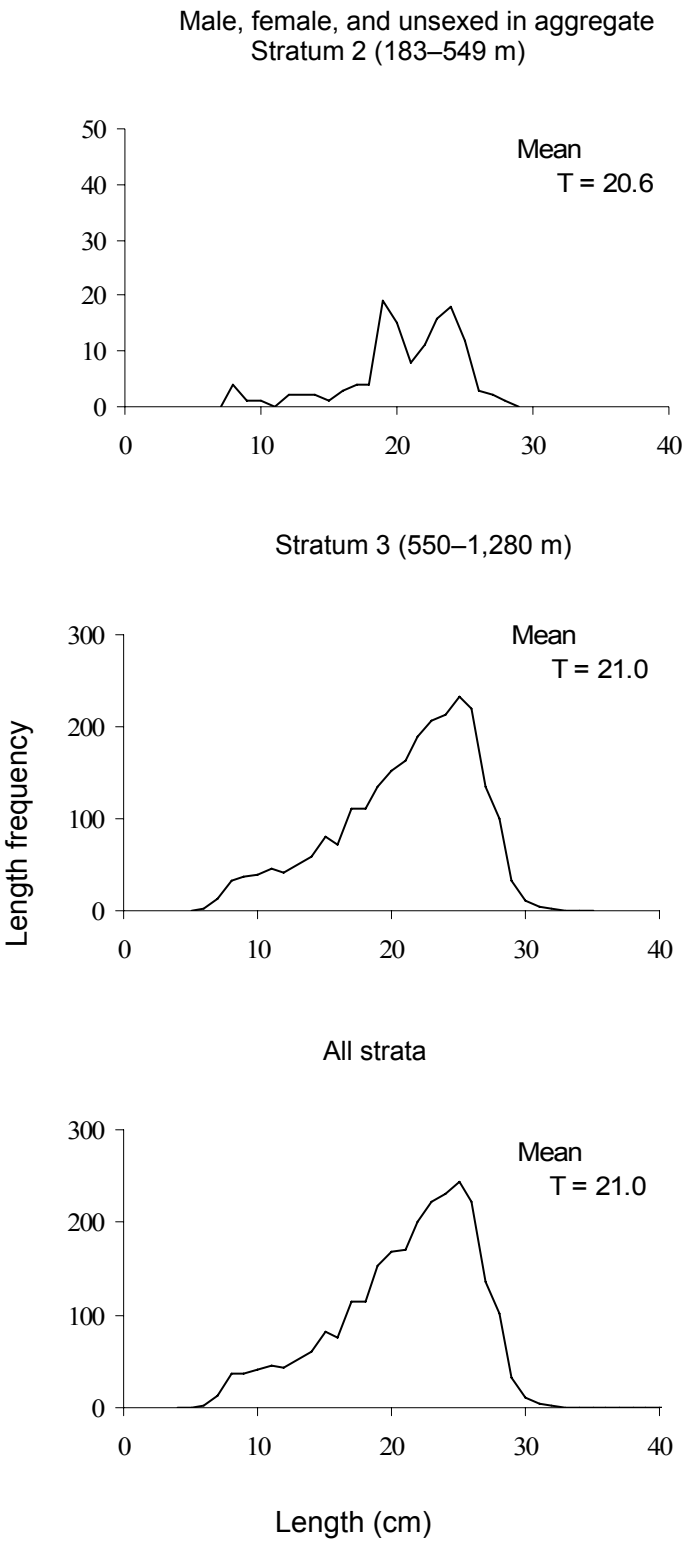


Figure 44. Unweighted length-frequency data and mean lengths (cm) of longspine thornyhead by depth stratum (depth in m) for the Monterey INPFC area from the 2003 West Coast groundfish trawl survey (T = males, females, and unsexed in aggregate).

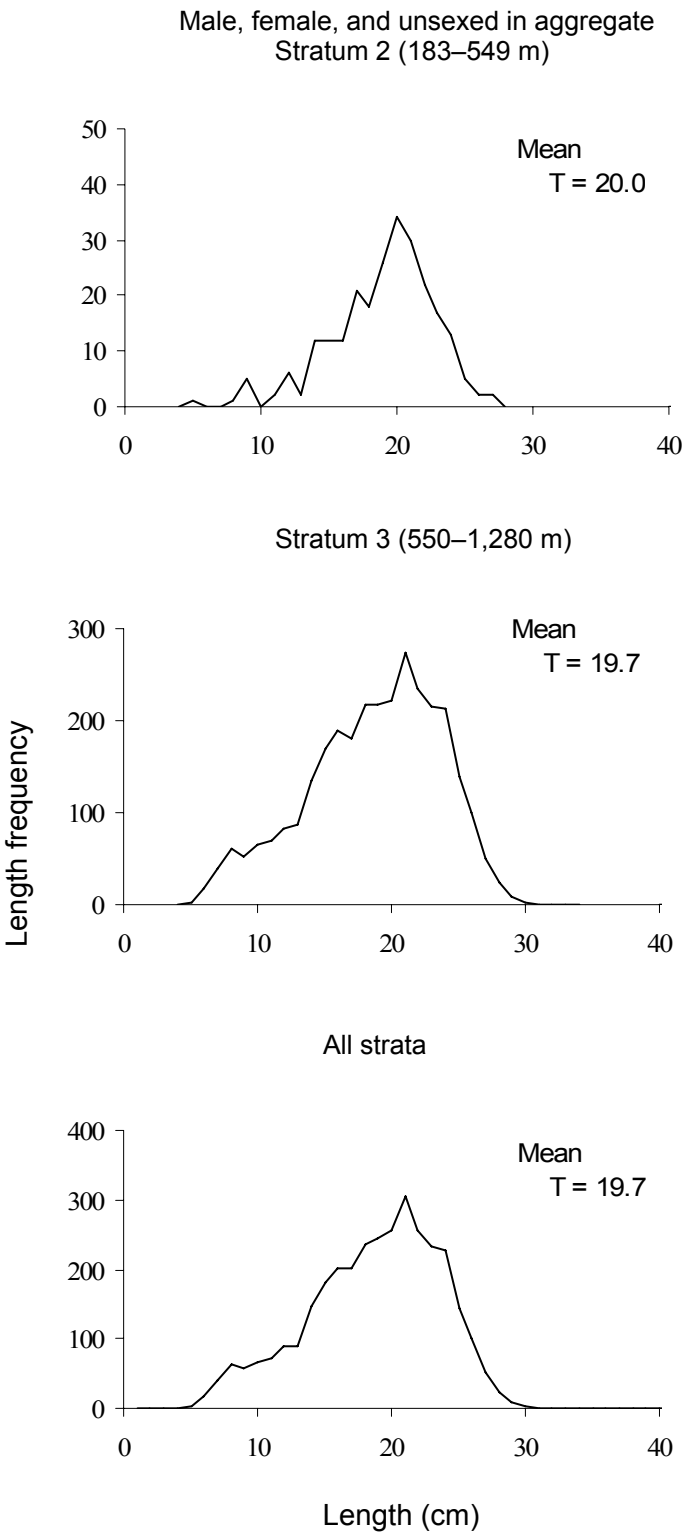


Figure 45. Unweighted length-frequency data and mean lengths (cm) of longspine thornyhead by depth stratum (depth in m) for the Eureka INPFC area from the 2003 West Coast groundfish trawl survey (T = males, females, and unsexed in aggregate).

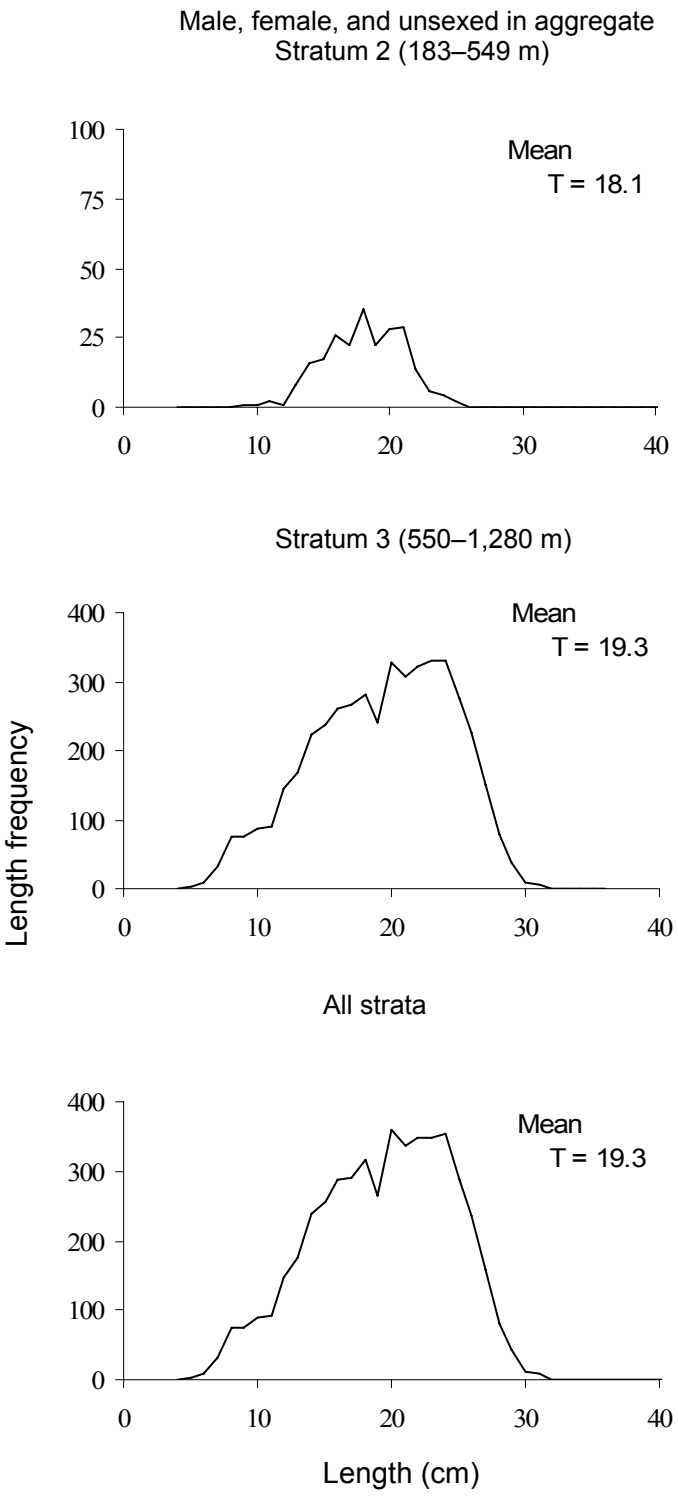


Figure 46. Unweighted length-frequency data and mean lengths (cm) of longspine thornyhead by depth stratum (depth in m) for the Columbia INPFC area from the 2003 West Coast groundfish trawl survey (T = males, females, and unsexed in aggregate).

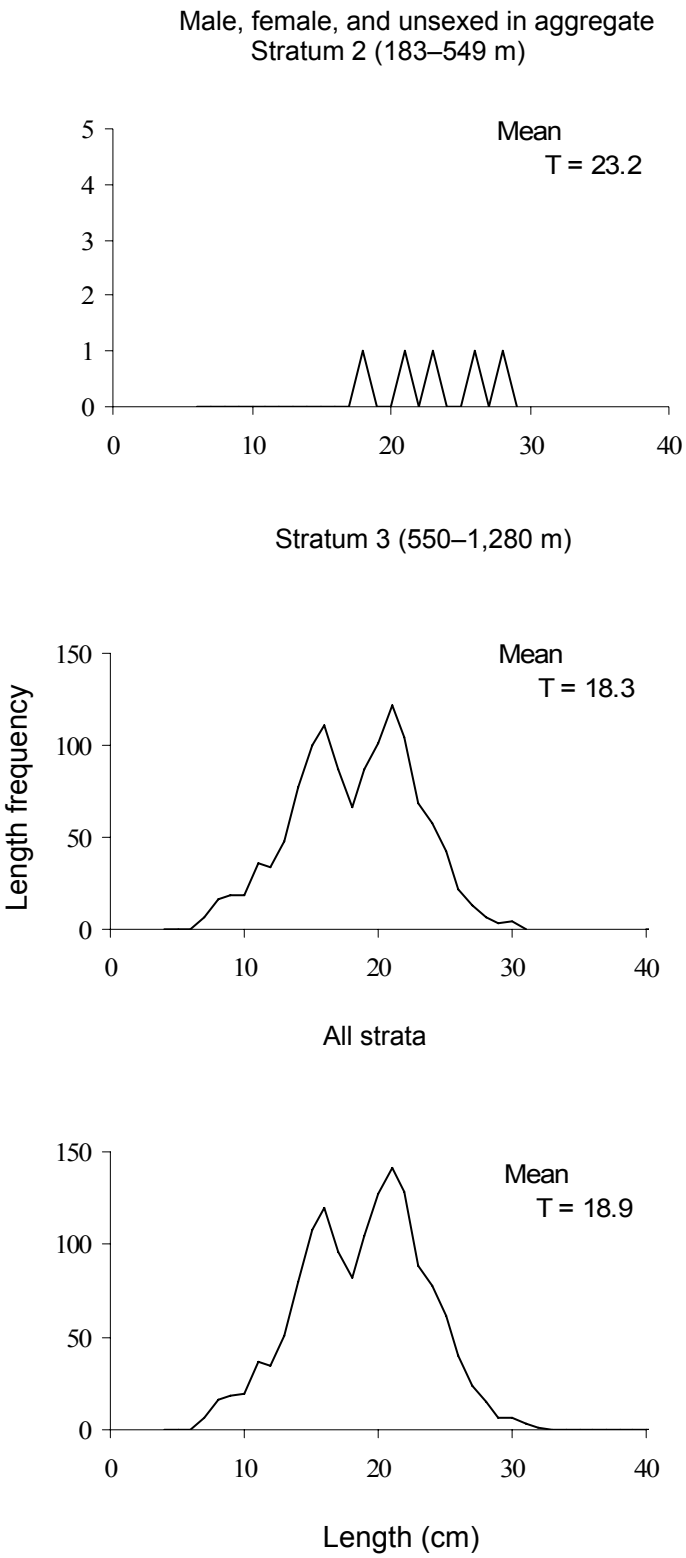


Figure 47. Unweighted length-frequency data and mean lengths (cm) of longspine thornyhead by depth stratum (depth in m) for the U.S.-Vancouver INPFC area from the 2003 West Coast groundfish trawl survey (T = males, females, and unsexed in aggregate).

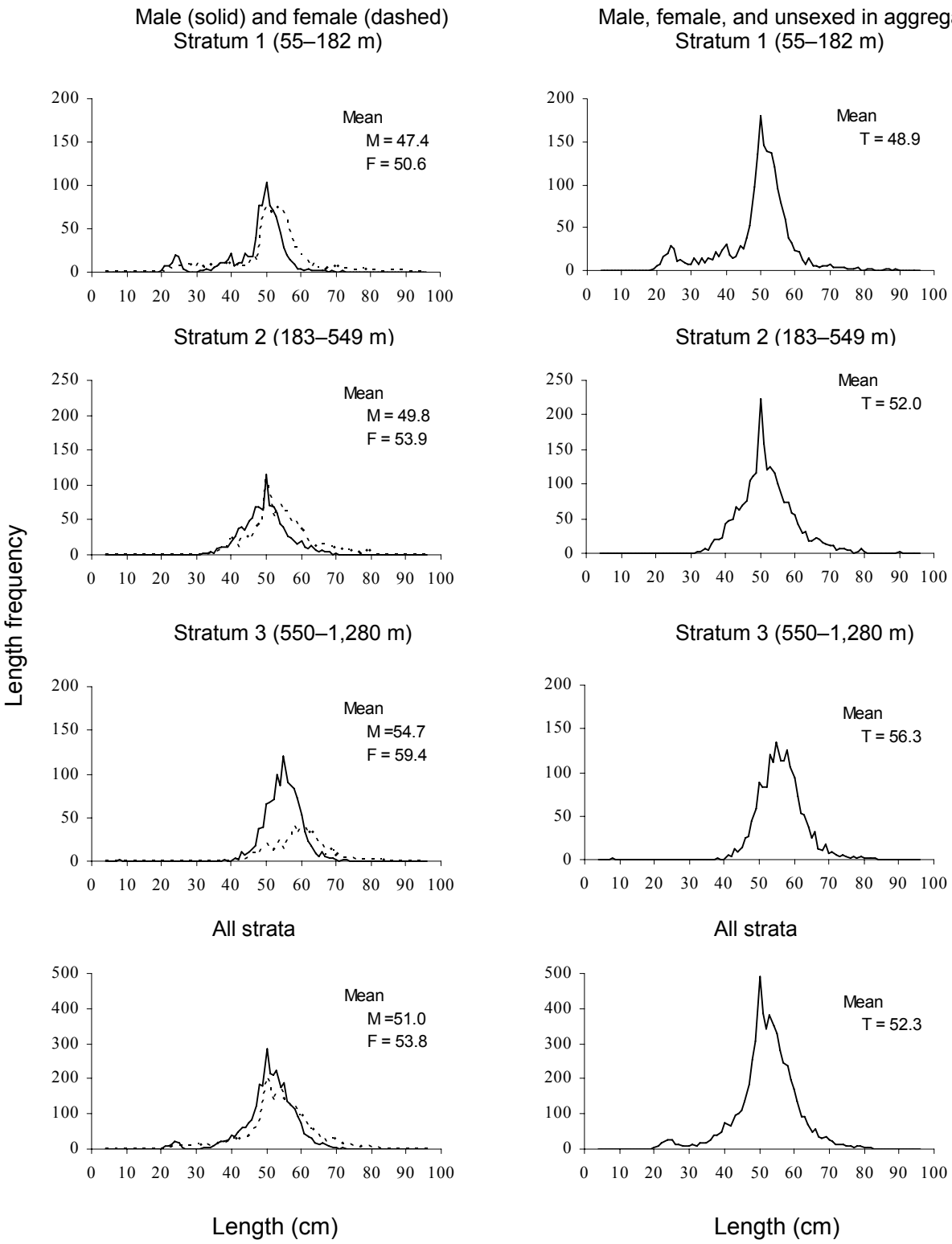


Figure 48. Unweighted length-frequency data and mean lengths (cm) of sablefish by depth stratum (depth in m) and by sex (M = male, F = female, and T = males, females, and unsexed in aggregate) for all INPFC areas sampled from the 2003 West Coast groundfish trawl survey.

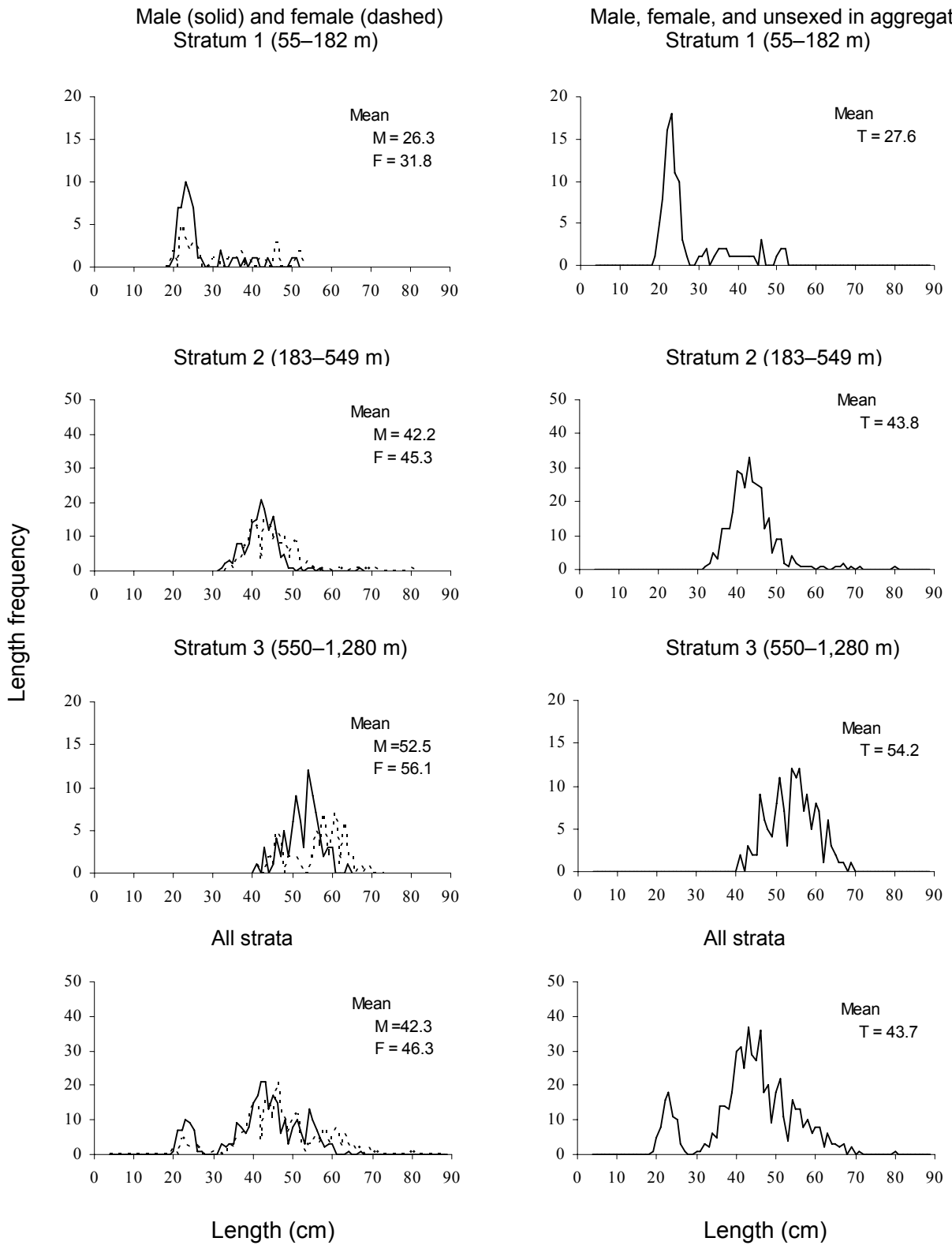


Figure 49. Unweighted length-frequency data and mean lengths (cm) of sablefish by depth stratum (depth in m) and by sex (M = male, F = female, and T = males, females, and unsexed in aggregate) for the INPFC Conception area from the 2003 West Coast groundfish trawl survey.

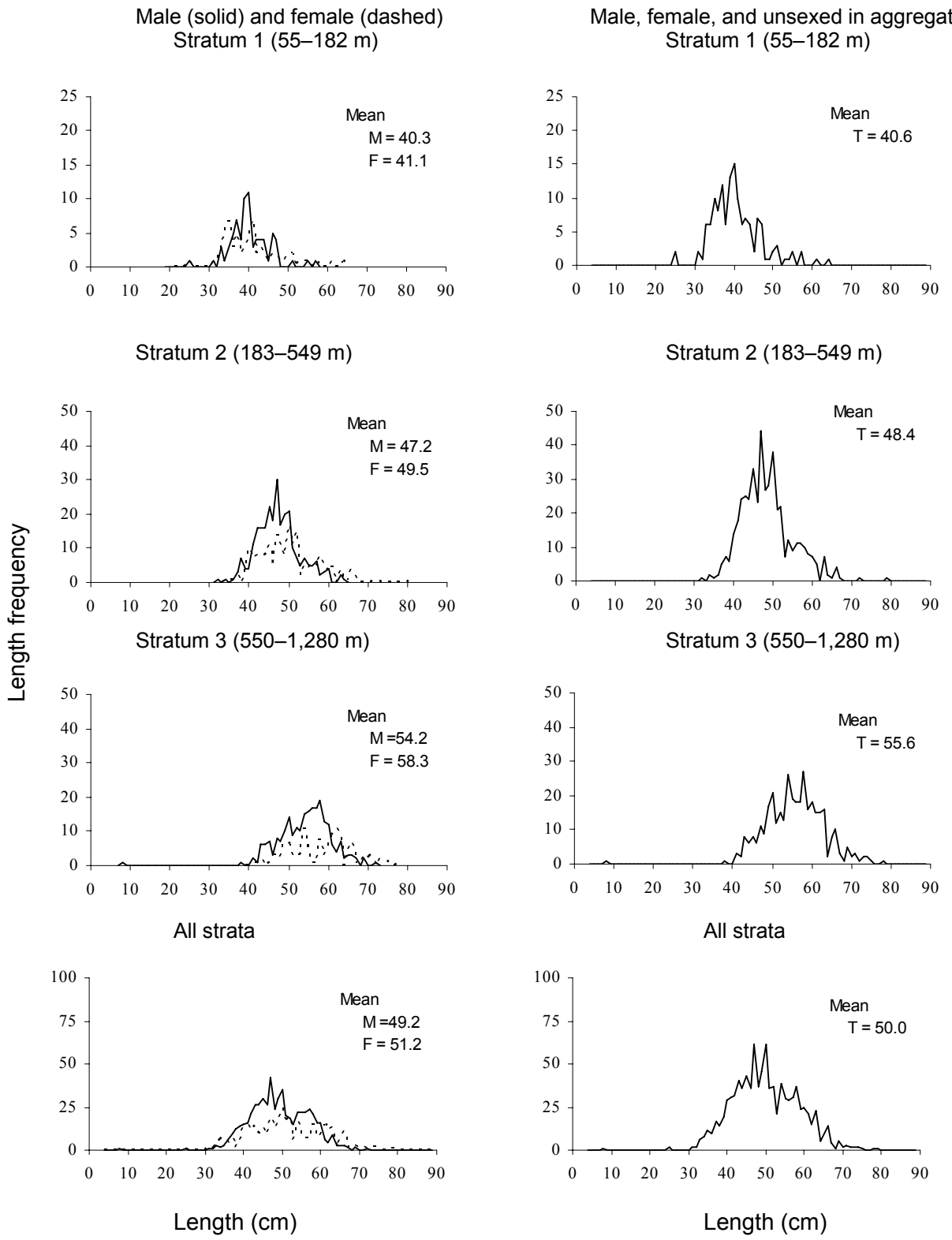


Figure 50. Unweighted length-frequency data and mean lengths (cm) of sablefish by depth stratum (depth in m) and by sex (M = male, F = female, and T = males, females, and unsexed in aggregate) for the INPFC Monterey area from the 2003 West Coast groundfish trawl survey.

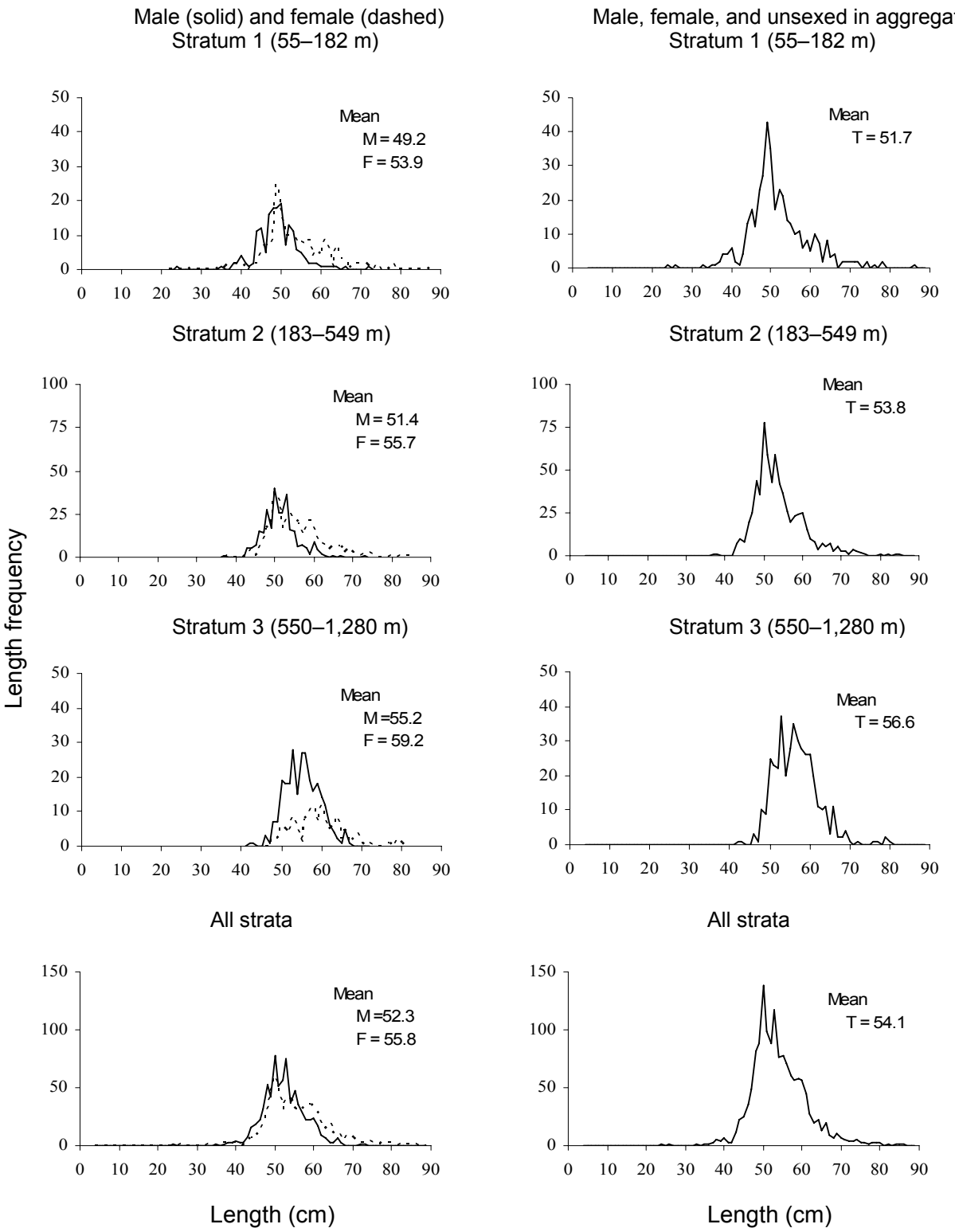


Figure 51. Unweighted length-frequency data and mean lengths (cm) of sablefish by depth stratum (depth in m) and by sex (M = male, F = female, and T = males, females, and unsexed in aggregate) for the INPFC Eureka area from the 2003 West Coast groundfish trawl survey.

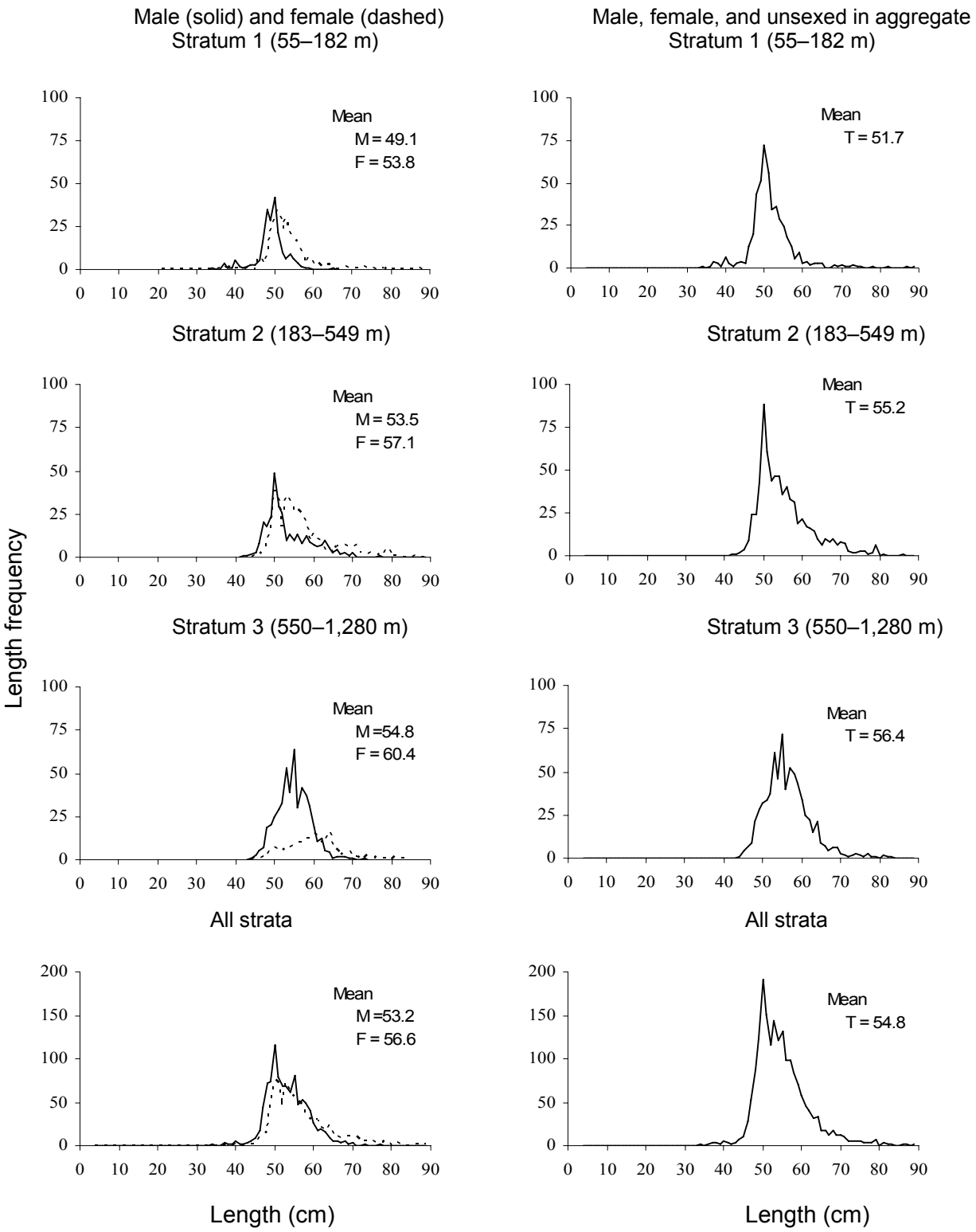


Figure 52. Unweighted length-frequency data and mean lengths (cm) of sablefish by depth stratum (depth in m) and by sex (M = male, F = female, and T = males, females, and unsexed in aggregate) for the INPFC Columbia area from the 2003 West Coast groundfish trawl survey.

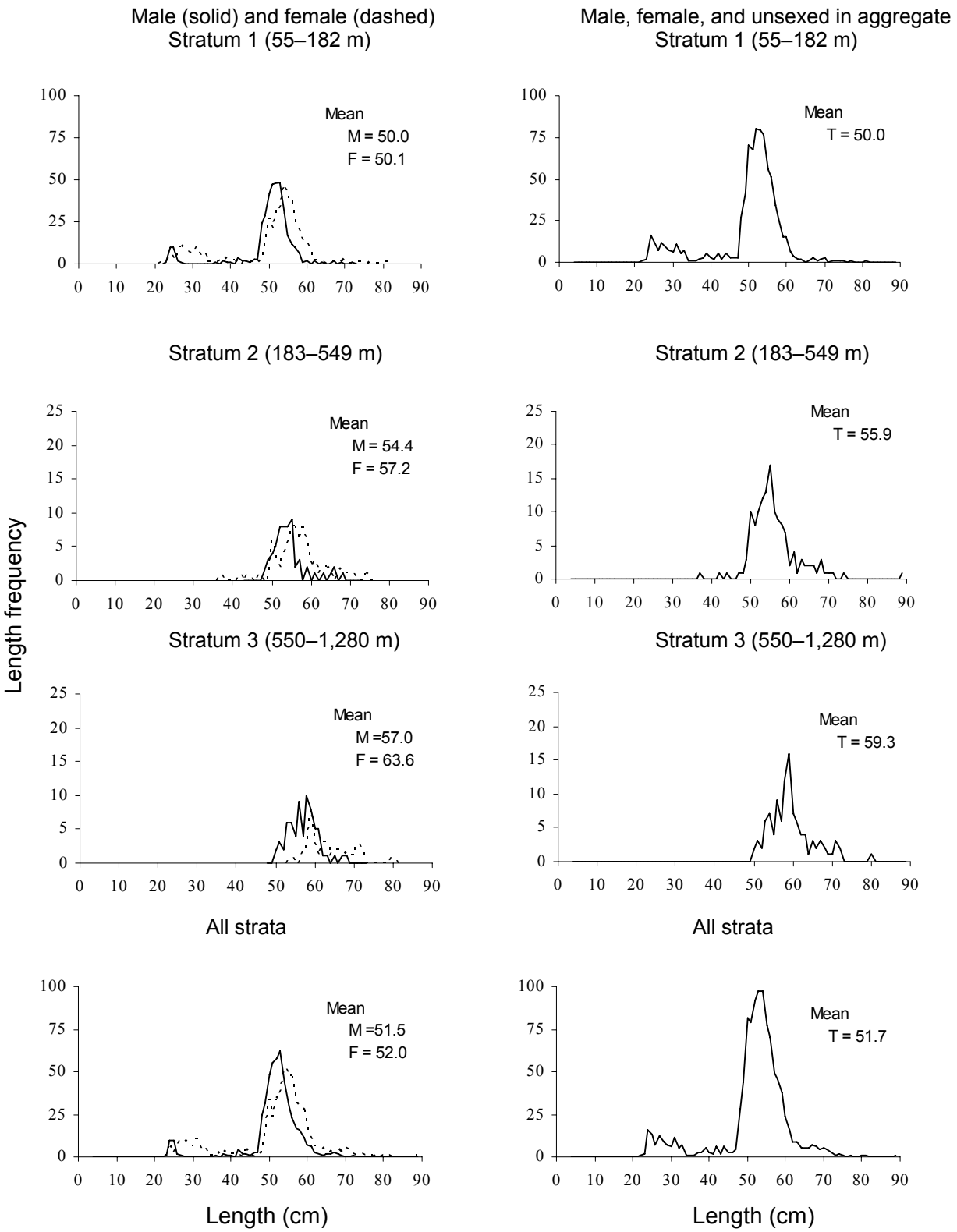


Figure 53. Unweighted length-frequency data and mean lengths (cm) of sablefish by depth stratum (depth in m) and by sex (M = male, F = female, and T = males, females, and unsexed in aggregate) for the INPFC U.S.-Vancouver area from the 2003 West Coast groundfish trawl survey.

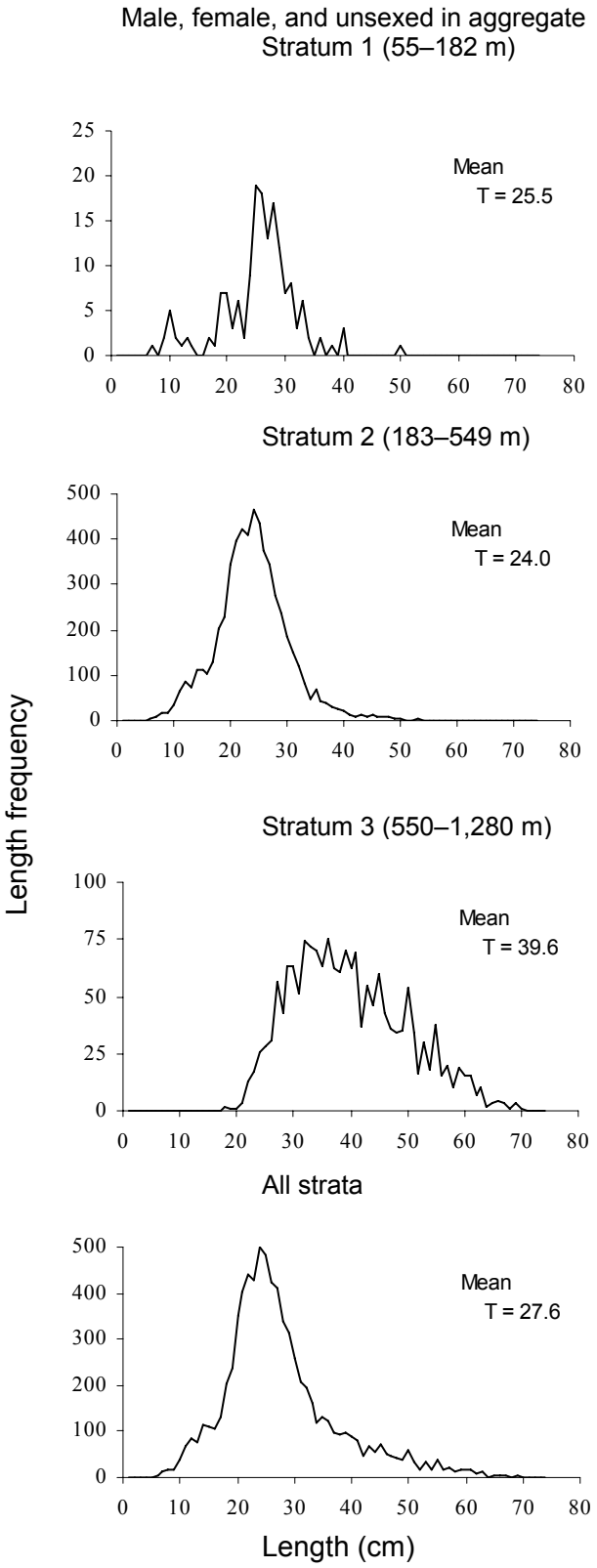


Figure 54. Unweighted length-frequency data and mean lengths (cm) of shortspine thornyhead by depth stratum (depth in m) for all INPFC areas sampled during the 2003 West Coast groundfish trawl survey (T = males, females, and unsexed).

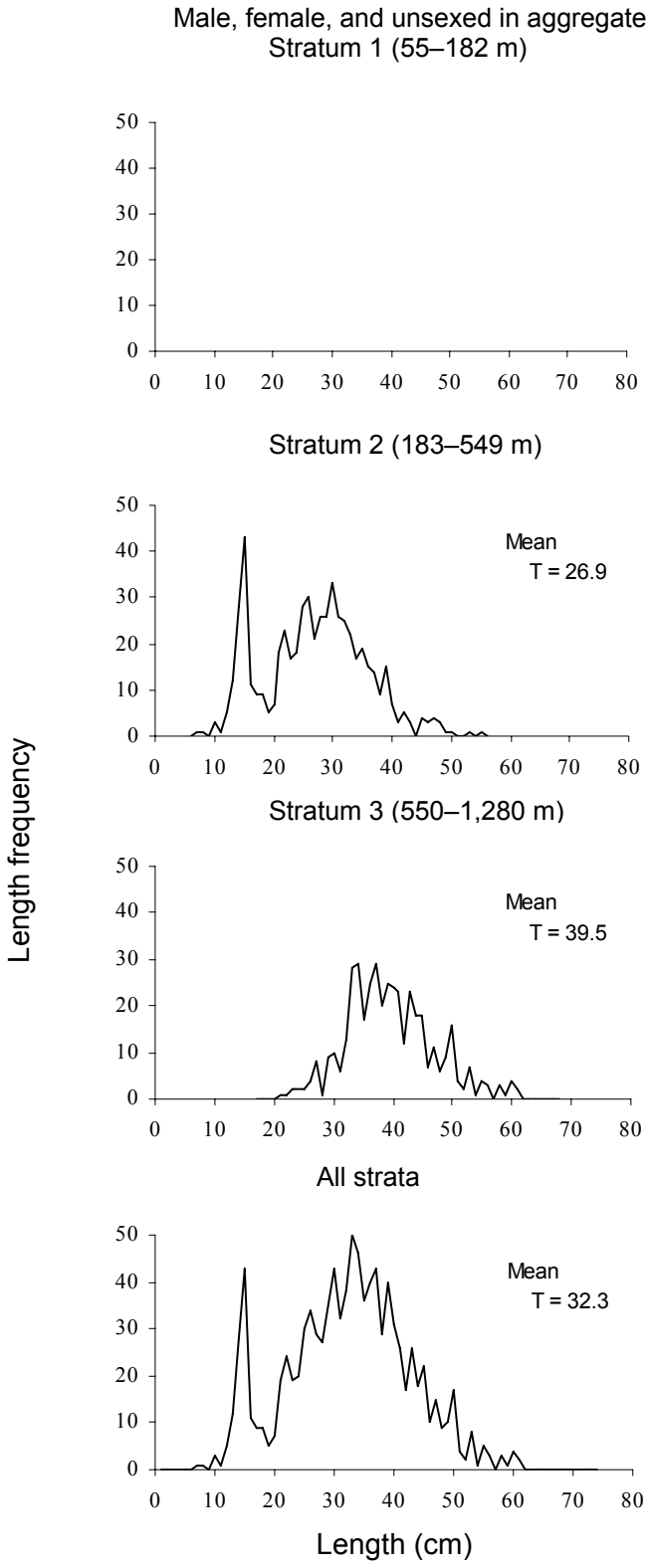


Figure 55. Unweighted length-frequency data and mean lengths (cm) of shortspine thornyhead by depth stratum (depth in m) for the INPFC Conception area from the 2003 West Coast groundfish trawl survey (T = males, females, and unsexed).

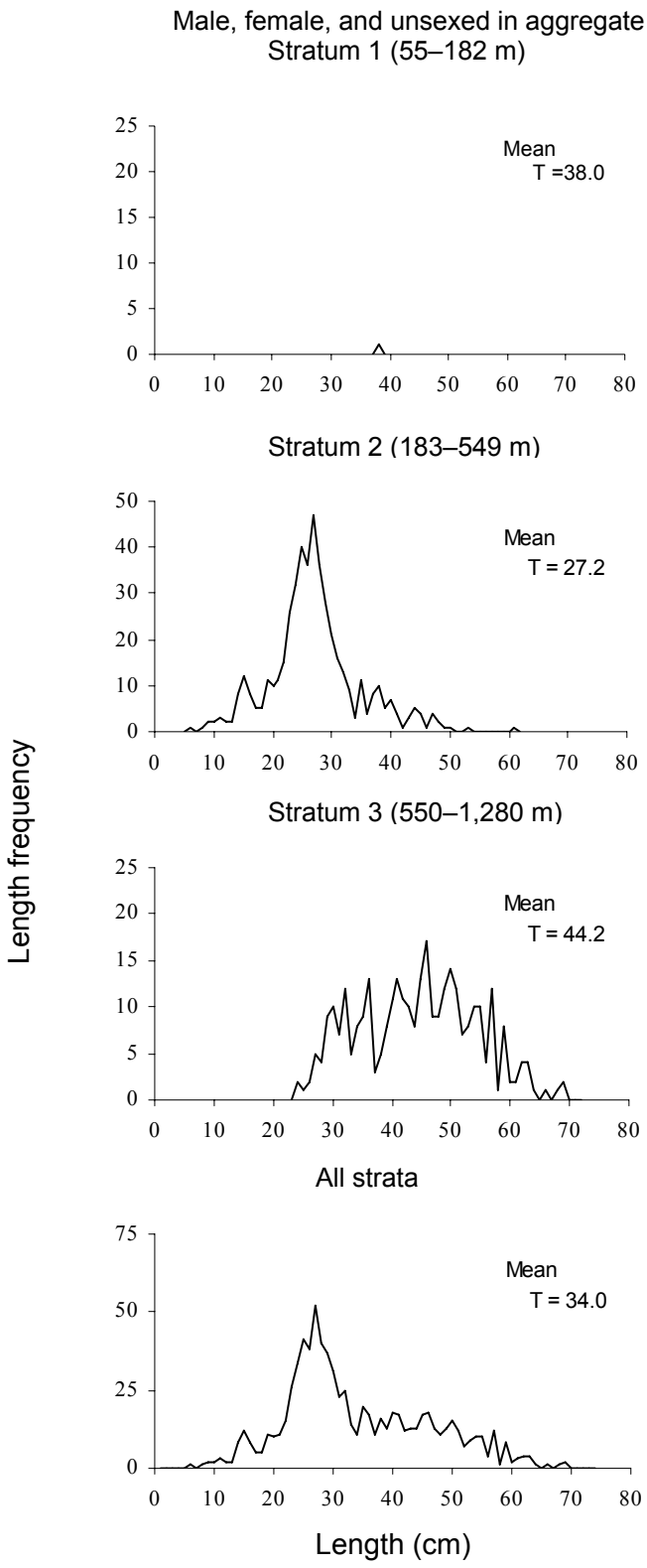


Figure 56. Unweighted length-frequency data and mean lengths (cm) of shortspine thornyhead by depth stratum (depth in m) for the INPFC Monterey area from the 2003 West Coast groundfish trawl survey (T = males, females, and unsexed).

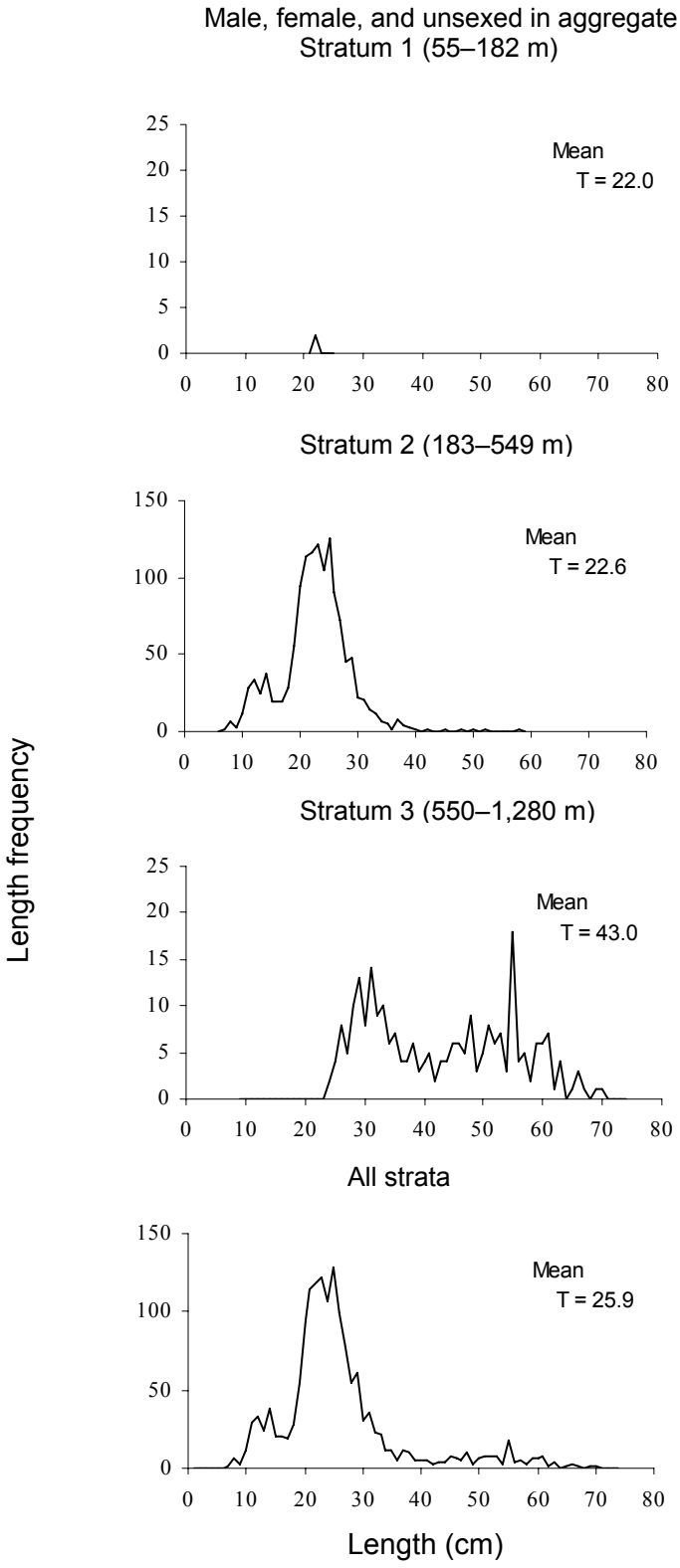


Figure 57. Unweighted length-frequency data and mean lengths (cm) of shortspine thornyhead by depth stratum (depth in m) for the INPFC Eureka area from the 2003 West Coast groundfish trawl survey (T = males, females, and unsexed).

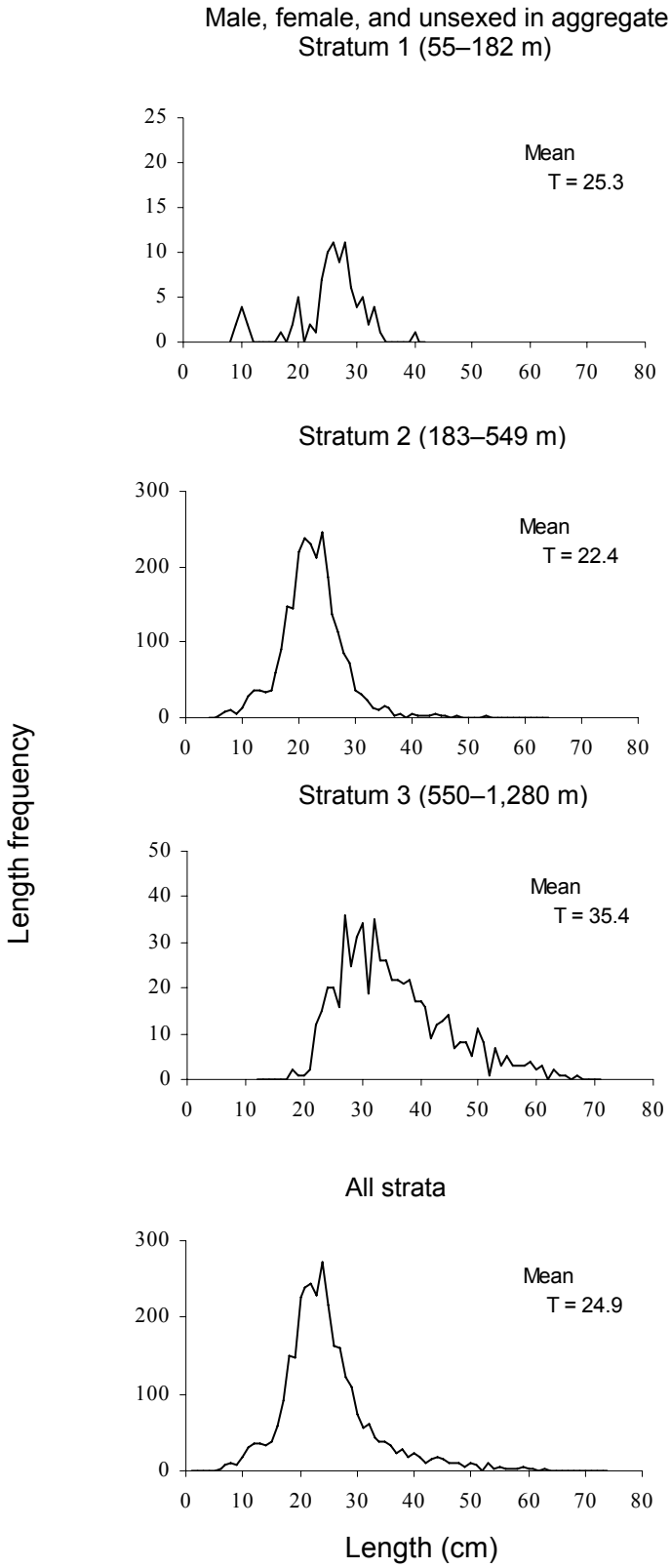


Figure 58. Unweighted length-frequency data and mean lengths (cm) of shortspine thornyhead by depth stratum (depth in m) for the INPFC Columbia area from the 2003 West Coast groundfish trawl survey (T = males, females, and unsexed).

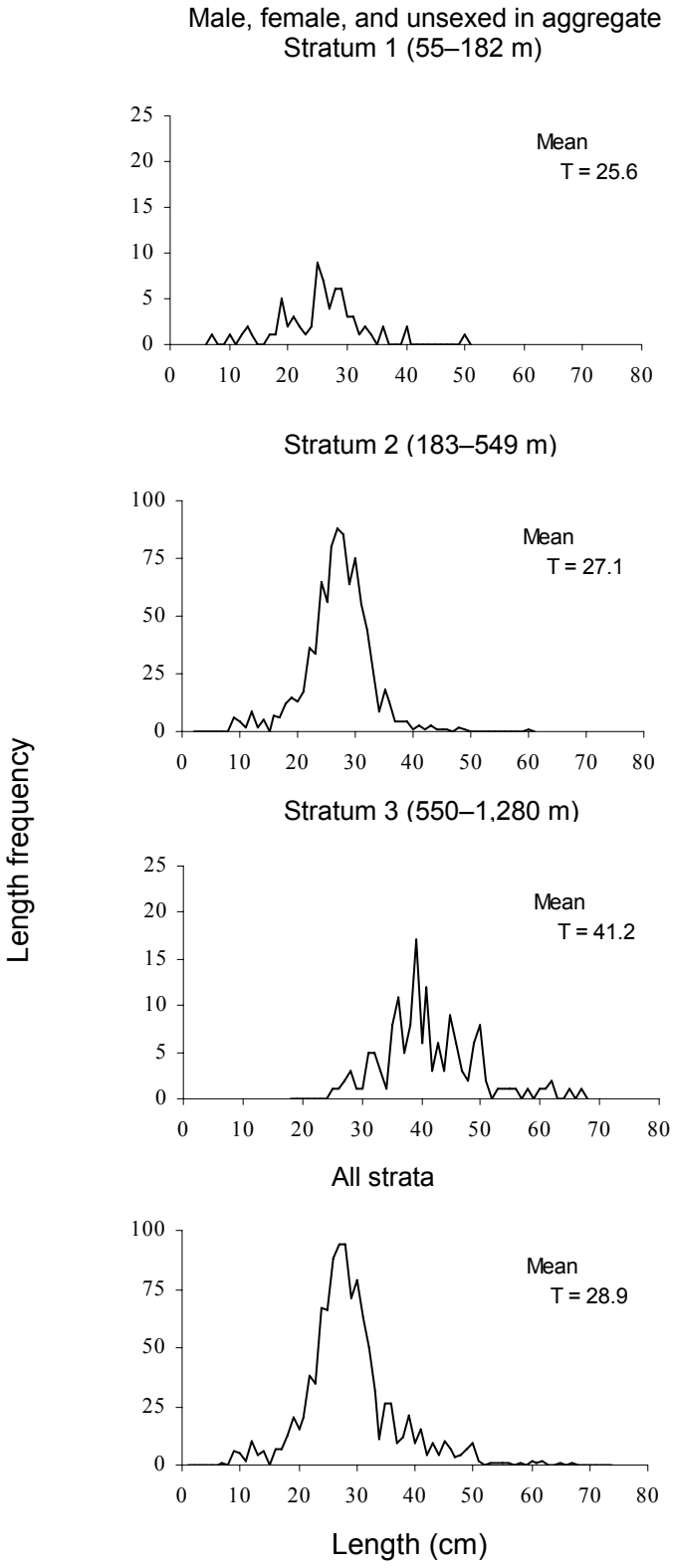


Figure 59. Unweighted length-frequency data and mean lengths (cm) of shortspine thornyhead by depth stratum (depth in m) for the INPFC U.S.-Vancouver area from the 2003 West Coast groundfish trawl survey (T = males, females, and unsexed).

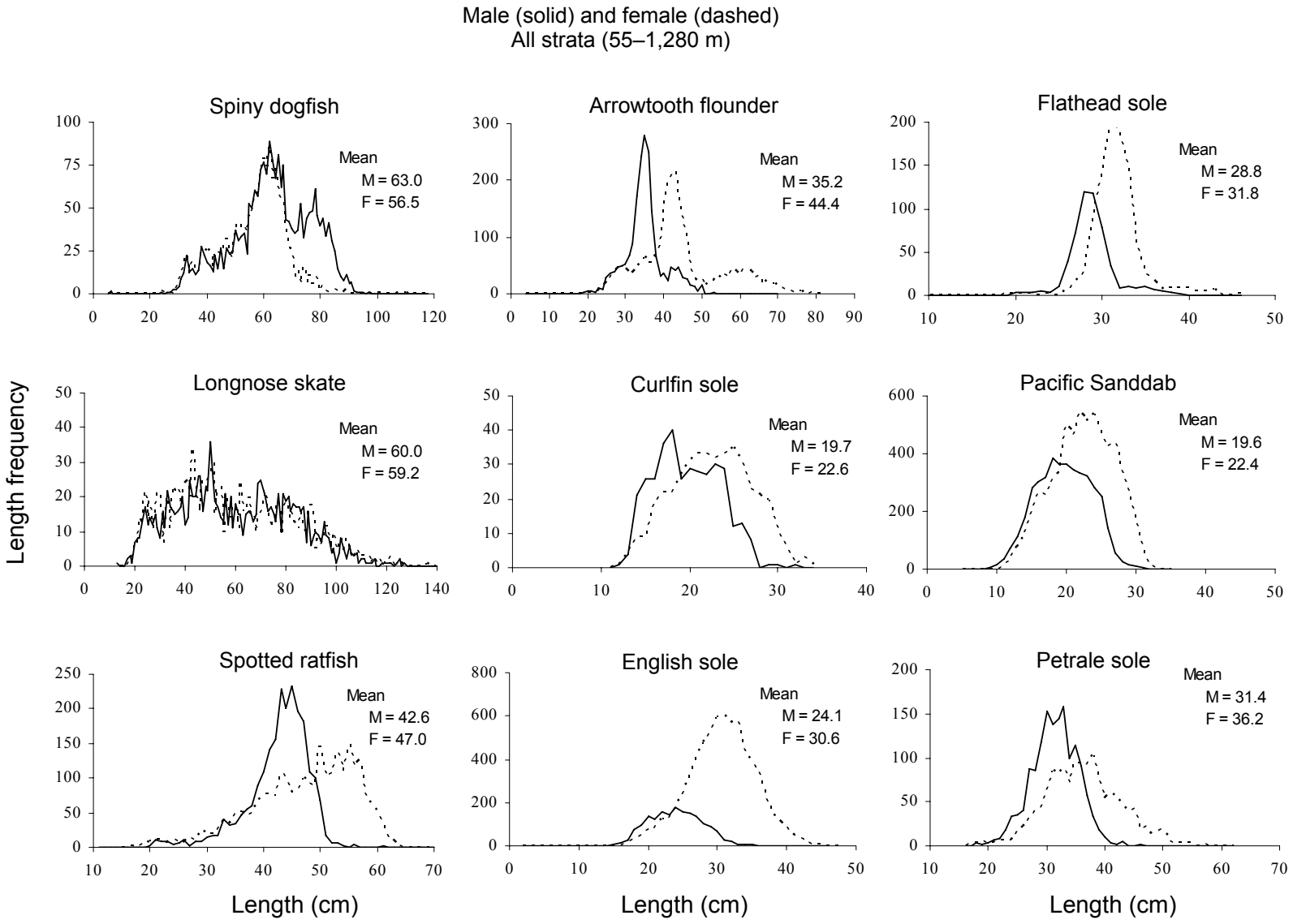


Figure 60. Unweighted length-frequency data and mean lengths (cm) of spiny dogfish, arrowtooth flounder, flathead sole, longnose skate, curlfin sole, Pacific sanddab, spotted ratfish, English sole, and petrale sole by sex (M = males, F = females) for all depths (55–1,280 m) and all INPFC areas sampled from the 2003 West Coast groundfish trawl survey.

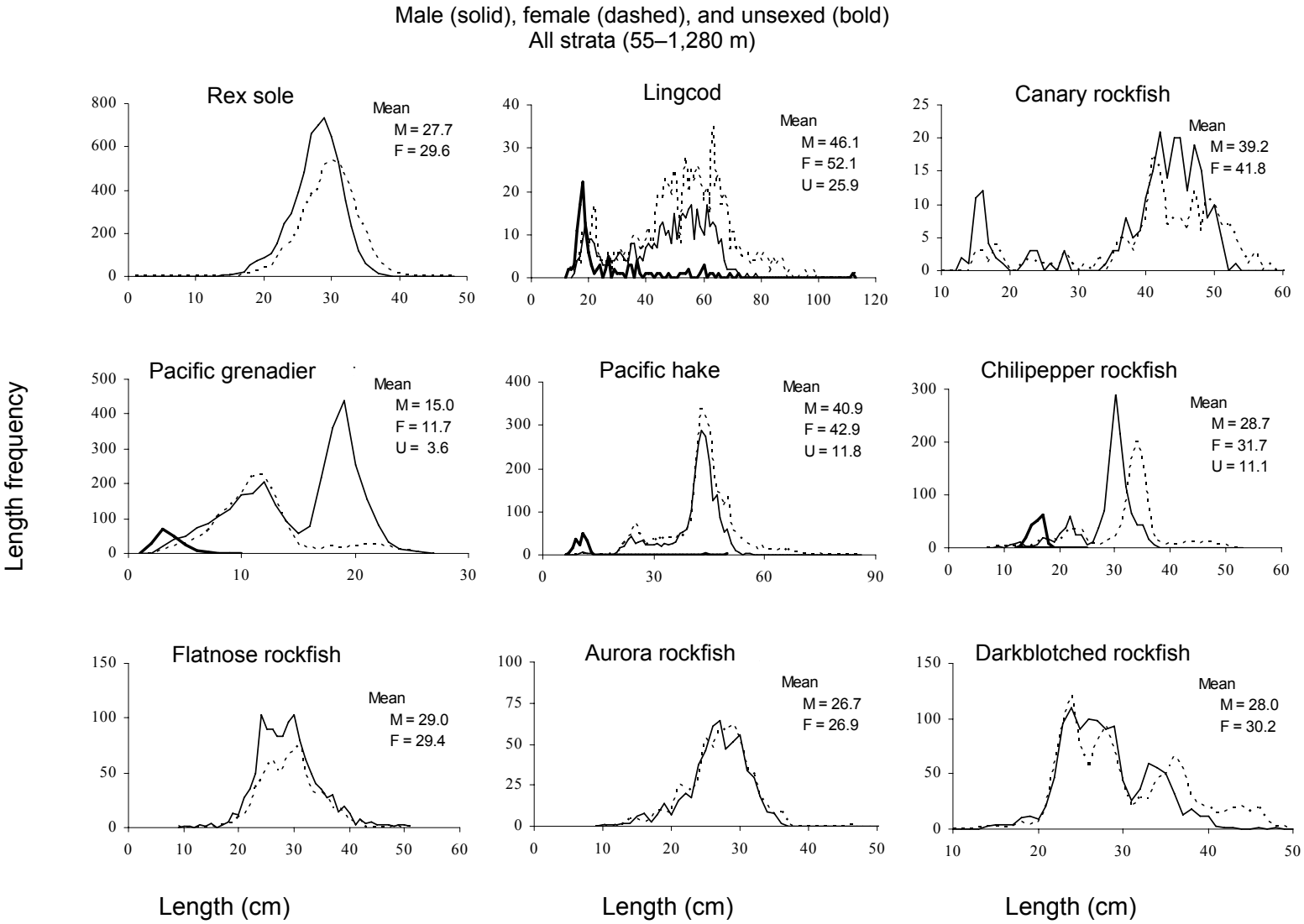


Figure 61. Unweighted length-frequency data and mean lengths (cm) of rex sole, lingcod, canary rockfish, Pacific grenadier, Pacific hake, chilipepper rockfish, flatnose rockfish, aurora rockfish, and darkblotched rockfish by sex (M = males, F = females, U = unsexed) for all depths (55–1,280 m) and all INPFC areas sampled from the 2003 West Coast groundfish trawl survey.

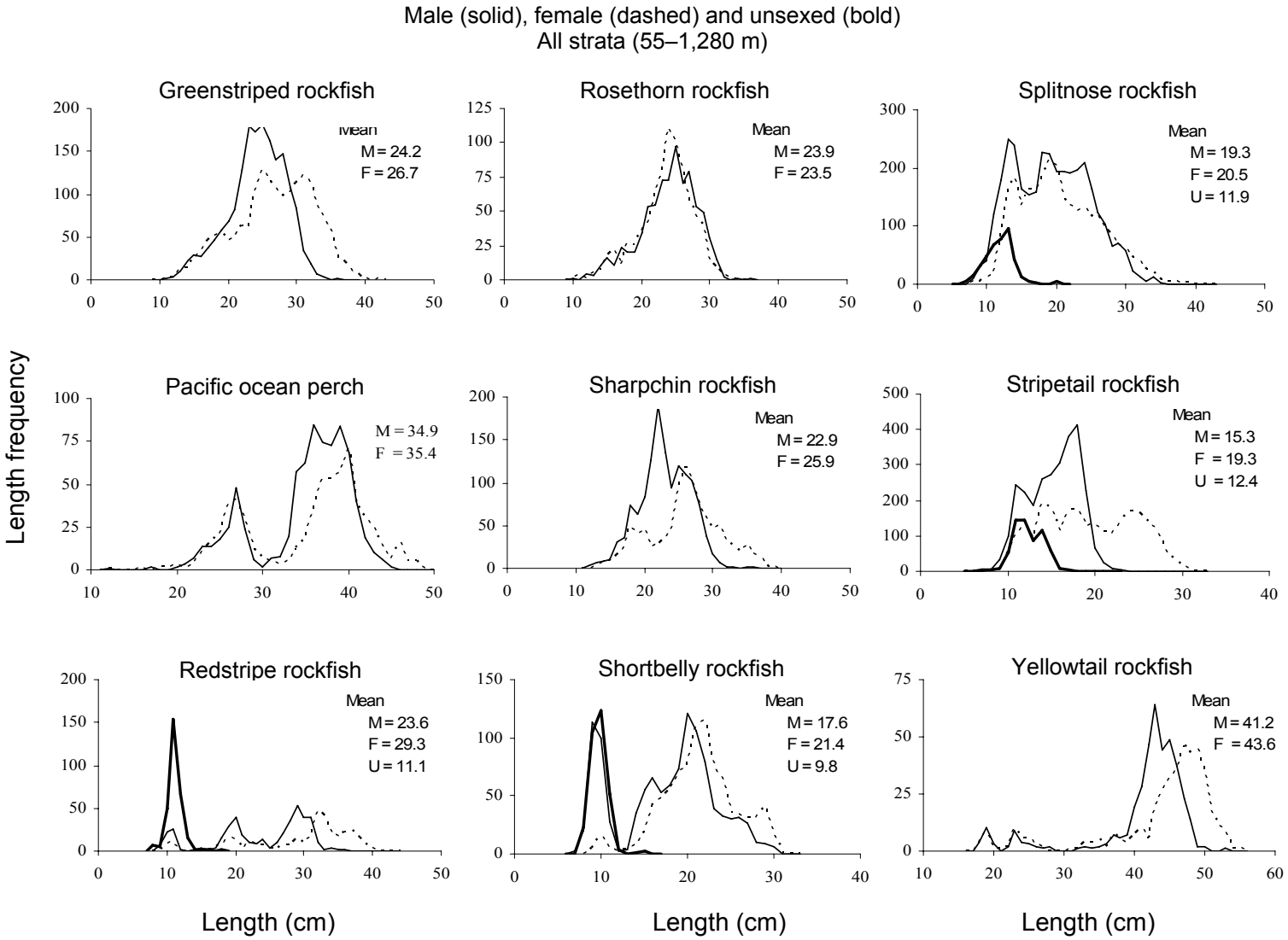


Figure 62. Unweighted length-frequency data and mean lengths (cm) of greenstriped rockfish, rosethorn rockfish, splitnose rockfish, Pacific ocean perch, sharpchin rockfish, stripetail rockfish, redstriped rockfish, shortbelly rockfish, and yellowtail rockfish by sex (M = males, F = females, U = unsexed) for all depths (55–1,280 m) and all INPFC areas sampled from the 2003 West Coast groundfish trawl survey.

Weight-length Relationships

Individual measurements of weight (g) and length (cm) were collected for 36 groundfish species during the 2003 West Coast trawl survey. These data were fit to the following weight-length relationship using a nonlinear least squares fit,

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

where W is fish weight in grams; L is 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 34 groundfish species (Table 2) to determine ages. To date, ages have been determined for age structures collected from Dover sole, lingcod, sablefish, canary rockfish, darkblotched rockfish, Pacific ocean perch, and yellowtail rockfish. For this report, each species is treated as a single homogeneous stock and all age data collected during the 2003 survey are used to estimate the species length-age relationship. Growth was described by the von Bertalanffy growth model (von Bertalanffy 1938),

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

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 63). 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 2003 West Coast groundfish trawl survey using a nonlinear least squares fit for the following equation: Fish weight (g) = a × length (cm)^b.

Species	Number sampled	Weight-length coefficients		
		a	b	r^2
Spiny dogfish	690	0.002496	3.1069	0.98
Pacific sanddab	870	0.004613	3.2402	0.92
Arrowtooth flounder	921	0.002191	3.3922	0.98
Pacific halibut	5	0.001319	3.5056	0.95
Petrale sole	1,582	0.001600	3.5473	0.97
English sole	1,864	0.007008	3.0732	0.95
Dover sole	2,989	0.002247	3.4068	0.97
Sablefish	2,365	0.002941	3.3033	0.97
Pacific grenadier	834	0.297766	2.6180	0.93
Lingcod	866	0.001842	3.3938	0.99
Hake	1,151	0.008055	2.9353	0.98
Aurora rockfish	533	0.009675	3.1457	0.96
Bank rockfish	4	0.003498	3.3995	0.99
Blackgill rockfish	118	0.015980	2.9922	0.98
Bocaccio	121	0.006662	3.1454	0.99
Canary rockfish	264	0.008457	3.1825	0.99
Chilipepper rockfish	693	0.006010	3.2308	0.97
Cowcod	13	0.008158	3.1910	0.99
Darkblotched rockfish	679	0.009299	3.1873	0.97
Greenstriped rockfish	383	0.006374	3.1987	0.94
Longspine thornyhead	957	0.010438	3.0306	0.89
Pacific ocean perch	367	0.005334	3.2806	0.97
Redbanded rockfish	189	0.007878	3.2202	0.99
Redstripe rockfish	201	0.008467	3.1115	0.98
Rosethorn rockfish	425	0.004216	3.3769	0.96
Rougheye rockfish	52	0.007090	3.2161	0.99
Sharpchin rockfish	511	0.011808	3.0550	0.90
Shortbelly rockfish	540	0.001817	3.5544	0.89
Shortspine thornyhead	1,249	0.004787	3.2644	0.98
Silvergray rockfish	32	0.006758	3.1847	0.99
Splitnose rockfish	888	0.010615	3.1226	0.93
Widow rockfish	11	0.003067	3.4399	0.97
Yelloweye rockfish	73	0.006564	3.2601	0.98
Yellowmouth rockfish	33	0.005717	3.2695	0.99
Yellowtail rockfish	218	0.008945	3.1444	0.99

Table 30. Fitted parameters for the von Bertalanffy growth curve model for selected fish species sampled during the 2003 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 the following equation: $L_t = L_\infty (1 - e^{-k(t-t0)})$ with L_t fork length (cm) at age t (years), L_∞ theoretical maximum length (cm), k 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	545	47.731	0.130	–2.20
Male	441	43.610	0.098	–5.54
Combined	992	46.756	0.105	–4.01
Lingcod				
Female	570	101.70	0.205	–1.06
Male	309	75.440	0.341	–0.89
Combined	950	95.267	0.227	–1.00
Sablefish				
Female	444	64.532	0.340	–1.55
Male	515	57.369	0.371	–1.75
Combined	964	60.063	0.380	–1.52
Canary rockfish				
Female	130	54.590	0.186	–0.088
Male	173	49.925	0.234	0.165
Combined	303	52.026	0.209	0.045
Darkblotched rockfish				
Female	335	44.687	0.161	–1.60
Male	425	41.294	0.173	–1.85
Combined	763	43.420	0.161	–1.82
Pacific ocean perch				
Female	130	41.725	0.213	–0.75
Male	243	39.310	0.215	–1.19
Combined	433	40.196	0.220	–0.88
Yellowtail rockfish				
Female	162	51.674	0.188	–0.33
Male	160	45.869	0.228	–0.39
Combined	322	47.952	0.225	–0.17

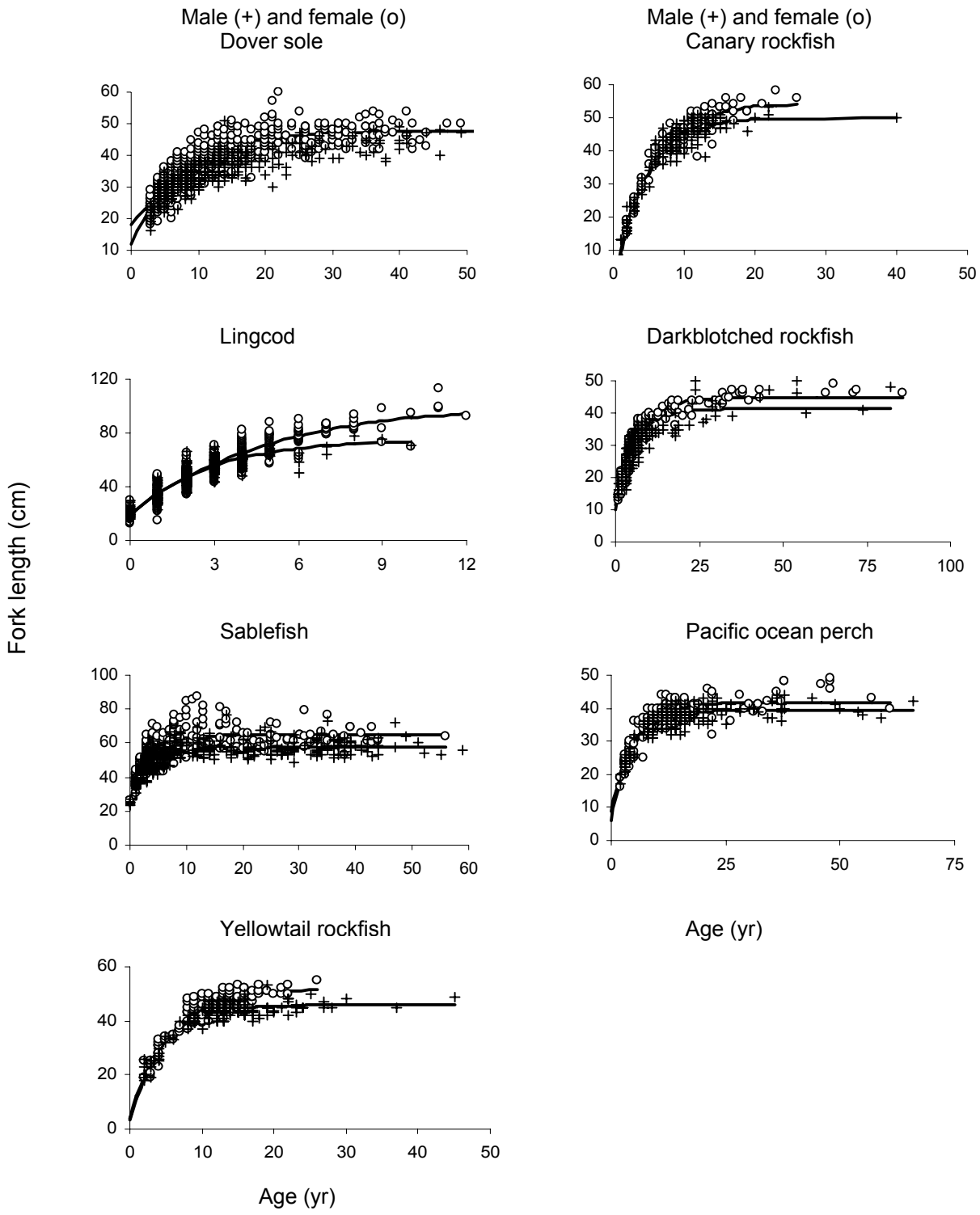


Figure 63. von Bertalanffy growth models for male (+) and female (o) Dover sole, canary rockfish, lingcod, darkblotched rockfish, sablefish, Pacific ocean perch, and yellowtail rockfish from the 2003 West Coast groundfish trawl survey.

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 for more detailed information, contact the senior author (telephone 206-860-3460 or e-mail aimee.keller@noaa.gov).

References

Builder Ramsey, T., T. A. Turk, E. L. Fruh, J. R. Wallace, B. H. Horness, A. J. Cook, K. L. Bosley, D. J. Kamikawa, L. C. Hufnagle Jr., and K. Piner. 2002. The 1999 Northwest Fisheries Science Center Pacific West Coast upper continental slope 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-55.

Draper, N., and H. Smith. 1981. Applied regression analysis, 2nd ed. John Wiley, New York.

Gunderson, D. R. 1993. Surveys of fisheries resources. John Wiley, New York.

Helser, T. E., A. E. Punt, and R. D. Methot. 2004. A generalized linear model analysis of a multi-vessel fishery resource survey. Fish. Res. 70:239–250.

Keller, A. A., T. L. Wick, E. L. Fruh, K. L. Bosley, D. J. Kamikawa, J. R. Wallace, and B. H. Horness. 2005. The 2000 U.S. West Coast upper continental slope 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-70.

Keller, A. A., E. L. Fruh, K. L. Bosley, D. J. Kamikawa, J. R. Wallace, B. H. Horness, V. H. Simon, and V. J. Tuttle. 2006a. The 2001 U.S. West Coast upper continental slope 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-72.

Keller, A. A., B. H. Horness, V. J. Tuttle, J. R. Wallace, V. H. Simon, E. L. Fruh, K. L. Bosley, and D. J. Kamikawa. 2006b. The 2002 U.S. West Coast upper continental slope 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-75.

Lauth, R. R. 1999. The 1997 Pacific West Coast upper continental slope trawl survey of groundfish resources off Washington, Oregon, and California: Estimates of distribution, abundance, and composition. U.S. Dept. Commer., NOAA Tech. Memo. NMFS-AFSC-98.

Lauth, R. R. 2001. The 2000 Pacific West Coast upper continental slope trawl survey of groundfish resources off Washington, Oregon, and California: Estimates of distribution, abundance, and composition. U.S. Dept. Commer., NOAA Tech. Memo. NMFS-AFSC-120.

Methot, R. D., J. R. Wallace, and C. W. West. 2000. Introducing a new trawl survey for U.S. West Coast slope groundfish. Presented at ICES Annual Science Conference, Brugge, Belgium, September 2000. (Available from R. Methot, NWFSC, Fishery Resource Analysis and Monitoring Division, 2725 Montlake Blvd. E., Seattle, WA 98112.)

Naval Oceanographic Office. No date. DBDB−V (Digital Bathymetric Data Base−Variable resolution), version 4.3. Naval Oceanographic Office, Stennis Space Center, MS.

SAS Institute Inc. 1999. SAS/STAT user's guide, version 8. SAS Institute Inc., Cary, NC.

S−Plus. 1999. S−Plus 2000 user's guide. Mathsoft Inc., Data Analysis Products Division, Seattle, WA.

Stauffer, G. 2004. NOAA protocols for groundfish bottom trawl surveys of the nation's fishery resources. U.S. Dept. Commer., NOAA Tech. Memo. NMFS-F/SPO-65.

Turk, T. A., T. L. Builder, C. W. West, D. J. Kamikawa, J. R. Wallace, R. D. Methot, A. R. Bailey, K. L. Bosley, A. J. Cook, E. L. Fruh, B. H. Horness, K. Piner, H. R. Sanborn, W. W. Wakefield. 2001. The 1998 Northwest Fisheries Science Center Pacific West Coast upper continental slope 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-50.

von Bertalanffy, L. 1938. A quantitative theory of organic growth. Hum. Biol. 10:181–213.

Wallace, J. R. 2000a. Calculating tow position and distance from FRAM 2000 slope survey data. Unpubl. manuscr. (Available from J. Wallace, NWFSC, Fishery Resource Analysis and Monitoring Division, 2725 Montlake Blvd. E., Seattle, WA 98112.)

Wallace, J. R. 2000b. Calculating tow position and distance from FRAM 1999 slope survey data. Unpubl. manuscr. (Available from J. Wallace, NWFSC, Fishery Resource Analysis and Monitoring Division, 2725 Montlake Blvd. E., Seattle, WA 98112.)

Wallace, J. R., and C. W. West. 2006. Measurements of distance fished during the trawl retrieval period. Fish. Res. 77:285–292.

West, C. W., D. R. Gunderson, and R. D. Methot. 1998. Evaluation of West Coast slope survey methodology. Unpubl. Manuscr. (Available from R. Methot, NWFSC, Fishery Resource Analysis and Monitoring Division, 2725 Montlake Blvd. E., Seattle, WA 98112.)

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85 Norman, K., J. Sepez, H. Lazrus, N. Milne, C. Package, S. Russell, K. Grant, R.P. Lewis, J. Primo, E. Springer, M. Styles, B. Tilt, and I. Vaccaro. 2007. Community profiles for West Coast and North Pacific fisheries–Washington, Oregon, California, and other U.S. states. U.S. Dept. Commer., NOAA Tech. Memo. NMFS-NWFSC-85, 602 p. NTIS number pending.

84 Brand, E.J., I.C. Kaplan. C.J. Harvey, P.S. Levin, E.A. Fulton, A.J. Hermann, and J.C. Field. 2007. A spatially explicit ecosystem model of the California Current's food web and oceanography. U.S. Dept. Commer., NOAA Tech. Memo. NMFS-NWFSC-84, 145 p. NTIS number PB2008-102578.

83 Hecht, S.A., D.H. Baldwin, C.A. Mebane, T. Hawkes, S.J. Gross, and N.L. Scholz. 2007. An overview of sensory effects on juvenile salmonids exposed to dissolved copper: Applying a benchmark concentration approach to evaluate sublethal neurobehavioral toxicity. U.S. Dept. Commer., NOAA Tech. Memo. NMFS-NWFSC-83, 39 p. NTIS number PB2008-102577.

82 Helser, T.E., I.J. Stewart, C.E. Whitmire, and B.H. Horness. 2007. Model-based estimates of abundance for 11 species from the NMFS slope surveys. U.S. Dept. Commer., NOAA Tech. Memo. NMFS-NWFSC-82, 145 p. NTIS number PB2008-102576.

81 Hard, J.J., J.M. Myers, M.J. Ford, R.G. Cope, G.R. Pess, R.S. Waples, G.A. Winans, B.A. Berejikian, F.W. Waknitz, P.B. Adams. P.A. Bisson, D.E. Campton, and R.R. Reisenbichler. 2007. Status review of Puget Sound steelhead *(Oncorhynchus mykiss)*. U.S. Dept. Commer., NOAA Tech. Memo. NMFS-NWFSC-81, 117 p. NTIS number PB2008-100451.

80 Berntson, E.A., P.S. Levin, and P.C. Moran (editors). 2007. Conservation of North Pacific rockfishes: Ecological genetics and stock structure. Proceedings of the workshop, March 2-3, 2004, Seattle, Washington. U.S. Dept. Commer., NOAA Tech. Memo. NMFS-NWFSC-80, 80 p. NTIS number PB2007-111137.

79 Lawson, P.W., E.P. Bjorkstedt, M.W. Chilcote, C.W. Huntington, J.S. Mills, K.M.S. Moore, T.E. Nickelson, G.H. Reeves, H.A. Stout, T.C. Wainwright, and L.A. Weitkamp. 2007. Identification of historical populations of coho salmon *(Oncorhynchus kisutch)* in the Oregon coast evolutionarily significant unit. U.S. Dept. Commer., NOAA Tech. Memo. NMFS-NWFSC-79, 129 p. NTIS number PB2007-111607.

78 Ruckelshaus, M.H., K.P. Currens, W.H. Graeber, R.R. Fuerstenberg, K. Rawson, N.J. Sands, and J.B. Scott. 2006. Independent populations of Chinook salmon in Puget Sound. U.S. Dept. Commer., NOAA Tech. Memo. NMFS-NWFSC-78, 125 p. NTIS number PB2007-104920.

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