NOAA Technical Memorandum NMFS-NWFSC-93

The 2005 U.S. West Coast Bottom Trawl Survey of Groundfish Resources

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

July 2008

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Aimee A. Keller, Beth H. Horness, Erica L. Fruh,
Victor H. Simon, Vanessa J. Tuttle, Keith L. Bosley,
John C. Buchanan, Dan J. Kamikawa,
and John R. Wallace

Northwest Fisheries Science Center
Fishery Resource Analysis and Monitoring Division
2725 Montlake Boulevard East
Seattle, Washington 98112

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Executive Summary

The Northwest Fisheries Science Center's Fishery Resource Analysis and Monitoring Division (FRAM) completed the eighth in an annual series of groundfish bottom trawl surveys in 2005. The survey was conducted from 23 May to 25 October 2005 and targeted the commercial groundfish resources inhabiting depths of 55 to 1,280 m (30–700 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 trawl vessels. This ongoing series of annual surveys, conducted by FRAM since 1998, are designed to monitor long-term trends in the distribution and abundance of West Coast groundfish, especially those species of management concern. The 2005 survey represents the third year in which the depth range was expanded to include both the continental shelf (55–183 m) and continental slope (183–1,280 m) and the third year in which a stratified random sampling design was adopted.

In 2005 720 primary sampling sites and associated secondary sites were selected randomly prior to the start of the survey. Trawling locations were allocated according to a stratified random sampling design that divided the region into two geographic areas (north and south of Point Conception, California, and three depth zones (strata). The objective was to provide a representative sample of the various groundfish species and relative numbers in each stratum. By selecting random stations within certain depth zones, all towable ground has an equal probability of being sampled during the survey. Thus the method produces unbiased estimates of the relative stock size. In 2005 a total of 675 successful tows were completed out of 749 attempts. Simrad Integrated Trawl Instrumentation net mensuration data, as well as global positioning system (GPS) 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 616 species or families were identified within the survey area. Although the biological sampling efforts continue to include Dover sole (*Microstomus pacificus*), shortspine thornyhead (*Sebastolobus alascanus*), longspine thornyhead (*S. altivelis*), and sablefish (*Anoplopoma fimbria*), the focus 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*, *Noah's Ark,* and *Raven* for their efforts during the 2005 Northwest Fisheries Science Center's West Coast groundfish bottom trawl survey. We also thank the biologists who participated in the survey, including (in alphabetical order) Justin Ainsworth, Lewis Barnett, Matt Barnhart, Chante Davis, Amy Grondin, Melanie Johnson**,** Isaac Kaplan, Jodie Little, Jim Miller, Suzanne Romain, John Wallace, and Keri York. Scott McEntire at the Resource Assessment and Conservation Engineering Division of the Alaska Fisheries Science Center designed the bottom contact sensors. We also express our appreciation to Brian Parker, Mary Breaker, Mary Craig, and Carol Ksycinski for their shoreside logistical support and Curt Whitmire and Julia Clemons for creating the GIS 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 account for 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 eighth in a series of annual bottom trawl surveys of groundfish resources off the U.S. West Coast, conducting survey operations from 23 May to 25 October 2005. 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 upper continental slope and shelf of the U.S. West Coast. The survey area extended from northern Washington (U.S.-Canada border) to southern California (U.S.-Mexico border) in waters ranging from 55 to 1,280 m (30–700 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, 2007a, 2007b).

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 groundfish stock status, but also an extension of two established, long-term time series from which informed management decisions can be made.

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

coverage of the West Coast surveys varied between years due to constraints imposed by annual budget levels and availability of NOAA ship time (Lauth 2001).

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

The WCGTS spans from latitude 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 objective of this report is to document the operations, survey design, and initial results of the 2005 survey. Data summaries are provided for species composition, catch, distribution, relative density, biomass estimates, and size composition of selected species. The results are summarized by depth strata (55–183 m, 184–549 m and 550–1,280 m, or 30–100 fm, 101–300 fm and 301–700 fm) and INPFC area. Weight-length and length-at-age relationships, with age determined from otoliths, are also described for select groundfish species. In this report, we document operations and results of the 2005 groundfish survey with the intent to provide the indices of abundance necessary for subsequent stock assessment exercises.

[*] Mandated authority over fisheries along the West Coast of the United States, including specifically the states of Washington, Oregon, and California, 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.

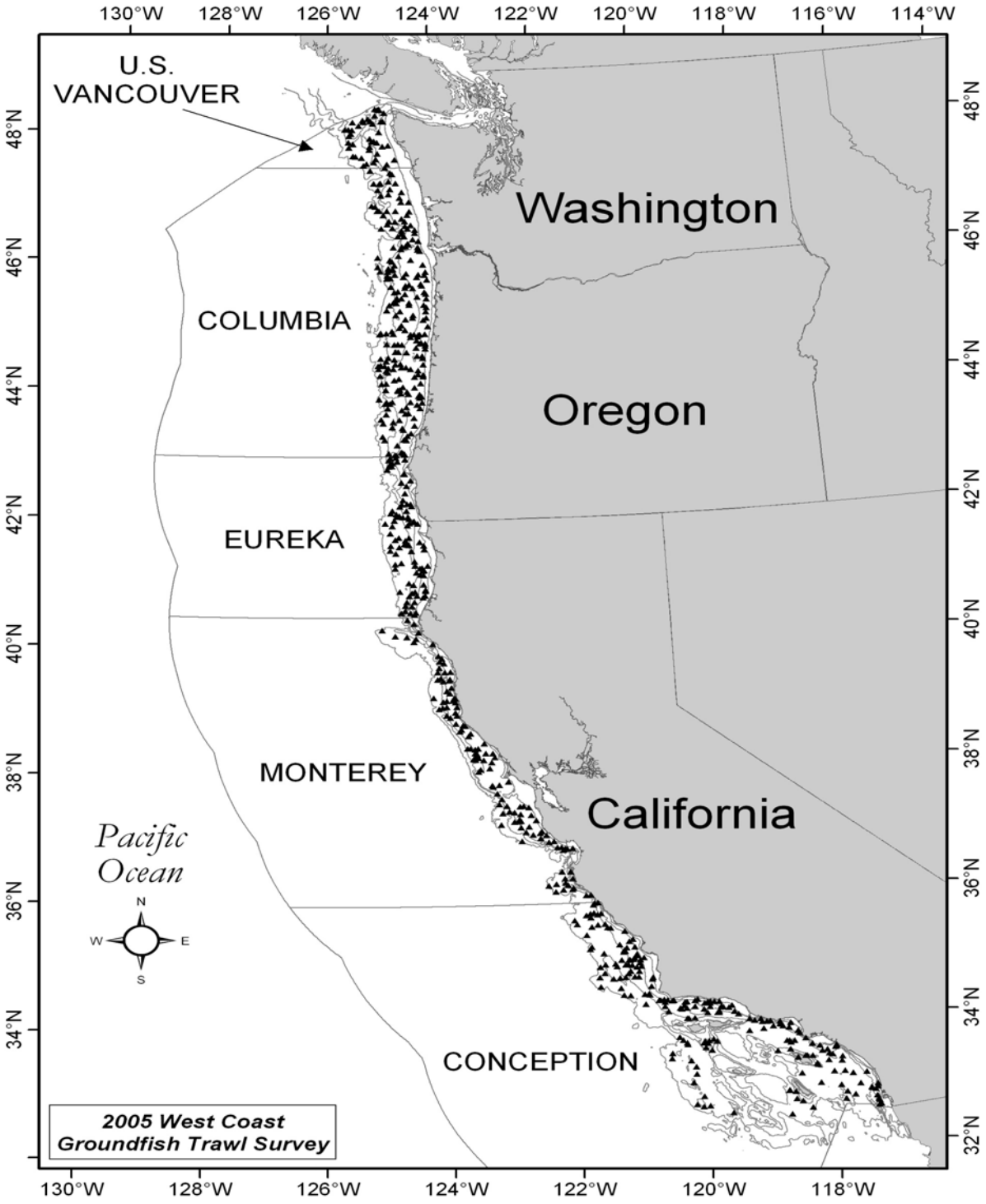

Figure 1. Map showing extent of the 2005 West Coast groundfish trawl survey and the locations of completed stations (▲).

Survey Methods

Survey Period and Sampling Area

The 2005 WCGTS was conducted in two cycles of operations, or passes, between 23 May and 27 October 2005 from the areas off Cape Flattery, Washington (lat 48°10′N), to the U.S.-Mexico border (lat 32°30′N). Four bottom trawl vessels were chartered through a standard competitive bid process. The fishing vessels (FVs) *Ms. Julie* and *Noah's Ark* were used during the first survey period from 23 May to 27 July 2005. Two additional vessels, the FV *Excalibur* and FV *Raven*, were used during the second survey period from 15 August to 25 October 2005. All vessels started operations off Cape Flattery and progressed south along the coast, finishing the completed cycle south of San Diego, California.

Vessels and Sampling Gear

The four chartered vessels ranged in size from 65 to 92 feet (19.8 to 28.0 m) and in power from 450 to 1,200 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, NWFSC provided each vessel with two ⅝″ steel core trawl cables, each 2,288 m (1,250 fm) in length. Cables were measured side by side and marked at 25 fm increments while being spooled onto the vessel's winches. The markings provided real-time verification of the release of equal warp length from both winches while setting a tow.

All vessels were provided with two standard Aberdeen-style nets (Figure 2 and Figure 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.

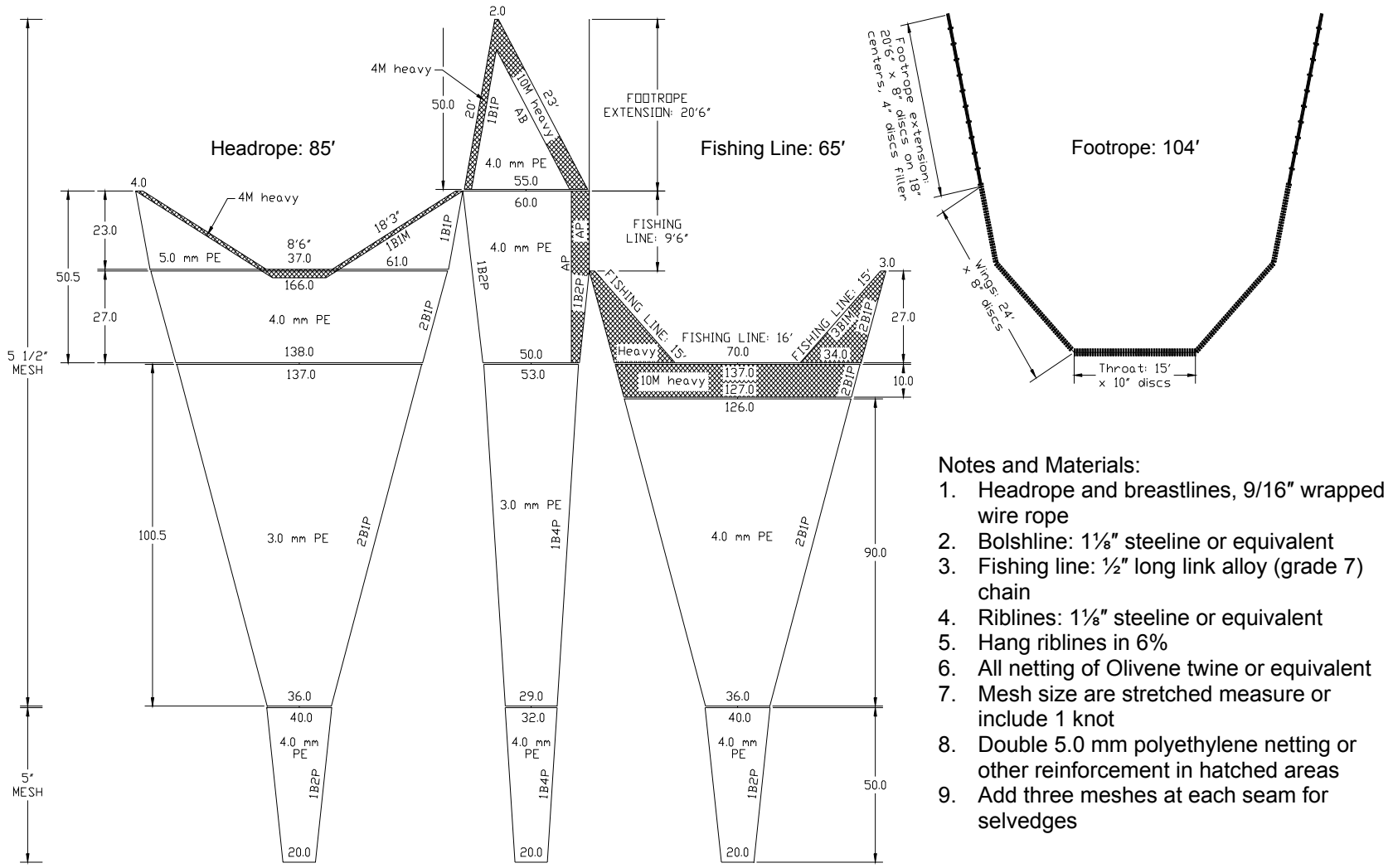

Figure 2. Detailed diagram of the NWFSC Aberdeen-style sampling trawl, including descriptions of dimensions, materials, mesh sizes, and mesh counts. See Figure 3 for a detail of the footrope.

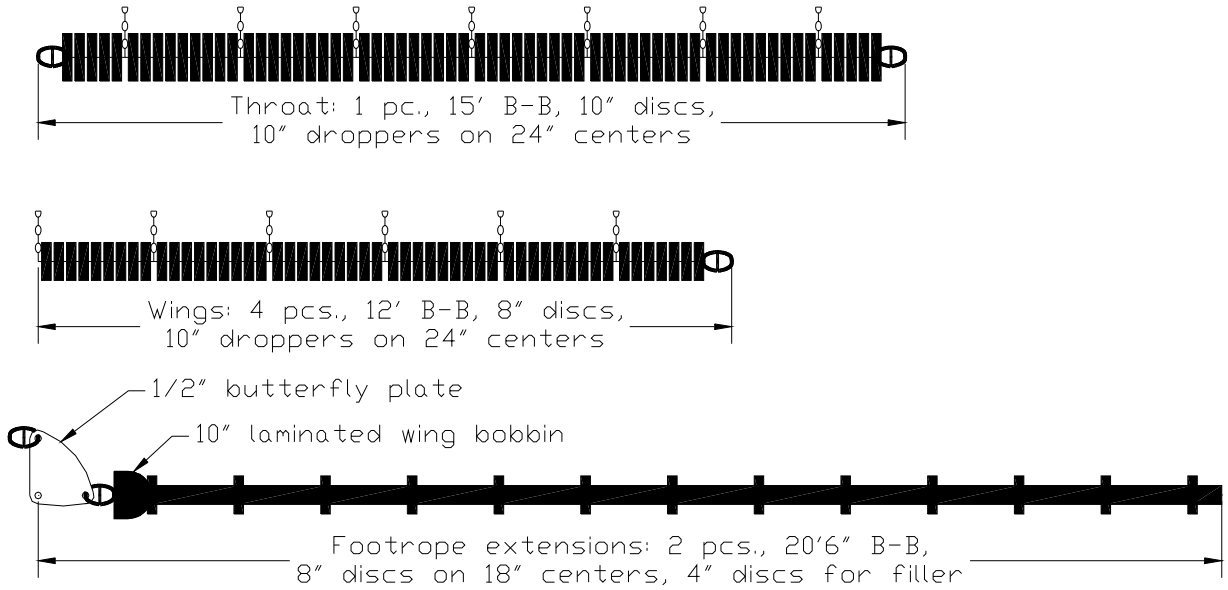

Figure 3. Footrope for the NWFSC Aberdeen-style sampling trawl composed of seven sections with an overall length of 104 feet. A single section of each component of the footrope is shown in the figure. Notes: Footrope composed of ½″ long link alloy (grade 7) chain, with rubber discs (8–10″) and dropper 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, selection of sample sites for the WCGTS was based on a fixed transect design. Following an evaluation of the transect-based survey design by assessment and survey scientists, a stratified random sampling design was adopted in 2003. The survey area was partitioned into approximately 12,000 adjacent cells of equal area (1.5 nautical miles [nm] longitude by 2.0 nm latitude based on Albers Equal Area projection) with each vessel assigned a primary subset of 180 randomly selected cell sites. In 2003 sampling density was assigned to areas defined by IPFCM areas and specified depth categories. After the 2003 survey season, further review by assessment scientists indicated that a greater flexibility in the development of poststratification strategies would be gained if the geographic allocation of randomly selected sites were reduced to a simple north-south geographic division at lat 34°30′N (Point Conception, California).

Consequently, starting in 2004, sampling locations were allocated accordingly, with 80% of the effort allocated to the northern portion of the survey and 20% allocated to the southern area. This allocation scheme was selected to maintain a comparable level of sampling effort in the area north of Point Conception as sampled in prior years. The survey area was further stratified into three depth zones (55–183 m, 184–549 m, and 550–1,280 m), with the percentage of sampling stations allocated to each of the three depth ranges in the northern and southern geographic areas based roughly on the proportion of the area within each depth stratum. North

of Point Conception, 40% of the area is located within the shallow depth stratum (55–183 m) and 30% within each of the two remaining strata (middepth and deep zones). South of Point Conception, 25% of the area was allocated within the shallow depth zone, 45% within the middepth zone, and the remaining 30% within the deep depth range.

The total number of sites targeted for the survey year was apportioned across geographic area and depth categories based on the above scheme, then primary stations were drawn from the survey cell pool, by strata, using a pseudorandom number generator. Each cell was sequentially assigned to an individual vessel. The process was repeated to identify two alternate sampling sites per location. Additional constraints were imposed to ensure alternate sites were neither so close to an untrawlable primary site that they exhibit the same untrawlable features, nor were at an impractical transit distance. In 2005 720 primary sites were selected with each vessel assigned 180 tows (one tow per cell). A total of 675 successful tows were completed out of 749 attempts.

Trawl Operation Protocol

Standard trawl operations were followed to minimize differences in sampling (fishing) efficiency across the range of conditions encountered during the survey and over time (Stauffer 2004). By established conventions, trawling operations were limited to the daylight period, that is, the initial tow each day began (net on seafloor) following official sunrise, and the last tow of the day ended (net off seafloor) before official sunset. Once a vessel was in the preselected sampling area (1.5 by 2.0 nm cell), the captain was instructed to observe the following search rules to identify a specific tow site: 1) search within the specified depth range, 2) remain fully within the specified area, and 3) complete the search for trawlable ground within 1 hour. If no trawlable site was found within the 1-hour limit, the cell was noted in the log as untrawlable and the vessel proceeded to the secondary cell. If the secondary cell also proved untrawlable, 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 differential GPS navigation unit (Northstar 500, Northstar Technologies, Acton, Massachusetts), supplied by the National Marine Fisheries Service, or the vessel's speed indicators were used to monitor towing speed for each survey haul (target 2.2 knots over ground). All hauls were additionally monitored using the Simrad Integrated Trawl Instrumentation (ITI, Kongsberg Simrad Mesotech Ltd., Port Coquitlam, British Columbia, Canada) system. Four sensors from the ITI trawl system were attached to the net prior to setting the gear. Two instruments were mounted on the center of the net headrope. The trawl eye provided information on the vertical opening of the trawl, distance to the seafloor, and footrope clearance above the bottom; the temperature-depth sensor recorded ambient temperature and the depth of the trawl headrope. Paired wing units (communication sensor and remote sensor) were attached on the port and starboard wings of the net to measure wingspread. Extreme or prolonged periods of abnormal wingspread were indicative of net performance problems.

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

A pair of bottom contact sensors (BCSs) and a secondary temperature and depth recorder (Seabird SBE39, Seabird 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. They recorded the angle of incline of the net, indicating when the net landed on and lifted off the seafloor, and provided redundancy in the event that the ITI failed to perform adequately. The Seabird temperature and depth recorder was attached to the head rope in an ABS plastic sleeve. The BCS and Seabird temperature and 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 seafloor, vessel speed was targeted at 2.2 ±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 haulback. Tow duration was targeted at 15 minutes. The Simrad ITI trawl eye was used to monitor real-time, ground gear contact during a haul, but the actual bottom time was determined using data from the BCS. Position data, collected at 2-second intervals for each haul using a GPS, were used to monitor ground speed, track the vessel path, and estimate distance fished. Average net speed over ground and distance fished were calculated from the position data and the trawl's actual bottom time. All features of the trawl event (i.e., from commencement of the deployment of the net to the completion of net retrieval), 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 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 for each of the 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 aging from the subset of fish chosen for length determination. Up to 25 individuals per species were targeted for age structure removal per haul. Individual lengths and weights were collected from all fish selected for age structure removal. For other species, only total counts and aggregate weights were recorded, except when additional information was collected for special projects (including stomach contents, tissue samples, fecundity, and toxicology). Data were logged wirelessly into a ruggedized Itronix[3] notebook computer (General Dynamics Itronix Corp., Spokane Valley, Washington) using the Fisheries Scientific Computing System version 1.6.

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

Survey Analysis

Sensor Data

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

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

Since sensor readings should be consistently present during a tow, recorded values of zero were treated as missing values and filtered prior to estimation of depth, net dimensions, and temperature. Exclusion of extreme points was more difficult. Large isolated spikes in the depth, net dimension, and temperature readings were frequent and assumed to be the result of acoustic or electronic noise. These 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) both fell within the estimation time interval and were satisfactorily unaffected by persistent data strings. The extent to which these single or few point subsamples were representative of the entire tow was necessarily a subjective judgment. If the points seemed in alignment with the trajectory of points outside the subset time interval, they were used as the basis for estimation. Notations hand recorded 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 and 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.

The period of time a net was dragged over the seafloor was split into two distinct phases to estimate distance fished. 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 FPC controlled the length of the first phase and, unless problems occur, this phase was maintained for 15 minutes. The second phase, referred to as liftoff lag, followed sequentially and represented the time required for the net to lift off the seafloor in response to the initiation of the haulback operation. The length of this second 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. However, the vessel typically was not moving forward during the liftoff lag phase, and consequently the GPS sent erroneous bearing information to the ITI. Since 2003 this problem has been 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 in which the default value was not used. Details of this procedure can be found in reports by Wallace (2000a, 2000b). The trigonometric method, developed for the 1998 survey analysis (Turk et al. 2001, Wallace and West 2006), was used when there was insufficient information for the above procedure. Within the database, all net configuration estimates were tagged with qualifying information indicating the estimation method employed.

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

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

Area Estimates

Area estimates were calculated using digital bathymetry points acquired from Naval Oceanographic Office DBDB-V (Digital Bathymetric Data Base−Variable resolution) Version 2.0 (Naval Oceanographic Office no date). The input data had variable resolutions of 5.0 minutes, 1.0 minute, and 0.5 minute. The data points were gridded at 1-minute pixel resolution and contour lines for the survey depth zones were created from this grid. The contour lines were created at 30, 100, 300, and 700 fm. Contour lines were then combined with INPFC area boundaries and 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 create polygons of each depth zone. Bathymetry data were projected to the Albers Equal Area projection, and the total seafloor area was calculated in the three depth zones (30–100 fm, 100−300 fm, and 300−700 fm) and the five INPFC areas. 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 had a value between 30 and 700 fm.

Temperature

Water temperature was recorded during each tow using a Simrad ITI temperature sensor (accuracy $\pm$0.2°C) and a Seabird temperature sensor (accuracy $\pm$0.002°C) mounted in the mouth of the net. The output sensor pattern indicated that the Simrad sensor required the full duration

of the tow to acclimate. Because the Seabird demonstrated higher accuracy and faster acclimation time than the Simrad sensor, bottom temperature was estimated as the mean of the Seabird sensor readings taken while the net was on bottom. If Seabird data were missing, bottom temperature was estimated from the Simrad sensor, based on data collected during the final 10% of the tow duration. Surface temperature was recorded using a thermometer in the surface water at the start of each tow.

Relative Density and Biomass Estimates

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

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

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 and deep for all areas combined), and the individual INPFC areas (depth strata combined within areas), the initial means were weighted using the appropriate areas within each stratum. Mean biomass estimates (metric tons) were similarly calculated by multiplying the weighted mean CPUE for total area, depth strata, or INPFC region by the appropriate area of the stratum or region,

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

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, middepth, 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 2005 WCGTS was designed to incorporate 720 primary sampling locations, with 749 tows subsequently attempted, including failed tows, aborted tows, or tows at secondary or tertiary sites. A total of 675 tows were successfully sampled. Simard ITI net mensuration data, as well as GPS course and position data, and bottom-contact sensor data were obtained from most of the successful tows. Table 1 shows the latitudinal boundaries, depth-strata areas (km^2), and sampling densities (hauls/1,000 km^2) by INPFC statistical area based on successful tows.

Mean net widths (m) and distances fished (km) were calculated for each haul. When net mensuration data were available, the mean net width for each tow was calculated based on 80% of the tow duration, excluding the initial and final 10% of the tow time. Distances fished were calculated by estimating the length 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 13.88 m was calculated using data from the 675 hauls that both exhibited good trawl performance and had available net mensuration estimates. The mean net widths ranged from 9.75 m to 16.42 m with a standard deviation of 1.08 m. When the net mensuration instrumentation was not functioning properly, the mean net width per tow was calculated using multiple linear regressions as a function of trawl depth and inverse scope for the individual chartered vessel (Figure 4).

The number of lengths and age structures collected from groundfish species are summarized in Table 2. Individual length measurements were collected from 78 groundfish species; age structures were collected from 58 species. A total of 159,902 length measurements were made and 24,683 individuals had age structures removed. The number of lengths collected ranged from 1 to 18,189 measurements per species while the number of age structures collected ranged from 1 to 2,966 structures per species. The species with the greatest number of measurements and age structures included Dover sole (*Microstomus pacificus*), Pacific sanddab (*Citharichthys sordidus*), petrale sole (*Eopsetta jordani*), English sole (*Parophrys vetulus*), rex sole (*Glyptocephalus zachirus*), sablefish (*Anoplopoma fimbria*), longspine thornyhead (*Sebastolobus altivelis*), shortspine thornyhead (*S. alascanus*), chilipepper rockfish (*Sebastes goodei*), splitnose rockfish (*S. diploproa*), and stripetail rockfish (*S. saxicola*).

A total of 607 unique taxa were identified over the entire survey area, with 259 species or groups of fish and the remaining 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. Latitudinal boundaries, depth stratum area (km^2), and sampling densities by INPFC statistical area based on successful tows during the 2005 NWFSC 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	21	9.06	2,853	14	4.91	2,286	8	3.50	7,457	43	5.77
Columbia 43°00′–47°30′	14,413	119	8.26	8,621	51	5.92	9,804	53	5.41	32,838	223	6.79
Eureka 40°30′–43°00′	4,069	38	9.34	2,034	23	11.31	6,365	28	4.40	12,467	89	7.14
Monterey 36°00′–40°30′	8,605	78	9.06	3,650	21	5.75	8,646	20	2.31	20,902	119	5.69
Conception 32°30′–36°00′	6,994	54	7.72	12,839	75	5.84	42,041	72	1.71	61,874	201	3.25
Entire survey area 32°30′–Border	36,399	310	8.52	29,997	184	6.13	69,142	181	2.62	135,538	675	4.98

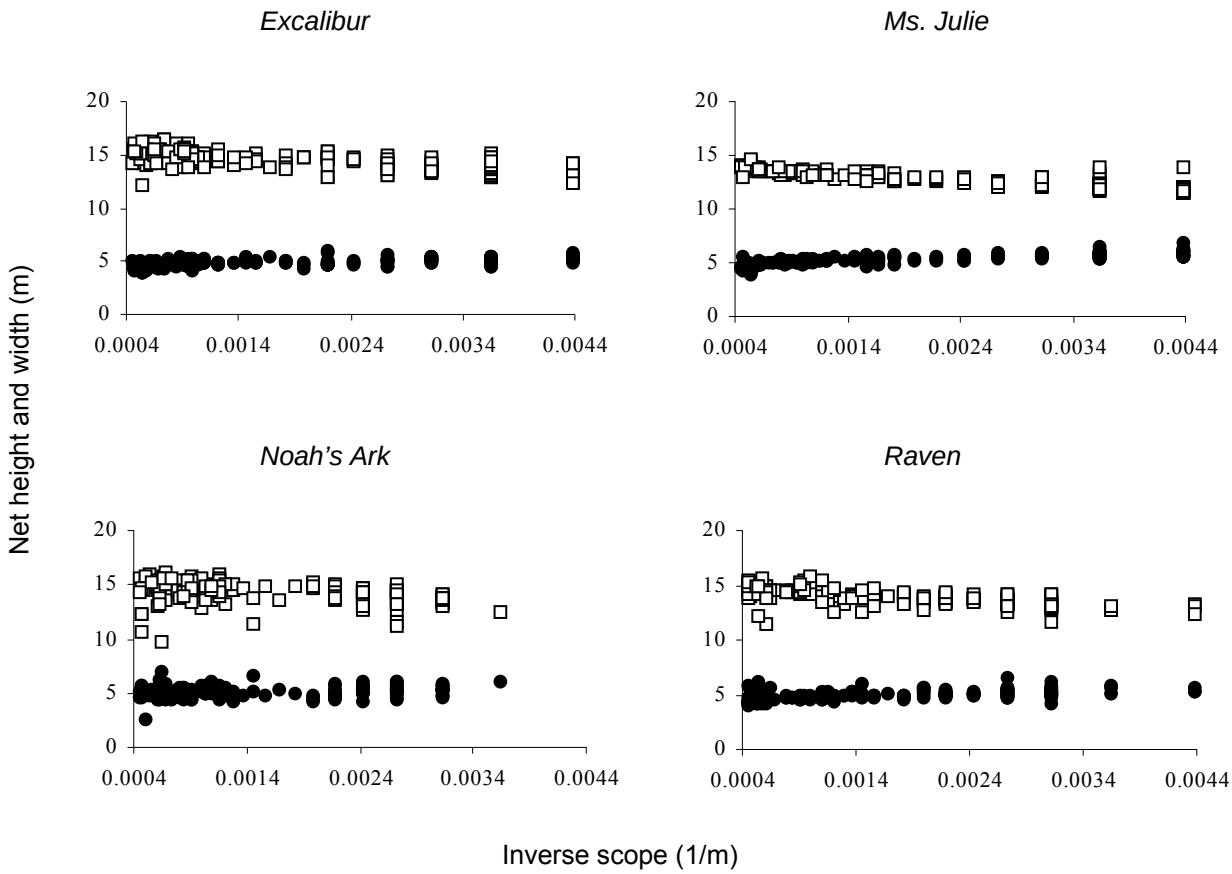

Figure 4. Mean net width (m) and height (m) for trawls conducted as part of the 2005 West Coast groundfish trawl survey. Estimates are grouped by vessel with net width (●) and net height (□) in meters plotted relative to inverse scope (1/meters). Multiple linear regressions of width versus net height and inverse scope (factored by vessel) were used to estimate net widths for tows lacking direct width observations. (FV *Excalibur*: Net width = 22.255 – 1.462 × net height – 290.3 × inverse scope; FV *Ms. Julie:* Net width = 18.01 – 0.862 × net height – 278.8 × inverse scope; FV *Noah's Ark*: Net width = 20.24 – 0.984 × net height – 426.9 × inverse scope; and FV *Raven*: Net width = 18.05 – 0.709 × net height – 320.3 × inverse scope.)

Table 2. Number of individual length measurements and age structures collected by species during the 2005 West Coast groundfish trawl survey. Dorsal spines were collected for spiny dogfish, dorsal finrays for lingcod, and otoliths for all other species.

Species	Lengths	Ages	Species	Lengths	Ages	Species	Lengths	Ages
Spiny dogfish	3,842	957	Pacific hake YOY*	182	0	Puget Sound rockfish	6	6
Soupfin shark	3	0	Pacific hake	9,214	0	Pygmy rockfish	196	53
Big skate	349	0	Shortspine thornyhead	8,184	1,430	Quillback rockfish	2	2
California skate	461	0	Longspine thornyhead	14,065	1,159	Redbanded rockfish	174	174
Longnose skate	3,377	0	Aurora rockfish	1,705	583	Redstripe rockfish	240	113
Starry skate	16	0	Bank rockfish	96	50	Rosethorn rockfish	931	325
Spotted ratfish	3,852	0	Blackgill rockfish	401	194	Rosy rockfish	98	30
Arrowtooth flounder	4,034	872	Blue rockfish	21	15	Rougheye rockfish	259	140
Butter sole	132	0	Bocaccio rockfish	320	197	Sharpchin rockfish	890	158
Curlfin sole	567	0	Brown rockfish	48	25	Shortbelly rockfish	2,156	574
Dover sole	18,189	2,598	Calico rockfish	258	119	Shortraker rockfish	8	8
English sole	9,036	1,362	Canary rockfish	622	277	Silvergray rockfish	51	46
Flathead sole	593	0	Chilipepper rockfish	4,107	897	Splitnose rockfish	4,500	543
Pacific halibut	10	0	Copper rockfish	70	43	Squarespot rockfish	434	132
Pacific sanddab	11,226	1,152	Cowcod	32	32	Starry rockfish	4	4
Petrale sole	5,072	1,984	Darkblotched rockfish	1,983	804	Stripetail rockfish	4,647	591
Rex sole	16,393	0	Flag rockfish	17	17	Swordspine rockfish	51	0
Sand sole	31	0	Freckled rockfish	79	44	Tree rockfish	1	1
Southern rock sole	168	0	Gopher rockfish	1	1	Vermilion rockfish	60	39
Starry flounder	54	43	Greenblotched rockfish	30	30	Widow rockfish	197	83
Sablefish	5,772	2,996	Greenspotted rockfish	326	183	Yelloweye rockfish	40	40
Pacific grenadier	2,673	553	Greenstriped rockfish	4,038	735	Yellowmouth rockfish	23	23
Pacific cod	234	0	Halfbanded rockfish	2,854	428	Yellowtail rockfish	1,234	380
Pacific flatnose	1,206	0	Honeycomb rockfish	91	33	California scorpionfish	362	147
Lingcod	1,214	975	Olive rockfish	2	2	Grooved tanner crab	5,492	0
Kelp greenling	48	47	Pacific ocean perch	533	264	Baird's tanner crab	10	0

*YOY = young-of-the-year

Table 3. Frequency of occurrence, depth, and latitudinal ranges for fish and invertebrate species, grouped by family (or higher taxonomic classification), caught during the 2005 NWFSC slope/shelf survey.

Family and scientific name	Common name	Frequency of occurrence (No. hauls)	Depth (m)			Latitudinal range (dd)	
			Min.	Max.	Mean	South	North
Myxinidae							
Myxinidae	Hagfish unident.	66	103	1,251	736	32.77	47.87
Eptatretus deani	Black hagfish	52	256	1,230	804	32.61	47.87
E. stoutii	Pacific hagfish	21	95	1,152	691	39.07	47.79
Triakidae							
Triakididae	Smoothhound unident.	8	61	171	89	32.60	35.54
Galeorhinus galeus	Soupfin shark	3	76	175	126	33.73	41.37
Mustelus californicus	Gray smoothhound	6	58	247	102	32.74	37.54
M. henlei	Brown smoothhound	12	59	114	87	32.87	35.40
Scyliorhinidae							
Scyliorhinidae	Cat shark unident.	6	383	1,208	899	33.36	44.75
Apristurus brunneus	Brown cat shark	222	114	1,230	684	32.54	47.86
A. kampae	Longnose cat shark	9	785	1,186	1,034	32.61	40.31
Cephaloscyllium ventriosum	Swell shark	2	72	86	79	34.37	34.41
Parmaturus xaniurus	Filetail cat shark	64	171	838	478	32.73	36.39
Hexanchidae							
Hexanchus griseus	Sixgill shark	2	81	307	194	33.61	36.85
Somnosidae							
Somniosus pacificus	Pacific sleeper shark	1	1,166	1,166	1,166	36.18	36.18
Squalidae							
Squalus acanthias	Spiny dogfish	281	53	571	160	32.58	48.42
Squatinidae							
Squatina californica	Pacific angel shark	7	68	87	80	32.83	34.41
Etmopteridae							
Centroscyllium nigrum	Combtooth dogfish	3	916	1,056	1,000	32.77	32.94
Elasmobranch egg cases							
Apristurus brunneus egg case	Cat shark egg case	17	74	1,065	418	32.73	46.13
Torpedinidae							

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 2005 NWFSC slope/shelf survey.

Family and scientific name	Common name	Frequency of occurrence (No. hauls)	Depth (m)			Latitudinal range (dd)	
			Min.	Max.	Mean	South	North
Torpedo californica	Pacific electric ray	47	58	367	124	33.30	45.63
Rajidae							
Rajidae	Skate unident.	1	648	648	648	33.84	33.84
Raja binoculata	Big skate	115	53	283	106	33.57	48.23
R. inornata	California skate	97	58	648	100	32.58	48.04
R. rhina	Longnose skate	403	58	1,023	259	32.73	48.42
R. stellulata	Starry skate	9	61	499	132	33.81	45.02
Arhynchobatidae							
Bathyraja sp.	Skate unident.	3	449	1,102	883	32.89	45.00
B. abyssicola	Deepsea skate	5	1,006	1,251	1,115	32.61	46.10
B. aleutica	Aleutian skate	3	359	638	471	40.20	45.98
B. interrupta	Bering skate	192	65	916	269	32.72	48.42
B. trachura	Roughtail skate	85	552	1,251	937	32.61	47.83
Rhinobatidae							
Zapteryx exasperata	Banded guitarfish	1	60	60	60	33.79	33.79
Myliobatidae							
Myliobatis californicus	Bat ray	10	61	90	74	32.60	34.42
Rajiformes (order) egg cases							
Rajiformes	Skate egg case unident.	46	58	1,132	248	32.77	48.42
Raja sp.	Skate egg case unident.	6	76	237	125	37.11	47.73
Rajiformes (order) egg cases							
Bathyraja trachura	Roughtail skate egg case	1	1,243	1,243	1,243	45.95	45.95
Raja binoculata	Big skate egg case	19	61	232	96	34.66	47.12
Chimaeridae							
Hydrolagus colliei	Spotted ratfish	358	53	571	181	32.58	48.42
Nemichthyidae							
Nemichthyidae	Snipe eel unident.	4	424	972	767	32.74	35.80
Avocettina infans	Blackline snipe eel	6	808	1,154	1,016	32.77	47.87

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 2005 NWFSC slope/shelf survey.

Family and scientific name	Common name	Frequency of occurrence (No. hauls)	Depth (m)			Latitudinal range (dd)	
			Min.	Max.	Mean	South	North
Nemichthys larseni	Pale snipe eel	1	806	806	806	33.88	33.88
N. scolopaceus	Slender snipe eel	4	482	1,075	824	32.77	33.95
Serrivomeridae							
Serrivomer sector	Sawtooth eel	8	516	1,113	919	32.73	46.91
Nettastomatidae							
Venefica sp.	Duckbill eel unident.	3	916	1,140	1,037	32.77	32.91
Facciolella gilbertii	Dogface witch-eel	2	419	425	422	34.28	34.35
Saccopharyngidae							
Saccopharyngidae	Whiptail gulper eel unident.	2	1,075	1,098	1,087	32.83	33.25
Clupeidae							
Alosa sapidissima	American shad	111	53	232	113	33.97	48.23
Clupea pallasii	Pacific herring	73	53	188	96	34.66	48.33
Sardinops sagax	Pacific sardine	18	71	502	134	32.83	43.36
Engraulidae							
Engraulis mordax	Northern anchovy	45	64	806	151	32.68	46.97
Argentinidae							
Argentinidae	Argentine unident.	1	105	105	105	32.58	32.58
Argentina sialis	Pacific argentine	20	77	247	147	32.68	38.09
Bathylagidae							
Bathylagidae	Deepsea smelt unident.	113	427	1,251	897	32.61	47.87
Bathylagus sp.	Blacksmelt unident.	7	644	1,098	855	33.25	43.75
Pseudobathylagus milleri	Robust blacksmelt	3	811	1,028	896	32.94	46.91
Bathylagus pacificus	Pacific blacksmelt	1	968	968	968	41.81	41.81
Leuroglossus sp.	Smoothtongue unident.	2	425	499	462	34.25	34.28
L. schmidti	Northern smoothtongue	7	497	898	631	33.39	42.12
L. stilbius	California smoothtongue	14	470	1,140	676	32.54	35.20
Opisthoproctidae							
Macropinna microstoma	Barreleye	5	812	1,124	932	33.16	42.01

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 2005 NWFSC slope/shelf survey.

Family and scientific name	Common name	Frequency of occurrence (No. hauls)	Depth (m)			Latitudinal range (dd)	
			Min.	Max.	Mean	South	North
Platytroctidae							
Platytroctidae	Tubeshoulder unident.	1	1,029	1,029	1,029	34.53	34.53
Maulisia mauli		3	838	1,172	1,008	35.30	45.82
Sagamichthys abei	Shining tubeshoulder	5	516	1,075	656	32.73	47.46
Alepocephalidae							
Alepocephalus tenebrosus	California slickhead	130	492	1,230	885	32.54	47.69
Bajacalifornia burragei	Sharpchin slickhead	3	805	1,075	969	32.83	33.00
Talismania bifurcata	Threadfin slickhead	45	601	1,140	850	32.54	47.69
Osmeridae							
Osmeridae	Smelt unident.	2	128	146	137	45.80	46.71
Allosmerus elongatus	Whitebait smelt	22	58	104	81	37.88	47.86
Osmerus mordax	Rainbow smelt	4	136	156	145	45.83	47.92
Spirinchus starksi	Night smelt	1	53	53	53	40.58	40.58
S. thaleichthys	Longfin smelt	1	62	62	62	40.84	40.84
Thaleichthys pacificus	Eulachon	19	96	169	130	42.00	47.90
Alepisauridae							
Alepisaurus ferox	Longnose lancetfish	1	1,041	1,041	1,041	32.77	32.77
Gonostomatidae							
Gonostomatidae	Bristlemouth unident.	2	1,028	1,088	1,058	32.94	41.33
Sternoptychidae							
Sternoptychidae	Hatchetfish unident.	5	490	1,124	843	32.94	35.00
Argyropelecus sp.	Hatchetfish unident.	6	334	1,029	676	32.77	39.07
A. affinis	Slender hatchetfish	8	307	1,098	766	32.83	42.26
Sternoptyx diaphana	Longspine hatchetfish	6	754	1,230	953	32.54	41.74
Stomiidae							
subfamily Melanostomiidae	Scaleless dragonfish unident.	1	307	307	307	33.61	33.61
Aristostomias scintillans	Shining loosejaw	11	176	1,019	662	34.81	47.54
Chauliodus macouni	Pacific viperfish	94	372	1,251	817	32.54	47.87

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 2005 NWFSC slope/shelf survey.

Family and scientific name	Common name	Frequency of occurrence (No. hauls)	Depth (m)			Latitudinal range (dd)	
			Min.	Max.	Mean	South	North
Idiacanthus antrostomus	Pacific blackdragon	15	489	1,102	775	32.54	35.22
Stomias atriventer	Blackbelly dragonfish	15	464	1,056	715	32.62	36.39
Tactostoma macropus	Longfin dragonfish	58	176	1,172	756	33.16	47.87
Scopelarchidae							
Benthalbella dentata	Northern pearleye	2	877	1,205	1,041	43.89	47.83
Paralepididae							
Arctozenus risso	Ribbon barracudina	1	1,102	1,102	1,102	32.89	32.89
Lestidiops ringens	Slender barracudina	2	71	393	232	34.42	37.16
Magnisudis atlantica	Duckbill barracudina	2	520	808	664	40.22	44.38
Synodontidae							
Synodontidae	Lizardfish unident.	3	79	85	82	32.74	34.05
Synodus lucioceps	California lizardfish	10	67	105	79	32.58	35.54
Myctophidae							
Myctophidae	Lanternfish unident.	161	86	1,251	687	32.73	47.90
Lampanyctus sp.	Lanternfish unident.	96	419	1,243	792	32.74	47.83
Diaphus theta	California headlightfish	12	176	1,186	583	34.99	46.66
Nannobrachium ritteri	Broadfin lanternfish	6	551	903	695	41.70	47.86
Tarletonbeania crenularis	Blue lanternfish	11	208	1,083	666	34.53	47.68
Neoscopelidae							
Neoscopelidae	Blackchin unident.	1	1,132	1,132	1,132	45.89	45.89
Ophidiidae							
Chilara taylori	Spotted cusk-eel	12	86	232	162	33.76	44.44
Lamprogrammus niger	Paperbone cusk-eel	1	876	876	876	33.16	33.16
Bythitidae							
Cataetyx rubrirostris	Rubynose brotula	10	324	805	539	32.72	35.97
Macrouridae							
Albatrossia pectoralis	Giant grenadier	98	499	1,251	931	32.61	47.87
Coryphaenoides acrolepis	Pacific grenadier	134	317	1,251	864	32.61	47.87

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 2005 NWFSC slope/shelf survey.

Family and scientific name	Common name	Frequency of occurrence (No. hauls)	Depth (m)			Latitudinal range (dd)	
			Min.	Max.	Mean	South	North
Coryphaenoides cinereus	Popeye grenadier	6	604	1,172	953	42.80	47.87
Nezumia liolepis	Smooth grenadier	31	516	1,230	839	32.54	46.23
N. stelgidolepis	California grenadier	39	392	1,065	607	32.73	44.97
Melanonidae							
Melanonus zugmayeri	Arrowtail	3	766	1,124	970	33.59	47.26
Moridae							
Antimora microlepis	Pacific flatnose	123	391	1,251	869	32.54	47.79
Physiculus rastrelliger	Hundred fathom codling	4	328	341	336	33.28	33.56
Merlucciidae							
Merluccius productus	Pacific hake	410	53	1,029	262	32.58	48.42
M. productus	Pacific hake young-of-the-year	15	110	1,015	419	32.88	36.22
Gadidae							
Gadus macrocephalus	Pacific cod	30	71	210	136	45.53	48.42
Microgadus proximus	Pacific tomcod	21	58	109	75	37.31	47.39
Theragra chalcogramma	Walleye pollock	3	87	200	133	48.23	48.42
Batrachoididae							
Porichthys notatus	Plainfin midshipman	99	58	195	100	32.74	47.03
Melanocetidae							
Melanocetus johnsonii	Common blackdevil	1	503	503	503	34.54	34.54
Oneirodidae							
Oneirodidae	Dreamer unident.	3	805	876	832	33.00	33.16
Oneirodes sp.	Dreamer unident.	2	528	1,006	767	32.61	33.43
Chaenophryne draco	Smooth dreamer	3	766	1,186	993	32.94	47.26
Melamphaidae							
Melamphaidae	Bigscale unident.	4	489	1,030	798	33.12	41.70
Melamphaes lugubris	Highsnout bigscale	7	741	1,172	944	32.61	45.82
Poromitra crassiceps	Crested bigscale	18	631	1,124	938	32.54	46.90
Anoplogastridae							

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 2005 NWFSC slope/shelf survey.

Family and scientific name	Common name	Frequency of occurrence (No. hauls)	Depth (m)			Latitudinal range (dd)	
			Min.	Max.	Mean	South	North
Anoplogaster cornuta	Fangtooth	10	689	1,140	890	32.74	47.26
Scorpaenidae							
Scorpaena guttata	California scorpionfish	15	59	109	77	32.60	34.29
Sebastolobus alascanus	Shortspine thornyhead	332	115	1,243	610	32.54	48.42
S. altivelis	Longspine thornyhead	244	323	1,251	742	32.54	47.87
Sebastes aleutianus	Rougheye rockfish	27	125	480	290	43.08	48.27
S. alutus	Pacific ocean perch	40	87	715	298	40.68	48.42
S. auriculatus	Brown rockfish	7	59	92	75	34.29	41.67
S. aurora	Aurora rockfish	92	307	710	472	32.72	47.90
S. babcocki	Redbanded rockfish	55	86	417	262	33.72	48.42
S. borealis	Shortraker rockfish	2	352	397	374	44.54	46.06
S. brevispinis	Silvergray rockfish	6	171	283	205	40.61	48.23
S. carnatus	Gopher rockfish	1	76	76	76	34.41	34.41
S. caurinus	Copper rockfish	7	70	98	84	33.57	37.39
S. chlorostictus	Greenspotted rockfish	35	72	301	130	32.58	44.45
S. constellatus	Starry rockfish	3	70	141	100	33.57	37.39
S. crameri	Darkblotched rockfish	112	89	499	202	34.40	48.23
S. dalli	Calico rockfish	16	59	86	73	32.60	34.42
S. diploproa	Splitnose rockfish	129	117	528	296	32.72	48.23
S. elongatus	Greenstriped rockfish	189	64	294	145	32.58	48.39
S. emphaeus	Puget Sound rockfish	1	92	92	92	43.26	43.26
S. ensifer	Swordspine rockfish	1	127	127	127	33.73	33.73
S. entomelas	Widow rockfish	23	72	314	176	34.41	48.23
S. flavidus	Yellowtail rockfish	49	60	231	139	33.79	48.39
S. goodei	Chilipepper	94	60	301	147	33.58	45.12
S. helvomaculatus	Rosethorn rockfish	49	67	397	198	32.83	48.25
S. hopkinsi	Squarespot rockfish	19	60	148	95	32.58	36.39
S. jordani	Shortbelly rockfish	73	61	392	163	32.60	41.37

Table 3 continued. Frequency of occurrence, depth, and latitudinal ranges for fish and invertebrate species, grouped by family (or higher taxonomic classification), caught during the 2005 NWFSC slope/shelf survey.

Family and scientific name	Common name	Frequency of occurrence (No. hauls)	Depth (m)			Latitudinal range (dd)	
			Min.	Max.	Mean	South	North
Sebastes lentiginosus	Freckled rockfish	6	60	86	72	32.60	33.79
S. levis	Cowcod	23	74	232	145	33.66	42.26
S. maliger	Quillback rockfish	2	94	104	99	46.97	48.25
S. melanostomus	Blackgill rockfish	30	133	552	409	32.72	46.04
S. miniatus	Vermilion rockfish	10	60	127	82	32.60	37.39
S. mystinus	Blue rockfish	1	86	86	86	34.41	34.41
S. paucispinis	Bocaccio	52	60	314	134	32.60	45.12
S. pinniger	Canary rockfish	56	61	234	143	33.57	48.42
S. proriger	Redstripe rockfish	17	92	256	161	40.27	48.25
S. reedi	Yellowmouth rockfish	2	210	256	233	42.98	44.63
S. rosaceus	Rosy rockfish	9	60	292	134	32.68	43.03
S. rosenblatti	Greenblotched rockfish	13	76	309	194	32.66	38.30
S. ruberrimus	Yelloweye rockfish	14	99	210	151	38.84	48.25
S. rubrivinctus	Flag rockfish	7	60	127	86	32.60	33.89
S. rufus	Bank rockfish	11	108	499	254	33.61	38.28
S. saxicola	Stripetail rockfish	149	59	387	156	32.68	47.90
S. semicinctus	Halfbanded rockfish	71	59	179	98	32.58	43.36
S. serranoides	Olive rockfish	1	134	134	134	37.65	37.65
S. serriceps	Tree rockfish	1	60	60	60	33.79	33.79
S. umbrosus	Honeycomb rockfish	3	78	90	82	33.57	33.61
S. wilsoni	Pygmy rockfish	10	86	182	131	33.73	48.25
S. zacentrus	Sharpchin rockfish	36	104	381	211	34.21	48.25
Triglidae							
Prionotus stephanophrys	Lumptail sea robin	1	87	87	87	33.84	33.84
Anoplopomatidae							
Anoplopoma fimbria	Sablefish	463	62	1,243	467	32.54	48.42
Hexagrammidae							
Hexagrammos decagrammus	Kelp greenling	11	64	122	92	34.41	46.97

Table 3 continued. Frequency of occurrence, depth, and latitudinal ranges for fish and invertebrate species, grouped by family (or higher taxonomic classification), caught during the 2005 NWFSC slope/shelf survey.

Family and scientific name	Common name	Frequency of occurrence (No. hauls)	Depth (m)			Latitudinal range (dd)	
			Min.	Max.	Mean	South	North
Ophiodon elongatus	Lingcod	215	53	410	138	32.68	48.39
Zaniolepis latipinnis	Longspine combfish	78	58	239	88	32.58	41.55
Z. frenata	Shortspine combfish	14	77	250	126	32.58	36.81
Cottidae							
Cottidae	Sculpin unident.	3	141	1,015	480	33.72	44.63
Icelinus sp.	Sculpin unident.	1	116	116	116	33.81	33.81
Chitonotus pugetensis	Roughback sculpin	2	58	71	65	37.07	38.97
Enophrys taurina	Bull sculpin	7	61	76	69	34.37	36.12
Gymnocanthus pistilliger	Threaded sculpin	1	141	141	141	46.31	46.31
Hemilepidotus hemilepidotus	Red Irish lord	2	92	96	94	43.26	46.22
Hemilepidotus sp.	Irish lord	1	122	122	122	45.66	45.66
H. spinosus	Brown Irish lord	2	82	108	95	45.46	46.26
Icelinus burchami	Dusky sculpin	1	432	432	432	47.25	47.25
I. filamentosus	Threadfin sculpin	48	97	352	174	33.61	48.42
I. fimbriatus	Fringed sculpin	5	90	293	157	33.76	46.04
I. tenuis	Spotfin sculpin	1	105	105	105	34.13	34.13
Jordania zonope	Longfin sculpin	1	239	239	239	36.24	36.24
Leptocottus armatus	Pacific staghorn sculpin	8	58	82	67	37.39	46.26
Malacocottus kincaidi	Blackfin sculpin	3	293	358	334	46.04	47.90
Nautichthys oculofasciatus	Sailfin sculpin	1	88	88	88	44.36	44.36
Radulinus asprellus	Slim sculpin	11	76	699	161	34.41	46.60
Rhamphocottus richardsoni	Grunt sculpin	1	116	116	116	33.81	33.81
Zesticelus profundorum	Flabby sculpin	2	1,029	1,186	1,108	34.53	40.31
Psychrolutidae							
Psychrolutes phrictus	Blob sculpin	2	1,114	1,186	1,150	40.31	41.35
Agonidae							
Agonopsis vulsa	Northern spearnose poacher	4	61	127	96	35.99	44.39
Bathyagonus nigripinnis	Blackfin poacher	41	169	994	611	40.75	47.87

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 2005 NWFSC slope/shelf survey.

Family and scientific name	Common name	Frequency of occurrence (No. hauls)	Depth (m)			Latitudinal range (dd)	
			Min.	Max.	Mean	South	North
Bathyagonus pentacanthus	Bigeye poacher	8	188	432	288	34.04	47.25
Chesnonia verrucosa	Warty poacher	4	62	70	65	40.81	46.35
Xeneretmus latifrons	Blacktip poacher	17	111	352	194	34.43	47.73
X. leiops	Smootheye poacher	1	323	323	323	44.91	44.91
Liparidae							
Liparidinae	Snailfish unident.	4	63	937	660	32.62	47.87
Careproctus cypselurus	Blackfin snailfish	19	317	1,208	887	34.53	47.69
C. gilberti	Smalldisk snailfish	8	248	552	459	34.82	44.04
C. melanurus	Blacktail snailfish	73	258	958	582	33.16	47.86
Elassodiscus caudatus	Humpback snailfish	5	446	638	534	37.43	44.14
Paraliparis cephalus	Swellhead snailfish	18	510	1,065	814	32.62	47.57
Paraliparis dactylosus	Red snailfish	11	491	871	672	33.79	46.23
Liparidinae	Broadfin snailfish	1	1,063	1,063	1,063	43.58	43.58
Paraliparis rosaceus	Rosy snailfish	2	972	1,056	1,014	32.74	32.91
Rhinoliparis barbulifer	Longnose snailfish	1	955	955	955	36.99	36.99
Serranidae							
Paralabrax nebulifer	Barred sand bass	6	60	90	77	32.83	34.01
Carangidae							
Trachurus symmetricus	Jack mackerel	15	61	228	106	32.83	39.20
Sciaenidae							
Genyonemus lineatus	White croaker	59	58	132	84	32.58	38.52
Embiotocidae							
Cymatogaster aggregata	Shiner perch	33	58	110	78	33.42	41.96
Rhacochilus vacca	Pile perch	3	60	86	69	32.83	37.13
Hyperprosopon anale	Spotfin surfperch	4	58	61	59	35.99	37.51
Zalembius rosaceus	Pink sea perch	102	58	157	90	32.58	39.90
Bathymasteridae							
Ronquilus jordani	Northern ronquil	3	111	181	143	38.72	48.42

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 2005 NWFSC slope/shelf survey.

Family and scientific name	Common name	Frequency of occurrence (No. hauls)	Depth (m)			Latitudinal range (dd)	
			Min.	Max.	Mean	South	North
Zoarcidae							
Zoarcidae	Eelpout unident.	1	1,132	1,132	1,132	45.89	45.89
Lycodapus sp.		1	506	506	506	35.65	35.65
Bothrocara brunneum	Twoline eelpout	107	476	1,243	836	32.61	47.87
Lycenchelys camchatica	Kamchatka eelpout	3	710	898	806	35.84	42.12
L. crotalinus	Snakehead eelpout	91	63	1,208	870	32.89	47.87
Lycodapus endemoscotus	Deepwater eelpout	9	386	1,152	585	34.28	45.90
L. fierasfer	Blackmouth eelpout	1	871	871	871	46.47	46.47
L. mandibularis	Pallid eelpout	3	601	1,090	889	33.55	47.87
Lycodes cortezianus	Bigfin eelpout	184	60	700	367	32.72	48.11
L. diapterus	Black eelpout	124	115	806	488	33.54	48.27
L. pacificus	Blackbelly eelpout	131	60	417	134	32.87	48.23
Melanostigma pammelas	Midwater eelpout	1	806	806	806	33.88	33.88
Stichaeidae							
Poroclinus rothrocki	Whitebarred prickleback	2	117	154	135	43.05	48.22
Anarhichadidae							
Anarrhichthys ocellatus	Wolf-eel	7	71	109	87	32.68	39.10
Chiasmodontidae							
Chiasmodon niger	Black swallower	5	698	1,113	946	32.83	35.73
Kali indica	Shortnose swallower	1	1,028	1,028	1,028	32.94	32.94
K. normani	Needletooth swallower	1	1,178	1,178	1,178	33.36	33.36
Uranoscopidae							
Kathetostoma averruncus	Smooth stargazer	1	86	86	86	34.27	34.27
Icosteidae							
Icosteus aenigmaticus	Ragfish	1	598	598	598	46.83	46.83
Trichiuridae							
Lepidopus xantusi	Silver scabbardfish	1	412	412	412	32.72	32.72
Scombridae							

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 2005 NWFSC slope/shelf survey.

Family and scientific name	Common name	Frequency of occurrence (No. hauls)	Depth (m)			Latitudinal range (dd)	
			Min.	Max.	Mean	South	North
Scomber japonicus	Chub mackerel	4	68	132	87	33.58	37.13
Stromateidae							
Stromateidae	Butterfish unident.	3	78	109	91	33.58	34.27
Peprilus simillimus	Pacific butterfish	59	58	550	105	32.58	38.81
Centrolophidae							
Icichthys lockingtoni	Medusafish	2	314	470	392	34.28	35.83
Paralichthyidae							
Citharichthys sordidus	Pacific sanddab	250	53	234	102	32.58	48.39
C. stigmaeus	Speckled sanddab	1	65	65	65	44.76	44.76
C. xanthostigma	Longfin sanddab	7	59	90	74	32.68	34.36
Pleuronectidae							
Atheresthes stomias	Arrowtooth flounder	219	70	598	210	38.28	48.42
Embassichthys bathybius	Deepsea sole	138	352	1,251	850	32.61	47.87
Eopsetta jordani	Petrale sole	299	53	434	124	32.92	48.42
Glyptocephalus zachirus	Rex sole	444	53	937	225	32.72	48.42
Hippoglossina stomata	Bigmouth sole	32	59	155	89	32.58	35.54
Hippoglossoides elassodon	Flathead sole	42	62	327	147	32.92	48.36
Hippoglossus stenolepis	Pacific halibut	42	62	427	161	37.85	48.42
Isopsetta isolepis	Butter sole	6	62	74	66	44.25	44.76
Lepidopsetta bilineata	Southern rock sole	35	58	147	92	33.72	48.42
Lyopsetta exilis	Slender sole	356	59	556	199	32.72	48.42
Microstomus pacificus	Dover sole	582	58	1,186	359	32.54	48.42
Paralichthys californicus	California halibut	10	58	90	68	32.74	38.81
Parophrys vetulus	English sole	317	53	392	123	32.60	48.42
Platichthys stellatus	Starry flounder	8	58	70	63	37.51	44.72
Pleuronichthys decurrens	Curlfin sole	89	53	155	84	32.60	46.97
P. verticalis	Hornyhead turbot	37	59	496	94	32.60	37.88
Psettichthys melanostictus	Sand sole	6	62	79	66	44.27	46.97

Table 3 continued. Frequency of occurrence, depth, and latitudinal ranges for fish and invertebrate species, grouped by family (or higher taxonomic classification), caught during the 2005 NWFSC slope/shelf survey.

Family and scientific name	Common name	Frequency of occurrence (No. hauls)	Depth (m)			Latitudinal range (dd)	
			Min.	Max.	Mean	South	North
Xystreurys liolepis	Fantail sole	3	63	74	68	32.92	34.36
Cynoglossidae							
Cynoglossidae	Tonguefish unident.	1	60	60	60	36.86	36.86
Symphurus atricaudus	California tonguefish	2	72	110	91	34.15	34.37
Osteichthyes (class)	Fish eggs unident.	1	105	105	105	45.53	45.53
Osteichthyes (class)	Fish unident.	1	60	60	60	33.79	33.79
Porifera (phylum)							
Hexactinellida	Glass sponge unident.	2	937	1,063	1,000	33.75	43.58
Porifera	Sponge unident.	154	61	1,230	476	32.54	48.42
Porifera	Vase sponge unident.	9	70	984	450	32.72	45.20
Acanthascus sp.	Chimney sponge unident.	7	127	1,088	444	33.61	47.26
Aphrocallistes vastus	Clay pipe sponge	61	97	1,098	584	32.72	47.87
Chonelasma calyx	Goblet sponge	3	510	581	548	33.37	40.68
Farrea convolulus	Crusty tube sponge	5	307	1,083	768	32.94	47.68
Hyalonema sp.	Fiber optic sponge unident.	20	502	1,140	872	32.62	47.68
Leucandra heathi	Spiny vase sponge	1	256	256	256	44.63	44.63
Rhabdocalyptus sp.	Cloud sponge unident.	11	307	838	579	32.73	46.06
Staurocalyptus sp.	Spiny vase sponge unident.	15	336	1,140	680	32.73	47.69
Suberites ficus	Hermit sponge	1	87	87	87	33.84	33.84
Tethya sp.	Ball sponge unident.	6	71	826	358	32.72	34.38
Scyphozoa (class)							
Scyphozoa	Jellyfish unident.	97	58	1,243	464	32.61	47.84
Aequorea sp.		2	584	857	721	35.09	43.32
Atolla sp.	Wheel jelly unident.	62	455	1,243	886	32.77	47.69
Aurelia labiata		10	63	427	169	37.74	46.67
Aurelia sp.	Moon jelly unident.	12	59	1,015	263	34.29	47.26
Chrysaora melanaster	Sunrise jelly	1	79	79	79	46.82	46.82
Chrysaora sp.	Chrysaora jellyfish unident.	28	58	761	118	32.58	47.84

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 2005 NWFSC slope/shelf survey.

Family and scientific name	Common name	Frequency of occurrence (No. hauls)	Depth (m)			Latitudinal range (dd)	
			Min.	Max.	Mean	South	North
Cyanea capillata	Lion's mane	1	147	147	147	48.10	48.10
Pelagia colorata	Purple striped jellyfish	4	90	464	188	32.87	36.85
Periphylla periphylla	Purple cone jellyfish	60	317	1,229	823	32.61	47.87
Phacellophora camtschatica	Egg-yolk jellyfish	97	59	1,172	294	33.69	48.42
Anthozoa (class)							
Actiniaria	Sea anemone unident.	58	69	1,140	599	32.54	48.23
Actiniaria	Purple striated sea anemone unident.	53	300	1,063	621	35.03	47.59
Actiniaria	Red striated sea anemone unident.	38	62	1,208	767	33.74	48.25
Actinostolidae		40	53	1,154	696	32.77	47.69
Alcyonacea	Soft coral unident.	8	60	1,172	759	33.37	47.69
Alcyonaria	Octocoral unident.	1	631	631	631	33.32	33.32
Antipatheria	Black coral unident.	25	137	1,152	731	34.82	47.87
Gorgonacea	Gorgonian coral unident.	8	61	1,075	500	32.83	43.26
Hormathiidae	Hormathiid anemones unident.	71	64	1,243	720	32.73	47.90
Pennatulacea	Sea pen or sea whip unident.	22	69	1,125	295	32.74	47.92
Virgulariidae	Sea whip unident.	22	59	1,152	245	32.68	47.90
Actinauge verrilli	Reticulated sea anemone	67	292	1,230	754	32.61	47.90
Actinernus spp.	Lava sea anemone unident.	15	352	1,230	869	32.62	46.06
Actinoscyphia sp.	Sea whip sea anemone unident.	13	140	1,090	478	32.62	47.59
Actinostola sp.		7	467	1,186	815	34.82	44.38
Anthomastus ritteri	Mushroom coral	18	293	972	593	32.62	47.86
Anthomastus sp.	Mushroom coral unident.	1	958	958	958	46.90	46.90
Anthoptilum grandiflorum	Fleshy sea pen	48	105	1,208	778	32.89	47.90
A. murrayi	Murray's sea pen	4	516	1,083	911	32.73	47.69
Bathypathes sp.	Quill black coral	4	136	1,243	946	33.36	45.95
Callogorgia kinoshitae	Golden coral	4	127	464	222	33.51	33.76
Coenocyathus bowersi	Colonial cup coral	1	74	74	74	32.92	32.92
Corallimorphus sp.	Club tipped sea anemone	9	336	1,205	884	32.77	45.82

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 2005 NWFSC slope/shelf survey.

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			Min.	Max.	Mean	South	North
Distichoptilum gracile	Deep-sea sea whip	2	1,090	1,229	1,159	33.46	33.51
Lillipathes sp.	Long-stemmed black coral	3	531	1,243	969	45.89	45.95
Liponema brevicornis	Tentacle-shedding sea anemone	183	93	1,251	618	32.61	48.11
Lophogorgia chilensis	Red gorgonian	3	86	710	456	32.83	35.97
Metridium farcimen	Giant sea anemone	235	58	838	146	32.58	48.42
Metridium sp.		3	71	380	193	34.38	44.05
Oractis diomedeae	Grape sea anemone	2	569	571	570	44.75	47.07
Paractinostola faeculenta	Rough purple sea anemone	259	179	1,230	669	32.54	47.87
Paragorgia pacifica		3	621	1,166	858	36.18	41.92
Paragorgia sp.	Peppermint coral	1	185	185	185	47.64	47.64
Polymyces montereyensis	Cup coral	2	283	421	352	32.85	44.63
Ptilosarcus gurneyi	Orange sea pen	14	60	781	161	34.07	45.88
Sicyonis spp.	Orange actinistolid unident.	8	499	1,172	869	34.64	47.46
Stomphia coccinea	Swimming sea anemone	22	71	1,075	270	32.72	47.64
Stomphia sp.		2	174	1,077	626	45.49	46.43
Stylatula gracile	Roughstem sea whip	40	71	1,243	503	33.00	47.84
Stylatula sp.	Slender sea whip	25	93	1,113	457	33.54	47.56
Swiftia pacifica		3	78	1,186	654	33.39	40.31
S. simplex		7	62	1,075	512	32.83	48.04
Swiftia sp.	Red sea fan	17	60	1,152	566	33.34	47.69
Umbellula sp.	Flower sea pen	16	453	1,152	741	34.54	47.59
Urticina crassicornis	Painted sea anemone	12	64	124	92	38.52	47.86
Urticina sp.		48	58	496	113	33.96	48.42
Hydrozoa (class)							
Distichopora sp.	Hydrocoral unident.	1	1,140	1,140	1,140	32.91	32.91
Dromalia alexandri	Sea pineapple	65	90	916	528	32.62	36.22
Ctenophora (phylum)							
Ctenophora	Comb jelly unident.	3	575	1,132	767	42.08	47.79

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 2005 NWFSC slope/shelf survey.

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			Min.	Max.	Mean	South	North
Brachiopoda (phylum)							
Brachiopod	Lampshells unident.	11	85	175	121	33.42	45.80
Terebratalia transversa	Common brachiopod	1	141	141	141	41.26	41.26
Aplacophora (class)							
Aplacophora	Aplacophora unident.	7	93	1,186	591	37.43	45.39
Neomenia sp.	Solenogaster unident.	16	209	1,166	660	32.73	48.27
Bivalvia (class)							
Bivalvia	Bivalve unident.	5	118	957	625	33.93	46.26
Acesta sphoni	Sphons giant file clam	4	516	756	654	32.73	33.84
Acharax johnsoni		2	449	520	485	44.38	45.04
Chlamys hastata hericia	Spiny scallop	1	97	97	97	36.49	36.49
Delectopecten vancouverensis	Vancouver scallop	18	141	1,230	897	32.83	47.83
Panopea abrupta	Pacific geoduck	1	58	58	58	37.07	37.07
Patinopecten caurinus	Weather vane scallop	3	74	782	315	40.93	43.93
Solemya sp.	Awning clam	1	957	957	957	46.26	46.26
Vesicomya pacifica	Cold seep clam	2	871	1,152	1,011	45.77	46.47
Yoldia sp.		3	820	885	859	34.38	46.47
Cephalopoda (phylum)							
Teuthida	Squid unident.	2	552	811	681	33.37	46.91
Octopodidae	Octopus unident.	12	69	552	244	32.60	47.86
Benthoctopus leioderma	Smooth octopus	1	464	464	464	33.92	33.92
Benthoctopus spp.		40	156	1,243	629	34.40	47.84
Berryteuthis magister	Magistrate armhook squid	1	190	190	190	45.68	45.68
Chiroteuthis calyx		4	480	939	773	41.62	45.56
Cranchia scabra	Sandpaper squid	2	516	832	674	35.22	39.07
Dosidicus gigas	Humboldt squid	11	96	885	474	37.16	45.88
Enteroctopus dofleini	Giant Pacific octopus	24	71	624	464	34.99	47.50
Galiteuthis phyllura	Arrow squid	3	556	877	666	34.31	47.83

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 2005 NWFSC slope/shelf 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	248	998	527	35.01	47.84
Gonatus onyx	Arm tooth squid	33	58	1,128	563	33.12	47.90
Gonatus sp.		4	138	1,063	624	38.72	43.58
Graneledone boreopacifica	Ghost octopus	2	1,166	1,205	1,185	36.18	43.89
Graneledone sp.	Deep-sea octopus	3	1,125	1,172	1,154	36.18	46.16
Histioteuthis heteropsis	Jewel or cock-eye squid	38	326	1,114	548	32.73	47.83
H. hoylei	Long-armed jewel squid	1	1,088	1,088	1,088	41.33	41.33
Histioteuthis sp.	Jewel squid	1	1,041	1,041	1,041	32.77	32.77
Japetella diaphana	Yellowring octopus	2	877	1,077	977	46.43	47.83
Loligo opalescens	California market squid	170	53	504	115	32.58	47.86
Moroteuthis robusta	Robust clubhook squid	3	335	455	394	43.06	47.26
Octopoteuthis deletron	Octopus squid	107	90	1,208	730	32.74	47.83
Octopus californicus	North Pacific bigeye octopus	20	72	754	297	32.62	35.11
O. rubescens	Red octopus	27	71	516	329	32.73	35.28
Octopus sp.		7	69	1,251	392	42.63	48.36
Onychoteuthis borealijaponicus	Boreal clubhook squid	1	380	380	380	34.54	34.54
O. californiana	Flapjack devilfish	48	60	1,083	583	33.92	47.69
Rossia pacifica	Eastern Pacific bobtail squid	59	59	305	134	33.58	48.10
Taonius pavo	Cone squid	12	75	1,251	736	34.20	46.90
Vampyroteuthis infernalis	Vampire squid	41	450	1,208	885	32.54	47.83
Gastropoda (class)							
Gastropod eggs	Snail eggs unident.	17	84	1,152	734	32.62	46.67
Gastropod	Snail unident.	2	820	903	862	34.38	47.86
Heteropoda		4	421	1,243	857	32.85	45.95
Nudibranchia	Nudibranch unident.	21	70	1,083	335	32.62	48.36
Doridiidae	Dorid nudibranch unident.	2	88	283	186	44.36	44.63
Anisodoris nobilis	Pacific sea lemon	3	70	104	89	37.39	48.25
Antiplanes perversa	Lefthanded turrid	1	787	787	787	41.92	41.92

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 2005 NWFSC slope/shelf survey.

Family and scientific name	Common name	Frequency of occurrence (No. hauls)	Depth (m)			Latitudinal range (dd)	
			Min.	Max.	Mean	South	North
Armina californica	Striped tongue nudibranch	4	64	136	91	44.43	45.87
Bathybembix bairdii	Green top snail	109	528	1,230	858	32.54	47.83
Buccinum viridum	Turban whelk	15	383	1,128	924	34.53	47.68
Calinaticina oldroydii	Oldroyd's moonsnail	30	72	419	156	34.15	47.50
Calliostoma platinum	Silvery top snail	1	820	820	820	34.38	34.38
Carinaria cristata		6	86	1,006	498	35.83	44.97
Colus aphelus	Oblique whelk	3	911	1,114	1,038	41.33	44.41
C. georgianus	Georgia's whelk	1	820	820	820	34.38	34.38
Colus spp.		7	449	1,125	866	41.59	46.90
C. trophius	Ribbed whelk	1	820	820	820	34.38	34.38
Cryptonatica russa	Rusty moonsnail	1	820	820	820	34.38	34.38
Euspira lewisii	Moonsnail	1	162	162	162	44.90	44.90
Fusitriton oregonensis	Oregon triton	10	125	785	315	42.94	47.25
Megasurcula stearnsiana	Stearn's turrid	1	86	86	86	34.41	34.41
Natica sp.		1	1,125	1,125	1,125	46.16	46.16
Neptunea amianta	Deep-sea neptune	51	163	1,243	739	33.00	47.69
N. eulimata		1	446	446	446	44.14	44.14
N. humboldtiana	Humboldt neptune	2	575	871	723	46.47	47.79
N. ithia	Slender neptune	1	359	359	359	45.98	45.98
N. pribiloffensis	Pribilof neptune	2	547	958	753	39.09	46.90
N. smirnia	Chocolate neptune	2	105	1,152	628	45.53	45.77
Neptunea sp.		99	136	1,230	767	32.77	47.87
N. tabulata	Tabled neptune	1	93	93	93	45.98	45.98
Philine bakeri	Ocean won ton	14	78	516	274	32.58	38.45
Pleurobranchaea californica	California sea slug	121	59	499	177	32.58	47.92
Plicifusus griseus	Gray whelk	3	689	820	745	34.38	41.70
Solariella nuda	Naked solarelle	1	467	467	467	39.51	39.51
Tritonia diomedea	Rosy tritonia	186	58	1,251	336	32.62	47.87

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 2005 NWFSC slope/shelf survey.

Family and scientific name	Common name	Frequency of occurrence (No. hauls)	Depth (m)			Latitudinal range (dd)	
			Min.	Max.	Mean	South	North
Sipuncula (phylum)							
Sipuncula	Peanut worm unident.	2	76	309	193	34.04	44.34
Polychaeta (phylum)							
Annelida	Worm unident.	9	84	1,140	545	32.77	45.65
Polychaeta	Polychaete worm unident.	8	104	1,152	398	33.39	48.39
Polychaeta	Tube worm unident.	2	1,019	1,075	1,047	41.55	47.69
Aphrodita sp.	Sea mouse unident.	82	81	1,230	407	32.74	48.42
Pycnogonida (class)							
Pycnogonida	Sea spider unident.	1	584	584	584	35.09	35.09
Malacostraca (class)							
Brachyura	Crab unident.	1	328	328	328	33.43	33.43
Calappidae	Box crab unident.	2	136	141	138	33.72	44.45
Dendrobrachiata	Shrimp unident.	2	412	869	641	32.72	33.90
Galatheidae	Galatheid crab unident.	1	601	601	601	33.55	33.55
Isopoda	Isopod unident	8	58	1,243	610	32.89	47.54
Mysidacea	Mysid unident.	2	811	1,075	943	32.83	46.91
Paguridae	Hermit crab unident.	48	62	1,208	504	32.83	48.10
Pasiphaeidae	Pasiphaeid shrimp unident.	1	470	470	470	34.28	34.28
Thoracica	Barnacle unident.	1	633	633	633	47.46	47.46
Acanthephyra curtirostris	Peaked shrimp	4	520	957	783	33.00	39.53
Acantholithodes hispidus	Fuzzy crab	5	86	283	153	34.41	44.63
Calocarides sp.	Deep-sea shrimp unident.	7	324	497	419	34.28	35.28
Cancer anthonyi	Yellow rock crab	14	61	239	119	32.66	36.24
C. gracilis	Graceful rock crab	2	71	85	78	34.66	39.24
C. magister	Dungeness crab	242	53	727	139	34.66	48.23
C. productus	Red rock crab	18	58	255	105	34.01	38.81
Chionoecetes bairdi	Baird's tanner crab	4	165	317	249	44.63	48.11
C. tanneri	Grooved tanner crab	180	163	1,251	789	32.61	47.87

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 2005 NWFSC slope/shelf survey.

Family and scientific name	Common name	Frequency of occurrence (No. hauls)	Depth (m)			Latitudinal range (dd)	
			Min.	Max.	Mean	South	North
Chirostylus sp.	Spiny pinch bug	1	1,132	1,132	1,132	45.89	45.89
Chorilia longipes	Long horned decorator crab	65	90	1,230	568	32.58	48.33
Crangon septemspinosa	Sand shrimp	7	63	156	119	34.36	47.86
Crangon sp.	Crangon unident.	20	75	327	160	34.19	48.36
Eualus biunguis	Two-clawed eualid	5	391	1,243	920	34.82	47.83
E. macrophthalmus	Bigeye eualid	45	383	1,205	562	33.16	47.79
Eualus sp.	Eualid unident.	8	367	754	545	32.62	47.84
Glyptolithodes cristatipes	Deep-sea rock crab	8	309	552	452	32.85	34.04
Hemisquilla californiensis	Mantis shrimp	5	69	86	78	32.60	32.83
Janetogalathea californiensis	California pinch bug	1	876	876	876	33.16	33.16
Lithodes couesi	Scarlet king crab	33	598	1,208	944	32.54	47.69
Lopholithodes foraminatus	Brown box crab	38	86	490	191	33.73	48.42
Loxorhynchus crispatus	Masking crab	8	92	464	167	33.72	43.26
L. grandis	Sheep crab	6	61	85	72	32.92	34.36
Macroregonia macrochira	Long-armed spider crab	1	630	630	630	32.77	32.77
Moloha faxoni	Pacific carrier crab	2	127	141	134	33.72	33.73
Munida hispida		6	328	1,230	647	32.73	34.28
M. quadrispina	Pinch bug	13	78	787	399	32.72	48.04
Munidopsis hystrix		3	756	826	796	33.00	33.69
M. quadrata	Pale rough pinch bug	1	1,166	1,166	1,166	36.18	36.18
Munidopsis sp.	Thorny pinch bug unident.	13	105	1,178	875	32.58	45.77
Neograngon communis	Two-spine crangon	7	108	185	136	39.20	47.64
Neognathophausia gigas		1	756	756	756	33.69	33.69
N. ingens	Giant red mysid	24	569	1,230	902	32.62	40.22
Neognathophausia sp.	Red mysid unident.	13	489	1,140	904	32.89	41.35
Neolithodes diomedeae	Spiky king crab	2	1,154	1,229	1,191	33.46	35.27
Notostomus japonicus	Spinyridge shrimp	3	210	601	383	45.13	48.24
Paguristes turgidus	Hermit crab	4	82	434	236	34.07	46.26

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 2005 NWFSC slope/shelf survey.

Family and scientific name	Common name	Frequency of occurrence (No. hauls)	Depth (m)			Latitudinal range (dd)	
			Min.	Max.	Mean	South	North
Pagurus capillatus	Hairy hermit crab	2	108	185	147	43.92	47.64
Pagurus sp.	Hermit crab unident.	10	111	1,186	562	32.94	47.59
P. tanneri	Tanner's hermit crab	3	547	898	778	39.09	42.12
Pandalopsis ampla	Smooth shrimp	26	419	1,243	1,074	32.74	45.95
P. dispar	Sidestripe shrimp	19	176	432	258	33.28	48.27
Pandalus hypsinotus	Coonstripe shrimp	2	65	78	72	41.55	47.86
P. jordani	Ocean shrimp	110	82	1,056	188	32.91	48.42
P. platyceros	Spot shrimp	26	124	397	239	33.43	47.90
Pandalus sp.	Pandalid unident.	1	787	787	787	41.92	41.92
P. tridens	Yellowleg pandalid	1	276	276	276	42.94	42.94
Paralithodes californiensis	California king crab	20	105	1,098	366	32.58	36.24
P. rathbuni	Spiny king crab	13	86	499	262	34.01	38.45
Paralithodes sp.	King crab unident.	1	255	255	255	35.03	35.03
Paralomis manningi	Deep-sea spider crab	1	1,132	1,132	1,132	45.89	45.89
P. multispina	Hair crab	26	426	1,243	1,070	32.74	47.68
P. verrilli	Vermillion crab	1	496	496	496	33.96	33.96
Pasiphaea pacifica	Pacific glass shrimp	101	171	994	524	32.87	48.42
P. tarda	Crimson pasiphaeid	90	181	1,243	863	32.61	47.66
Platymera gaudichaudii	Armed box crab	48	58	195	108	32.58	39.78
Pleuroncodes planipes	Pelagic red crab	2	179	312	245	34.19	34.21
Polycheles sculptus	Deep-sea lobster	10	850	1,229	1,080	32.77	41.35
Pugettia richii	Cryptic kelp crab	1	97	97	97	44.19	44.19
Sergestes similis	Pacific sergestid	30	296	1,140	608	32.77	47.54
Sergestes sp.		6	367	851	570	33.42	46.52
Sicyonia ingentis	Razor-back prawn	29	59	502	100	32.60	34.42
Asteroidea (class)							
Asteroidea	Sea star unident.	14	69	1,251	596	32.60	47.87
Ampheraster marianus	Pink star	35	143	994	669	32.73	47.83

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 2005 NWFSC slope/shelf survey.

Family and scientific name	Common name	Frequency of occurrence (No. hauls)	Depth (m)			Latitudinal range (dd)	
			Min.	Max.	Mean	South	North
Ampheraster sp.		2	813	998	906	37.25	47.54
Anteliaster sp.	Soft star unident.	5	499	994	739	32.73	45.65
Asterias sp.		1	115	115	115	45.56	45.56
Asterina miniata	Bat star	8	58	755	234	33.93	37.39
Astropecten armatus	Spiny sand star	14	71	832	200	33.68	43.03
A. californicus	California sand star	10	59	496	138	32.92	42.43
A. ornatissimus	Ornate sand star	6	61	489	188	36.12	38.34
Brisingella exilis	Lacy-armed star	24	499	1,054	674	33.55	47.79
Brisingella sp.		2	707	818	762	41.63	42.01
Ceramaster arcticus	Arctic bat sea star	1	1,166	1,166	1,166	36.18	36.18
C. leptoceramus	California cookie star	17	171	870	637	32.73	48.04
C. patagonicus	Orange cookie star	3	601	756	662	33.32	33.69
Ceramaster sp.		5	615	1,208	848	35.02	42.12
Cheiraster dawsoni	Fragile star	9	323	977	490	44.54	47.87
Crossaster borealis	Grooved sea star	117	79	1,251	801	32.73	48.39
C. papposus	Rose sea star	19	92	331	166	38.45	48.42
Crossaster sp.		1	432	432	432	47.25	47.25
Cryptopeltaster lepidonotus	Grainy star	20	352	1,102	680	32.62	47.90
Ctenodiscus crispatus	Common mud star	15	163	1,166	488	36.18	48.27
Ctenodiscus sp.	Mud star unident.	1	383	383	383	45.20	45.20
Dermasterias imbricata	Leather sea star	13	61	137	98	35.99	45.87
Diplopteraster multipes	Pincushion sea star	20	293	1,102	518	32.83	47.90
Diplopteraster sp.	Pincushion sea star unident.	1	181	181	181	46.83	46.83
Dipsacaster borealis	Northern sand star	1	1,166	1,166	1,166	36.18	36.18
D. eximius	Broad sand star	46	114	1,102	745	32.54	46.83
Henricia sp.		15	87	1,230	349	33.16	48.25
Heterozonias alternatus	Pink sun star	173	106	1,229	768	32.73	47.87
Hippasteria californica	Deep-sea spiny star	115	60	1,208	674	32.54	47.90

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 2005 NWFSC slope/shelf survey.

Family and scientific name	Common name	Frequency of occurrence (No. hauls)	Depth (m)			Latitudinal range (dd)	
			Min.	Max.	Mean	South	North
Hippasteria sp.		4	69	1,140	543	32.60	41.27
H. spinosa	Spiny sea star	77	64	1,172	270	32.72	48.42
Leptychaster arcticus	Arctic sand star	1	383	383	383	44.74	44.74
L. pacificus	Pacific sand star	1	531	531	531	45.92	45.92
Lophaster furcilliger	Pink crested sea star	9	276	1,166	780	33.59	46.04
Lophaster sp.		6	489	1,229	1,023	32.89	35.49
L. vexator	Crested sea star	3	715	998	842	46.56	47.57
Luidia foliolata	Flat mud star	341	53	1,125	164	32.66	48.24
Mediaster aequalis	Equal armed star	68	61	1,152	221	33.51	48.42
Mediaster sp.		17	74	604	272	34.41	45.90
M. tenellus	Pale equal armed star	3	489	715	608	33.12	47.57
Myxoderma platyacanthum	Red sea star	129	86	1,166	580	32.73	47.25
M. sacculatum	Snakehead sea star	33	426	1,251	937	32.88	47.68
Nearchaster aciculosus	Deep-sea fragile star	77	317	1,251	845	32.62	47.90
Nearchaster sp.		17	391	1,229	884	32.77	45.78
Orthasterias koehleri	Rainbow sea star	11	61	410	169	35.99	48.41
Orthasterias sp.		6	86	142	115	41.16	44.19
Pisaster brevispinus	Short-spined pink star	64	58	309	98	34.04	47.56
Poraniopsis flexilis	Flexible thorny star	6	179	957	589	32.77	47.16
P. inflata	Thorny star	19	70	805	263	33.00	48.42
Pseudarchaster alascensis	Alaskan pseudarchaster	9	157	1,113	400	35.73	47.25
P. dissonus	Deep-sea pseudarchaster	5	99	234	148	38.68	45.69
P. parelii	Scarlet sea star	2	176	520	348	44.38	46.66
Pseudarchaster sp.	Pseudarchaster unident.	26	79	1,243	431	33.12	47.54
Pteraster jordani	Jordan's slime star	31	397	1,140	716	32.62	47.87
P. militaris	Wrinkled slime star	8	92	1,186	520	33.69	48.25
Pteraster sp.	Slime star unident.	22	97	1,229	838	32.77	48.25
P. tesselatus	Slimy cushion star	9	94	785	328	33.61	48.42

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 2005 NWFSC slope/shelf survey.

Family and scientific name	Common name	Frequency of occurrence (No. hauls)	Depth (m)			Latitudinal range (dd)	
			Min.	Max.	Mean	South	North
Pteraster trigonodon	Triangle-toothed cushion star	5	516	1,230	955	32.73	41.92
Pycnopodia helianthoides	Sunflower sea star	131	53	832	127	34.05	48.23
Rathbunaster californicus	Deep-sea sunflower star	122	61	850	221	32.66	48.36
Sclerasterias heteropaes	False rainbow star	1	138	138	138	38.72	38.72
Solaster dawsoni	Morning sun star	1	185	185	185	47.64	47.64
S. exiguus	Deep-sea sun star	15	323	1,178	901	32.77	46.56
Solaster sp.	Orange sun star unident.	24	73	1,229	350	32.77	48.42
Stylasterias forreri	Fish-eating star	76	58	387	154	34.01	48.42
Thrissacanthias penicillatus	Carpet star	186	78	1,243	724	32.61	47.90
Zoroaster evermani	Slender sea star	94	317	1,251	836	32.73	47.90
Z. ophiurus		1	1,019	1,019	1,019	41.55	41.55
Crinoidea (class)							
Crinoidea	Crinoid unident.	5	92	998	433	33.61	47.54
Florometra sp.		3	97	1,083	751	44.19	47.69
Florometra serratissima	Featherstar crinoid	5	72	1,132	384	34.21	48.25
Echinoidea (class)							
Echinacea	Sea urchin unident.	18	165	569	381	33.54	47.91
Spatangoida	Heart sea urchin unident.	2	516	584	550	35.09	35.22
Allocentrotus fragilis	Fragile red sea urchin	229	77	1,102	417	32.54	48.42
Brisaster latifrons	Mud urchin	258	72	1,114	398	32.73	48.42
Brisaster sp.	Mud urchin unident.	3	323	851	556	33.42	34.81
B. townsendi	Giant mud urchin	1	631	631	631	33.32	33.32
Brissopsis pacifica	Oval sea biscuit	34	171	937	500	32.73	39.09
Lytechinus anamesus	White urchin	14	60	110	83	32.58	34.41
Spatangus californicus	Giant sea biscuit	18	86	426	261	32.88	39.10
Strongylocentrotus franciscanus	Red sea urchin	2	76	127	102	33.73	34.41
S. pallidus	Crowned sea urchin	8	104	327	177	48.20	48.42
Holothuroidea (class)							

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 2005 NWFSC slope/shelf survey.

Family and scientific name	Common name	Frequency of occurrence (No. hauls)	Depth (m)			Latitudinal range (dd)	
			Min.	Max.	Mean	South	North
Holothuroidea	Sea cucumber unident.	7	59	631	325	33.32	44.04
Synallactidae	Deep-sea papillose sea cucumber	9	502	972	753	32.73	33.34
Cucumaria sp.		1	503	503	503	34.54	34.54
Molpadia intermedia	Purple sea potato	56	63	1,166	415	32.83	48.42
Pannychia moseleyi	Sloppy cucumber	66	331	1,166	654	32.77	47.87
P. californicus	California cucumber	56	59	489	133	32.60	48.27
P. leukothele	Giant soft cucumber	113	77	808	212	32.72	48.42
P. parvimensis	Warty sea cucucumber	7	307	1,028	747	32.94	33.75
Pseudostichopus mollis	Sandy sea cucumber	55	139	1,243	596	32.61	47.90
Psolus squamatus	Whitescaled cucumber	27	323	1,172	718	32.54	47.86
Scotoplanes spp.	Sea pig	18	1,019	1,229	1,101	32.89	47.69
Ophiuroidea (class)							
Ophiuroida	Ophuiroid unident.	8	194	1,132	719	33.15	48.00
Amphiophiura sp.	Southern armored brittlestar	6	820	1,166	1,052	32.74	36.18
Amphiura diomedeae	Tan brittlestar	1	1,230	1,230	1,230	33.16	33.16
Asteronyx longifissus	Long-slit serpent brittlestar	17	462	1,166	714	32.91	41.01
A. loveni	Giant serpent brittlestar	31	163	1,243	649	33.39	47.83
Asteronyx sp.		17	105	1,229	748	32.58	36.22
Gorgonocephalus eucnemis	Basketstar	62	58	1,205	181	33.61	48.39
Ophiacantha diplasia	Lacy brittlestar	2	569	615	592	35.02	44.75
Ophiacantha sp.		4	256	532	411	44.63	45.47
Ophiomusium jolliensis	Red brittlestar	13	453	1,088	660	32.94	47.79
O. lymani	Lyman's brittlestar	4	1,041	1,243	1,114	32.77	45.95
Ophiopholis sp.		18	92	998	440	32.73	48.42
Ophiopthalmus normani	Rosy brittlestar	3	1,098	1,125	1,108	32.89	46.16
Ophioscolex corynetes	Blob disc serpent brittlestar	1	449	449	449	45.00	45.00
Ophiura sarsi	Notched brittlestar	40	85	647	364	34.66	48.42
Ophiura sp.		22	61	1,113	537	32.66	46.47

Table 3 continued. Frequency of occurrence, depth, and latitudinal ranges for fish and invertebrate species, grouped by family (or higher taxonomic classification), caught during the 2005 NWFSC slope/shelf survey.

Family and scientific name	Common name	Frequency of occurrence (No. hauls)	Depth (m)			Latitudinal range (dd)	
			Min.	Max.	Mean	South	North
Stegophiura ponderosa	Giant armored brittlestar	19	477	1,102	748	32.89	47.79
Tunicata (subphylum)							
Tunicata	Tunicate unident.	12	552	1,230	957	32.89	47.69
Thaliacea	Salps unident.	263	58	1,243	467	32.54	48.42
Halocynthia igaboja	Spiny tunicate	1	175	175	175	45.80	45.80
Halocynthia sp.	Sea peach unident.	2	92	181	136	43.26	46.83
Molgula grifithsii	Sea grape	9	499	1,088	835	34.38	47.46
Pyrosoma atlanticum	Sea tongue	4	87	1,154	650	33.49	35.27
Styela rustica	Sea potato	13	71	1,152	381	32.66	48.23
Thetys vagina	Rabbit-eared salp	2	79	785	432	33.79	34.05
Animalia (kingdom)							
Animalia	Invertebrate unident.	9	99	1,102	550	32.89	45.66
Animalia	Unsorted shab	10	134	1,230	609	33.16	48.27

Table 4. Number of length-frequency measurements collected by stratum for the most frequently sampled groundfish species during the 2005 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	2,912	929	1	3,842
California skate	460	1	0	461
Longnose skate	1,577	1,675	125	3,377
Spotted ratfish	2,564	1,259	29	3,852
Arrowtooth flounder	2,905	1,123	6	4,034
Pacific sanddab	11,180	46	0	11,226
Flathead sole	427	166	0	593
Petrale sole	4,886	186	0	5,072
English sole	8,604	432	0	9,036
Dover sole	7,830	7,035	3,324	18,189
Rex sole	10,509	5,627	257	16,393
Curlfin sole	567	0	0	567
Sablefish	1,124	2,165	2,483	5,772
Pacific grenadier	0	30	2,643	2,673
Pacific flatnose	0	38	1,168	1,206
Lingcod	1,028	186	0	1,214
Pacific hake	5,520	3,567	132	9,219
Shortspine thornyhead	101	5,880	2,203	8,184
Longspine thornyhead	0	2,943	11,122	14,065
Pacific ocean perch	168	361	4	533
Aurora rockfish	0	1,593	112	1,705
Darkblotched rockfish	960	1,023	0	1,983
Splitnose rockfish	442	4,058	0	4,500
Greenstriped rockfish	3,355	683	0	4,038
Yellowtail rockfish	1,184	50	0	1,234
Chilipepper rockfish	3,044	1,063	0	4,107
Rosethorn rockfish	266	665	0	931
Squarespot rockfish	434	0	0	434
Shortbelly rockfish	1,420	736	0	2,156
Blackgill rockfish	1	399	1	401
Canary rockfish	485	137	0	622
Stripetail rockfish	3,091	1,556	0	4,647
Halfband rockfish	2,854	0	0	2,854
Sharpchin rockfish	398	492	0	890
Grooved tanner crab	1	135	5,356	5,942

Table 5. Number of length-frequency measurements collected by stratum for the most frequently sampled groundfish species during the 2005 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	147	102	0	249
California skate	114	0	0	114
Longnose skate	24	722	73	819
Spotted ratfish	502	338	29	869
Arrowtooth flounder	0	0	0	0
Pacific sanddab	2,079	5	0	2,084
Flathead sole	1	0	0	1
Petrale sole	96	54	0	150
English sole	1,120	5	0	1,125
Dover sole	62	2,119	1,072	3,253
Rex sole	77	1,556	4	1,637
Curlfin sole	79	0	0	79
Sablefish	12	801	757	1,570
Pacific grenadier	0	2	395	397
Pacific flatnose	0	0	318	318
Lingcod	114	18	0	132
Pacific hake	439	1,781	56	2,276
Shortspine thornyhead	0	1,493	925	2,418
Longspine thornyhead	0	1,228	3,982	5,210
Pacific ocean perch	0	0	0	0
Aurora rockfish	0	1,192	73	1,265
Darkblotched rockfish	0	6	0	6
Splitnose rockfish	12	1,999	0	2,011
Greenstriped rockfish	98	7	0	105
Yellowtail rockfish	97	0	0	97
Chilipepper rockfish	185	150	0	335
Rosethorn rockfish	14	139	0	153
Squarespot rockfish	433	0	0	433
Shortbelly rockfish	447	324	0	771
Blackgill rockfish	0	372	1	373
Canary rockfish	239	1	0	240
Stripetail rockfish	1,089	502	0	1,591
Halfband rockfish	2,472	0	0	2,472
Sharpchin rockfish	3	2	0	5
Grooved tanner crab	0	30	643	673

Table 6. Number of length-frequency measurements collected by stratum for the most frequently sampled groundfish species during the 2005 West Coast groundfish trawl survey for the INPFC Monterey area.

Species	Stratum 1 (55–183 m)	Stratum 2 (184–549 m)	Stratum 3 (550–1,280 m)	Total
Spiny dogfish	1,452	376	1	1,829
California skate	333	1	0	334
Longnose skate	688	275	28	991
Spotted ratfish	443	136	0	579
Arrowtooth flounder	9	10	0	19
Pacific sanddab	3,206	41	0	3,247
Flathead sole	0	0	0	0
Petrale sole	1,675	90	0	1,765
English sole	2,244	261	0	2,505
Dover sole	1,419	1,047	629	3,095
Rex sole	2,144	737	0	2,881
Curlfin sole	315	0	0	315
Sablefish	303	191	412	906
Pacific grenadier	0	0	391	391
Pacific flatnose	0	4	247	251
Lingcod	288	26	0	314
Pacific hake	1,252	303	7	1,562
Shortspine thornyhead	1	236	264	501
Longspine thornyhead	0	192	993	1,185
Pacific ocean perch	0	0	0	0
Aurora rockfish	0	120	36	156
Darkblotched rockfish	37	91	0	128
Splitnose rockfish	27	558	0	585
Greenstriped rockfish	702	113	0	815
Yellowtail rockfish	162	0	0	162
Chilipepper rockfish	2,322	774	0	3,096
Rosethorn rockfish	12	14	0	26
Squarespot rockfish	1	0	0	1
Shortbelly rockfish	959	412	0	1,371
Blackgill rockfish	1	17	0	18
Canary rockfish	43	0	0	43
Stripetail rockfish	1,465	747	0	2,212
Halfband rockfish	381	0	0	381
Sharpchin rockfish	19	2	0	21
Grooved tanner crab	0	13	971	984

Table 7. Number of length-frequency measurements collected by stratum for the most frequently sampled groundfish species during the 2005 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	345	165	0	510
California skate	3	0	0	3
Longnose skate	254	275	19	548
Spotted ratfish	200	410	0	610
Arrowtooth flounder	465	184	0	649
Pacific sanddab	1,181	0	0	1,181
Flathead sole	11,180	46	0	11,226
Petrale sole	1,014	5	0	1,019
English sole	1,481	62	0	1,543
Dover sole	1,111	1,019	733	2,863
Rex sole	1,909	1,115	142	3,166
Curlfin sole	119	0	0	119
Sablefish	257	364	584	1,205
Pacific grenadier	0	0	499	499
Pacific flatnose	0	9	169	178
Lingcod	279	125	0	404
Pacific hake	729	549	37	1,315
Shortspine thornyhead	3	867	253	1,123
Longspine thornyhead	0	304	1,778	2,082
Pacific ocean perch	2	42	0	44
Aurora rockfish	0	108	0	108
Darkblotched rockfish	112	393	0	505
Splitnose rockfish	147	484	0	631
Greenstriped rockfish	478	214	0	692
Yellowtail rockfish	107	0	0	107
Chilipepper rockfish	321	139	0	460
Rosethorn rockfish	0	184	0	184
Squarespot rockfish	0	0	0	0
Shortbelly rockfish	14	0	0	14
Blackgill rockfish	0	1	0	1
Canary rockfish	83	132	0	215
Stripetail rockfish	401	274	0	675
Halfband rockfish	0	0	0	0
Sharpchin rockfish	1	229	0	230
Grooved tanner crab	0	0	1,373	1,373

Table 8. Number of length-frequency measurements collected by stratum for the most frequently sampled groundfish species during the 2005 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	408	88	0	496
California skate	1	0	0	1
Longnose skate	496	244	3	743
Spotted ratfish	1,169	178	0	1,347
Arrowtooth flounder	1,823	478	6	2,307
Pacific sanddab	4,492	0	0	4,492
Flathead sole	285	22	0	307
Petrale sole	1,894	36	0	1,930
English sole	3,292	68	0	3,360
Dover sole	4,455	2,269	885	7,609
Rex sole	5,542	1,861	111	7,514
Curlfin sole	54	0	0	54
Sablefish	483	631	686	1,800
Pacific grenadier	0	28	1,011	1,039
Pacific flatnose	0	25	373	398
Lingcod	301	15	0	316
Pacific hake	2,949	895	32	3,876
Shortspine thornyhead	97	2,972	715	3,784
Longspine thornyhead	0	1,219	3,866	5,085
Pacific ocean perch	158	166	2	326
Aurora rockfish	0	164	3	167
Darkblotched rockfish	748	502	0	1,250
Splitnose rockfish	253	948	0	1,201
Greenstriped rockfish	1,743	178	0	1,921
Yellowtail rockfish	312	5	0	317
Chilipepper rockfish	216	0	0	216
Rosethorn rockfish	195	306	0	501
Squarespot rockfish	0	0	0	0
Shortbelly rockfish	0	0	0	0
Blackgill rockfish	0	9	0	9
Canary rockfish	78	0	0	78
Stripetail rockfish	133	32	0	165
Halfband rockfish	1	0	0	1
Sharpchin rockfish	347	228	0	575
Grooved tanner crab	1	92	2,036	2,129

Table 9. Number of length-frequency measurements collected by stratum for the most frequently sampled groundfish species during the 2005 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	560	198	0	758
California skate	9	0	0	9
Longnose skate	115	159	2	276
Spotted ratfish	250	197	0	447
Arrowtooth flounder	608	451	0	1,059
Pacific sanddab	222	0	0	222
Flathead sole	141	144	0	285
Petrale sole	207	1	0	208
English sole	467	36	0	503
Dover sole	783	581	5	1,369
Rex sole	837	358	0	1,195
Curlfin sole	0	0	0	0
Sablefish	69	178	44	291
Pacific grenadier	0	0	347	347
Pacific flatnose	0	0	61	61
Lingcod	46	2	0	48
Pacific hake	151	39	0	190
Shortspine thornyhead	0	312	46	358
Longspine thornyhead	0	0	503	503
Pacific ocean perch	8	153	2	163
Aurora rockfish	0	9	0	9
Darkblotched rockfish	63	31	0	94
Splitnose rockfish	3	69	0	72
Greenstriped rockfish	334	171	0	505
Yellowtail rockfish	506	45	0	551
Chilipepper rockfish	0	0	0	0
Rosethorn rockfish	45	22	0	67
Squarespot rockfish	0	0	0	0
Shortbelly rockfish	0	0	0	0
Blackgill rockfish	0	0	0	0
Canary rockfish	42	4	0	46
Stripetail rockfish	3	1	0	4
Halfband rockfish	0	0	0	0
Sharpchin rockfish	28	31	0	59
Grooved tanner crab	0	0	333	333

Temperature Data

Near bottom temperatures ranged from 2.6°C to 10.5°C during the May–July 2005 portion of the survey, and from 3.1°C to 11.7°C during the August–October 2005 portion of the survey (Figure 5). The mean bottom temperature was 6.9°C. Sea surface temperatures ranged from 10.0°C to 22.2°C during the May–July 2005 portion of the survey, and from 7.8°C to 20.0°C during the August–October 2005 portion of the survey (Figure 6). The mean sea surface temperature was 14.0°C.

Relative Density and Distribution of Species

Information on the relative density and distribution of the 20 most abundant groundfish and select crab species are reported in several ways: 1) for all depth strata and INPFC areas combined (Table 10), 2) by depth strata for all INPFC areas combined (Table 11), and 3) by depth stratum within each individual INPFC area (Tables 12–16). The top five most abundant species (by weight) for all areas and depth strata combined (i.e., survey-wide) were Dover sole, longspine thornyhead, sablefish, chilipepper and Pacific hake. For all depth strata combined, Dover sole had the highest catch rate in the Columbia, Eureka, and Conception INPFC area and the second highest rates in the Monterey INPFC areas. Within depth strata for all INPFC areas combined, Dover sole catch rate ranked first at middepths (184–549 m) and second in the deep (550–1,280 m) depth stratum, and third in the shallow (55–182 m) depth stratum (Table 11).

Longspine thornyhead had the second highest catch rate for all INPFC areas combined and the second highest catch rate in the Eureka and Columbia INPFC areas (Table 10). Within depth strata for all INPFC areas combined, longspine thornyhead ranked first in the deepest depth (550–1,280 m) stratum (Table 11). Sablefish catch rate ranked third in the Columbia, Eureka, and Conception INPFC areas for all depth strata combined and exhibited the third highest catch rate for all INPFC areas combined (Table 10). Sablefish was the fifth most abundant species in the middepth (184–549 m) stratum and third most abundant in the deep (550–1,280 m) stratum when all INPFC areas were combined. Chilipepper ranked fourth overall and was the most frequently caught species in the Monterey INPFC area (Table 10). When all INPFC areas combined were separated into depth strata, chilipepper had the second highest catch rate in the shallow stratum and Pacific hake had the highest catch rate in the shallow stratum (Table 11).

Catch rates varied with depth stratum for individual INPFC areas (Tables 12–16). Within individual INPFC areas, the dominance of Dover sole in the catch tended to decline in the southern portion of the survey (Tables 12–16). In the shallow stratum, spiny dogfish had the highest catch rates in the U.S.-Vancouver INPFC area, while Pacific hake was the predominant species in the shallow strata in the Columbia and Eureka INPFC areas (Tables 14–16). Halfbanded rockfish were most abundant in the shallow stratum in the Conception INPFC area while chilipepper were highest in the Monterey INPFC area (Tables 12–13). Dover sole was the dominant species in the middepth stratum in the Eureka, Columbia, and U.S.-Vancouver INPFC areas while splitnose rockfish and shortbelly rockfish were most abundant at middepths in the Conception and Monterey INPFC areas. Longspine thornyhead catch rates were highest in the deep stratum in all INPFC areas except Monterey, where it was the second most abundant

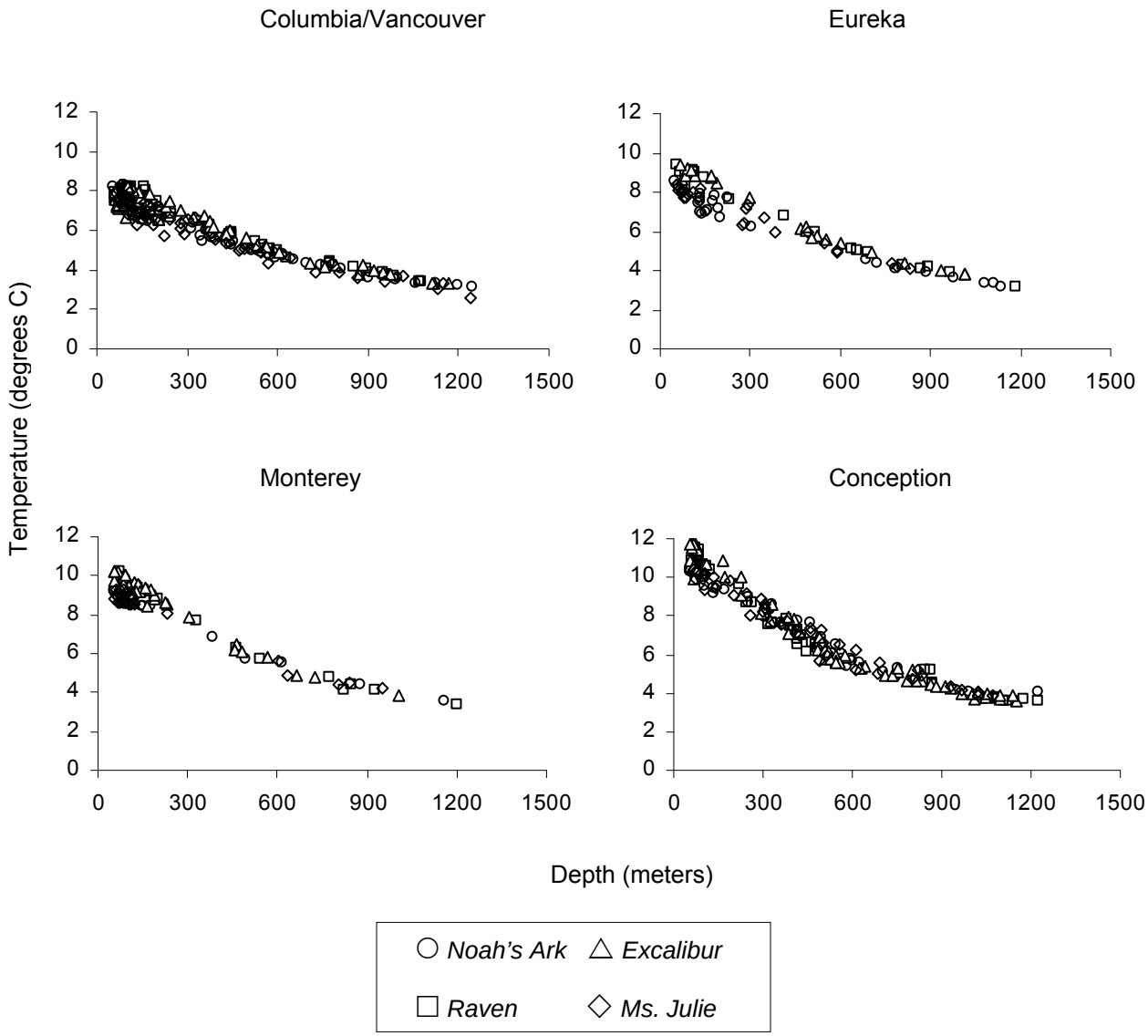

Figure 5. Near bottom temperature observed at the mouth of the net for each tow conducted during the 2005 West Coast groundfish trawl survey. Observations are grouped by INPFC area and plotted relative to haul depth.

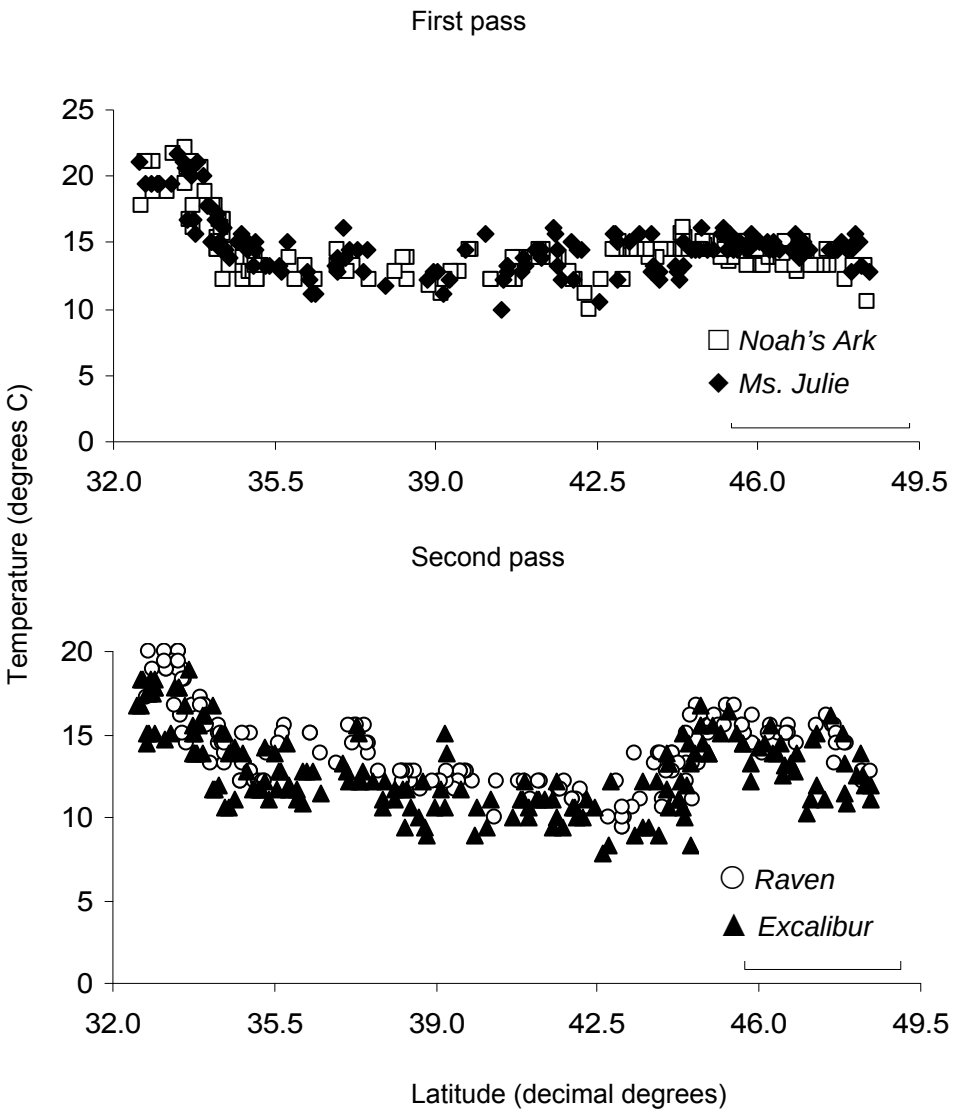

Figure 6. Sea surface temperature observed at the start of each tow during the 2005 NWFSC West Coast groundfish trawl survey. Observations are grouped by date (first pass from 30 May 2005 to 24 July 2005; second pass from 22 August 2005 to 17 October 2005), and plotted relative to latitude.

Table 10. Mean CPUE (kg/ha) of 20 most abundant groundfish and selected crab species caught in INPFC areas for strata 55–1,280 m combined during 2005 West Coast groundfish trawl survey.

All areas **Number of hauls = 675**		**U.S.-Vancouver area** **Number of hauls = 43**		**Columbia area** **Number of hauls = 223**	
Dover sole	21.29	Spiny dogfish	43.60	Dover sole	22.90
Longspine thornyhead	10.99	Arrowtooth flounder	32.54	Pacific Hake	14.41
Sablefish	8.35	Dover sole	30.96	Sablefish	8.39
Chilipepper rockfish	8.06	Yellowtail rockfish	12.18	Longspine thornyhead	6.91
Pacific hake	7.62	Sablefish	10.57	Rex sole	6.40
Shortbelly rockfish	5.49	Longspine thornyhead	9.16	Grooved tanner crab	5.97
Spiny dogfish	4.66	Longnose skate	8.83	Dungeness crab	5.83
Grooved tanner crab	4.00	Pacific ocean perch	5.58	Pacific sanddab	5.52
Shortspine thornyhead	3.98	Spotted ratfish	5.20	Darkblotched rockfish	5.20
Longnose skate	3.73	Greenstriped rockfish	4.55	Arrowtooth flounder	5.13
Rex sole	3.72	Rex sole	4.44	Longnose skate	4.88
Arrowtooth flounder	3.25	Splitnose rockfish	3.99	Giant grenadier	4.22
Splitnose rockfish	3.07	Grooved tanner crab	3.59	Shortspine thornyhead	3.79
Pacific sanddab	2.79	Giant grenadier	2.93	Sharpchin rockfish	3.19
Dungeness crab	2.55	Shortspine thornyhead	2.27	Greenstriped rockfish	2.88
Pacific grenadier	2.54	English sole	2.26	Pacific grenadier	2.87
Stripetail rockfish	2.42	Bering skate	1.93	English sole	2.77
English sole	2.40	Pacific halibut	1.90	Pacific ocean perch	2.71
California slickhead	2.13	Flathead sole	1.81	Yellowtail rockfish	2.69
Giant grenadier	2.08	Pacific cod	1.60	Petrale sole	2.20

Eureka area **Number of hauls = 89**		**Monterey area** **Number of hauls = 119**		**Conception area** **Number of hauls = 201**	
Dover sole	42.26	Chilipepper rockfish	46.95	Dover sole	11.92
Longspine thornyhead	25.19	Dover sole	30.54	Longspine thornyhead	9.67
Sablefish	13.49	Shortbelly rockfish	29.85	Sablefish	6.64
Pacific hake	12.81	Pacific hake	14.08	Shortspine thornyhead	4.61
Rex sole	10.62	Longspine thornyhead	13.50	California slickhead	3.62
Lingcod	9.64	Stripetail rockfish	10.99	Halfbanded rockfish	3.62
Dungeness crab	7.52	Spiny dogfish	10.07	Splitnose rockfish	3.10
Spotted ratfish	7.47	Sablefish	9.52	Spotted ratfish	2.05
Grooved tanner crab	7.23	Grooved tanner crab	7.37	Shortbelly rockfish	1.93
Splitnose rockfish	6.17	Pacific grenadier	6.15	Longnose skate	1.89
Sharpchin rockfish	5.82	Petrale sole	5.65	Pacific hake	1.54
Longnose skate	5.52	Pacific sanddab	4.66	Pacific grenadier	1.22
English sole	5.38	English sole	4.54	Grooved tanner crab	1.21
Stripetail rockfish	5.34	Longnose skate	4.51	Rex sole	1.06
Chilipepper rockfish	4.44	Shortspine thornyhead	3.08	Brown cat shark	0.92
Shortspine thornyhead	3.87	Rex sole	3.04	Chilipepper rockfish	0.86
Canary rockfish	3.83	Dungeness crab	2.46	Pacific sanddab	0.79
Pacific sanddab	3.60	Splitnose rockfish	2.24	Filetail cat shark	0.75
Petrale sole	2.60	California slickhead	2.11	Aurora rockfish	0.68
Spinydogfish	2.56	Lingcod	1.89	Giant grenadier	0.50

Table 11. Mean CPUE (kg/ha) of 20 most abundant groundfish and selected crab species caught by depth strata in all INPFC areas combined during the 2005 West Coast groundfish trawl survey.

Stratum 1 (55–183 m)		Stratum 2 (184–549 m)		Stratum 3 (550–1,280 m)	
Pacific hake	21.11	Dover sole	34.78	Longspine thornyhead	20.81
Chilipepper rockfish	19.91	Shortbelly rockfish	18.88	Dover sole	19.01
Dover sole	14.50	Splitnose rockfish	13.59	Sablefish	10.30
Spiny dogfish	13.46	Chilipepper rockfish	12.25	Grooved tanner crab	7.74
Pacific sanddab	10.38	Sablefish	11.63	Shortspine thornyhead	5.32
Dungeness crab	8.99	Longnose skate	9.20	Pacific grenadier	4.75
English sole	7.48	Pacific hake	8.45	California slickhead	4.07
Rex sole	6.48	Rex sole	8.16	Giant grenadier	3.19
Halfbanded rockfish	6.33	Stripetail rockfish	7.38	Brown cat shark	1.46
Arrowtooth flounder	6.17	Arrowtooth flounder	7.16	Deepsea sole	1.10
Petrale sole	6.07	Darkblotched rockfish	5.76	Longnose skate	0.78
Spotted ratfish	5.37	Shortspine thornyhead	5.65	Roughtail skate	0.76
Yellowtail rockfish	4.95	Spotted ratfish	4.83	Pacific flatnose	0.55
Shortbelly rockfish	4.87	Spiny dogfish	4.73	Twoline eelpout	0.51
Longnose skate	4.85	Pacific ocean perch	4.11	Rex sole	0.34
Lingcod	3.34	Sharpchin rockfish	3.85	Filetail cat shark	0.34
Greenstriped rockfish	3.02	Lingcod	3.35	Aurora rockfish	0.19
Big skate	2.84	Greenstriped rockfish	1.76	Snakehead eelpout	0.19
Stripetail rockfish	2.84	Longspine thornyhead	1.71	Pacific hake	0.16
Sablefish	1.95	Bering skate	1.48	Deepsea skate	0.16
Number of hauls	**310**	**Number of hauls**	**184**	**Number of hauls**	**181**

Table 12. Mean CPUE (kg/ha) of 20 most abundant groundfish and selected crab species caught by depth strata in the Conception INPFC area during the 2005 West Coast groundfish trawl survey.

Stratum 1 (55–183 m)		Stratum 2 (184–549 m)		Stratum 3 (550–1,280 m)	
Halfbanded rockfish	31.99	Splitnose rockfish	14.94	Longspine thornyhead	13.51
Spotted ratfish	15.23	Dover sole	14.23	Dover sole	13.18
Pacific sanddab	7.01	Shortbelly rockfish	8.17	Sablefish	7.53
Pacific butterfish	3.45	Sablefish	7.31	Shortspine thornyhead	5.54
White croaker	2.95	Pacific hake	6.61	California slickhead	5.33
English sole	2.68	Longnose skate	6.48	Pacific grenadier	1.79
Spiny dogfish	2.62	Rex sole	5.04	Grooved tanner crab	1.73
Pink sea perch	2.62	Shortspine thornyhead	4.09	Brown cat shark	1.21
Canary rockfish	2.08	Chilipepper rockfish	3.13	Longnose skate	0.78
Shortbelly rockfish	2.08	Aurora rockfish	2.50	Giant grenadier	0.74
Squarespot rockfish	1.94	Longspine thornyhead	2.38	Roughtail skate	0.54
Chilipepper rockfish	1.89	Blackgill rockfish	2.08	Filetail cat shark	0.50
California scorpionfish	1.47	Filetail cat shark	1.94	Deepsea sole	0.37
Bat ray	1.28	Stripetail rockfish	1.67	Twoline eelpout	0.37
Rosethorn rockfish	1.25	Slender sole	1.34	Pacific flatnose	0.36
California halibut	1.19	Spotted ratfish	1.18	Aurora rockfish	0.23
Pygmy rockfish	1.05	Rosethorn rockfish	0.93	Deepsea skate	0.21
Northern anchovy	1.03	Bering skate	0.81	Threadfin slickhead	0.16
Big skate	0.89	Bigfin eelpout	0.61	Pacific hake	0.14
Stripetail rockfish	0.80	Spiny dogfish	0.54	Smooth grenadier	0.14
Number of hauls	**54**	**Number of hauls**	**75**	**Number of hauls**	**72**

Table 13. Mean CPUE (kg/ha) of 20 most abundant groundfish and selected crab species caught by depth strata in the Monterey INPFC area during the 2005 West Coast groundfish trawl survey.

Stratum 1 (55–183 m)		Stratum 2 (184–549 m)		Stratum 3 (550–1,280 m)	
Chilipepper rockfish	78.13	Shortbelly rockfish	126.40	Dover sole	52.51
Pacific hake	27.42	Chilipepper rockfish	84.65	Longspine thornyhead	32.41
Shortbelly rockfish	18.90	Stripetail rockfish	52.94	Grooved tanner crab	17.78
Spiny dogfish	13.89	Dover sole	38.45	Sablefish	16.71
Petrale sole	12.49	Spiny dogfish	24.81	Pacific grenadier	14.87
Pacific sanddab	11.25	Pacific hake	15.85	Shortspine thornyhead	6.60
English sole	9.80	Splitnose rockfish	12.83	California slickhead	5.09
Longnose skate	6.20	Rex sole	9.61	Deepsea sole	2.52
Dungeness crab	5.63	Sablefish	9.51	Brown cat shark	2.05
Dover sole	5.11	Longnose skate	7.84	Giant grenadier	1.62
Stripetail rockfish	4.24	Bocaccio rockfish	6.89	Longnose skate	1.44
Lingcod	3.71	Petrale sole	2.90	Pacific flatnose	1.20
Spotted ratfish	3.49	English sole	2.90	Roughtail skate	1.06
Rex sole	3.30	Spotted ratfish	2.25	Twoline eelpout	0.43
Big skate	2.91	Lingcod	2.10	Aurora rockfish	0.38
Sablefish	2.29	Shortspine thornyhead	1.96	Snakehead eelpout	0.35
California skate	1.90	Greenstriped rockfish	1.72	Filetail cat shark	0.30
Jack mackerel	1.72	Bering skate	1.29	Deepsea smelt unident.	0.18
White croaker	1.66	Bigfin eelpout	1.21	Deepsea skate	0.10
Greenstriped rockfish	1.21	Brown cat shark	1.08	Cat shark unident.	0.09
Number of hauls	**78**	**Number of hauls**	**21**	**Number of hauls**	**20**

Table 14. Mean CPUE (kg/ha) of 20 most abundant groundfish and selected crab species caught by depth strata in the Eureka INPFC area during the 2005 West Coast groundfish trawl survey.

Stratum 1 (55–183 m)		Stratum 2 (184–549 m)		Stratum 3 (550–1,280 m)	
Pacific hake	29.82	Dover sole	117.87	Longspine thornyhead	48.90
Dungeness crab	21.93	Spotted ratfish	42.56	Dover sole	32.92
Dover sole	19.09	Lingcod	39.68	Sablefish	17.91
English sole	16.22	Splitnose rockfish	37.50	Grooved tanner crab	14.17
Stripetail rockfish	14.78	Sharpchin rockfish	35.65	Shortspine thornyhead	5.56
Rex sole	11.93	Rex sole	30.23	Rex sole	3.52
Pacific sanddab	11.02	Canary rockfish	20.56	Brown cat shark	3.36
Lingcod	9.72	Sablefish	18.16	Pacific grenadier	3.03
Chilipepper rockfish	9.12	Longnose skate	18.07	Giant grenadier	2.41
Petrale sole	7.92	Pacific hake	17.70	Deepsea sole	2.30
Longnose skate	6.32	Chilipepper rockfish	8.95	Roughtail skate	1.10
Spiny dogfish	5.92	Darkblotched rockfish	6.65	Longnose skate	1.00
Big skate	4.74	Shortspine thornyhead	6.27	Snakehead eelpout	0.74
Sablefish	4.24	Arrowtooth flounder	5.87	California slickhead	0.70
Arrowtooth flounder	4.00	Spiny dogfish	3.85	Bigfin eelpout	0.45
Greenstriped rockfish	2.98	Stripetail rockfish	3.14	Pacific flatnose	0.42
Slender sole	2.38	Bigfin eelpout	2.04	Black eelpout	0.39
Yellowtail rockfish	1.71	Dungeness crab	2.04	Twoline eelpout	0.38
Spotted ratfish	1.61	Greenstriped rockfish	2.01	Pacific hake	0.38
Canary rockfish	1.46	Bering skate	2.00	Hagfish unident.	0.19
Number of hauls	**38**	**Number of hauls**	**23**	**Number of hauls**	**28**

Table 15. Mean CPUE (kg/ha) of 20 most abundant groundfish and selected crab species caught by depth strata in the Columbia INPFC area during the 2005 West Coast groundfish trawl survey.

Stratum 1 (55–183 m)		Stratum 2 (184–549 m)		Stratum 3 (550–1,280 m)	
Pacific hake	27.23	Dover sole	34.24	Longspine thornyhead	21.55
Dover sole	25.01	Darkblotched rockfish	17.76	Grooved tanner crab	19.59
Pacific sanddab	12.58	Sablefish	14.04	Giant grenadier	14.12
Dungeness crab	12.58	Shortspine thornyhead	9.76	Sablefish	12.81
Rex sole	10.05	Longnose skate	9.57	Dover sole	9.82
Arrowtooth flounder	7.94	Pacific ocean perch	9.39	Pacific grenadier	9.59
English sole	6.15	Pacific hake	8.26	Shortspine thornyhead	3.94
Yellowtail rockfish	6.07	Rex sole	7.45	Deepsea sole	1.84
Longnose skate	5.28	Splitnose rockfish	7.29	Roughtail skate	1.27
Petrale sole	4.84	Arrowtooth flounder	6.09	Twoline eelpout	1.03
Greenstriped rockfish	4.36	Sharpchin rockfish	4.88	Brown cat shark	0.94
Sharpchin rockfish	4.34	Greenstriped rockfish	3.67	Pacific flatnose	0.90
Big skate	3.62	Rougheye rockfish	3.48	California slickhead	0.87
Lingcod	2.62	Longspine thornyhead	1.84	Ragfish	0.32
Spotted ratfish	2.61	Pacific halibut	1.48	Snakehead eelpout	0.23
Spiny dogfish	2.36	Bering skate	1.39	Pacific hake	0.22
Sablefish	2.01	Spotted ratfish	1.24	Longnose skate	0.18
Slender sole	1.63	Bigfin eelpout	1.24	Arrowtooth flounder	0.14
Darkblotched rockfish	1.23	Dungeness crab	1.17	Deepsea skate	0.13
Pacific halibut	0.74	Slender sole	0.82	Black eelpout	0.13
Number of hauls	**119**	**Number of hauls**	**51**	**Number of hauls**	**53**

Table 16. Mean CPUE (kg/ha) of 20 most abundant groundfish and selected crab species caught by depth strata in the U.S.-Vancouver INPFC area during the 2005 West Coast groundfish trawl survey.

Stratum 1 (55–183 m)		Stratum 2 (184–549 m)		Stratum 3 (550–1,280 m)	
Spiny dogfish	126.88	Dover sole	64.93	Longspine thornyhead	29.88
Arrowtooth flounder	40.34	Arrowtooth flounder	52.26	Grooved tanner crab	11.71
Yellowtail rockfish	35.02	Sablefish	21.89	Giant grenadier	9.58
Dover sole	19.42	Longnose skate	15.77	Sablefish	5.12
Greenstriped rockfish	10.06	Pacific ocean perch	14.46	Pacific grenadier	4.79
Longnose skate	8.83	Spiny dogfish	10.87	Deepsea sole	2.50
English sole	6.30	Splitnose rockfish	10.43	Shortspine thornyhead	1.71
Spotted ratfish	6.30	Spotted ratfish	8.47	Twoline eelpout	1.56
Rex sole	5.94	Rex sole	6.77	Brown cat shark	0.80
Pacific halibut	5.36	Bering skate	4.60	Snakehead eelpout	0.74
Lingcod	3.73	Shortspine thornyhead	4.56	Pacific flatnose	0.55
Petrale sole	3.03	Flathead sole	3.80	Roughtail skate	0.30
Pacific hake	2.94	Greenstriped rockfish	3.71	Dover sole	0.23
Pacific cod	2.84	Yellowtail rockfish	3.38	California slickhead	0.15
Pacific sanddab	2.41	Slender sole	2.13	Longnose skate	0.15
Slender sole	2.16	Pacific cod	1.87	Black hagfish	0.15
Sablefish	2.02	Rougheye rockfish	1.38	Pacific ocean perch	0.12
Canary rockfish	1.99	Redstripe rockfish	1.24	Hagfish unident.	0.08
Dungeness crab	1.84	Pacific hake	1.19	Black eelpout	0.07
Flathead sole	1.14	English sole	0.79	Pacific hagfish	0.06
Number of hauls	**21**	**Number of hauls**	**14**	**Number of hauls**	**8**

(Tables 12–16). Dover sole catch rates were highest in the deep stratum in the Monterey INPFC area (Table 13).

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

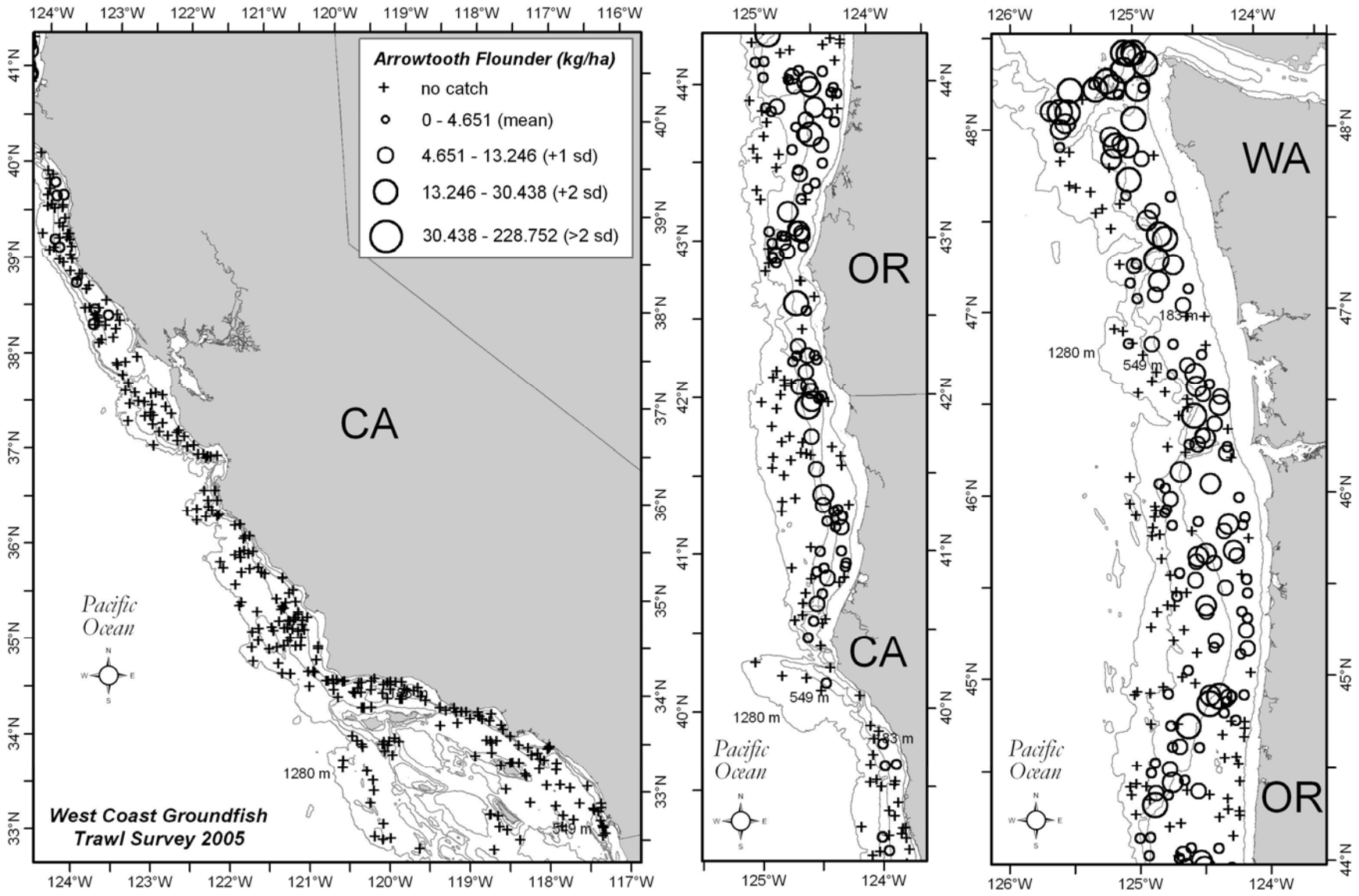

Figure 7. Arrowtooth flounder distribution and relative abundance (kg/ha) from the 2005 West Coast groundfish trawl survey.

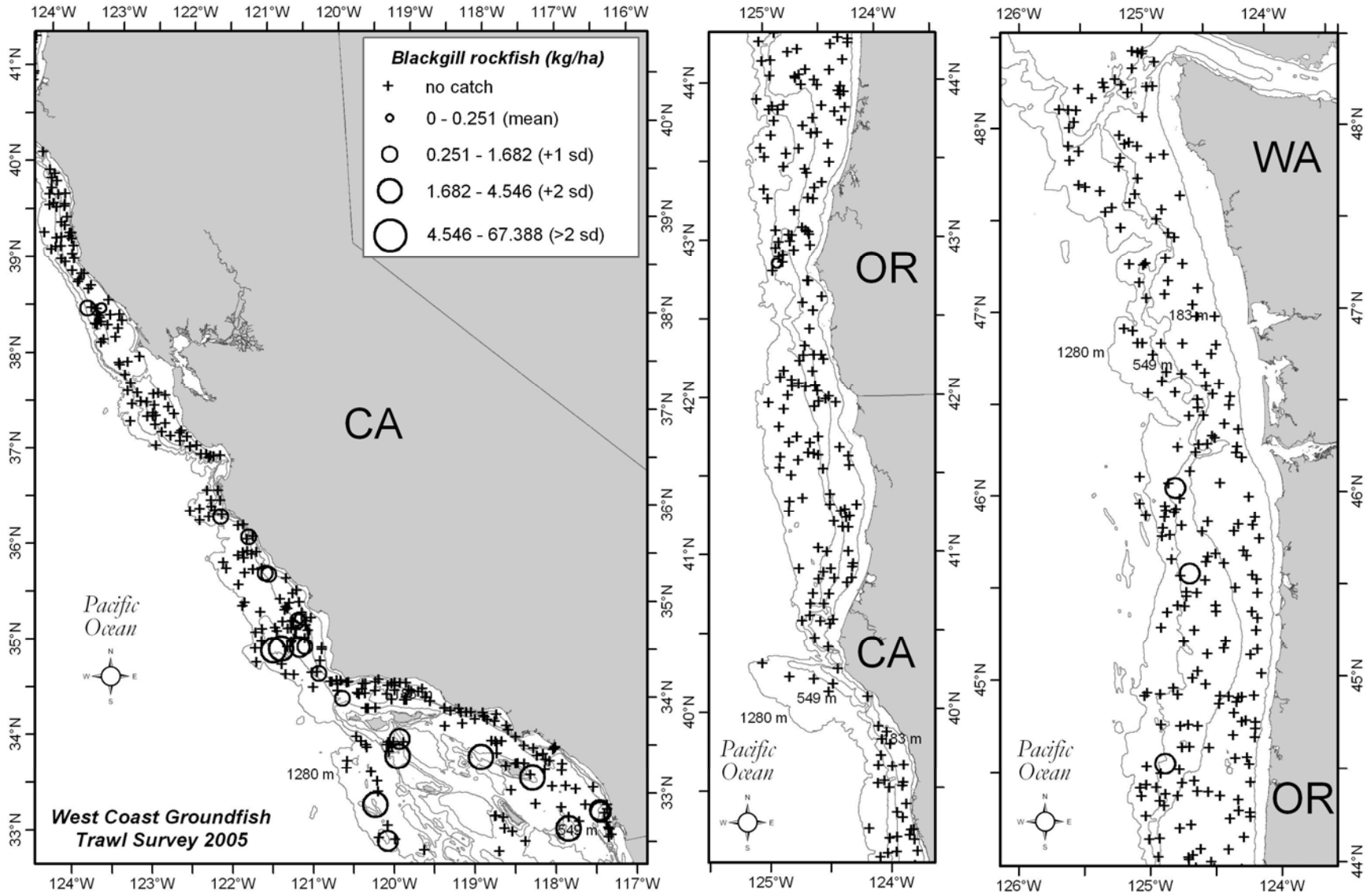

Figure 8. Blackgill rockfish distribution and relative abundance (kg/ha) from the 2005 West Coast groundfish trawl survey.

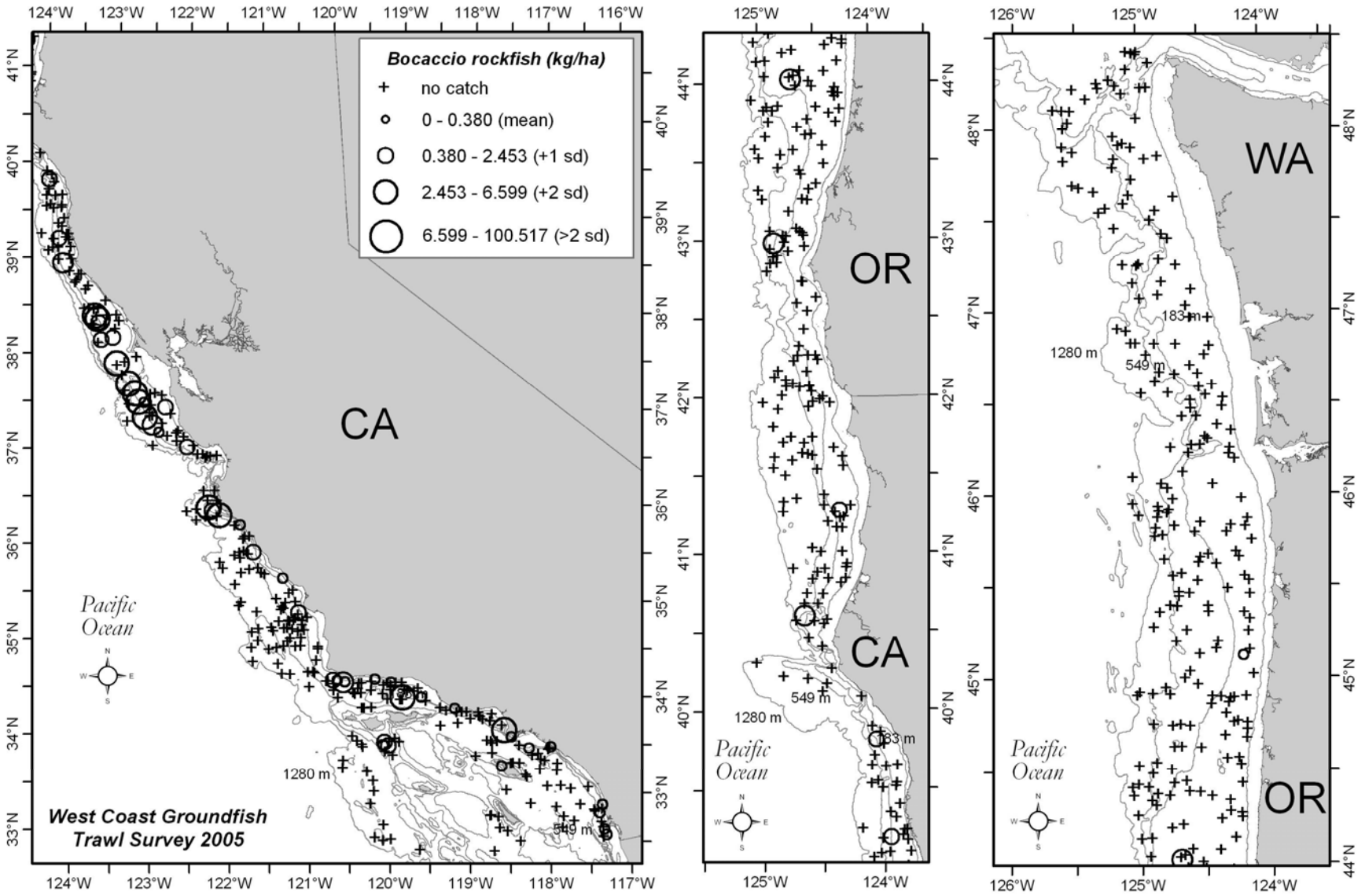

Figure 9. Bocaccio rockfish distribution and relative abundance (kg/ha) from the 2005 West Coast groundfish trawl survey.

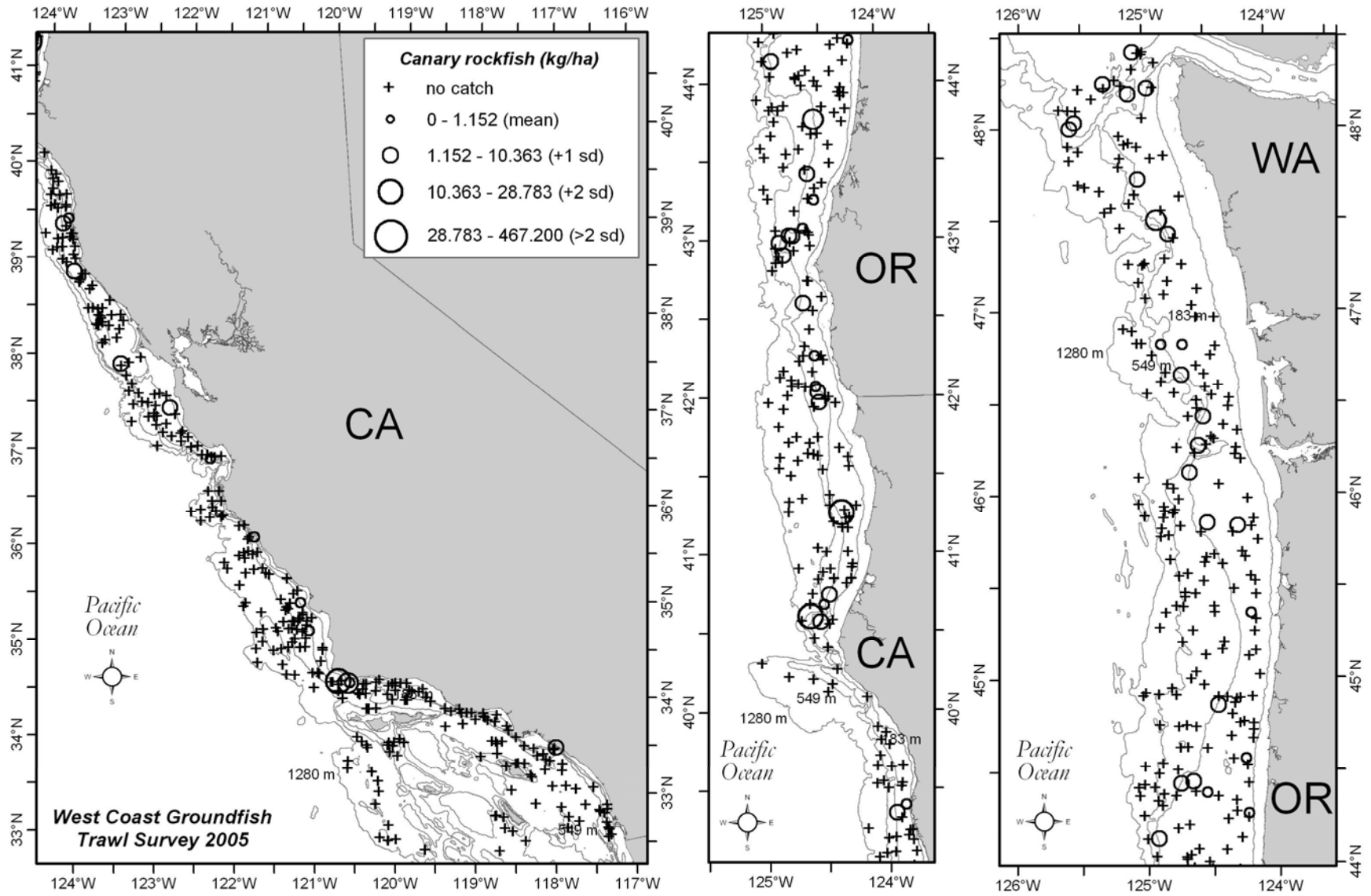

Figure 10. Canary rockfish distribution and relative abundance (kg/ha) from the 2005 West Coast groundfish trawl survey.

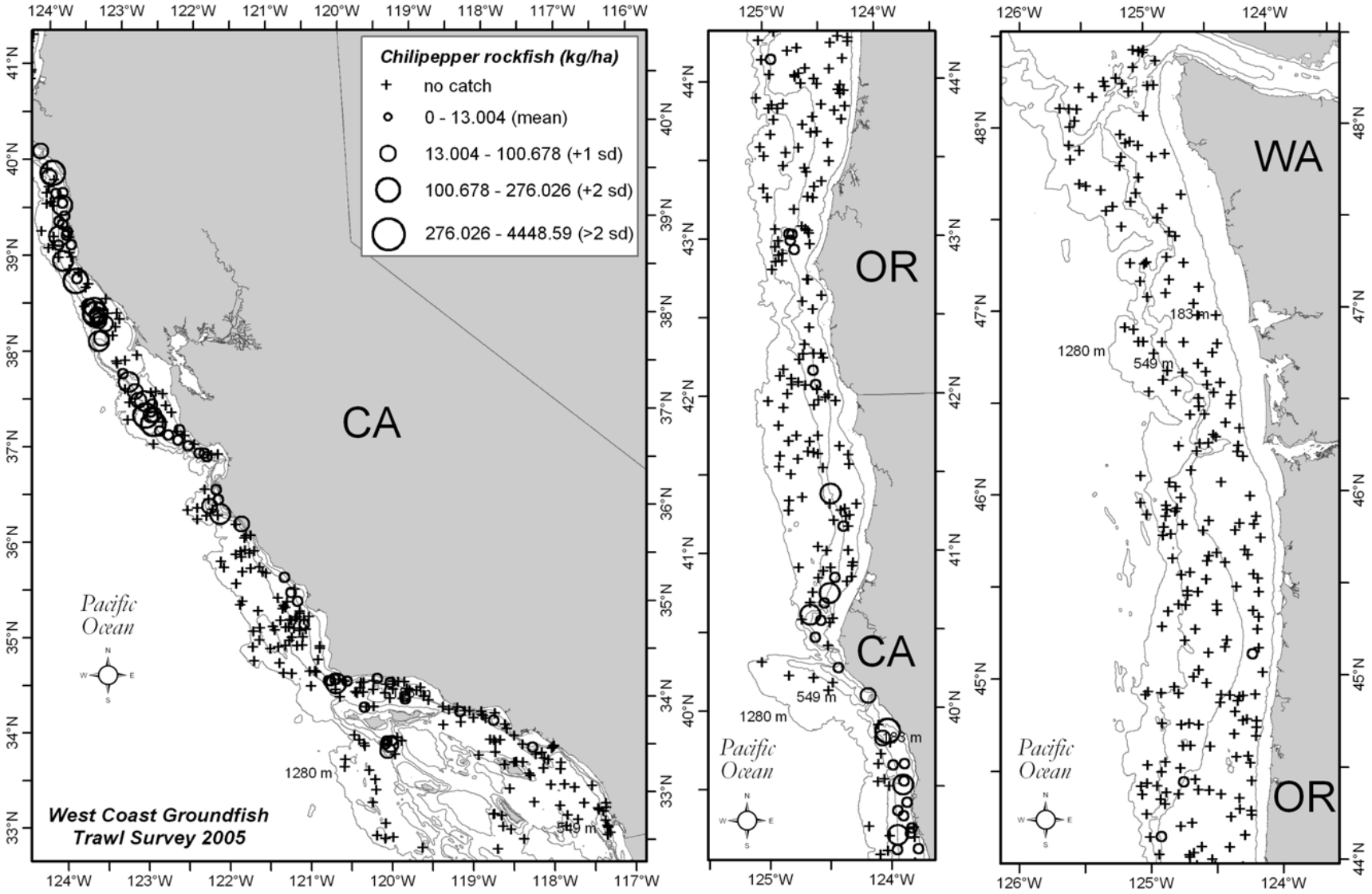

Figure 11. Chilipepper rockfish distribution and relative abundance (kg/ha) from the 2005 West Coast groundfish trawl survey.

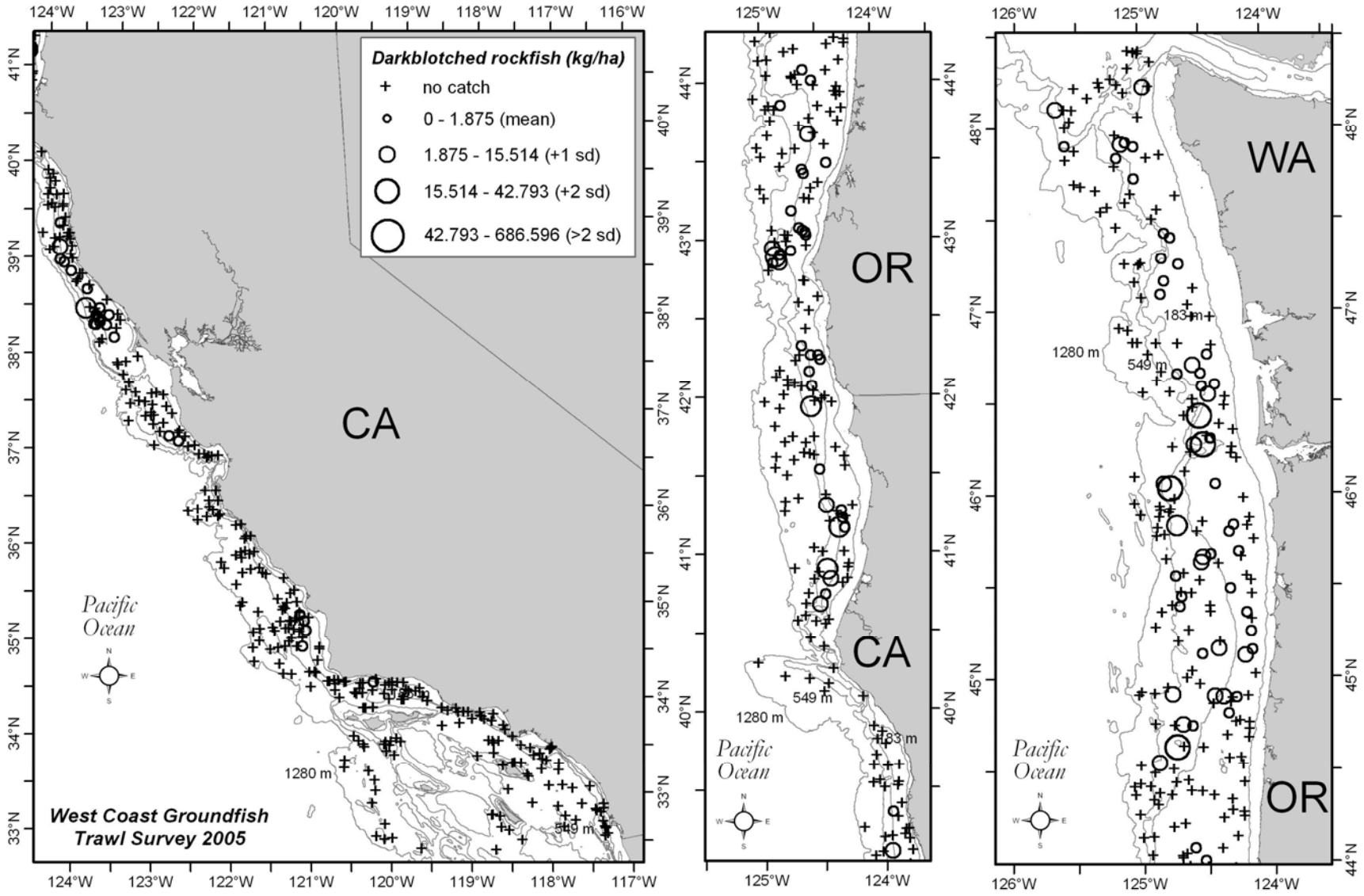

Figure 12. Darkblotched rockfish distribution and relative abundance (kg/ha) from the 2005 West Coast groundfish trawl survey.

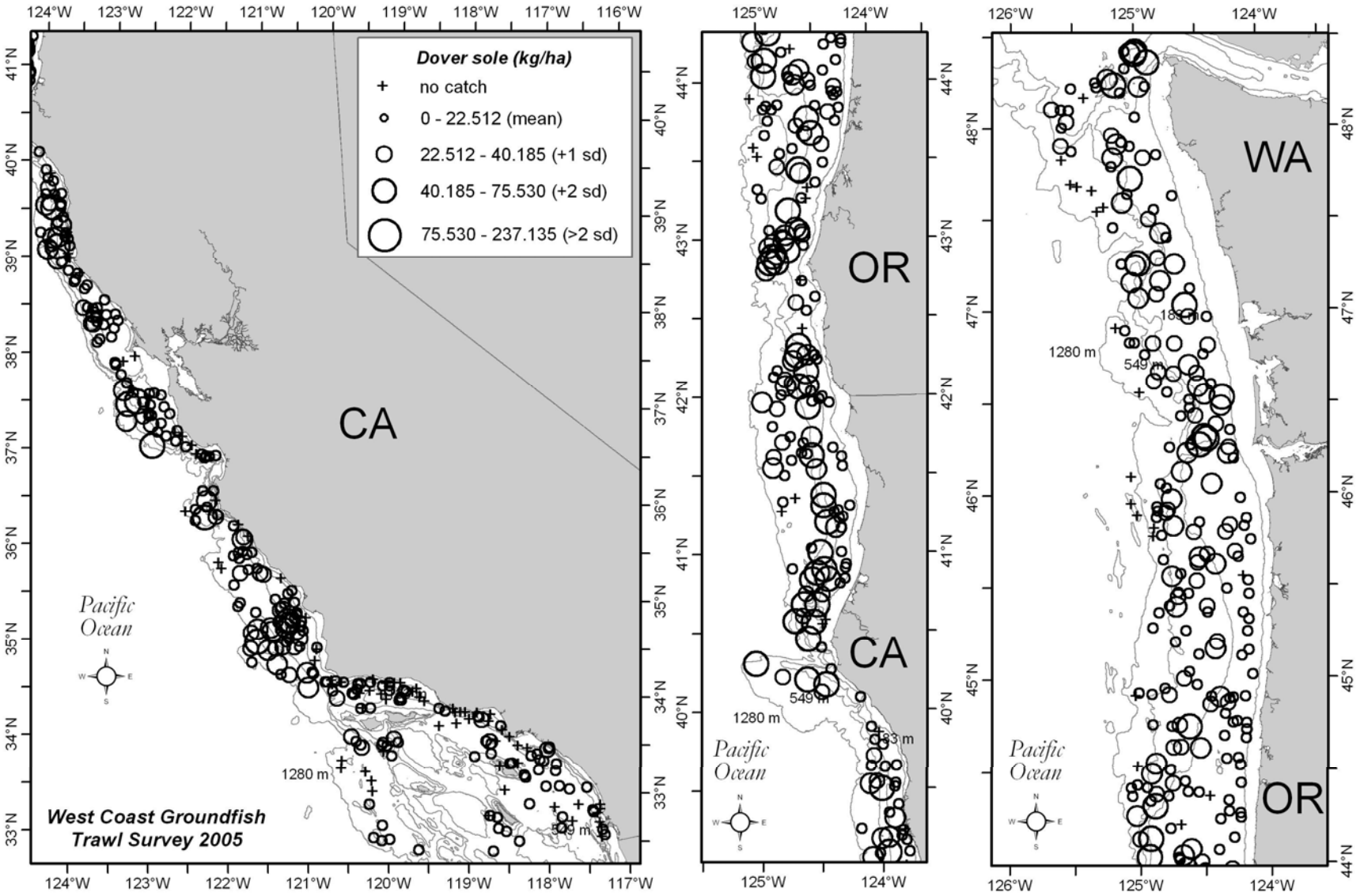

Figure 13. Dover sole distribution and relative abundance (kg/ha) from the 2005 West Coast groundfish trawl survey.

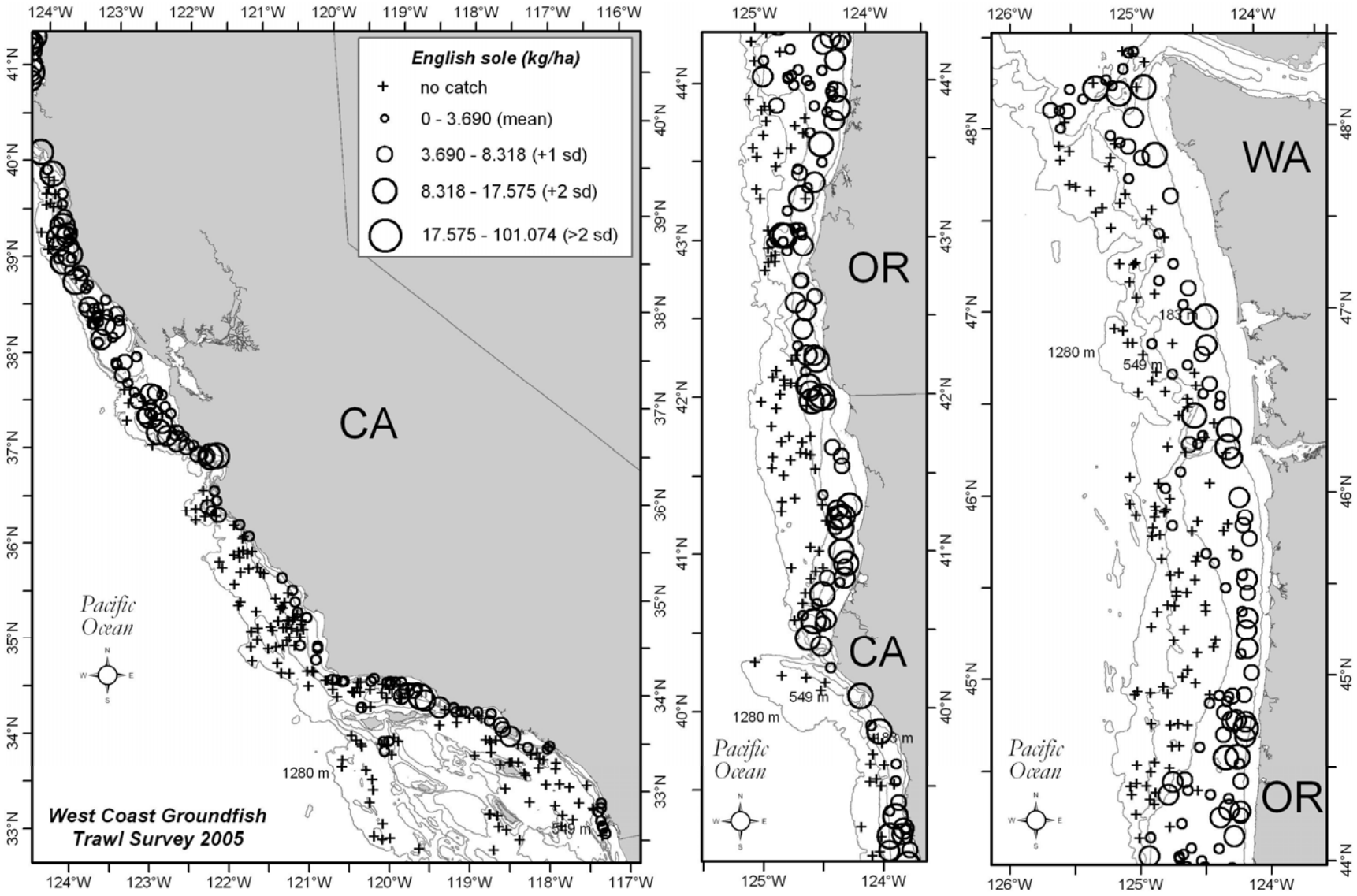

Figure 14. English sole distribution and relative abundance (kg/ha) from the 2005 West Coast groundfish trawl survey.

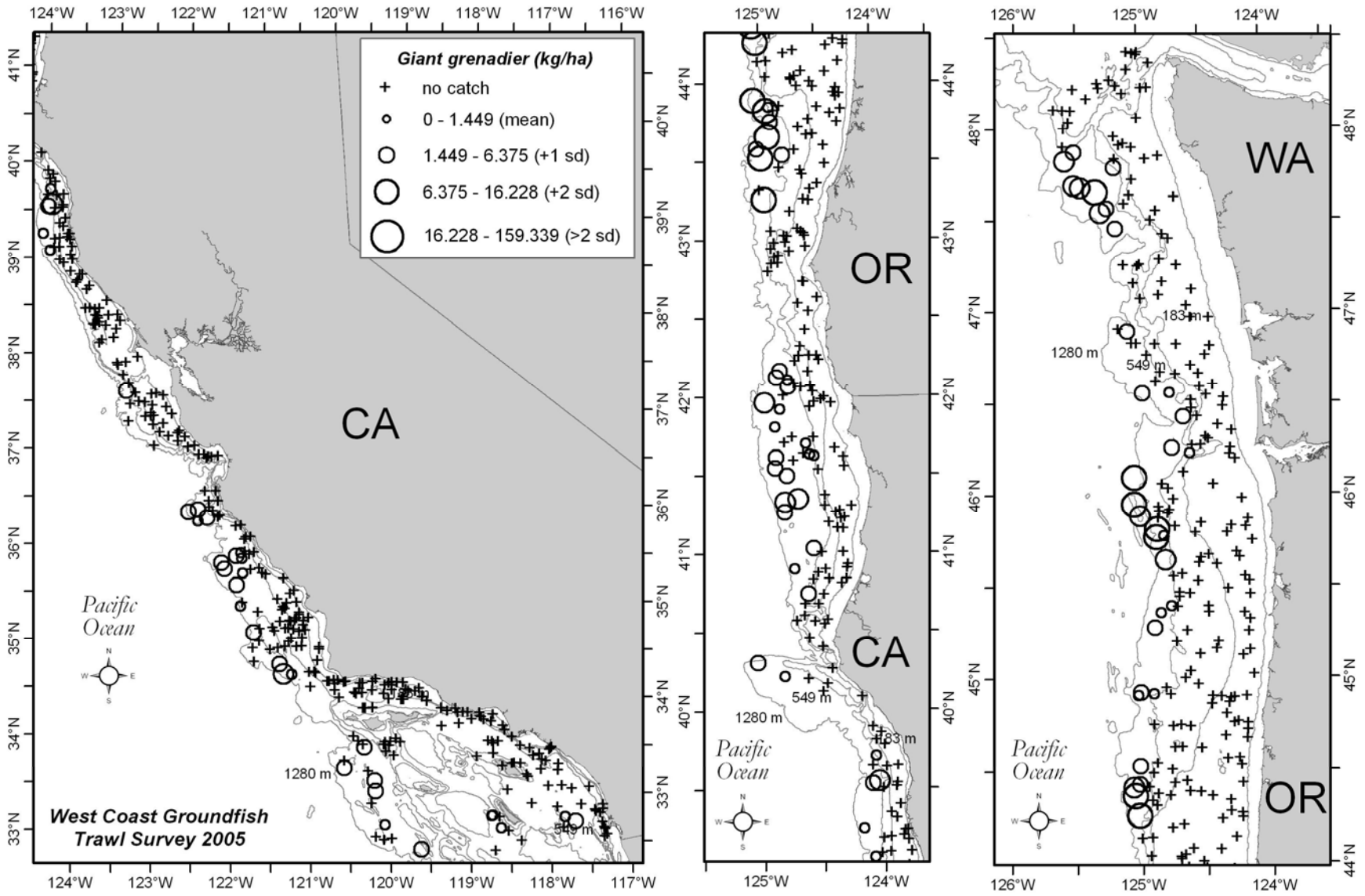

Figure 15. Giant grenadier distribution and relative abundance (kg/ha) from the 2005 West Coast groundfish trawl survey.

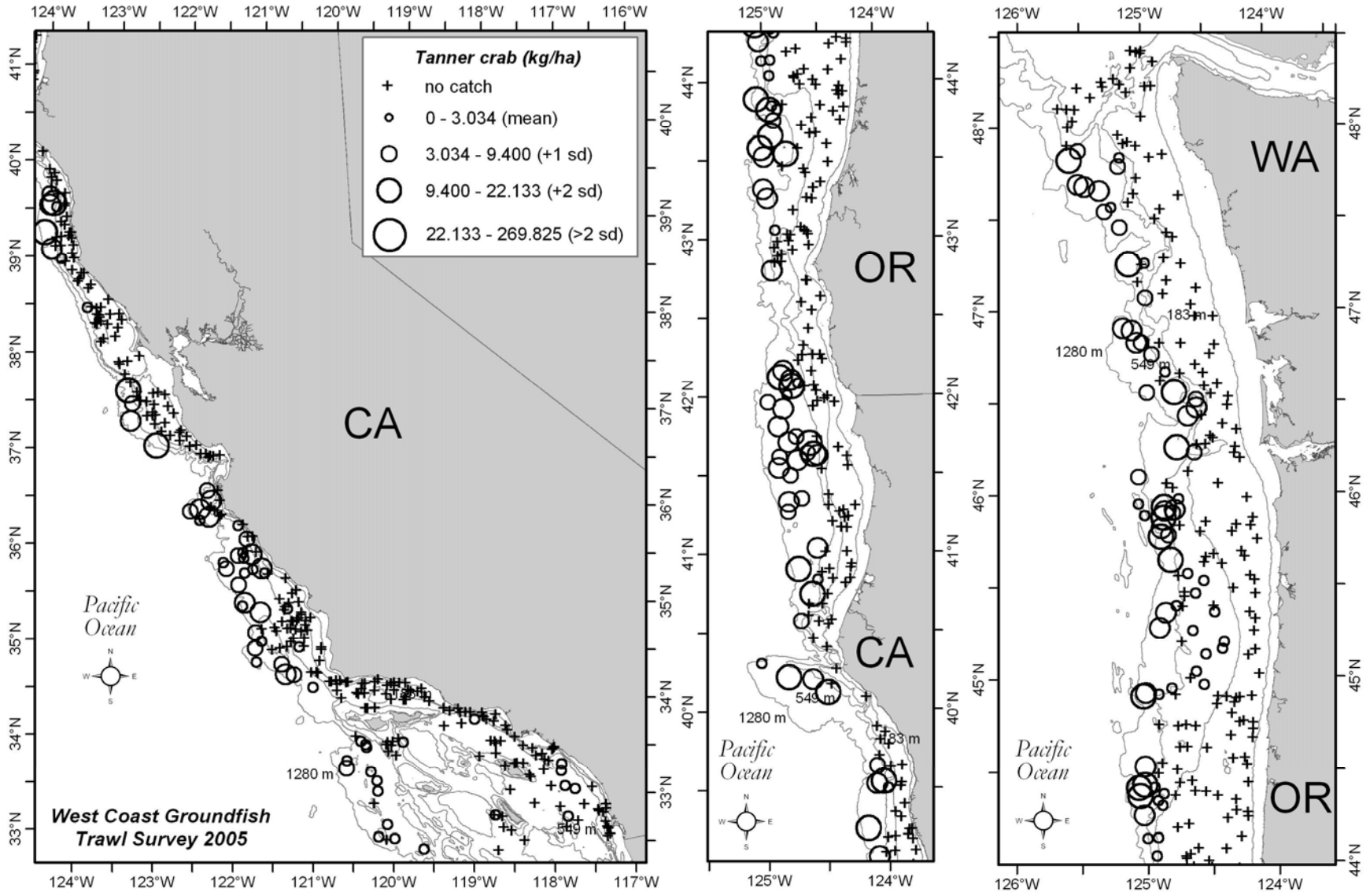

Figure 16. Grooved tanner crab distribution and relative abundance (kg/ha) from the 2005 West Coast groundfish trawl survey.

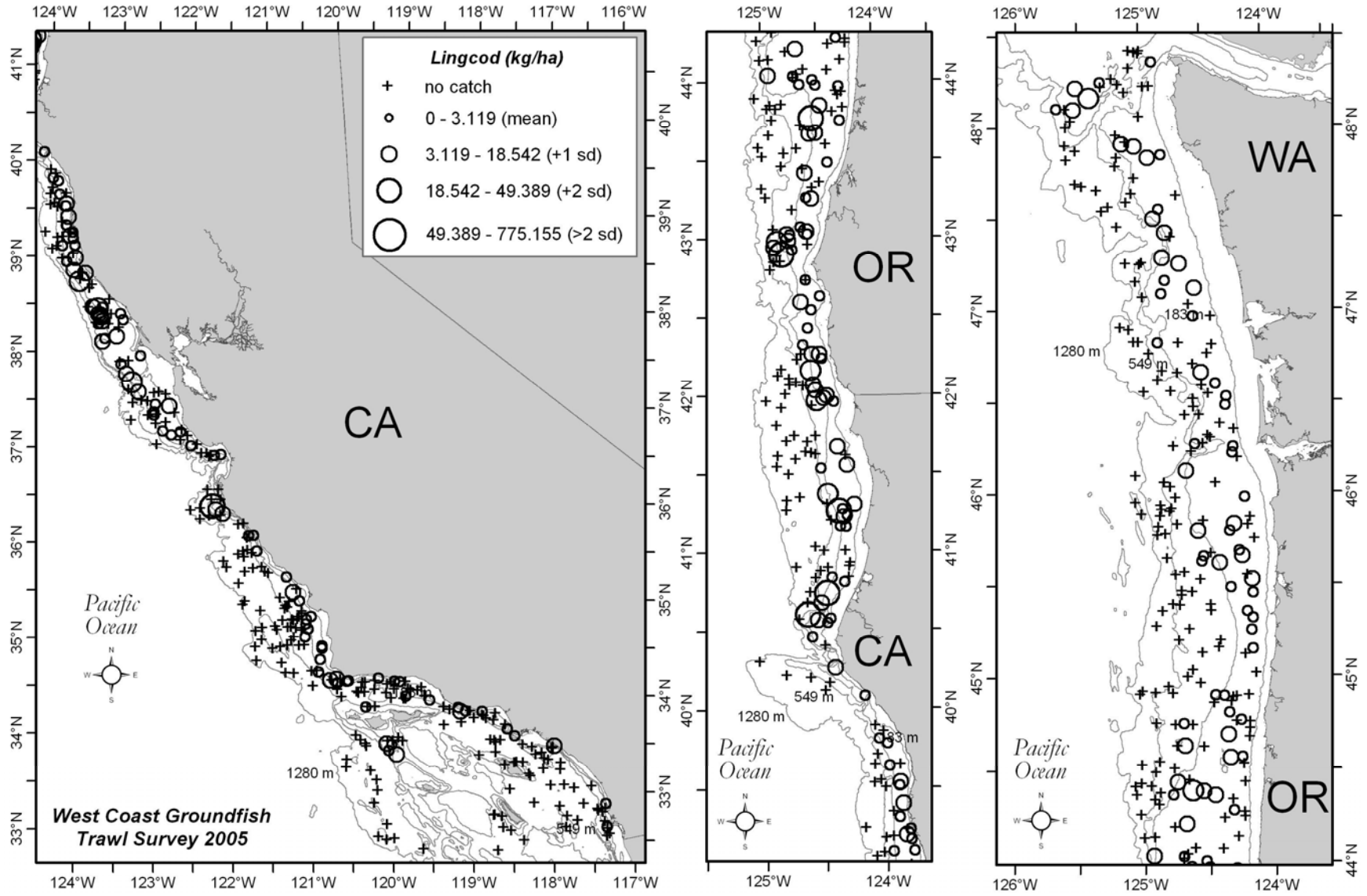

Figure 17. Lingcod distribution and relative abundance (kg/ha) from the 2005 West Coast groundfish trawl survey.

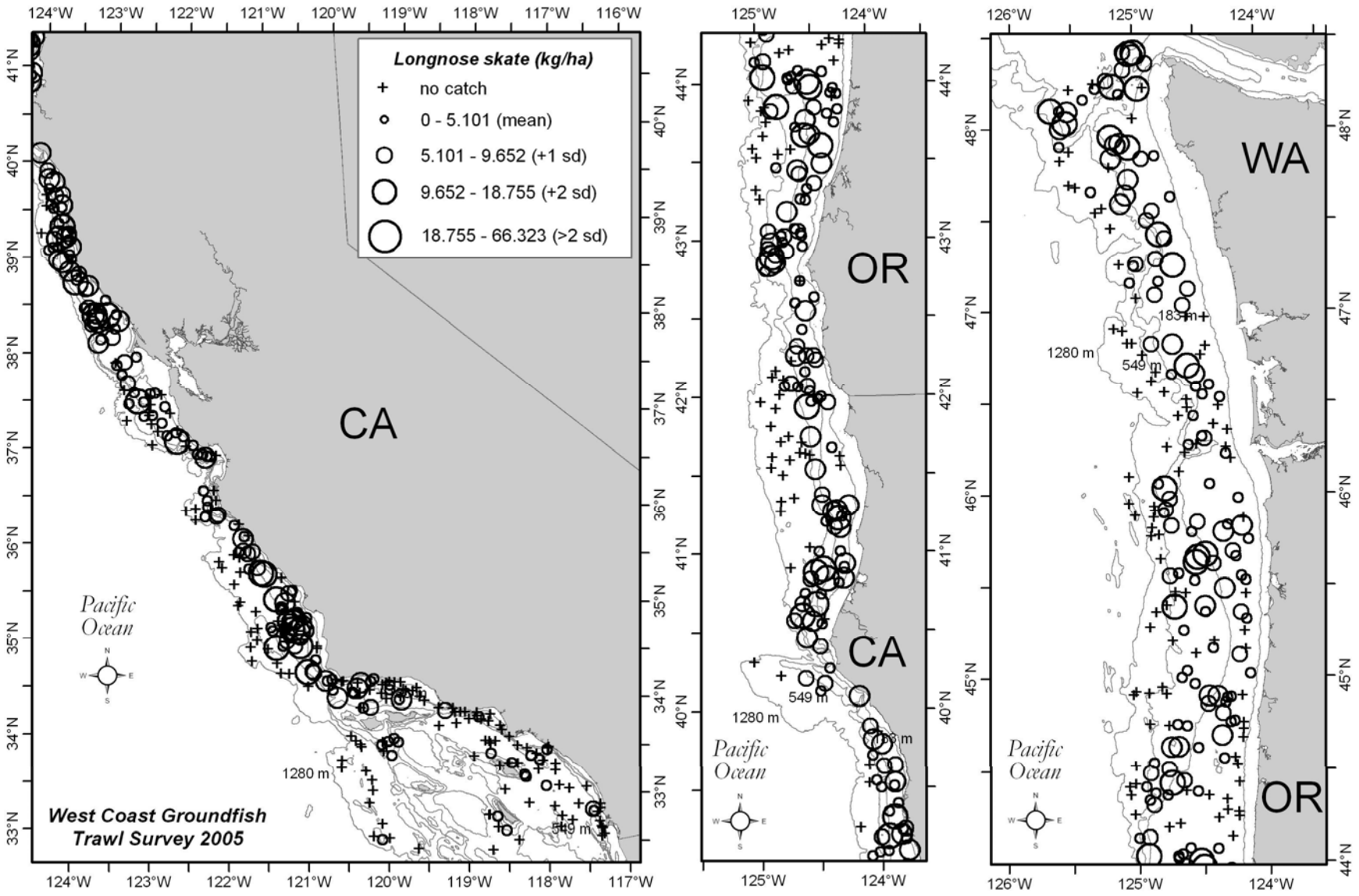

Figure 18. Longnose skate distribution and relative abundance (kg/ha) from the 2005 West Coast groundfish trawl survey.

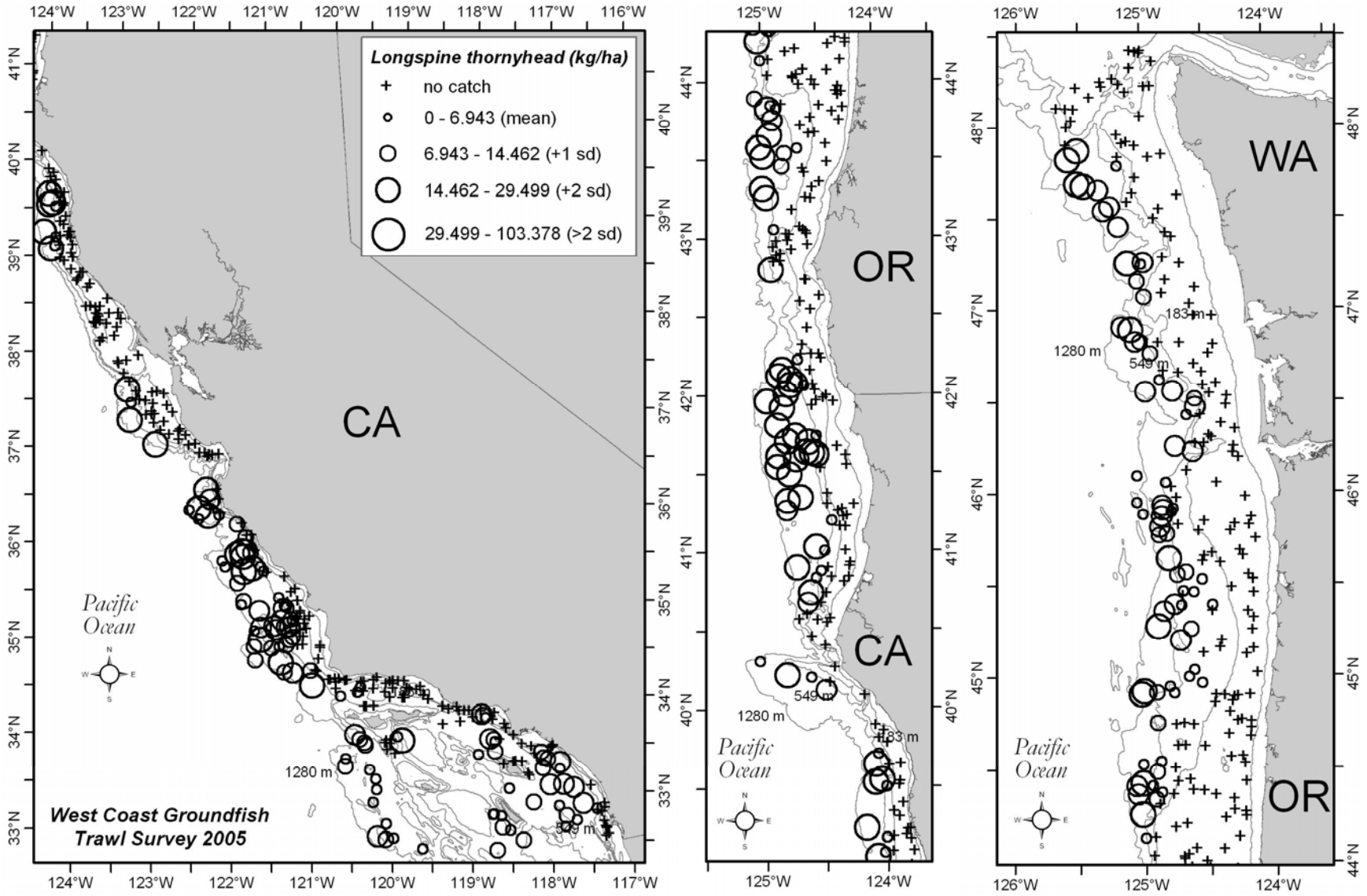

Figure 19. Longspine thornyhead distribution and relative abundance (kg/ha) from the 2005 West Coast groundfish trawl survey.

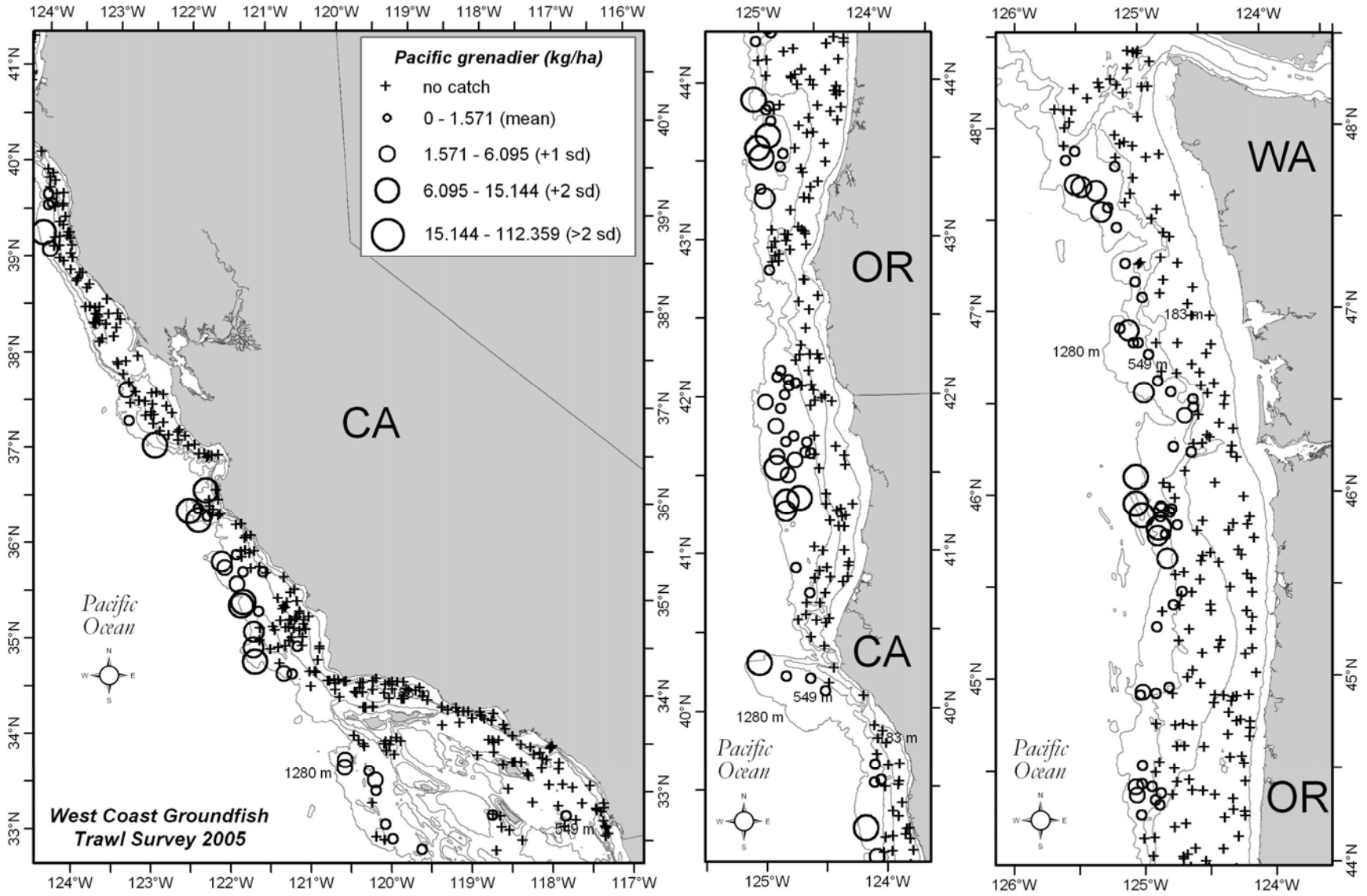

Figure 20. Pacific grenadier distribution and relative abundance (kg/ha) from the 2005 West Coast groundfish trawl survey.

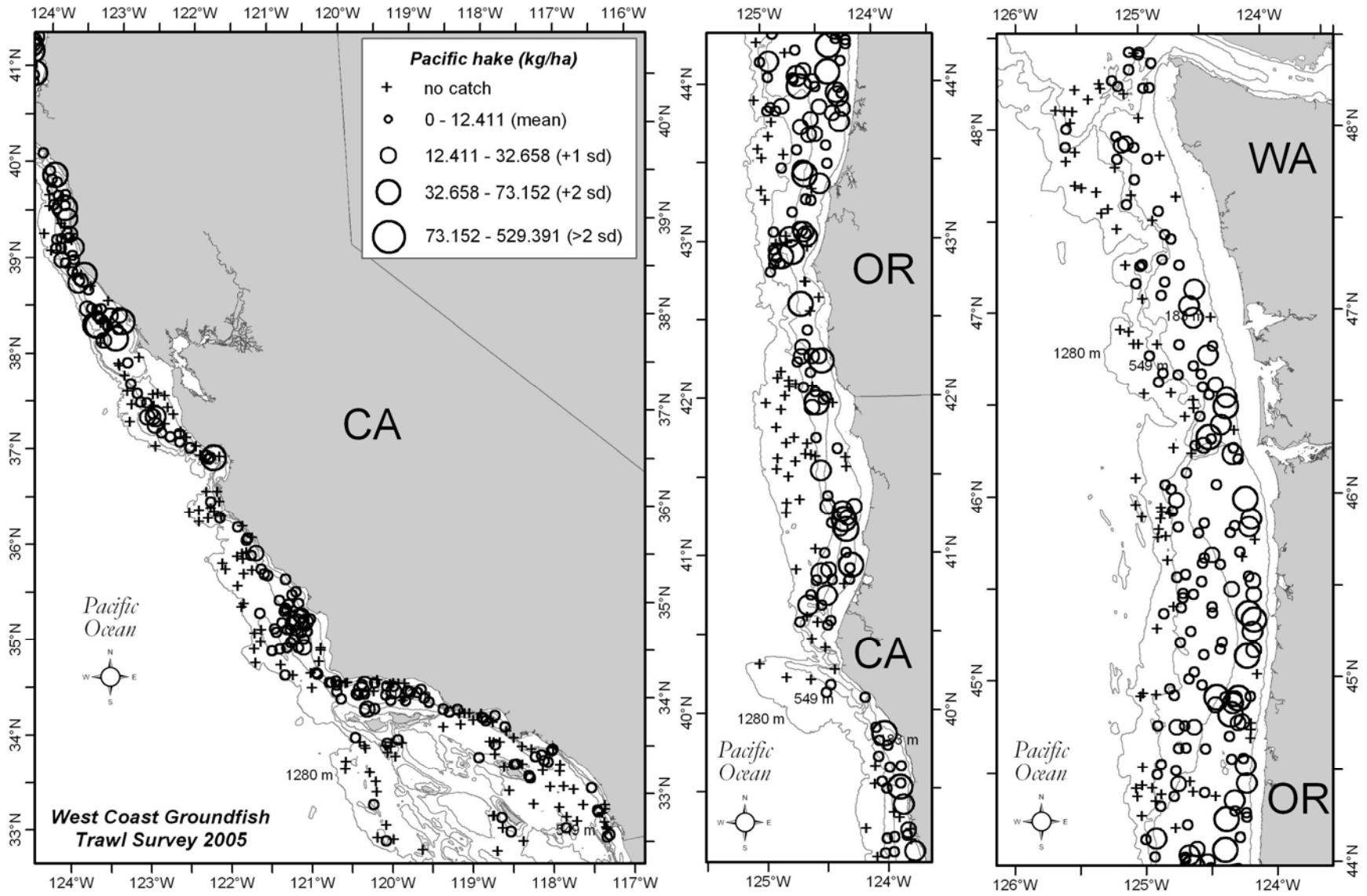

Figure 21. Pacific hake distribution and relative abundance (kg/ha) from the 2005 West Coast groundfish trawl survey.

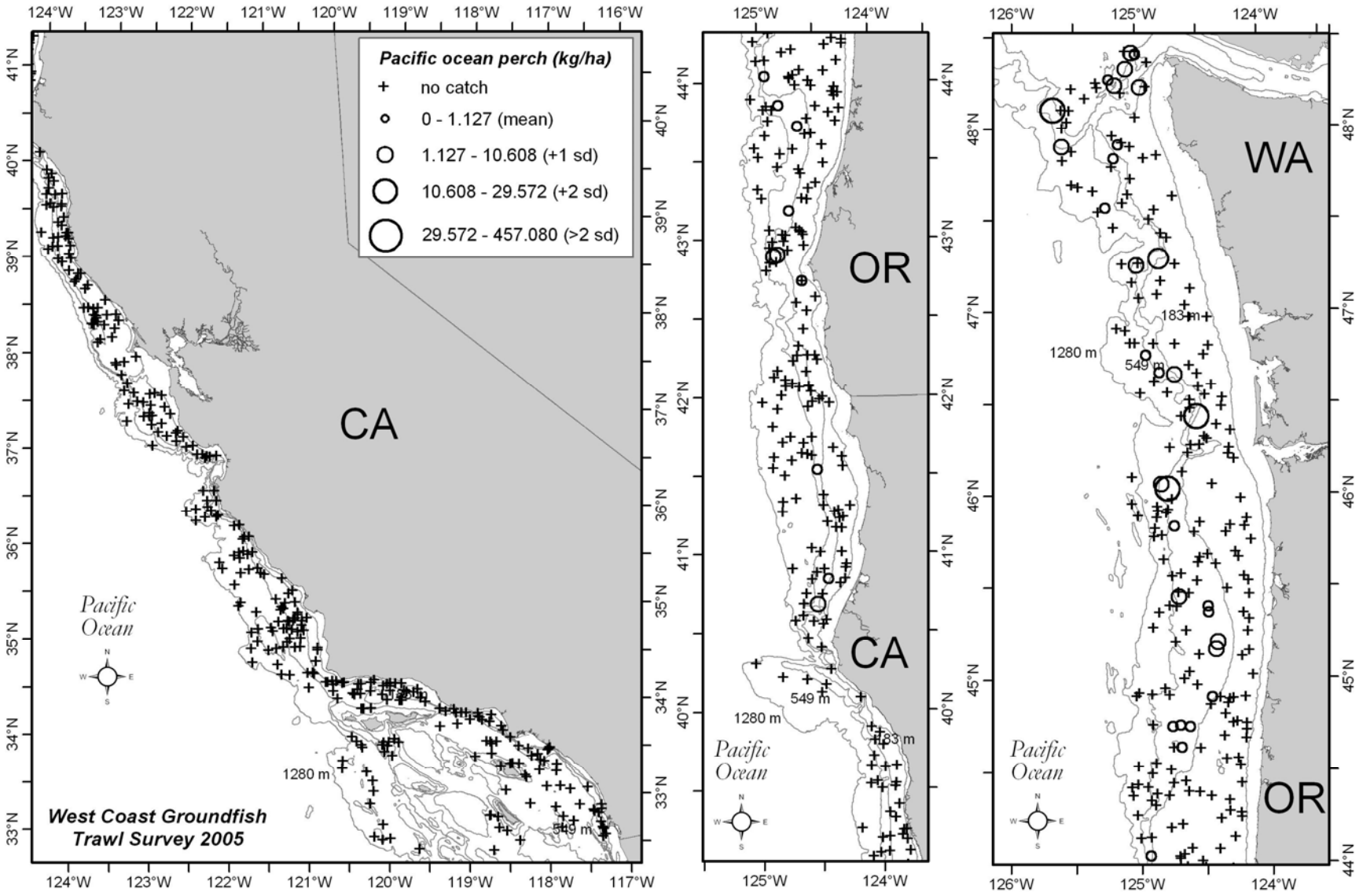

Figure 22. Pacific ocean perch distribution and relative abundance (kg/ha) from the 2005 West Coast groundfish trawl survey.

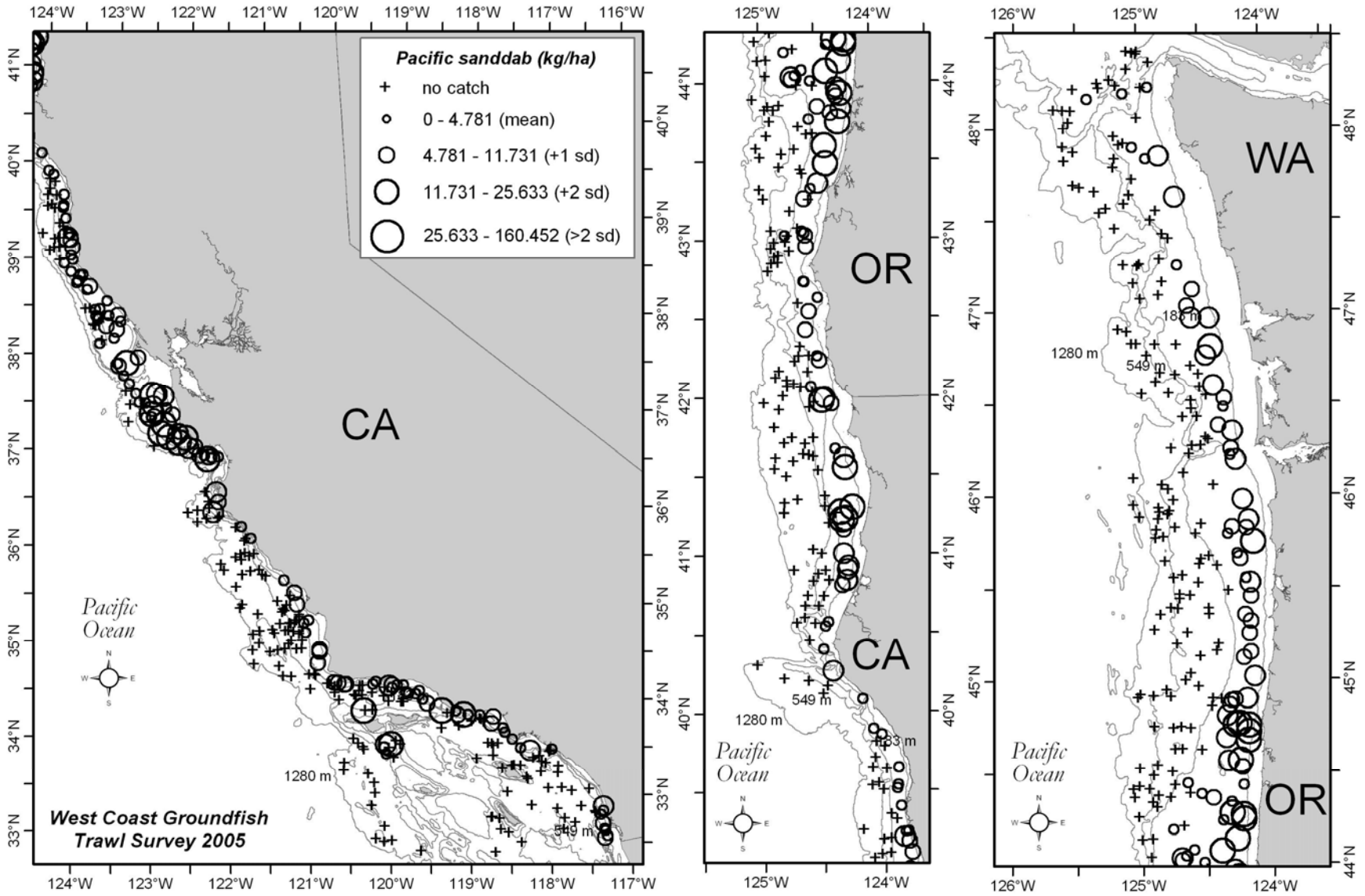

Figure 23. Pacific sanddab distribution and relative abundance (kg/ha) from the 2005 West Coast groundfish trawl survey.

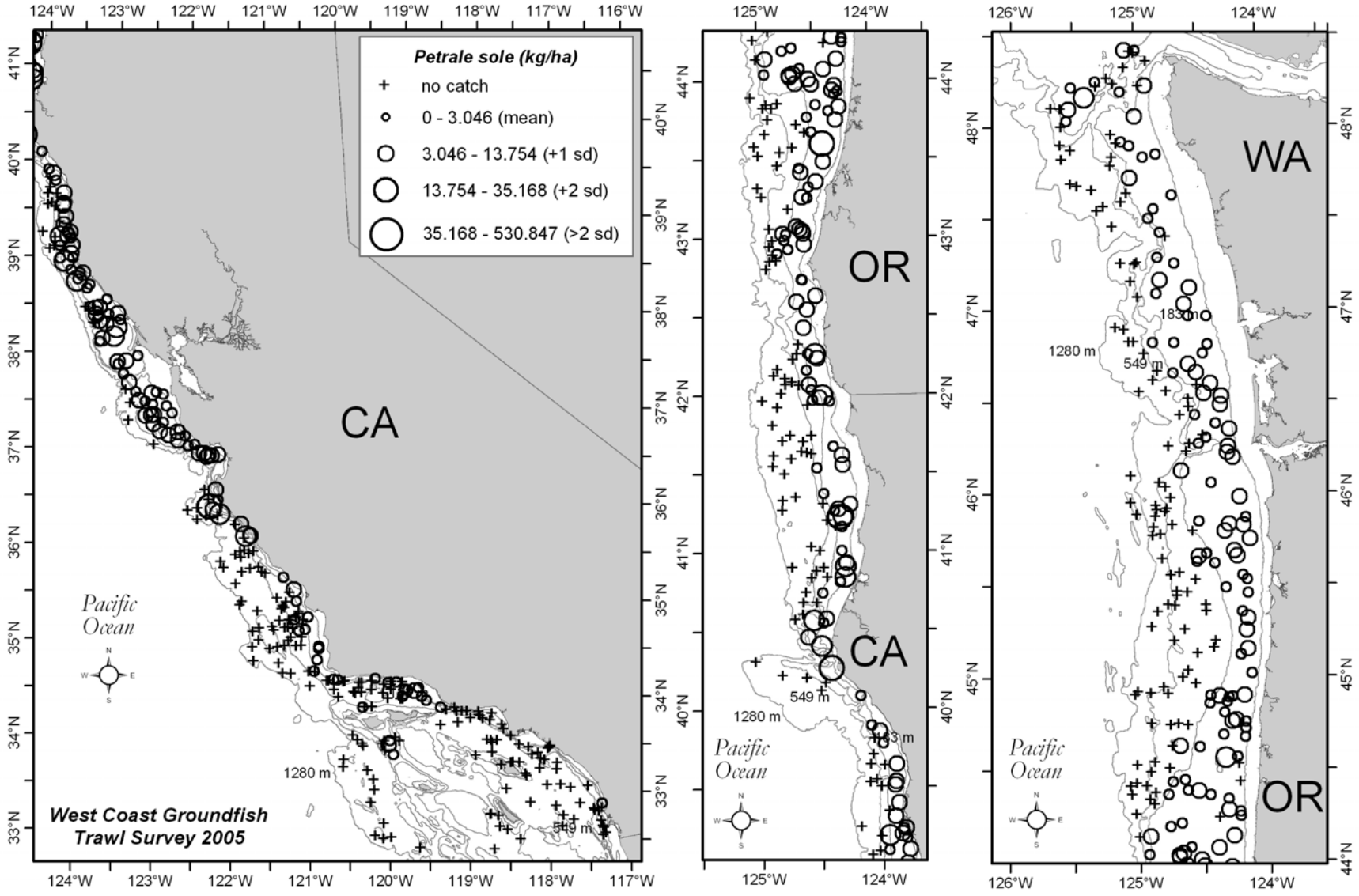

Figure 24. Petrale sole distribution and relative abundance (kg/ha) from the 2005 West Coast groundfish trawl survey.

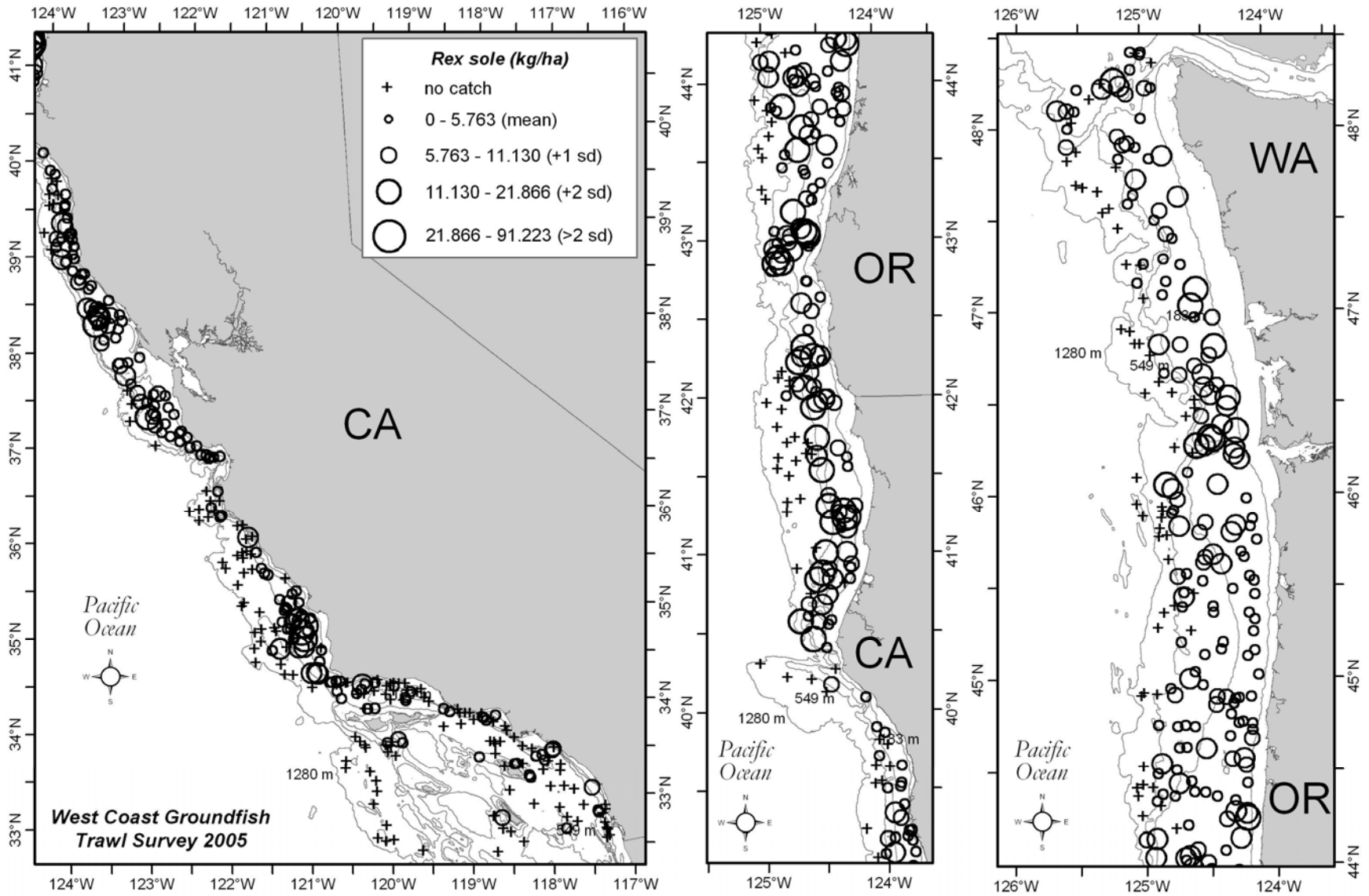

Figure 25. Rex sole distribution and relative abundance (kg/ha) from the 2005 West Coast groundfish trawl survey.

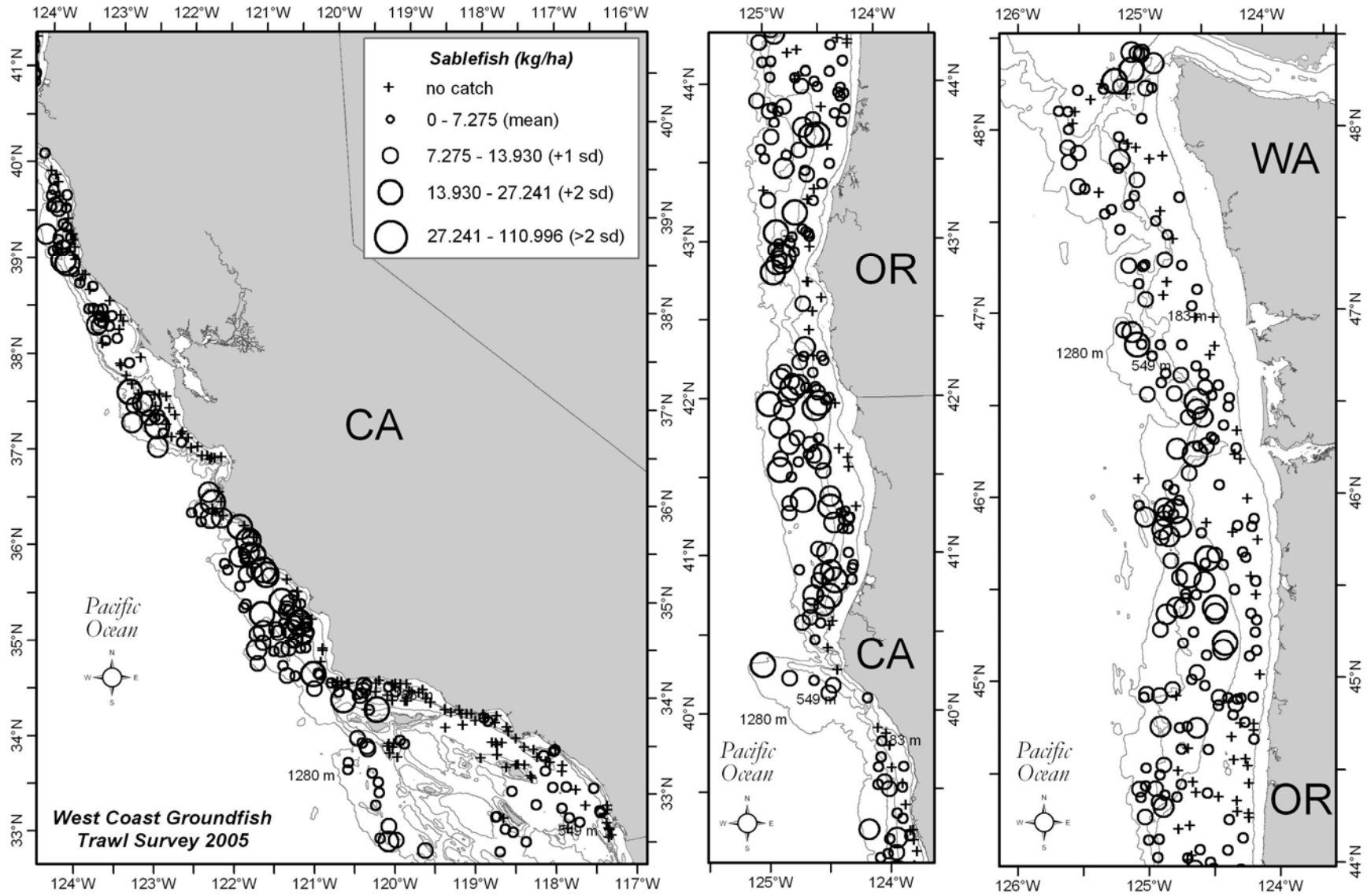

Figure 26. Sablefish distribution and relative abundance (kg/ha) from the 2005 West Coast groundfish trawl survey.

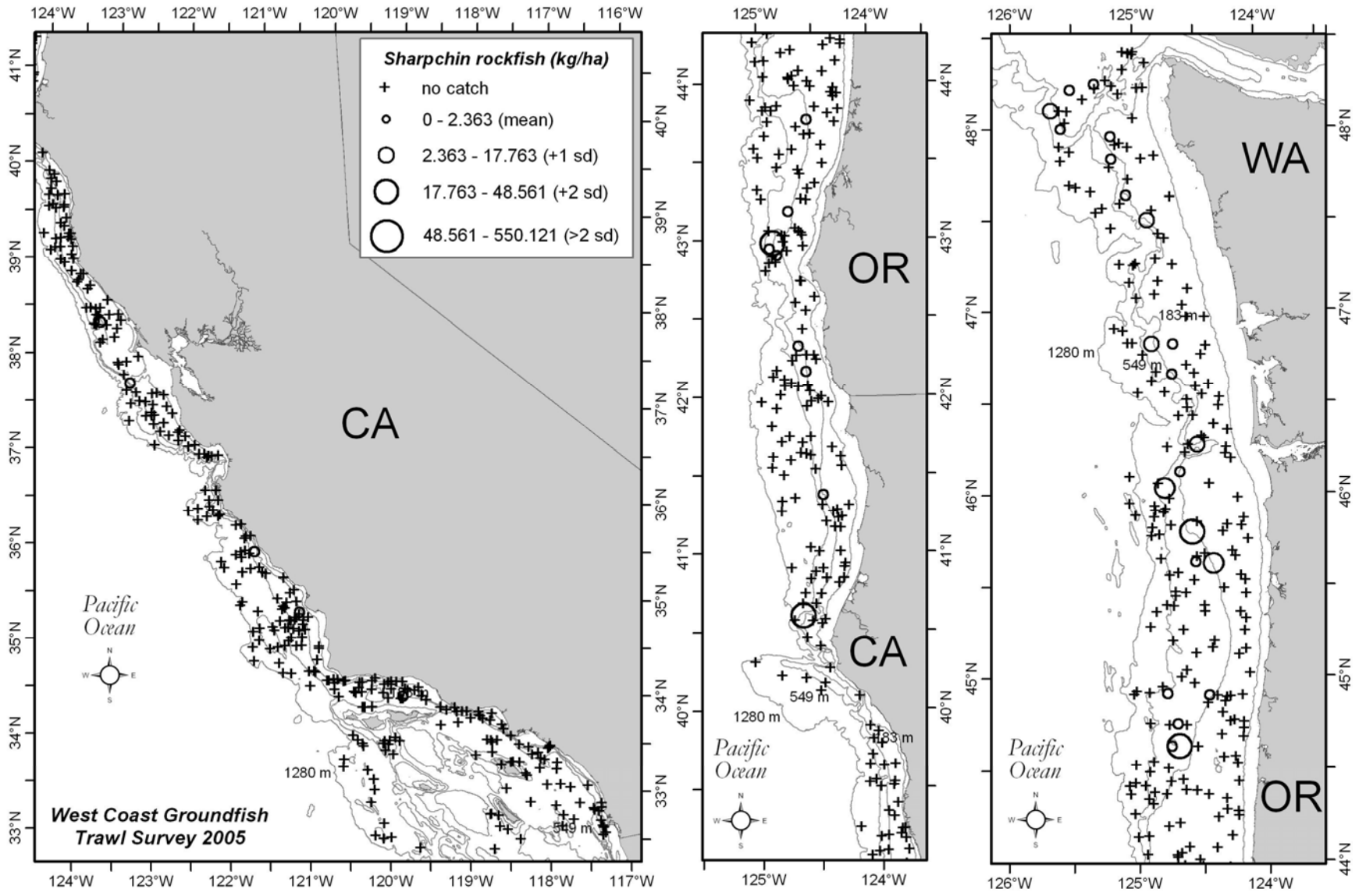

Figure 27. Sharpchin rockfish distribution and relative abundance (kg/ha) from the 2005 West Coast groundfish trawl survey.

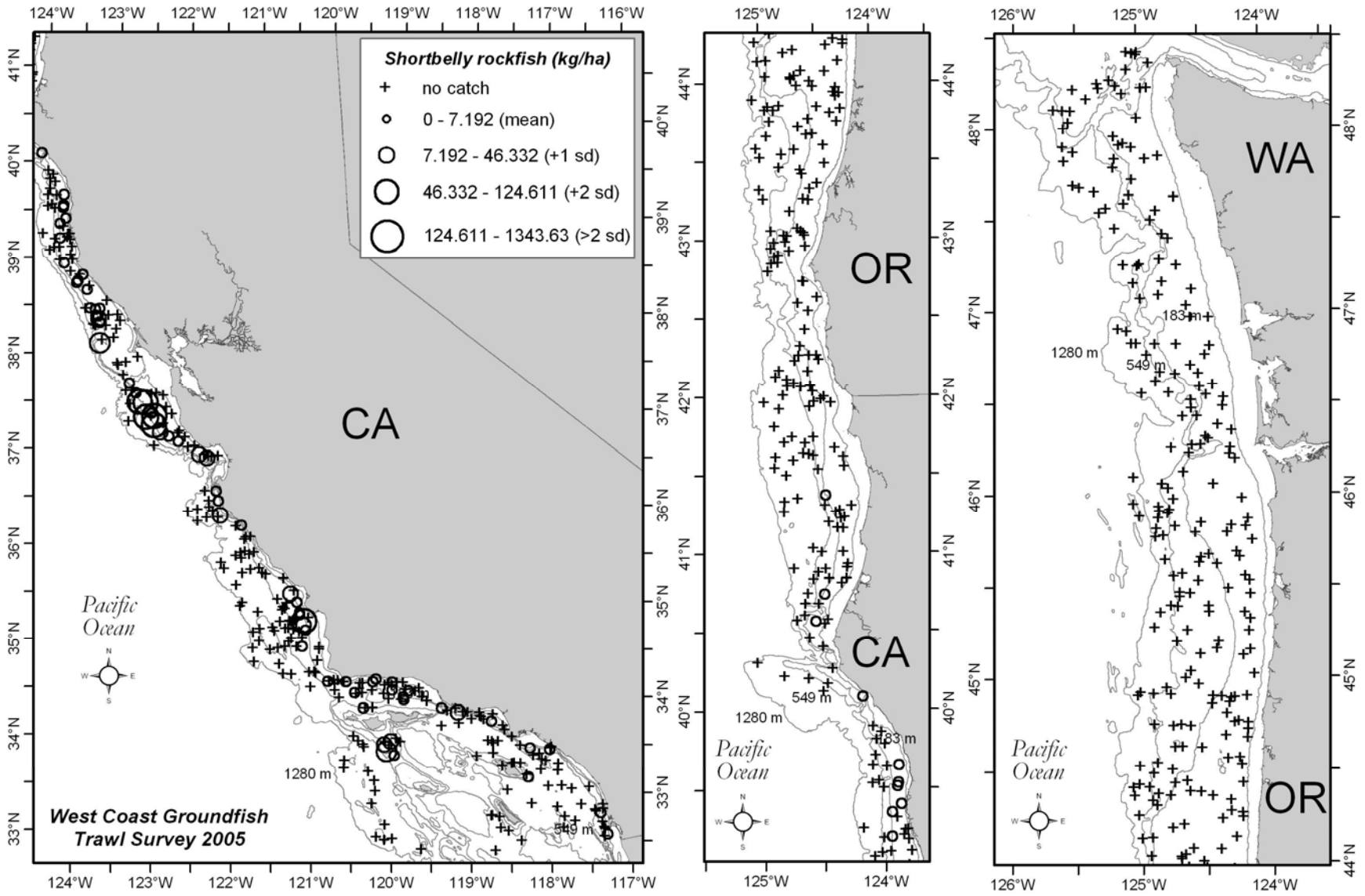

Figure 28. Shortbelly rockfish distribution and relative abundance (kg/ha) from the 2005 West Coast groundfish trawl survey.

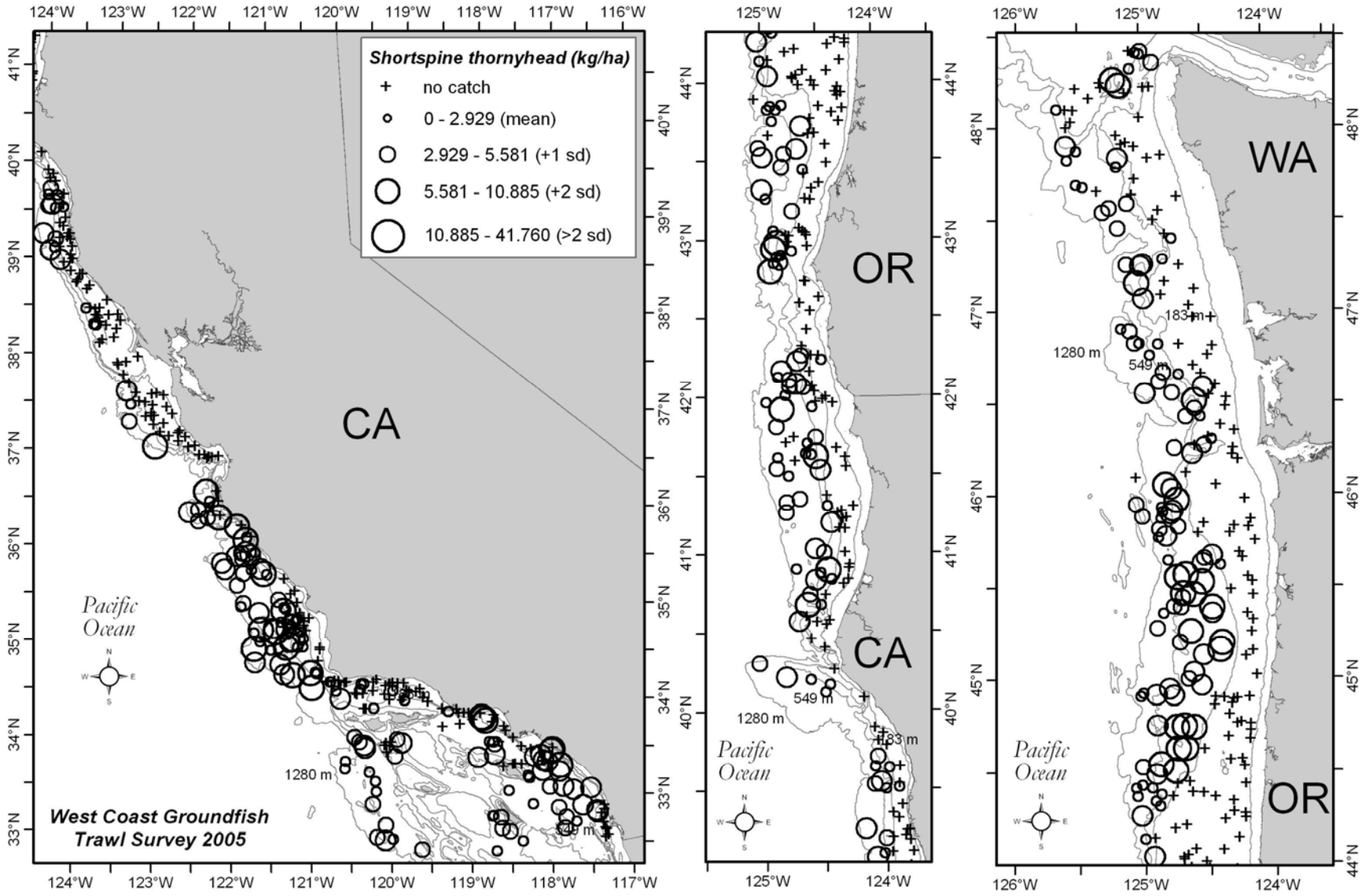

Figure 29. Shortspine thornyhead distribution and relative abundance (kg/ha) from the 2005 West Coast groundfish trawl survey.

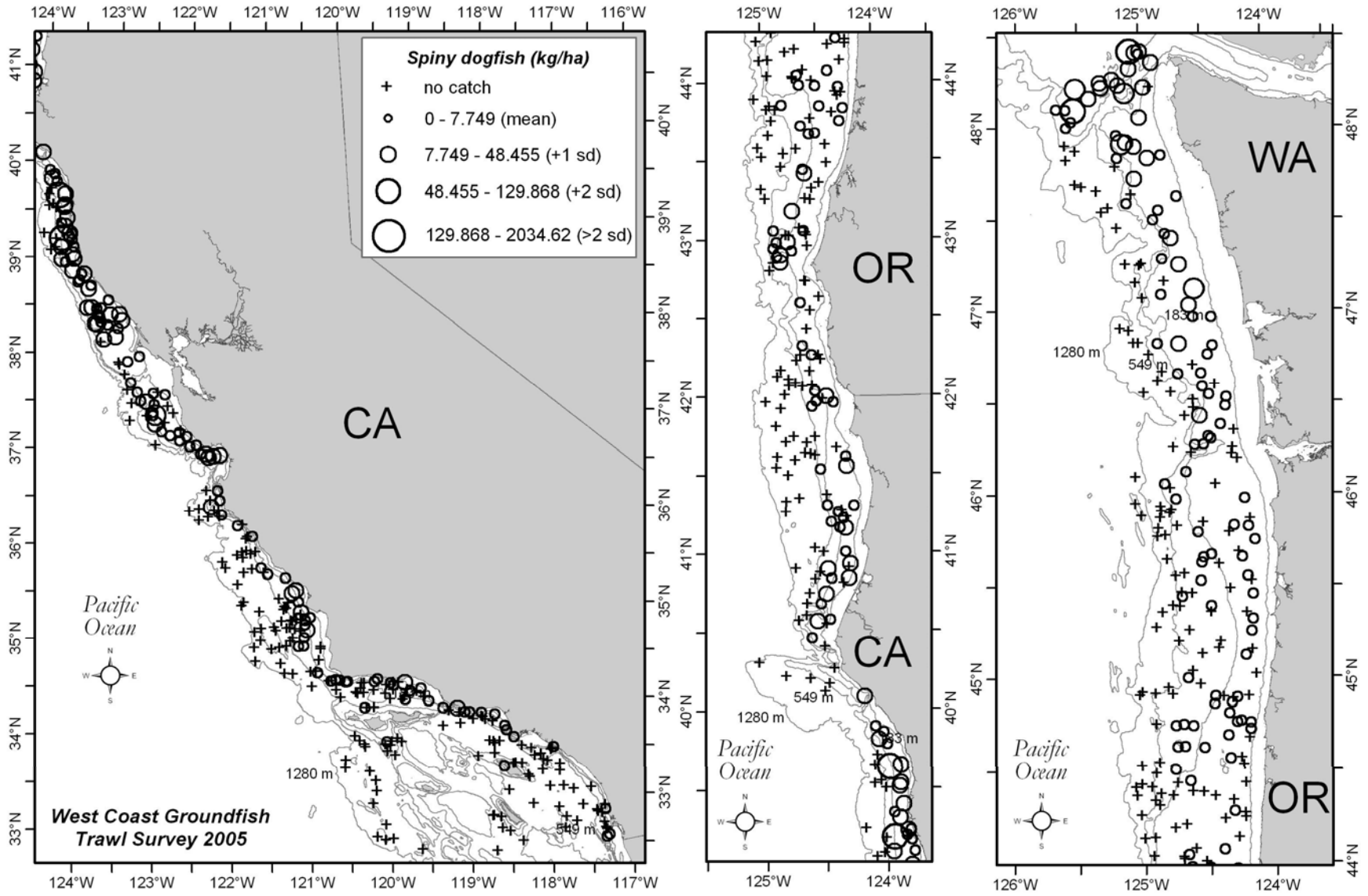

Figure 30. Spiny dogfish distribution and relative abundance (kg/ha) from the 2005 West Coast groundfish trawl survey.

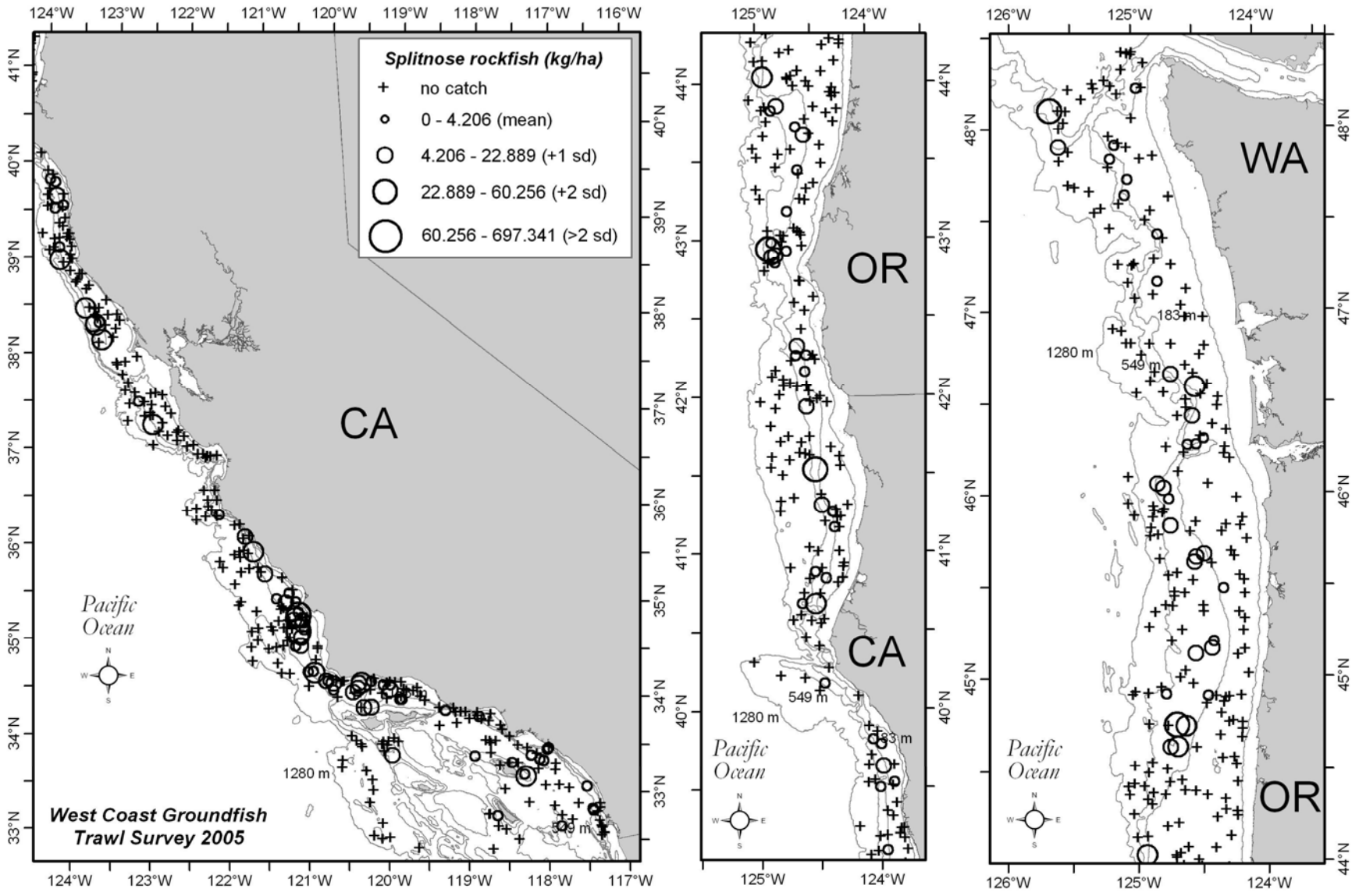

Figure 31. Splitnose rockfish distribution and relative abundance (kg/ha) from the 2005 West Coast groundfish trawl survey.

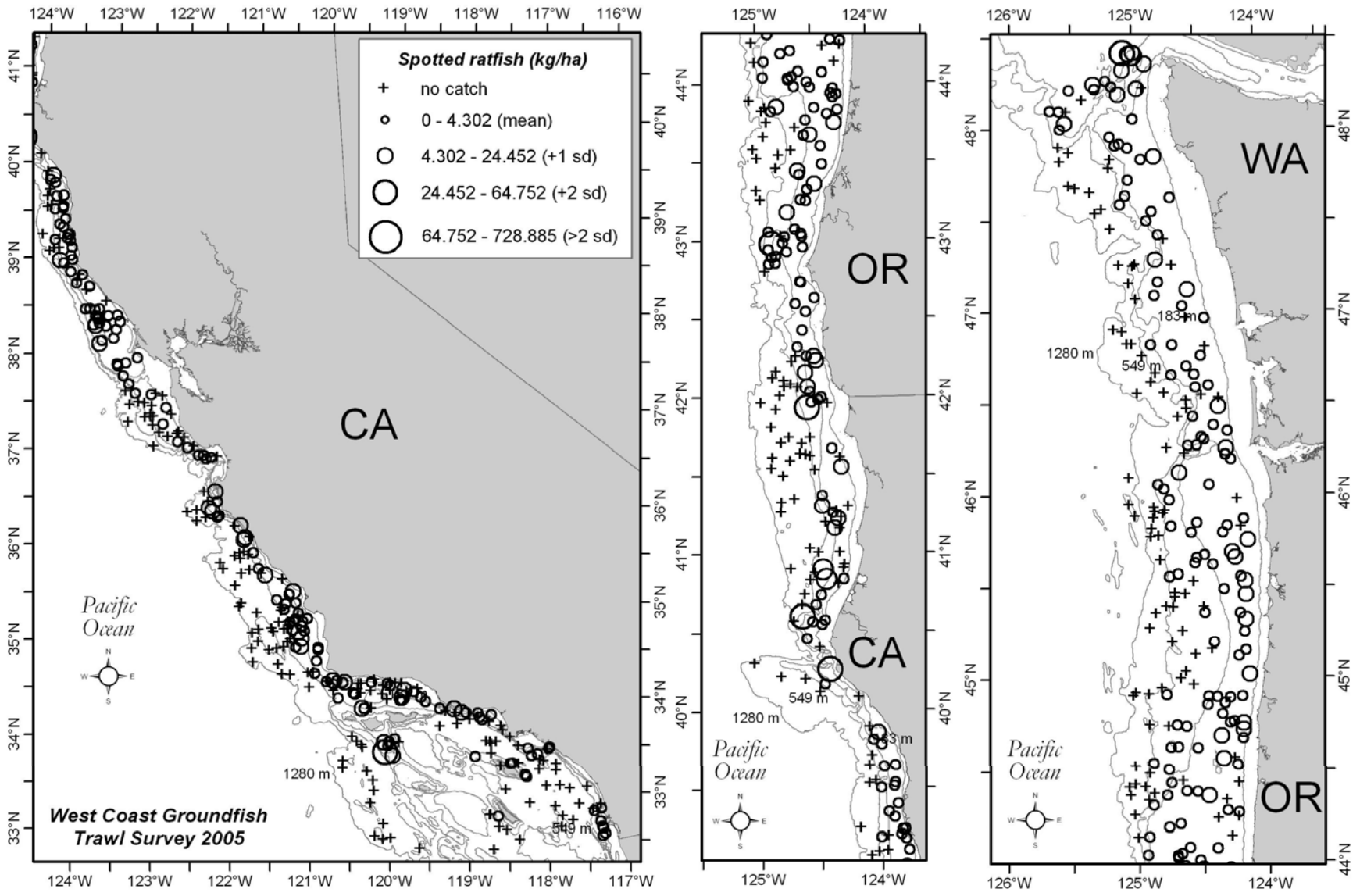

Figure 32. Spotted ratfish distribution and relative abundance (kg/ha) from the 2005 West Coast groundfish trawl survey.

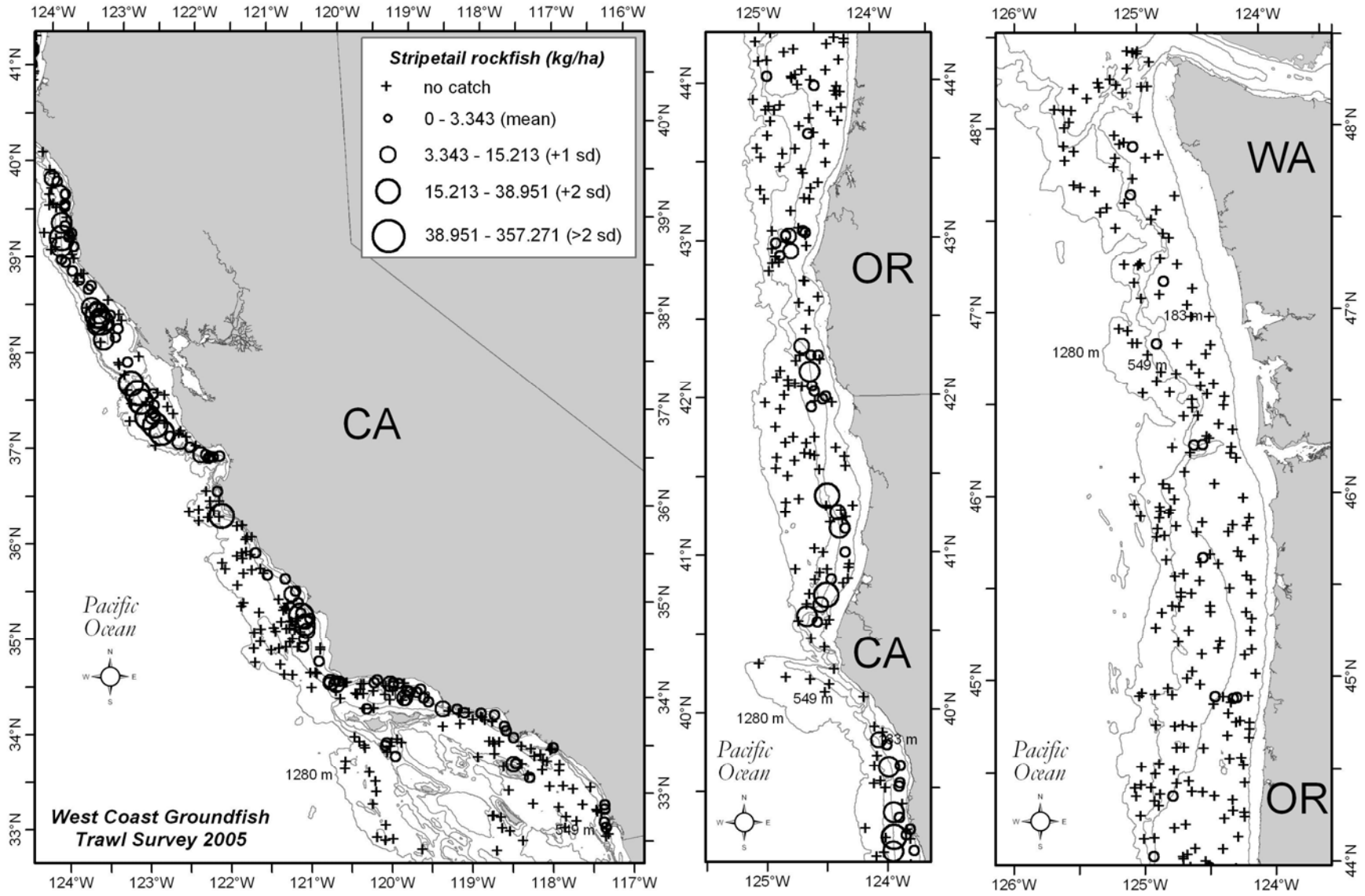

Figure 33. Stripetail rockfish distribution and relative abundance (kg/ha) from the 2005 West Coast groundfish trawl survey.

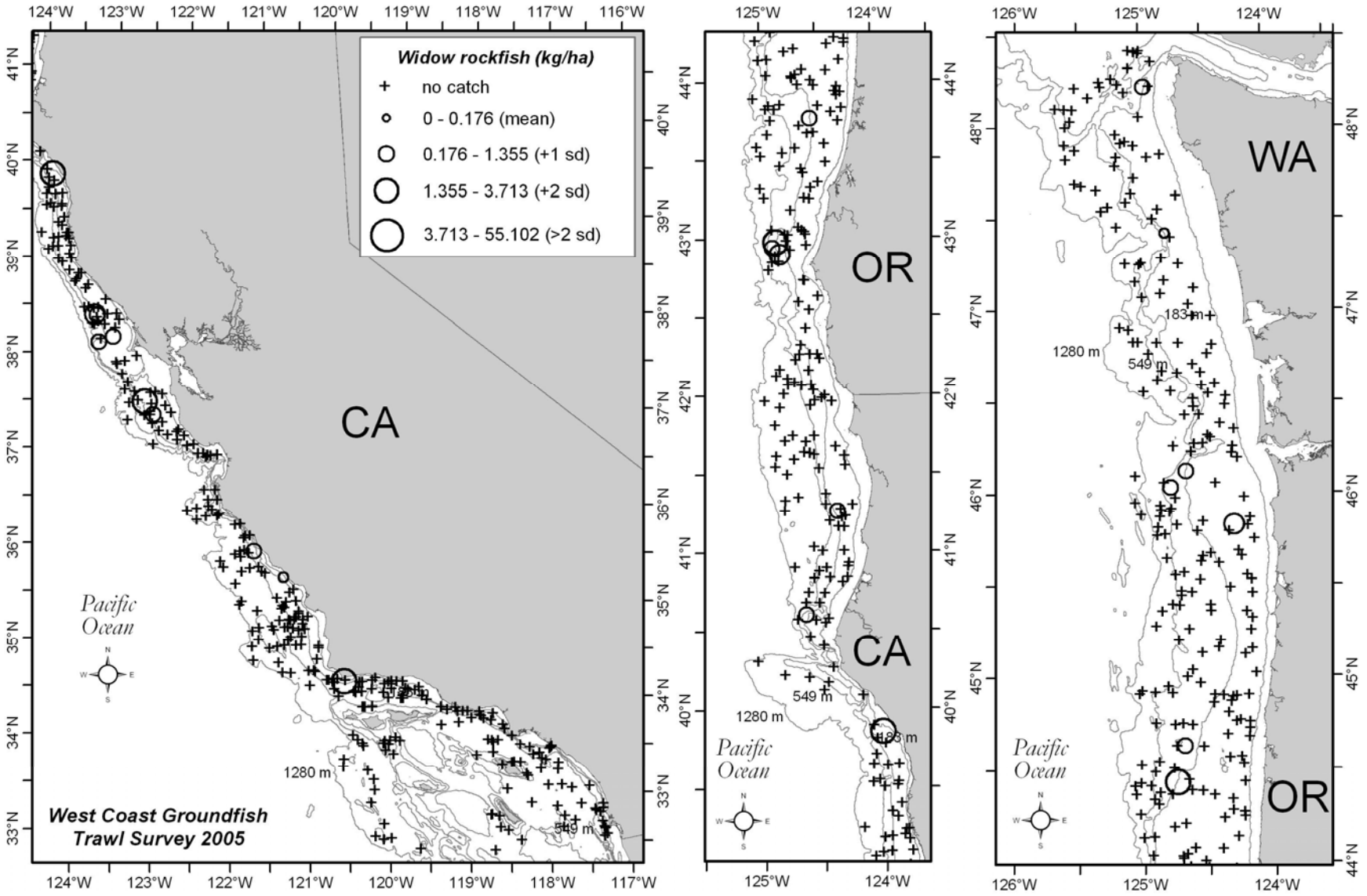

Figure 34. Widow rockfish distribution and relative abundance (kg/ha) from the 2005 West Coast groundfish trawl survey.

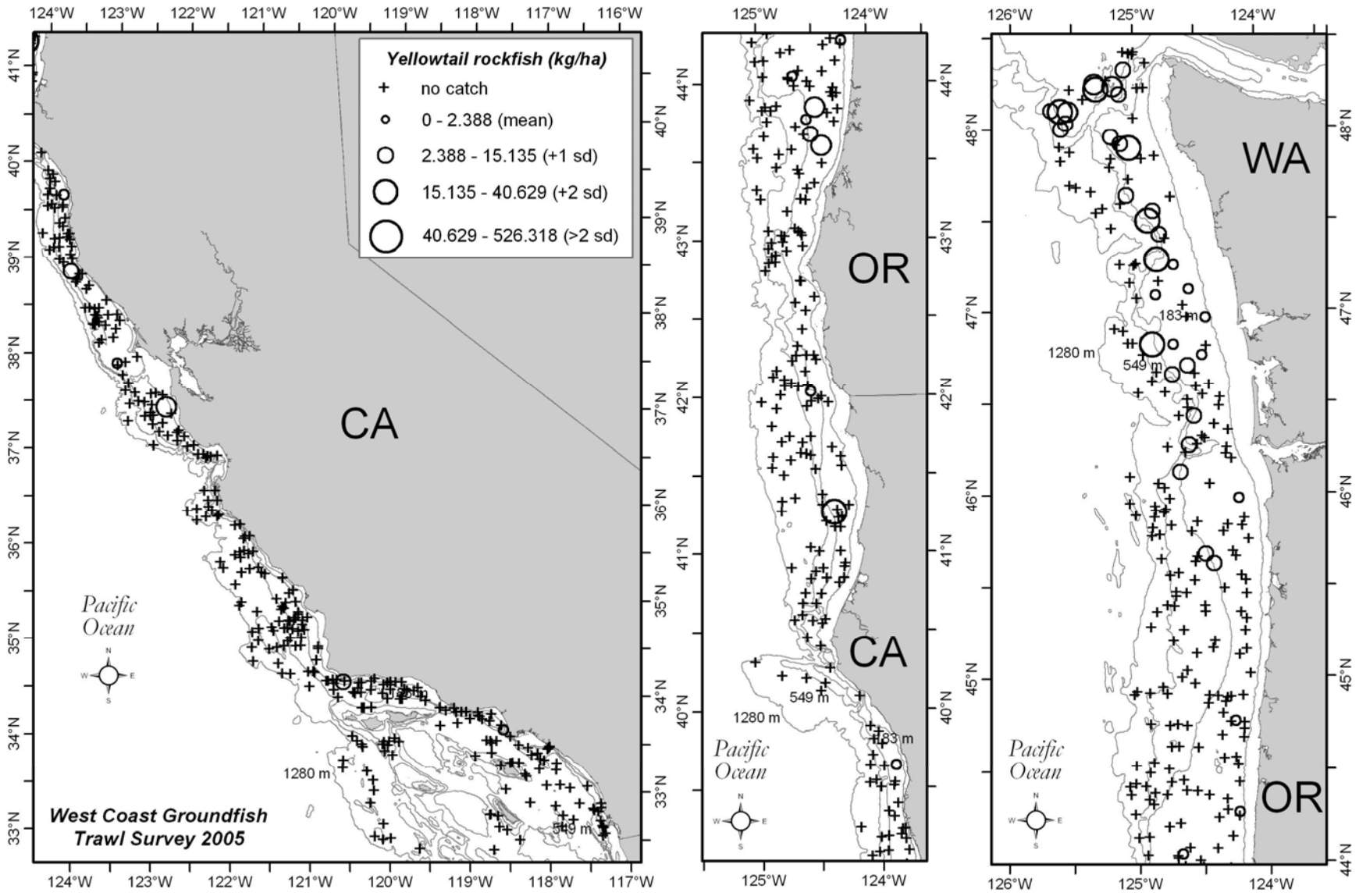

Figure 35. Yellowtail rockfish distribution and relative abundance (kg/ha) from the 2005 West Coast groundfish trawl survey.

Biomass and Population Estimates

Abundance estimates of biomass in metric tons (mt) along with associated CVs are presented for the 20 most abundant groundfish and crab species (Tables 17–22) based on all areas combined by depth strata and INPFC areas. Dover sole had the highest biomass in the middepth stratum and in all depth strata for the combined INPFC areas (Table 17). Longspine thornyhead, sablefish, chilipepper, Pacific hake, and shortbelly rockfish followed Dover sole in decreasing order of biomass in all strata for the combined INPFC areas. Unlike Dover sole, Pacific hake and chilipepper 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 sablefish, grooved tanner crab, shortspine thornyhead, Pacific grenadier, and California slickhead. Sablefish had moderately high levels of biomass in both the middepth and deep strata while chilipepper biomass was elevated in the shallow and middepth strata. Shortbelly rockfish were concentrated in the middepth stratum, where they ranked second 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, chilipepper biomass was greater than Dover sole in the Monterey INPFC area while spiny dogfish biomass was greater 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, and Eureka areas. In the Columbia and U.S.-Vancouver areas, longspine thornyhead and grooved tanner crab biomass were elevated in the deep stratum. In the northern portion of the survey, Dover sole biomass was elevated in the middepth stratum while splitnose rockfish, shortbelly rockfish, and chilipepper biomass were higher in the south. Generally, either Pacific hake, spiny dogfish, or chilipepper biomass was highest in the shallow stratum from the Monterey INPFC area to the U.S.-Vancouver INPFC area. In the INPFC Conception area, biomass of halfbanded rockfish (data not shown) was the highest observed in the shallow stratum.

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 capture 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, number of fish, and lengths were collected for the 35 most abundant groundfish and selected invertebrate species, are shown in Tables 23–28 by depth stratum and INPFC area for each species.

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 2005 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	52,766	21	104,320	20	131,446	27	288,531	23
Longspine thornyhead	0	–	5,120	30	143,893	15	149,013	15
Sablefish	7,100	40	34,899	27	71,230	21	113,229	25
Chilipepper rockfish	72,468	144	36,742	99	0	–	109,211	254
Pacific hake	76,846	30	25,337	37	1,111	81	103,293	61
Shortbelly rockfish	17,724	144	56,633	135	0	–	74,357	258
Spiny dogfish	49,011	186	14,176	114	32	266	63,219	370
Groved tanner crab	3	156	666	72	53,530	41	54,199	41
Shortspine thornyhead	174	87	16,956	20	36,792	16	53,921	18
Longnose skate	17,655	20	27,602	22	5,366	40	50,623	34
Rex sole	23,601	17	24,476	27	2,382	210	50,459	39
Arrowtooth flounder	22,416	57	21,479	49	139	174	44,079	93
Splitnose rockfish	818	84	40,753	91	0	–	41,571	211
Pacific sanddab	37,769	20	64	158	0	–	37,833	51
Spotted ratfish	19,529	107	14,478	232	536	104	34,543	276
Dungeness crab	32,714	46	1,717	77	48	223	34,480	111
Pacific grenadier	0	–	37	110	32,819	59	32,856	60
Stripetail rockfish	10,342	122	22,141	92	0	–	32,483	177
English sole	27,240	20	1,658	61	0	–	28,898	49
California slickhead	0	–	19	276	28,144	18	28,163	19

Table 18. Estimates of fish biomass (metric tons) and CV by stratum for the INPFC Conception area from the 2005 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	52	35	18,271	14	55,415	19	72,737	16
Longspine thornyhead	0	–	3,051	20	56,799	10	59,850	9
Sablefish	42	100	9,387	21	31,652	18	41,081	19
Chilipepper rockfish	1,324	64	4,023	96	0	–	5,347	225
Pacific hake	470	34	8,492	14	587	35	9,550	37
Shortbelly rockfish	1,454	58	10,494	92	0	–	11,498	241
Spiny dogfish	1,835	29	693	46	0	–	2,529	103
Grooved tanner crab	0	–	236	75	7,256	23	7,491	21
Shortspine thornyhead	0	–	5,248	17	23,292	11	28,540	12
Longnose skate	95	47	8,319	16	3,271	35	11,685	34
Rex sole	35	52	6,469	22	24	62	6,529	64
Arrowtooth flounder	0	–	0	–	0	–	0	–
Splitnose rockfish	1	82	19,186	56	0	–	19,187	165
Pacific sanddab	4,906	20	7	67	0	–	4,913	91
Spotted ratfish	10,653	88	1,513	21	536	100	12,702	337
Dungeness crab	386	53	0	–	0	–	386	244
Pacific grenadier	0	–	7	99	7,532	34	7,538	30
Stripetail rockfish	561	25	2,140	51	0	–	2,701	120
English sole	1,876	23	19	55	0	–	1,895	103
California slickhead	0	–	0.1	100	22,407	16	22,407	14

Table 19. Estimates of fish biomass (metric tons) and CV by stratum for the INPFC Monterey area from the 2005 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	4,396	29	14,035	20	45,399	22	63,830	19
Longspine thornyhead	0	–	204	58	28,020	16	28,224	16
Sablefish	1,974	41	3,470	23	14,445	23	19,889	21
Chilipepper rockfish	67,233	73	30,899	40	0	–	98,132	103
Pacific hake	23,591	38	5,787	45	62	62	29,440	64
Shortbelly rockfish	16,261	74	46,139	59	0	–	62,401	111
Spiny dogfish	11,954	35	9,055	63	32	100	21,042	76
Grooved tanner crab	0	–	24	58	15,373	20	15,397	20
Shortspine thornyhead	3	100	717	49	5,707	16	6,427	19
Longnose skate	5,334	16	2,860	23	1,243	33	9,437	25
Rex sole	2,842	15	3,507	25	0	–	6,349	35
Arrowtooth flounder	36	54	120	47	0	–	156	90
Splitnose rockfish	3	87	4,682	33	0	–	4,685	80
Pacific sanddab	9,683	23	57	64	0	–	9,740	45
Spotted ratfish	3,006	56	822	37	0	–	3,828	88
Dungeness crab	4,845	35	294	46	10	100	5,149	65
Pacific grenadier	0	–	0	–	12,861	42	12,861	42
Stripetail rockfish	3,651	38	19,324	38	0	–	22,976	77
English sole	8,436	20	1,059	27	0	–	9,495	36
California slickhead	0	–	19	100	4,398	30	4,417	29

Table 20. Estimates of fish biomass (metric tons) and CV by stratum for the INPFC Eureka area from the 2005 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	7,769	30	23,972	12	20,950	23	52,691	21
Longspine thornyhead	0	–	282	56	31,122	9	31,404	10
Sablefish	1,724	36	3,693	18	11,399	14	16,817	18
Chilipepper rockfish	3,711	69	1,820	96	0	–	5,531	135
Pacific hake	12,134	26	3,600	26	241	76	15,976	44
Shortbelly rockfish	8	56	0	–	0	–	8	113
Spiny dogfish	2,409	31	782	47	0	–	3,192	59
Grooved tanner crab	0	–	0	–	9,020	16	9,020	18
Shortspine thornyhead	7	75	1,276	30	3,542	27	4,824	33
Longnose skate	2,573	16	3,675	20	638	49	6,886	36
Rex sole	4,484	20	6,149	16	2,238	52	13,241	29
Arrowtooth flounder	1,627	28	1,193	33	0	–	2,820	55
Splitnose rockfish	71	71	7,627	80	0	–	7,698	249
Pacific sanddab	4,484	23	0	–	0	–	4,484	45
Spotted ratfish	653	21	8,655	74	0	–	9,309	215
Dungeness crab	8,925	50	415	35	34	70	9,374	96
Pacific grenadier	0	–	0	–	1,926	39	1,926	42
Stripetail rockfish	6,016	65	638	52	0	–	6,653	119
English sole	6,598	15	115	51	0	–	6,713	31
California slickhead	0	–	0	–	448	26	448	28

Table 21. Estimates of fish biomass (metric tons) and CV by stratum for the INPFC Columbia area from the 2005 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	36,046	10	29,514	19	9,629	21	75,189	11
Longspine thornyhead	0	–	1,582	28	21,124	9	22,706	15
Sablefish	2,892	18	12,103	19	12,563	18	27,558	20
Chilipepper rockfish	200	78	0	–	0	–	200	129
Pacific hake	39,968	14	7,119	22	220	46	47,308	21
Shortbelly rockfish	0	–	0	–	0	–	0	–
Spiny dogfish	3,398	42	544	31	0	–	3,942	61
Grooved tanner crab	3	100	404	54	19,205	26	19,612	42
Shortspine thornyhead	164	58	8,413	11	3,861	12	12,438	14
Longnose skate	7,605	14	8,247	21	180	57	16,031	23
Rex sole	14,492	10	6,240	18	119	51	21,032	15
Arrowtooth flounder	11,446	16	5,252	20	139	46	16,838	22
Splitnose rockfish	741	57	6,282	35	0	–	7,023	58
Pacific sanddab	18,136	16	0	–	0	–	18,136	26
Spotted ratfish	3,758	12	1,070	34	0	–	4,828	20
Dungeness crab	18,131	14	1,009	55	4	100	19,144	22
Pacific grenadier	0	–	30	71	9,405	34	9,436	55
Stripetail rockfish	113	74	38	77	0	–	151	99
English sole	8,870	12	238	66	0	–	9,108	20
California slickhead	0	–	0	–	855	26	855	43

Table 22. Estimates of fish biomass (metric tons) and CV by stratum for the INPFC U.S.-Vancouver area from the 2005 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	4,503	28	18,528	21	53	67	23,084	28
Longspine thornyhead	0	–	0	–	6,829	20	6,829	29
Sablefish	469	41	6,246	39	1,170	26	7,885	46
Chilipepper rockfish	0	–	0	–	0	–	0	–
Pacific hake	682	50	338	28	0	–	1,020	76
Shortbelly rockfish	0	–	0	–	0	–	0	–
Spiny dogfish	29,413	76	3,101	30	0	–	32,514	154
Grooved tanner crab	0	–	2	100	2,676	23	2,679	32
Shortspine thornyhead	0	–	1,302	33	390	30	1,692	39
Longnose skate	2,048	26	4,501	18	35	100	6,584	26
Rex sole	1,378	19	1,930	37	0	–	3,308	36
Arrowtooth flounder	9,352	32	14,912	23	0	–	24,265	35
Splitnose rockfish	1	71	2,976	96	0	–	2,977	143
Pacific sanddab	558	53	0	–	0	–	558	120
Spotted ratfish	1,459	65	2,417	31	0	–	3,876	62
Dungeness crab	427	73	0	–	0	–	427	165
Pacific grenadier	0	–	0	–	1,096	32	1,096	45
Stripetail rockfish	0	100	2	100	0	–	2	131
English sole	1,460	30	227	73	0	–	1,687	61
California slickhead	0	–	0	–	35	51	35	72

Table 23. Number of hauls by depth strata where weight (Wt.), number of fish (No.), and lengths (Len.) were collected for the 35 most abundant groundfish and selected invertebrate species in the combined INPFC areas (U.S.-Vancouver, Columbia, Eureka, Monterey, and Conception) from the 2005 West Coast groundfish trawl survey.

	Stratum 1 55–183 m Total hauls = 310 Hauls with:			**Stratum 2 184–549 m Total hauls = 184 Hauls with:**			**Stratum 3 550–1,280 m Total hauls = 181 Hauls with:**		
Species	**Wt.**	**No.**	**Len.**	**Wt.**	**No.**	**Len.**	**Wt.**	**No.**	**Len.**
Dover sole	251	250	248	180	179	178	141	141	140
Longspine thornyhead	0	0	0	67	67	66	173	173	171
Sablefish	138	138	138	157	157	156	163	163	161
Chilipepper rockfish	71	71	71	21	21	20	0	0	0
Pacific hake	204	204	204	173	173	171	30	29	29
Shortbelly rockfish	49	49	49	22	22	22	0	0	0
Spiny dogfish	198	198	197	76	75	74	1	1	1
Grooved tanner crab	1	1	1	29	28	25	146	146	143
Shortspine thornyhead	12	12	12	148	148	148	167	167	165
Longnose skate	207	207	207	156	154	151	34	32	32
Rex sole	259	259	258	162	162	161	17	17	17
Arrowtooth flounder	137	137	136	76	76	76	5	5	5
Splitnose rockfish	19	19	19	109	109	107	0	0	0
Pacific sanddab	238	238	237	6	6	6	0	0	0
Spotted ratfish	238	236	232	112	111	110	1	1	1
Pacific grenadier	0	0	0	9	9	9	122	121	118
Stripetail rockfish	103	103	103	46	46	45	0	0	0
English sole	276	276	275	36	36	35	0	0	0
California slickhead	0	0	0	2	2	0	127	127	0
Petrale sole	267	267	265	27	27	26	0	0	0
Halfbanded rockfish	69	69	69	0	0	0	0	0	0
Lingcod	172	172	172	38	38	37	0	0	0
Giant grenadier	0	0	0	1	1	0	95	95	0
Darkblotched rockfish	62	62	61	50	49	49	0	0	0
Yellowtail rockfish	42	42	40	6	6	6	0	0	0
Sharpchin rockfish	15	15	15	21	21	21	0	0	0
Greenstriped rockfish	153	153	151	32	32	31	0	0	0
Pacific ocean perch	5	5	5	33	33	33	2	2	2
Brown cat shark	1	1	0	69	69	0	148	148	0
Big skate	108	105	104	5	5	5	0	0	0
Canary rockfish	49	49	49	7	7	7	0	0	0
Deepsea sole	0	0	0	10	9	0	125	123	0
Slender sole	219	215	0	131	127	0	2	2	0
Aurora rockfish	0	0	0	76	76	76	14	14	14
Bering skate	76	74	0	108	104	0	7	7	0

Table 24. Number of hauls by depth strata where weight (Wt.), number of fish (No.), and lengths (Len.) were collected for the 35 most abundant groundfish and selected invertebrate species in the INPFC U.S.-Vancouver area from the 2005 West Coast groundfish trawl survey.

	Stratum 1 55–183 m Total hauls = 21 Hauls with:			Stratum 2 184–549 m Total hauls = 14 Hauls with:			Stratum 3 550–1,280 m Total hauls = 8 Hauls with:		
Species	**Wt.**	**No.**	**Len.**	**Wt.**	**No.**	**Len.**	**Wt.**	**No.**	**Len.**
Dover sole	20	20	20	14	14	14	2	2	2
Longspine thornyhead	0	0	0	0	0	0	8	8	8
Sablefish	11	11	11	14	14	14	7	7	7
Chilipepper rockfish	0	0	0	0	0	0	0	0	0
Pacific hake	9	9	9	11	11	10	0	0	0
Shortbelly rockfish	0	0	0	0	0	0	0	0	0
Spiny dogfish	20	20	20	12	11	11	0	0	0
Grooved tanner crab	0	0	0	1	1	0	8	8	8
Shortspine thornyhead	0	0	0	11	11	11	7	7	7
Longnose skate	17	17	17	14	14	14	1	1	1
Rex sole	18	18	18	12	12	12	0	0	0
Arrowtooth flounder	19	19	19	13	13	13	0	0	0
Splitnose rockfish	2	2	2	5	5	5	0	0	0
Pacific sanddab	7	7	7	0	0	0	0	0	0
Spotted ratfish	18	17	17	12	12	12	0	0	0
Pacific grenadier	0	0	0	0	0	0	8	8	8
Stripetail rockfish	1	1	1	1	1	1	0	0	0
English sole	15	15	15	7	7	7	0	0	0
California slickhead	0	0	0	0	0	0	3	3	0
Petrale sole	17	17	17	1	1	1	0	0	0
Halfbanded rockfish	0	0	0	0	0	0	0	0	0
Lingcod	10	10	10	2	2	2	0	0	0
Giant grenadier	0	0	0	0	0	0	8	8	0
Darkblotched rockfish	4	4	4	4	4	4	0	0	0
Yellowtail rockfish	11	11	11	5	5	5	0	0	0
Sharpchin rockfish	4	4	4	4	4	4	0	0	0
Greenstriped rockfish	13	13	13	5	5	5	0	0	0
Pacific ocean perch	1	1	1	9	9	9	1	1	1
Brown cat shark	0	0	0	1	1	0	5	5	0
Big skate	4	4	4	0	0	0	0	0	0
Canary rockfish	6	6	6	2	2	2	0	0	0
Deepsea sole	0	0	0	0	0	0	7	7	0
Slender sole	19	19	0	12	11	0	0	0	0
Aurora rockfish	0	0	0	2	2	2	0	0	0
Bering skate	10	10	0	14	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 35 most abundant groundfish and selected invertebrate species in the INPFC Columbia area from the 2005 West Coast groundfish trawl survey.

	Stratum 1 55–183 m Total hauls = 119 Hauls with:			Stratum 2 184–549 m Total hauls = 51 Hauls with:			Stratum 3 550–1,280 m Total hauls = 53 Hauls with:		
Species	**Wt.**	**No.**	**Len.**	**Wt.**	**No.**	**Len.**	**Wt.**	**No.**	**Len.**
Dover sole	114	114	114	50	50	50	41	41	40
Longspine thornyhead	0	0	0	25	25	24	53	53	51
Sablefish	78	78	78	48	48	48	51	51	49
Chilipepper rockfish	5	5	5	0	0	0	0	0	0
Pacific hake	104	104	104	50	50	50	8	7	7
Shortbelly rockfish	0	0	0	0	0	0	0	0	0
Spiny dogfish	61	61	61	22	22	22	0	0	0
Grooved tanner crab	1	1	1	21	20	18	49	49	47
Shortspine thornyhead	9	9	9	49	49	49	50	50	48
Longnose skate	86	86	86	41	40	40	4	3	3
Rex sole	118	118	118	47	47	47	7	7	7
Arrowtooth flounder	87	87	87	39	39	39	5	5	5
Splitnose rockfish	9	9	9	23	23	23	0	0	0
Pacific sanddab	81	81	81	0	0	0	0	0	0
Spotted ratfish	101	100	99	27	26	26	0	0	0
Pacific grenadier	0	0	0	7	7	7	50	49	47
Stripetail rockfish	12	12	12	4	4	4	0	0	0
English sole	100	100	100	7	7	7	0	0	0
California slickhead	0	0	0	0	0	0	29	29	0
Petrale sole	111	111	111	7	7	7	0	0	0
Halfbanded rockfish	1	1	1	0	0	0	0	0	0
Lingcod	61	61	61	7	7	7	0	0	0
Giant grenadier	0	0	0	0	0	0	34	34	0
Darkblotched rockfish	37	37	36	21	21	21	0	0	0
Yellowtail rockfish	23	23	22	1	1	1	0	0	0
Sharpchin rockfish	8	8	8	8	8	8	0	0	0
Greenstriped rockfish	68	68	67	10	10	10	0	0	0
Pacific ocean perch	3	3	3	19	19	19	1	1	1
Brown cat shark	0	0	0	19	19	0	42	42	0
Big skate	56	55	55	2	2	2	0	0	0
Canary rockfish	23	23	23	0	0	0	0	0	0
Deepsea sole	0	0	0	6	5	0	45	45	0
Slender sole	104	103	0	41	41	0	1	1	0
Aurora rockfish	0	0	0	21	21	21	2	2	2
Bering skate	50	48	0	35	34	0	1	1	0

Table 26. Number of hauls by depth strata where weight (Wt.), number of fish (No.), and lengths (Len.) were collected for the 35 most abundant groundfish and selected invertebrate species in the INPFC Eureka area from the 2005 West Coast groundfish trawl survey.

	Stratum 1 55–183 m Total hauls = 38 Hauls with:			Stratum 2 184–549 m Total hauls = 23 Hauls with:			Stratum 3 550–1,280 m Total hauls = 28 Hauls with:		
Species	**Wt.**	**No.**	**Len.**	**Wt.**	**No.**	**Len.**	**Wt.**	**No.**	**Len.**
Dover sole	34	34	33	23	23	23	26	26	26
Longspine thornyhead	0	0	0	7	7	7	27	27	27
Sablefish	23	23	23	23	23	23	28	28	28
Chilipepper rockfish	7	7	7	4	4	4	0	0	0
Pacific hake	25	25	25	21	21	21	4	4	4
Shortbelly rockfish	3	3	3	0	0	0	0	0	0
Spiny dogfish	21	20	20	13	13	13	0	0	0
Grooved tanner crab	0	0	0	0	0	0	28	28	28
Shortspine thornyhead	2	2	2	20	20	20	25	25	25
Longnose skate	34	34	34	22	21	21	6	6	6
Rex sole	37	37	37	23	23	23	6	6	6
Arrowtooth flounder	25	25	24	19	19	19	0	0	0
Splitnose rockfish	4	4	4	15	15	14	0	0	0
Pacific sanddab	27	27	27	0	0	0	0	0	0
Spotted ratfish	28	28	27	14	14	14	0	0	0
Pacific grenadier	0	0	0	0	0	0	24	24	23
Stripetail rockfish	14	14	14	8	8	8	0	0	0
English sole	38	38	38	6	6	6	0	0	0
California slickhead	0	0	0	0	0	0	23	23	0
Petrale sole	37	37	37	3	3	3	0	0	0
Halfbanded rockfish	0	0	0	0	0	0	0	0	0
Lingcod	31	31	31	9	9	9	0	0	0
Giant grenadier	0	0	0	0	0	0	19	19	0
Darkblotched rockfish	10	10	10	13	13	13	0	0	0
Yellowtail rockfish	2	2	2	0	0	0	0	0	0
Sharpchin rockfish	1	1	1	6	6	6	0	0	0
Greenstriped rockfish	17	17	17	8	8	8	0	0	0
Pacific ocean perch	1	1	1	5	5	5	0	0	0
Brown cat shark	0	0	0	11	11	0	27	27	0
Big skate	22	22	22	2	2	2	0	0	0
Canary rockfish	8	8	8	4	4	4	0	0	0
Deepsea sole	0	0	0	2	2	0	25	25	0
Slender sole	31	31	0	19	19	0	1	1	0
Aurora rockfish	0	0	0	7	7	7	0	0	0
Bering skate	12	12	0	16	16	0	1	1	0

Table 27. Number of hauls by depth strata where weight (Wt.), number of fish (No.), and lengths (Len.) were collected for the 35 most abundant groundfish and selected invertebrate species in the INPFC Monterey area from the 2005 West Coast groundfish trawl survey.

	Stratum 1 55–183 m Total hauls = 78 Hauls with:			Stratum 2 184–549 m Total hauls = 21 Hauls with:			Stratum 3 550–1,280 m Total hauls = 20 Hauls with:		
Species	**Wt.**	**No.**	**Len.**	**Wt.**	**No.**	**Len.**	**Wt.**	**No.**	**Len.**
Dover sole	64	63	62	21	21	20	19	19	19
Longspine thornyhead	0	0	0	5	5	5	20	20	20
Sablefish	25	25	25	19	19	18	20	20	20
Chilipepper rockfish	43	43	43	11	11	10	0	0	0
Pacific hake	46	46	46	19	19	18	4	4	4
Shortbelly rockfish	30	30	30	7	7	7	0	0	0
Spiny dogfish	65	65	64	14	14	13	1	1	1
Grooved tanner crab	0	0	0	3	3	3	20	20	20
Shortspine thornyhead	1	1	1	11	11	11	20	20	20
Longnose skate	62	62	62	20	20	18	9	8	8
Rex sole	73	73	72	19	19	18	0	0	0
Arrowtooth flounder	6	6	6	5	5	5	0	0	0
Splitnose rockfish	2	2	2	14	14	13	0	0	0
Pacific sanddab	72	72	71	3	3	3	0	0	0
Spotted ratfish	54	54	53	15	15	14	0	0	0
Pacific grenadier	0	0	0	0	0	0	17	17	17
Stripetail rockfish	42	42	42	13	13	12	0	0	0
English sole	74	74	73	12	12	11	0	0	0
California slickhead	0	0	0	1	1	0	16	16	0
Petrale sole	77	77	76	10	10	9	0	0	0
Halfbanded rockfish	19	19	19	0	0	0	0	0	0
Lingcod	42	42	42	9	9	8	0	0	0
Giant grenadier	0	0	0	1	1	0	11	11	0
Darkblotched rockfish	11	11	11	7	7	7	0	0	0
Yellowtail rockfish	4	4	3	0	0	0	0	0	0
Sharpchin rockfish	1	1	1	1	1	1	0	0	0
Greenstriped rockfish	36	36	35	8	8	7	0	0	0
Pacific ocean perch	0	0	0	0	0	0	0	0	0
Brown cat shark	1	1	0	7	7	0	19	19	0
Big skate	20	19	18	0	0	0	0	0	0
Canary rockfish	6	6	6	0	0	0	0	0	0
Deepsea sole	0	0	0	1	1	0	16	15	0
Slender sole	55	52	0	15	15	0	0	0	0
Aurora rockfish	0	0	0	5	5	5	1	1	1
Bering skate	4	4	0	14	14	0	3	3	0

Table 28. Number of hauls by depth strata where weight (Wt.), number of fish (No.), and lengths (Len.) were collected for the 35 most abundant groundfish and selected invertebrate species in the INPFC Conception area from the 2005 West Coast groundfish trawl survey.

	Stratum 1 55–183 m Total hauls = 54 Hauls with:			Stratum 2 184–549 m Total hauls = 75 Hauls with:			Stratum 3 550–1,280 m Total hauls = 72 Hauls with:		
Species	**Wt.**	**No.**	**Len.**	**Wt.**	**No.**	**Len.**	**Wt.**	**No.**	**Len.**
Dover sole	19	19	19	71	71	71	53	53	53
Longspine thornyhead	0	0	0	30	30	30	65	65	65
Sablefish	1	1	1	53	53	53	57	57	57
Chilipepper rockfish	16	16	16	6	6	6	0	0	0
Pacific hake	20	20	20	72	72	72	14	14	14
Shortbelly rockfish	16	16	16	15	15	15	0	0	0
Spiny dogfish	32	32	32	15	15	15	0	0	0
Grooved tanner crab	0	0	0	4	4	4	41	41	40
Shortspine thornyhead	0	0	0	57	57	57	65	65	65
Longnose skate	8	8	8	59	59	58	14	14	14
Rex sole	13	13	13	61	61	61	4	4	4
Arrowtooth flounder	0	0	0	0	0	0	0	0	0
Splitnose rockfish	2	2	2	52	52	52	0	0	0
Pacific sanddab	51	51	51	3	3	3	0	0	0
Spotted ratfish	37	37	36	44	44	44	1	1	1
Pacific grenadier	0	0	0	2	2	2	23	23	23
Stripetail rockfish	34	34	34	20	20	20	0	0	0
English sole	49	49	49	4	4	4	0	0	0
California slickhead	0	0	0	1	1	0	56	56	0
Petrale sole	25	25	24	6	6	6	0	0	0
Halfbanded rockfish	49	49	49	0	0	0	0	0	0
Lingcod	28	28	28	11	11	11	0	0	0
Giant grenadier	0	0	0	0	0	0	23	23	0
Darkblotched rockfish	0	0	0	5	4	4	0	0	0
Yellowtail rockfish	2	2	2	0	0	0	0	0	0
Sharpchin rockfish	1	1	1	2	2	2	0	0	0
Greenstriped rockfish	19	19	19	1	1	1	0	0	0
Pacific ocean perch	0	0	0	0	0	0	0	0	0
Brown cat shark	0	0	0	31	31	0	55	55	0
Big skate	6	5	5	1	1	1	0	0	0
Canary rockfish	6	6	6	1	1	1	0	0	0
Deepsea sole	0	0	0	1	1	0	32	31	0
Slender sole	10	10	0	44	41	0	0	0	0
Aurora rockfish	0	0	0	41	41	41	11	11	11
Bering skate	0	0	0	29	27	0	2	2	0

Size Compositions

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

In general Figures 62–64 include species with greater than 500 length measurements taken throughout the survey period: spiny dogfish, California skate, longnose skate, arrowtooth flounder, curlfin sole, English sole, Pacific sanddab, petrale sole, rex sole, Pacific grenadier, lingcod, Pacific hake, aurora rockfish, bocaccio rockfish, canary rockfish, chilipepper rockfish, darkblotched rockfish, greenspotted rockfish, greenstriped rockfish, halfbanded rockfish, Pacific ocean perch, rosethorn rockfish, sharpchin rockfish, shortbelly rockfish, splitnose rockfish, stripetail rockfish, and yellowtail rockfish. If sex could not be determined for more 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.

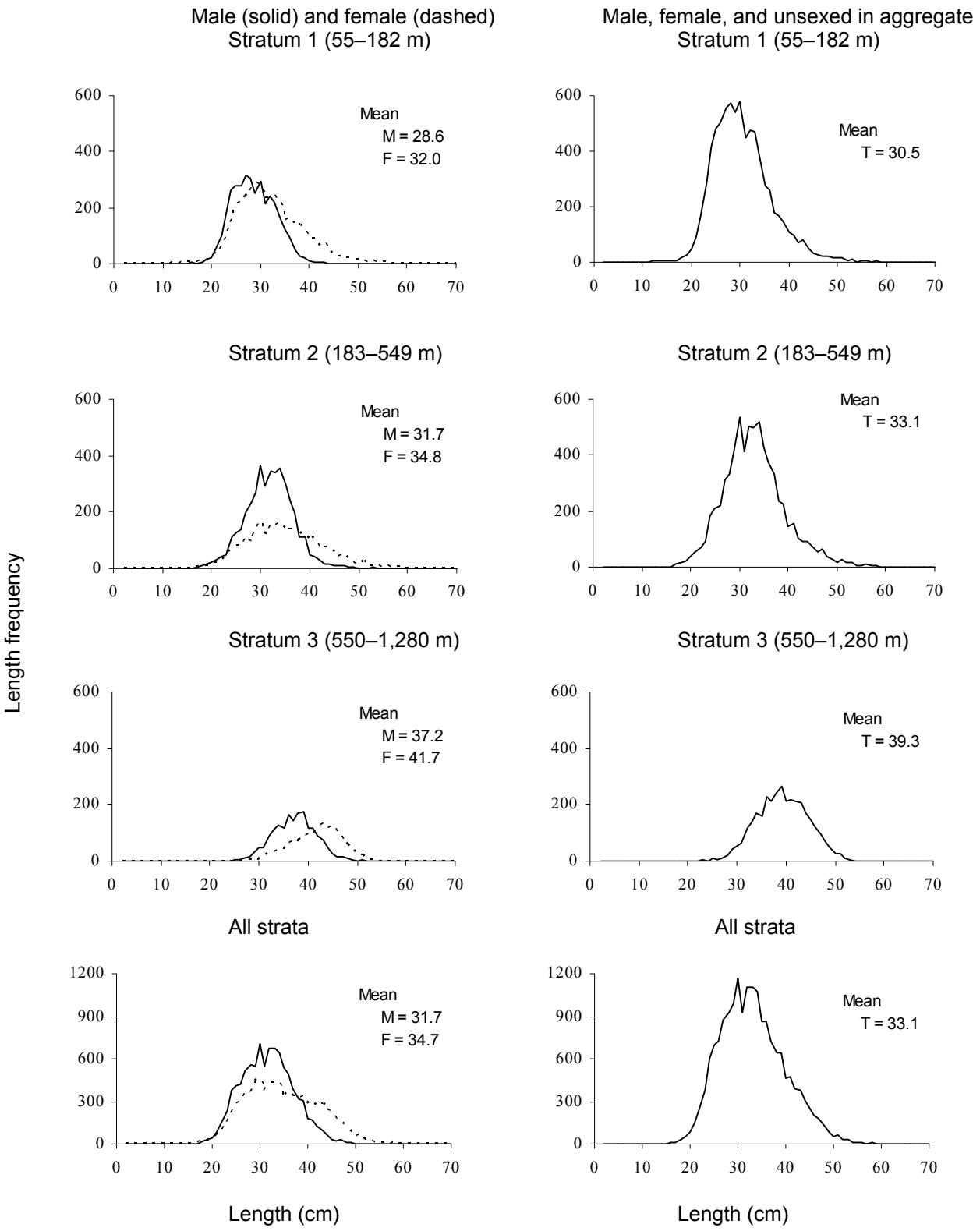

Figure 36. Unweighted length-frequency data and mean lengths (cm) of Dover sole by depth stratum and by sex (M = male, F = female, and T = males, females, and unsexed in aggregate) for all INPFC areas sampled from the 2005 West Coast groundfish trawl survey.

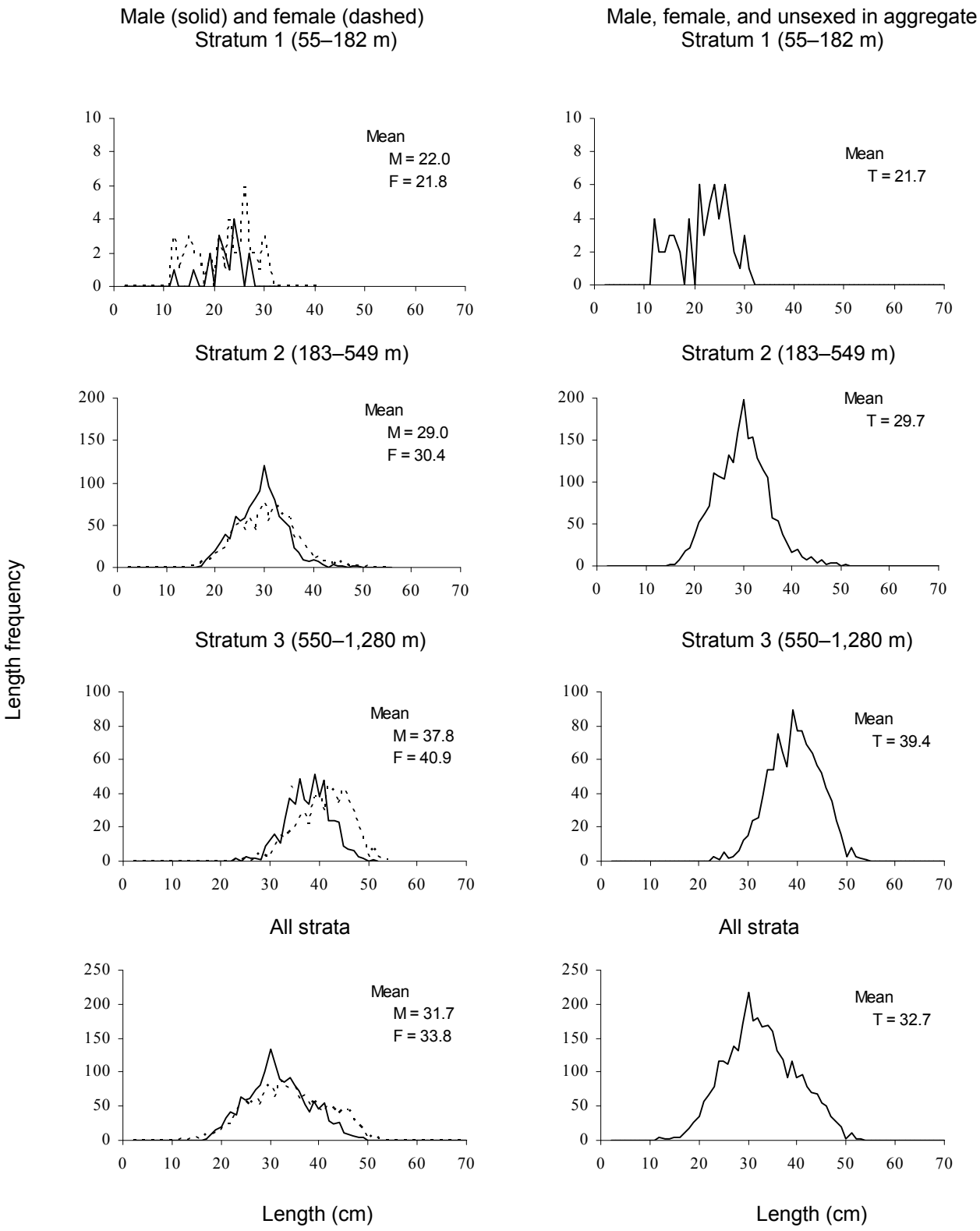

Figure 37. Unweighted length-frequency data and mean lengths (cm) of Dover sole by depth stratum and by sex (M = male, F = female, and T = males, females, and unsexed) for the INPFC Conception area from the 2005 West Coast groundfish trawl survey.

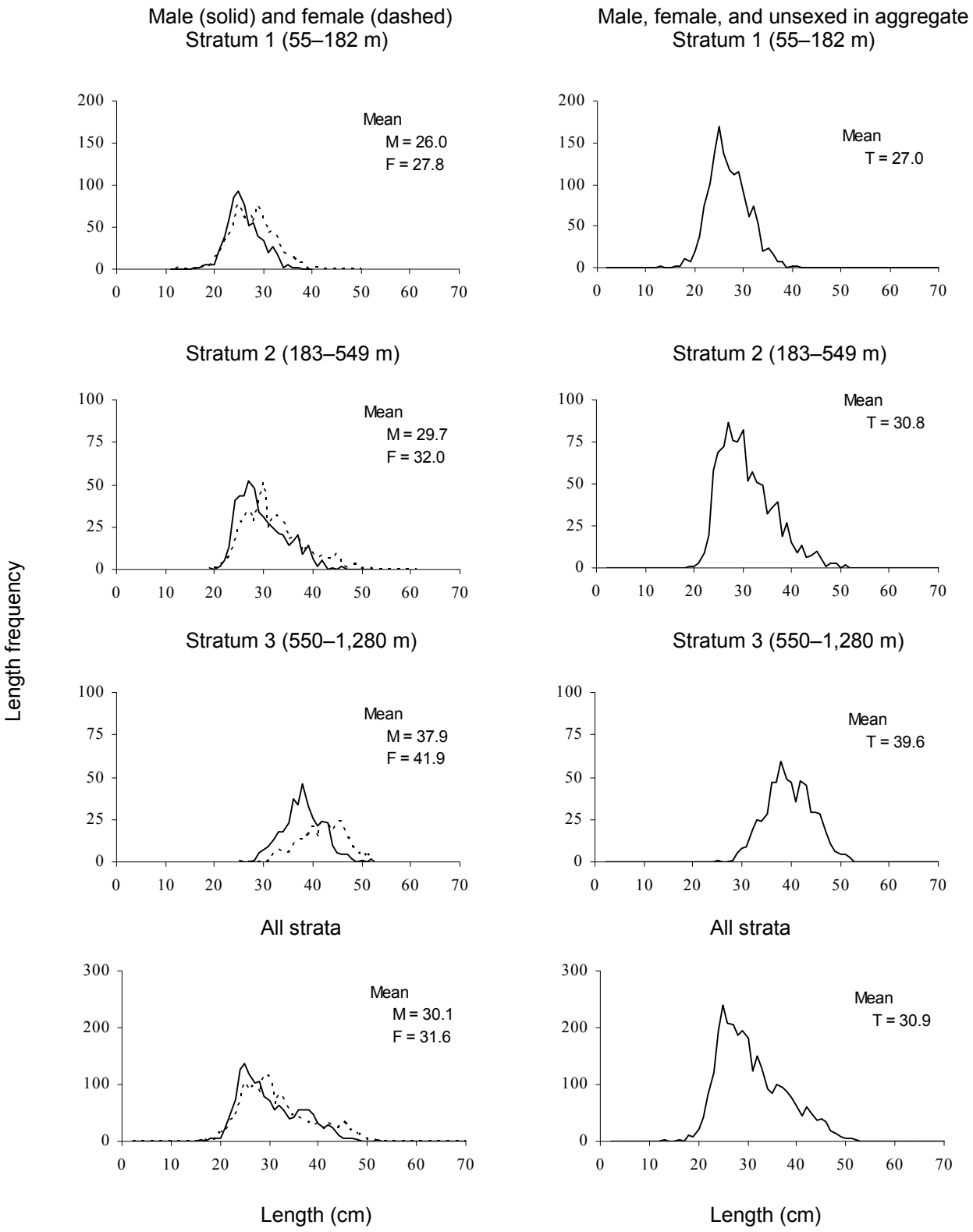

Figure 38. Unweighted length-frequency data and mean lengths (cm) of Dover sole by depth stratum and by sex (M = male, F = female, and T = males, females, and unsexed) for the INPFC Monterey area from the 2005 West Coast groundfish trawl survey.

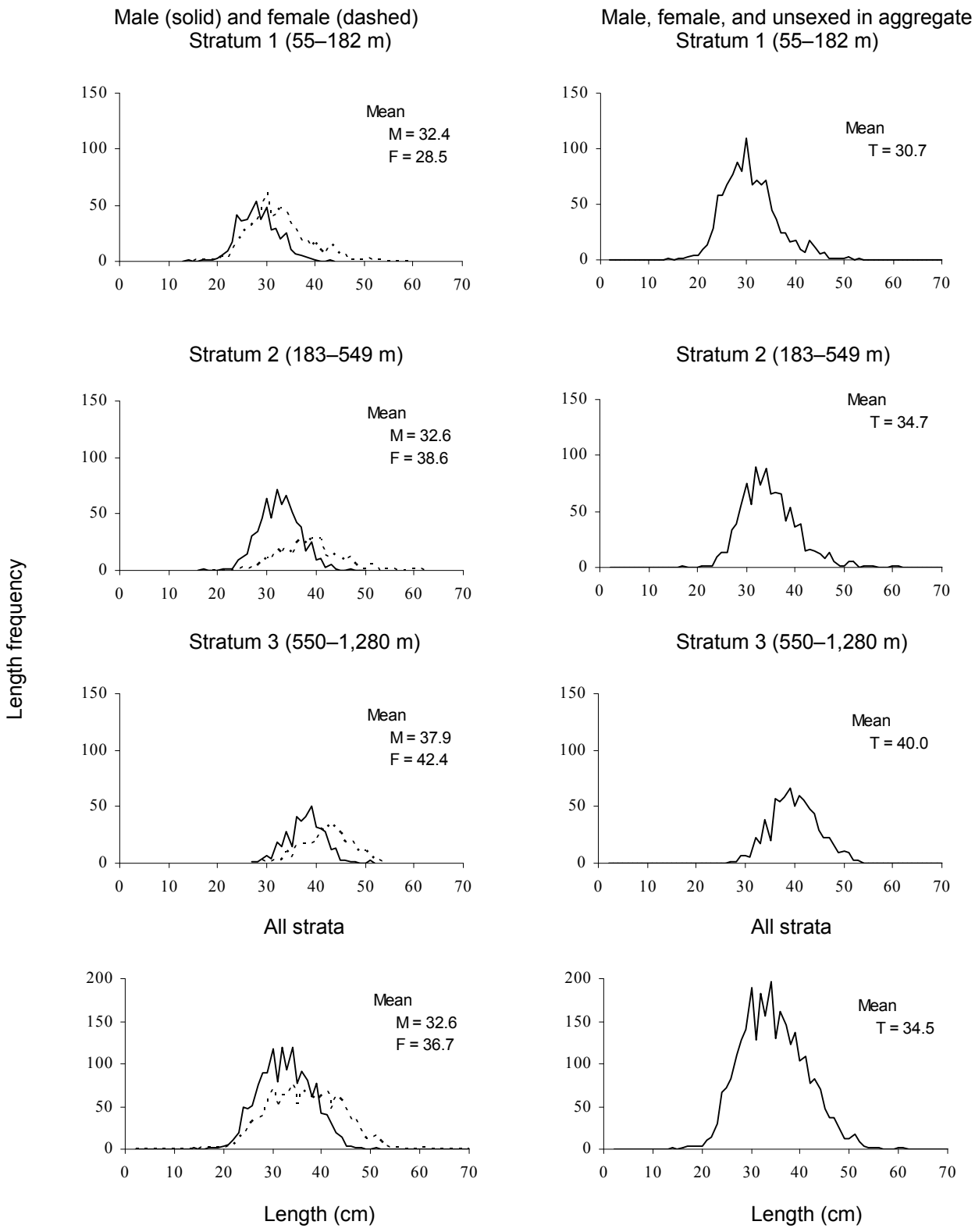

Figure 39. Unweighted length-frequency data and mean lengths (cm) of Dover sole by depth stratum and by sex (M = male, F = female, and T = males, females, and unsexed) for the INPFC Eureka area from the 2005 West Coast groundfish trawl survey.

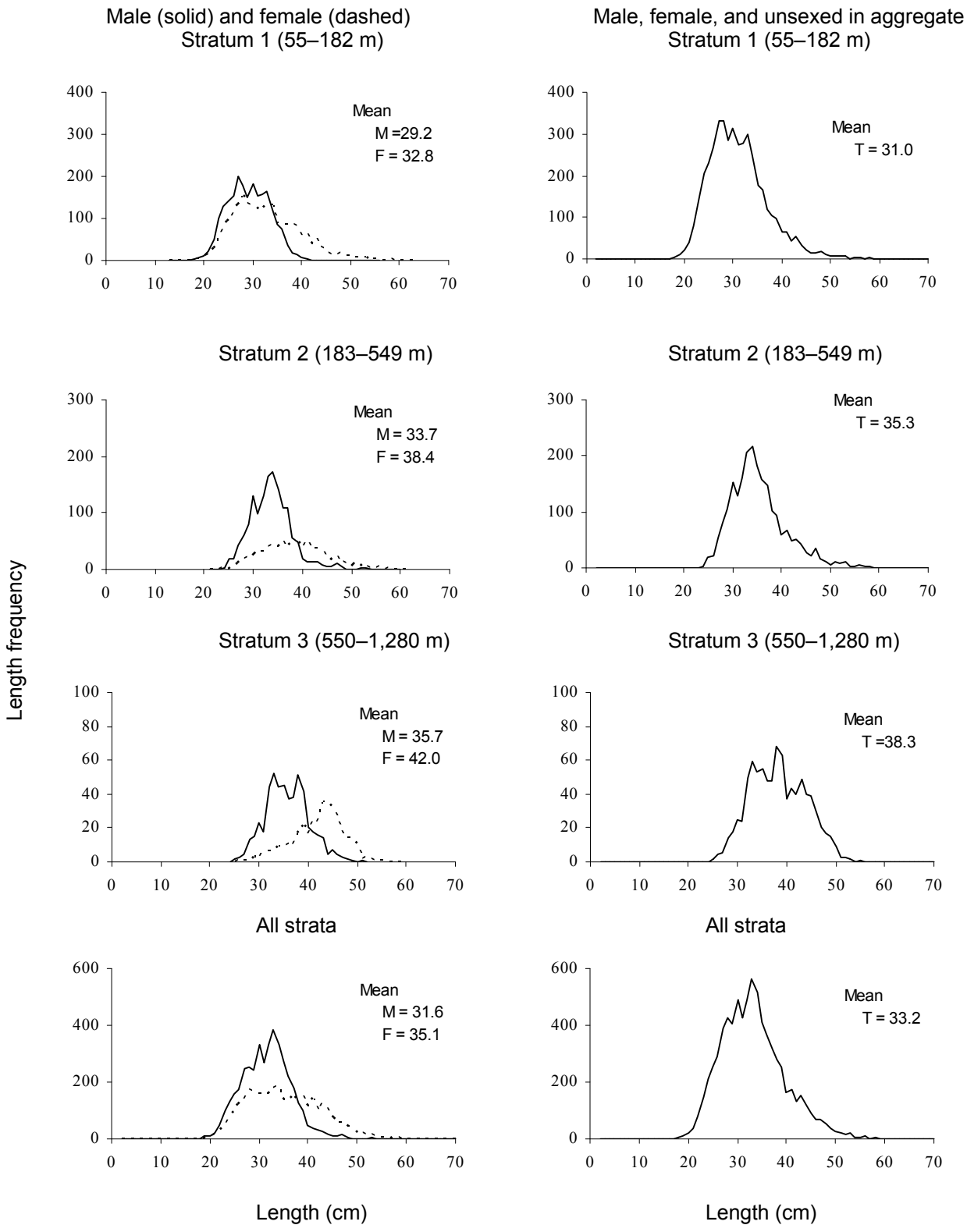

Figure 40. Unweighted length-frequency data and mean lengths (cm) of Dover sole by depth stratum and by sex (M = male, F = female, and T = males, females, and unsexed) for the INPFC Columbia area from the 2005 West Coast groundfish trawl survey.

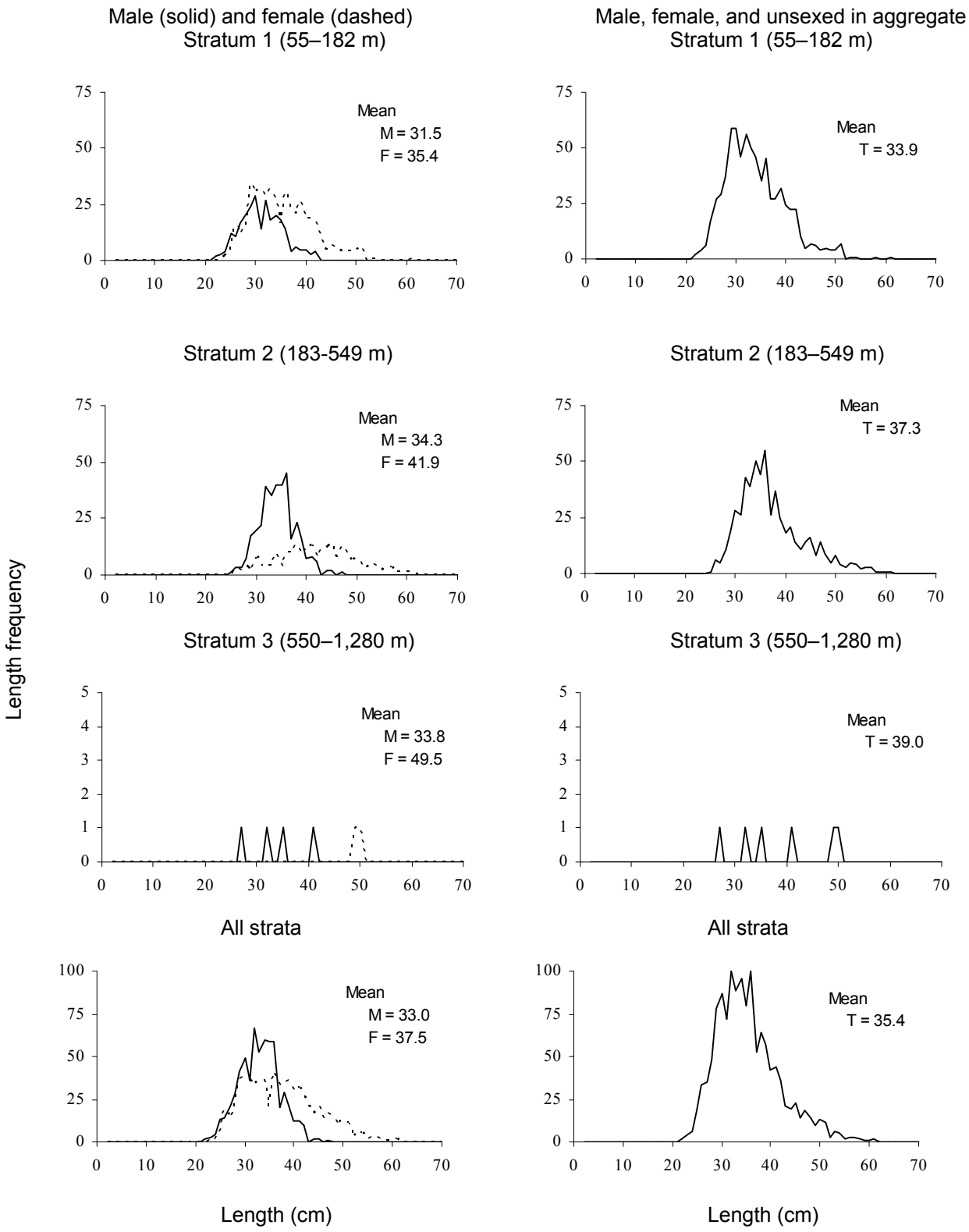

Figure 41. Unweighted length-frequency data and mean lengths (cm) of Dover sole by depth stratum and by sex (M = male, F = female, and T = males, females, and unsexed) for the INPFC U.S.-Vancouver area from the 2005 West Coast groundfish trawl survey.

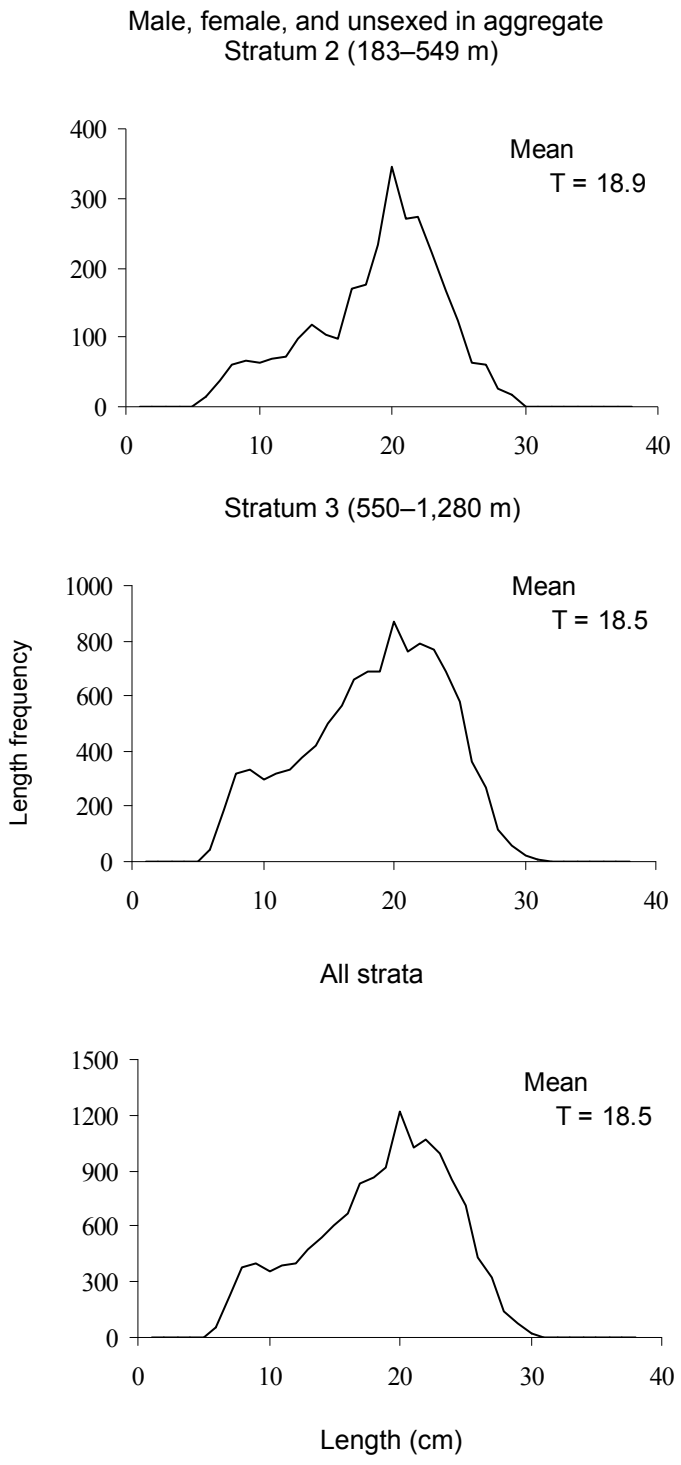

Figure 42. Unweighted length-frequency data and mean lengths (cm) of longspine thornyhead by depth stratum for all INPFC areas sampled during the 2005 West Coast groundfish trawl survey (T = males, females, and unsexed in aggregate).

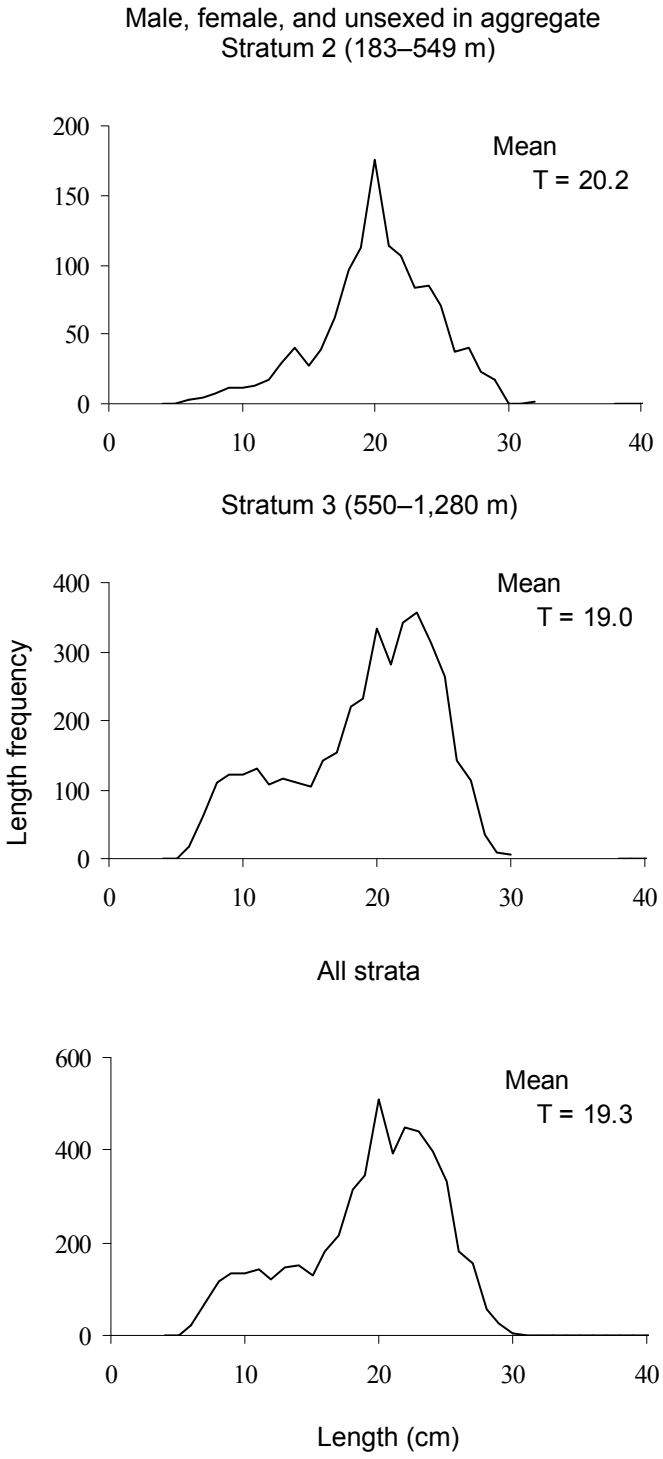

Figure 43. Unweighted length-frequency data and mean lengths (cm) of longspine thornyhead by depth stratum for the Conception INPFC area from the 2005 West Coast groundfish trawl survey (T = males, females, and unsexed in aggregate).

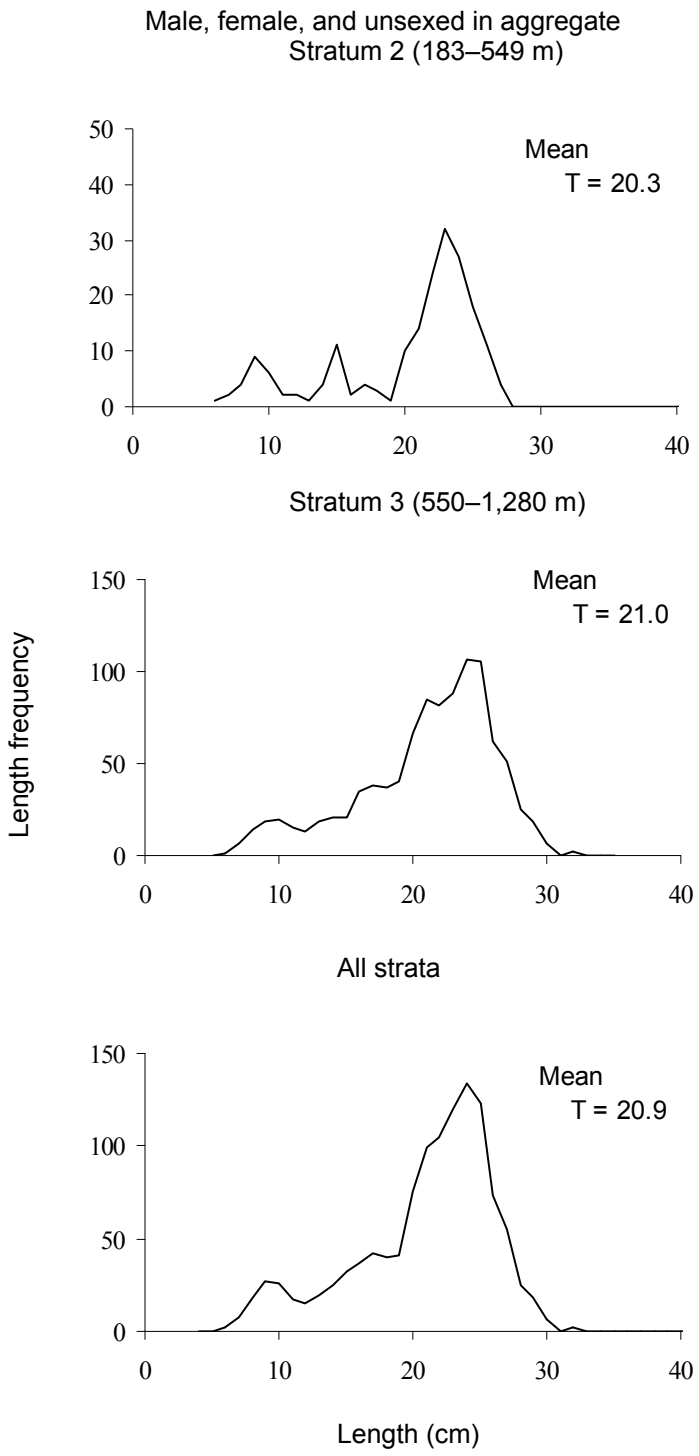

Figure 44. Unweighted length-frequency data and mean lengths (cm) of longspine thornyhead by depth stratum for the Monterey INPFC area from the 2005 West Coast groundfish trawl survey (T = males, females, and unsexed in aggregate).

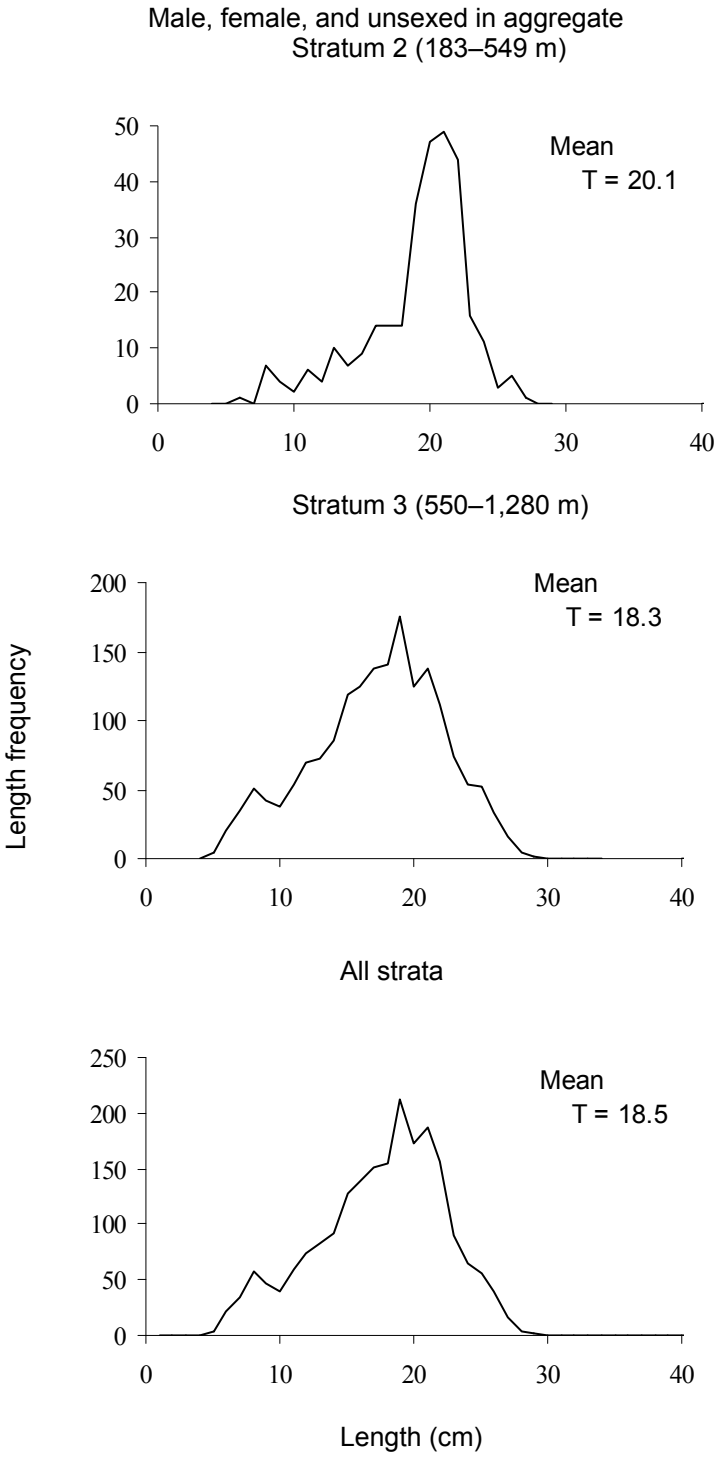

Figure 45. Unweighted length-frequency data and mean lengths (cm) of longspine thornyhead by depth stratum for the Eureka INPFC area from the 2005 West Coast groundfish trawl survey (T = males, females, and unsexed in aggregate).

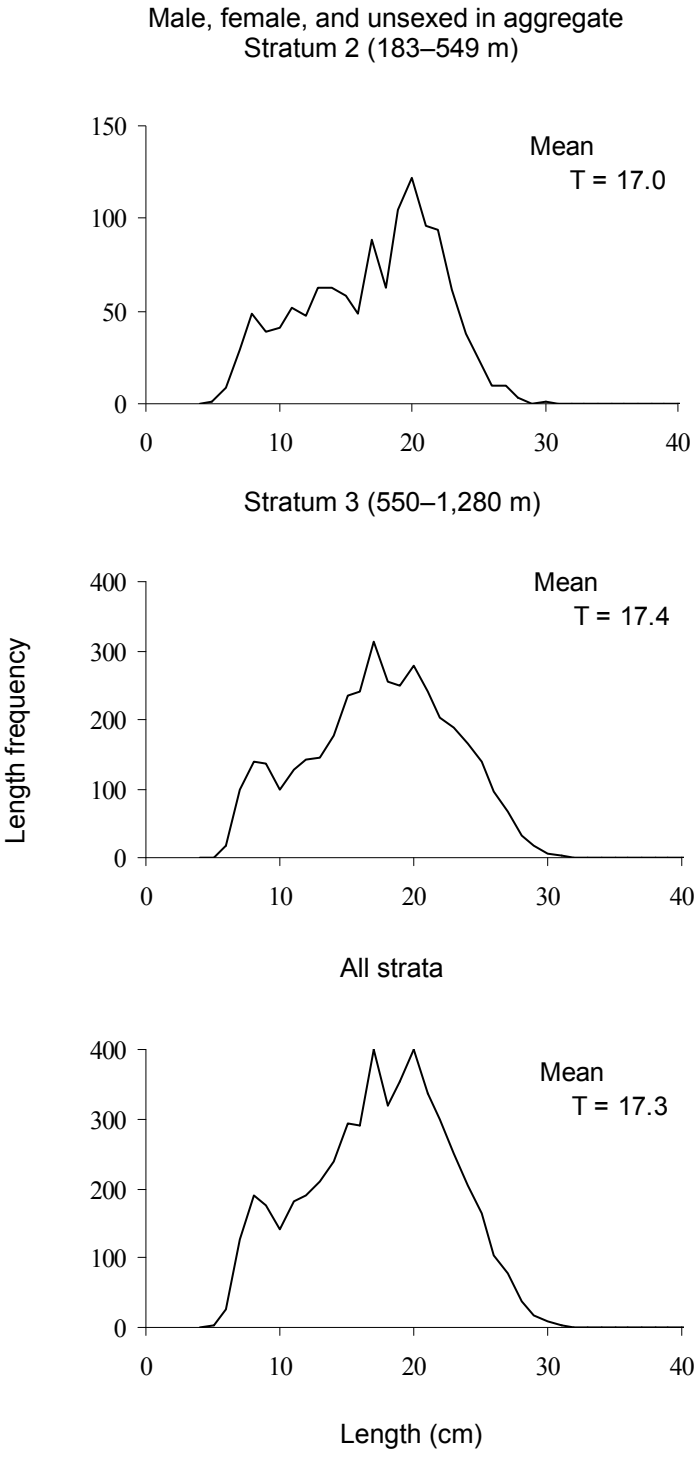

Figure 46. Unweighted length-frequency data and mean lengths (cm) of longspine thornyhead by depth stratum for the Columbia INPFC area from the 2005 West Coast groundfish trawl survey (T = males, females, and unsexed in aggregate).

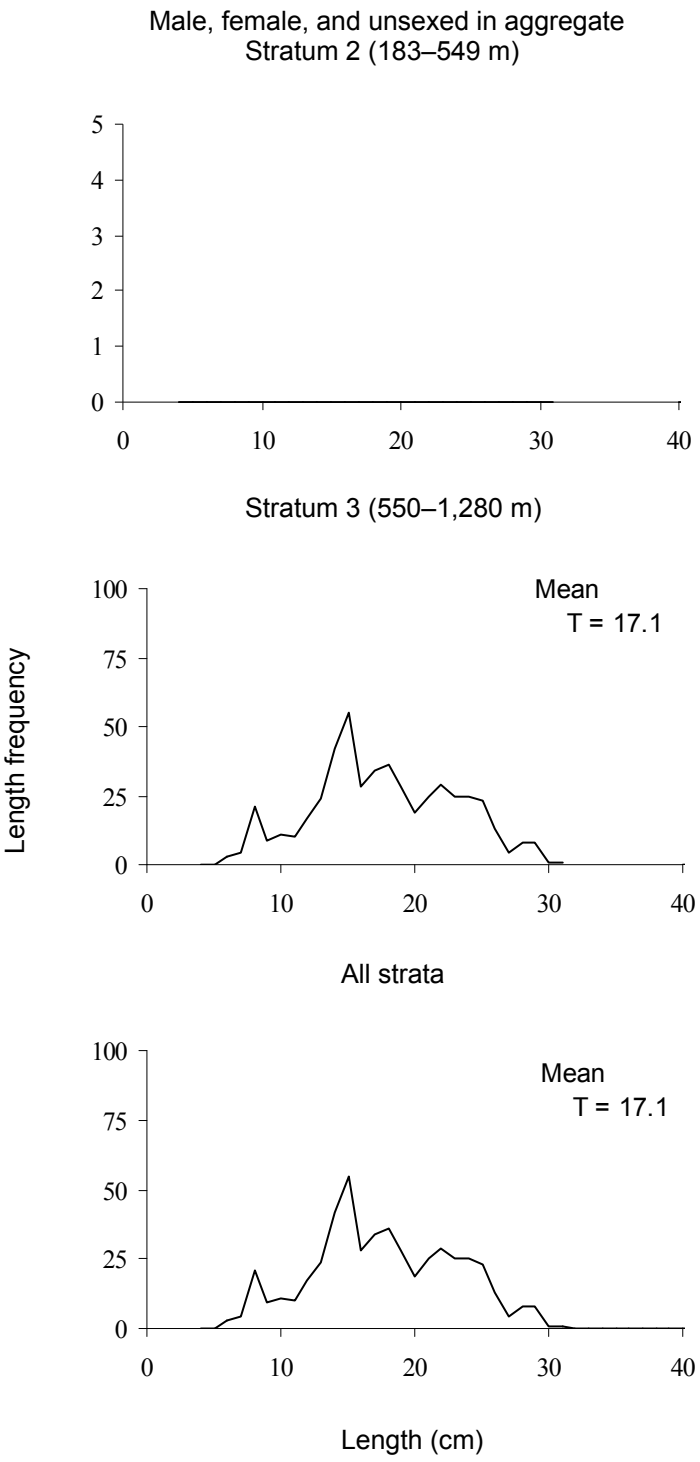

Figure 47. Unweighted length-frequency data and mean lengths (cm) of longspine thornyhead by depth stratum for the U.S.-Vancouver INPFC area from the 2005 West Coast groundfish trawl survey (T = males, females, and unsexed in aggregate).

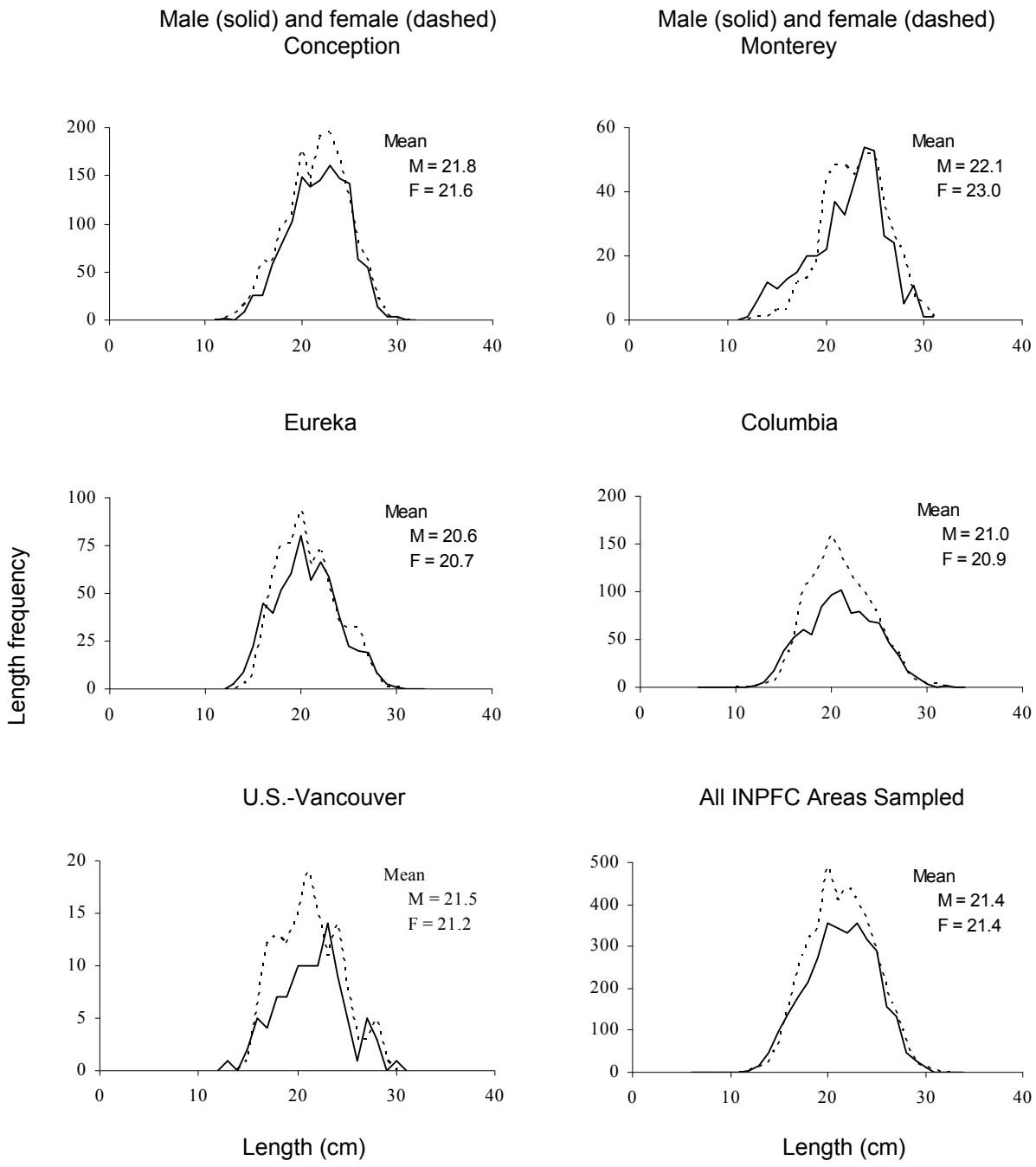

Figure 48. Unweighted length-frequency data and mean lengths (cm) of sexed longspine thornyhead (M = male, F = female) from stratum 3 (550–1,280 m) by INPFC area during the 2005 West Coast groundfish trawl survey.

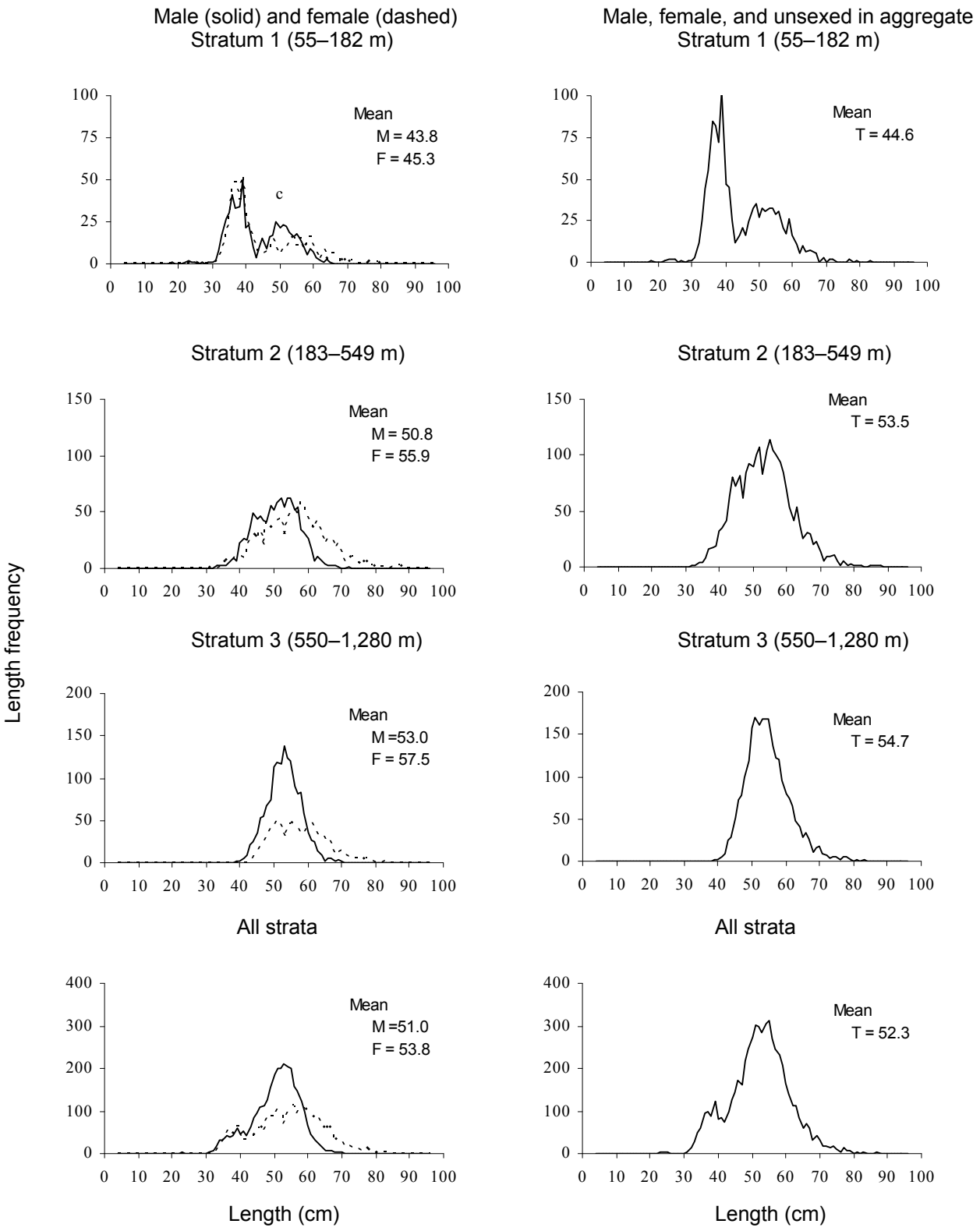

Figure 49. Unweighted length-frequency data and mean lengths (cm) of sablefish by depth stratum and by sex (M = male, F = female, and T = males, females, and unsexed in aggregate) for all INPFC areas sampled from the 2005 West Coast groundfish trawl survey.

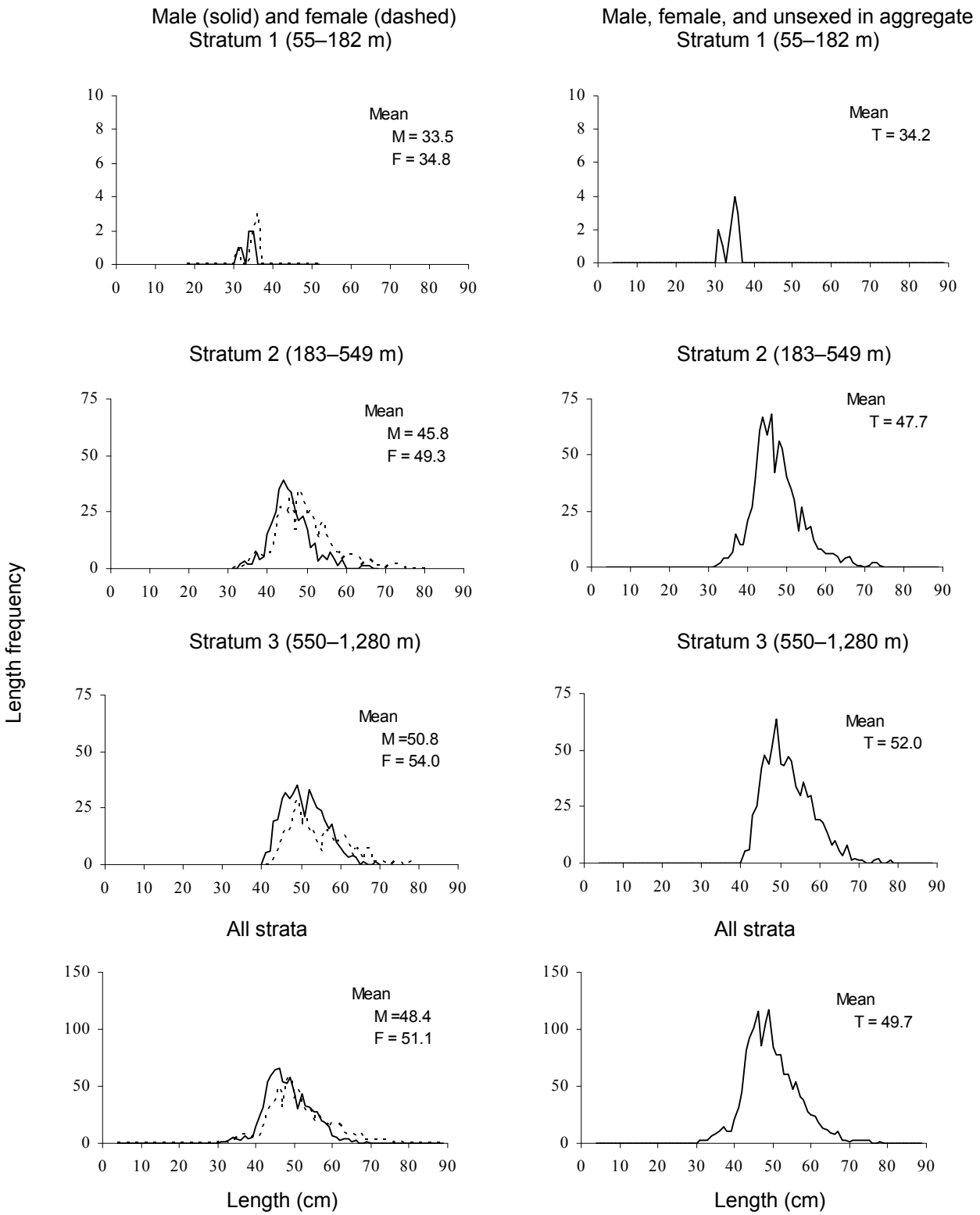

Figure 50. Unweighted length-frequency data and mean lengths (cm) of sablefish by depth stratum and by sex (M = male, F = female, and T = males, females, and unsexed in aggregate) for the INPFC Conception area from the 2005 West Coast groundfish trawl survey.

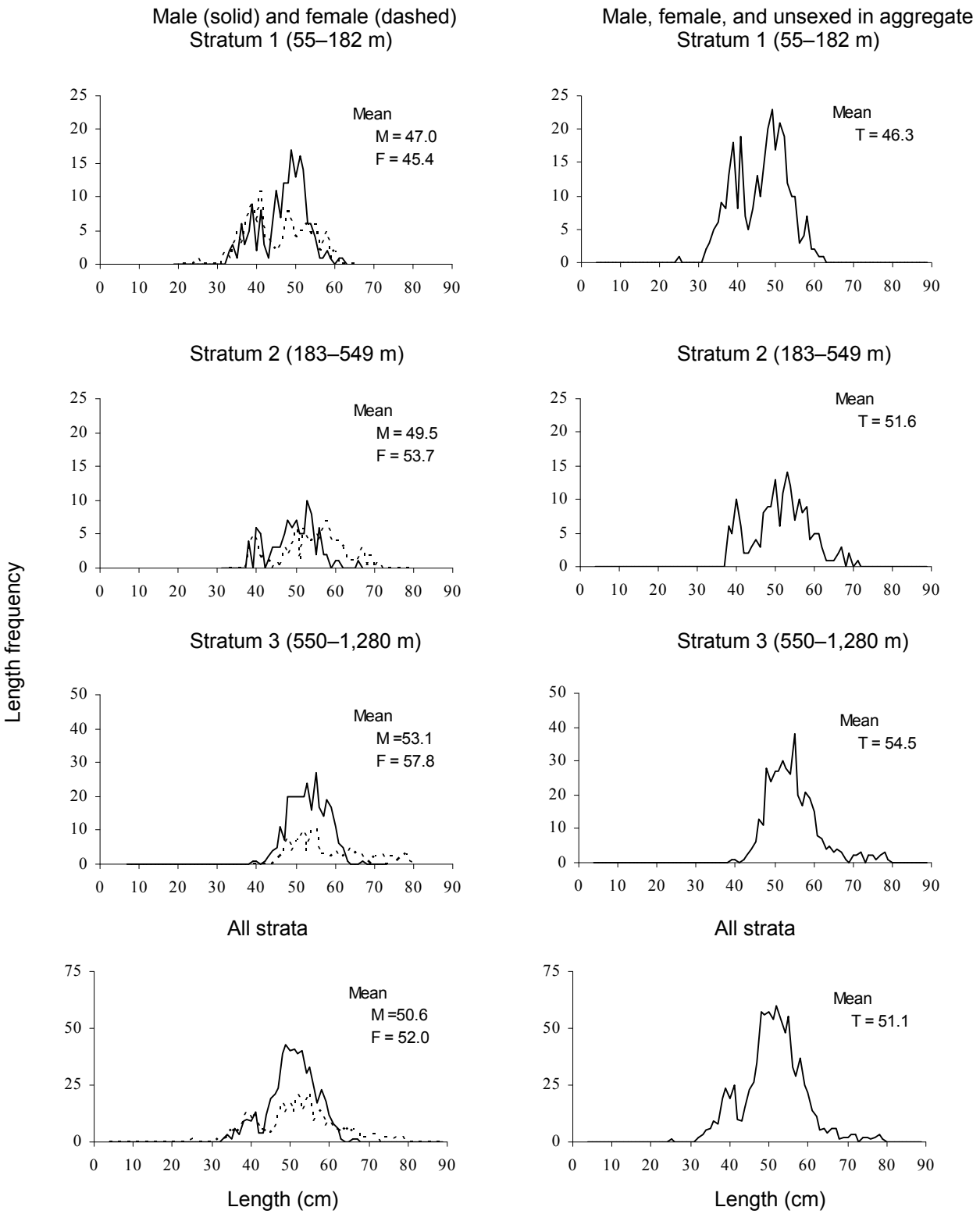

Figure 51. Unweighted length-frequency data and mean lengths (cm) of sablefish by depth stratum and by sex (M = male, F = female, and T = males, females, and unsexed in aggregate) for the INPFC Monterey area from the 2005 West Coast groundfish trawl survey.

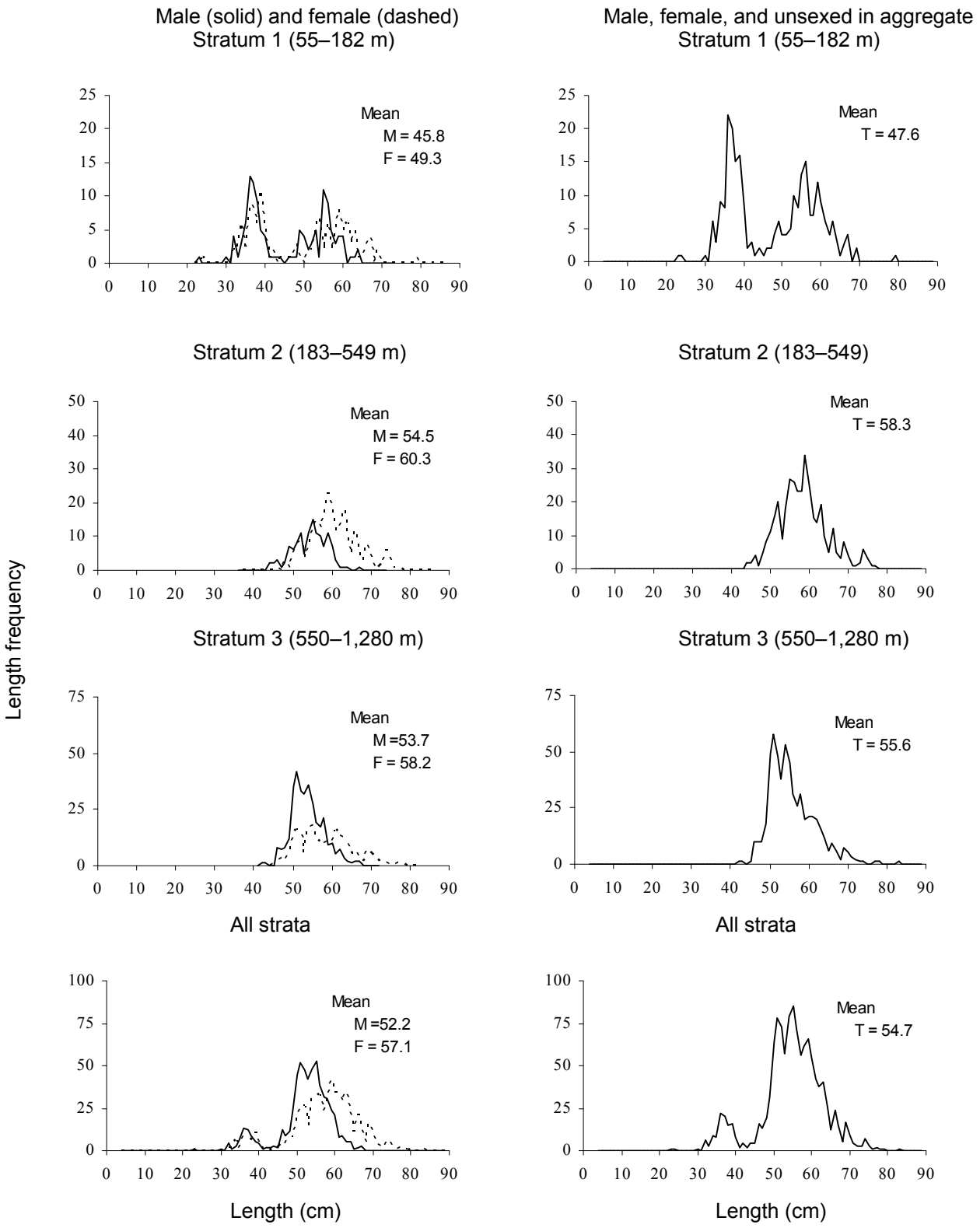

Figure 52. Unweighted length-frequency data and mean lengths (cm) of sablefish by depth stratum and by sex (M = male, F = female, and T = males, females, and unsexed in aggregate) for the INPFC Eureka area from the 2005 West Coast groundfish trawl survey.

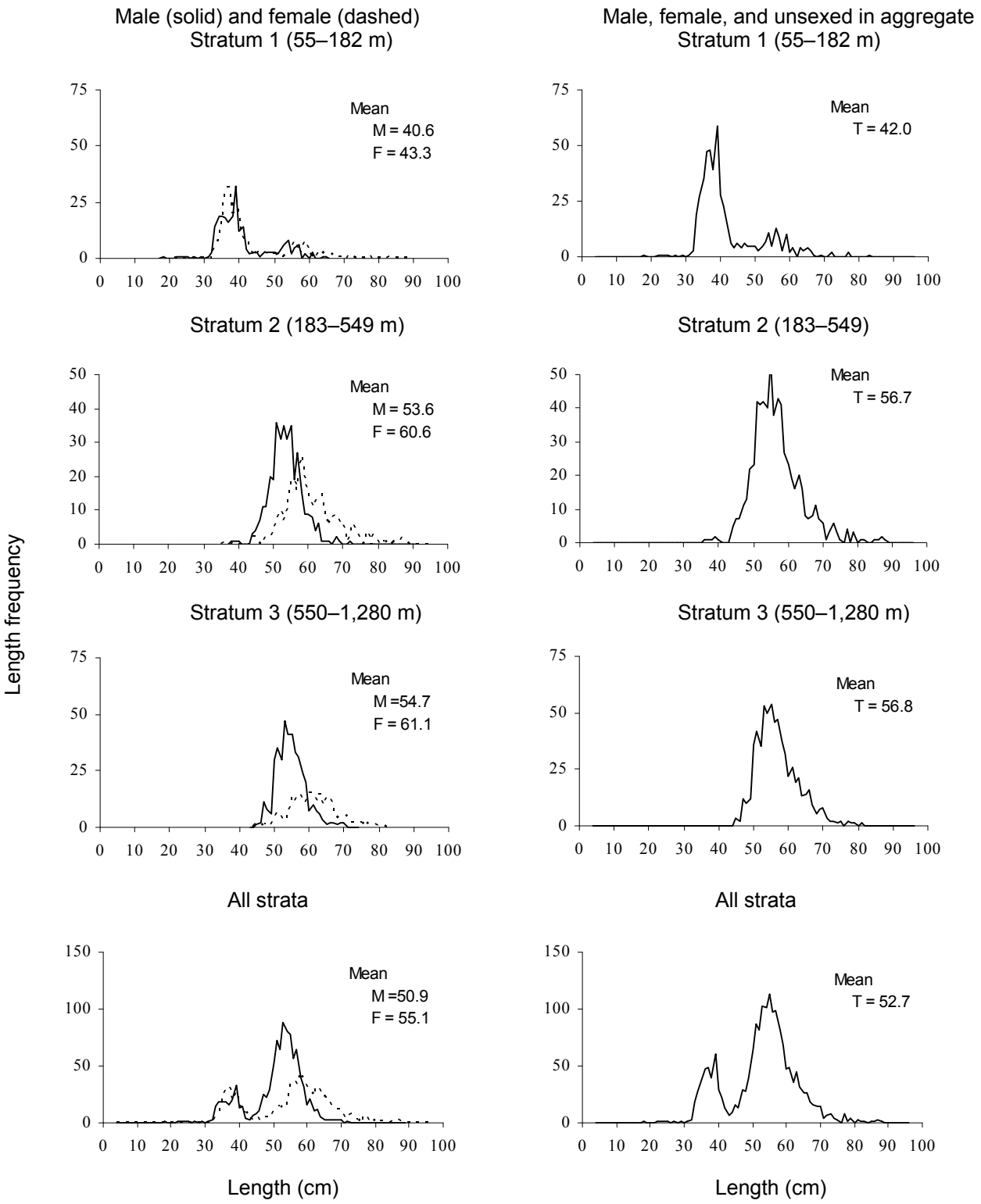

Figure 53. Unweighted length-frequency data and mean lengths (cm) of sablefish by depth stratum and by sex (M = male, F = female, and T = males, females, and unsexed in aggregate) for the INPFC Columbia area from the 2005 West Coast groundfish trawl survey.

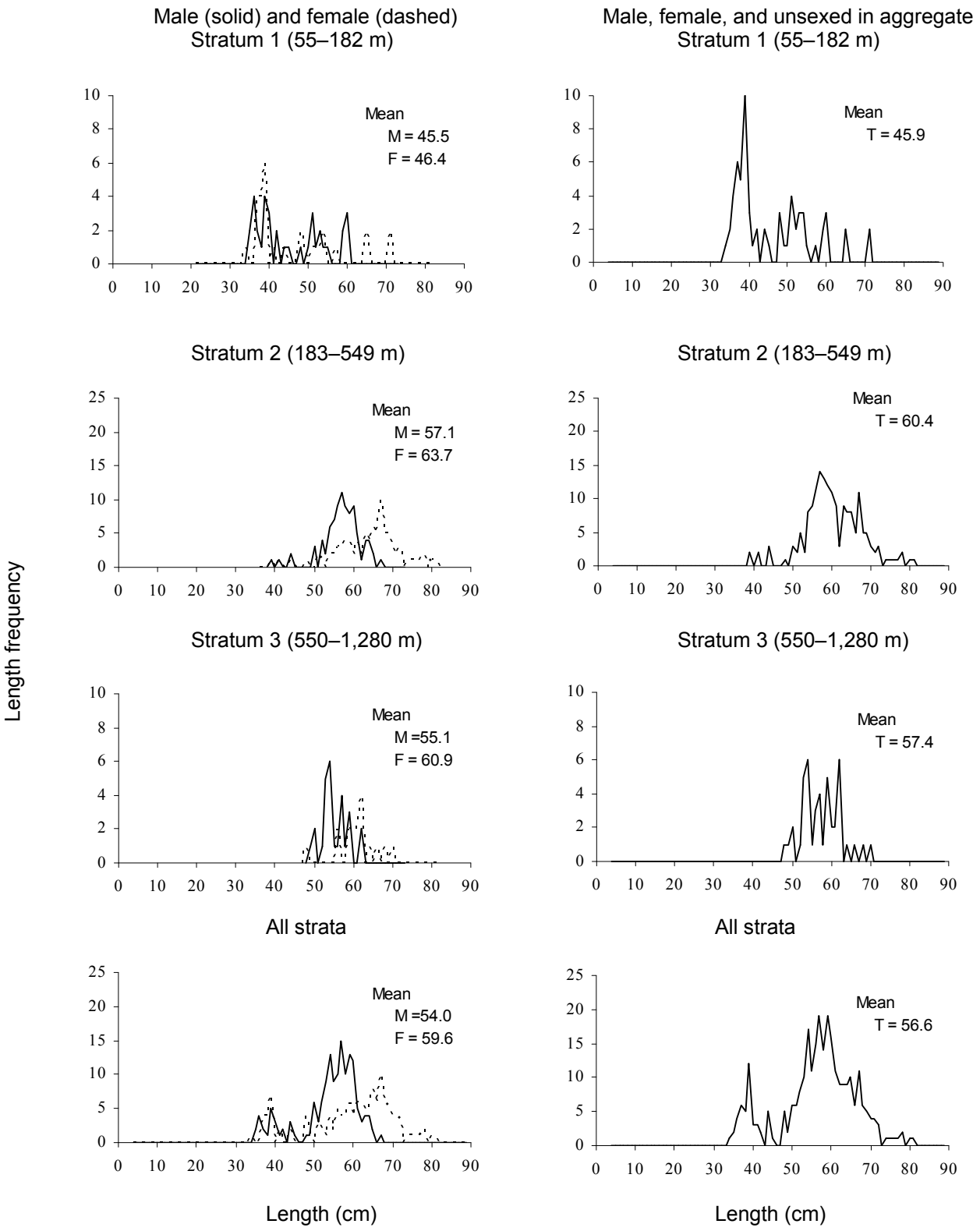

Figure 54. Unweighted length-frequency data and mean lengths (cm) of sablefish by depth stratum and by sex (M = male, F = female, and T = males, females, and unsexed in aggregate) for the INPFC U.S.-Vancouver area from the 2005 West Coast groundfish trawl survey.

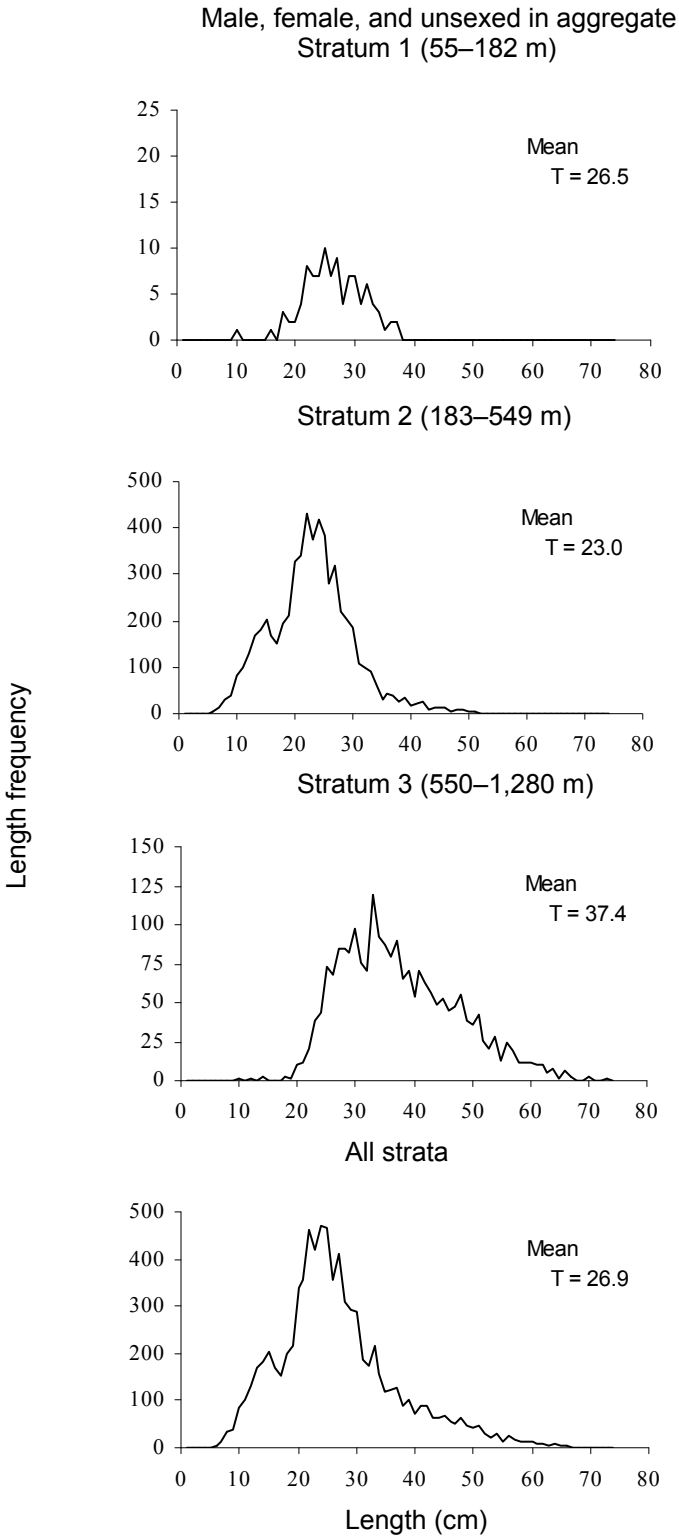

Figure 55. Unweighted length-frequency data and mean lengths (cm) of shortspine thornyhead by depth stratum for all INPFC areas sampled during the 2005 West Coast groundfish trawl survey (T = males, females, and unsexed).

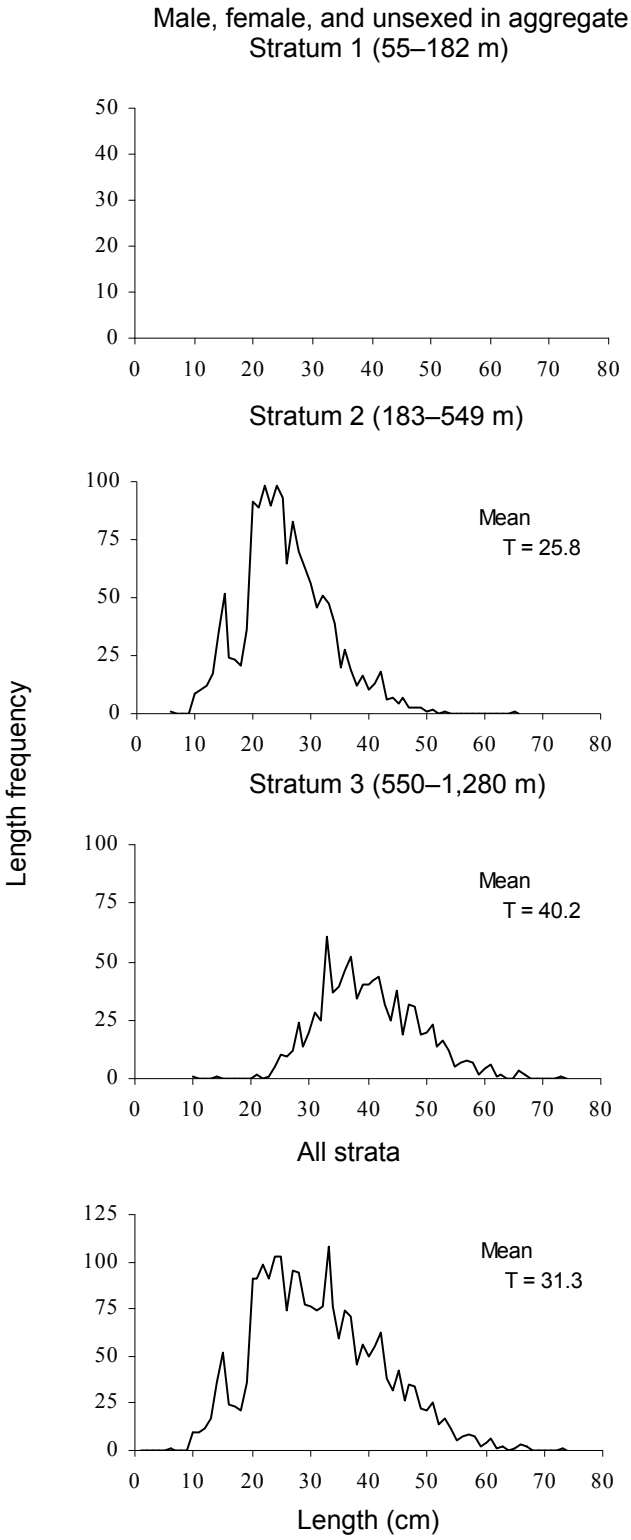

Figure 56. Unweighted length-frequency data and mean lengths (cm) of shortspine thornyhead by depth stratum for the INPFC Conception area from the 2005 West Coast groundfish trawl survey (T = males, females, and unsexed).

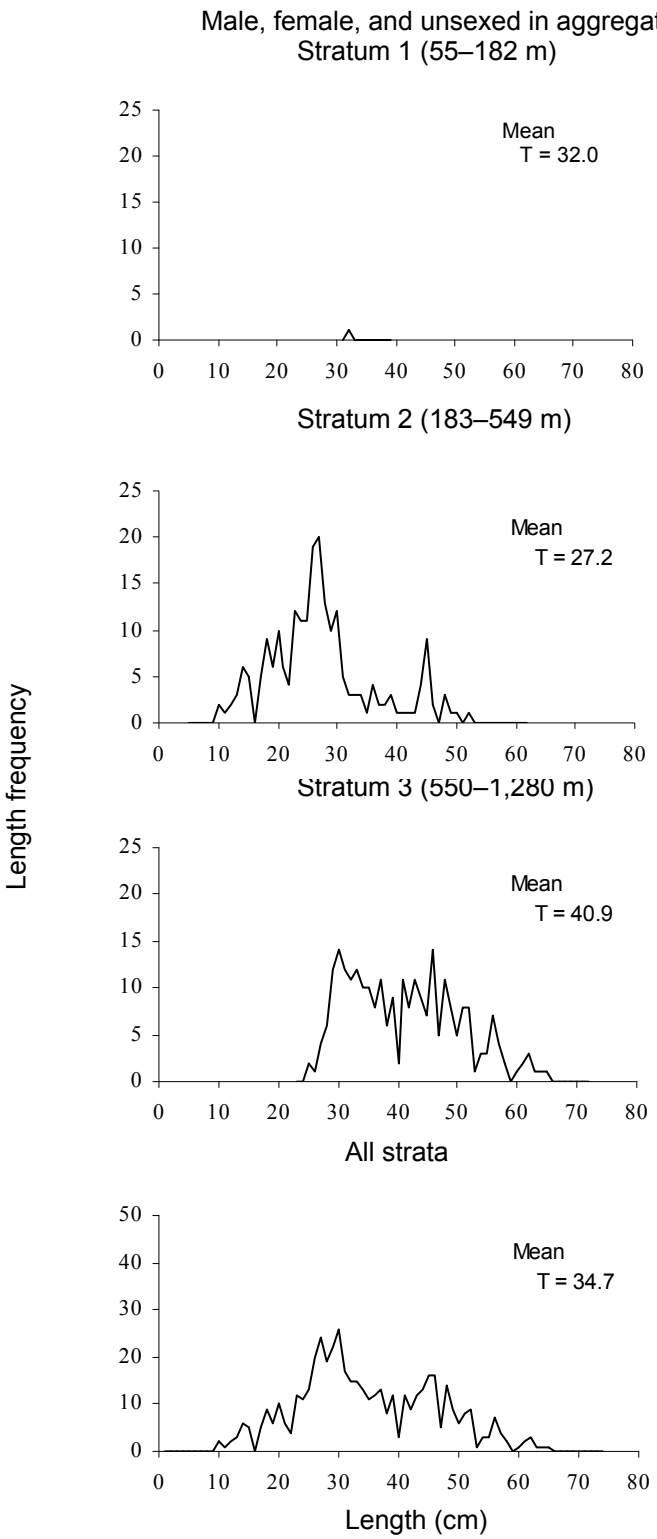

Figure 57. Unweighted length-frequency data and mean lengths (cm) of shortspine thornyhead by depth stratum for the INPFC Monterey area from the 2005 West Coast groundfish trawl survey (T = males, females, and unsexed).

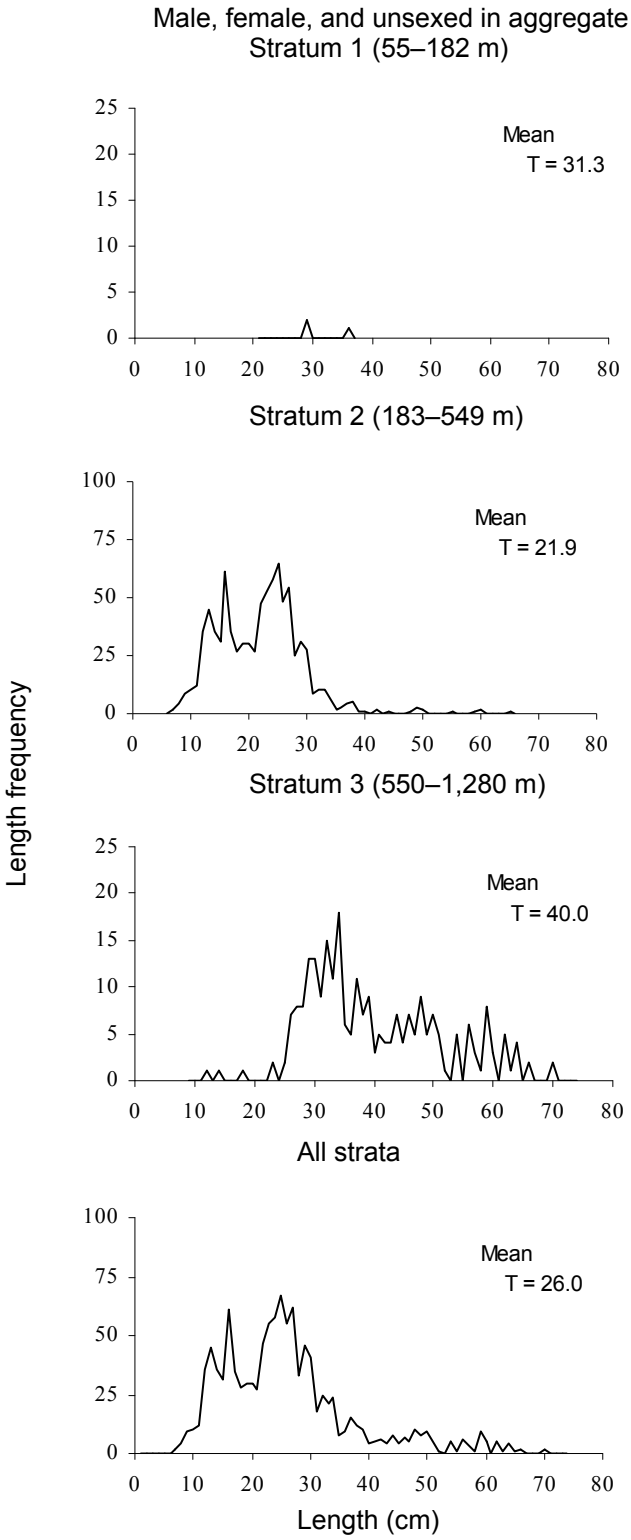

Figure 58. Unweighted length-frequency data and mean lengths (cm) of shortspine thornyhead by depth stratum for the INPFC Eureka area from the 2005 West Coast groundfish trawl survey (T = males, females, and unsexed).

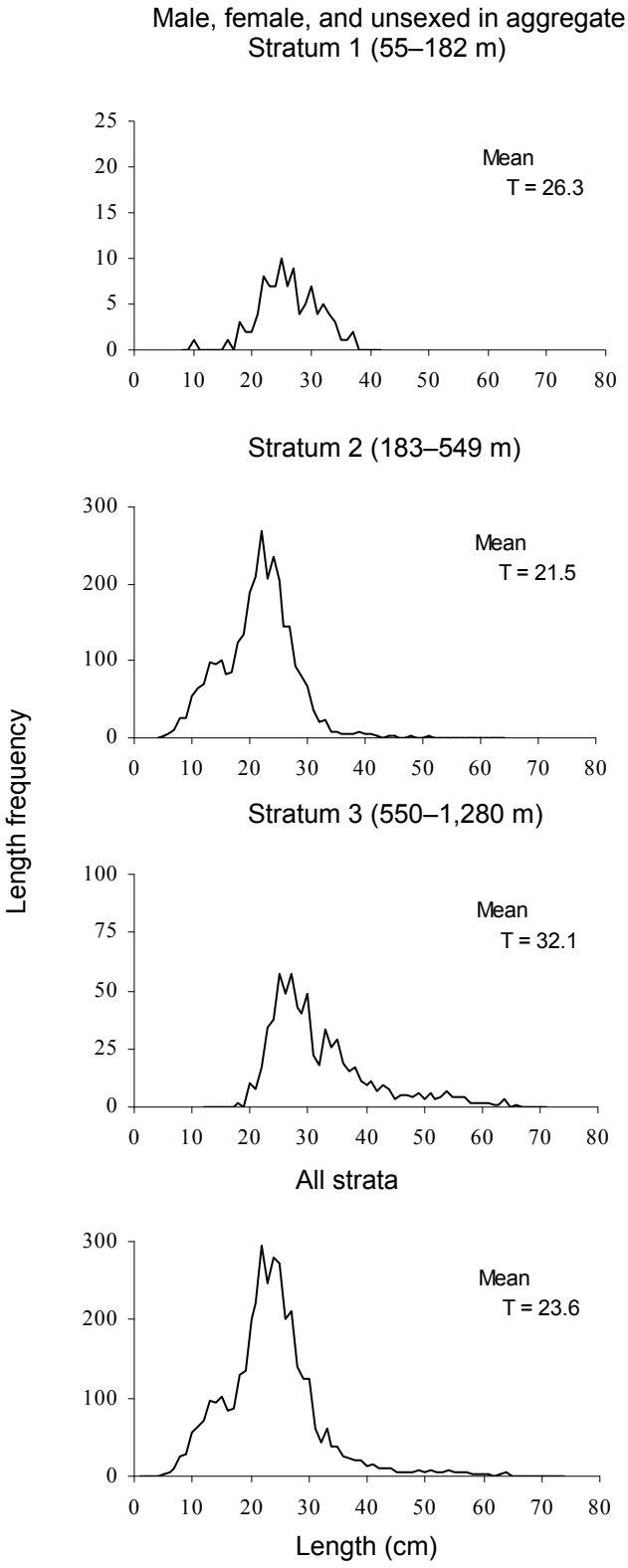

Figure 59. Unweighted length-frequency data and mean lengths (cm) of shortspine thornyhead by depth stratum for the INPFC Columbia area from the 2005 West Coast groundfish trawl survey (T = males, females, and unsexed).

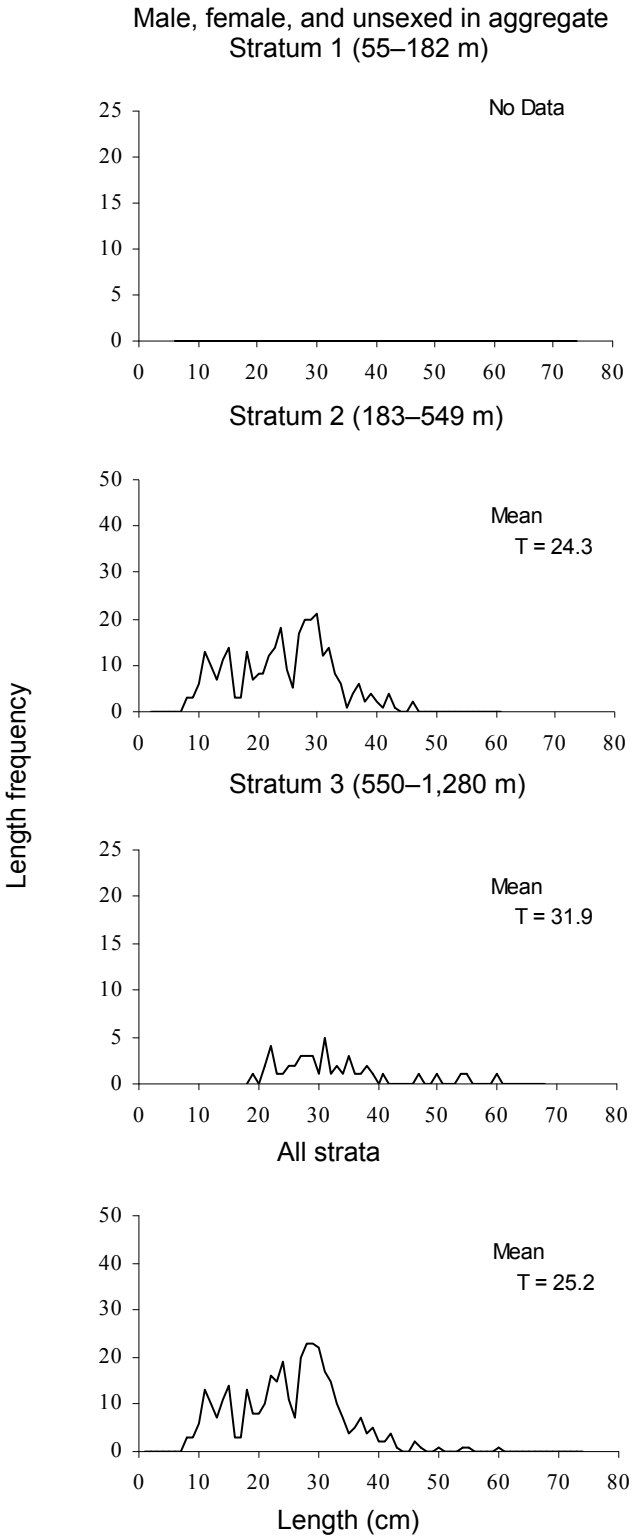

Figure 60. Unweighted length-frequency data and mean lengths (cm) of shortspine thornyhead by depth stratum for the INPFC U.S.-Vancouver area from the 2005 West Coast groundfish trawl survey (T = males, females, and unsexed).

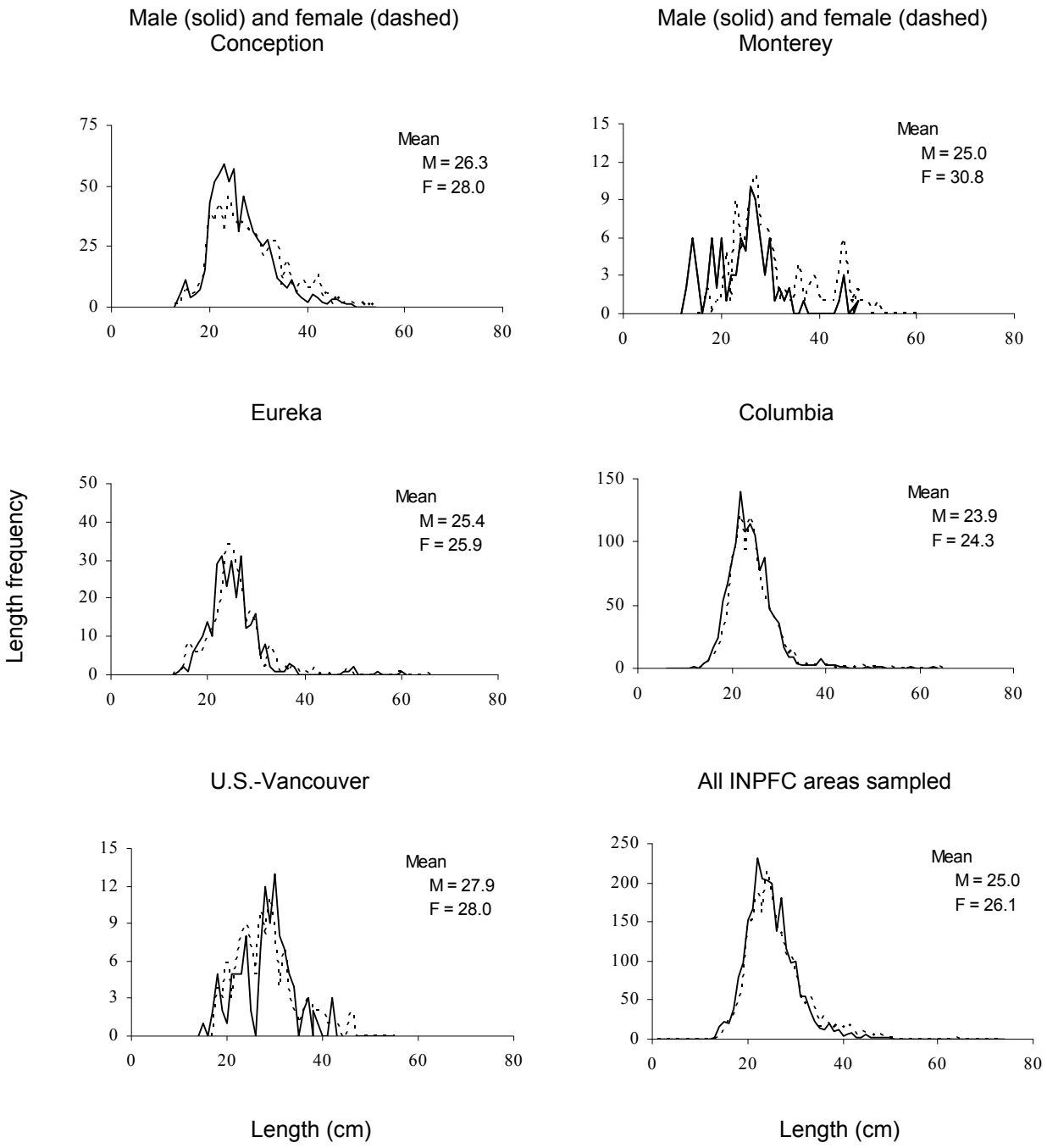

Figure 61. Unweighted length-frequency data and mean lengths (cm) of sexed shortspine thornyhead (M = male, F = female) from stratum 2 (183–549 m) by INPFC area during the 2005 West Coast groundfish trawl survey.

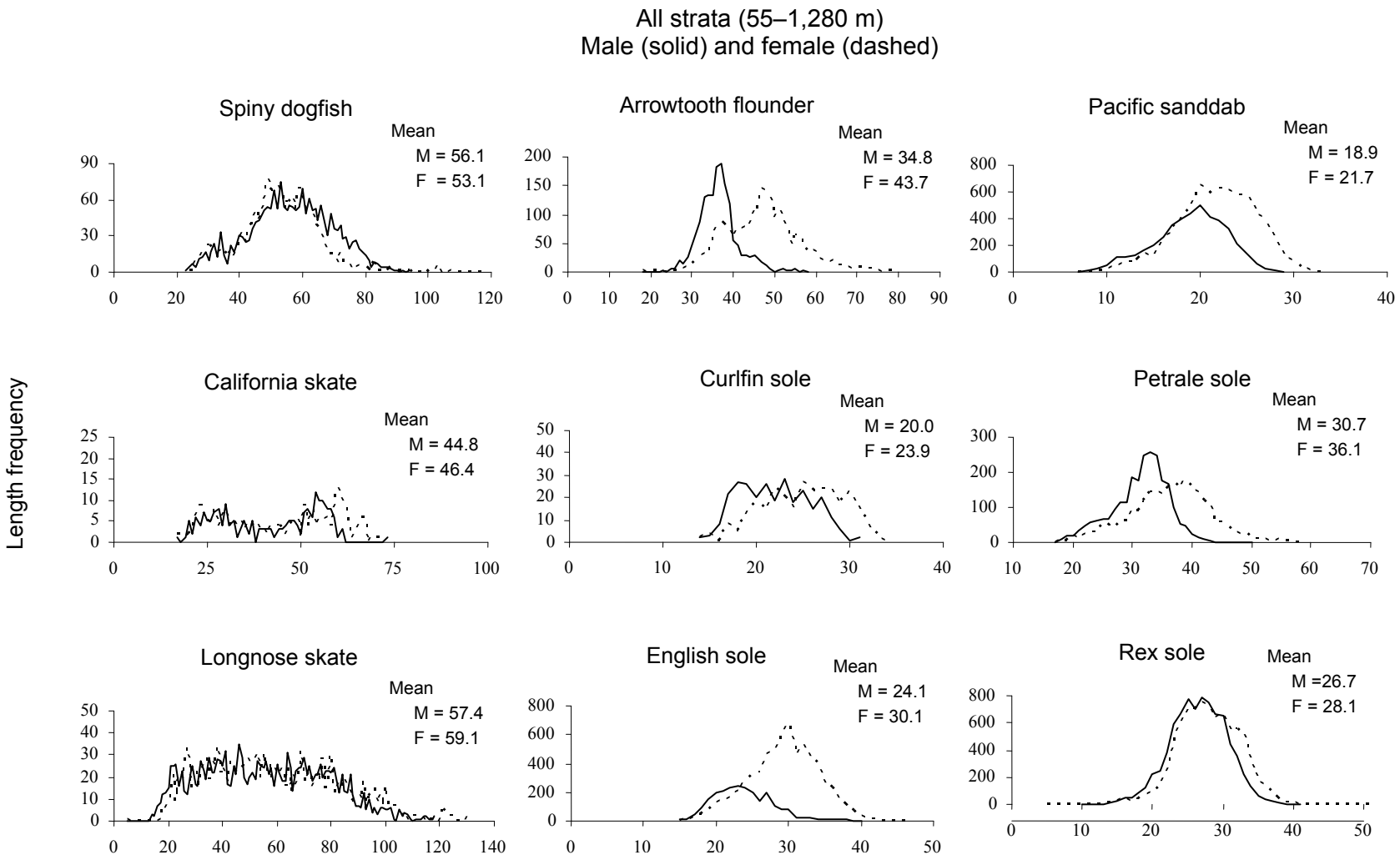

Figure 62. Unweighted length-frequency data and mean lengths (cm) of spiny dogfish, arrowtooth flounder, Pacific sanddab, California skate, curlfin sole, petrale sole, longnose skate, English sole, and rex sole by sex (M = males, F = females) for all depths and all INPFC areas sampled from the 2005 West Coast groundfish trawl survey.

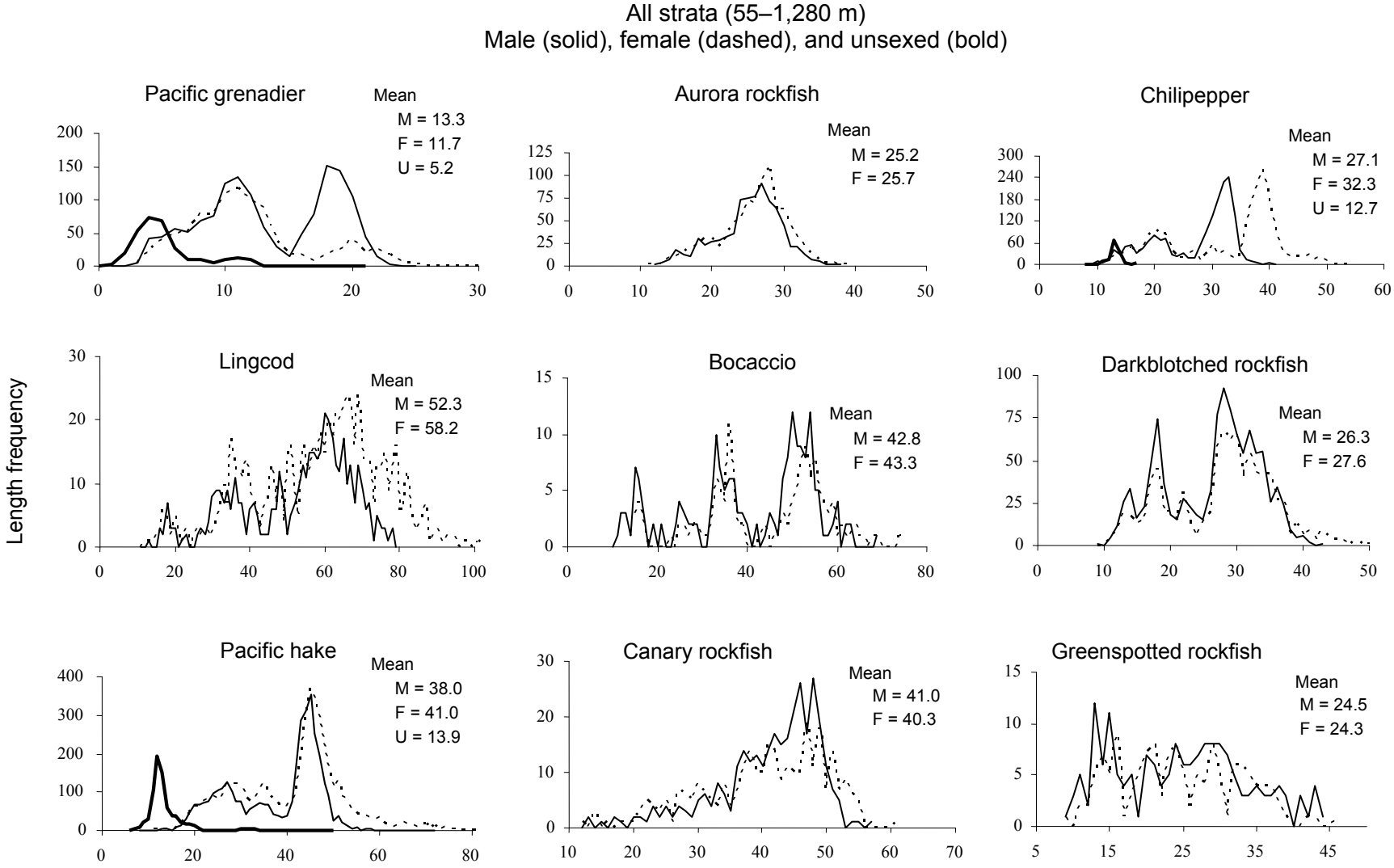

Figure 63. Unweighted length-frequency data and mean lengths (cm) of Pacific grenadier, aurora rockfish, chilipepper rockfish, lingcod, bocaccio, darkblotched rockfish, Pacific hake, canary rockfish, and greenspotted rockfish by sex (M = males, F = females, U = unsexed) for all depths and all INPFC areas sampled from the 2005 West Coast groundfish trawl survey.

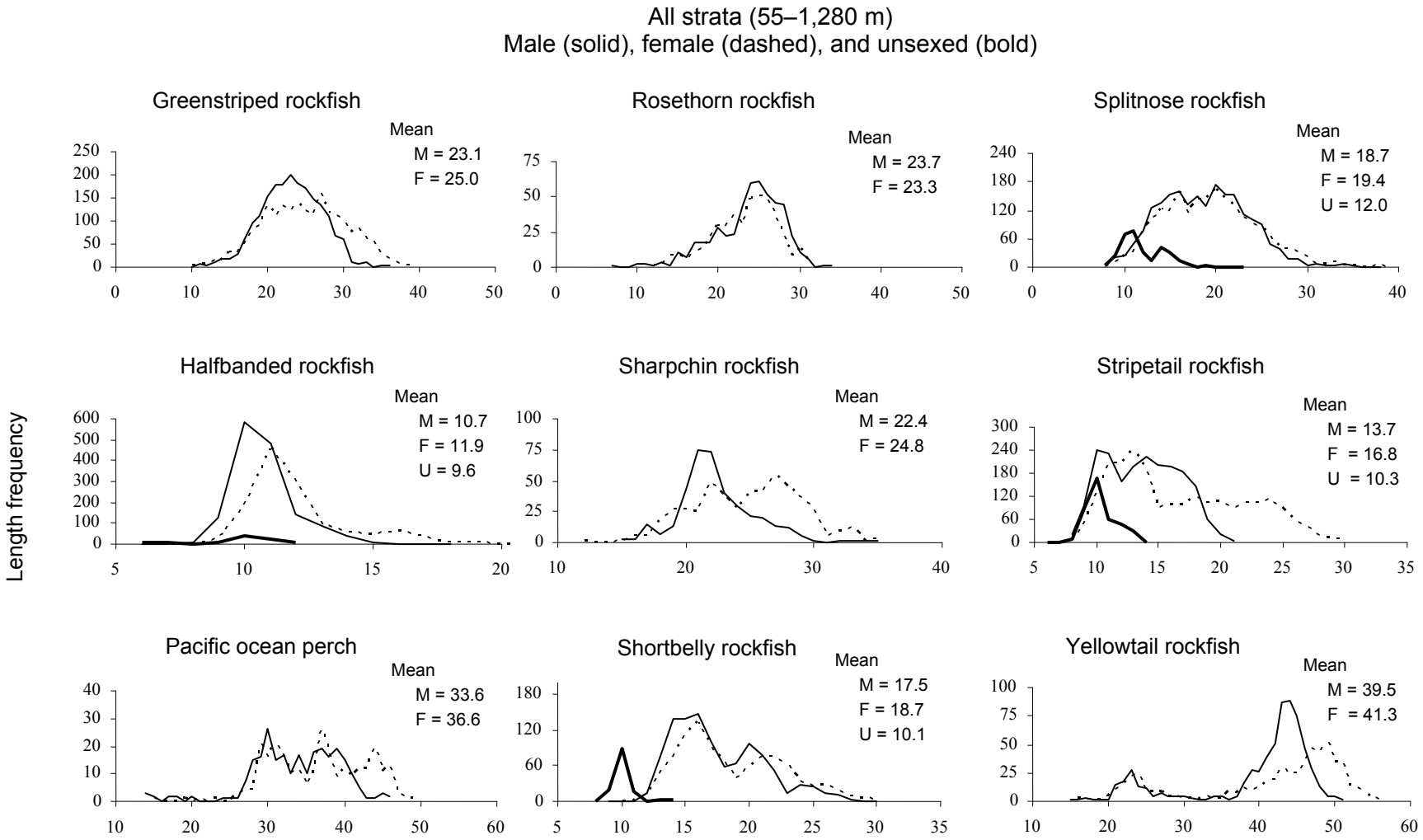

Figure 64. Unweighted length-frequency data and mean lengths (cm) of greenstriped rockfish, rosethorn rockfish, splitnose rockfish, halfbanded rockfish, sharpchin rockfish, stripetail rockfish, Pacific ocean perch, shortbelly rockfish, and yellowtail rockfish by sex (M = males, F = females, U = unsexed) for all depths and all INPFC areas sampled from the 2005 West Coast groundfish trawl survey.

Weight-length Relationships

Individual measurements of weight (g) and length (cm) were collected for 56 groundfish species during the 2005 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 cm; and a and b are constants. As 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 56 groundfish species (Table 2) to determine ages. To date, ages have been determined for age structures collected from arrowtooth flounder, English sole, sablefish, and Pacific ocean perch. For this report, each species is treated as a single homogeneous stock and all age data collected during the 2005 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 the 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 using least squares, nonlinear regression (SAS Institute Inc. 1999). The von Bertalanffy growth model parameters were estimated for males and females separately to account for possible sex-specific growth rates and for both sexes combined (Table 30). Growth curves were compared by using the extra sum of square principle (Draper and Smith 1981). Growth between the sexes was significantly different ($P < 0.05$), with females growing slower but reaching a larger maximum size than males (Figure 65). Age composition of management species are reported in greater geographic detail in stock assessment documents published by the Pacific Fishery Management Council.

Table 29. The weight-length relationships from the 2005 West Coast groundfish trawl survey using a least squares fit for Equation 4.

Species	Number sampled	Weight-length coefficients		r^2
		a	b	
Spiny dogfish	953	0.0038	3.0179	0.98
Spotted ratfish	25	0.0978	2.8207	0.97
Pacific sanddab	1,145	0.0094	3.0081	0.94
Arrowtooth flounder	875	0.0038	3.2408	0.98
Petrale sole	1,968	0.0025	3.4259	0.98
English sole	1,363	0.0101	2.9607	0.96
Dover sole	2,588	0.0028	3.3564	0.98
Starry flounder	43	0.0052	3.2371	0.98
Sablefish	2,963	0.0031	3.2893	0.98
Pacific grenadier	545	0.2406	2.7289	0.96
Lingcod	970	0.0024	3.3182	0.99
Kelp greenling	47	0.0050	3.2700	0.95
Pacific hake	416	0.0059	3.0224	0.98
Aurora rockfish	574	0.0092	3.1616	0.98
Bank rockfish	50	0.0091	3.1346	0.97
Blackgill rockfish	181	0.0157	3.0021	0.99
Blue rockfish	15	0.0080	3.2002	0.97
Bocaccio rockfish	208	0.0084	3.0879	0.99
Brown rockfish	25	0.0043	3.3863	0.95
Calico rockfish	121	0.0297	2.7255	0.73
California scorpionfish	147	0.0205	2.9693	0.96
Canary rockfish	278	0.0103	3.1364	0.99
Chilipepper rockfish	898	0.0090	3.1203	0.99
Copper rockfish	43	0.0115	3.1287	0.99
Cowcod	32	0.0084	3.1868	0.99
Darkblotched rockfish	799	0.0116	3.1233	0.99
Flag rockfish	16	0.0198	2.9407	0.98
Freckled rockfish	44	0.0023	3.6945	0.94
Greenblotched rockfish	29	0.0119	3.1006	0.99
Greenspotted rockfish	183	0.0081	3.2082	0.99
Greenstriped rockfish	735	0.0109	3.0559	0.97
Halfbanded rockfish	428	0.1102	2.1658	0.64
Honeycomb rockfish	33	0.0071	3.2852	0.87
Longspine thornyhead	1145	0.0175	2.8751	0.95
Pacific ocean perch	264	0.0119	3.0542	0.98
Puget Sound rockfish	5	0.0026	3.6066	0.98
Pygmy rockfish	53	0.0327	2.6411	0.87
Redbanded rockfish	173	0.0073	3.2390	0.99
Redstripe rockfish	113	0.0041	3.3510	0.98

Table 29 continued. The weight-length relationships from the 2005 West Coast groundfish trawl survey using a least squares fit for Equation 4.

Species	Number sampled	Weight-length coefficients		r^2
		a	b	
Rosethorn rockfish	323	0.0151	2.9673	0.95
Rosy rockfish	30	0.0014	3.8251	0.87
Rougheye rockfish	140	0.0101	3.1107	0.99
Sharpchin rockfish	157	0.0082	3.1631	0.97
Shortbelly rockfish	585	0.0073	3.1251	0.95
Shortspine thornyhead	1,425	0.0062	3.1893	0.99
Shortraker rockfish	8	0.0174	2.9883	0.95
Silvergray rockfish	46	0.0439	2.7012	0.84
Splitnose rockfish	543	0.0257	2.8490	0.96
Squarespot rockfish	132	0.0173	2.9031	0.92
Starry rockfish	4	0.0491	2.6512	0.99
Stripetail rockfish	589	0.0359	2.6833	0.92
Vermilion rockfish	40	0.0133	3.0894	0.98
Widow rockfish	83	0.0060	3.2438	0.99
Yelloweye rockfish	40	0.0104	3.1509	0.99
Yellowmouth rockfish	23	0.0078	3.1968	0.99
Yellowtail rockfish	381	0.0096	3.1276	0.99

Table 30. Fitted parameters for the von Bertalanffy growth curve model for selected fish species sampled during the 2005 West Coast groundfish trawl survey relating length (fork length, cm) to age (years) for males, females and both sexes combined. Coefficients were determined using a nonlinear least squares fit for Equation 5.

Species	Number sampled	Coefficients		
		L_∞	k	t_0
Arrowtooth flounder				
Female	577	73.427	0.133	–1.740
Male	291	49.029	0.186	–2.480
Combined	868	81.740	0.090	–2.690
English sole				
Female	315	34.942	0.359	–0.940
Male	83	28.307	0.339	–1.890
Combined	398	33.903	0.365	–0.880
Sablefish				
Female	752	65.881	0.358	–1.513
Male	865	55.757	0.458	–1.418
Combined	1,618	59.071	0.418	–1.421
Pacific ocean perch				
Female	122	44.409	0.122	–3.530
Male	141	39.517	0.194	–1.290
Combined	263	41.764	0.163	–1.790

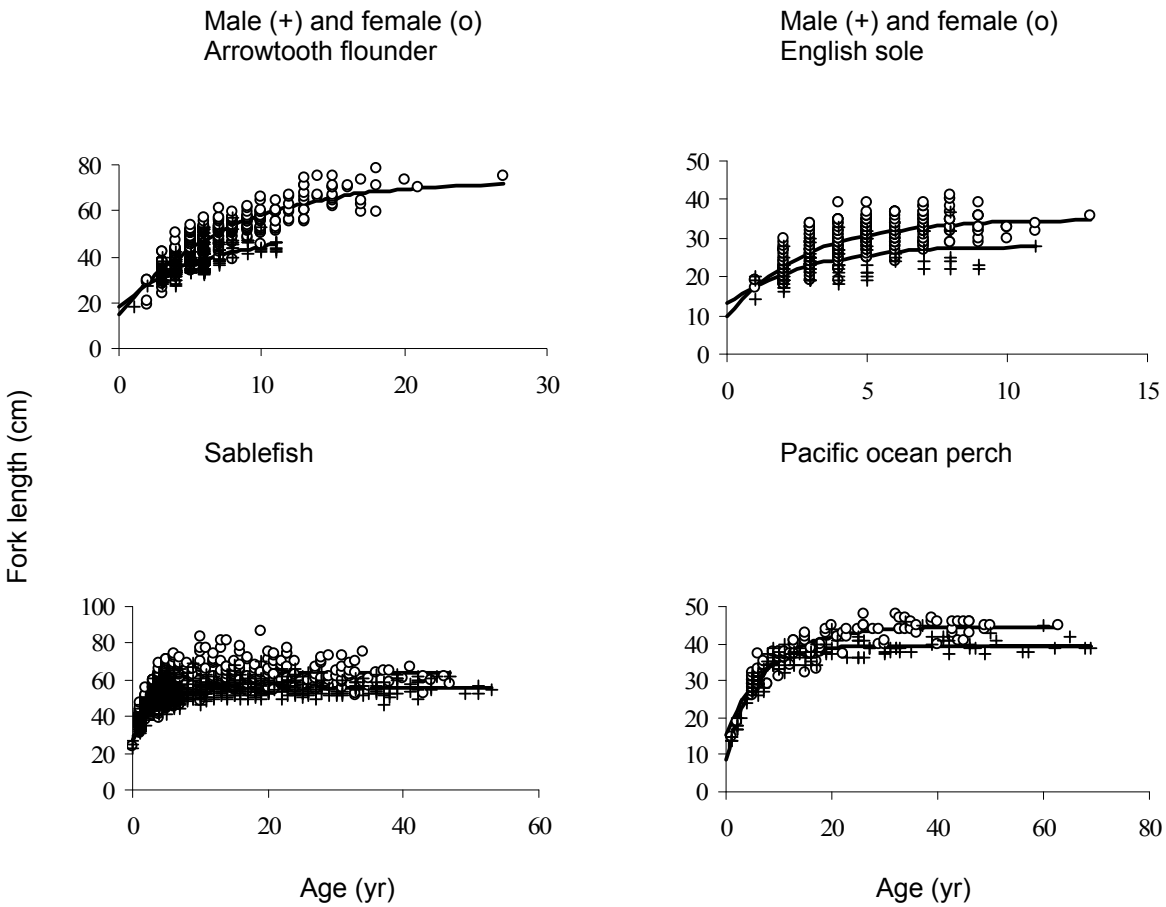

Figure 65. von Bertalanffy growth models for male (+) and female (o) arrowtooth flounder, English sole, sablefish, and Pacific ocean perch from the 2005 West Coast groundfish trawl survey.

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 fishing vessels conducting this survey, thus 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 presented in Helser et al. (2004). The results from that analysis provide a better understanding of vessel effects.

This document only includes information for key species. For information on other species not listed herein or more detailed information, contact the data manager (telephone 206-860-3311 or e-mail beth.horness@noaa.gov).

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