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1984 Spring and Autumn Surveys of Pacific West Coast Upper Continental Slope Groundfish Resources

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Abstract

The Alaska Fisheries Science Center conducted bottom trawl surveys of Pacific west coast upper continental slope groundfish resources from 21 April to 3 May and from 8 September to 6 October, 1984. Two vessels were deployed in the International North Pacific Fisheries Commission Columbia statistical area from Coquille Point (43°00'N) to Cape Falcon (45° 45'N), Oregon. A Soviet research trawler, the *Poseydon*,was conducting hydroacoustic, midwater, and demersal trawling surveys along the west coast during the spring and was available opportunistically to collect demersal trawl samples from slope stations. The fishing vessel *Half Moon Bay* was chartered during the autumn to collect trawl samples from slope waters). Bottom trawl hauls were completed at 54 stations in waters 110-549 m deep in the spring. During the autumn, 93 stations in waters 110-915 m deep were successfully trawled and 4 stations were fished using vertically deployed fish traps to investigate--'the vertical distribution of sablefish, *Anoplopoma fimbria*.

This report describes the sampling and analytical methods used and summarizes the data collected during both surveys. The contents include temperature data, catch species composition, distribution and relative abundance of commercially important groundfish species, and rankings of groundfish species by geographic area and depth strata in terms of catch per unit effort. Biomass, population, and size composition estimates are

presented for the commercially more important species. Estimates of age composition by depth stratum and the results of vertical distribution investigations for sablefish; and length-weight relationships for sablefish, Dover sole, *Microstomus pacificus*, and arrowtooth flounder, *Atheresthes stomias* are included. Seasonal temperature differences are compared and we also compare seasonal differences in species incidence and bathymetric data thought to be least likely affected by variability in gear selectivity and catchability.

CONTENTS

INTRODUCTION

Groundfish resources along the U.S. Pacific Coast have been surveyed triennially since 1977. These surveys have been conducted by the Resource Assessment and Conservation Engineering Division of the Alaska Fisheries Science Center (AFSC). These assessments have focused on the distribution and abundance of Pacific whiting (*Merluccius productus*) and rockfish (*Sebastes* spp.) stocks inhabiting the continental shelf and have provided information to supplement data on the commercial catch used by management in annual stock assessments (Gunderson and Sample 1980; Dark et al. 1983; Weinberg et al. 1984). The surveys, however, were not designed to provide comprehensive quantitative information on groundfish resources such as Dover sole (*Microstomus pacificus*), arrowtooth flounder (*Atheresthes stomias*), sablefish (*Anoplopoma fimbria*), and certain rockfish species which primarily inhabit continental slope waters.

Previous studies have examined the distribution and abundance of individual continental slope groundfish species (Heyamoto and Alton 1965; Demory 1971, 1975; Pruter et al. 1971; Pearcy 1978); and multispecies similarity indices and cluster analysis techniques have been used to investigate continental slope species assemblages and describe species associations (Day and Pearcy 1968; Gabriel and Tyler 1980). Additionally, demersal trawl surveys have been used to investigate and describe the bathymetric distribution, abundance, seasonal changes in availability, and size distributions of groundfish species inhabiting continental slope waters (Alton 1972; Pearcy et al. 1982).

The impetus for scheduling upper continental slope surveys in 1984 was provided by: rising commercial landings of arrowtooth flounder: the increasing importance of sablefish, Dover sole, and continental slope rockfish resources along the Pacific coast; and requests from the Pacific Fishery Management Council's (PFMC) groundfish management team for additional background information on continental slope stocks of these resources.

Two continental slope groundfish surveys were completed during 1984. In the spring, a Soviet research trawler sampled stations in continental slope waters 110-549 m (60-300 fathoms) deep. In the autumn, a chartered U.S. commercial trawling vessel sampled stations in waters 110-915 m (60-500 fm) deep. Stations sampled in the autumn were essentially identical to those surveyed during the spring, but additional stations were sampled in the 549-915 m zone.

The objectives for the 1984 slope surveys were 1) to determine the feasibility of utilizing demersal trawl gear in deep water with diverse bottom topography to assess abundance, geographic and bathymetric distribution, and biological characteristics of major groundfish resources inhabiting the upper continental slope; 2) to update status of stock documents for these resources for management purposes: and 3) to investigate the feasibility of using vertically deployed fish traps to examine the distribution and availability of sablefish to demersal trawl sampling.

Although survey design and catch processing procedures were similar during the spring and autumn surveys, the vessels used to conduct the surveys differed significantly in size and horsepower, and the sampling trawls differed in size, construction, and rigging. Fishing power coefficients could not be developed for the survey vessels because comparative fishing tows were not made. Consequently, we are unable to account for differences in catch rates for individual species which may be solely due to differences in fishing power between the two survey vessels. Therefore, the survey results presented here, especially intersurvey (seasonal) comparisons, should be examined cautiously.

METHODS

Survey Area and Sampling Period

The survey region included the portion of the International North Pacific Fisheries Commission (INPFC) Columbia statistical area from Coquille Point (lat. 43°OO'N) to Cape Falcon (lat. 45°45'N), Oregon between the depths of 110 and 915 m (60-500 fm) (Figs. 1 and 2). This region was selected because it contains stocks of the principal species of interest, it is an area of known economic importance, and it contains areas of diverse bottom relief.

The survey region contains a total surface area of

13,961 km^2 (4,071 nmi^2) between the depths of 110 and 915 m. Within this region the continental shelf (<183 m) varies from 20.9 to 36.2 km in width and the upper slope (>183 m) varies from 4.6 to 54.3 km. The average inclination of the Oregon continental slope varies from 1°24' to 7°14' (Pearcy et al. 1982), with 2-3° being the most common inclination (Byrne 1962). The topographically complex slope is characterized by deeply incised valleys, ridges, steep escarpments, benches, hills, rocky outcrops, and depressions. Upper slope substrates vary from sand and sand-silt on topographic highs to clayey silts in the lows (Kulm and Scheidegger 1979). Rock, mud, and hard clay areas are abundant, and substrate composition can change rapidly within short distances.

Surface current flow over this part of the slope and shelf is generally southward along the coast during the summer (Ingraham and Love 1977). Flow at depths greater than 100 m consists of a northward countercurrent denoted as the California Undercurrent (Favorite et al. 1976).

Survey Design and Sampling Station Allocation

A Soviet research vessel, the Poseydon, conducted demersal and midwater trawl investigations in the survey region from 21 April to 3 May 1984. U.S. investigations were conducted in autumn between 8 September and 6 October 1984 by the chartered fishing vessel Half Moon Bay under contract to the National Marine Fisheries Service (NMFS). This report is based on samples obtained from the geographic region sampled by both vessels.

A systematic, random sampling design was followed in the selection of trawl stations. To investigate the bathymetric distribution of target species, the survey area was stratified into five depth intervals: 110-183 m, 183-366 m, 366-549 m, 549-732 m, and 732-915 m.

Sampling stations were placed randomly along tracklines. The tracklines were situated 16.7 km (9 nmi) apart and were drawn roughly perpendicular to the slope isobaths. The number of stations within each depth stratum were allocated proportionally to the trackline length across each depth interval (determined from National Ocean Service charts 18520 and 18580). Intervals less than 13 km wide were allocated one station, intervals 13.1 to 25.9 km wide received two sampling stations, and intervals exceeding 26 km received three randomly situated stations. A total of 68 stations were designated as potential sampling sites in waters 110-549 m deep for the spring slope survey. Those 68 stations plus an additional 36 stations in waters 549-915 m deep were designated as potential sampling sites for the autumn survey. The geographic locations of the successful bottom tows are shown in Figures 1 and 2.

Trackline placement and sampling density were selected to sample as much of the survey region as available vessel time would allow. During the autumn survey, an additional 4-5 days were allocated to investigate sablefish vertical distribution. In this supplemental survey vertically deployed sablefish traps were situated on tracklines where bottom trawl sampling had demonstrated the presence of sablefish within each depth stratum the traps were to sample (Fig. 3).

To investigate geographic differences in abundance and species composition, the entire survey area was divided into north and south subareas, using lat. 44°22.5'N as the boundary. The geographical area (km^2) of each stratum used in the analysis of the 1984 slope survey data is summarized in Table 1.

Throughout the spring survey two trained U.S. technicians were aboard the Poseydon to assist the Soviet scientists with processing catches and with collecting, compiling, and processing data in accordance with standardized procedures.

Vessels and Sampling Gears

In 1984 the Poseydon was used opportunistically during the spring to collect demersal trawl samples from slope stations shallower than 549 m, the maximum depth limit of their trawling capability. The chartered Half Moon Bay was used in the autumn to obtain samples from stations in the 110-915 m depth range.

The Poseydon is an 84.7 m (278 ft) long Soviet BMRT research trawler. It has a single 2,000 horsepower main engine, and deck equipment includes split trawl winches with 1,200 m of steel trawl cable. Electronic equipment includes a satellite navigation system, depth sounder, and radar. The crabber/trawler Half Moon Bay is 32.9 m (108 ft) long and has a single diesel engine of approximately 850 continuous horsepower. Deck equipment includes hydraulically powered split trawl winches, 2,195 m of 15.9 mm steel trawl cable, three net reels situated above the stern and another just aft of the house, and a hydraulic articulated deck crane. Electronic equipment includes loran-C receivers, a loran-C video plotter, dual radars, echo sounders, and a netsonde with multiple transducers.

Trawl Gear

Two sets of demersal trawl gear were used for assessing groundfish resources in the slope survey area. During the spring survey, a Soviet commercial bottom trawl equipped with roller gear fabricated from 17 spherical, 50 cm-diameter steel bobbins and 6.0 x 6.0 m, 1,750 kg oval doors was used to sample demersal groundfish populations (Table 2). The Soviets reported that their trawl has a vertical opening of 6.0 m (19.7 ft) and a horizontal opening of 18.0 m (59.1 ft); however, it is unknown whether these figures were derived from static measurements or from measurements made as the trawl was being fished. Mesh size for the Soviet trawl tapered from 100 mm to 80 mm in the wing and body, from 55 mm to 30 mm in the intermediate, and was 30 mm in the codend. No codend liner was used in the Soviet trawl.

During the autumn survey, the Half Moon Bay was equipped with a modified AFSC 90/105 Noreastern bottom trawl which was rigged with 75 deep-sea headrope floats 20 cm in diameter and was constructed with heavy (i.e., 72 thread) nylon mesh in the belly for use on rough grounds. Mesh size was 127 mm in the wing and body. Mesh size was 89 mm in the intermediate section and the codend, and a 32 mm codend liner was used at all times (Table 2). The Noreastern trawl was fished exclusively with 1.8 x 2.7 m, 907 kg steel V-doors and roller gear constructed of 20 cm-diameter solid rubber disks strung from wing to wing on 15.8 mm high tensile chain for added weight and increased bottom tending capability. Net dimensions while fishing were not available, so we estimated the net opening using measurements made on similarly sized and powered vessels that were equipped with a standard AFSC Noreastern net but rigged with different roller gear and smaller (1.5 x 2.1 m) doors. Such gear has a mean horizontal opening of 13.4 m and a mean vertical opening of 9.2 m. Limited observations obtained with the netsonde transducer attached to the headrope of the modified Noreastern trawl indicated a vertical opening that ranged between 6.7 and 9.1 m. Table 2 summarizes the dimensions and construction details of the Soviet and U.S. bottom trawls.

<u>Sablefish Traps</u>

Pruter et al. (1971) employed strings of vertically deployed fish traps off the Columbia River mouth to study the vertical distribution of fishes on the upper continental slope. During the autumn survey, strings of identical fish traps were deployed to investigate the vertical distribution of sablefish. These traps were fabricated by lashing two 76 x 102 cm elliptical plastic lobster traps to two central 102 x 102 cm metal frames constructed from 1.27 cm-diameter steel rod and covered with 6.35 cm mesh nylon webbing. When completely assembled, the traps formed a cloverleaf-shaped sablefish trap with four tunnels

(Fig. 4). The traps were fished with a single steel ballast weight attached to the floor of each trap and with two 25 cm deep-sea trawl floats attached to the upper surface to float the trap horizontally in the water column (confirmed by direct observations made by scuba divers during tests done before the autumn survey).

Each trap was attached to a buoyant 1.59 cm polypropylene mainline by a gangion of 1.27 cm polypropylene line and a G-hook. Assembled traps were not pre-conditioned in seawater before they were used. Figure 5 shows the components of an assembled trap string when fishing and Table 3 lists the components required to assemble trap strings for fishing at various deployment depths.

Trawling Procedures

During the spring survey, trawling operations began on the northern tracklines and proceeded southward. During the autumn, operations began near Coquille Point, Oregon, and proceeded northward. Sampling procedures were similar on both the U.S. and Soviet vessels.

Tow duration at each sampling site was 30 minutes; between 6 and 36 minutes (depending on the depth being fished) was allowed between setting the trawl winch brakes and beginning the tow to ensure the net had settled to the bottom. The net sink rate was established at the beginning of the autumn survey for the modified Noreastern trawl by intermittently deploying the netsonde and observing the actual time required for the net to reach bottom (time to equilibrium) after the winch brakes had been applied.

Prior to setting the trawl, each potential sampling site was surveyed with the echosounder to determine the starting and ending position of each tow, station depth, trawlability of the bottom, and the orientation and variation of the depth contour. Trawling was conducted following the established depth contour as closely as practical for the duration of each tow. Towing speed was approximately 5.5 km/h (3 knots). When untrawlable bottom was encountered at a preselected station, an attempt was made to locate an alternative site within a 1 nmi radius. If an alternative site could not be located, the site was noted as untrawlable, and the next station was surveyed. During the autumn survey, the echosounder and loran-C plotter were used in combination to establish the direction of the selected depth contour and the course to follow to maximize the probability of keeping the trawl at a constant depth for the duration of each tow. During many of the tows, however, steep inclines precluded maintaining a constant fishing depth. Tracklines on which substantial sablefish catches were obtained from each depth stratum were noted as stations for subsequent sablefish vertical trap sampling.

Sablefish Trap Sampling Procedures

Baited sablefish traps attached to vertically deployed strings were used to investigate vertical distribution and the vulnerability of the species to the Noreastern trawl on the upper continental slope during the autumn survey. Trap strings were deployed at sites located on a trackline in waters approximately 110, 379, 647, and 915 m deep to sample the maximum and minimum depths of the trawl survey range and two depths equidistant from the extremes. Each site was sampled twice during daylight and twice at night to ascertain optimal diel sampling periods when sablefish are more apt to be off bottom and consequently less vulnerable to trawl gear. Trap strings were fished for approximately 11-12 hours.

Each string included five sablefish traps positioned on the vertical mainline to fish on the bottom and at heights of 5, 10, 20, and 35 m off the bottom (Fig. 5). These heights were selected to sample the vertical opening range of the Noreastern trawl, as well as waters substantially above the headrope.

Traps were secured to gangions attached to the mainline and the entire string was deployed from the stern ramp on the *Half Moon Bay*. The string anchor was deployed first and was followed by the traps; the necessary shots (91.4 m lengths) of buoyant polypropylene line; sinking nylon line; and the surface buoy, flag, and light array (Table 3). Trap strings were retrieved with the hydraulic crab pot pulling block.

Temperature Data Collection

Sea surface temperature (SST) was obtained with a bucket thermometer at all sampling stations. Bottom water temperature (BWT) was obtained at all sampling stations using a reversing thermometer during the spring survey. Expendable bathythermograph (XBT) probes were used at preselected stations on tracklines which traversed the 110-915 m depth range during the autumn slope survey. Sites for XBTs were selected to sample the entire geographic and bathymetric range within the survey region.

Deck Sampling Procedures

Standard AFSC catch sampling procedures (Smith and Bakkala 1982; Wakabayashi et al. 1985) were used. These procedures were modified slightly during the spring survey to accommodate factory processing of large catches. A brief summary follows.

Trawl catches less than 1,200 kg were released from the codend directly onto the sorting table and processed completely; before the larger catches were processed, they were randomly subsampled following procedures described by Hughes (1976). Processed catches were sorted by species, and weights and numbers of each species were recorded. Catch weights and numbers from subsamples were extrapolated to the entire catch. Most fish and invertebrates occurring in the trawl catches were identified to species; organisms that were difficult to identify were grouped by genus or combined within a more general taxonomic category. After the catch was weighed and counted a randomly selected sample of target species was selected for further biological processing. Similar procedures were used to process sablefish trap samples; however, care was taken to ensure that data on the catch from each trap was recorded separately for later analysis of vertical distribution.

During the spring survey, large catches were sorted and subsampled directly from the factory processing lines rather than from sorting tables on deck. Catches less than 1,200 kg, however, were released directly on the deck and sorted; commercially desirable species not needed for scientific investigations were removed and sent to the factory for processing.

Biological Data Collection Procedures

Age structures and length, sex, and weight information, were collected from target species in the catches. The primary target species for the 1984 west coast upper continental slope survey were sablefish, arrowtooth flounder, and Dover sole. Secondary target species were Tanner crab (*Chionoecetes tanneri*) and those species which comprise the slope rockfish complex (Pacific ocean perch (*Sebastes alutus*), darkblotched rockfish (*S. crameri*), sharpchin rockfish (*S. zacentrus*), splitnose rockfish (*S. diplooroa*), and shortspine and longspine thornyhead (*Sebastolobus alascanus* and *S. altivelis*). Data were also obtained from non-target species when they were a major component of the catch and time was available after processing target species.

Otoliths were collected from target and nontarget species for age determination (Table 5). To obtain an even geographical distribution of age samples, we established three subregions by dividing the survey region into three latitudinally equal biological sampling areas (Coos Bay, Newport, and Cape Lookout) and three depth strata (110-183, 183-549, 549-915 m). Generally, length-weight data were obtained whenever otoliths were collected.

A variety of samples were collected for special studies conducted by the AFSC and other scientific organizations. These collections included: tissue samples from sablefish and jack mackerel (*Trachurus symmetricus*) for genetic stock identification studies (AFSC), tissue samples for species divergence studies (Yale University), Tanner crab muscle for yield-recovery and chemical composition analyses (AFSC), and whole cephalopods and selected rare deepsea fish specimens for distribution and abundance studies (Oregon State University). During the autumn survey, juvenile (<40 cm FL) sablefish were tagged and released to continue AFSC investigations of juvenile migration and recruitment.

Data Analysis Procedures

A detailed description of the analytical procedures applied to demersal trawl data is given by Smith and Bakkala (1982) and Wakabayashi et al. (1985). In general, catches at each station were standardized to a single sampling unit: the weight of catch per kilometer of trawling (kg/km). Mean catch per unit of effort (CPUE) by major taxonomic group and species were computed from the standardized catch rates for the overall survey area, for individual geographic areas, and by depth stratum. Standing stock (biomass) estimates were made using the "area swept" methods described by Alverson and Pereyra (1969). Vulnerability of all species to both the Soviet and U.S. trawl was assumed to be 1.0. Spring biomass estimates were derived using the measure of horizontal opening (18.0 m) supplied by the Soviets for their trawl. Biomass estimates derived from the autumn survey data were based on the assumption that the modified Noreastern bottom trawl used during the survey had a horizontal opening identical to a standard AFSC Noreastern trawl (13.4 m).

We must caution that estimates of biomass may include uncorrected biases. Factors such as lower vulnerability of a species to sampling gear than assumed, possible overestimation of the horizontal openings of the U.S. and Soviet trawls, and imprecise calculations of minimum area of the depth strata will result in overall conservative estimates of groundfish abundance.

The calculated geographic area (km^2) of a depth stratum is the sea surface area within the boundaries of the stratum. However, due to topographic irregularities and variation in inclination, the actual area of sea floor within a stratum might differ substantially from the calculated sea surface area. Measurements of the sea floor area would produce more accurate estimates in the computation of biomass. Unfortunately, it is not possible for us to derive such sea floor area estimates.

To estimate population size composition within a stratum, the estimated total population numbers were apportioned into individual sex and 1 cm size classes based on the length-frequency samples weighted by CPUE.

Figures 6-31 and 46-72 showing the geographic distribution and relative abundance for primary and secondary target species and other economically important species were prepared as follows. Abundance levels for each species were geographically depicted using three density levels when sufficient catch data were available. Nonzero station CPUE values (densities) were ranked from smallest to largest for each species. The range of CPUE values in the lowest 60% of the stations was selected to represent the lowest densities. Moderate densities correspond to the range of CPUE values in the next higher 30%, and the highest range of CPUE values comprise the remaining 10% of the stations. Exceptionally large CPUE values (i.e., isolated, extremely large catches) were depicted in the figures by a star symbol.

Otoliths were collected from target species and returned to the AFSC for age determinations. Sablefish age composition was estimated by apportioning the population length-frequency distribution into ages using one age-length key for all depths and areas that were stratified by sex and size categories. Age structure samples for other species have not been analyzed.

Length-weight data were collected from individuals within each 1 cm length class by sex. Whenever age structures were collected, the whole, freshly caught individual fish were weighed to the nearest gram on a double beam balance. The power function relationship between length and weight described by Ricker (1975) was used to depict these data.

RESULTS

Spring Survey

Sampling

Of 68 potential trawl sampling sites surveyed with the echo sounder, 57 bottom trawl hauls were attempted. Fifty-four of these were completed successfully--11 in the 110-183 m depth stratum, 21 at 183-366 m, and 22 at 366-549 m (Fig. 1). The maximum variation in bottom depth within a tow was 82 m; however, most depth variation did not exceed 18 m.

Most catches were less than 1,500 kg in total weight and were processed in their entirety. Two tows heavier than 2,400 kg were subsampled and processed using procedures previously described.

Temperature Data

Sea surface temperature and BWT were obtained at each trawl station during the spring survey (Figs. 6 and 7). Throughout most of the survey region, spring SSTs ranged between 10.2° and 10.9°C. Slightly warmer surface temperatures were encountered offshore between Coos Bay and Coquille Point, Oregon. Spring BWTs ranged between 5.0° and 7.4°C, and warmer temperatures typically occurred in the inshore waters.

The Northwest Ocean Service Center (NOSC) Sea Surface Thermal Analysis charts which were produced from shipboard and satellite images during the 1984 spring survey period indicated that upwelling within the survey region was nonexistent.

Species Composition

During the spring survey, 69 fish species from 43 genera and 33 families and 12 invertebrate taxa were recorded from the successful trawl samples (Tables 4 and 5). Figures 8 and 9 list the fish and invertebrate taxa recorded during the spring survey and summarize the observed bathymetric distributions. The upper continental slope fauna, as sampled with a Soviet commercial bottom trawl, was dominated by fish species which made up 99%, by weight, of the mean total CPUE. The incidence of major fish families and invertebrate taxa is summarized in Table 8. Twenty scorpaenid (rockfish) species, sablefish, and Pacific whiting accounted for almost 85%, by weight, of the mean total CPUE in the 110-549 m depth stratum. High catch rates of fish (primarily Pacific whiting, rockfishes, and sablefish), up to 5,707 kg/km trawled, were taken southeast (183-366 m depth stratum) and west (366-549 m) of Heceta Bank, and in the 183-366 m waters west of Cape Lookout (Fig. 8).

Aboard the *Poseydon*, invertebrates were assigned to broad taxonomic categories (i.e., crabs and squids) and 94% of the invertebrate taxa taken were species of sponges, crabs, and squids. Combined invertebrate taxa accounted for only 1%, by weight, of the mean total CPUE.

Principal Species

During the spring, the most frequently occurring species were sablefish (found at 96% of the 54 stations sampled), Pacific whiting (91%), rex sole (*Errex zachirus*) (87%), Dover sole (80%), arrowtooth flounder (80%), and shortspine thornyhead (76%). The frequency of occurrence of these six species did not vary significantly between the north and south subareas. Individually, the remaining fish and invertebrate taxa occurred in less than 60% of the 54 spring trawl samples (Table 9).

Relative Population Densities

The relative spring abundance of the 20 most dominant fish taxa samples for all depths and by individual depth stratum in the survey area are summarized in Tables 10-13. Pacific whiting, sablefish, darkblotched rockfish (Sebastes crameri), and jack mackerel were the most abundant species and collectively accounted for almost 80% of the average CPUE. Dover sole, arrowtooth flounder, Pacific ocean perch, shortspine thornyhead, and splitnose rockfish collectively made up just 8.6% of the overall mean total catch (Table 10).

Population densities of target species varied considerably among the three depth strata sampled during this survey. In the shallow (110-183 m) stratum (Table 11), sablefish was the only target species found in the top 10 species caught, with a mean CPUE of 4.71 kg/km (2.2% of the overall total CPUE). In the intermediate (183-366 m) depth stratum, darkblotched rockfish (9.3%), sablefish (9.1%), and splitnose rockfish (1.8%) were the most abundant target species. Average catch rates for target species in the intermediate depth stratum ranged from 65.08 kg/km for darkblotched rockfish to 12.38 kg/km for splitnose rockfish (Table 12). In the deepest stratum, sablefish ranked first with a mean CPUE of 76.09 kg/km, 34.9% of the average CPUE for all species (Table 13). Pacific whiting (23%), a nontarget species, was ranked second, followed by shortspine thornyhead (8.2%), Dover sole (8.0%), Pacific ocean perch (6.0%), darkblotched rockfish (5.4%), and splitnose rockfish (4.6%).

Average catch rates for target and nontarget species also varied geographically during the spring. Tables 14 and 15 summarize observed average catch rates in the north and south subareas, by depth stratum, for fish species which collectively comprised 90% of the overall mean total CPUE. Four species (Pacific whiting, sablefish, darkblotched rockfish, and Dover sole) accounted for 90% of the overall mean total catch in the south subarea (Table 15). South subarea catch rates for Pacific whiting, Dover sole, and sablefish exceeded those observed in the overall (110-549 m) north subarea (Table 14). In comparing the catch rates for all species for the same stratum between subareas we found that for most species, catches were lower in the north subarea. There were exceptions to this trend: catch rates for sablefish and Pacific sanddab in the shallow stratum were lower in the southern subarea, darkblotched and splitnose rockfish in the intermediate stratum, and darkblotched rockfish in the deep stratum (Tables 14-15). The geographic distributions and relative abundances of target species and other species of economic importance taken during the spring survey in waters 110-549 m deep are illustrated in Figures 9-31.

Biomass Estimates

Biomass estimates (metric tons, t) for major fish species are summarized by depth stratum in Table 16. During the spring, total area biomass estimates were highest for Pacific whiting (118,150 t), sablefish (25,527 t), darkblotched rockfish (13,764 t), and rex sole (5,706 t).

Spring biomass estimates can be summarized as follows: in the shallow stratum Pacific whiting, Pacific sanddab, and yellowtail rockfish were largest with estimates of 21,269 t, 4,045 t, and 3,123 t, respectively; in the intermediate stratum Pacific whiting (88,128 t), darkblotched rockfish (11,371 t), and sablefish (11,025 t) were dominant; and in the deepest stratum sablefish (13,272 t), Pacific whiting (8,753 t), shortspine thornyhead (3,137 t), and Dover sole (3,057 t) were dominant.

Population Size Composition

Length-frequency data were collected form 10 fish species. Figures 32-41 illustrate the size composition and mean size, by sex and depth stratum, observed for these 10 species within the north and south subareas and for the total survey area. Blank spaces within figures indicate areas and depth strata where length data were not obtained. Size data by sex were not available for some species.

The overall size distribution for the spring sablefish population was trimodal: modes were at 32 cm, 38 cm, and 51 cm; larger fish (mean length = 51.6 cm) were dominant in the south subarea (Fig. 32). Sablefish mean length increased with increased depth.

Dover sole size distribution was unimodal with one mode at 31 cm (Fig. 33), though larger fish were found in the north subarea. A trend of increased mean size with increased sampling depth was also observed.

Arrowtooth flounder was not taken in significant quantities during the spring survey, and the minimum sample sizes required for taking length-frequency data were not obtained in the trawl catches sampled.

Pacific ocean perch were taken primarily in the north subarea, in waters 183-549 m deep. The overall distribution was bimodal (27 cm and 37 cm) and mean size increased with depth (Fig. 34).

Darkblotched rockfish were primarily taken in the intermediate and deepest depth strata in the north subarea (Fig. 35). Mean length increased with depth and the overall distribution was unimodal with the mode at 30 cm.

<u>Sablefish</u> Age <u>Composition</u>

We estimated sablefish age composition by depth stratum for the entire survey area (Tables 18-20). Sablefish age composition and mean age, by sex and depth stratum, for the total survey area and by subareas are illustrated in Figures 42 and 43. During the spring, the 1981 and 1982 year classes were dominant in the intermediate stratum, and the 1978 and 1979 year classes dominated the 366-549 m stratum (Tables 18-19). The 1979 year class was the strongest group overall (183-549 m) (Table 20). Sablefish age samples were not obtained from the shallow stratum during the spring survey.

Autumn Survey

Sampling

Of 104 potential sampling sites surveyed with the echo sounder during the autumn survey, bottom tows were attempted at 97 sites; 93 were successfully completed (15 in the 110-183 m depth stratum, 27 in 183-366 m, 17 in 366-549 m, 19 in 549-732 m, and 15 in 732-915 m). Bottom depth during several tows varied as much as 37 m and the maximum observed variation was 64 m. During most tows, however, depth varied less than 9 m. The netsonde was used on the earlier autumn tows and it provided graphic evidence that the net was tending bottom throughout each tow. The netsonde also indicated that bottom contact could be maintained even though the bottom depth changed 64 m over the course of a half-hour tow. The geographic locations of successful trawl hauls are shown in Figure 2.

Autumn trawl catches were generally less than 1,100 kg/trawl and were completely processed. Only three trawl hauls exceeded 1,100 kg and required subsampling prior to standard processing.

Inclement weather during the autumn survey limited the use of vertical strings of sablefish traps to 16 of 32 planned deployments. Figure 3 shows the locations where sablefish traps strings were deployed successfully.

Temperature Data

A total of 93 sea surface and 43 bottom water temperatures were taken. During the autumn, SSTs of inshore waters 110-183 m deep generally ranged between 13.0° and 14.9°C; offshore waters 183-915 m deep typically ranged between 15.0° and 17.5°C. The warmest autumn SSTs were encountered in the offshore waters from Coos Bay to Coquille Point, Oregon (Fig. 44).

Bottom water temperatures ranged between 3.8° and 8.9°C and warmer temperatures primarily occurred in the inshore waters (Fig. 45). National Ocean Service Center Sea Surface Thermal Analysis charts, produced during the 1984 autumn survey period, indicated that upwelling within the survey region was weak to nonexistent.

Species Composition

A total of 95 fish species distributed among 64 genera and 43 families, and 74 invertebrate taxa were recorded during the autumn survey. Tables 21 and 22 list the fish and invertebrate taxa recorded and summarize their observed bathymetric distributions. The upper slope fauna, sampled with the Noreastern trawl, was dominated by fish species which comprised 93%, by weight, of the mean total CPUE. The apparent abundance of major fish families and invertebrate taxa during the 1984 autumn survey period is summarized in Table 23. Sablefish, Pacific whiting, 22 species of Scorpaenidae, and 8 species of Pleuronectidae, made up 86% of the total mean CPUE for the entire range of depths (110-915 m) sampled. Fish catch rates did not exceed 1,250 kg/km trawled and consisted primarily of Dover sole, rockfishes; sablefish, and Pacific whiting. The largest catches were found west at depths of 183 to 732 m and north (183-366 m) of Heceta Bank, in the shallower depth strata northwest of Newport, and in shallower depths northwest of Cape Lookout (Fig. 46).

Invertebrate taxa made up 7.5%, by weight, of the total mean CPUE in waters 110-915 m deep. Approximately 88% of the total invertebrate catch comprised sponge, crab, seastar, sea urchin, brittle star, and sea cucumber taxa.

Principal Species

Occurrences of the 25 most common fish and crab taxa recorded during the autumn are summarized in Table 24 for the entire survey area, for north and south geographical subareas, and by depth stratum. In the samples for the total survey area, the species that occurred most frequently were Dover sole (found at 97% of the 93 stations sampled), sablefish (96%), shortspine thornyhead (85%), Pacific whiting (8l%), and rex sole (70%). The remaining species occurred in less than 53% of the 93 total trawl samples. The five dominant species of the total survey area also occurred as frequently in the south subarea. However, in the north subarea, sablefish (98%) were taken slightly more frequently than Dover sole (96%). Species composition changed in the deeper (549-732 m and 732-915 m) strata with longspine thornyhead, Tanner crab, two grenadier species, Pacific flatnose (*Antimora microlepis*), and broadfin lanternfish (*Lampanyctus* *ritteri*) being taken in 78% or more of the samples from each depth stratum (Table 24).

Relative Population Densities

The relative abundance of the 20 most dominant fish and crab taxa recorded from autumn samples of the total depth range is summarized in Table 25. Pacific whiting, sablefish, Dover sole, shortspine thornyhead, sharpchin rockfish, rex sole, and darkblotched rockfish collectively accounted for 72% of the mean total CPUE in the total survey area. Mean catch rates for primary target species were 41.91 kg/km for sablefish (23% of the mean total CPUE), 18.12 kg/km for Dover sole (10%), and 2.91 kg/km for arrowtooth flounder (2%).

The observed relative abundances of fish and crab taxa recorded from the five depth strata sampled are summarized in Tables 26-30. In the two shallowest (110-183 m and 183-366 m) strata, the mean CPUE for Pacific whiting accounted for 45% (90.53 kg/km) and 21% (48.72 kg/km), respectively, of the total mean CPUE of all fish and invertebrates (Tables 26-27). In the three deepest strata, sablefish was the most abundant species. Sablefish mean catch rates were 36.70 kg/km (25%) in the 366-549 m stratum, 77.69 kg/km (46%) at 549-732 m, and 38.36 kg/km (34%) at 732-915 m (Tables 28-30). Dover sole was among the five most abundant species in each of the depth strata sampled. Arrowtooth flounder ranked 12th (1%) at 110-183 m, 9th (2%) at 183-366 m, and 6th (3%) at 366-549 m. Arrowtooth flounder was not among the 20 most abundant species in. the two deepest strata sampled.

Additional differences observed in relative densities of the species complexes of the shallow and deeper strata include the increased abundance of shortspine thornyhead caught in waters 183-732 m deep, the increased density of longspine thornyhead in waters 366-919 m deep, larger catches (10.12 and 10.41 kg/km) of Tanner crab in the two deepest strata, decrease in relative abundance of Pacific whiting as sampling depth increased, the increased catches of giant grenadier (Albatrossia Pectoralis) and Pacific grenadier (Coryohaenoides acrolepis) with increased sampling depth, and the decreased representation of Sebastes spp. rockfishes in catches as sampling depth increased.

Differences in mean catch rates between north and south subareas were observed for target and nontarget species. Tables 31 and 32 summarize observed mean catch rates for fish and crab species which collectively accounted for 90% of the mean total catch, by depth stratum, for the 110-915 m survey area. Mean catch rates for the primary target species, sablefish and arrowtooth flounder, were larger in north subarea samples (Table 31) but Dover sole were more abundant in the south subarea (Table 32). All secondary target species (shortspine and longspine thornyhead; Tanner crab; darkblotched, sharpchin, and splitnose rockfish; Pacific ocean perch) had higher total catch rates for the 110-915 m depth range in the north subarea.

In comparing catch rates of species for the same depth stratum, we found that catch rates of most species taken in both the north and south subareas were greater in the north subarea. There were exceptions to this trend: Dover and rex sole catches in 110-183 m were larger in the south subarea; sablefish, rex sole, and lingcod (_Ophiodon elongatus_) at 183-366 m; sablefish and rex sole at 366-549 m; Dover sole and giant grenadier at 549-732 m; and Dover sole and shortspine thornyhead at 732-915 m (Tables 31-32). Figures 47-72 illustrate the geographic distributions and relative abundances of target species and other economically important species taken during the autumn survey in waters 110-915 m deep.

Biomass Estimates

Biomass estimates (t) by depth stratum for major fish species and Tanner crab are presented in Table 33. During the autumn survey, biomass estimates for the total area (110-915 m) were largest for Pacific whiting (48,249 t), sablefish (43,755 t), Dover sole (18,834 t), and shortspine thornyhead (9,912 t).

The following is a summary of the relative biomass estimates by depth stratum: in the shallowest stratum (110-183 m), Pacific whiting (31,700 t), sablefish (10,746 t), and Dover sole (5,763 t) were dominant; in the 183-366 m stratum, Pacific whiting (11,400 t), sablefish (11,213 t), sharpchin rockfish (6,050 t), and darkblotched rockfish (4,663 t) were most abundant: in the 366-549 m stratum, sablefish (8,737 t), Pacific whiting (4,980 t), and shortspine thornyhead (4,241 t) were most prevalent; in the 549-732 m stratum, sablefish, Dover sole, and longspine thornyhead were most abundant with estimates of 9,367 t, 3,697 t, and 2,242 t, respectively; and in the deepest stratum (732-915 m), sablefish (3,692 t), longspine thornyhead (2,930 t), Dover sole (1,800 t), and Tanner crab (1,002 t) were the dominant species.

Table 34 summarizes the percentage of the total estimated biomass for commercially important fish species and Tanner crab. During the autumn, sablefish and Dover sole biomass was relatively evenly distributed across the entire 110-732 m depth range, whereas arrowtooth flounder was taken only in waters 110-549 m deep. Pacific whiting (66% of total whiting biomass): canary (98%), yellowtail (97%), greenstriped (83%), and stripetail (76%) rockfish: English sole (84%); and Pacific sanddab (100%) were most prevalent in the shallow (110-183 m) stratum. Splitnose (94%), sharpchin (88%), and darkblotched (85%) rockfish occurred prominently in the 183-366 m stratum. Pacific ocean perch (89%) and shortspine thornyhead (43%) were prominent in the 366-549 m stratum and Tanner crab (98%), longspine thornyhead (97%), and giant grenadier (94%) were primarily found in the deepest (549-915 m) waters sampled.

<u>Population Size Composition</u>

During the autumn, length-frequency data were collected for 13 fish species. Figures 73-85 illustrate the size composition and mean size, by sex and depth stratum, observed for these 13 species within the north and south subareas and for the total survey area.

The overall size distribution for the sablefish population was trimodal with modes at 28 cm, 38 cm, and 52 cm. Larger fish were observed in the south subarea (Fig. 73). Generally, sablefish mean length increased as depth increased: however, a slight decrease in mean length was observed in the 732-915 m depth stratum.

Dover sole size distribution was unimodal with one mode at 34 cm (Fig. 74); larger fish were dominant in the north subarea and the trend of increased mean size with increased sampling depth was also observed.

Arrowtooth flounder samples were primarily obtained in the north subarea at depths of 110-549 m. The overall size composition was bimodal, primarily due to the influence of larger female fish. Modes were observed at 39 cm and 58 cm, and average size increased with sampling depth (Fig. 75).

Pacific ocean perch were taken primarily in the north subarea in waters 183-549 m deep. The overall distribution was bimodal (26 cm and 39 cm) and mean length increased with depth (Fig. 76).

Darkblotched rockfish were taken primarily in the 183-366 m stratum in both north and south subareas (Fig. 77). The overall size distribution was unimodal (29 cm). Mean size increased with sampling depth from 23 cm to 39 cm in the north subarea and from

25 to 32 cm in the south subarea. Mean length was 29.5 cm in the south and 28.6 cm in the north subarea.

Shortspine thornyhead were predominantly taken in waters 183-732 m deep in the north subarea (Fig. 80). The overall size distribution was unimodal (35 cm) but fish 40-70 cm in length were taken in significant numbers in the 549-732 m stratum of the north subarea. Mean size increased with sampling depth from 24 to 35 cm in the north subarea.

Longspine thornyhead were taken mainly in waters 366-915 m deep throughout the sampling area (Fig. 56) but length frequency samples were taken primarily in the north subarea (Fig. 81). The overall distribution was bimodal (10 and 21 cm) and mean length increased with sampling depth from 19 to 21 cm in the north subarea.

Sablefish Age Composition

Sablefish from the 1983 and 1982 year classes were dominant in waters 110-183 m deep (Table 35). Waters 183-366 m deep were dominated by the 1979-82 year classes that accounted for 68% of the sablefish population in those waters (Table 36). In the 366-549 m depth stratum, the 1979 year class was strongest (Table 37). The 1980 and 1979 year classes were most prominent in waters 549-732 m deep (Table 38). In the deepest depth stratum (732-915 m), the 1979 year class was dominant (Table 39). The three most prominent year classes in the total survey area (110-915 m) were 1983, 1979 and 1982. Collectively, the 1977-83 year classes accounted for over 92% of the sablefish population in waters 110-915 m deep (Table 40). Figures 86 and 87 illustrate the age composition and mean age for the total area and the north and south subareas.

Length-weight Relationships

Individual fish weights for selected species were obtained at the time when age structures were collected. For sablefish, Dover sole, and arrowtooth flounder (Figs. 88-90), we fit the data to length-weight regression curves. The following equations describe the relationship for sablefish, Dover sole, and arrowtooth flounder:

$$w\hat{} = 0.0000019697\ L^{3.259739} \quad \{\text{sablefish}\}$$

$$w\hat{} = 0.0000016260\ L^{3.306944} \quad \{\text{Dover sole}\}$$

$$w\hat{} = 0.0000019111\ L^{3.261454} \quad \{\text{arrowtooth}$$

wherein w^ is fresh whole weight in grams and L is fork length in millimeters.

Table 41 summarizes the length-weight relationships for seven fish species by sex and for all sexes combined. Predicted mean weights-at-length were generally greatest for females of all species except Dover sole and longspine thornyhead (Table 41).

Sablefish Vertical Distribution

Only four sablefish were taken in 16 trap sets. Strings of cloverleaf-shaped fish traps were deployed vertically 16 times during the 1984 autumn survey. One Tanner crab and four sablefish were taken from 4 of 16 sets as follows: the Tanner crab (3.1 lb) was taken on a string set during the day at 915 m from the trap positioned to fish on the sea floor; one sablefish (51 cm, male) was taken on a string set during the night at 379 m from the trap 20 m off bottom: one sablefish (61 cm, female) was taken on a string set during the day at 647 m from the on-bottom trap: two sablefish were taken on a string set during the night at 379 m, one each from traps 5 m (50 cm, male) and 20 m (50 cm, male) off bottom.

<u>Tanner Crab Studies</u>

During the autumn survey, Tanner crab were taken in large numbers only from-the deep (>549 m) stations. Because of their potential as an exploitable commercial resource, an investigation of the responses of the species to trawl capture was initiated.

When suitable numbers were obtained during trawling operations, samples were placed into live tanks filled with circulating surface temperature seawater and observed over a period of 8-24 hours. Movements of the captured crabs were sluggish and limbs generally hung limply when the animals were picked up. None recovered from the trauma of trawl capture and subsequent confinement in surface temperature water. Captured crabs did not spontaneously cast off limbs but many continued to move their mouthparts (thereby circulating water over their gills) for 2 to 6 hours. This lack of viability implies that commercial exploitation of the species will require technology designed to overcome capture trauma. We did not have the capability to determine whether crabs placed into chilled seawater (closer in temperature to that found in their deepwater habitat) could recover.

A small sample (15-20 individuals) was cleaned immediately after capture, washed in seawater, cooked for 10 minutes, frozen, and returned to the AFSC Utilization Research laboratory. According to H. Barnett,[1] recovery-yield and chemical analyses indicated a good quality product could be obtained if the species were processed at sea immediately after capture.

Some Seasonal Comparisons

Surveys designed to provide data over a long time series are usually scheduled for the same season each year in order to avoid confounding seasonal effects. As a result, data documenting seasonal differences in distribution, abundance, and biological parameters of west coast groundfish populations are sparse. The opportunistic nature of the 1984 spring survey precluded sampling standardization, so seasonal comparisons had to be limited and qualified. We have focused on 1984 species incidence and bathymetric data which are thought to be least likely affected by differences in catchability and gear selectivity. We also compared size and age compositions, recognizing that inter-survey differences may be partly due to dissimilarities in the sampling gears used.

Water Temperature

[1]Harold Barnett, Utilization Research Division, Northwest and Alaska Fisheries Center, National Marine Fisheries Service, 2725 Montlake Blvd. E., Seattle, WA 98112. Pers. commun., March 1985.

We summarized the mean sea surface and bottom water temperatures for the two cruises and the observed percentage differences by depth stratum, by geographic subarea, and for the entire survey area (Table 42). Throughout the survey area spring SSTs averaged 10.5°C for the 110-549 m depth stratum, whereas mean autumn SSTs were 15.1°C. This 43.8% difference in overall mean SSTs was typical of the percentage differences observed between spring and autumn SSTs for each depth stratum and for each subarea. Mean spring SSTs were, in all cases, lower than autumn SSTs. Mean spring BWT was 6.3°C and mean autumn BWT was 6.5°C (3.2% difference) for the entire survey area. In all cases, except the 366-549 m depth stratum in the south subarea, mean spring BWTs were lower than autumn BWTs.

Species Composition

We compared observed differences in the bathymetric distributions of major and minor fish species taken in waters 110-549 m deep during the spring and autumn surveys (Tables 6 and 21).

For many species it is not possible to attribute observed changes in bathymetric distribution solely to seasonal factors because of differential vulnerability to trawls. Therefore, we noted only a limited selection of observed changes in bathymetric distributions for fish species taken from depths sampled in common (110-549 m) during both surveys. The species we selected for seasonal comparisons are thought to respond to seasonal variability in food availability or in spawning requirements by changing their bathymetric distributions (Alverson et al. 1964; Alton 1972).

In the spring, English sole were taken in 110-549 m waters; in the autumn, they were only taken in waters 110-366 m deep. Pacific ocean perch were taken in waters 183-549 m deep in the spring but occurred in waters 110-549 m deep in the autumn. Splitnose rockfish and shortspine thornyhead occurred in waters 183-549 m deep during the spring but were also taken in shallower waters (110-549 m) during the autumn. Longspine thornyhead were not taken in the spring but were found in 183-549 m waters during the autumn. Our primary target species--sablefish, Dover sole, and arrowtooth flounder--had identical spring and autumn bathymetric distributions (110-549 m).

Some species were taken only during one of the surveys (Tables 6 and 21). In the spring, bigfin eelpout (_Aprodon cortezianus_) was the only Zoarcid taken in waters 110-549 m deep but in autumn, bigfin, black (_Lycodes diapterus_), and blackbelly (_Lycodoosis pacifica_) eelpouts were taken in 110-549 m waters. Similar relationships were observed for many other minor fish species.

Principal Species and _Relative Frequencies of Occurrence_

Spring catches were dominated by sablefish, Pacific whiting, rex sole, Dover sole, arrowtooth flounder and shortspine thornyhead (Table 9). In the autumn, Dover sole and Pacific whiting were found at 98.3% of the stations sampled in waters 110-549 m deep. Sablefish (96.6%), rex sole (93.2%), arrowtooth flounder (83.1%), slender sole (<u>Lyopsetta exilis</u>) (79.7%), and shortspine thornyhead (79.7%) also occurred frequently in autumn catches (Table 43). The remaining fish and crab taxa occurred in less than 60% of the spring trawl stations and in less than 73% of the autumn trawl stations.

<u>Population Size Composition</u>

Figures 32-41 and 73-85 illustrate size composition and mean size for selected fish species in the north and south subareas and in the total survey area for the surveys. Overall size distributions for target species that occurred in both surveys have been described earlier: therefore, only differences between spring and autumn distributions are noted.

In the spring, modes in the sablefish length distribution occurred at 32, 38, and 51 cm; in the autumn, modes occurred at 28, 38, and 52 cm. In the spring, small fish represented a larger percentage of the population than they did in the autumn (Figs. 32 and 73), which suggests that adult fish move up the continental slope into shallower waters in the autumn. However, this might also be caused by differences in the selectivity of the trawls used during the spring and autumn surveys. Mean length increased as sampling depth increased and larger fish were dominant in the south subarea during both surveys.

Dover sole mean length was larger during the autumn survey (30.8 cm in the spring survey and 34.2 cm in the autumn) and the length mode increased from 31 to 34 cm. This suggests that adult Dover sole also move into shallower waters in the autumn. Mean size increased with sampling depth and larger fish were dominant in the north subarea during both spring and autumn surveys (Figs. 33 and 74).

During both surveys, Pacific ocean perch were primarily taken in waters 183-549 m deep in the north subarea. Overall distributions were bimodal (27 cm and 37 cm, spring; 26 cm and 39 cm, autumn), mean length increased with sampling depth, and average male and female lengths were essentially identical (approximately 35.5 and 37.5 cm, respectively) in both seasons (Figs. 34 and 76).

Darkblotched rockfish were taken primarily in north subarea waters 183-366 m deep in both seasons (Figs. 35 and 77). Mean length increased with sampling depth. The largest fish were taken in north subarea waters 366-549 m deep (mean length being 35.8 cm, spring; and 39.4 cm, autumn), but the majority of samples were obtained from shallower waters and average size was smaller (mean length being 29.8 cm, spring: and 28.8 cm, autumn).

Sablefish Age Composition

Spring sablefish population estimates by age, year class, and depth stratum, and for the comparative (183-549 m) survey area are summarized in Tables 16-18. Autumn population estimates are presented by depth stratum in Tables 35-37 and estimates are presented for the comparative 183-549 m area in Table 44.

The 1979-82 year classes (83% and 68% of the respective spring and autumn sablefish population estimates) were dominant in the intermediate depth stratum (183-366 m) during both surveys

(Tables 18 and 36). The 1978 and 1979 year classes (58%) were most prominent in the spring, and the 1978-80 year classes (54%) were dominant in the autumn in waters 366-549 m deep (Tables 19 and 37). Tables 20 and 44 summarize the spring and autumn population estimates for the combined intermediate and deep strata because age data were not obtained from the shallow (110-183 m) stratum during the spring survey. The 1978-82 year classes accounted for 84% of the estimated spring sablefish population, and the 1977-82 year classes accounted for 86% of the autumn population in waters 183-549 m deep.

DISCUSSION

Past AFSC resource assessment surveys along the west coast have focused on obtaining distribution and abundance data characteristic of continental shelf populations (Dark et al. 1983; Weinberg et al. 1984; Coleman 1986). These surveys did not concentrate on obtaining comprehensive information on the groundfish species which primarily inhabit continental slope waters. Groundfish stocks from shallower waters have undergone increased exploitation, and commercial trawling operations have been gradually extended into deeper waters. Recent increases in commercial landings of sablefish, Dover sole, arrowtooth flounder, and several slope rockfish species prompted the need for increased information regarding these resources.

The 1984 spring and autumn groundfish surveys of the upper continental slope provided current, noncommercial data on demersal trawl catches. The data are useful indicators of population characteristics within the limitations of the survey's design. We compared the results of the two surveys in order to examine the distribution and abundance characteristics of the populations of commercial and potentially commercial groundfish resources inhabiting slope waters off the coast of Oregon. We examined species composition, frequency of occurrence, relative abundance, geographic and bathymetric distribution, biomass, size composition, and sablefish age composition and vertical distribution by depth, geographic subarea, and (where appropriate) by season.

The successful completion of both surveys demonstrates the practicability of using demersal trawl gear to sample groundfish populations in the deep waters on the topographically complex terrain of the west coast continental slope.

Factors Affecting Sampling

Trawling Operations

Bathymetric and geographic coverage of waters up to 549 m deep was the same during both surveys: however, waters greater than 549 m deep were only sampled during the autumn.

Spring and autumn survey vessel sizes and sampling gears were dissimilar. The Soviet vessel was 2.6 times longer than the U.S. vessel and generated 2.4 times the horsepower. The horizontal opening of the Soviet trawl was 1.3 times that of the U.S. Noreastern trawl. The vertical opening of the Noreastern trawl was 1.1-1.5 times that of the Soviet trawl. Mesh sizes in the component parts of the Noreastern were 1.3 times the mesh sizes in the Soviet wing, 1.6 times the size of the Soviet body mesh, 1.6-3.0 times the mesh sizes in the Soviet intermediate, and 3.0 times the mesh size of the Soviet codend. The U.S. codend liner was 1.1 times the size of the Soviet codend. The Noreastern trawl was fished with a codend liner and roller gear. This gear was closely attached to the trawl footrope so as to keep the footrope in close contact with the bottom and to prevent escapement beneath the trawl. The Soviet trawl was fished without a codend liner and used roller gear constructed of alternating sections of large and small bobbins. Consequently, we believe the Soviet gear had the greater potential for allowing groundfish escapement under the footrope. We also believe the Soviet gear had the greater potential for retaining smaller individuals given its smaller mesh sizes.

Because comparative trawl data for the two survey vessels and their trawl gears were unavailable, we were unable to establish relative fishing power coefficients for the survey vessels. Consequently, we have not attempted to compare biomass estimates between surveys. Nonetheless, we examined seasonal differences in sea surface and bottom water temperatures and in species composition, frequency of occurrence, population size composition, and sablefish age composition, recognizing that different trawl efficiencies could confound some comparisons.

Some of the limitations of the sampling gears used during the surveys should be noted. First, use of demersal trawls precluded sampling components of fish populations that inhabited waters more than 6 m off bottom during the spring and 9.2 m off bottom during the autumn. This gear efficiency influenced the sampling of slope rockfish species which are known to respond to diurnal movements of prey organisms (Feldman and Rose 1981). Also, since sablefish feed on a variety of benthic and pelagic organisms and appear to make significant vertical movements, only a portion of the population was sampled by the bottom trawl. The effects of this bias may be mitigated by the characteristic behavior of these species to move closer to the bottom during the hours of daylight when all our samples were obtained.

Second, some areas were unsuitable for bottom trawling, and stocks in these areas are inadequately represented in the survey results. Third, flatfish and other species that are primarily demersal may have been undersampled during the spring due to the escapement of fish under the Soviet net. Escapement may have a gear selection component associated with the different behavioral characteristics of individual groundfish species (Carrothers 1981). Differences in mesh sizes between the Soviet and U.S. nets and the use of a codend liner during the autumn survey also were contributing factors to the seasonal differences noted previously.

Sablefish Traps

Pruter et al. (1971) used vertically deployed fish traps to investigate sablefish vertical distribution. They found the traps to be highly selective for sablefish, with 145 fish being taken from 28 trap sets. They also found that most sablefish were taken in traps set within 3.7 m of the bottom. Our attempt to utilize traps of similar construction to investigate sablefish vertical distribution during the autumn survey was not successful.

The reasons for our lack of success are uncertain. Commercial trap fishermen soak their traps in seawater for several weeks prior to use to obtain better catch rates. Because our traps were constructed of new materials and could not be soaked prior to use during the survey, we believe the lack of trap conditioning may have contributed to our low catch rates. Otherwise, the traps we used were constructed of identical materials and in the same cloverleaf design as those used during the 1970 study.

In Pruter et al.'s study in 1970, traps were usually fished from 10 to 13 hours, whereas in 1984 the traps were fished 11 to 14 hours prior to retrieval. Chopped herring was used for bait during both surveys. During the 1970 survey, traps were set in waters 384-421 m deep, and in 1984 we fished strings in waters 110, 379, 647, and 915 m deep. We also used light-wire, free-swinging tunnel triggers during 1984 to reduce escapement when it became obvious that the traps were not catching fish. Because catch rates did not increase after triggers were installed, we concluded that fish simply were not entering the traps.

Groundfish Population Characteristics

Primary target species for the 1984 slope surveys were Dover sole, arrowtooth flounder, and sablefish. Secondary target species were Tanner crab and the slope rockfishes: Pacific ocean perch; darkblotched, sharpchin, and splitnose rockfish; and shortspine and longspine thornyhead.

Dover sole was characterized by a wide bathymetric distribution with samples being taken from the entire range of depths sampled during both spring and autumn surveys. The species shows a strong seasonal inshore and offshore movement. Tagging studies (Barss and Demory 1988) show that Dover sole move into deep water in the fall where they concentrate for spawning from November through March. In the summer they move inshore and disperse for feeding. During the 1984 surveys, the availability (CPUE) of Dover sole was highest during the autumn (the largest catches were from waters 549-732 m deep) and lowest in the spring. Similar trends in Dover sole abundance and availability by season and depth were reported by Alton (1972) who also noted a larger size range of Dover sole in shallower waters (91-320 m) than in deeper waters. We also noted an increase in mean size of autumn versus spring fish which may reflect both the seasonal spawning migration of the species into deeper waters during the winter (Barss and Demory 1988), and variability in gear selectivity caused by differences in trawl mesh sizes. Spring and autumn catches were dominated by males, although of the females taken a larger percentage was taken in the autumn, particularly from deeper waters. This supports the conclusions of Barss and Demory (1988) that juveniles and females primarily undertake inshore-offshore movements, whereas mature males remain in the deep water spawning areas throughout the year.

Arrowtooth flounder were found in waters of moderate depth (110-549 m) during both spring and autumn surveys. The autumn catches, though small in terms of overall mean CPUE, were consistently larger than spring catches. Alverson et al. (1964) and Alton (1972) attributed shifts in availability of arrowtooth flounder from deep water in the winter to shallower depths of the continental shelf in the summer to reproductive and feeding cycles. Spawning on the west coast occurs on the upper slope (366 m) from December to March (Fargo et al. 1981). We believe that differences in trawl gears used during the 1984 surveys contributed to the observed decrease in catch of this species during the spring survey. Arrowtooth flounder mean length increased with depth during both surveys. This was consistent with Hosie's (1976) observations of Oregon coast arrowtooth flounder that adults were most abundant at depths of 146 to 219 m and juveniles from 91 to 183 m.

Sablefish had a bathymetric distribution similar to Dover sole and were found throughout all depths sampled during both surveys. Sablefish migrate up the continental slope into shallower shelf and slope waters during the summer upwelling and move back into deeper waters in October (Klein 1984). During 1984, spring sablefish catches in waters 183-549 m deep were similar in magnitude to autumn catches in waters 549-732 m deep. Also, during the spring, immature (smaller that 43 cm) fish were abundant in shallower waters and the number of males and females were approximately equal. Mature fish were taken primarily in deeper waters and catches were also equally divided by sex. During the autumn, immature fish were found in shallow (110-183 m) waters with the number of males and females equal, but in deeper water the larger fish were predominantly males. These results are similar to those of Alton (1972) who also found that the large, older fish inhabit the deeper portion of the overall bathymetric range.

Rockfish species are noted for their extremely contagious distributions and the large variances and wide confidence intervals associated with mean catch rates and abundance estimates determined from trawl catch data (Wilkins and Weinberg 1987). A large number of tows are required to reduce the effects of this variability. However, during the 1984 slope surveys the number of tows was restricted because of limited time and the extended depth range we wanted to sample. Differences observed in the abundance, size composition, and distribution of Pacific ocean perch and darkblotched, sharpchin, and splitnose rockfish are related to the contagious. nature of these species. Differences in the selectivity of the trawl gears used for each survey and differences in the schooling and behavioral characteristics of these species were also contributing factors.

CONCLUSIONS

We believe the data obtained from the 1984 spring and autumn surveys provide useful, current information about the groundfish resources that inhabit the upper continental slope off the Oregon coast. The distribution, abundance, species composition, size, age (sablefish only), and length-weight data presented provide reasonable characterizations of target populations within the survey area given the limitations of the sampling gear and survey design. These data are fishery independent and should prove to be more representative than data derived from commercial sources since commercial fisheries select fish the basis of size and marketability.

The 1984 slope survey work indicates that it may be feasible to use demersal trawl gear to assess abundance and geographic and bathymetric distribution and to track periodic changes in the population characteristics of target populations if a standardized approach is utilized. Future investigations are needed to extend survey coverage to the Washington and northern California coasts because of the increased commercial interest and exploitation these areas are experiencing.

Investigations should also be continued to establish whether sablefish are entirely demersal, and if not, to establish the percentage of the population that resides off-bottom. Once this is clarified, it will be possible to improve the precision of population estimates because sampling effort can be better allocated to increase the efficiency of sampling the target population. We also believe that a passive (i.e., nonbaited) sampling gear such as a sunken gill-net might be effectively used to investigate this question.

Future studies should also attempt to characterize the physical structure of the sea floor, including its inclination and composition (e.g., rock, cobble, sand, and mud) in an effort to establish whether particular groundfish species of the continental slope are more likely to be associated with distinct bottom habitat types. Such information would also assist in establishing more efficient and precise survey designs and sampling patterns.

Table 1.-- Geographic areas (km^2)* of depth strata used during the spring and autumn 1984 west coast upper continental slope trawl surveys.

Depth stratum (m/fm)	Total area	South subarea	North subarea
110-183/ 60-100	4,705	2,517	2,188
183-366/100-200	3,144	1,144	2,000
366-549/200-300	3,139	839	2,300
549-732/300-400	1,680	735	945
732-915/400-500	1,293	496	797
Total	13,961	5,731	8,230

* Latitudinal limits of geographic areas: total area = 43°00'N-45°45'N; south subarea = 43°00'N-44°22.5'N; north subarea = 44°22.5'N-45°45'N.

Table 2.--Demersal trawl gears used during the 1984 west coast upper continental slope surveys.

Vessel	Headrope length (m)	Footrope length (m)	Mesh size: Wing and body (mm)	Mesh size: Intermediate (mm)	Mesh size: Cod-end (mm)	Mesh size: Codend liner (mm)	Accessory gear: Door[1] width and length (m)	Accessory gear: Dandyline length (m)
Poseydon	31.0	45.0	100/80[2]	55/30[3]	30	none	6.0 x 6.0	60.0
Half Moon Bay	27.4	32.0	127	89	89	32	1.8 x 2.7	54.9

[1]Trawl doors used on the _Poseydon_ weighed approximately 1,750 kg (3,860 lb) each; doors used on the _Half Moon Bay_ weighed approximately 907 kg (2,000 lb) each.
[2]Net mesh tapers from 100 mm to 80 mm.
[3]Net mesh tapers from 55 mm to 30 mm.

Table 3.--Components utilized in assembling vertically deployed sablefish trap strings[1] used during the 1984 autumn west coast upper continental slope survey.

Mainline components	Deployment depth (m): 110	379	647	915
200 lb anchor and chain	1	1	1	1
Sablefish traps[2]	5	5	5	5
Bait jars[3]	5	5	5	5
50 fm shots polypropylene line[4]	1	5	8	11
50 fm shots nylon line[5]	1	1	1	1
Surface buoy, flag, and light array	1	1	1	1

[1]See Figure 5.
[2]One trap attached at 0, 5, 10, 20, and 35 m off bottom to gangions secured through the mainline at specified positions.
[3]Each bait jar was filled with 1 kg of chopped Pacific herring.
[4]Buoyant line, 1.59 cm (5/8 in) in diameter. G-hooks attached to gangions for securing trap bridles on the lowermost shot of line.
[5]Sinking line, 1.27 cm (l/2 in) in diameter.

Table 4.--Number of length-frequency measurements obtained during the 1984 spring and autumn west coast upper continental slope surveys.

Species	Spring survey	Autumn survey
Arrowtooth flounder	--	483
Pacific halibut	25	23
English sole	200	--
Dover sole	823	6,767
Rex sole	--	357
Sablefish	2,437	5,466
Jack mackerel	447	22
Chub mackerel	409	--
Pacific whiting	1,148	944
Shortspine thornyhead	--	1,235
Longspine thornyhead	--	1,562
Pacific ocean perch	453	1,043
Darkblotched rockfish	598	1,728
Splitnose rockfish	752	35
Greenstriped rockfish	306	--
Yellowtail rockfish	123	--
Canary rockfish	--	143
Redstripe rockfish	--	54
Stripetail rockfish	73	--
Sharpchin rockfish	--	924
Total	7,794	20,786

Table 5.--Approximate number of otoliths collected during the 1984 spring and autumn west coast upper continental slope surveys.

Species	Spring survey	Autumn survey
Sablefish	505	855
Dover sole	384	931
Splitnose rockfish	100	---
Darkblotched rockfish	---	350
Pacific ocean perch	---	215
Sharpchin rockfish	---	202
Longspine thornyhead	---	165
Arrowtooth flounder	---	169
Total	989	2,887

Table 6.--List of fish taxa collected and their observed bathymetric distribution during the 1984 spring West Coast upper continental slope groundfish survey.

Scientific name[1]	Common name[1]	Depth stratum (m) 110-183	183-366	366-549[2]
Petromyzontidae				
Lampetra tridentata	Pacific lamprey			-------
Scyliorhinidae				
Apristurus brunneus	Brown cat shark		-------	-------
Squalidae				
Squalus acanthias	Spiny dogfish	-------	-------	-------
Rajidae				
Raja spp.	Skates	-------	-------	-------
R. kincaidi	Bering skate	-------		
R. rhina	Longnose skate	-------	-------	-------
Chimaeridae				
Hydrolagus colliei	Spotted ratfish	-------	-------	-------
Bothidae				
Citharichthys sordidus	Pacific sanddab	-------		-------
Pleuronectidae[3]				
Atheresthes stomias	Arrowtooth flounder	-------	-------	-------
Eopsetta jordani	Petrale sole	-------	-------	-------
Errex zachirus	Rex sole	-------	-------	-------
Hippoglossoides elassodon	Flathead sole	-------	-------	-------
Hippoglossus stenolepis	Pacific halibut	-------	-------	-------
Lyopsetta exilis	Slender sole	-------	-------	-------
Microstomus pacificus	Dover sole	-------	-------	-------
Pleuronectes vetulus	English sole	-------	-------	-------
Agonidae[3]	Poachers		-------	
Xeneretmus làtifrons	Blacktip poacher		-------	
Clupeidae				
Alosa sapidissima	American shad	-------	-------	
Clupea harangus pallasi	Pacific herring	-------	-------	
Sardinops sagax	Pacific sardine	-------		
Embiotocidae				
Cymatogaster aggregata	Shiner perch	-------		
Engraulidae				
Engraulis mordax	Northern anchovy	-------	-------	
Bathylagidae				
Bathylagus milleri[4]	Robust blacksmelt			-------

Table 6.--Continued.

Scientific name[1]	Common name[1]	Depth stratum (m) 110-183	183-366	366-549[2]
Chauliodontidae				
Chauliodus macouni	Pacific viperfish			-------
Carangidae				
Trachurus symmetricus	Jack mackerel	-------	-------	-------
Cottidae	Sculpins	-------		-------
Icelinus filamentosus	Threadfin sculpin	-------	-------	
I. tenuis	Spotfin sculpin		-------	
Gadidiae				
Theragra chalcogramma	Walleye pollock	-------	-------	
Hexagrammidae				
Ophiodon elongatus	Lingcod	-------	-------	-------
Anoplopomatidae				
Anoplopoma fimbria	Sablefish	-------	-------	-------

Cyclopteridae[3]	Snailfishes			-------
Careproctus sp.	Snailfish		-------	-------
C. melanurus	Blacktail snailfish			
Melanostomiidae				
Tactostoma macropus	Longfin dragonfish			-------
Myctophidae[3]				
Lampanyctus regalis	Pinpoint lampfish			-------
Stenobrachius leucopsarus	Northern lampfish			-------
Paralepididae				
Notolepis risso[4]	Ribbon barracudina			-------
Nemichthyididae				
Nemichthys scolopaceus	Slender snipe eel		-------	-------
Searsiidae				
Sagamichthys abei[4]	Shining tubeshoulder		-------	-------
Cryptacanthodidae				
Lyconectes aleutensis	Dwarf wrymouth	-------		
Merlucciidae				
Merluccius productus	Pacific whiting	-------	-------	-------

Table 6. --Continued.

Scientific name[1]	Common name[1]	Depth stratum (m)		
		110-183	183-366	366-549[2]
Osmeridae[3]	Smelt	-------		
Thaleichthys pacificus	Eulachon	-------	-------	-------
Salmonidae				
Oncorhynchus tshawytscha	Chinook salmon	-------	-------	
Scombridae[3]	Mackerel	-------	-------	
Scomber japonicus	Chub mackerel	-------		
Sternoptychidae[3,4]	Hatchetfishes			-------
Trachipteridae				
Trachipterus altivelis	King-of-the-salmon	-------		
Zoarcidae[3]	Eelpouts	-------	-------	-------
Aprodon cortezianus	Bigfin eelpout		-------	-------
Scorpaenidae				
Sebastes spp.	Rockfish			-------
S. aleutianus	Rougheye rockfish	-------	-------	-------
S. alutus	Pacific ocean perch		-------	-------
S. aurora	Aurora rockfish		-------	-------
S. babcocki	Redbanded rockfish	-------	-------	-------
S. borealis	Shortraker rockfish		-------	-------
S. brevispinis	Silvergray rockfish	-------	-------	-------
S. crameri	Darkblotched rockfish	-------	-------	-------
S. diploproa	Splitnose rockfish		-------	-------
S. elongatus	Greenstriped rockfish	-------	-------	-------
S. entomelas	Widow rockfish	-------	-------	
S. flavidus	Yellowtail rockfish	-------	-------	
S. goodei	Chilipepper			-------
S. helvomaculatus	Rosethorn rockfish	-------	-------	-------
S. jordani	Shortbelly rockfish	-------	-------	-------
S. paucispinis	Bocaccio	-------	-------	
S. pinniger	Canary rockfish	-------	-------	
S. proriger	Redstripe rockfish	-------	-------	
S. reedi	Yellowmouth rockfish		-------	
S. ruberrimus	Yelloweye rockfish		-------	
S. saxicola	Stripetail rockfis	-------	-------	-------
S. wilsoni	Pygmy rockfish		-------	
S. zacentrus	Sharpchin rockfish	-------	-------	-------

[1]Nomenclature from Robins (1980) unless otherwise noted.

[2]*Poseydon* carried only enough trawl cable to fish to 549 m.

[3]Common name associated with family name indicates unidentified members were encountered.

[4]Nomenclature from Hubbs and Dempster(1979).

Table 7.--List of invertebrate taxa collected and their observed bathymetric distribution during the 1984 spring West Coast upper continental slope groundfish survey.

Scientific name[1]	Common name[1]	Depth stratum (m)		
		110-183	183-366	366-549[2]
Arthropoda[3]				
Pandalidae	Pandalid shrimp	-------	-------	-------
Cancridae				
Cancer magister	Dungeness crab	-------	-------	
Paguridae	Hermit crab	-------		-------
Lithodidae				
Lopholithodes foraminatus	Box crab	-------	-------	-------
Mollusca[4]				
Gastropoda:Prosobranchia[1]	Snails			-------
Cephalopoda:Octopodidae	Octopus	-------		-------
Cephalopoda:Sepiolidae	Squid	-------	-------	-------
Cephalopoda:Gonatidae				
Loligo opalescens	Market squid	-------		-------
Echinodermata				
Asteroidea[5]	Seastars	-------		
Echinoidea	Sea urchins	-------		
Holothuroidea	Sea cucumbers		-------	
Porifera	Sponges			-------

1Nomenclature from Kozloff (1974) unless otherwise noted.
[2]Poseydon carried only enough trawl cable to fish to 549 m.
[3]Nomenclature for shrimp from Butler (1980).
[4]Nomenclature for mollusca from Abbott (1974) unless otherwise noted.
[5]Nomenclature for seastars from Fisher (1911,1928,1930).

Table 8.--Summary of average catch per unit fishing effort (kg/km) for major taxonomic groups during the spring 1984 west coast upper continental slope trawl survey[1].

Taxa	Mean CPUE[2] for entire survey area	Proportion of total catch	Mean CPUE by depth stratum (m) 110-183	183-366	366-549	Proportion of total catch by depth (m) 110-183	183-366	366-549
Squalidae	0.46	0.001	0.13	0.51	0.91	0.001	0.001	0.004
Rajidae	0.33	0.001	0.01	0.55	0.60	<0.001	0.001	0.003
Bothidae	6.68	0.019	15.51	---	0.14	0.073	---	0.001
Pleuronectidae	24.09	0.068	19.77	27.10	27.54	0.093	0.039	0.126
Anoplopomatidae	41.81	0.118	4.71	63.10	76.09	0.022	0.090	0.348
Hexagrammidae	0.85	0.002	1.68	0.38	0.06	0.008	0.001	<0.001
Merlucciidae	193.51	0.548	81.35	504.40	50.19	0.380	0.724	0.230
Zoarcidae	0.19	0.001	0.03	0.12	0.49	<0.001	<0.001	0.002
Carangidae	22.67	0.064	52.92	0.01	0.01	0.248	<0.001	<0.001
Scombridae	2.73	0.008	6.30	0.11	---	0.030	<0.001	---
Scorpaenidae	53.32	0.151	18.91	98.10	60.05	0.089	0.140	0.275
Sebastes spp.	45.73	0.129	18.90	89.55	42.06	0.089	0.128	0.193
Sebastolobus spp.	7.59	0.021	0.01	8.55	17.99	<0.001	0.012	0.082
Other fish	5.45	0.015	70.19	1.80	1.00	0.328	0.003	0.005
Total fish	352.09	0.996	212.29	696.06	217.07	0.994	0.999	0.994
Porifera	0.24	0.001	---	---	0.83	---	---	0.004
Crustacea	0.13	<0.001	0.17	0.15	0.07	0.001	<0.001	<0.001
Total crabs	0.09	<0.001	0.15	0.08	0.01	0.001	<0.001	<0.001
Total shrimps	0.04	<0.001	0.02	0.07	0.06	<0.001	<0.001	<0.001
Mollusca	0.71	0.002	1.12	0.29	0.52	0.005	<0.001	0.002
Gastropoda	tr[3]	<0.001	---	---	tr[3]	---	---	<0.001
Cephalopoda	0.71	0.002	1.12	0.29	0.52	0.005	<0.001	0.002
Echinodermata	0.01	<0.001	---	0.03	---	---	<0.001	---
Asteroidea	---	---	---	---	---	---	---	---
Echinoidea	---	---	---	---	---	---	---	---
Holothuroidea	0.01	<0.001	---	0.03	---	---	<0.001	---
Total invertebrates	1.09	0.004	1.29	0.47	1.42	0.006	0.001	0.006
Total catch	353.14	1.000	213.56	696.52	218.49	1.000	1.000	1.000
Total effort (km)	150.8		30.1	56.3	64.5			
Total trawls	54		11	21	22			

[1] See Figure 1.

[2] Mean CPUE and proportion of total catch for the overall (110-549 m) spring survey area.

[3] tr = CPUE <0.01 kg/km.

Table 9.--The 25 most common fish taxa recorded during the spring 1984 west coast continental slope demersal trawl survey, in order of percentage frequency of occurrence.

Rank	Species	All strata combined	Depth stratum* (m) 110-183	183-366	366-549	All strata south	All strata north
1	Sablefish	96.3	90.9	95.2	100.0	91.7	100.0
2	Pacific whiting	90.7	90.9	85.7	95.5	91.7	90.0
3	Rex sole	87.0	90.9	95.2	77.3	91.7	83.3
4	Dover sole	79.6	54.5	81.0	90.9	75.0	83.3
5	Arrowtooth flounder	79.6	54.5	90.5	81.8	70.8	86.7
6	Shortspine thornyhead	75.9	9.1	85.7	100.0	66.7	83.3
7	Pacific ocean perch	59.3	---	71.4	77.3	50.0	66.7
8	Darkblotched rockfish	59.3	27.3	81.0	54.5	58.3	60.0
9	Redbanded rockfish	57.4	18.2	71.4	63.6	62.5	53.3
10	Slender sole	55.6	72.7	76.2	27.3	58.3	53.3
11	Splitnose rockfish	48.1	---	71.4	50.0	50.0	46.7
12	Greenstriped rockfish	37.0	45.5	57.1	13.6	45.8	30.0
13	American shad	37.0	81.8	52.4	---	45.8	30.0
14	English sole	33.3	81.8	33.3	9.1	54.2	16.7
15	Spotted ratfish	31.5	27.3	28.6	36.4	29.2	33.3
16	Bigfin eelpout	27.8	---	19.0	50.0	33.3	23.3
17	Aurora rockfish	25.9	---	9.5	54.5	16.7	33.3
18	Spiny dogfish	24.1	18.2	38.1	13.6	29.2	20.0
19	Petrale sole	24.1	63.6	14.3	13.6	25.0	23.3
20	Pacific halibut	24.1	36.4	33.3	9.1	20.8	26.7
21	Rougheye rockfish	22.2	---	9.5	45.5	12.5	30.0
22	Unidentified eelpout	20.4	18.2	14.3	27.3	25.0	16.7
23	Rosethorn rockfish	20.4	9.1	14.3	31.8	20.8	20.0
24	Pacific sanddab	20.4	90.9	---	4.5	25.0	16.7
25	Brown cat shark	20.4	---	9.5	40.9	29.2	13.3
	Total trawls	54	11	21	22	24	30

*See Figure 1.

Table 10.--The 20 most abundant fish taxa recorded during the spring 1984 west coast upper continental slope trawl survey, in order of observed abundance, all depth strata 110-549 m (60-300 fm) combined'.

Rank	Taxon	CPUE (kg/km)[2]	Proportion of total CPUE[3]	Cumulative proportion
1	Pacific whiting	191.65	0.546	0.546
2	Sablefish	41.85	0.119	0.665
3	Jack mackerel	22.65	0.065	0.730
4	Darkblotched rockfish	22.33	0.064	0.793
5	Rex sole	9.33	0.027	0.820
6	Dover sole	8.06	0.023	0.843
7	Shortspine thornyhead	7.63	0.022	0.864
8	Pacific sanddab	6.68	0.019	0.883
9	Splitnose rockfish	6.41	0.018	0.902
10	Pacific ocean perch	5.46	0.016	0.917
11	Yellowtail rockfish	5.26	0.015	0.932
12	Pacific herring	3.07	0.009	0.941
13	Chub mackerel	2.70	0.008	0.949
14	Arrowtooth flounder	2.44	0.007	0.956
15	Greenstriped rockfish	2.34	0.007	0.962
16	English sole	1.74	0.005	0.967
17	Pacific halibut	1.12	0.003	0.970
18	Slender sole	1.02	0.003	0.973
19	American shad	0.93	0.003	0.976
20	Rougheye rockfish	0.92	0.003	0.979

[1]See Figure 1.

[2]Overall mean catch per unit effort, kg/km trawled. Total effort = 150.8 km.

[3]Proportion of total mean catch per unit effort, all fish and invertebrates combined. Total mean CPUE = 35.1.11 kg/km.

Table 11.--The 20 most abundant fish taxa recorded during the spring 1984 west coast upper continental slope trawl survey, in order of observed abundance, 110-183 m (60-100 fm)[1].

Rank	Taxon	CPUE (kg/km)[2]	Proportion of total CPUE[3]	Cumulative proportion
1	Pacific whiting	81.35	0.381	0.381
2	Jack mackerel	52.92	0.248	0.629
3	Pacific sanddab	15.51	0.073	0.701
4	Yellowtail rockfish	11.94	0.056	0.757
5	Rex sole	9.97	0.047	0.804
6	Pacific herring	7.18	0.034	0.838
7	Chub mackerel	6.30	0.030	0.867
8	Sablefish	4.71	0.022	0.889
9	Greenstriped rockfish	4.10	0.019	0.908
10	English sole	2.76	0.013	0.921
11	Dover sole	2.60	0.012	0.933
12	Eulachon	1.80	0.008	0.942
13	Lingcod	1.68	0.008	0.950
14	American shad	1.42	0.007	0.956
15	Arrowtooth flounder	1.31	0.006	0.962
16	Darkblotched rockfish	1.27	0.006	0.968
17	Slender sole	1.21	0.006	0.974
18	Pacific halibut	1.08	0.005	0.979
19	Canary rockfish	0.91	0.004	0.988
20	Petrale sole	0.79	0.004	0.992

[1]See Figure 1.

[2]Overall mean catch per unit effort, kg/km trawled. Total effort = 30.1 km.

[3]Proportion of total mean catch per unit effort, all fish and invertebrates combined. Total mean CPUE q 213.56 kg/km.

Table 12.--The 20 most abundant fish taxa recorded during the spring 1984 west coast upper continental slope trawl survey, in order of observed abundance, 183-366 m (100-200 fm)[1].

Rank	Taxon	CPUE (kg/km)[2]	Proportion of total CPUE[3]	Cumulative proportion
1	Pacific whiting	504.40	0.724	0.724
2	Darkblotched rockfish	65.08	0.093	0.818
3	Sablefish	63.10	0.091	0.908
4	Splitnose rockfish	12.38	0.018	0.926
5	Rex sole	9.93	0.014	0.940
6	Shortspine thornyhead	8.55	0.013	0.953
7	Dover sole	6.60	0.009	0.962
8	Pacific ocean perch	5.83	0.008	0.970
9	Arrowtooth flounder	4.98	0.007	0.978
10	Pacific halibut	2.18	0.003	0.981
11	Greenstriped rockfish	2.03	0.003	0.983
12	English sole	1.87	0.003	0.986
13	Slender sole	1.50	0.002	0.988
14	American shad	1.14	0.002	0.990
15	Stripetail rockfish	0.73	0.001	0.991
16	Redbanded rockfish	0.60	0.001	0.992
17	Aurora rockfish	0.56	0.001	0.993
18	Yellowtail rockfish	0.55	0.001	0.994
19	Spiny dogfish	0.48	0.001	0.994
20	Longnose skate	0.43	0.001	0.995

[1] See Figure 1.

[2] Overall mean catch per unit effort, kg/km trawled. Total effort = 56.3 km.

[3] Proportion of total mean catch per unit effort, all fish and invertebrates combined. Total mean CPUE q 696.50 kg/km.

Table 13.--The 20 most abundant fish taxa recorded during the spring 1984 west coast upper continental slope trawl survey, in order of observed abundance, 366-549 m (200-300 fm)[1].

Rank	Taxon	CPUE (kg/km)[2]	Proportion of total CPUE[3]	Cumulative proportion
1	Sablefish	76.09	0.349	0.349
2	Pacific whiting	50.19	0.230	0.579
3	Shortspine thornyhead	17.99	0.082	0.661
4	Dover sole	17.53	0.080	0.741
5	Pacific ocean perch	13.15	0.060	0.802
6	Darkblotched rockfish	11.82	0.054	0.856
7	Splitnose rockfish	10.07	0.046	0.902
8	Rex sole	7.82	0.036	0.938
9	Rougheye rockfish	3.15	0.014	0.952
10	Arrowtooth flounder	1.64	0.007	0.960
11	Shortraker rockfish	1.45	0.007	0.966
12	Aurora rockfish	1.33	0.006	0.972
13	Brown cat shark	0.80	0.004	0.980
14	Redbanded rockfish	0.79	0.004	0.984
15	Longnose skate	0.51	0.002	0.988
16	Bigfin eelpout	0.33	0.002	0.992
17	Slender sole	0.26	0.001	0.993
18	Eelpout unidentified	0.15	0.001	0.994
19	Pacific sanddab	0.14	0.001	0.995
20	Pacific halibut	0.13	0.001	0.995

[1]See Figure 1.
[2]Overall mean catch per unit effort, kg/km trawled. Total effort = 64.5 km.
[3]Proportion of total mean catch per unit effort, all fish and invertebrates combined. Total mean CPUE q 218.23 kg/km.

Table 14.--Summary of average catch per unit fishing effort (kg/km), by depth stratum, observed for major fish species[1] during the spring 1984 west coast upper continental slope groundfish survey, north subarea[2].

Species	Depth stratum (m) 110-183	183-366	366-549	110-549
Pacific whiting	76.83	134.59	38.28	101.16
Sablefish	8.87	47.03	70.30	40.61
Darkblotched rockfish	---	63.90	16.36	38.01
Shortspine thornyhead	---	12.28	18.70	10.02
Pacific ocean perch	---	9.68	19.07	8.68
Jack mackerel	116.05	---	---	32.29
Pacific sanddab	28.18	---	---	7.84
Yellowtail rockfish	26.18	---	---	7.33
Chub mackerel	13.79	---	---	---
Rex sole	5.08	---	---	5.65
Greenstriped rockfish	8.00	---	---	---
Splitnose rockfish	---	14.40	---	8.21
Dover sole	---	---	5.74	---

[1]Species listed in each depth stratum collectively comprised 90% of the overall mean total catch.

[2]North subarea is that portion of the overall survey area which is north of 44°22.5'N Lat. See Figure 1.

Table 15.--Summary of average catch per unit fishing effort (kg/km), by depth stratum, observed for major fish species[1] during the spring 1984 west coast upper continental slope groundfish survey, south subarea[2].

	Depth Stratum (m)			
Species	110-183	183-366	366-549	110-549
Pacific whiting	85.12	911.18	71.02	363.94
Dover sole	4.14	---	38.15	16.93
Rex sole	14.04	---	18.05	---
Sablefish	---	80.78	86.23	56.42
Pacific herring	10.17	---	---	---
Pacific sanddab	4.95	---	---	---
Splitnose rockfish	---	---	23.65	---
Darkblotched rockfish	---	---	---	24.29

[1]Species listed in each depth stratum collectively comprised 90% of the overall mean total catch.
[2]South subarea is that portion of the overall survey area which is south of 44°22.5'N Lat. See Figure 1.

Table 16.--Estimated biomass (metric tons) of major species, by depth stratum and 95% confidence intervals (absolute and as a percentage of the biomass estimate) for the total survey area, from the 1984 spring west coast upper continental slope survey.

Species	Depth stratum (m) 110-183	183-366	366-549[1]	Total[2]	95% Confidence interval (total)	
Sablefish	1,230	11,025	13,272	25,527	16,734 - 34,320	(+34%)
Dover sole	680	1,153	3,05	4,889	2,294 - 7,484	(+53%)
Arrowtooth flounder	343	870	285	1,498	1,036 - 1,961	(+31%)
Pacific whiting	21,269	88,128	8,753	118,150	17,381 - 218,918	(+85%)
Rex sole	2,606	1,735	1,365	5,706	2,061 - 9,350	(+64%)
Shortspine thornyhead	1	1,494	3,137	4,632	3,286 - 5,978	(+29%)
Pacific ocean perch	----	1,018	2,294	3,312	1,047 - 5,576	(+68%)
Darkblotched rockfish	332	11,371	2,061	13,764	2,969 - 24,558	(+78%)
Splitnose rockfish	----	2,163	1,756	3,919	1,326 - 6,512	(+66%)
Canary rockfish	238	50	----	288	0 - 671	(+133%)
Redstripe rockfish	----	12	----	12	0 - 27	(+125%)
Sharpchin rockfish	----	28	2	30	0 - 78	(+160%)
Greenstriped rockfish	1,073	355	9	1,437	0 - 3,471	(+142%)
Pacific sanddab	4,054	----	25	4,079	0 - 9,870	(+142%)
Lingcod	440	67	11	518	62 - 974	(+88%)
Chilipepper rockfish	----	----	1	1	0 - 2	(+100%)
Yellowtail rockfish	3,123	95	----	3,218	0 - 9,268	(+188%)
Stripetail rockfish	2	127	2	131	0 - 263	(+101%)
Bocaccio	108	63	----	171	0 - 395	(+130%)
Spiny dogfish	33	84	19	137	32 - 241	(+76%)
English sole	721	327	19	1,067	235 - 1,898	(+78%)

[1]*Poseydon* was not equipped to trawl waters deeper than 549 m (300 fm).
[2]Rounding accounts for minor discrepancies between sums for individual depth strata and overall totals. Total area q 43°00'N - 45°45'N lat.

Table 17.--Percent of estimated biomass of major species, by depth stratum, from the 1984 spring west coast upper continental slope survey.

Species	Depth stratum (m) 110-183	183-366	366-549*
Sablefish	4.8	43.2	52.0
Dover sole	13.9	23.6	62.5
Arrowtooth flounder	22.9	58.1	19.0
Pacific whiting	18.0	74.6	7.4
Rex sole	45.7	30.4	23.9
Shortspine thornyhead	<0.1	32.3	67.7
Pacific ocean perch	---	30.7	69.3
Darkblotched rockfish	2.4	82.6	15.0
Splitnose rockfish	---	55.2	44.8
Canary rockfish	82.6	17.4	---
Redstripe rockfish	---	100.0	---
Sharpchin rockfish	---	93.3	6.7
Greenstriped rockfish	74.7	24.7	0.6
Pacific sanddab	99.4	---	0.6
Lingcod	84.9	12.9	2.1
Chilipepper rockfish	---	---	100.0
Yellowtail rockfish	97.0	3.0	---
Stripetail rockfish	1.5	97.0	1.5
Bocaccio	63.2	36.8	---
Spiny dogfish	24.1	61.3	13.9
English sole	67.6	30.6	1.8

*_Poseydon_ was not equipped to trawl waters deeper than 549 m (300 fm).

Table 1b.--Population estimates for sablefish by year class and mean length at age during the spring 1984 vest coast upper continental slope survey, 183-366 m (100-200 fm).

Age	Year class	Population number (x1000)	Proportion	Cumulative proportion	Mean length (cm)
1	1982	3,726	0.266	0.266	31.2
2	1981	3,223	0.230	0.450	37.4
3	1980	2,210	0.158	0.653	43.7
4	1979	2,512	0.179	0.833	48.0
5	1978	1,257	0.090	0.922	51.8
6	1977	450	0.032	0.954	54.4
7	1976	225	0.016	0.970	58.9
8	1975	86	0.006	0.977	55.2
9	1974	62	0.004	0.981	63.4
10	1973	40	0.003	0.984	63.7
11	1972	62	0.004	0.988	59.3
12	1971	46	0.003	0.991	59.8
13	1970	54	0.004	0.995	62.0
14	1969	31	0.002	0.998	64.0
18	1965	5	<0.001	0.998	63.0
19	1964	3	<0.001	0.998	68.0
Between key lengths		27	<0.001	1.000	66.0
	Total	14,018	1.000	1.000	41.5

Table 19.--Population estimates for sablefish by year class and mean length at age during the spring 1984 west coast upper continental slope survey, 366-549 m (200-300 fm).

Age	Year class	Population number (x1000)	Proportion	Cumulative proportion	Mean length (cm)
1	1982	13	0.001	0.001	33.0
2	1981	176	0.019	0.020	39.7
3	1980	1,195	0.129	0.149	46.1
4	1979	3,123	0.336	0.485	49.5
5	1978	2,228	0.240	0.725	52.4
6	1977	1,024	0.110	0.835	54.5
7	1976	540	0.058	0.893	59.8
8	1975	195	0.021	0.914	56.0
9	1974	114	0.012	0.927	63.7
10	1973	76	0.008	0.935	64.1
11	1972	146	0.016	0.951	59.2
12	1971	151	0.016	0.967	61.0
13	1970	140	0.015	0.982	62.0
14	1969	35	0.004	0.986	64.0
18	1965	29	0.003	0.989	63.0
19	1964	25	0.003	0.992	72.5
Between key lengths		79	0.009	1.000	68.2
	Total	9,289	1.000	1.000	52.0

Table 20.--Population estimates for sablefish by year class and mean length at age during the spring 1984 west coast upper continental slope survey, 183-549 m (100-300 fm) .

Age	Year class	Population number (x1000)	Proportion	Cumulative proportion	Mean length (cm)
1	1982	3,739	0.160	0.160	31.2
2	1981	3,399	0.146	0.306	37.5
3	1980	3,405	0.146	0.452	44.5
4	1979	5,635	0.242	0.694	48.8
5	1978	3,485	0.150	0.844	52.2
6	1977	1,474	0.063	0.907	54.5
7	1976	765	0.033	0.940	59.5
8	1975	281	0.012	0.952	55.8
9	1974	176	0.008	0.960	63.6
10	1973	116	0.005	0.964	63.9
11	1972	208	0.009	0.973	59.2
12	1971	198	0.009	0.982	60.7
13	1970	194	0.008	0.990	62.0
14	1969	66	0.003	0.993	64.0
18	1965	34	0.001	0.994	63.0
19	1964	28	0.001	0.996	72.0
Between key lengths		106	0.001	1.000	67.7
	Total	23,307	1.000	1.000	45.7

*Age samples were not obtained in the 110-183 m (60-100 fm) depth stratum during the spring survey.

Table 21.--List of fish taxa collected and their observed bathymetric distribution during the 1984 autumn west coast upper continental slope groundfish surveys.

Scientific name[1]	Common name[1]	Depth stratum (m)				
		110-183	183-366	366-549	549-732[2]	732-915[2]
Myxinidae						
Eptatretus spp.	Hagfish			-------	-------	-------
E. stouti	Pacific hagfish		-------	-------	-------	-------
Petromyzontidae						
Lampetra tridentata	Pacific lamprey		-------			
Carcharhinidae						
Galeorhinus zyopterus	Soupfin shark	-------				
Scyliorhinidae						
Apristurus brunneus	Brown cat shark	-------	-------	-------	-------	-------
Squalidae						
Squalus acanthias	Spiny dogfish	-------	-------	-------		
Rajidae						
Raja binoculata	Big skate	-------				
R. kincaidi	Sandpaper skate	-------	-------	-------	-------	-------
R. rhina	Longnose skate	-------	-------	-------		
R. trachura	Roughtail skate				-------	-------
Torpedinidae						
Torpedo californica	Pacific electric ray	-------	-------			
Chimaeridae						
Hydrolagus colliei	Spotted ratfish	-------	-------	-------	-------	
Bothidae						
Citharichthys sordidus	Pacific sanddab	-------				
Pleuronectidae[3]	Righteye flounders			-------		
Atheresthes stomias	Arrowtooth flounder	-------	-------	-------		
Embassichthys bathybius	Deepsea sole			-------	-------	-------
Eopsetta jordani	Petrale sole	-------	-------	-------		
Errex zachirus	Rex sole	-------	-------	-------	-------	-------
Hippoglossoides elassodon	Flathead sole	-------	-------	-------		
Hippoglossus stenolepis	Pacific halibut	-------	-------	-------		
Lyopsetta exilis	Slender sole	-------	-------	-------		
Microstomus pacificus	Dover sole	-------	-------	-------	-------	-------
Pleuronectes vetulus	English sole	-------	-------			

Table 21.--Continued.

Scientific name[1]	Common name[1]	Depth stratum (m)				
		110-183	183-366	366-549	549-732[2]	732-915[2]
Agonidae[3]	Poachers			-------	-------	
Agonopsis vulsa	Northern spearnose poacher	-------	-------			
Bathyagonus alascanus	Gray starsnout	-------	-------			
B. nigripinnis	Blackfin poacher			-------		
Xeneretmus latifrons	Blacktip poacher	-------	-------	-------		
Clupeidae						
Alosa sapidissima	American shad	-------				
Clupea harengus pallasi	Pacific herring	-------				
Bathylagidae						
Bathylagus spp.	Deepsea smelts				-------	-------
B. milleri[4]	Robust blacksmelt			-------	-------	-------
Chauliodontidae						
Chauliodus macouni	Pacific viperfish				-------	-------
Carangidae						
Trachurus symmetricus	Jack mackerel	-------	-------			
Macrouridae						
Albatrossia pectoralis[4]	Giant grenadier			-------	-------	-------
Coryphaenoides acrolepis[4]	Pacific grenadier			-------	-------	-------
Cottidae						
Icelinus filamentosus	Threadfin sculpin	-------	-------	-------		
Gadidiae						
Gadus macrocephalus	Pacific cod	-------	-------			
Microgadus proximus	Pacific tomcod	-------				
Theragra chalcogramma	Walleye pollock		-------			
Moridae						
Antimora microlepis[4]	Pacific flatnose			-------	-------	-------
Physiculus rastrelliger[4]	Hundred-fathom codling				-------	
Hexagrammidae						
Ophiodon elongatus	Lingcod	-------	-------			
Gonostomatidae[3,4]	Bristlemouths					-------
Alepocephalidae						
Alepocephalus tenebrosus[4]	California slickhead				-------	-------
Talismania bifurcata[4]	Threadfin slickhead				-------	-------
Anarhichadidae						
Anarrhichthys ocellatus	Wolf-eel		-------			

Table 21.--Continued.

Scientific name[1]	Common name[1]	Depth stratum (m)				
		110-183	183-366	366-549	549-732[2]	732-915[2]
Anoplopomatidae						
Anoplopoma fimbria	Sablefish	-------	-------	-------	-------	-------
Icosteidae						
Icosteus aenigmaticus	Ragfish			-------		
Cyclopteridae[3]						
Careproctus melanurus	Blacktail snailfish		-------	-------	-------	-------
Melanostomiidae						
Tactostoma macropus	Longfin dragonfish		-------	-------	-------	-------
Myctophidae[3]	Lanternfishes		-------	-------	-------	-------
Diaphus theta	California headlightfish					-------
Lampanyctus ritteri[3]	Broadfin lanternfish		-------	-------		-------
Stenobrachius leucopsarus	Northern lampfish			-------		-------
Oneirodidae	Dreamers					-------
Paralepididae						
Lestidiops ringens[4]	Slender barracudina					-------
Merlucciidae						
Merluccius productus	Pacific whiting	-------	-------	-------	-------	-------
Osmeridae						
Thaleichthys pacificus	Eulachon	-------				
Salmonidae						
Oncorhynchus tshawytscha	Chinook salmon	-------				
Scombridae[3]						
Scomber japonicus	Chub mackerel	-------				
Stromateidae						
Icichthys lockingtoni	Medusafish			-------	-------	-------
Scomberesocidae						
Cololabis saira	Pacific saury				-------	-------
Alepisauridae						
Alepisaurus ferox	Longnose lancetfish				-------	-------
Scopelarchidae						
Benthalbella dentata	Northern pearleye				-------	

Table 21.--Continued.

Scientific name[1]	Common name[1]	Depth stratum (m)				
		110-183	183-366	366-549	549-732[2]	732-915[2]
Sternoptychidae[3,4]	Hatchetfishes		-------			
Trachipteridae						
Trachipterus altivelis	King-of-the-salmon	-------	-------			
Zoarcidae[3]	Eelpouts	-------	-------			-------
Aprodon cortezianus	Bigfin eelpout	-------	-------	-------	-------	
Bothrocara brunneum[4]	Twoline eelpout			-------	-------	-------
Embryx crotalinus[4]	Snakehead eelpout				-------	-------
Lycodapus fierasfer	Blackmouth eelpout					-------
L. mandibularis	Pallid eelpout				-------	
Lycodes diapterus	Black eelpout		-------	-------	-------	-------
Lycodopsis pacifica	Blackbelly eelpout		-------	-------		
Stylephoridae						
Stylephorus chordatus	Tube-eye					-------
Scorpaenidae						
Sebastes spp.	Rockfish				-------	
S. aleutianus	Rougheye rockfish	-------	-------	-------	-------	
S. alutus	Pacific ocean perch	-------	-------	-------		
S. aurora	Aurora rockfish		-------	-------	-------	
S. babcocki	Redbanded rockfish	-------	-------	-------		
S. borealis	Shortraker rockfish			-------		
S. brevispinis	Silvergray rockfish	-------	-------			
S. chlorostictus	Greenspotted rockfish	-------				
S. crameri	Darkblotched rockfish	-------	-------	-------		
S. diploproa	Splitnose rockfish	-------	-------	-------		
S. elongatus	Greenstriped rockfish	-------	-------			
S. entomelas	Widow rockfish	-------	-------			
S. flavidus	Yellowtail rockfish	-------	-------			
S. goodei	Chilipepper	-------	-------			
S. helvomaculatus	Rosethorn rockfish	-------	-------	-------		
S. jordani	Shortbelly rockfish	-------	-------			
S. paucispinis	Bocaccio	-------	-------			
S. pinniger	Canary rockfish	-------	-------			
S. proriger	Redstripe rockfish	-------	-------			
S. reedi	Yellowmouth rockfish		-------			
S. ruberrimus	Yelloweye rockfish	-------				
S. saxicola	Stripetail rockfish	-------	-------			
S. wilsoni	Pygmy rockfish	-------	-------			
S. zacentrus	Sharpchin rockfish	-------	-------	-------		

Table 21.--Continued.

Scientific name[1]	Common name[1]	Depth stratum (m) 110-183	183-366	366-549	549-732[2]	732-915[2]
Sebastolobue alascanus	Shortspine thornyhead	--------	--------	--------	--------	--------
S. altivelis	Longspine thornyhead		--------	--------	--------	--------

[1]Nomenclature from Robins (1980) unless otherwise noted.
[2]U.S. vessel Half Moon Bay only.
[3]Common name associated with family name indicates unidentified metiers were encountered.
[4]Nomenclature from Hubbs and Dempster (1979).

Table 22.--List of invertebrate taxa collected and their observed bathymetric distributions during the 1984 autumm west coast upper continental slops groundfish survey.

Scientific name[1]	Common name[1]	Depth stratum (m) 110-183	183-366	366-549	549-732[2]	732-915[2]
Cnidaria						
Scyphozoa	Jellyfish	———	———	———	———	———
Alcyonaria	Soft coral		———	———	———	———
Pennatulacea	Sea pen		———			
Stylatula gracile[3]	Roughstem seawhip	———	———		———	
Zoantharia	Sea anenome	———	———	———	———	———
Metridium senile	Sea anenome		———			
Annelida						
Aphroditidae	Sea mouse	———				
Arthropoda[4]						
Crangonidae	Crangonid shrimp	———				
Pasiphaeidae	Pasiphaeid shrimp				———	
Pasiphaea pacifica	Glass shrimp		———	———	———	———
P. tarda	Crimson pasiphaeid				———	———
Pandalidae						
Pandalus borealis	Pink shrimp	———	———			
P. jordani	Ocean pink shrimp	———	———			
Pandalopsis dispar	Sidestripe shrimp		———			
Oplophoridae						
Notostomus japonicus	Spiny ridge shrimp					———
Cancridae						
Cancer magister	Dungeness crab	———	———			
Majidae						
Chionoecetes tanneri	Tanner crab		———	———	———	———
Oregonia bifurca	Crab				———	
O. gracilis	Decorator crab			———		———
Paguridae	Hermit crab	———	———		———	
Lithodidae						
Lithodes couesi	Deepsea king crab					———
Lopholithodes foraminatus	Box crab	———	———	———	———	
Galatheidae	Galatheid crab					———
Mollusca[5]						
Gastropoda:Nudibranichia	Nudibranchs	———	———		———	———
Tritonia spp.	Tritonid nudibranch	———			———	
Gastropoda:Prosobranchia[1]	Snails		———	———	———	———
Bathybembix bairdii	Baird's margarite				———	———
Buccinum spp.	Snail					———
Fusitriton oregonensis	Oregon triton		———			
Neptunea amianta	Unspotted whelk		———	———	———	———
Polinices lewisis	Lewis' moon snail		———			
Cephalopoda:Octopodidae	Octopus	———	———	———	———	———
Cephalopoda:Opisthoteuthidae						
Opisthoteuthis californiana	Flapjack devilfish		———	———	———	———

Table 22.--Continued.

Scientific name[1]	Common name[1]	Depth stratum (m)				
		110-183	183-366	366-549	549-732[2]	732-915[2]
Cephalopoda:Sepiolidae	Squid	------	------	------	------	------
Rossia pacifica	Pacific bobtail squid	------				
Cephalopoda:Gonatidae						
Gonatus spp.	Squid		------	------	------	------
Cephalopoda:Onychoteuthidae						
Moroteuthis robusta	Giant squid		------			
Echinodermata						
Asteroidea[6]	Seastars		------	------	------	------
Ctenodiscus crispatus	Seastar		------	------		
Diplopteraster multipes	Seastar		------	------	------	------
Henricia spp.	Seastar		------	------	------	
H. aspera	Seastar		------		------	
Heterozonias alternatus	Seastar	------	------	------	------	------
Hippasteria spinosa	Seastar	------	------	------	------	------
Luidia spp.	Seastar					------
L. foliata	Seastar	------	------	------	------	
Luidiaster dawsoni	Seastar		------		------	------
Mediaster aequalis	Seastar	------				
Pisaster brevispinus	Seastar	------				
Poraniopsis inflata	Seastar					------
Pseudarchaster parelli	Seastar		------			
P. parelii alascensis	Seastar	------	------			
Psilaster pectinatus	Seastar	------	------	------	------	------
Pteraster tesselatus	Seastar					------
Rathbunaster californica	Seastar			------		
Solaster borealis	Seastar			------	------	------
Stylasterias forreri	Seastar	------				
Zoraster ophirus	Seastar		------	------	------	------
Echinoidea	Sea urchins	------	------	------	------	------
Allocentrotus fragilis	Sea urchin		------	------	------	------
Brisaster spp.	Heart urchin	------	------	------		
B. latifrons	Heart urchin	------	------	------	------	------
Ophiuroidea	Brittle stars	------	------	------		------
Gorgonocephalus caryi	Basket star	------	------		------	
Ophiura sarsi	Brittle star	------	------	------	------	
Holothuroidea	Sea cucumbers	------	------	------	------	
Molpadia spp.	Sea cucumber			------		
Pannychia moseleyi	Sea cucumber				------	
Pseudostichopus mollis	Sea cucumber		------	------		
Psolus spp.	Sea cucumber					------
Porifera	Sponges		------	------	------	------
Hexactinellida	Glass sponge		------	------	------	------

Table 22.--Continued.

Scientific name[1]	Common name[1]	Depth stratum (m) 110-183	183-366	366-549	549-732[2]	732-915[2]
Bryozoa	Bryozoans			--------	-------	
Brachiopoda						
Terebratalia transversa	Brachiopod			-------		

[1]Nomenclature from Kozloff (1974) unless otherwise noted.

[2]U.S. vessel Half Moon Bay only.

[3]Nomenclature from NWAFC species codebook.

[4]Nomenclature for shrimp from Butler (1980).

[5]Nomenclature for mollusca from Abbott (1974) unless otherwise noted.

[6]Nanenclature for seastars from Fisher (1911, 1928, 1930).

Table 23.--Summary of average catch per unit fishing effort (kg/km) for major taxonomic groups during autumn 1984 west coast upper continental slops trawl survey'.

Taxa	Mean CPUE[2] for entire survey area	Proportion of total catch	Mean CPUE by depth stratum (m) 110-183	183-366	366-549	549-732	732-915	Proportion of total catch by depth 110-183	183-366	366-549	549-732	732-915
Squalidae	2.31	0.012	3.64	4.18	1.33	0.81	0.31	0.018	0.018	0.009	0.005	0.003
Rajidae	3.13	0.017	4.44	2.92	3.10	2.08	0.33	0.022	0.012	0.020	0.013	0.003
Bothidae	1.29	0.007	3.84	---	---	---	---	0.019	---	---	---	---
Pleuronectidae	28.56	0.155	29.94	31.30	26.10	31.16	19.51	0.150	0.132	0.172	0.189	0.170
Anoplopomatidae	42.11	0.228	30.69	47.92	37.41	74.90	38.36	0.154	0.203	0.246	0.455	0.335
Macrouridae	0.91	0.005	---	---	0.20	4.53	3.47	---	---	0.001	0.028	0.030
Hexagrammidae	1.42	0.008	2.10	3.16	---	---	---	0.010	0.013	---	---	---
Merlucciidae	46.43	0.251	90.53	48.72	21.32	1.27	0.10	0.454	0.206	0.140	0.008	0.001
Zoarcidae	0.60	0.003	0.25	0.89	1.18	0.40	0.07	0.001	0.004	0.008	0.002	0.001
Scorpaenidae	43.46	0.235	23.11	85.79	40.77	31.32	36.86	0.116	0.363	0.268	0.190	0.322
Sebastes spp.	28.78	0.156	22.23	72.63	21.91	0.02	---	0.112	0.308	0.144	<0.001	---
Sebastolobus spp.	14.68	0.080	0.88	13.16	18.86	31.30	36.86	0.004	0.056	0.124	0.190	0.322
Carangidae	0.47	0.003	1.16	0.34	---	---	---	0.006	0.001	---	---	---
Scombridae	tr[3]	<0.001	0.01	---	---	---	---	<0.001	---	---	---	---
Other fish	2.24	0.012	4.44	1.65	1.76	2.33	1.82	0.022	0.007	0.012	0.014	0.016
Total fish	172.93	93.6	192.98	226.53	133.17	148.80	100.83	0.966	0.958	0.876	0.904	0.881
Coelenterata	0.85	0.005	0.43	1.24	1.45	0.49	0.38	0.002	0.005	0.010	0.003	0.003
Porifera	3.03	0.016	---	0.18	11.87	1.79	1.18	---	0.001	0.078	0.011	0.010
Crustacea	3.12	0.017	1.28	2.32	0.16	9.65	10.49	0.006	0.010	0.001	0.059	0.092
Total crabs	3.06	0.017	1.18	2.21	0.15	9.62	10.48	0.006	0.009	0.001	0.058	0.092
Total shrimps	0.06	<0.001	0.09	0.11	0.01	0.03	0.01	<0.001	<0.001	<0.001	<0.001	<0.001
Mollusca	0.64	0.004	0.01	1.36	0.78	0.88	0.55	<0.001	0.006	0.005	0.005	0.005
Gastropoda	0.17	0.001	tr[3]	0.08	0.35	0.39	0.24	<0.001	<0.001	0.002	0.002	0.002
Cephalopoda	0.47	0.003	tr[3]	1.28	0.43	0.49	0.31	<0.001	0.005	0.003	0.003	0.003
Echinodermata	3.96	0.021	4.69	4.51	4.61	1.98	0.90	0.024	0.019	0.030	0.012	0.008
Asteroidea	0.71	0.004	0.32	0.54	0.77	1.77	0.80	0.002	0.002	0.005	0.011	0.007
Echinoidea	2.61	0.014	3.54	3.58	2.62	0.14	0.03	0.018	0.015	0.017	0.001	<0.001
Ophiuroidea	0.16	0.001	0.19	0.05	0.36	0.02	tr[3]	0.001	<0.001	0.002	<0.001	<0.001
Holothuroidea	0.48	0.003	0.64	0.35	0.80	0.02	0.01	0.003	0.001	0.005	<0.001	<0.001
Other invertebrates	0.11	0.001	tr[3]	---	tr[3]	0.86	0.01	<0.001	---	<0.001	0.005	<0.001
Total invertebrates	11.71	0.064	6.41	9.61	18.87	15.65	13.51	0.034	0.042	0.124	0.096	0.119
Total catch	184.66	1.000	199.39	236.14	152.04	164.45	114.34	1.000	1.000	1.000	1.000	1.000
Total effort (km)	251.8		43.2	75.6	47.8	47.1	38.0					
Total trawls	93		15	27	17	19	15					

[1]See Figure 2.
[2]Mean CPUE and proportion of total catch for the overall (110-915 m) survey area.
[3]tr = CPUE <0.01 kg/km.

Table 24.--The 25 most common fish and crab taxa recorded during the autumn 1984 west coast continental slope demersal trawl survey, in order of percentage frequency of occurrence.

Rank	Species	All strata combined	Depth stratum (m)* 110-183	183-366	366-549	549-732	732-915	All strata south	All strata north
1	Dover sole	96.8	93.3	100.0	100.0	100.0	86.7	97.8	95.7
2	Sablefish	95.7	93.3	100.0	94.1	100.0	86.7	93.5	97.9
3	Shortspine thornyhead	84.9	40.0	92.0	94.1	100.0	86.7	82.6	87.2
4	Pacific whiting	80.6	100.0	96.2	100.0	57.9	40.0	78.3	83.0
5	Rex sole	70.0	100.0	92.6	88.2	47.4	6.7	63.0	76.6
6	Arrowtooth flounder	52.7	73.3	88.9	82.4	---	---	39.1	66.0
7	Slender sole	50.5	100.0	92.6	41.2	---	---	43.5	57.4
8	Bigfin eelpout	48.4	66.7	77.8	70.6	10.5	---	37.0	59.6
9	Longnose skate	47.3	53.3	63.0	70.6	36.8	---	32.6	61.7
10	Spotted ratfish	44.1	86.7	74.1	23.5	21.1	---	34.8	53.2
11	Spiny dogfish	43.0	80.0	81.5	35.3	---	---	32.6	53.2
12	Brown cat shark	43.0	6.7	11.1	52.9	89.5	66.7	52.2	34.0
13	Darkblotched rockfish	43.0	60.0	85.2	47.1	---	---	28.3	57.4
14	Longspine thornyhead	40.9	---	3.7	23.5	100.0	93.3	52.2	29.8
15	Tanner crab	38.7	---	11.1	11.8	89.5	93.3	45.7	31.9
16	Sandpaper skate	38.7	26.7	66.7	52.9	21.1	6.7	28.3	48.9
17	Giant grenadier	36.6	---	---	29.4	78.9	93.3	47.8	25.5
18	Redbanded rockfish	36.6	26.7	85.2	41.2	---	---	26.1	46.8
19	Splitnose rockfish	35.5	26.7	92.6	23.5	---	---	32.6	38.3
20	Pacific grenadier	35.5	---	---	23.5	78.9	93.3	43.5	27.7
21	Pacific flatnose	32.3	---	---	29.4	94.7	46.7	41.3	23.4
22	Broadfin lanternfish	32.3	---	---	11.8	84.2	73.3	43.5	21.3
23	Black eelpout	32.3	---	37.0	70.6	36.8	6.7	26.1	38.3
24	Pacific ocean perch	31.2	13.3	70.4	47.1	---	---	17.4	44.7
25	Greenstriped rockfish	29.0	100.0	44.4	---	---	---	30.4	27.7
	Total trawls	93	15	27	17	19	15	46	47

*See Figure 2.

Table 25.--The 20 most abundant fish and crab taxa recorded during the autumn 1984 west coast upper continental slope trawl survey in order of observed abundance, all depth strata 110-915 m (60-500 fm) combined [1].

Rank	Taxon	CPUE (kg/km)[2]	Proportion of total CPUE[3]	Cumulative proportion
1	Pacific whiting	46.57	0.253	0.253
2	Sablefish	41.91	0.227	0.480
3	Dover sole	18.12	0.098	0.578
4	Shortspine thornyhead	9.63	0.052	0.630
5	Sharpchin rockfish	6.31	0.034	0.665
6	Rex sole	5.12	0.028	0.692
7	Darkblotched rockfish	5.09	0.028	0.720
8	Longspine thornyhead	4.89	0.027	0.747
9	Pacific ocean perch	3.93	0.021	0.768
10	Greenstriped rockfish	3.14	0.017	0.785
11	Splitnose rockfish	3.01	0.016	0.801
12	Arrowtooth flounder	2.91	0.016	0.817
13	Canary rockfish	2.57	0.014	0.831
14	Spiny dogfish	2.29	0.012	0.843
15	Tanner crab	2.07	0.011	0.866
16	Longnose skate	1.70	0.009	0.875
17	Lingcod	1.39	0.008	0.900
18	Pacific sanddab	1.31	0.007	0.907
19	Big skate	0.99	0.005	0.913
20	Slender sole	0.97	0.005	0.918

[1] See Figure 2.

[2] Overall mean catch per unit effort, kg/km trawled. Total effort = 251.8 km.

[3] Proportion of total mean catch per unit effort, all fish and invertebrates combined. Total mean CPUE = 184.36 kg/km.

Table 26.--The 20 most abundant fish taxa recorded during the autumn 1984 west coast upper continental slope trawl survey in order of observed abundance, 110-183 m (60-100 fm)[1].

Rank	Taxon	CPUE (kg/km)[2]	Proportion of total CPUE[3]	Cumulative proportion
1	Pacific whiting	90.53	0.453	0.453
2	Sablefish	30.69	0.153	0.606
3	Dover sole	16.46	0.082	0.688
4	Greenstriped rockfish	7.73	0.039	0.727
5	Canary rockfish	7.40	0.037	0.764
6	Rex sole	6.94	0.035	0.799
7	Pacific sanddab	3.84	0.019	0.818
8	Spiny dogfish	3.63	0.018	0.836
9	Big skate	2.91	0.015	0.868
10	Slender sole	2.27	0.011	0.879
11	Sharpchin rockfish	2.26	0.011	0.891
12	Arrowtooth flounder	2.13	0.011	0.901
13	Lingcod	2.11	0.011	0.911
14	Spotted ratfish	1.63	0.008	0.920
15	Longnose skate	1.42	0.007	0.927
16	Jack mackerel	1.16	0.006	0.933
17	Darkblotched rockfish	1.14	0.006	0.939
18	Stripetail rockfish	0.94	0.005	0.943
19	Pacific halibut	0.89	0.004	0.948
20	Shortspine thornyhead	0.88	0.004	0.952

[1]See Figure 2.

[2]Overall mean catch per unit effort, kg/km trawled. Total effort = 43.2 km.

[3]Proportion of total mean catch per unit effort, all fish and invertebrates combined. Total mean CPUE = 200.02 kg/km.

Table 27.--The 20 most abundant fish and crab taxa recorded during the autumn 1984 vest coast upper continental slope trawl survey in order of observed abundance, 183-366 m (100-200 fm)[1].

Rank	Taxon	CPUE (kg/km)[2]	Proportion of total CPUE[3]	Cumulative proportion
1	Pacific whiting	48.72	0.206	0.206
2	Sablefish	47.92	0.203	0.409
3	Sharpchin rockfish	25.85	0.109	0.519
4	Darkblotched rockfish	19.93	0.084	0.603
5	Dover sole	15.07	0.064	0.667
6	Splitnose rockfish	13.19	0.056	0.723
7	Shortspine thornyhead	13.14	0.056	0.778
8	Rex sole	8.56	0.036	0.815
9	Arrowtooth flounder	4.84	0.020	0.835
10	Spiny dogfish	4.16	0.018	0.853
11	Lingcod	3.17	0.013	0.866
12	Greenstriped rockfish	2.38	0.010	0.887
13	Silvergrey rockfish	2.36	0.010	0.897
14	Longnose skate	2.36	0.010	0.907
15	Box crab	1.95	0.008	0.915
16	Pacific ocean perch	1.72	0.007	0.923
17	Pacific halibut	1.63	0.007	0.929
18	Yellowmouth rockfish	1.58	0.007	0.936
19	Redbanded rockfish	1.47	0.006	0.942
20	Bocaccio	1.27	0.005	0.948

[1]See Figure 2.

[2]Overall mean catch per unit effort, kg/km trawled. Total effort = 75.6 km.

[3]Proportion of total mean catch per unit effort, all fish and invertebrates combined. Total mean CPUE = 236.13 kg/km.

Table 28.--The 20 most abundant fish taxa recorded during the autumn 1984 west coast upper continental slope trawl survey in order of observed abundance, 366-549 m (200-300 fm)[1].

Rank	Taxon	CPUE (kg/km)[2]	Proportion of total CPUE[3]	Cumulative proportion
1	Sablefish	36.70	0.252	0.252
2	Pacific whiting	20.48	0.141	0.393
3	Shortspine thornyhead	17.18	0.118	0.511
4	Dover sole	16.51	0.114	0.625
5	Pacific ocean perch	13.88	0.095	0.720
6	Arrowtooth flounder	4.48	0.031	0.828
7	Rex sole	3.17	0.022	0.850
8	Longnose skate	2.53	0.017	0.868
9	Darkblotched rockfish	1.71	0.012	0.879
10	Aurora rockfish	1.64	0.011	0.891
11	Shortraker rockfish	1.29	0.009	0.909
12	Rougheye rockfish	0.99	0.007	0.924
13	Brown cat shark	0.73	0.005	0.941
14	Redbanded rockfish	0.70	0.005	0.946
15	Longspine thornyhead	0.67	0.005	0.950
16	Bigfin eelpout	0.66	0.005	0.954
17	Spiny dogfish	0.62	0.004	0.959
18	Pacific halibut	0.62	0.004	0.963
19	Sandpaper skate	0.57	0.004	0.967
20	Splitnose rockfish	0.44	0.003	0.974

[1] See Figure 2.

[2] Overall mean catch per unit effort, kg/km trawled. Total effort = 50.4 km.

[3] Proportion of total mean catch per unit effort, all fish and invertebrates combined. Total mean CPUE = 145.40 kg/km.

Table 29.--The 20 most abundant fish and crab taxa recorded during the autumn 1984 west coast upper continental slope trawl survey in order of observed abundance, 549-732 m (300-400 fm)[1].

Rank	Taxon	CPUE (kg/km)[2]	Proportion of total CPUE[3]	Cumulative proportion
1	Sablefish	77.69	0.456	0.456
2	Dover sole	31.05	0.182	0.638
3	Longspine thornyhead	18.91	0.117	0.750
4	Shortspine thornyhead	14.08	0.083	0.832
5	Tanner crab	10.12	0.059	0.892
6	Giant grenadier	4.45	0.026	0.918
7	Rex sole	1.12	0.007	0.924
8	Longnose skate	1.01	0.006	0.936
9	Pacific whiting	1.00	0.006	0.942
10	Roughtail skate	0.72	0.004	0.957
11	Brown cat shark	0.71	0.004	0.961
12	California slickhead	0.54	0.003	0.968
13	Deepsea sole	0.51	0.003	0.974
14	Pacific flatnose	0.48	0.003	0.976
15	Pacific grenadier	0.34	0.002	0.983
16	Sandpaper skate	0.30	0.002	0.985
17	Twoline eelpout	0.27	0.002	0.986
18	Blacktail snailfish	0.13	0.001	0.992
19	Black eelpout	0.11	0.001	0.993
20	Longnose lancetfish	0.09	0.001	0.994

[1]See Figure 2.

[2]Overall mean catch per unit effort, kg/km trauled. Total effort = 44.5 km.

[3]Proportion of total mean catch per unit effort, all fish and invertebrates combined. Total mean CPUE q 170.31 kg/km.

Table 30.--The 20 most abundant fish and crab taxa recorded during the autumn 1984 west coast upper continental slope trawl survey in order of observed abundance, 732-915 m (400-500 fm)[1].

Rank	Taxon	CPUE (kg/km)[2]	Proportion of total CPUE[3]	Cumulative proportion
1	Sablefish	38.36	0.336	0.336
2	Longspine thornyhead	30.45	0.267	0.603
3	Dover sole	18.71	0.164	0.767
4	Tanner crab	10.41	0.091	0.859
5	Shortspine thornyhead	6.41	0.056	0.915
6	Giant grenadier	1.93	0.017	0.932
7	Pacific grenadier	1.54	0.013	0.945
8	Deepsea sole	0.80	0.007	0.961
9	California slickhead	0.79	0.007	0.968
10	Threadfin slickhead	0.36	0.003	0.971
11	Roughtail skate	0.31	0.003	0.974
12	Brown cat shark	0.22	0.002	0.978
13	Pacific whiting	0.10	0.001	0.990
14	Stout blacksmelt	0.10	0.001	0.991
15	Pacific flatnose	0.08	0.001	0.992
16	Lithodes couesi	0.07	0.001	0.993
17	Broadfin lanternfish	0.06	0.001	0.994
18	Pacific hagfish	0.06	0.001	0.995
19	Twoline eelpout	0.05	0.001	0.996
20	Unidentified hagfish	0.04	0.001	0.997

[1]See Figure 2.

[2]Overall mean catch per unit effort, kg/km trawled. Total effort = 38.0 km.

[3]Proportion of total mean catch per unit effort, all fish and invertebrates combined. Total mean CPUE = 114.04 kg/km.

Table 31.--Summary of average catch per unit fishing effort, by depth stratum, observed for major fish and crab species[1] during the autumn 1984 west coast upper continental slope trawl survey, north subarea[2].

	Depth stratum (m)						
Species	110-183	183-366	366-549	549-732	732-915	110-915	110-549
Sablefish	55.71	38.68	36.24	116.10	60.83	54.97	42.98
Dover sole	13.97	16.57	18.81	16.53	10.18	15.68	16.25
Pacific whiting	176.30	52.27	26.30	---	---	77.65	82.10
Greenstriped rockfish	10.23	3.66	---	---	---	4.27	4.82
Rex sole	6.37	7.07	---	---	---	4.14	5.91
Spiny dogfish	6.05	7.05	---	---	---	3.79	5.67
Sharpchin rockfish	4.21	44.85	---	---	---	11.04	25.47
Canary rockfish	15.09	---	---	---	---	5.19	4.33
Shortspine thornyhead	---	18.38	23.23	19.42	---	12.52	14.27
Darkblotched rockfish	---	24.41	2.57	---	---	6.13	13.92
Arrowtooth flounder	---	6.62	6.52	---	---	4.36	5.88
Longnose skate	---	3.68	3.12	---	---	---	3.05
Splitnose rockfish	---	18.25	---	---	---	4.07	10.01
Lingcod	---	2.97	---	---	---	---	---
Pacific ocean perch	---	---	20.82	---	---	5.65	5.31
Aurora rockfish	---	---	2.21	---	---	---	---
Longspine thornyhead	---	---	---	21.23	32.73	5.51	---
Tanner crab	---	---	---	12.11	11.59	2.45	---
Giant grenadier	---	---	---	2.80	---	---	---

[1]Species listed in each depth stratum collectively comprised 90% of the overall mean total catch.

[2]North subarea is that portion of the overall survey area north of 44°22.5'N Lat. See Figure 2.

Table 32.--Summary of average catch per unit fishing effort, by depth stratum, observed for major fish and crab species[1] during the autumn 1984 west coast upper continental slope trawl survey, south subarea[2] .

Species	Depth stratum (m) 110-183	183-366	366-549	549-732	732-915	110-915	110-549
Sablefish	8.80	59.46	37.61	53.25	23.38	33.46	35.55
Dover sole	18.64	13.20	11.92	40.29	24.39	18.98	15.23
Shortspine thornyhead	1.22	6.59	5.08	10.68	6.78	5.02	4.56
Pacific whiting	15.49	44.28	8.83	---	---	17.24	22.20
Rex sole	7.44	10.42	6.13	---	---	6.67	8.25
Darkblotched rockfish	1.40	14.32	---	---	---	3.54	4.89
Lingcod	1.18	3.41	---	---	---	1.13	1.45
Longnose skate	1.13	---	1.35	---	---	0.79	---
Pacific sanddab	5.99	---	---	---	---	2.04	2.02
Greenstriped rockfish	5.54	---	---	---	---	2.05	2.11
Big skate	5.38	---	---	---	---	1.83	1.82
Slender sole	2.91	---	---	---	---	1.21	1.30
Spiny dogfish	1.51	---	---	---	---	---	---
Spotted ratfish	1.35	---	---	---	---	---	---
Pacific halibut	0.93	---	---	---	---	---	---
Splitnose rockfish	---	6.87	---	---	---	1.61	2.26
Silvergray rockfish	---	4.22	---	---	---	0.90	1.30
Bocaccio	---	2.85	---	---	---	0.80	---
Arrowtooth flounder	---	2.61	---	---	---	0.84	1.13
Brown cat shark	---	---	1.66	---	---	---	---
Longspine thornyhead	---	---	---	17.45	28.92	4.44	---
Tanner crab	---	---	---	8.85	9.62	1.85	---
Giant grenadier	---	---	---	5.49	---	0.97	---

[1]Species Listed in each depth stratum collectively comprised 90% of the overall mean total catch.

[2]South subarea is that portion of the overall survey area south of 44°22.5lN Lat. See Figure 2.

Table 33.--Estimated biomass (metric tons) of major species, by depth stratum and 95% confidence intervals (absolute and as a percentage of the biomass estimate) for the total survey area, from the 1984 autumn west coast upper continental slope survey.

Species	Depth stratum (m) 110-183	183-366	366-549	549-732	732-915	Total[1]	95% Confidence interval (total)		
Sablefish	10,746	11,213	8,737	9,367	3,692	43,755	26,645 -	60,865	(+39%)
Dover sole	5,763	3,527	4,046	3,697	1,800	18,834	14,310 -	23,358	(+24%)
Arrowtooth flounder	747	1,132	1,108	----	----	2,987	1,917 -	4,056	(+36%)
Pacific whiting	31,700	11,400	4,980	159	10	48,249	976 -	95,522	(+98%)
Rex sole	2,431	2,002	770	139	tr[2]	5,342	3,970 -	6,715	(+26%)
Shortspine thornyhead	307	3,074	4,241	1,672	617	9,912	7,706 -	12,118	(+22%)
Longspine thornyhead	----	6	164	2,242	2,930	5,342	3,654 -	7,031	(+32%)
Pacific ocean perch	7	402	3,432	----	----	3,841	1,133 -	6,550	(+71%)
Darkblotched rockfish	400	4,663	424	----	----	5,487	2,404 -	8,571	(+56%)
Splitnose rockfish	82	3,087	109	----	----	3,278	1,731 -	4,826	(+47%)
Canary rockfish	2,591	54	----	----	----	2,646	0 -	7,918	(+199%)
Redstripe rockfish	48	97	----	----	----	145	0 -	332	(+129%)
Sharpchin rockfish	792	6,050	6	----	----	6,847	0 -	18,271	(+167%)
Greenstriped rockfish	2,706	557	----	----	----	3,263	1,899 -	4,627	(+42%)
Pacific sanddab	1,344	----	----	----	----	1,344	0 -	2,949	(+119%)
Lingcod	737	741	----	----	----	1,478	652 -	2,305	(+56%)
Chilipepper rockfish	2	3	----	----	----	5	0 -	12	(+140%)
Yellowtail rockfish	327	105	----	----	----	297	0 -	713	(+140%)
Stripetail rockfish	327	105	----	----	----	432	0 -	1,111	(+157%)
Bocaccio	226	296	----	----	----	522	0 -	1,124	(+115%)
Spiny dogfish	1,271	975	152	----	----	2,398	1,132 -	3,664	(+53%)
English sole	259	48	----	----	----	307	88 -	527	(+72%)
Giant grenadier	----	----	43	527	186	756	385 -	1,126	(+49%)
Tanner crab	----	25	20	1,199	1,002	2,246	911 -	3,581	(+59%)

[1]Rounding accounts for minor discrepancies between sums of individual depth strata and overall area totals.

[2]tr = biomass estimate of 0.1-0.9 mt.

Table 34.--Percent of estimated biomass of major species, by depth stratum, from the 1984 autumn west coast, upper continental slope trawl survey.

	Depth stratum (m)				
Species	110-183	183-366	366-549	549-732	732-915
Sablefish	24.6	25.6	20.0	21.4	8.4
Dover sole	30.6	18.7	21.5	19.6	9.6
Arrowtooth flounder	25.0	37.9	37.1	---	---
Pacific whiting	65.7	23.6	10.3	---	---
Rex sole	45.5	37.5	14.4	2.6	<0.1
Shortspine thornyhead	3.1	31.0	42.8	16.9	6.2
Longspine thornyhead	---	0.1	3.1	42.0	54.8
Pacific ocean perch	0.2	10.5	89.4	---	---
Darkblotched rockfish	7.3	85.0	7.7	---	---
Splitnose rockfish	2.5	94.2	3.3	---	---
Canary rockfish	98.0	2.0	---	---	---
Redstripe rockfish	33.1	66.9	---	---	---
Sharpchin rockfish	33.1	66.9	---	---	---
Greenstriped rockfish	82.9	17.1	---	---	---
Pacific sanddab	100.0	---	---	---	---
Lingcod	49.9	50.1	---	---	---
Chilipepper rockfish	40.0	60.0	---	---	---
Yellowtail rockfish	97.3	2.7	---	---	---
Stripetail rockfish	75.7	24.3	---	---	---
Bocaccio	43.3	56.7	---	---	---
Spiny dogfish	53.0	40.7	6.3	---	---
English sole	84.4	15.6	---	---	---
Giant grenadier	---	---	5.7	69.7	24.6
Tanner crab	---	1.1	0.9	53.4	44.6

Table 35.-Population estimates for sablefish by year class and mean length at age during the autumn 1984 west coast upper continental slope survey, 110-183 m (60-100 fm).

Age	Year class	Population number (x1000)	Proportion	Cumulative proportion	Mean length (cm)
Below minimum key lengths		7,801	0.459	0.459	35.3
1	1983	5,058	0.298	0.757	38.8
2	1982	2,608	0.154	0.910	40.9
3	1981	500	0.029	0.940	44.8
4	1980	195	0.012	0.951	47.8
5	1979	181	0.011	0.962	52.6
6	1978	169	0.010	0.972	60.3
7	1977	116	0.007	0.979	63.8
8	1976	22	0.001	0.980	57.1
9	1975	124	0.001	0.987	68.0
10	1974	6	<0.001	0.988	60.9
11	1973	6	<0.001	0.988	66.1
12	1972	19	<0.001	0.989	68.1
13	1971	2	<0.001	0.989	61.5
14	1970	20	<0.001	0.990	81.1
15	1969	10	<0.001	0.991	65.5
16	1968	1	<0.001	0.991	52.3
Between key lengths		154	0.001	1.000	76.5
	Total	16,992	1.000	1.000	39.0

Table 36.--Population estimates for sablefish by year class and mean length at age during the autumn 1984 west coast upper continental slope survey, 183-366 m (100-200 fm).

Age	Year class	Population number (x1000)	Proportion	Cumulative proportion	Mean length (cm)
Below minimum key lengths		32	0.004	0.004	35.5
1	1983	182	0.024	0.029	40.1
2	1982	1,215	0.162	0.191	44.2
3	1981	1,264	0.169	0.360	46.8
4	1980	1,187	0.159	0.519	49.8
5	1979	1,420	0.190	0.708	52.4
6	1978	784	0.105	0.813	54.2
7	1977	635	0.085	0.898	56.1
8	1976	217	0.029	0.927	55.2
9	1975	200	0.027	0.953	60.7
10	1974	51	0.007	0.960	59.7
11	1973	44	0.006	0.966	56.5
12	1972	45	0.006	0.972	59.3
13	1971	32	0.004	0.976	58.0
14	1970	35	0.005	0.981	62.5
15	1969	23	0.003	0.984	62.5
16	1968	16	0.002	0.986	52.0
Above and between key lengths		103	0.014	1.000	---
	Total	7,486	1.000	1.000	50.7

Table 37.--Population estimates for sablefish by year class and mean length at age during the autumn 1984 west coast upper continental slope survey, 366-549 m (200-300 fm).

Age	Year class	Population number (x1000)	Proportion	Cumulative proportion	Mean length (cm)
1	1983	6	0.001	0.001	41.8
2	1982	341	0.065	0.067	45.4
3	1981	600	0.115	0.182	48.1
4	1980	851	0.163	0.345	51.2
5	1979	1,241	0.238	0.583	53.4
6	1978	729	0.140	0.723	54.6
7	1977	666	0.128	0.851	56.4
8	1976	224	0.043	0.894	56.2
9	1975	188	0.036	0.930	60.5
10	1974	66	0.013	0.943	59.9
11	1973	54	0.010	0.953	62.9
12	1972	39	0.008	0.961	58.7
13	1971	37	0.007	0.968	58.4
14	1970	24	0.005	0.972	56.1
15	1969	15	0.003	0.975	59.9
16	1968	16	0.003	0.978	52.1
Between key lengths		113	0.022	1.000	78.3
	Total	5,212	1.000	1.000	53.6

Table 38.--Population estimates for sablefish by year class and mean length at age during the autumn 1984 uest coast upper continental slope survey, 549-732 m (300-400 fm).

Age	Year class	Population number (x1000)	Proportion	Cumulative proportion	Mean length (cm)
1	1983	<1	<0.001	<0.001	42.0
2	1982	153	0.026	0.026	47.0
3	1981	522	0.087	0.113	49.6
4	1980	1,027	0.172	0.285	51.9
5	1979	1,638	0.274	0.559	53.3
6	1978	981	0.164	0.723	54.1
7	1977	854	0.143	0.866	55.2
8	1976	285	0.048	0.914	54.9
9	1975	166	0.028	0.942	56.3
10	1974	77	0.013	0.955	59.4
11	1973	51	0.009	0.963	54.1
12	1972	48	0.008	0.971	55.9
13	1971	51	0.009	0.980	57.9
14	1970	37	0.006	0.986	51.3
15	1969	14	0.002	0.989	53.0
16	1968	33	0.006	0.994	52.2
17	1967	4	0.001	0.995	97.0
Between key lengths		32	0.005	1.000	78.6
	Total	5,972	1.000	1.000	53.4

Table 39.--Population estimates for sablefish by year class and mean length at age during the autumn 1984 west coast upper continental slope survey, 732-915 m (400-500 fm).

Age	Year class	Population number (x1000)	Proportion	Cumulative proportion	Mean length (cm)
2	1982	72	0.030	0.030	47.2
3	1981	246	0.101	0.131	49.5
4	1980	448	0.185	0.316	51.3
5	1979	671	0.277	0.592	52.7
6	1978	396	0.163	0.755	53.7
7	1977	312	0.129	0.884	54.7
8	1976	108	0.044	0.928	53.9
9	1975	63	0.026	0.954	56.2
10	1974	18	0.007	0.962	58.0
11	1973	16	0.007	0.968	50.8
12	1972	16	0.007	0.975	54.4
13	1971	13	0.006	0.980	56.5
14	1970	16	0.007	0.987	51.1
15	1969	8	0.004	0.990	58.1
16	1968	14	0.006	0.996	52.0
Between key lengths		10	0.004	1.000	77.0
	Total	2,429	1.000	1.000	52.7

Table 40.--Population estimates for sablefish by year class and mean length at age during the autumn 1984 west coast upper continental slope survey, 110-915 m (60-500 fm).

Age	Year class	Population number (x1000)	Proportion	Cumulative proportion	Mean length (cm)
Below minimum key lengths		7,833	0.206	0.206	35.3
1	1983	5,248	0.138	0.343	38.9
2	1982	4,389	0.115	0.459	42.5
3	1981	3,132	0.082	0.541	47.4
4	1980	3,708	0.097	0.638	50.8
5	1979	5,151	0.135	0.774	53.0
6	1978	3,059	0.080	0.854	54.5
7	1977	2,583	0.068	0.922	56.1
8	1976	855	0.023	0.944	55.2
9	1975	741	0.020	0.964	60.5
10	1974	218	0.006	0.969	59.5
11	1973	172	0.005	0.974	57.6
12	1972	168	0.004	0.978	58.7
13	1971	136	0.004	0.982	58.0
14	1970	132	0.004	0.985	59.6
15	1969	70	0.002	0.987	59.9
16	1968	80	0.002	0.989	52.1
17	1967	4	<0.001	0.989	97.0
Above and between key lengths		412	0.011	1.000	----
	Total	38,091	1.000	1.000	46.5

Table 41.--Length-weight relationship[1] observed for fish species obtained during the autumn 1984 west coast upper continental slope survey.

Species	Sex[2]	Number sampled	Length-weight coefficients a	b	Predicted weight at length (gm)		
					30 cm	40 cm	60 cm
Sablefish	M	337	0.00000265470	3.210525	238.2	599.8	2204.6
	F	202	0.00000164500	3.290563	233.0	600.4	2279.5
	C	539	0.00000196970	3.259739	234.0	597.6	2241.0
					20 cm	35 cm	50 cm
Dover sole	M	526	0.00000091919	3.405323	63.0	423.4	1426.5
	F	303	0.00000333960	3.183464	70.6	419.4	1305.5
	C	829	0.00000162600	3.306944	66.1	420.9	1369.2
					30 cm	45 cm	60 cm
Arrowtooth flounder	M	99	0.00004025100	2.745227	254.1	773.5	1703.9
	F	70	0.00000116990	3.348677	230.8	897.2	2351.1
	C	169	0.00000191110	3.261454	229.2	860.2	2198.3
					20 cm	30 cm	45 cm
Pacific ocean perch	M	69	0.00001151300	3.027986	106.8	364.7	1244.7
	F	146	0.00005077300	2.785956	130.7	404.4	1251.3
	C	215	0.00001279900	3.015041	110.9	376.5	1278.6
					20 cm	30 cm	45 cm
Darkblotched rockfish	M	258	0.00007964400	2.744068	164.2	499.5	1519.7
	F	278	0.00004223800	2.859754	160.7	512.5	1633.9
	C	536	0.00004736000	2.837899	160.5	507.3	1603.1
					20 cm	30 cm	45 cm
Sharpchin rockfish	M	140	0.00001903300	2.953330	118.9	393.8	1304.1
	F	158	0.00002563100	2.909955	127.3	414.1	1347.4
	C	298	0.00001140400	3.050693	119.3	411.1	1416.4
					10 cm	20 cm	30 cm
Longspine thornyhead	M	93	0.00001587800	2.960081	13.2	102.8	341.4
	F	72	0.00000957550	3.048000	11.9	98.8	340.0
	C	165	0.00001453600	2.974213	12.9	101.4	338.8

[1] Regression equation based on $w = aL^b$ where: w = fresh whole weight in grams; L = fork length in millimeters; a and b = Length at weight coefficients.

[2] M = males; F = females; C = sexes combined.

Table 42.--Mean sea surface and bottom water temperatures (SST and BWT) and the SST and BUT percentage differences (%D) observed during the 1984 spring and autumn west coast upper continental slope trawl surveys, by depth stratum, geographic subarea, and total (110-549 m) survey area.

Stratum (m)	Subarea	SST (°C) Spring	SST (°C) Autumn	SST %D[1]	BWT (°C) Spring	BWT (°C) Autumn	BWT %D[2]
110-183	North	10.4	14.2	36.5	7.0	8.3	18.6
	South	10.6	14.6	35.8	6.6	8.5	28.8
	Total	10.5	14.4	37.1	6.8	8.4	23.5
183-366	North	10.5	14.5	38.1	6.5	7.5	15.4
	South	10.7	15.8	47.7	6.4	7.4	15.6
	Total	10.6	15.1	42.5	6.5	7.5	15.4
366-549	North	10.4	14.5	39.4	5.5	6.2	12.7
	South	10.9	16.4	50.5	5.7	5.5	-3.5
	Total	10.6	14.5	36.8	5.6	6.0	7.1
110-549	North	10.4	14.6	40.4	6.3	6.6	4.3
	South	10.7	15.6	45.8	6.2	6.3	1.6
	Total	10.5	15.1	43.8	6.3	6.5	3.2

‘Percent difference is calculated as: $\frac{\text{Autumn (SST) - Spring (SST)}}{\text{Spring (SST)}} \times 100$

‘Percent difference is calculated as: $\frac{\text{Autumn (BWT) - Spring (BWT)}}{\text{Spring (BWT)}} \times 100$

Table 43.--The 25 most common fish and crab taxa recorded during the autumn 1984 west coast continental slope demersal trawl survey, in order of percentage frequency of occurrence, for total area waters 110-549 m deep, by depth stratum and geographic subarea.

Rank	Species	110-549	Depth stratum (m)* 110-183	183-366	366-549	All strata south	All strata north
1	Dover sole	98.3	93.3	100.0	100.0	96.0	100.0
2	Pacific whiting	98.3	100.0	96.3	100.0	100.0	97.1
3	Sablefish	96.6	93.3	100.0	94.1	92.0	100.0
4	Rex sole	93.2	100.0	92.6	88.2	92.0	94.1
5	Arrowtooth flounder	83.1	73.3	88.9	82.4	72.0	91.2
6	Slender sole	79.7	100.0	92.6	41.2	80.0	79.4
7	Shortspine thornyhead	79.7	40.0	92.6	94.1	72.0	85.3
8	Bigfin eelpout	72.9	66.7	77.8	70.6	64.0	79.4
9	Darkblotched rockfish	67.8	60.0	85.2	47.1	52.0	79.4
10	Spiny dogfish	67.8	80.0	81.5	35.3	60.0	73.5
11	Spotted ratfish	62.7	86.7	74.1	23.5	52.0	70.6
12	Longnose skate	62.7	53.3	63.0	70.6	48.0	73.5
13	Redbanded rockfish	57.6	26.7	85.2	41.2	48.0	64.7
14	Splitnose rockfish	55.9	26.7	92.6	23.5	60.0	53.9
15	Sandpaper skate	52.5	26.7	66.7	52.9	40.0	61.8
16	Pacific ocean perch	49.2	13.3	70.4	47.1	32.0	61.8
17	Greenstriped rockfish	45.8	100.0	44.4	---	56.0	38.2
18	Box crab	42.4	73.3	40.7	17.6	64.0	26.5
19	Black eelpout	37.3	---	37.0	70.6	28.0	44.1
20	Threadfin sculpin	32.2	60.0	29.6	11.8	52.0	17.6
21	Sharpchin rockfish	30.5	20.0	44.4	17.6	24.0	35.3
22	Rosethorn rockfish	28.8	26.7	44.4	5.9	24.0	32.4
23	English sole	27.1	66.7	22.3	---	36.0	20.6
24	Dungeness crab	25.4	66.7	18.5	---	40.0	14.7
25	Stripetail rockfish	25.4	40.0	33.3	---	40.0	14.7
	Total trawls	59	15	27	17	25	34

*See Figure 2.

Table 44.--Population estimates for sablefish by year class and mean length at age during the autumn 1984 west coast upper continental slope survey, 183-549 m (100-300 fm).

Age	Year class	Population number (x1000)	Proportion	Cumulative proportion	Mean length (cm)
Below minimum key lengths		32	0.003	0.003	35.5
1	1983	189	0.015	0.018	40.2
2	1982	1,556	0.123	0.140	44.5
3	1981	1,865	0.147	0.287	47.2
4	1980	2,038	0.161	0.447	50.4
5	1979	2,661	0.210	0.657	52.9
6	1978	1,513	0.119	0.776	54.4
7	1977	1,301	0.103	0.879	56.3
8	1976	441	0.035	0.913	55.7
9	1975	388	0.031	0.944	60.6
10	1974	117	0.009	0.953	59.8
11	1973	98	0.008	0.961	60.1
12	1972	84	0.007	0.967	59.0
13	1971	69	0.005	0.973	58.2
14	1970	59	0.005	0.977	59.9
15	1969	38	0.003	0.980	61.5
16	1968	33	0.003	0.983	52.1
Above and between key lengths		216	0.017	1.000	----
	Total	12,698	1.000	1.000	44.5

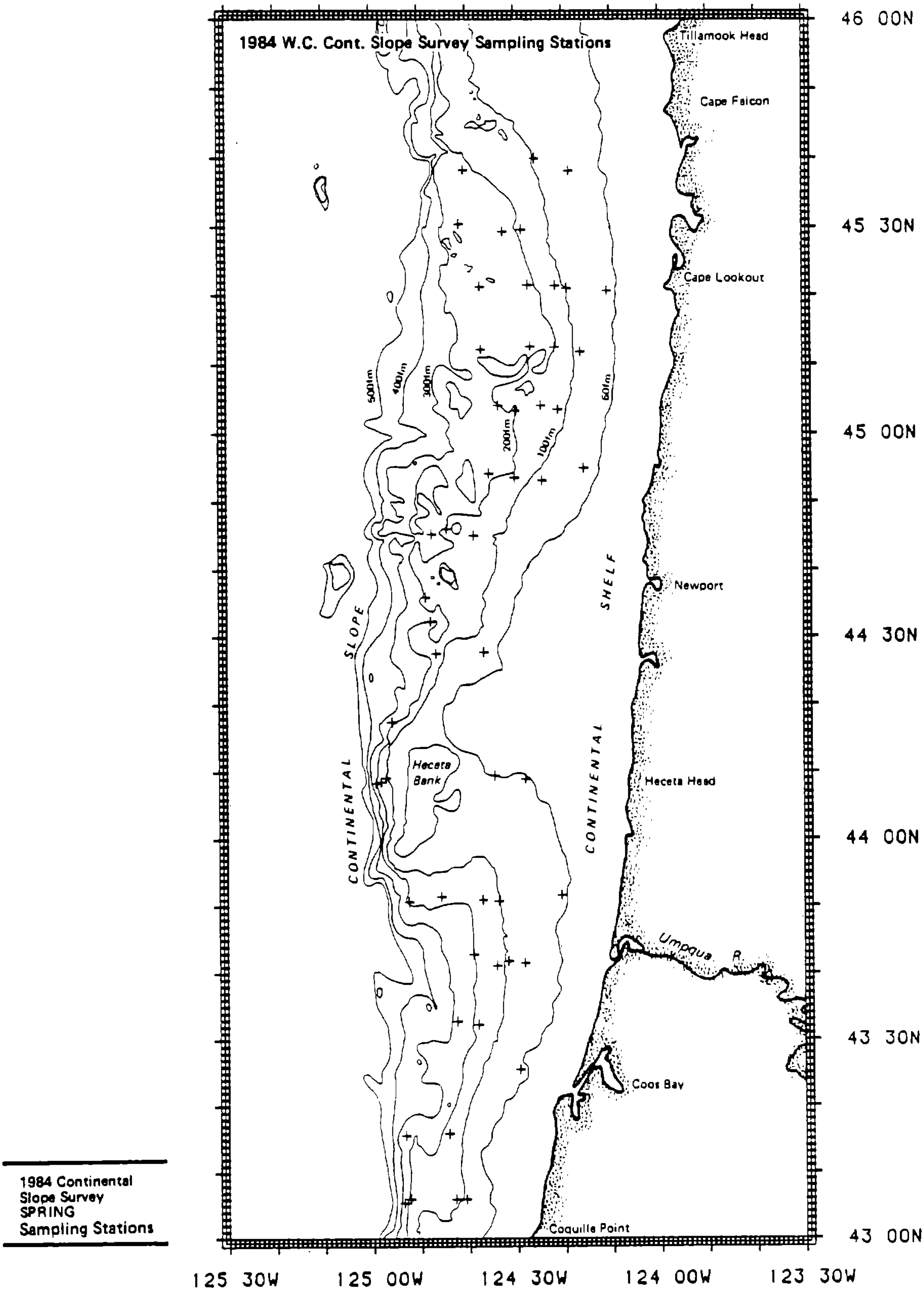


Figure 1.--Location of successful bottom trawling stations during the spring 1984 west coast upper continental slope groundfish survey.

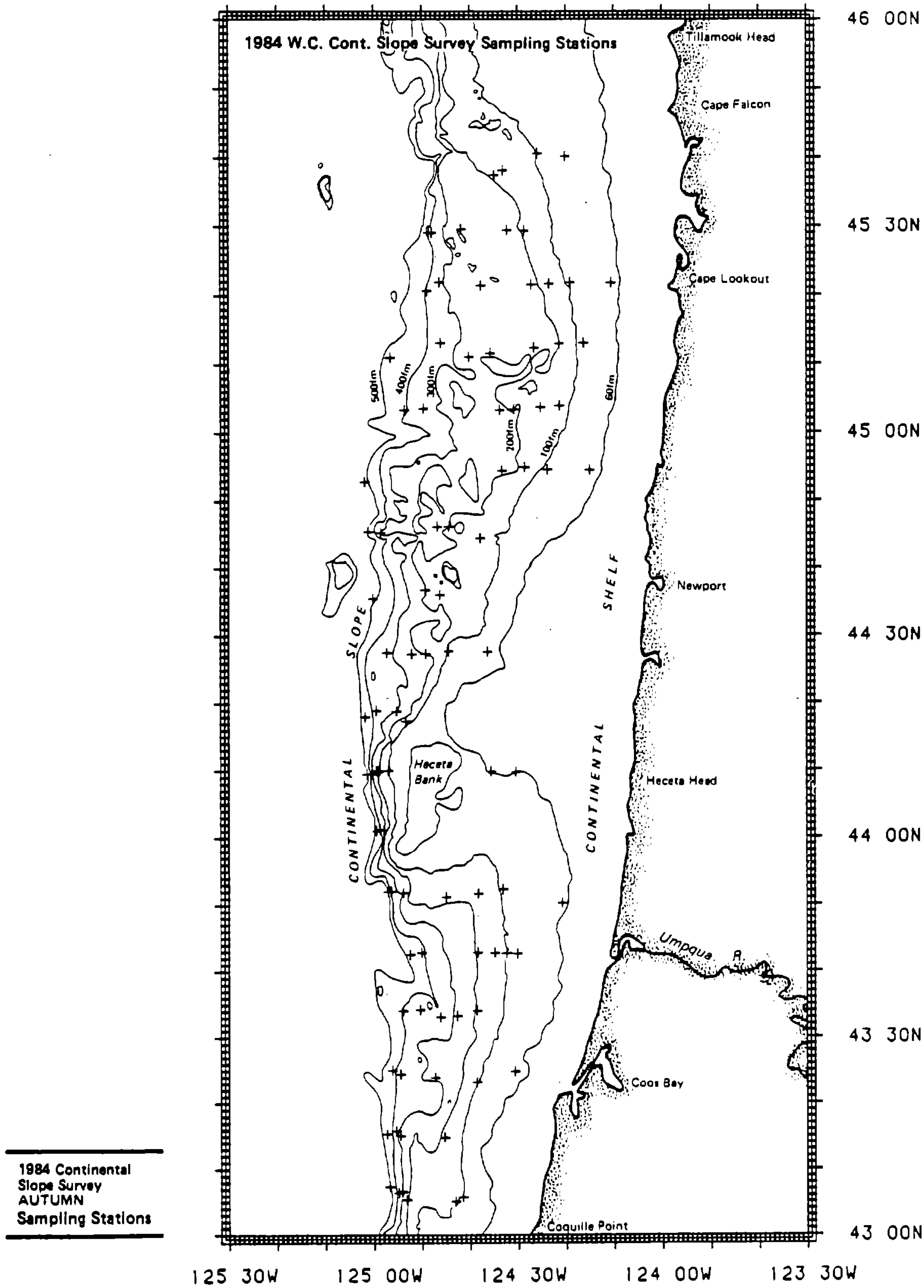


Figure 2.--Location of successful bottom trawling stations during the autumn 1984 west coast upper continental slope groundfish survey.

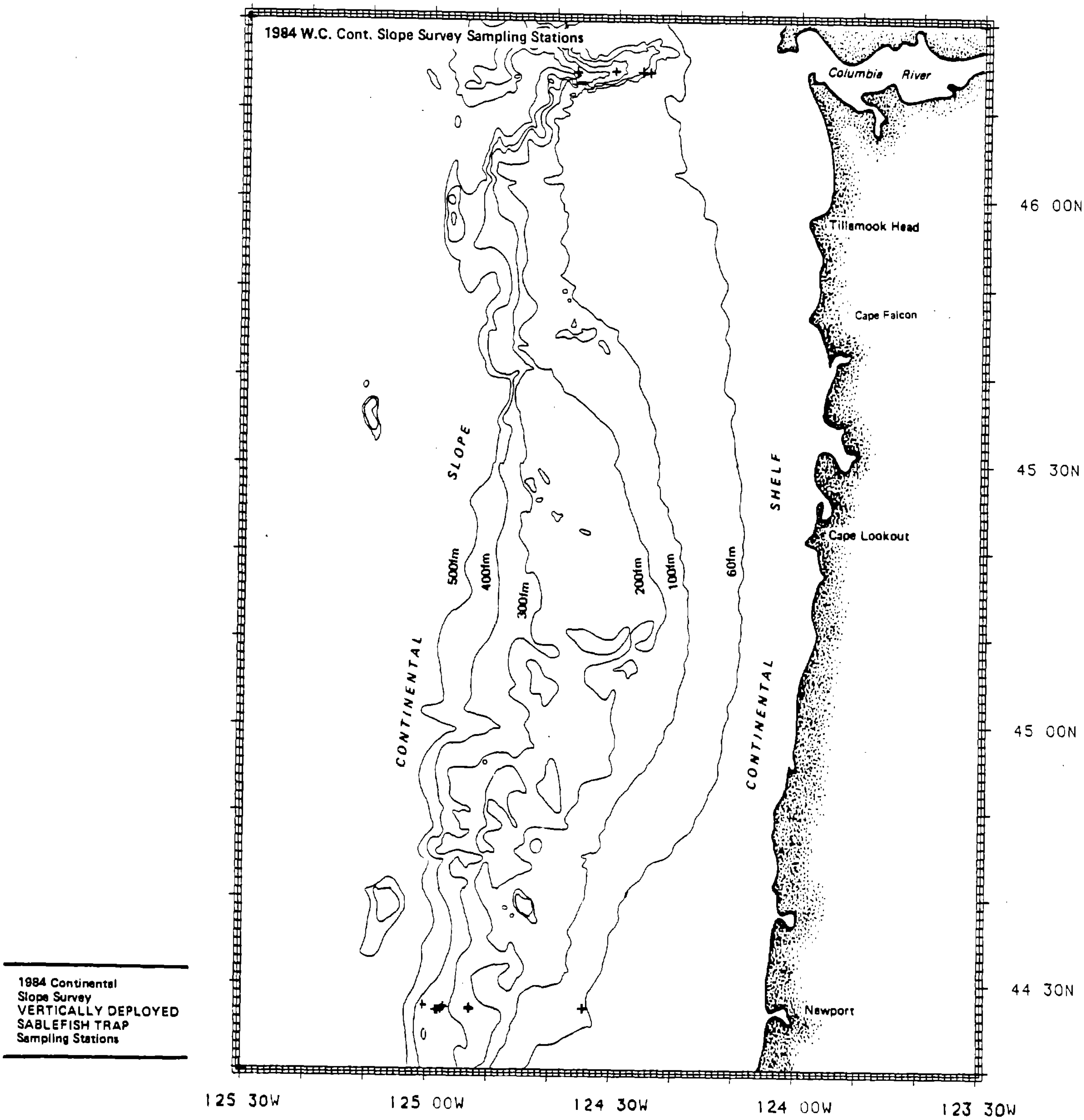


Figure 3.--Location of vertically deployed sablefish trap sampling stations during the 1984 autumn slope survey.

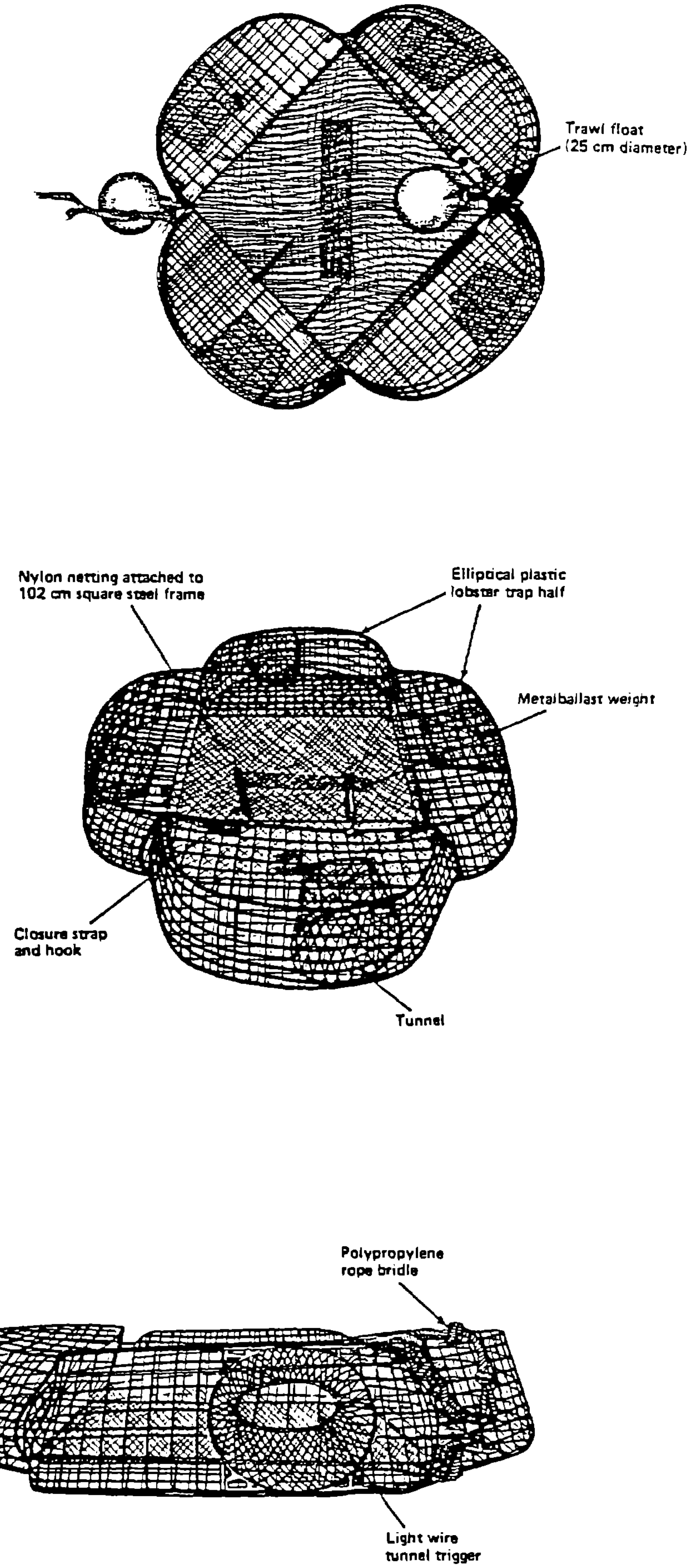


Figure 4.--The cloverleaf shaped trap used to investigate the vertical distribution of sablefish during the 1984 autumn survey.

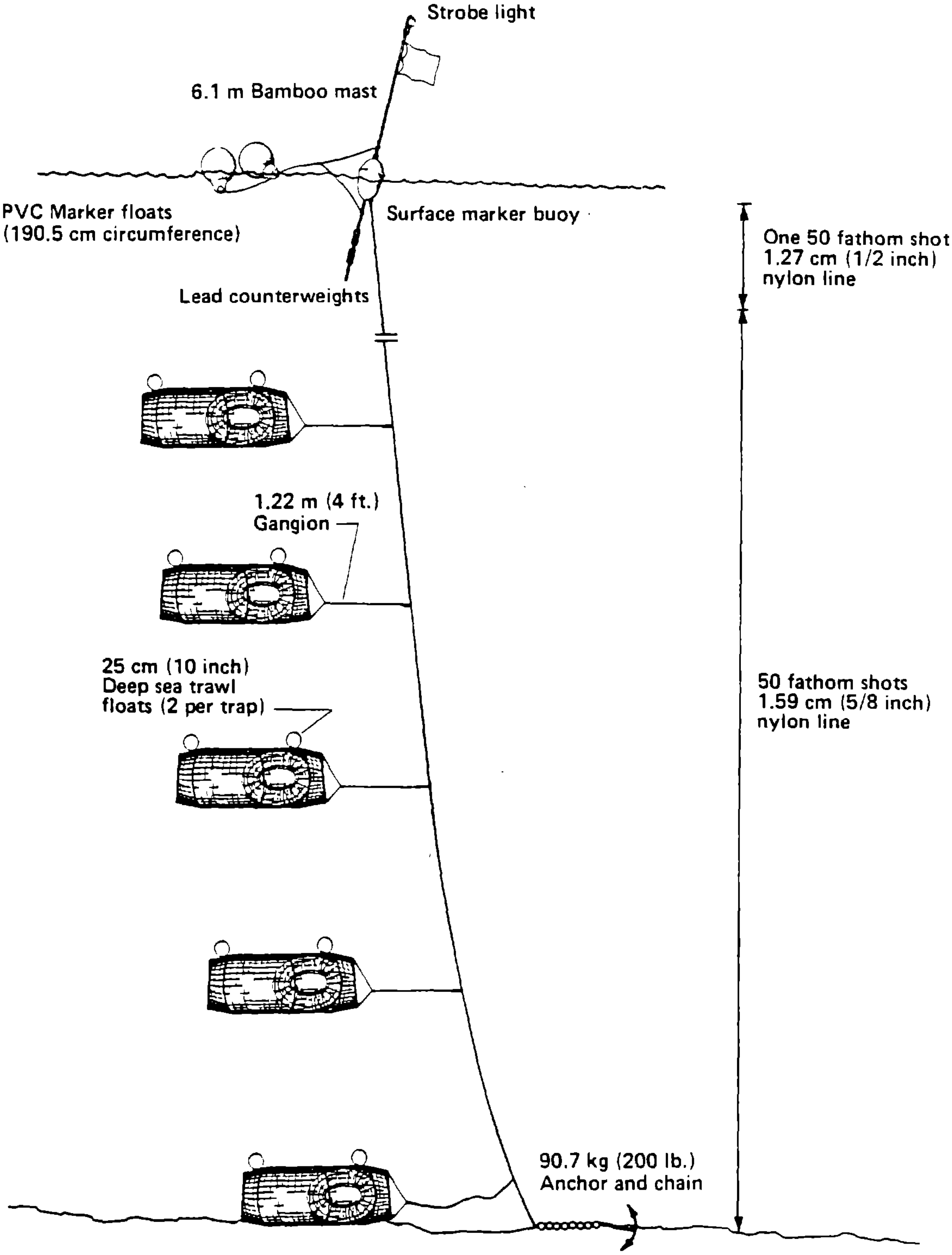


Figure 5.--Assembled components of the vertically deployed sablefish trap string used during the 1984 autumn survey.

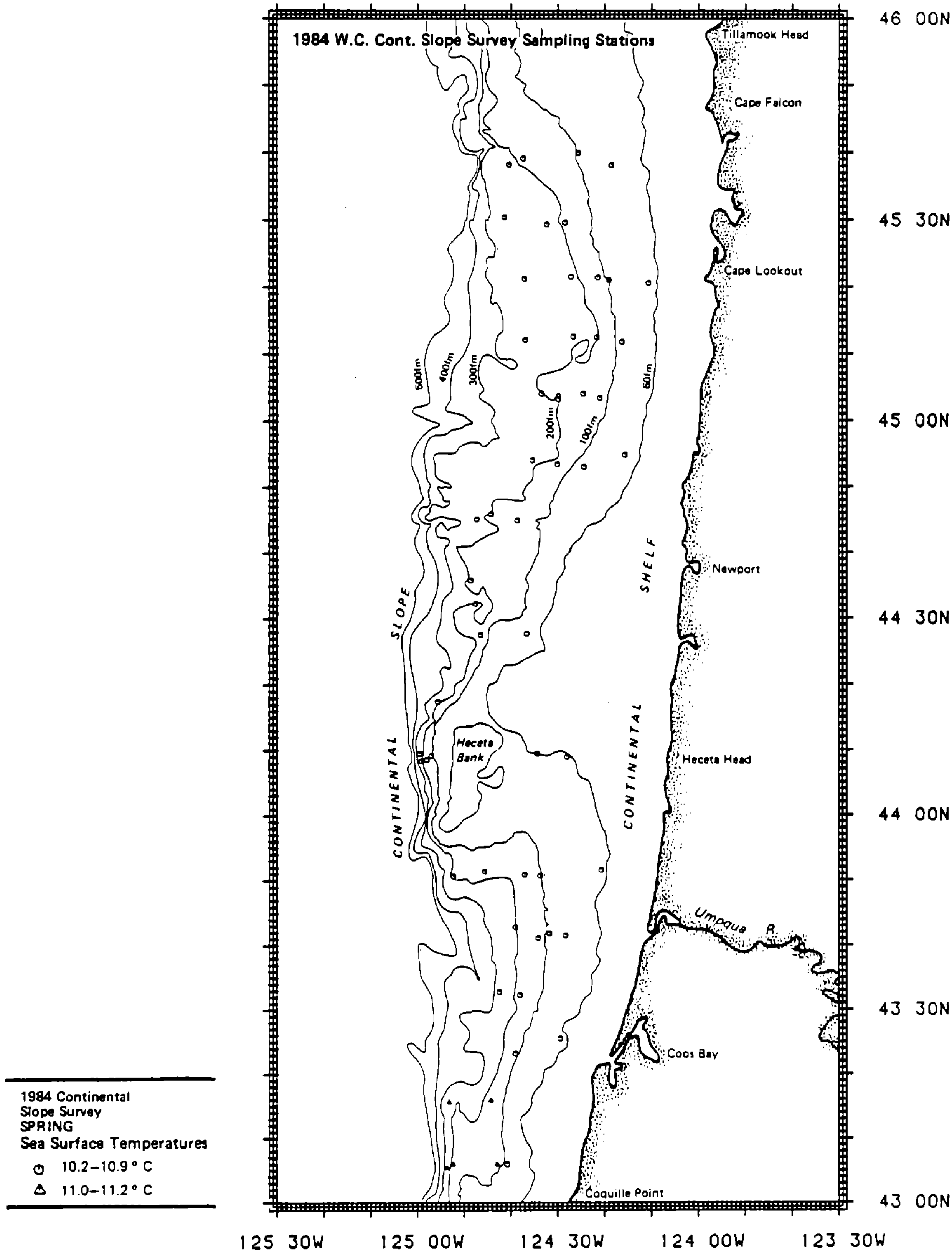


Figure 6.--Distribution of sea surface temperatures during the 1984 spring survey.

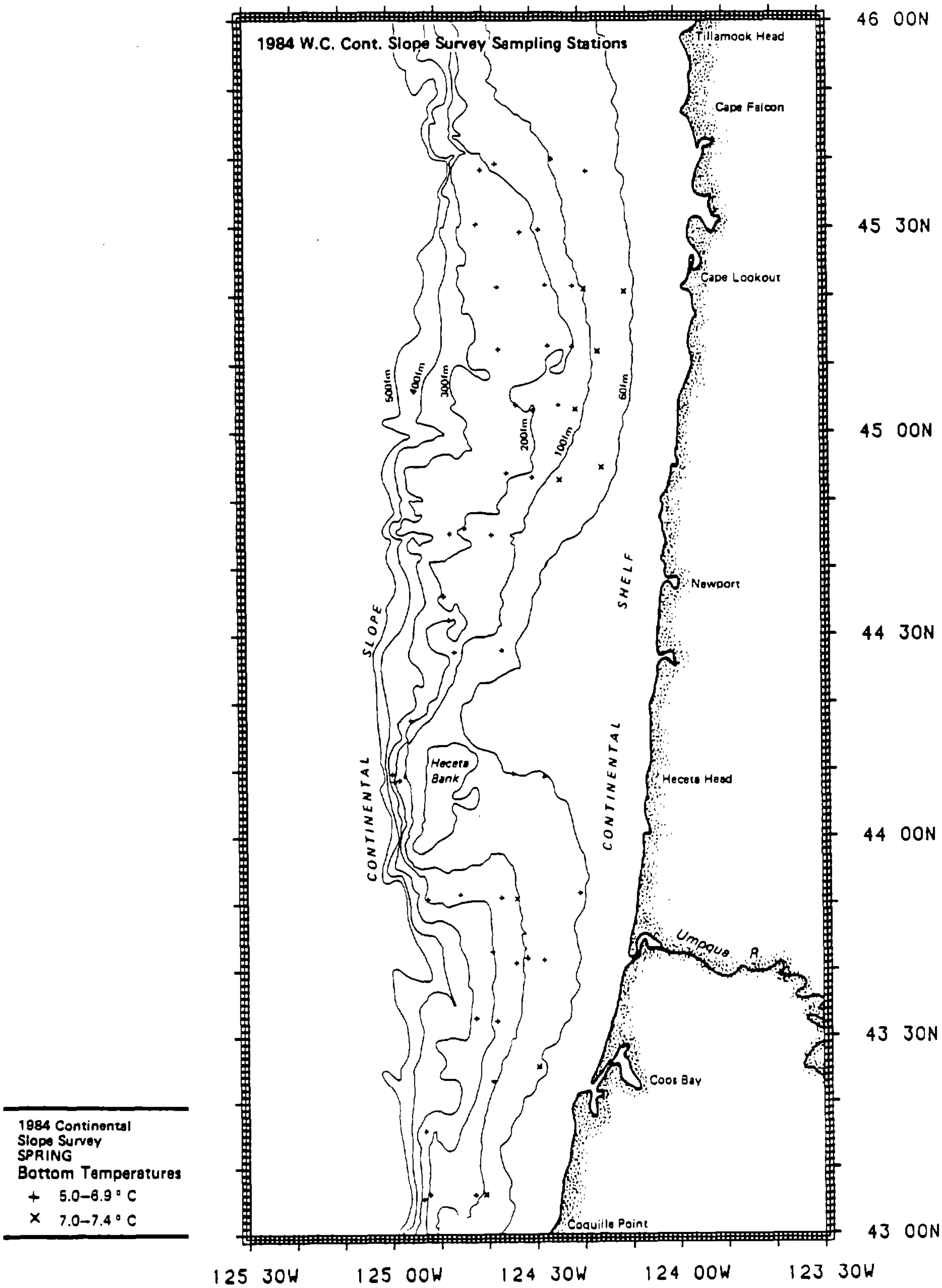


Figure 7.--Distribution of bottom water temperatures during the 1984 spring survey.

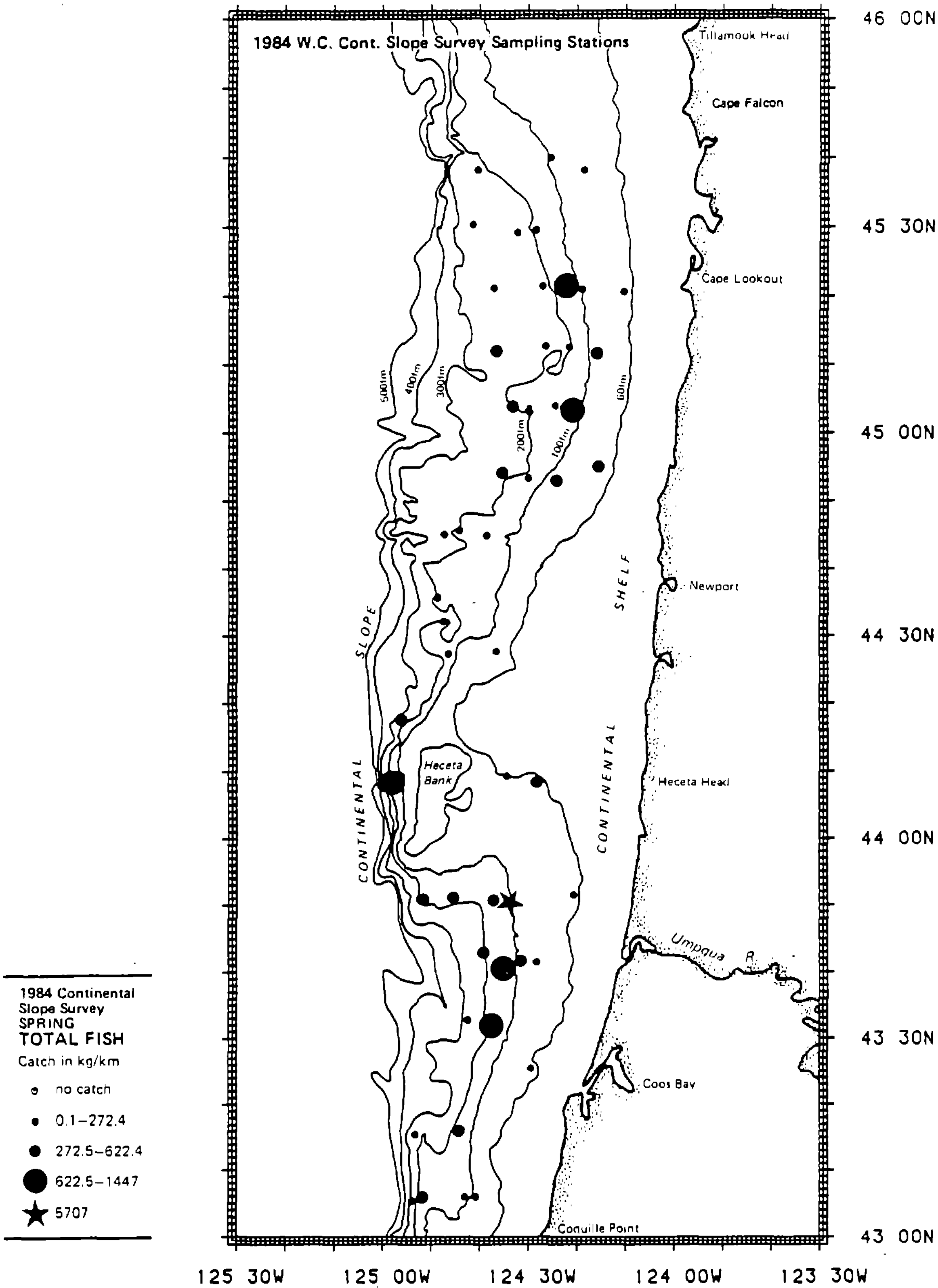


Figure 8.--Distribution and relative abundance (kg/km trawled) of total fish during the 1984 spring survey.

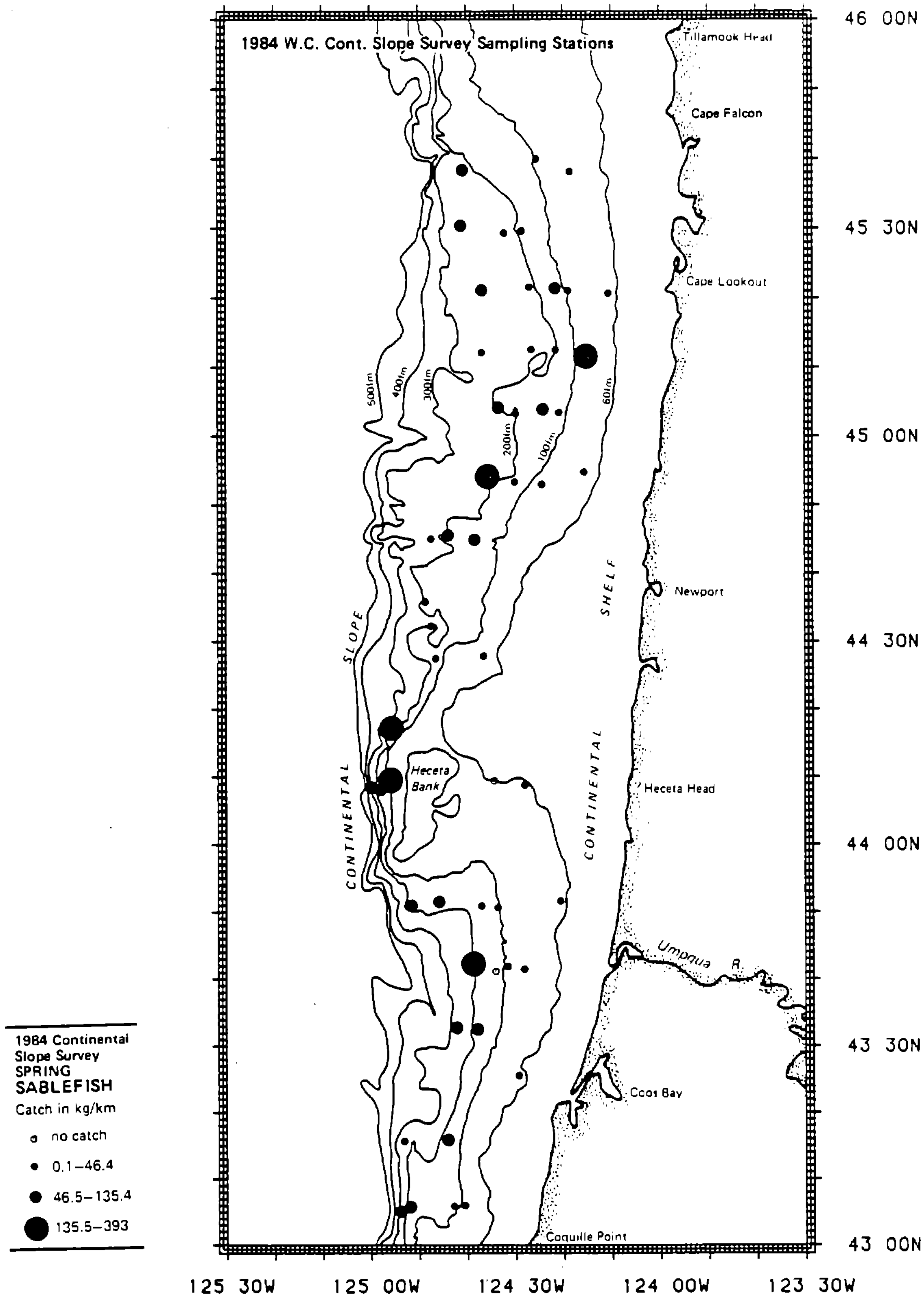


Figure 9.--Distribution and relative abundance (kg/km trawled) of sablefish during the 1984 spring survey.

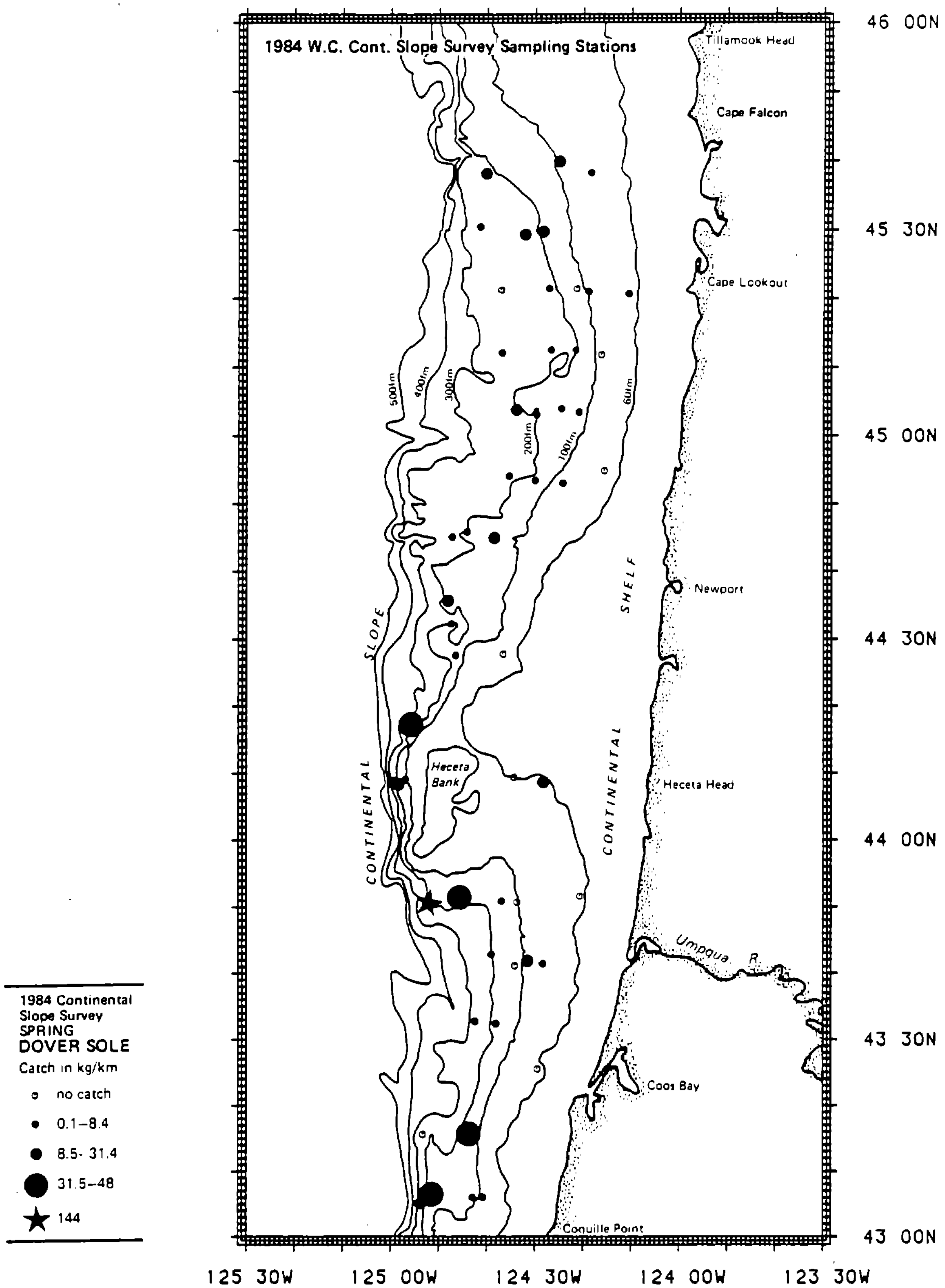


Figure 10.--Distribution and relative abundance (kg/km trawled) of Dover sole during the 1984 spring survey.

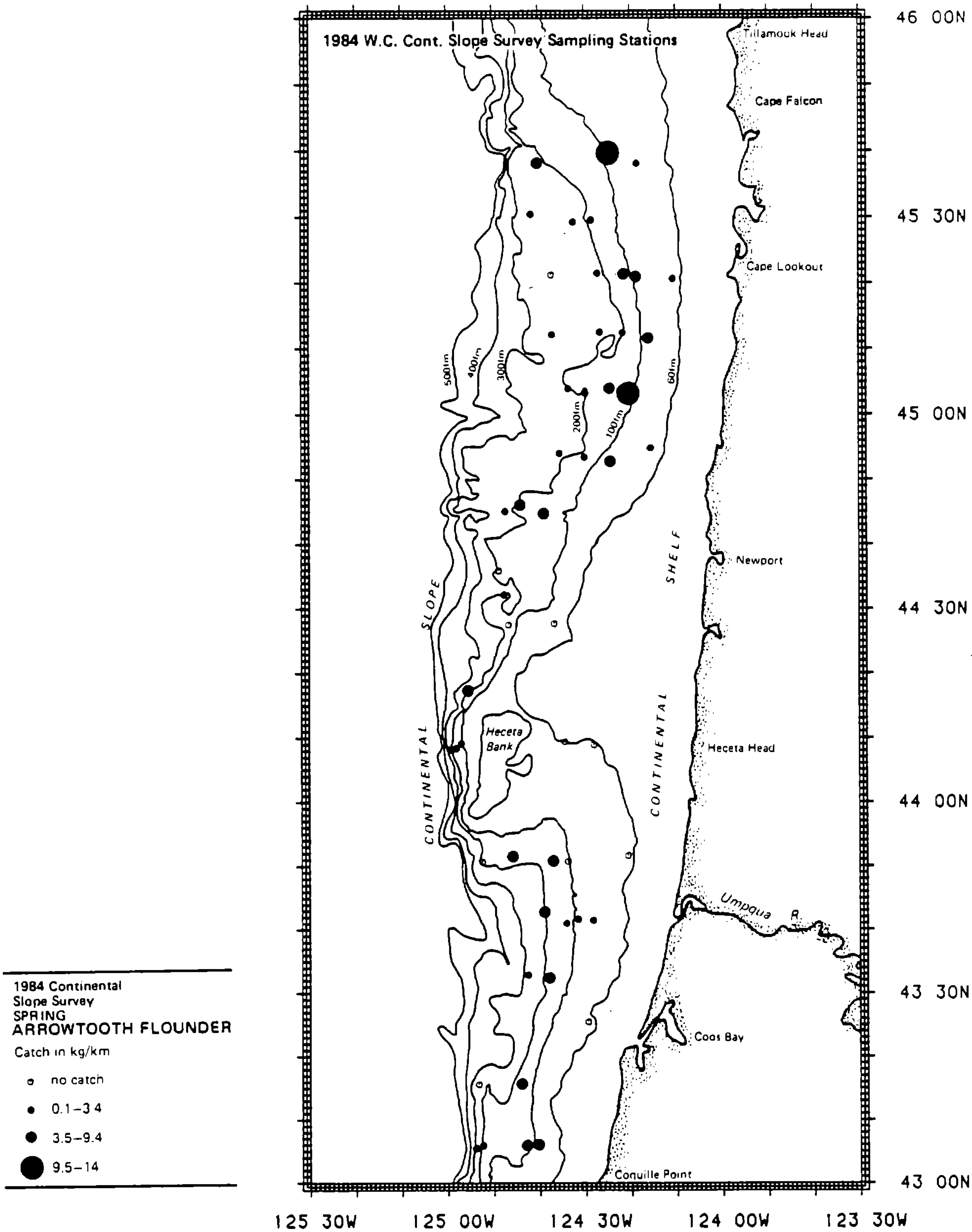


Figure 11.--Distribution and relative abundance (kg/km trawled) of arrowtooth flounder during the 1984 spring survey.

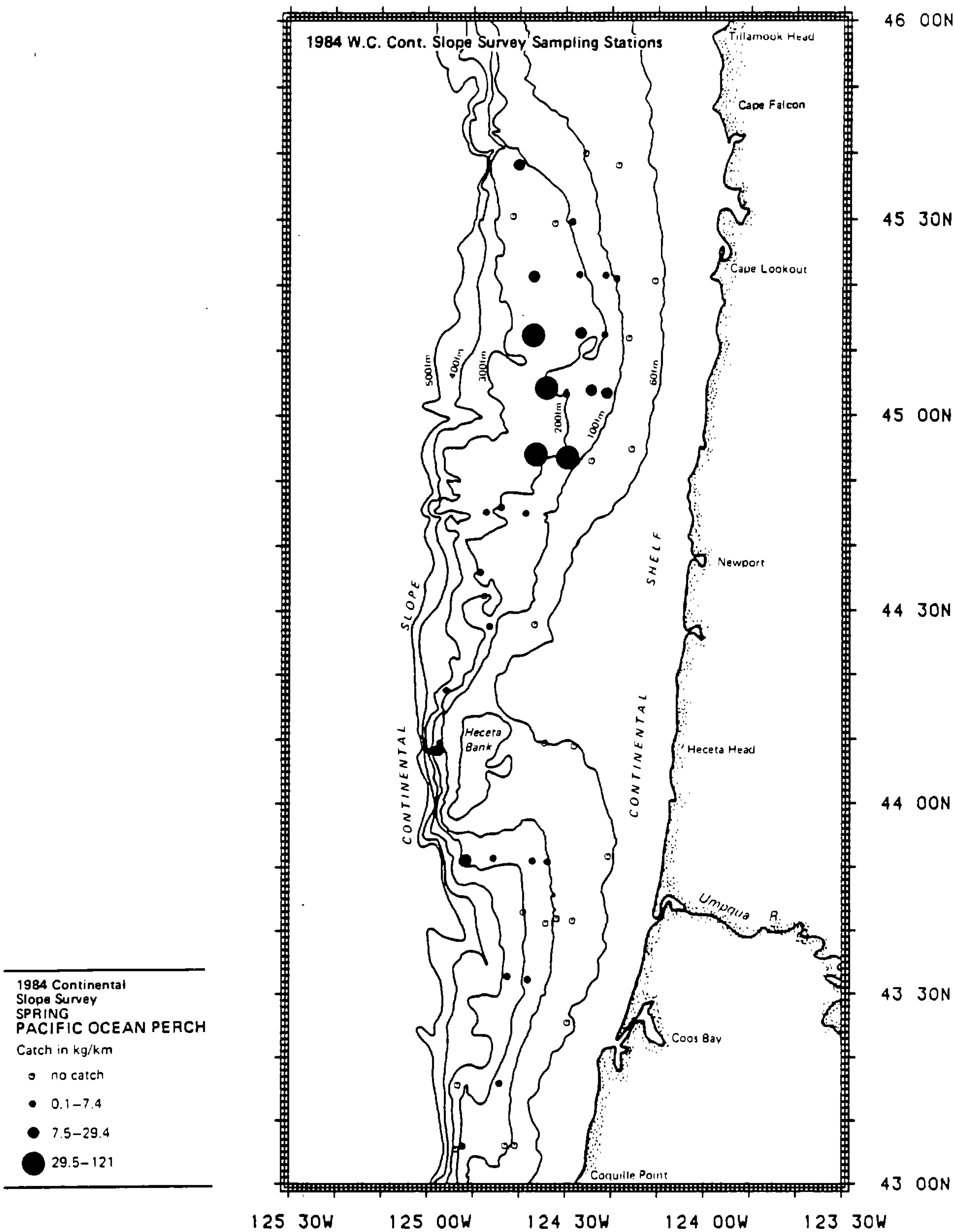


Figure 12.--Distribution and relative abundance (kg/km trawled) of Pacific ocean perch during the 1984 spring survey.

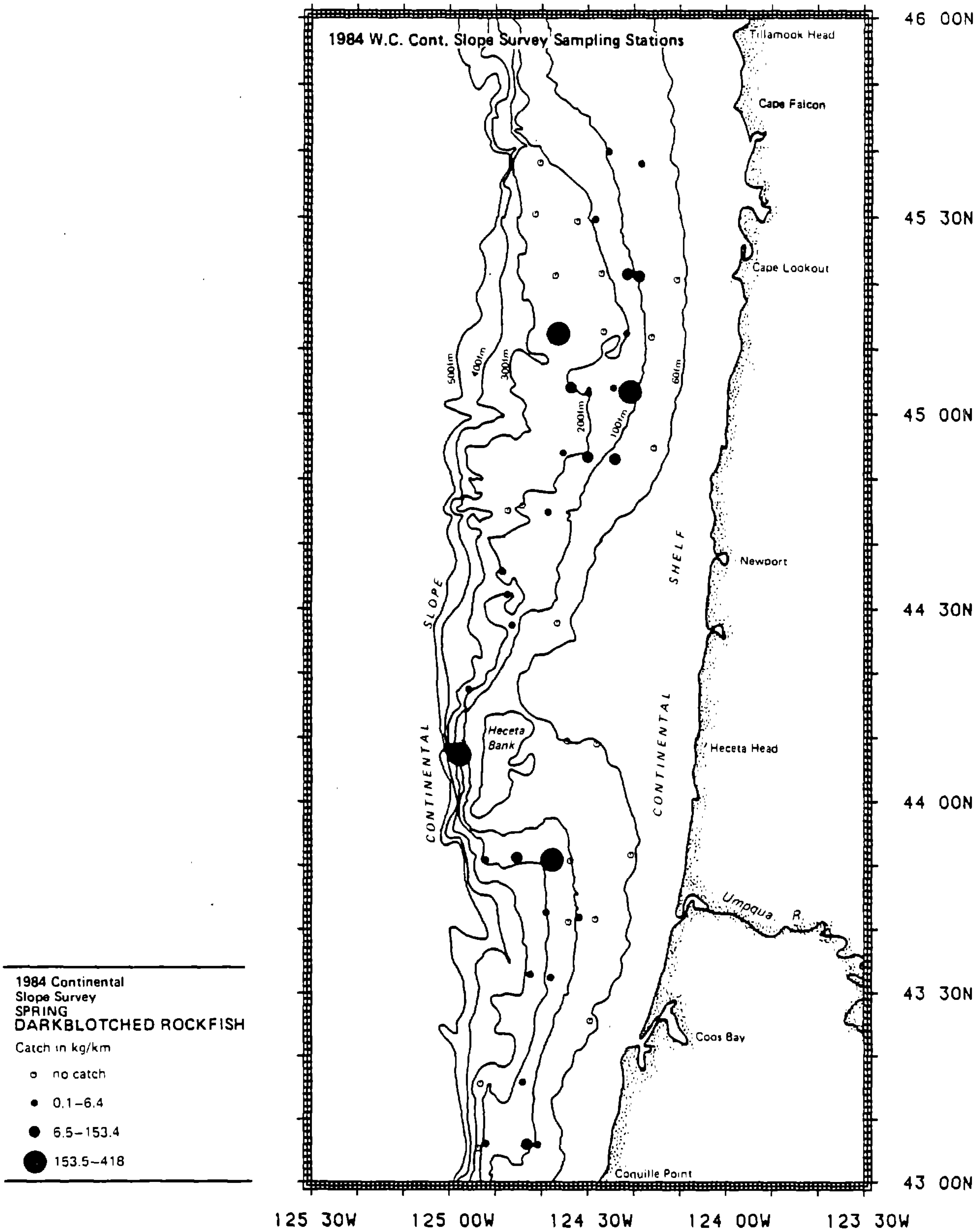


Figure 13.--Distribution and relative abundance (kg/km trawled) of darkblotched rockfish during the 1984 spring survey.

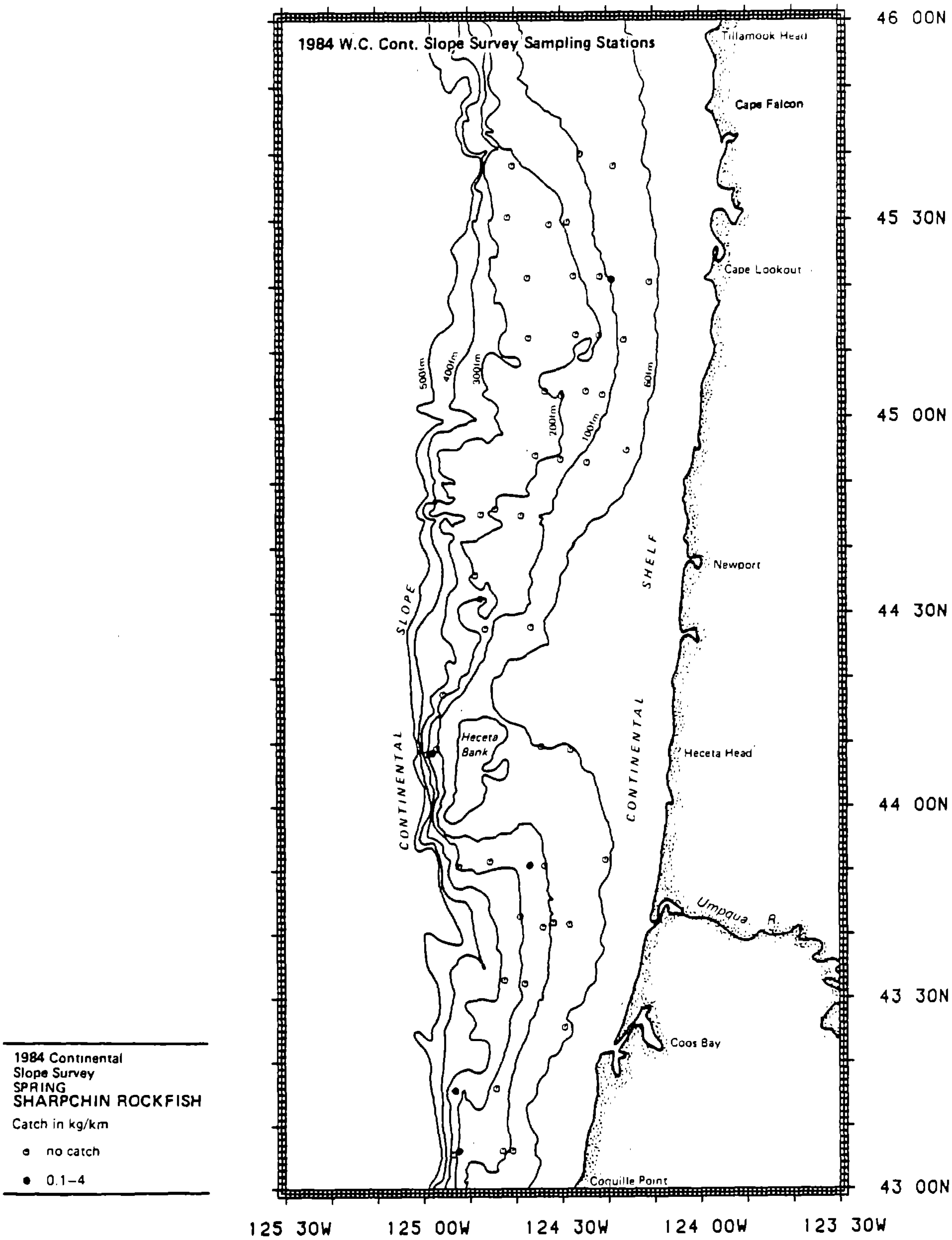


Figure 14.--Distribution and relative abundance (kg/km trawled) of sharpchin rockfish during the 1984 spring survey.

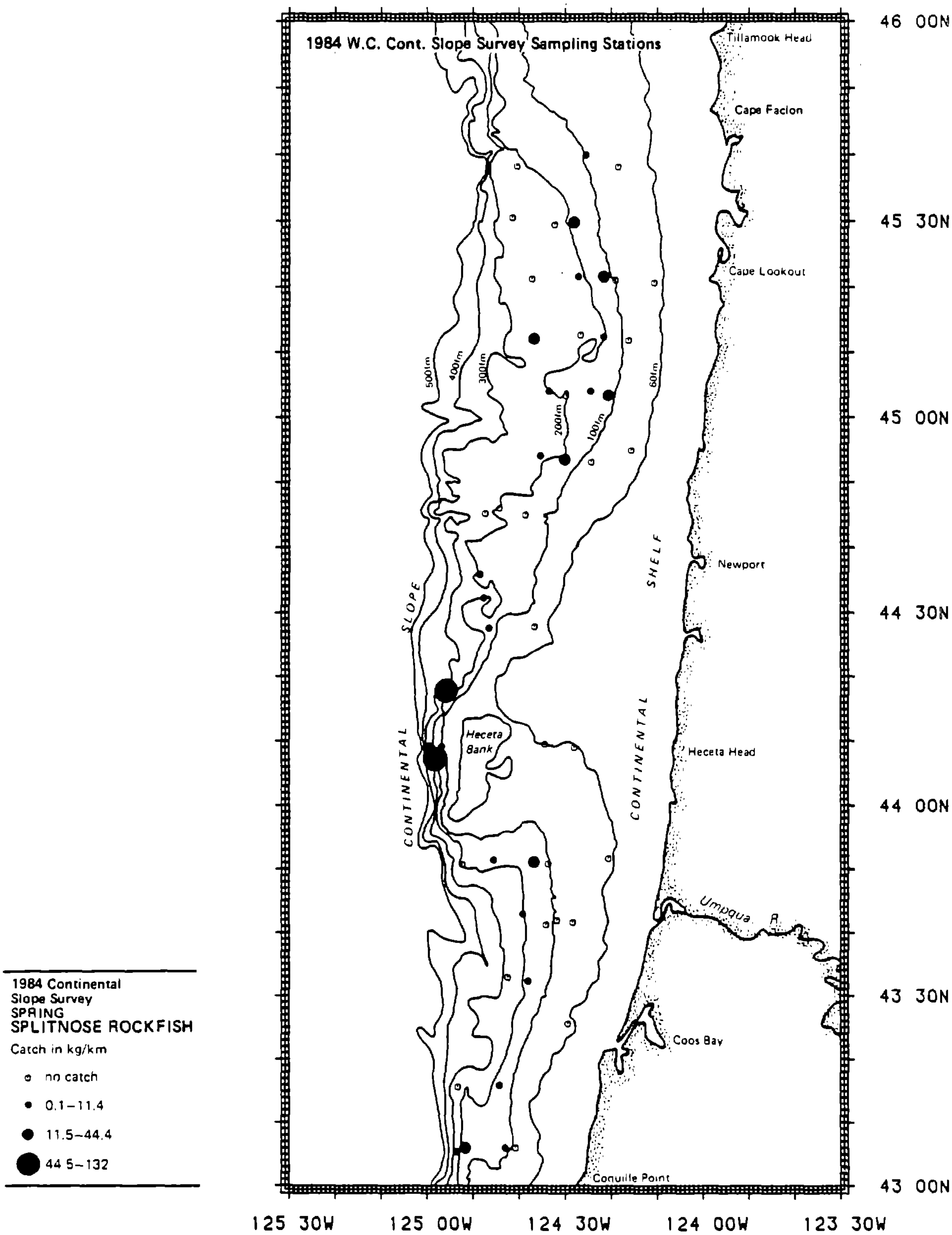


Figure 15.--Distribution and relative abundance (kg/km trawled) of splitnose rockfish during the 1984 spring survey.

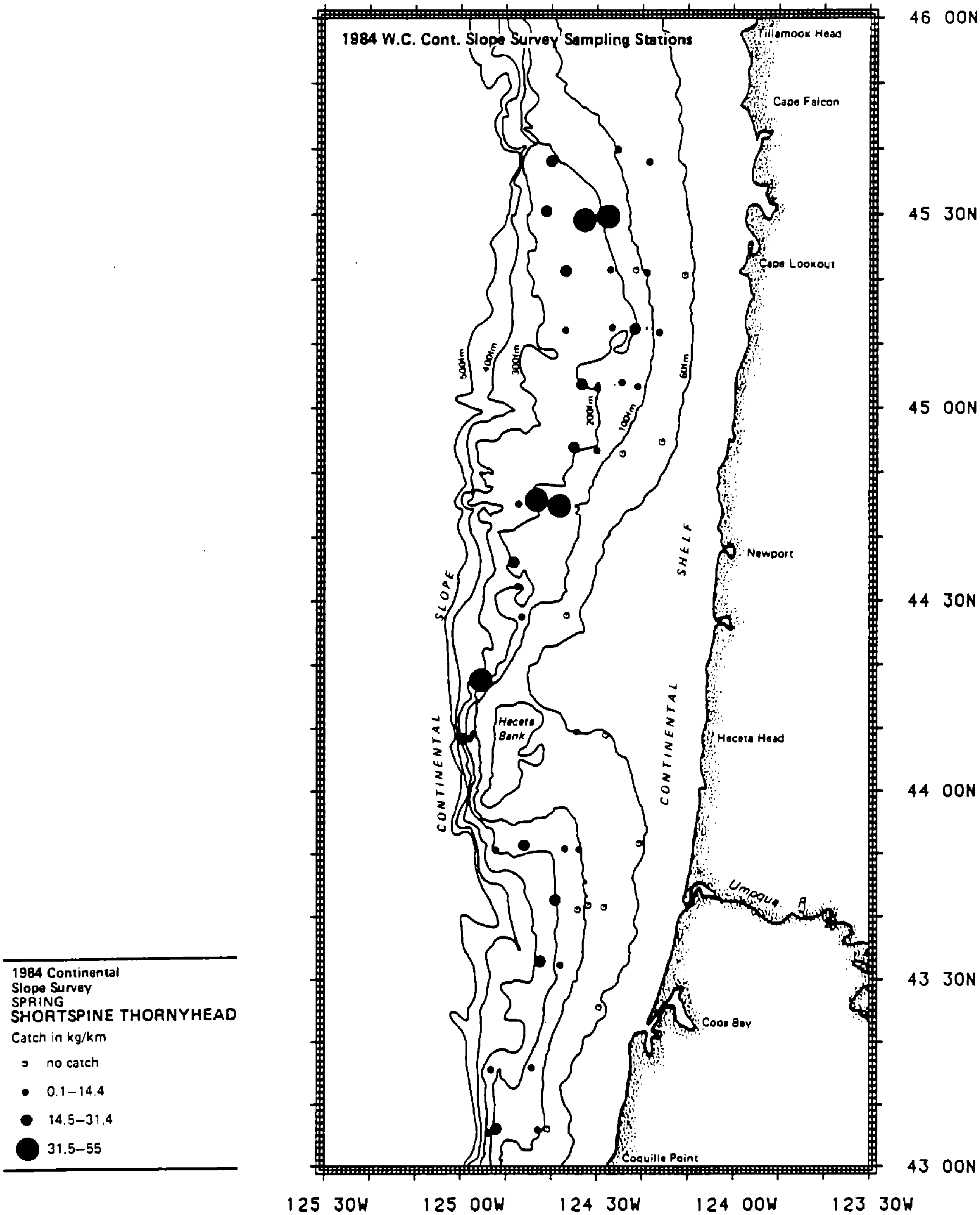


Figure 16.--Distribution and relative abundance (kg/km trawled) of shortspine thornyhead during the 1984 spring survey.

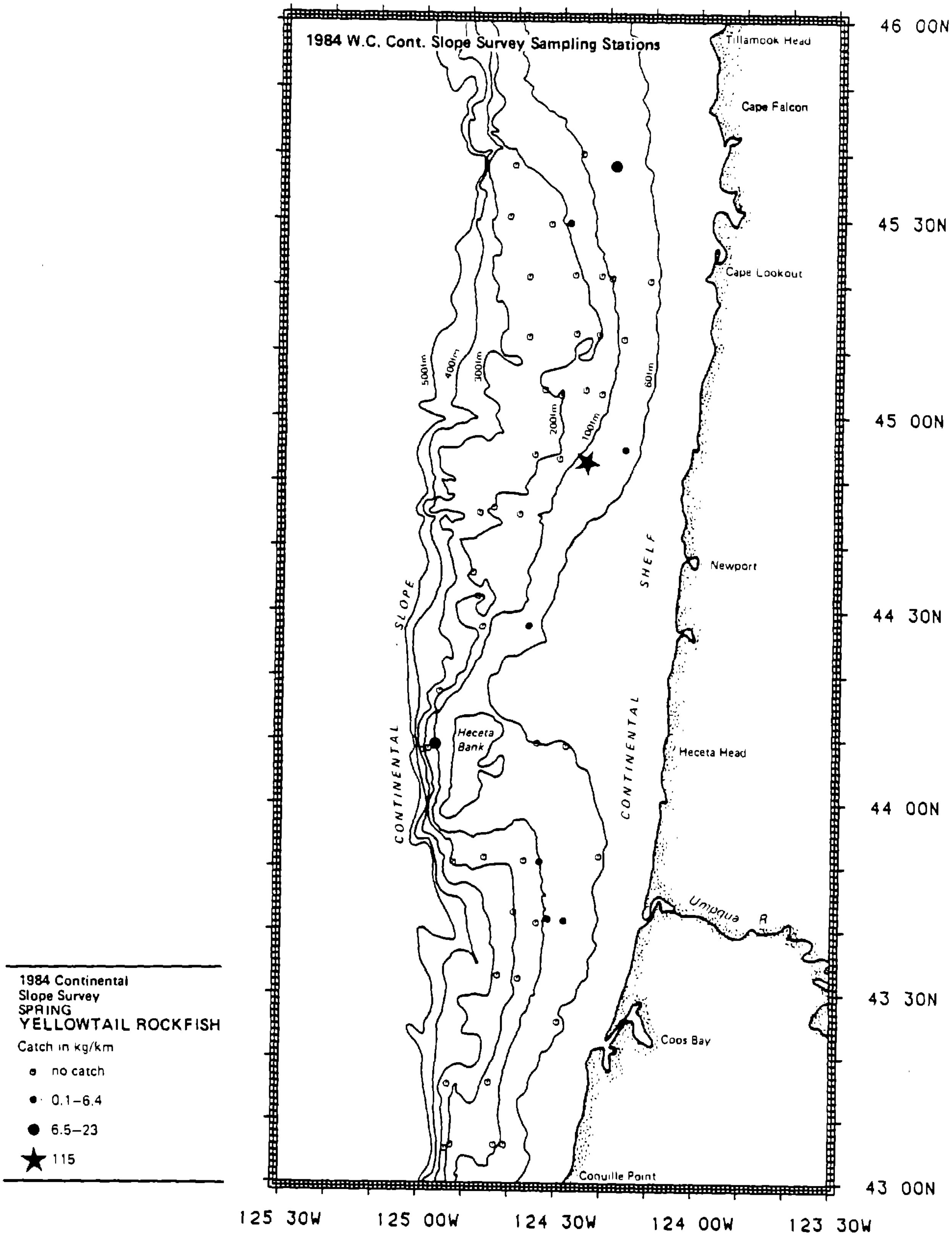


Figure 17.-Distribution and relative abundance (kg/km trawled) of yellowtail rockfish during the 1984 spring survey.

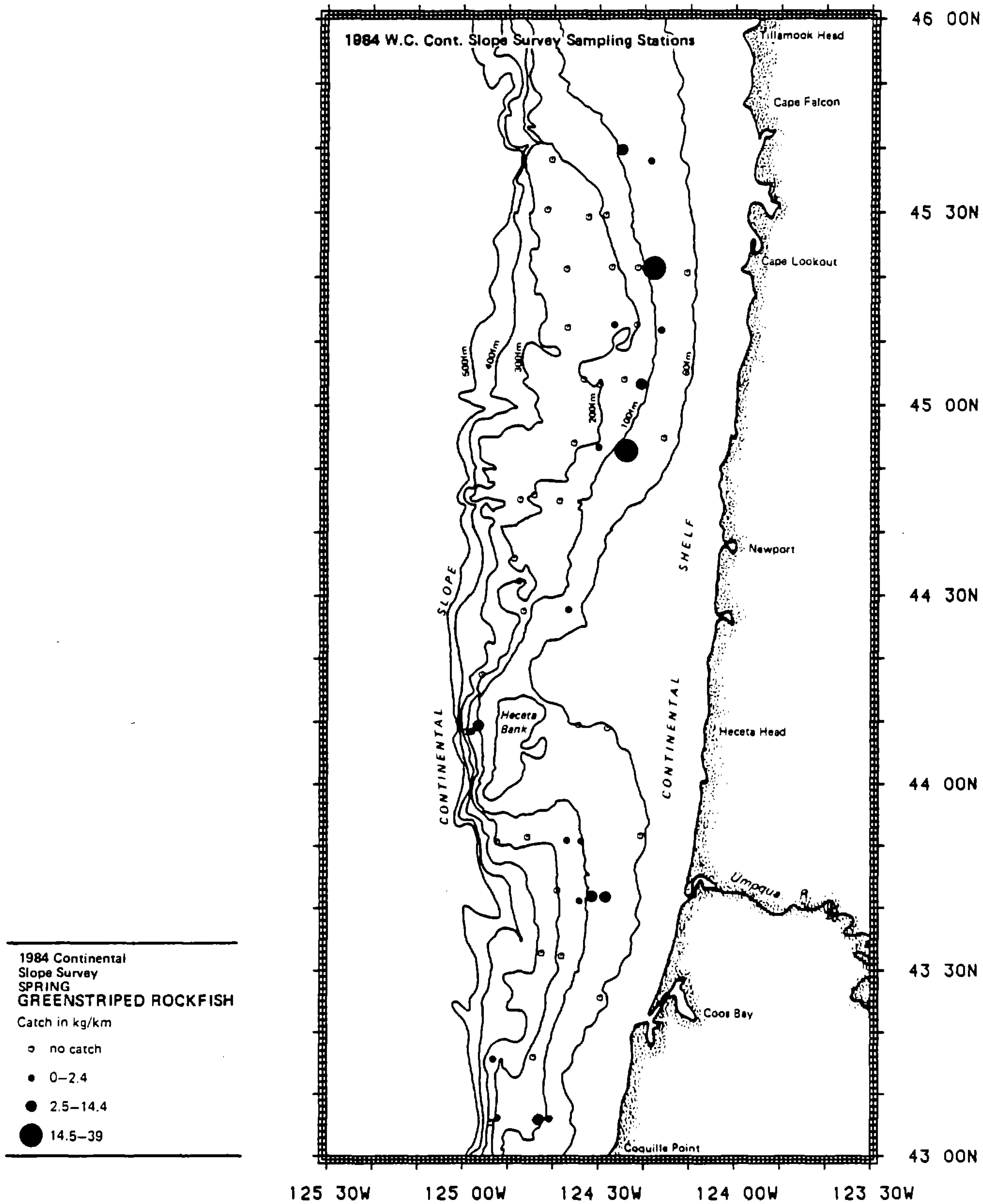


Figure 18.--Distribution and relative abundance (kg/km trawled) of greenstriped rockfish during the 1984 spring survey.

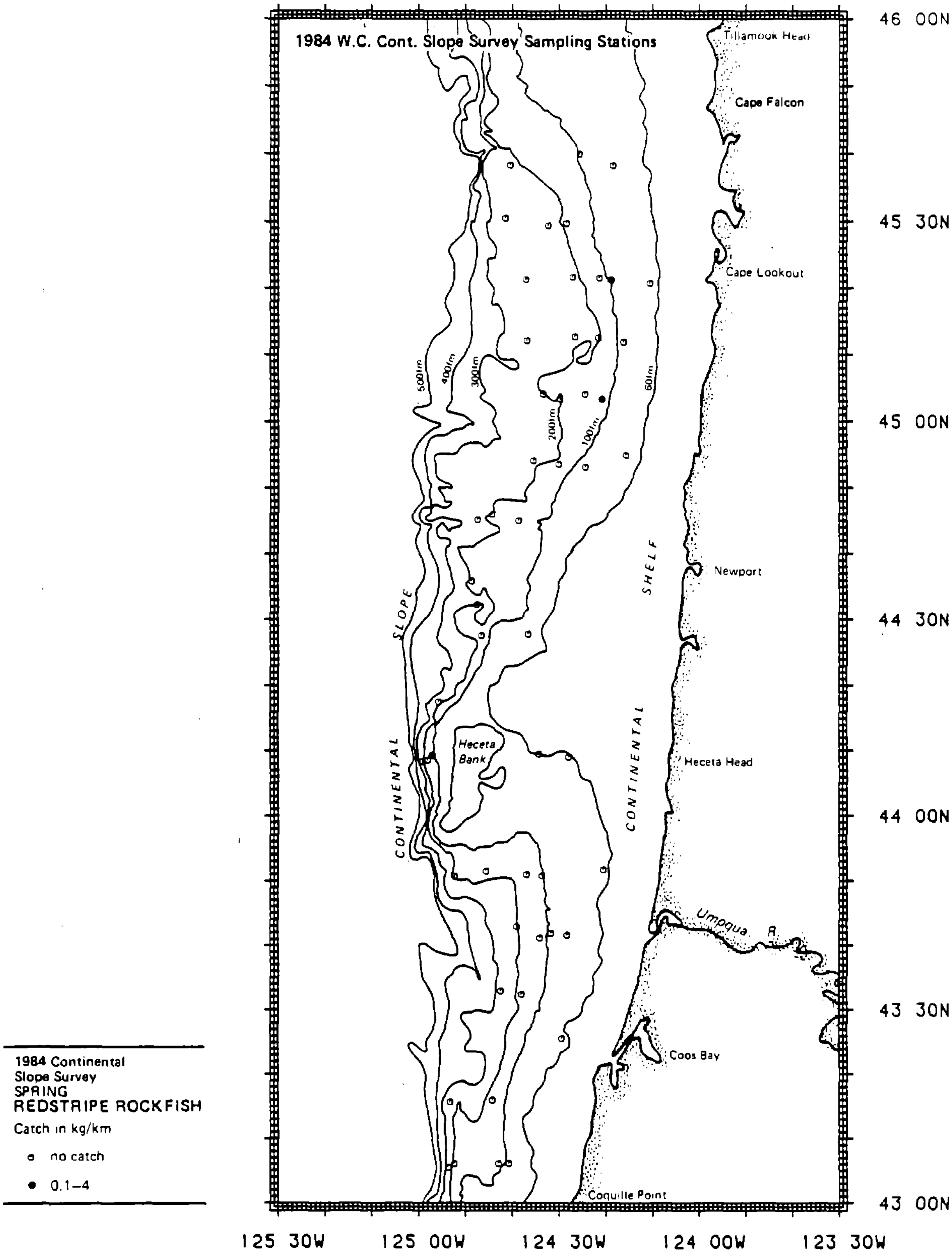


Figure 19.--Distribution and relative abundance (kg/km trawled) of redstripe rockfish during the 1984 spring survey.

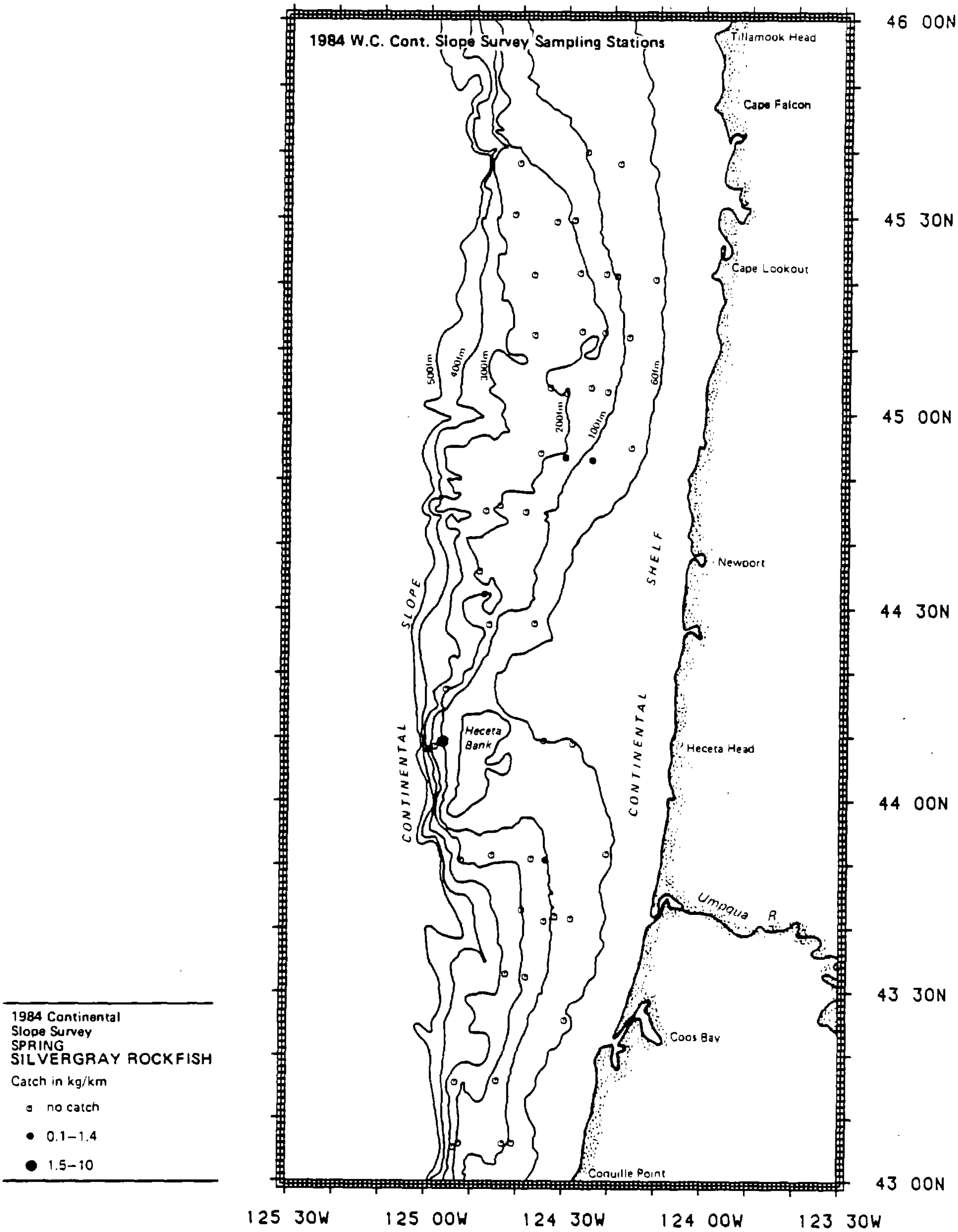


Figure 20.--Distribution and relative abundance (kg/km trawled) of silvergray rockfish during the 1984 spring survey.

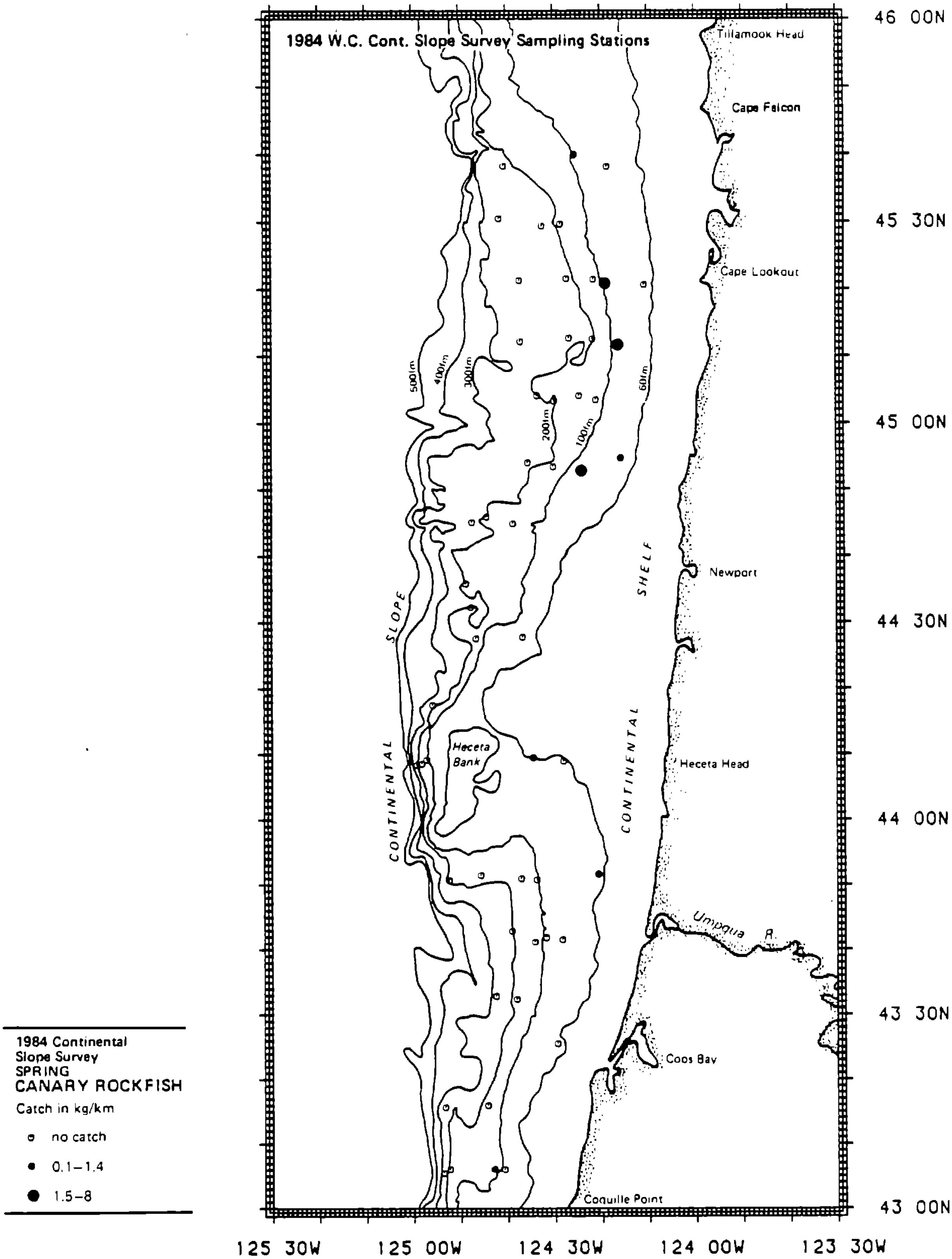


Figure 21.--Distribution and relative abundance (kg/km trawled) of canary rockfish during the 1984 spring survey.

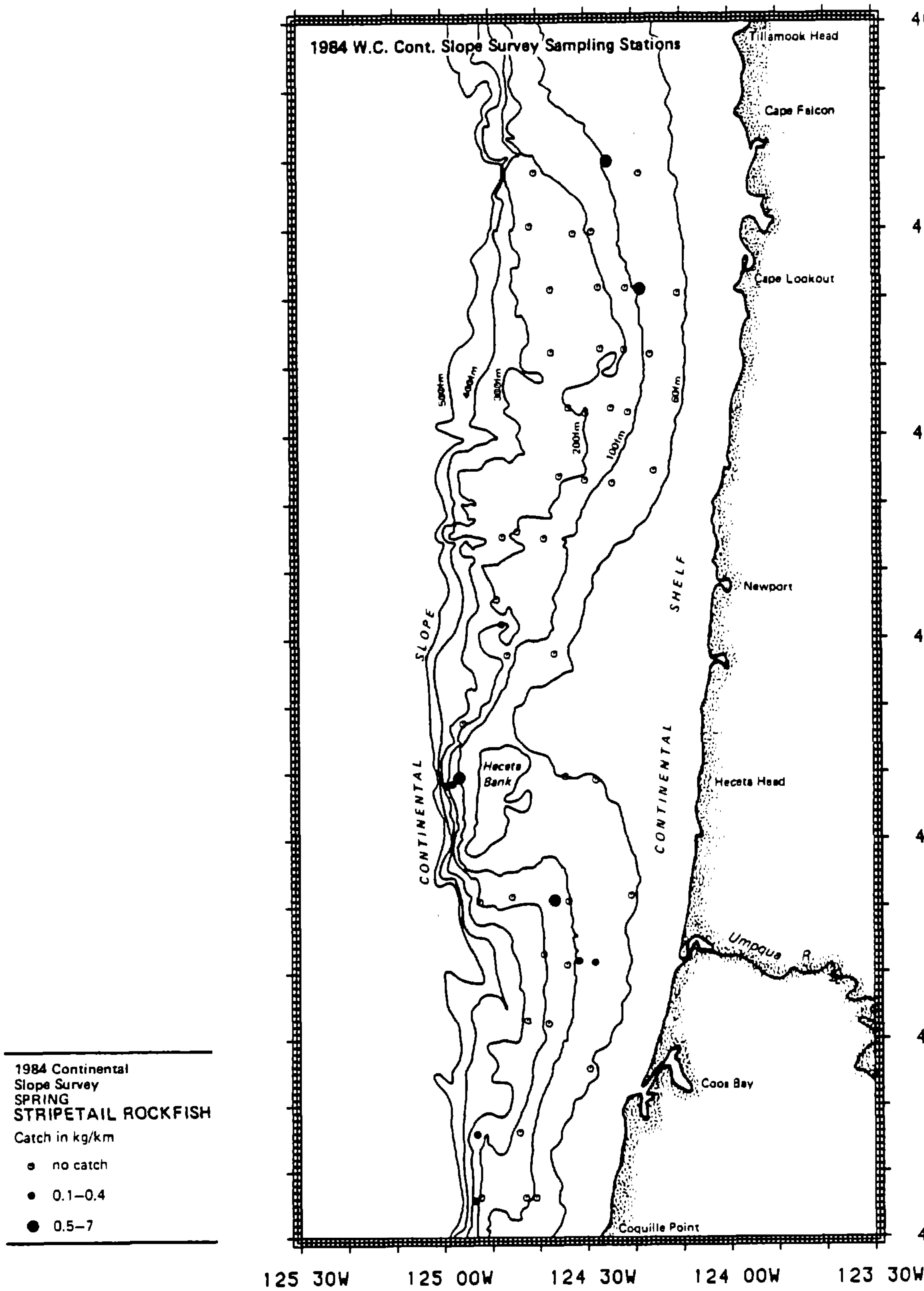


Figure 22.--Distribution and relative abundance (kg/km trawled) of stripetail rockfish during the 1984 spring survey.

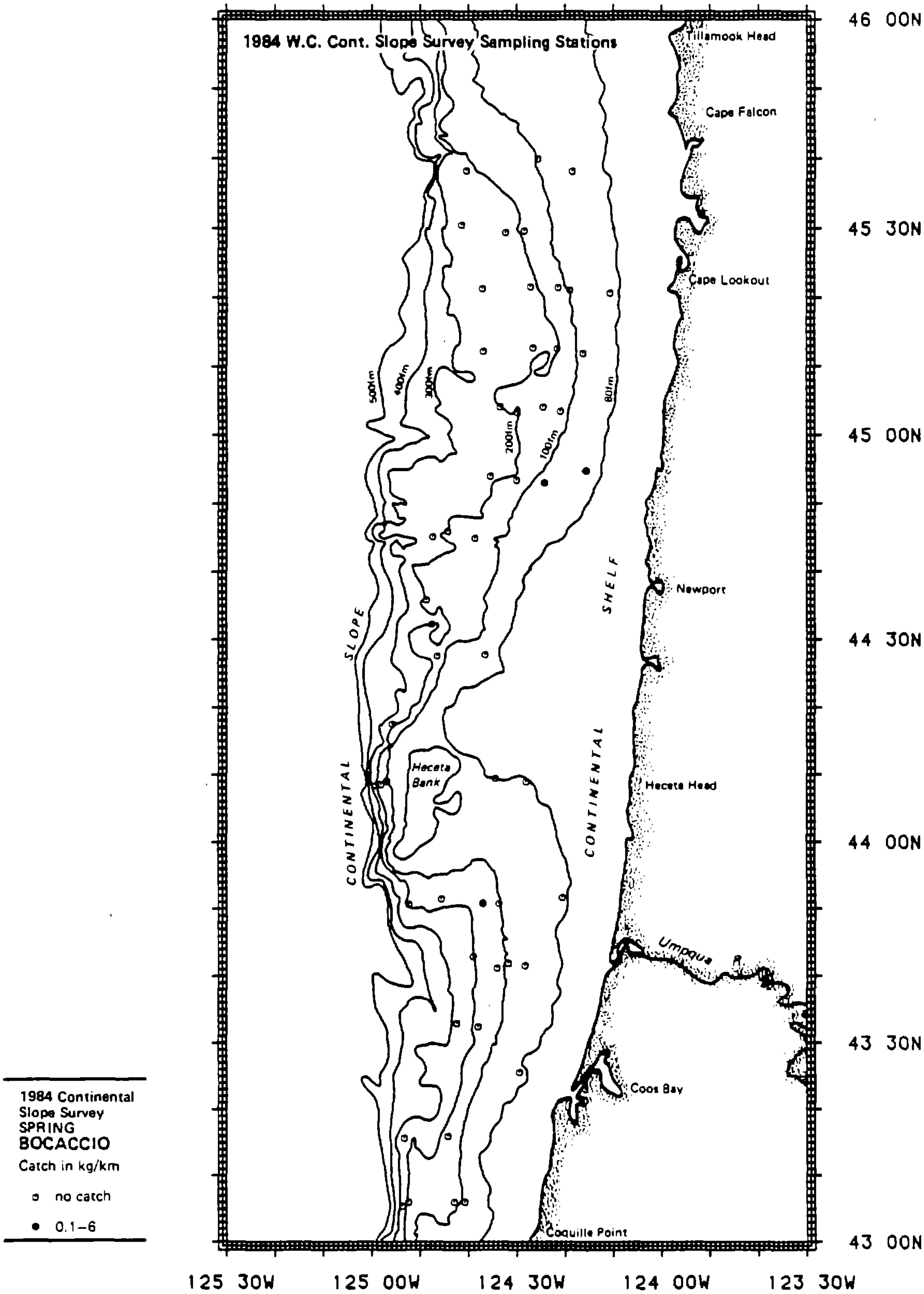


Figure 23.--Distribution and relative abundance (kg/km trawled) of bocaccio during the 1984 spring survey.

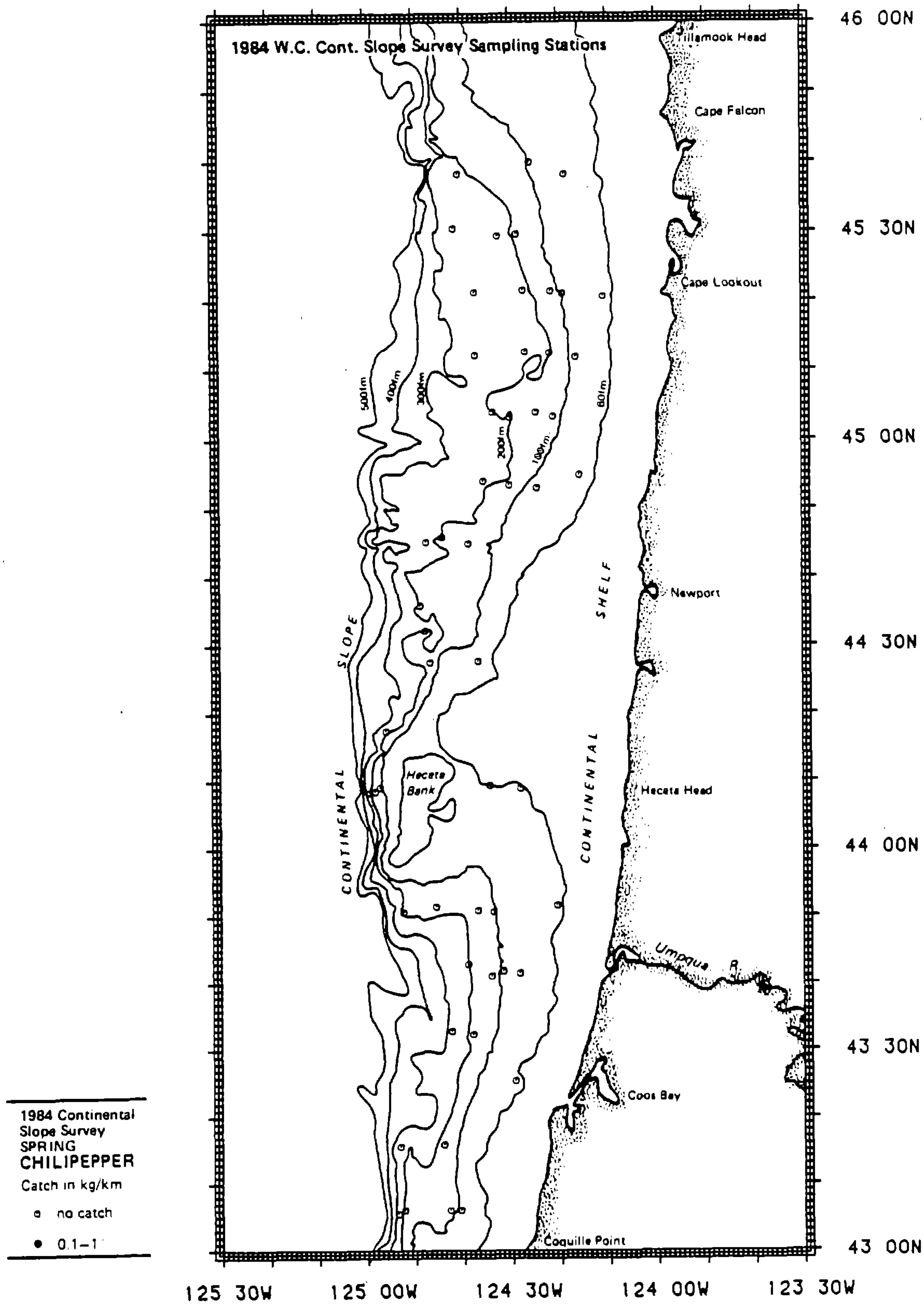


Figure 24.--Distribution and relative abundance (kg/km trawled) of chilipepper rockfish during the 1984 spring survey.

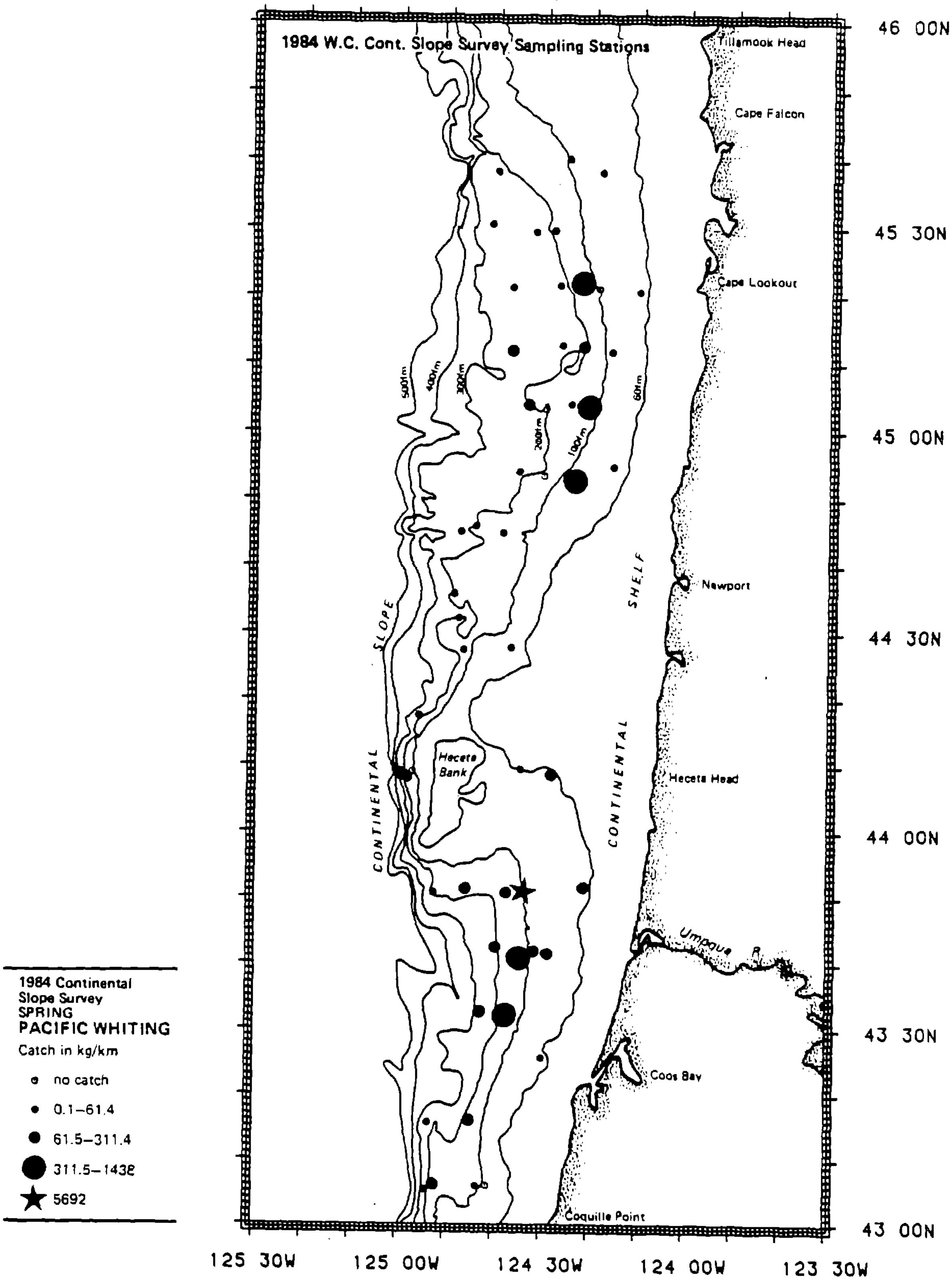


Figure 25.--Distribution and relative abundance (kg/km trawled) of Pacific whiting during the 1984 spring survey.

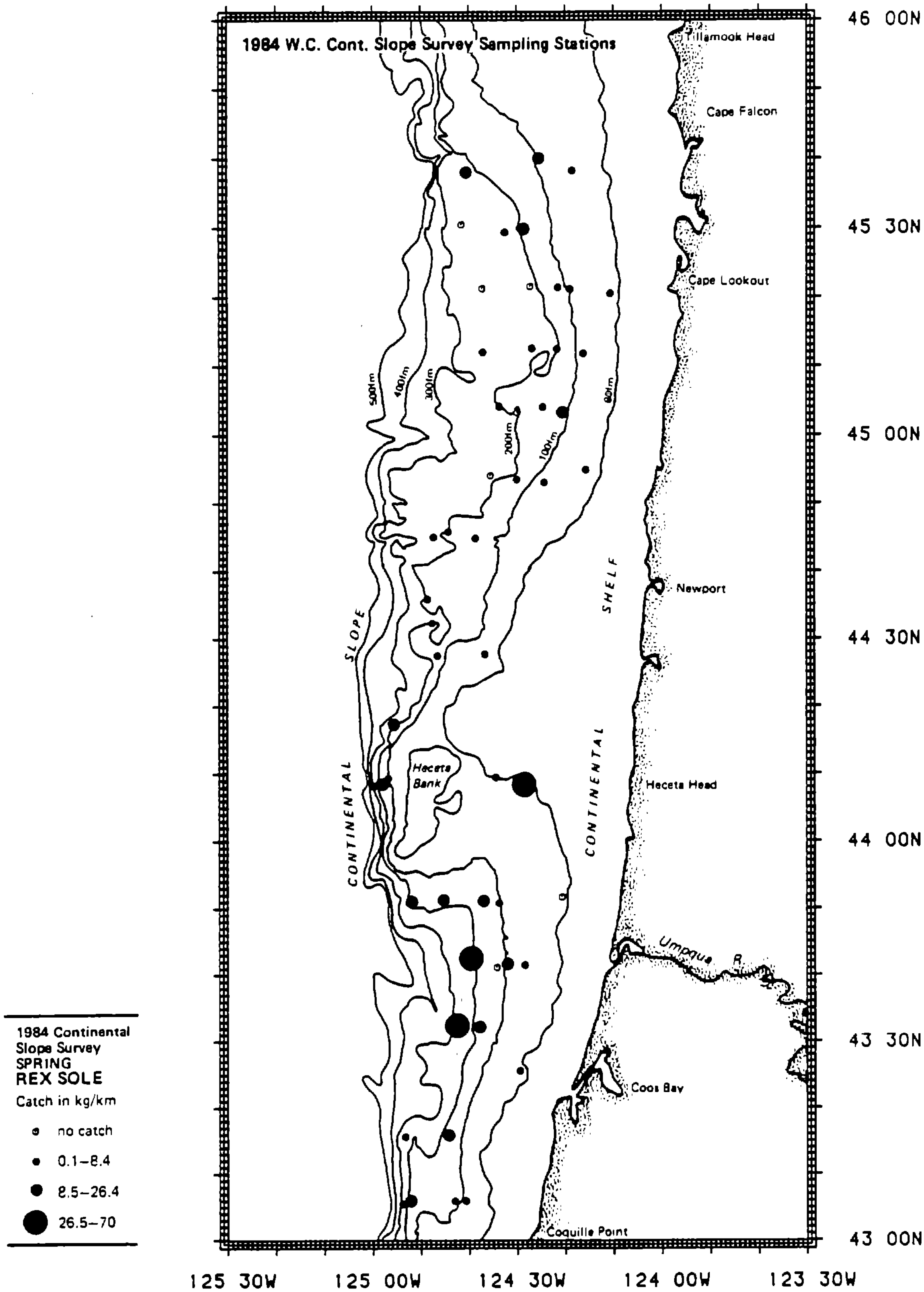


Figure 26.--Distribution and relative abundance (kg/km trawled) of rex sole during the 1984 spring survey.

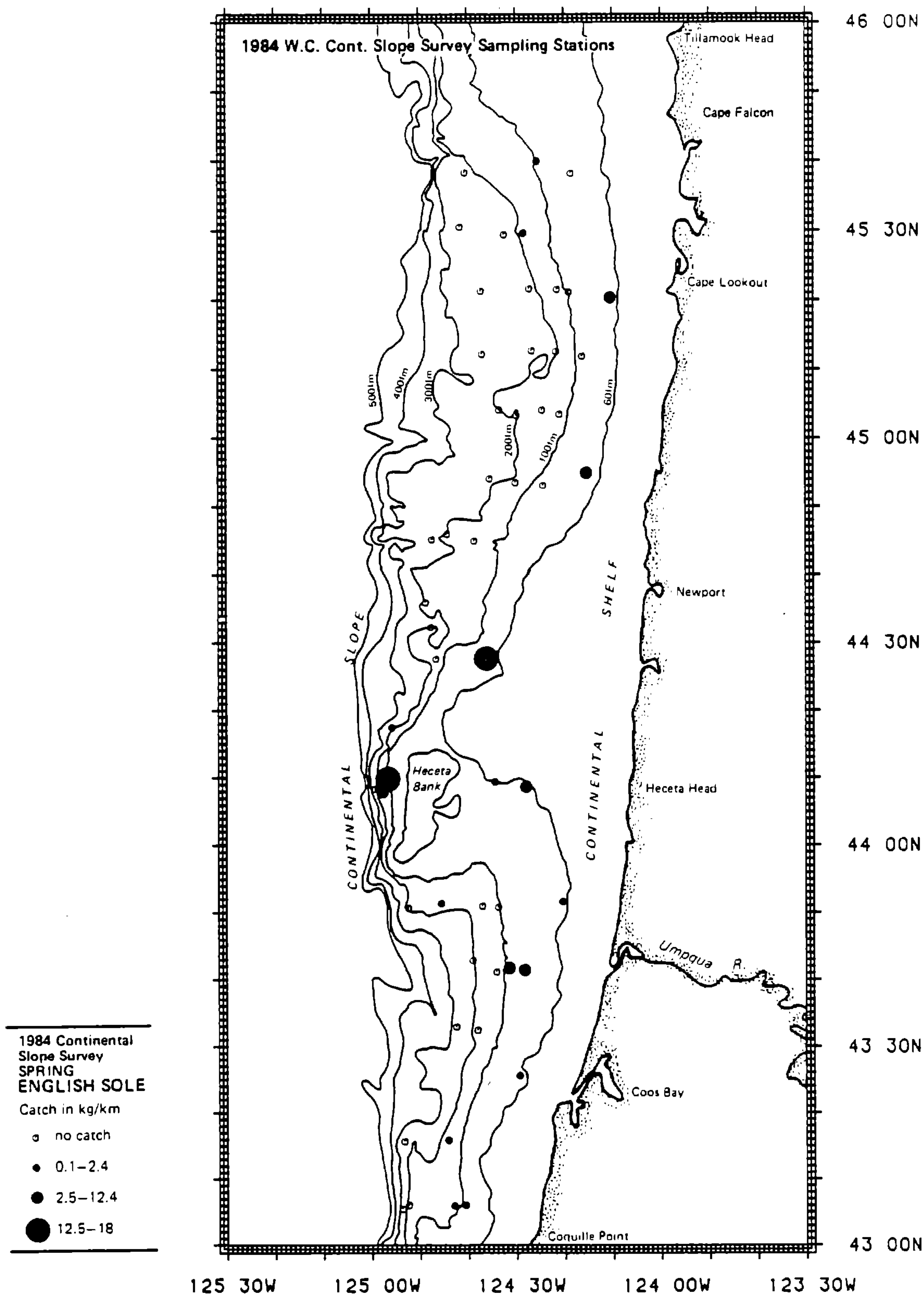


Figure 27.--Distribution and relative abundance (kg/km trawled) of English sole during the 1984 spring survey.

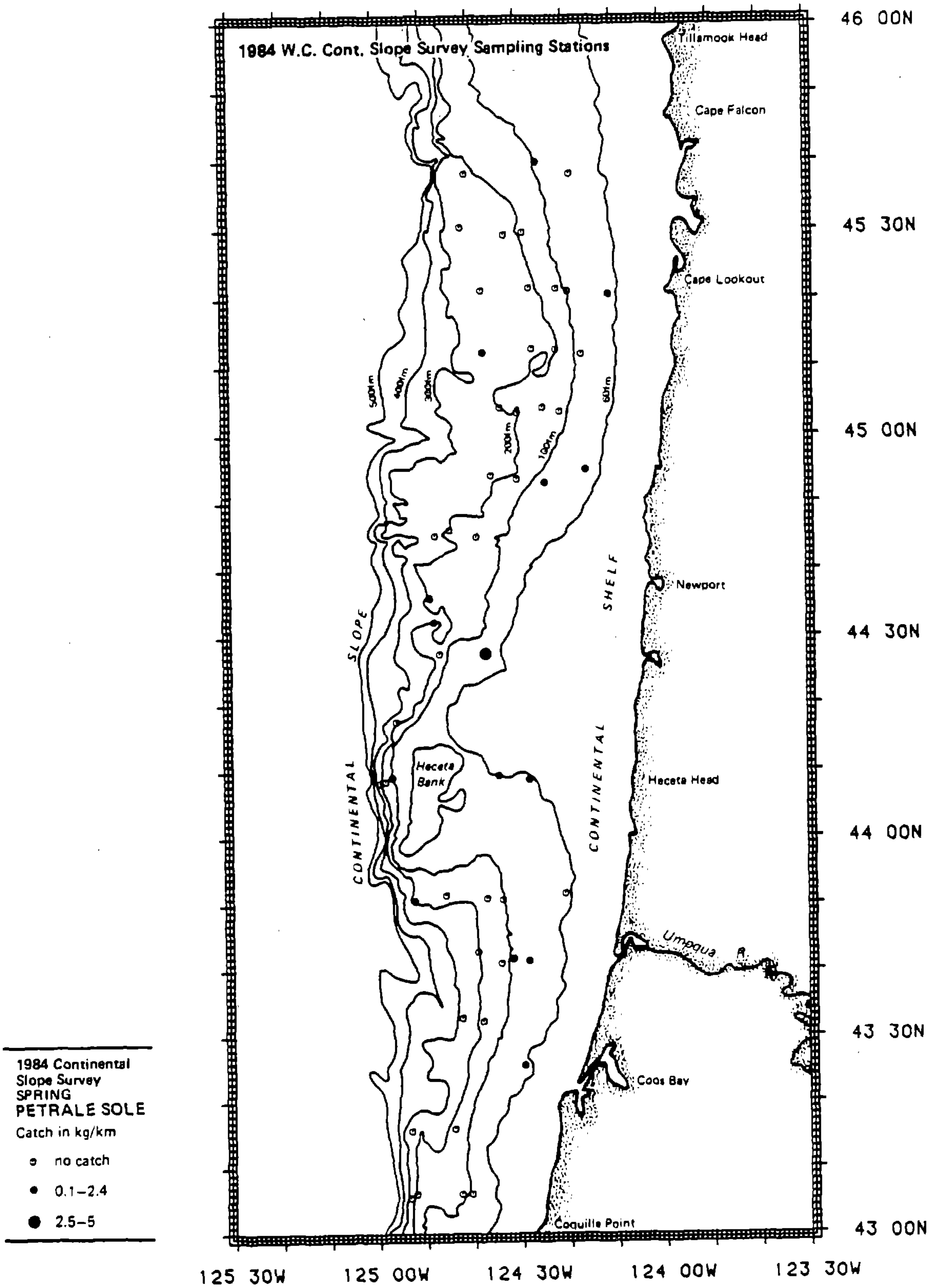


Figure 28.--Distribution and relative abundance (kg/km trawled) of petrale sole during the 1984 spring survey.

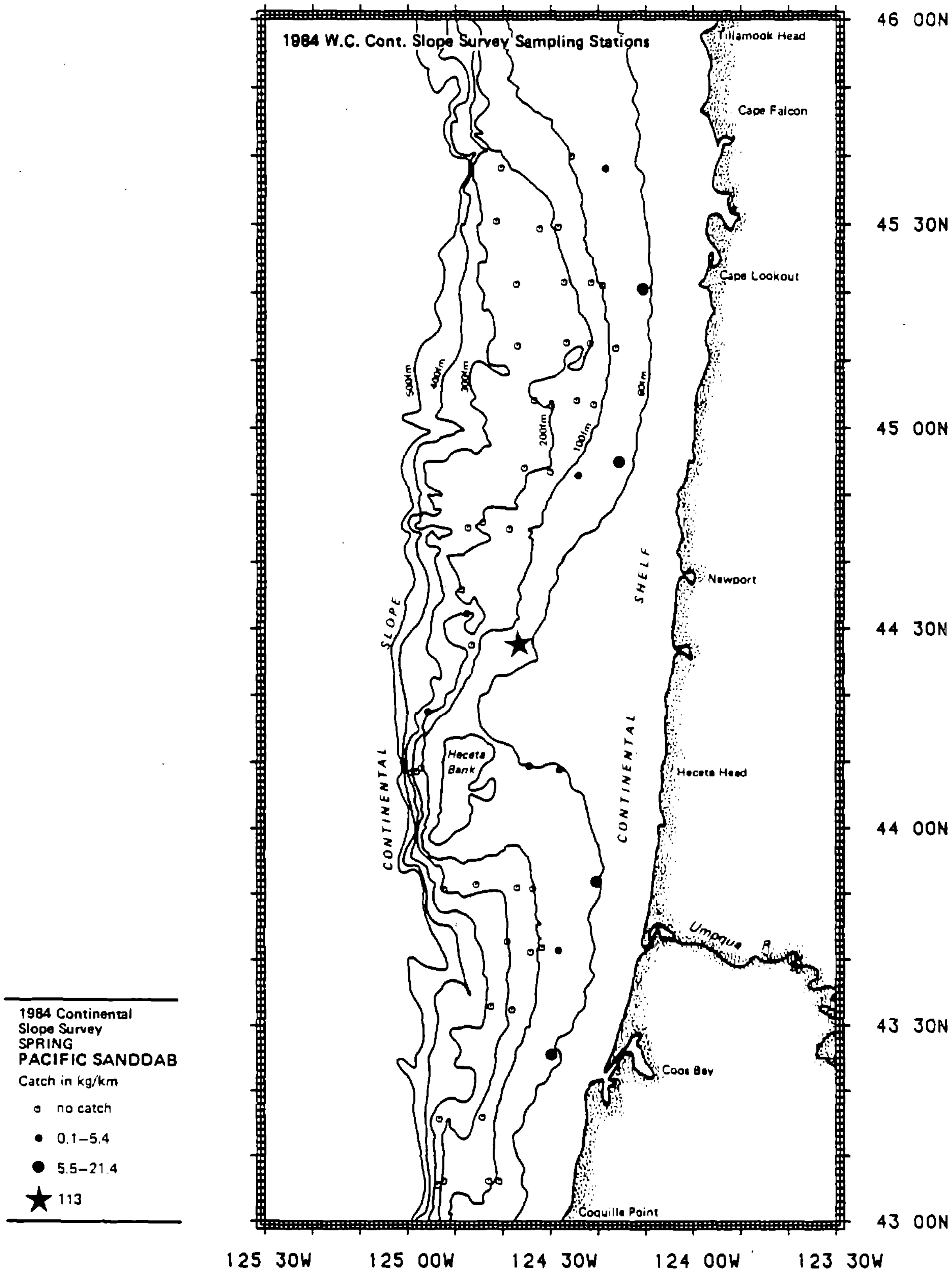


Figure 29.--Distribution and relative abundance (kg/km trawled) of Pacific sanddab during the 1984 spring survey.

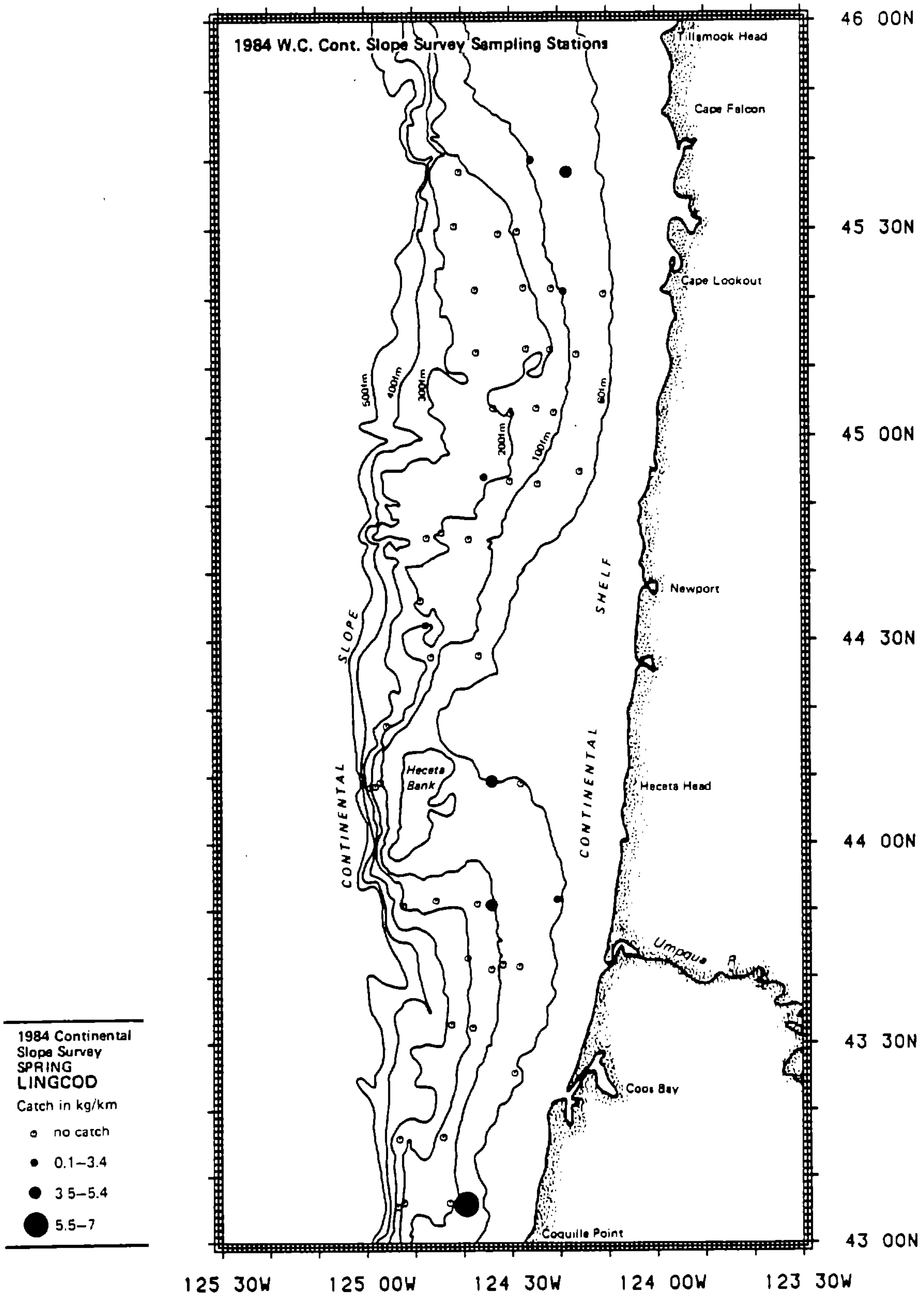


Figure 30.--Distribution and relative abundance (kg/km trawled) of lingcod during the 1984 spring survey.

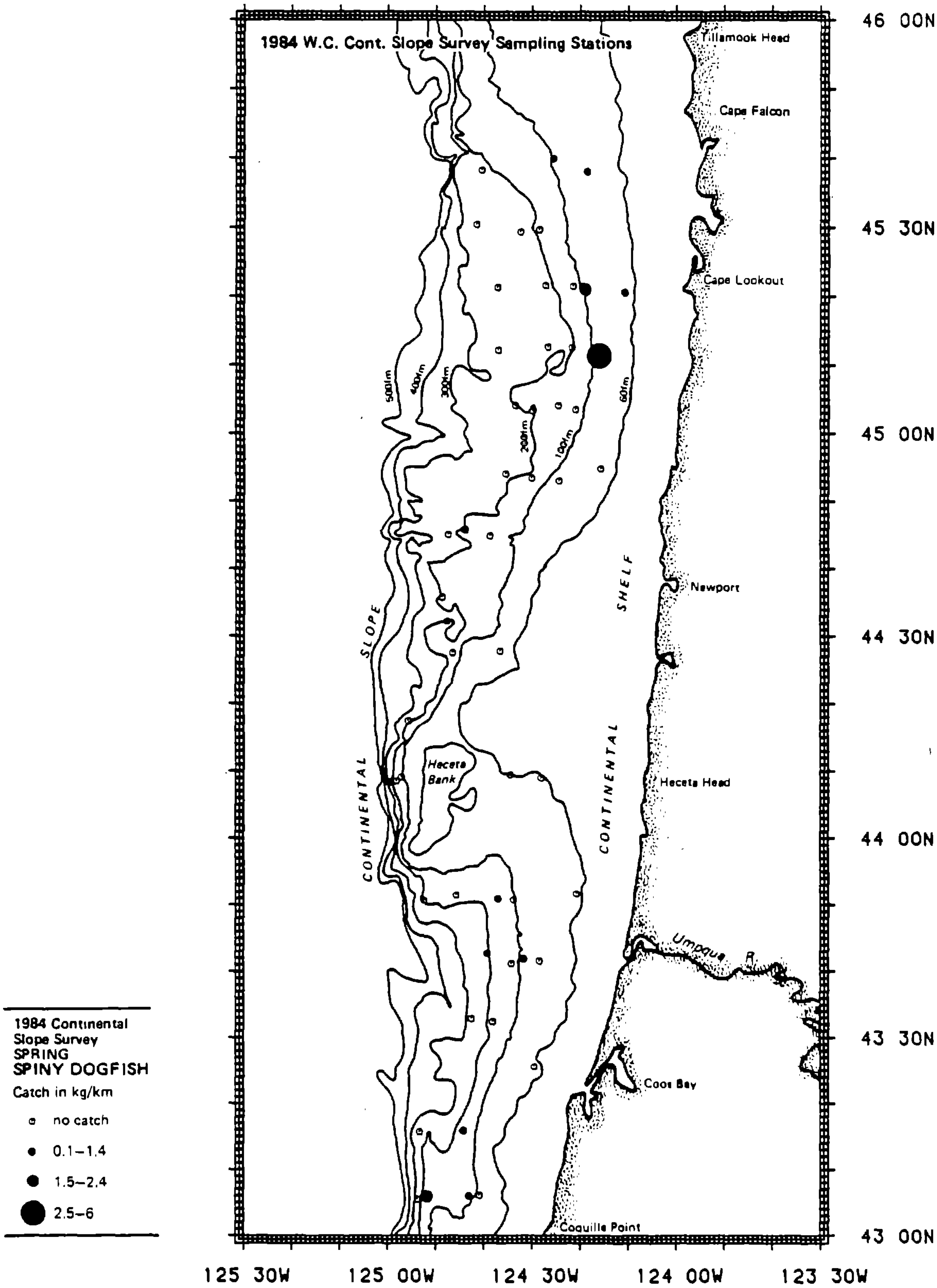


Figure 31.-Distribution and relative abundance (kg/km trawled) of spiny dogfish during the 1984 spring survey.

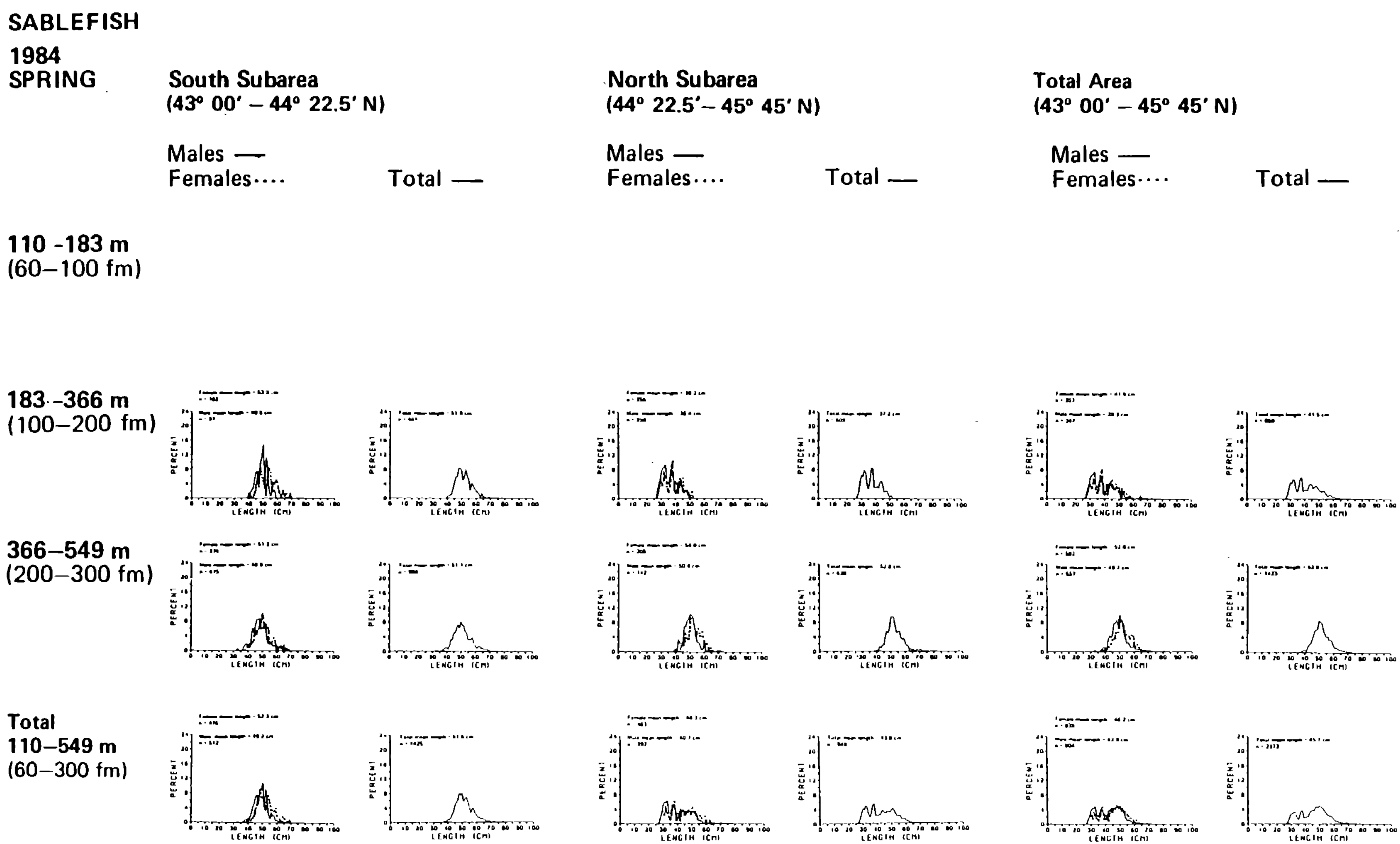


Figure 32.--Sablefish size composition during the 1984 spring slope survey by sex and geographic subarea.

DOVER SOLE

1984
SPRING

South Subarea
(43° 00′ – 44° 22.5′ N)

Males —
Females····

Total —

North Subarea
(44° 22.5′ – 45° 45′ N)

Males —
Females····

Total —

Total Area
(43° 00′ – 45° 45′ N)

Males —
Females····

Total —

110–183 m
(60–100 fm)

183–366 m
(100–200 fm)

366–549 m
(200–300 fm)

Total
110–549 m
(60–300 fm)

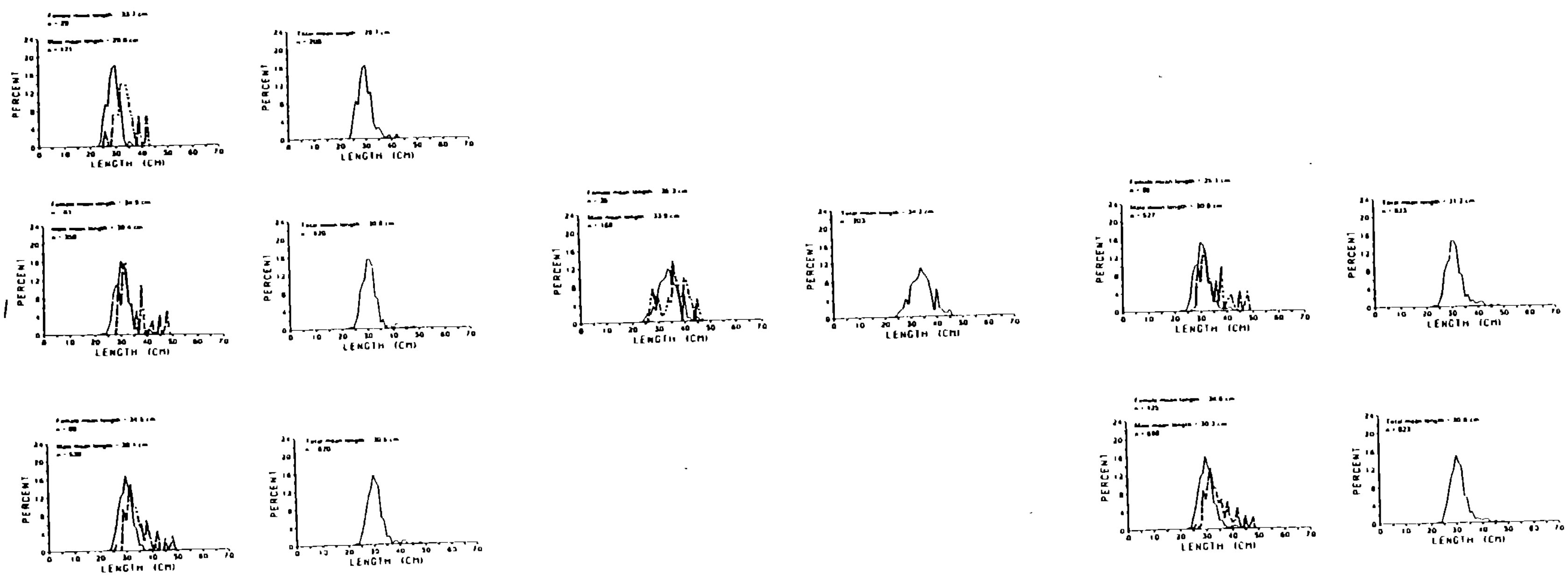


Figure 33.--Dover sole size composition during the 1984 spring slope survey by sex and geographic subarea.

PACIFIC OCEAN PERCH

1984
SPRING

	South Subarea (43° 00' – 44° 22.5' N)		North Subarea (44° 22.5'– 45° 45' N)		Total Area (43° 00' – 45° 45' N)	
	Males —— Females ····	Total ——	Males —— Females ····	Total ——	Males —— Females ····	Total ——
110–183 m (60–100 fm)						
183–366 m (100–200 fm)						
366–549 m (200–300 fm)						
Total 110–549 m (60–300 fm)						

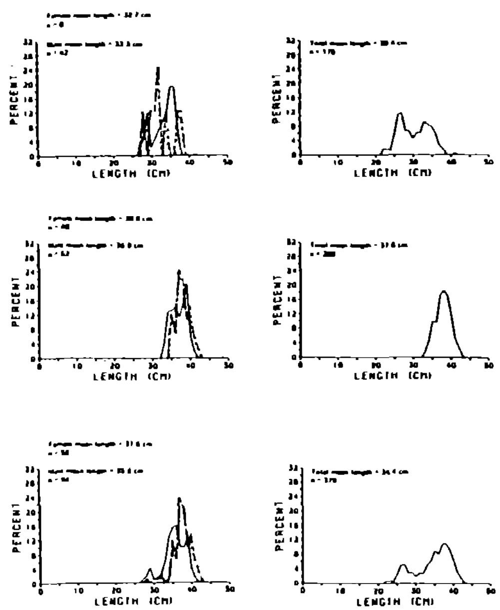


Figure 34.--Pacific ocean perch size composition during the 1984 spring slope survey by sex and geographic

DARKBLOTCHED ROCKFISH

1984
SPRING

South Subarea (43° 00' – 44° 22.5' N): Males —— Females ···· | Total ——

North Subarea (44° 22.5' – 45° 45' N): Males —— Females ···· | Total ——

Total Area (43° 00' – 45° 45' N): Males —— Females ···· | Total ——

110–183 m (60–100 fm)

183–366 m (100–200 fm)

366–549 m (200–300 fm)

Total 110–549 m (60–300 fm)

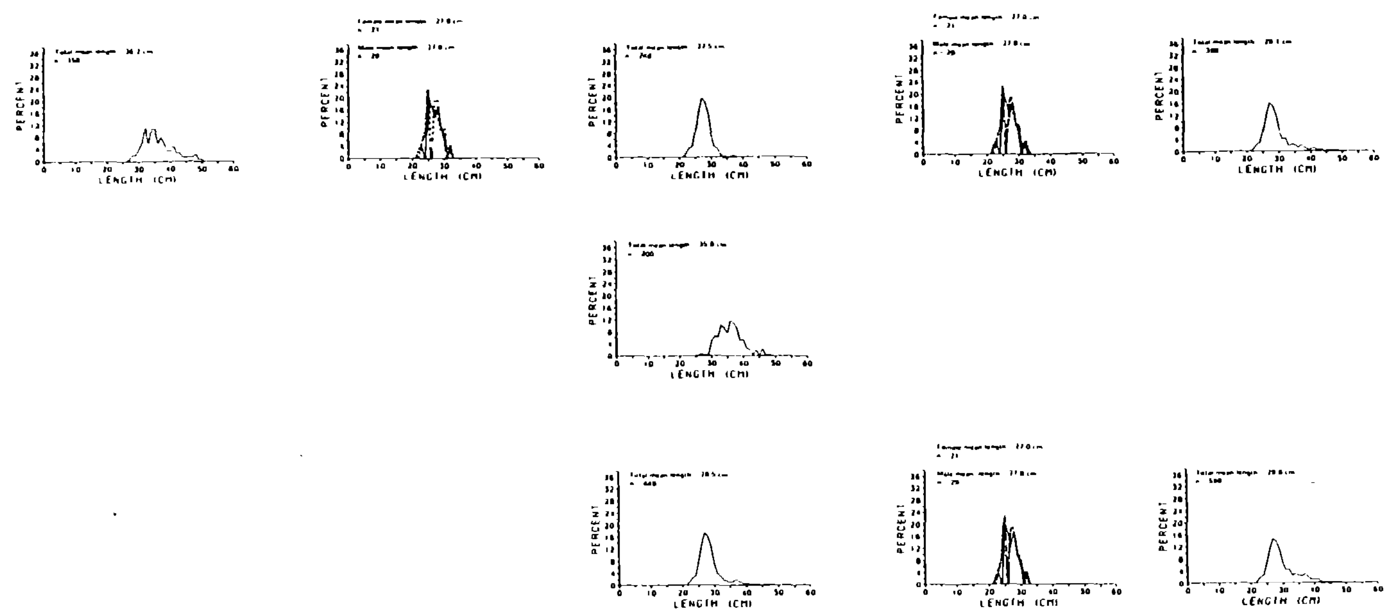


Figure 35.--Darkblotched rockfish size composition during the 1984 spring slope survey by sex and geographic

SPLITNOSE ROCKFISH

1984
SPRING

	South Subarea (43° 00′ – 44° 22.5′ N)		North Subarea (44° 22.5′ – 45° 45′ N)		Total Area (43° 00′ – 45° 45′ N)	
	Males —— Females ····	Total ——	Males —— Females ····	Total ——	Males —— Females ····	Total ——
110–183 m (60–100 fm)						
183–366 m (100–200 fm)						
366–549 m (200–300 fm)						
Total 110–549 m (60–300 fm)						

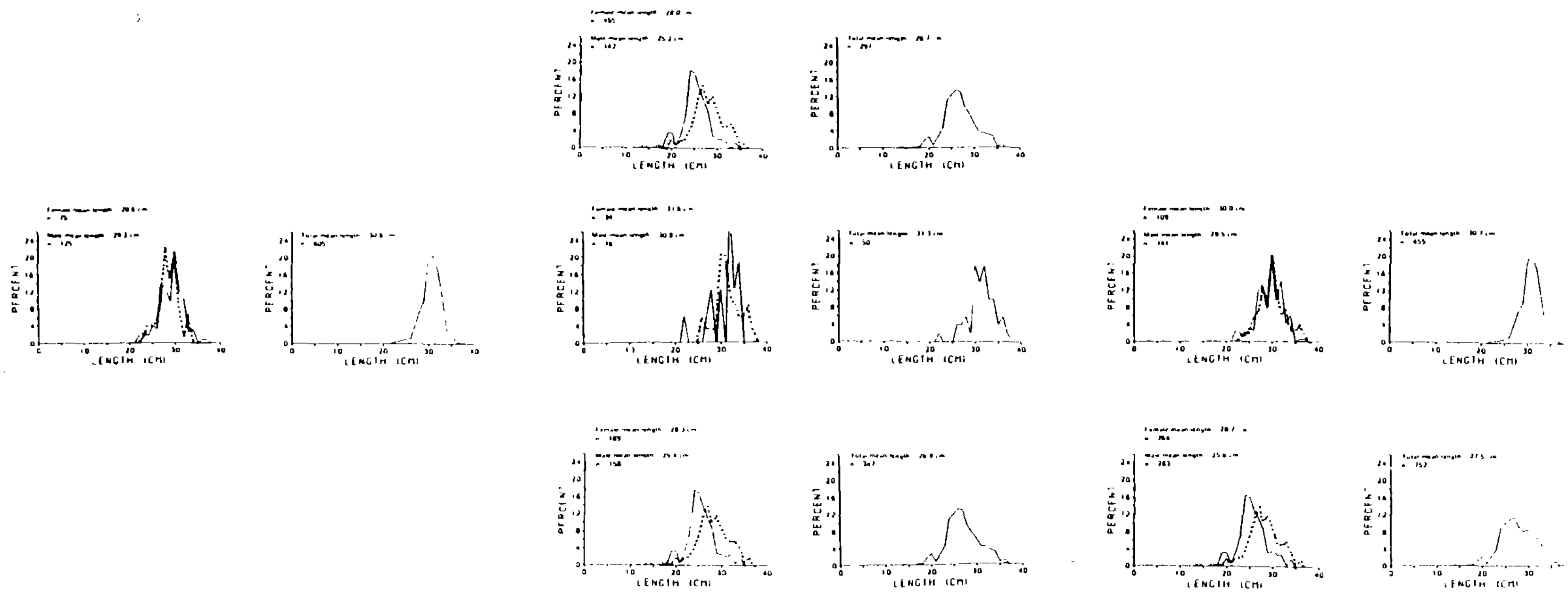


Figure 36.--Splitnose rockfish size composition during the 1984 spring slope survey by sex and geographic subarea.

STRIPETAIL ROCKFISH

1984 SPRING

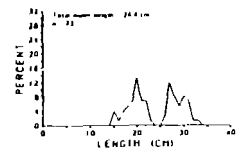
	South Subarea (43° 00′ – 44° 22.5′ N)		North Subarea (44° 22.5′ – 45° 45′ N)		Total Area (43° 00′ – 45° 45′ N)	
	Males —— Females	Total ——	Males —— Females	Total ——	Males —— Females	Total ——
110–183 m (60–100 fm)						
183–366 m (100–200 fm)						
366–549 m (200–300 fm)						
Total 110–549 m (60–300 fm)						

Figure 37.--Stripetail rockfish size composition during the 1984 spring slope survey by sex and geographic subarea.

YELLOWTAIL ROCKFISH

1984
SPRING

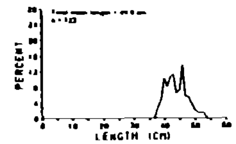
	South Subarea (43° 00′ – 44° 22.5′ N)		North Subarea (44° 22.5′ – 45° 45′ N)		Total Area (43° 00′ – 45° 45′ N)	
	Males —— Females ····	Total ——	Males —— Females ····	Total ——	Males —— Females ····	Total ——
110–183 m (60–100 fm)						
183–366 m (100–200 fm)						
366–549 m (200–300 fm)						
Total 110–549 m (60–300 fm)						

Figure 38.--Yellowtail rockfish size composition during the 1984 spring slope survey by sex and geographic subarea.

GREENSTRIPED ROCKFISH

1984
SPRING

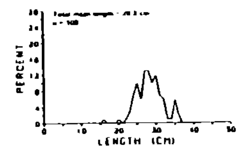
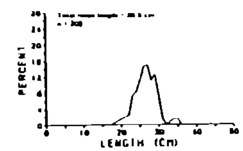
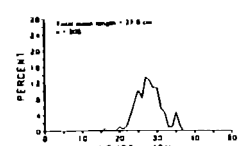
	South Subarea (43° 00′ – 44° 22.5′ N)		North Subarea (44° 22.5′– 45° 45′ N)		Total Area (43° 00′ – 45° 45′ N)	
	Males —— Females····	Total ——	Males —— Females····	Total ——	Males —— Females····	Total ——
110–183 m (60–100 fm)						
183–366 m (100–200 fm)						
366–549 m (200–300 fm)						
Total 110–549 m (60–300 fm)						

Figure 39.--Greenstriped rockfish size composition during the 1984 spring slope survey by sex and geographic

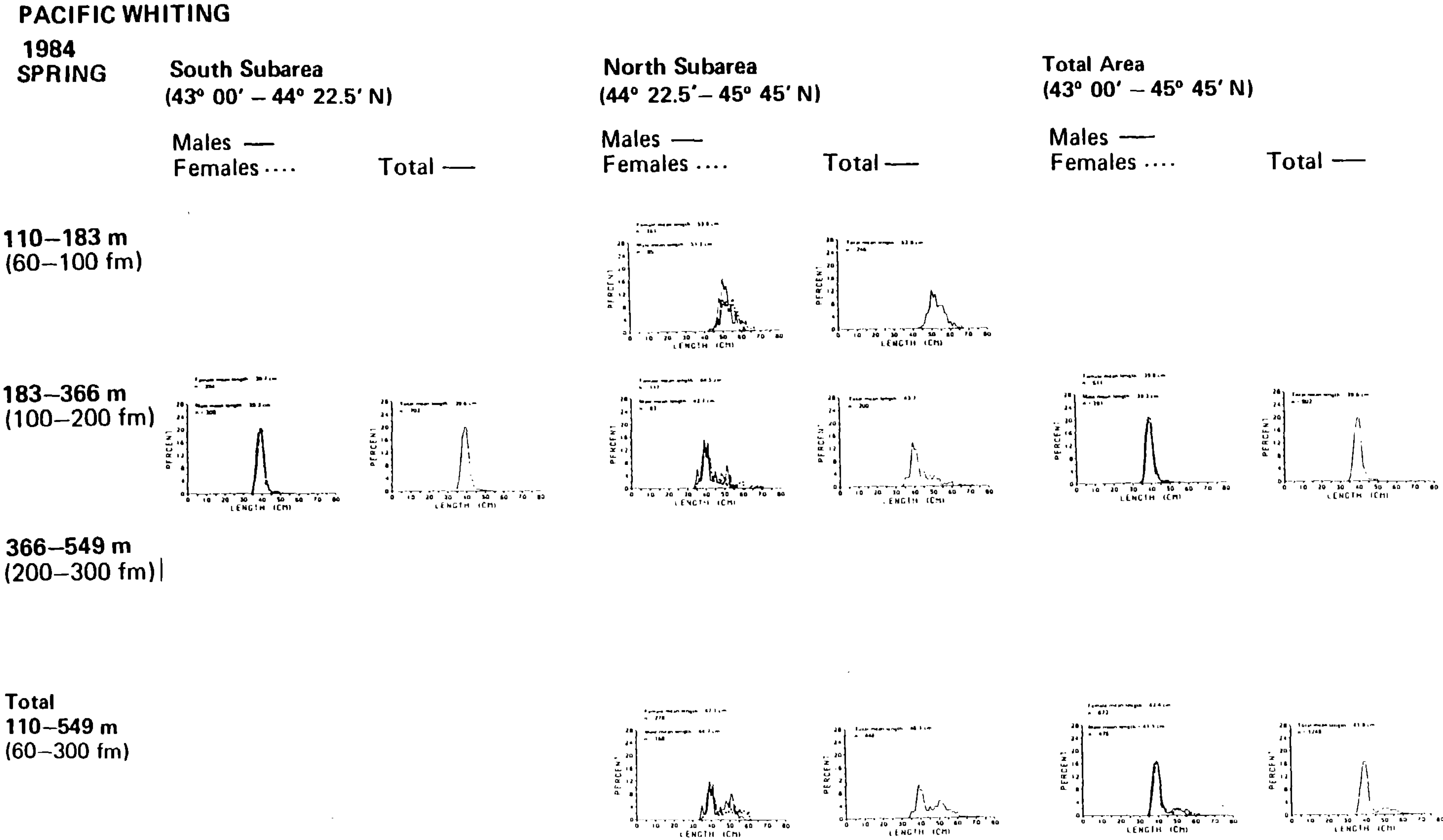


Figure 40.--Pacific whiting size composition during the 1984 spring slope survey by sex and geographic subarea.

ENGLISH SOLE
1984
SPRING

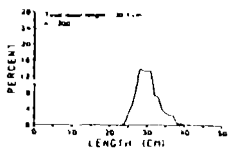
South Subarea
(43° 00' – 44° 22.5' N)
Males —— Females ···· Total ——

North Subarea
(44° 22.5' – 45° 45' N)
Males —— Females ···· Total ——

Total Area
(43° 00' – 45° 45' N)
Males —— Females ···· Total ——

110–183 m
(60–100 fm)

183–366 m
(100–200 fm)



366–549 m
(200–300 fm)

Total
110–549 m
(60–300 fm)

Figure 41.--English sole size composition during the 1984 spring slope survey by sex and geographic subarea.

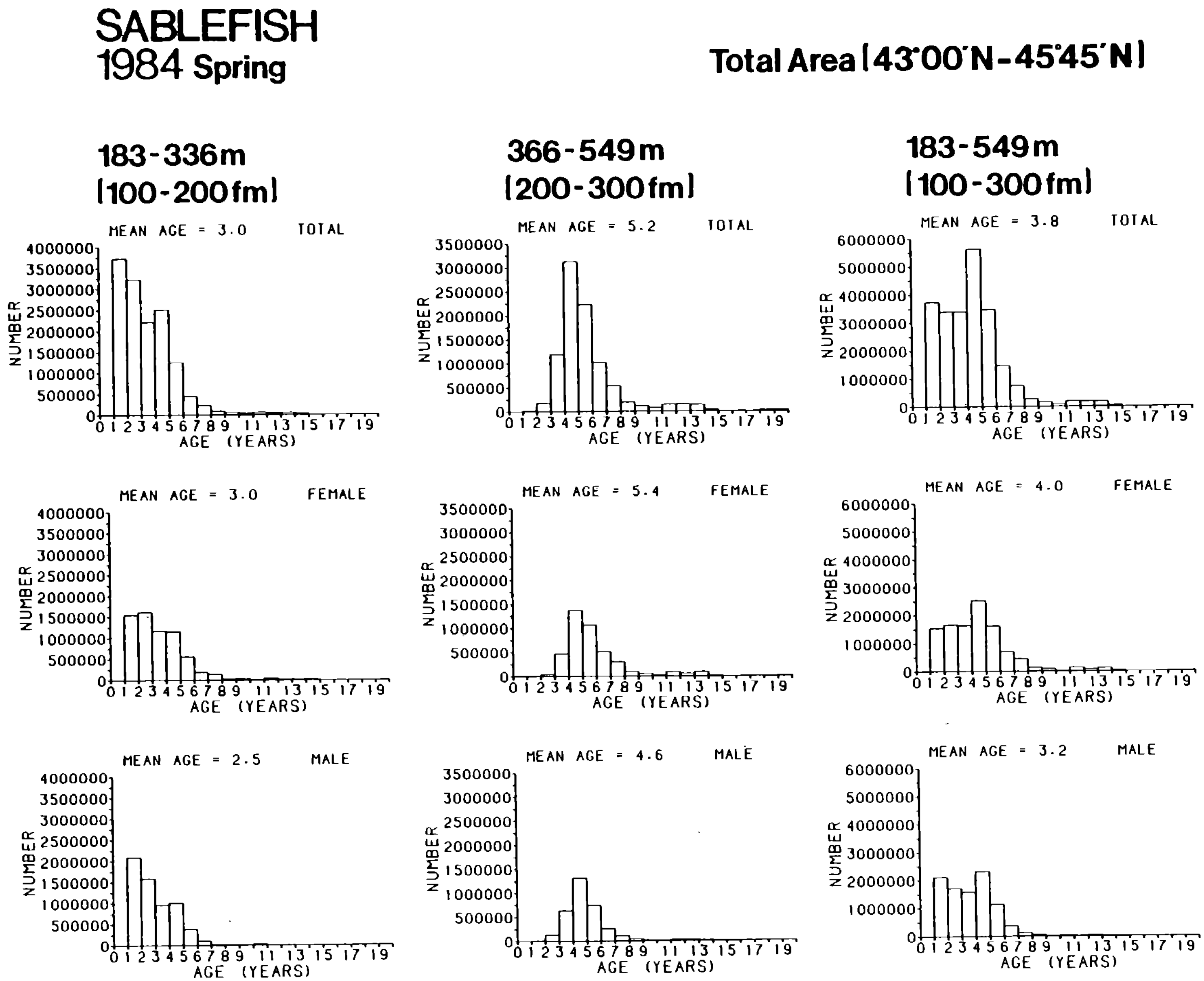


Figure 42.--Estimated sablefish age composition, by sex and depth stratum, for the entire 1984 spring slope survey area.

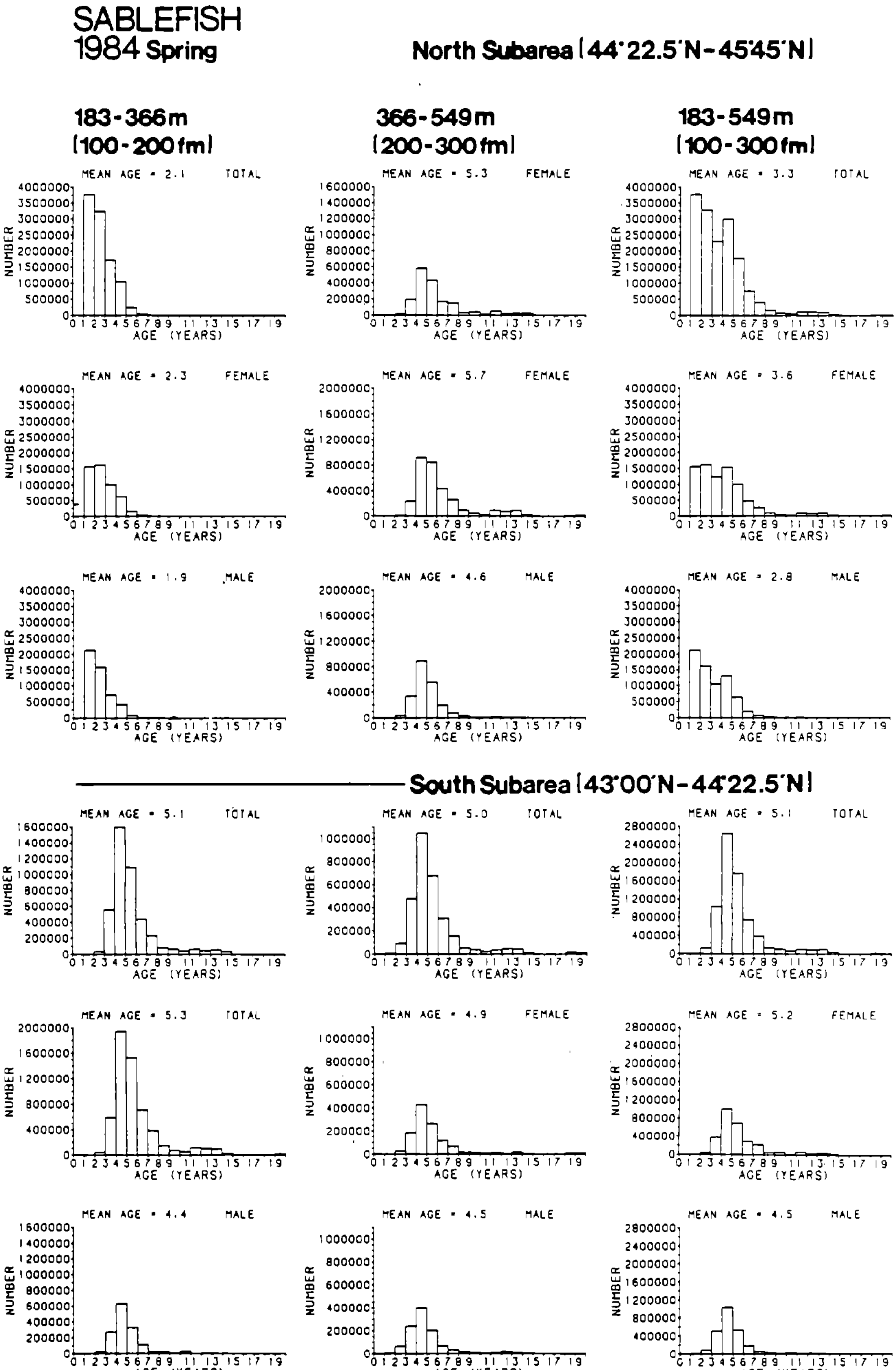


Figure 43.--Estimated sablefish age composition, by sex and depth stratum, for the 1984 spring slope survey, north and south subareas.

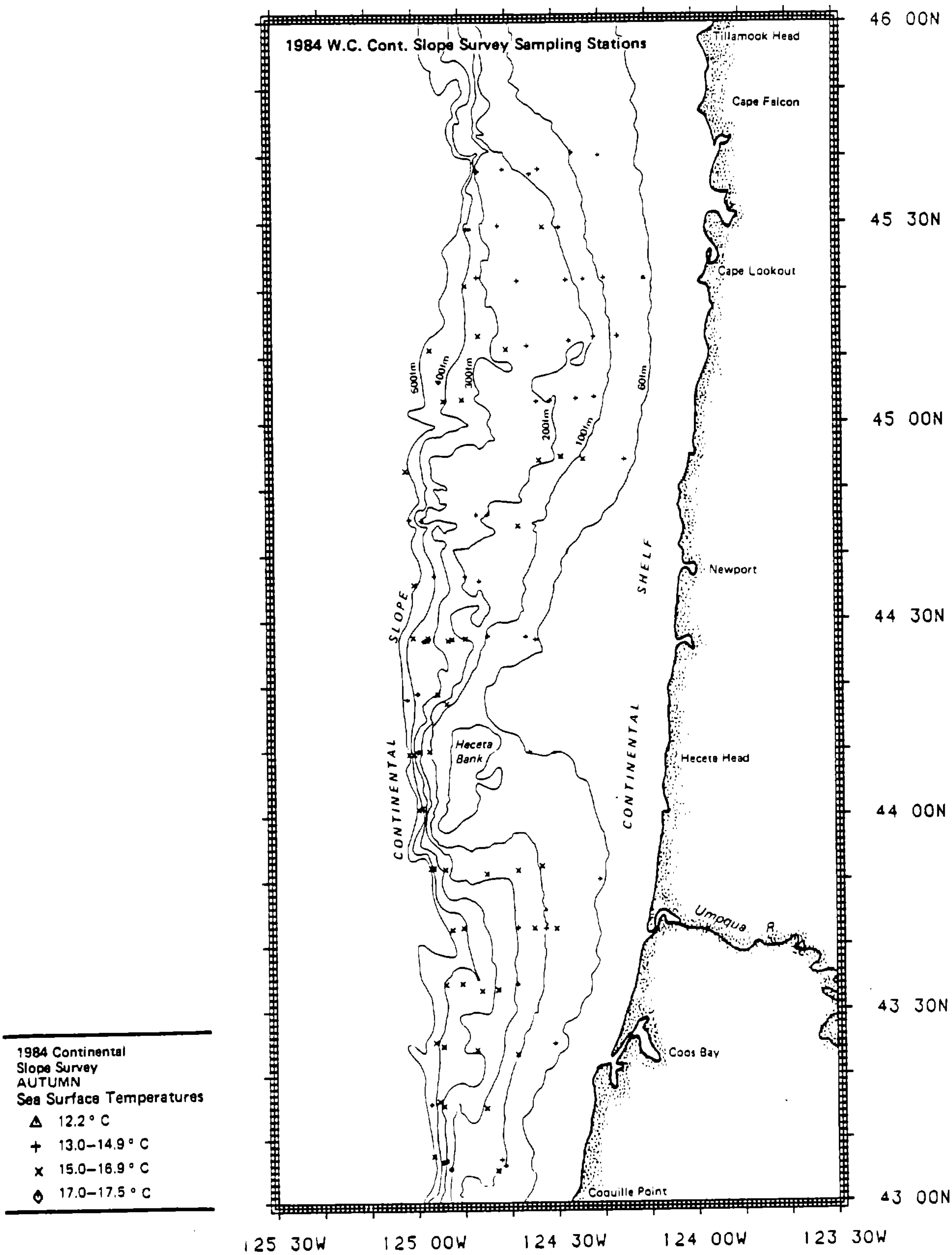


Figure 44.--Distribution of sea surface temperatures during the 1984 autumn survey.

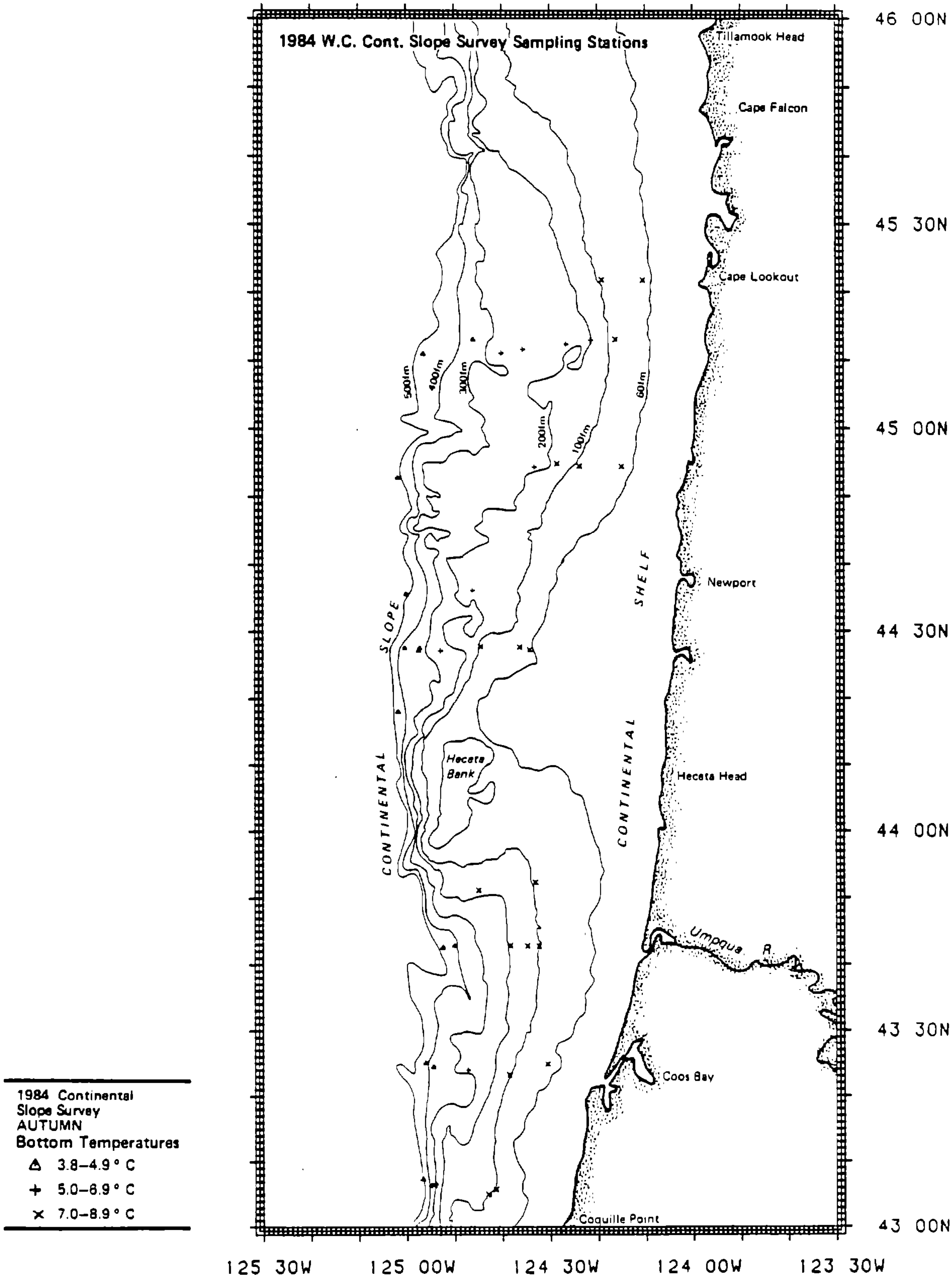


Figure 45.--Distribution of bottom water temperatures during the 1984 autumn survey.

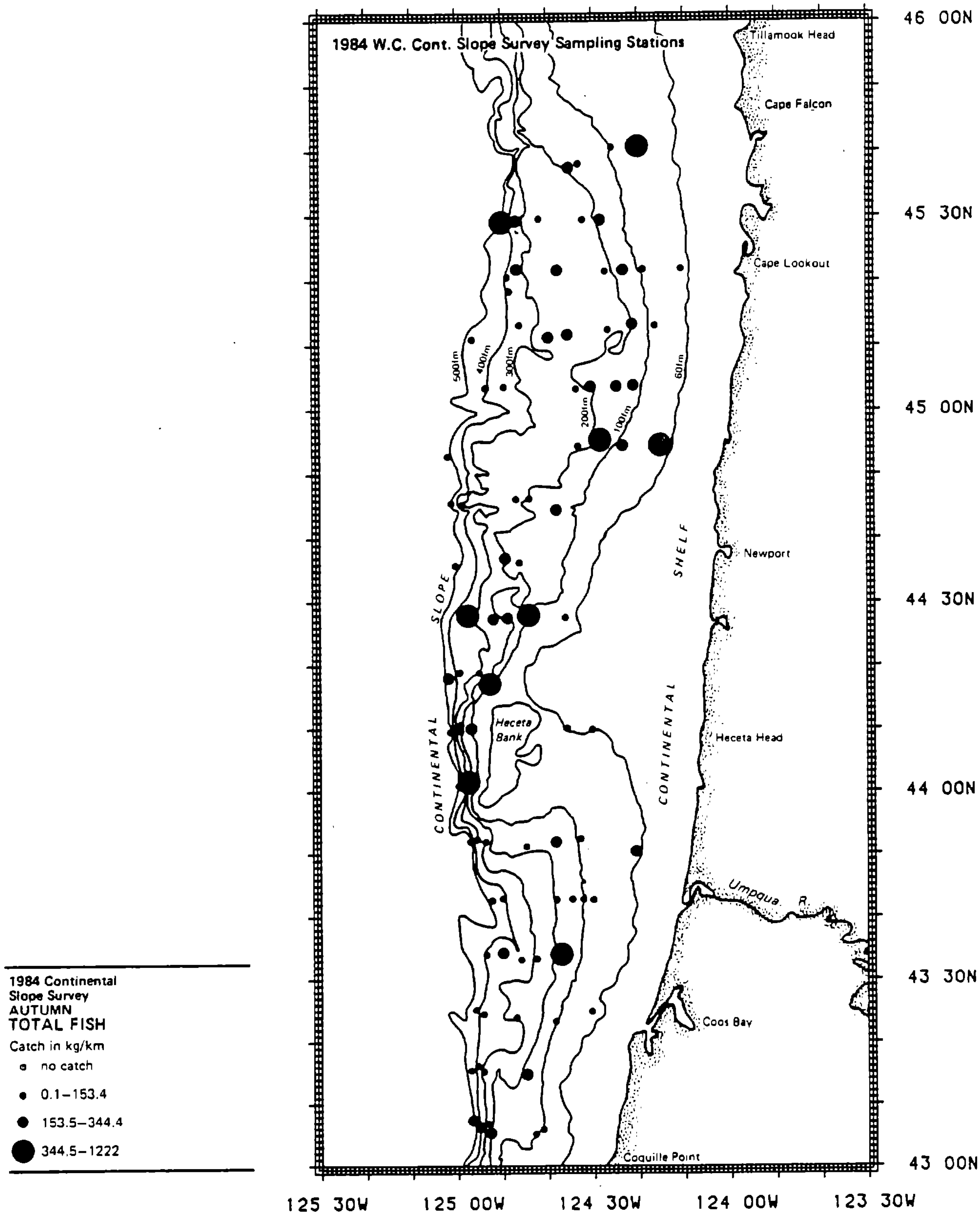


Figure 46.--Distribution and relative abundance (kg/km trawled) of total fish during the 1984 autumn survey.

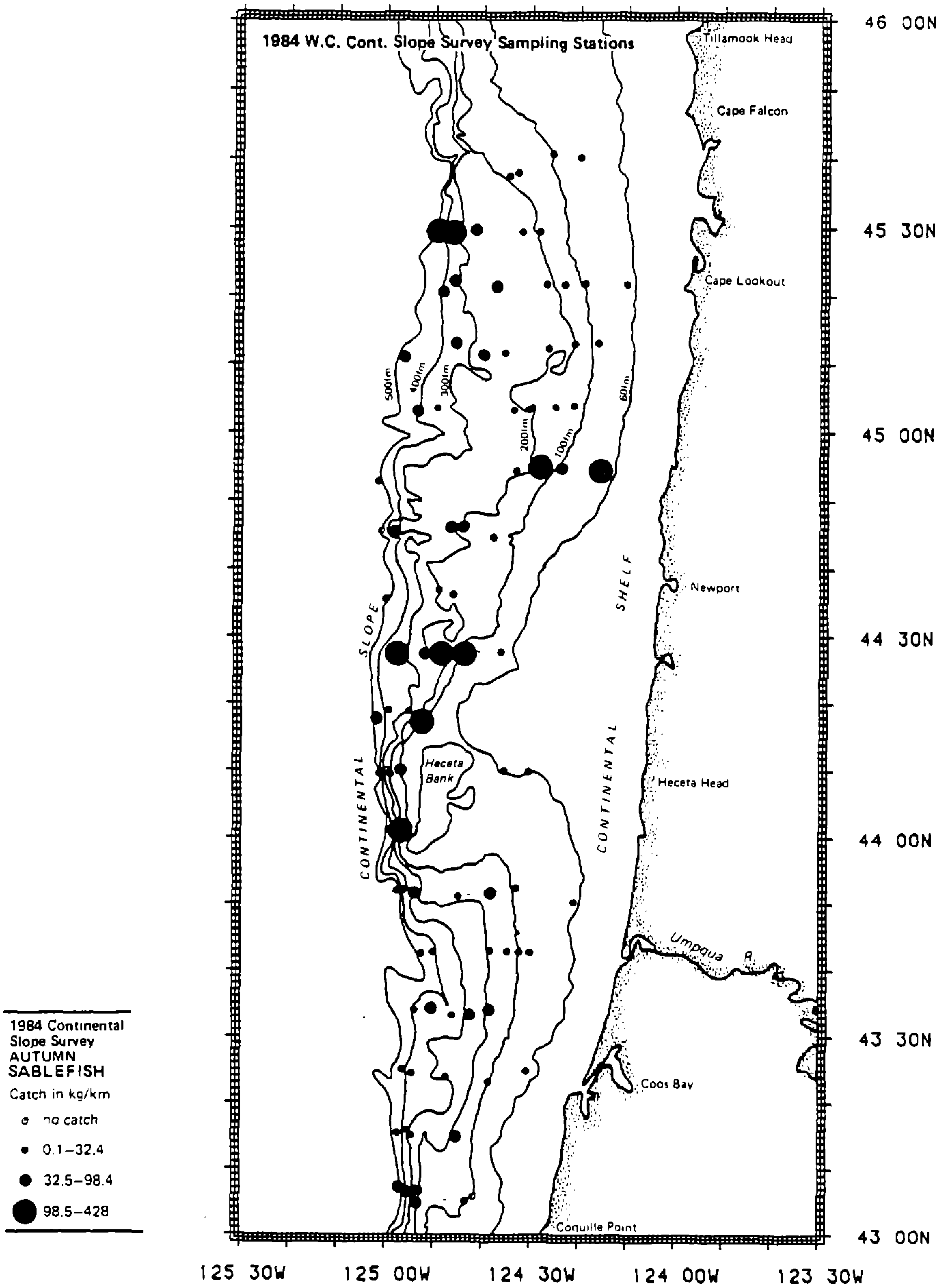


Figure 47.--Distribution and relative abundance (kg/km trawled) of sablefish during the 1984 autumn survey.

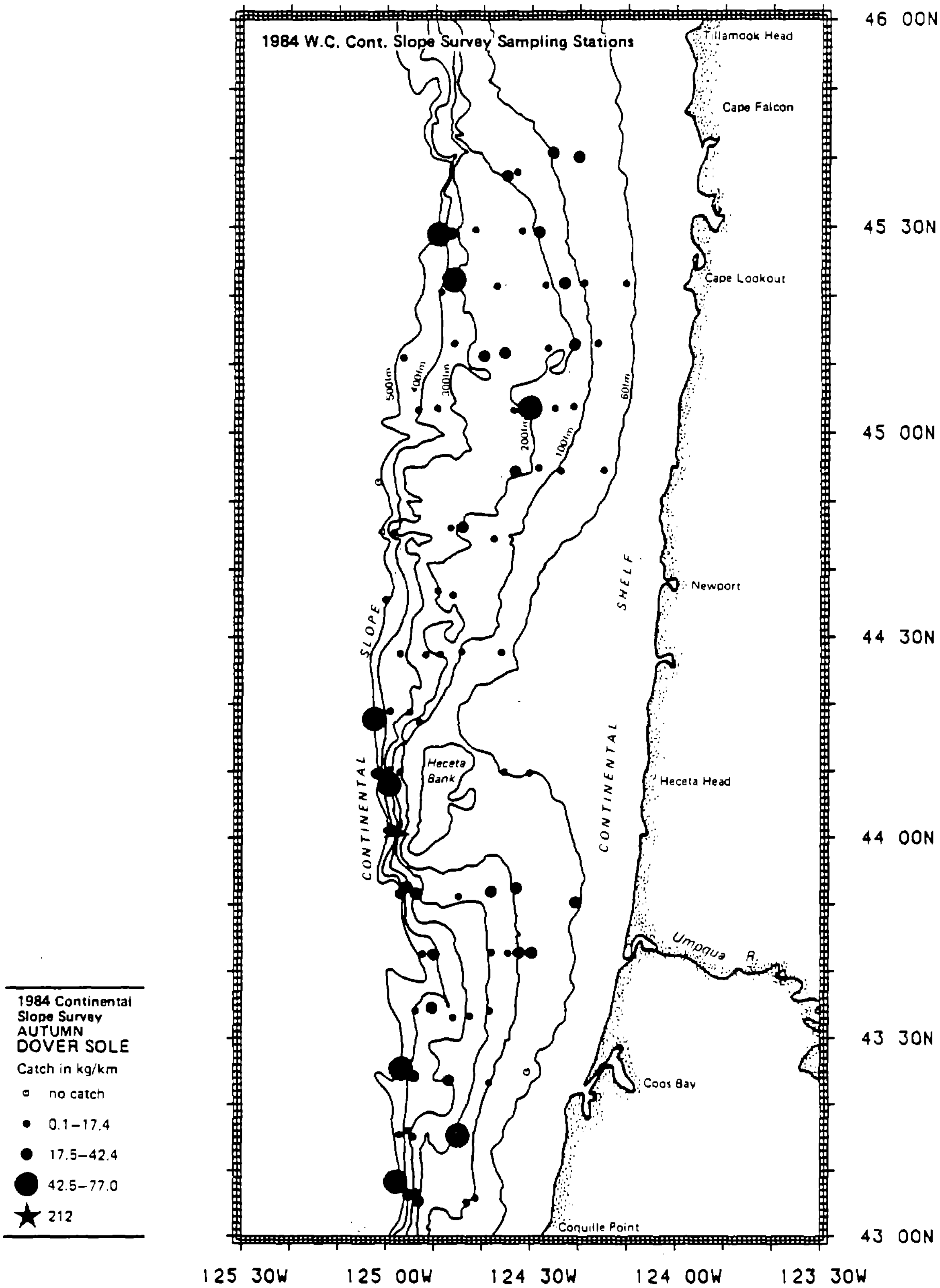


Figure 48.--Distribution and relative abundance (kg/km trawled) of Dover sole during the 1984 autumn survey.

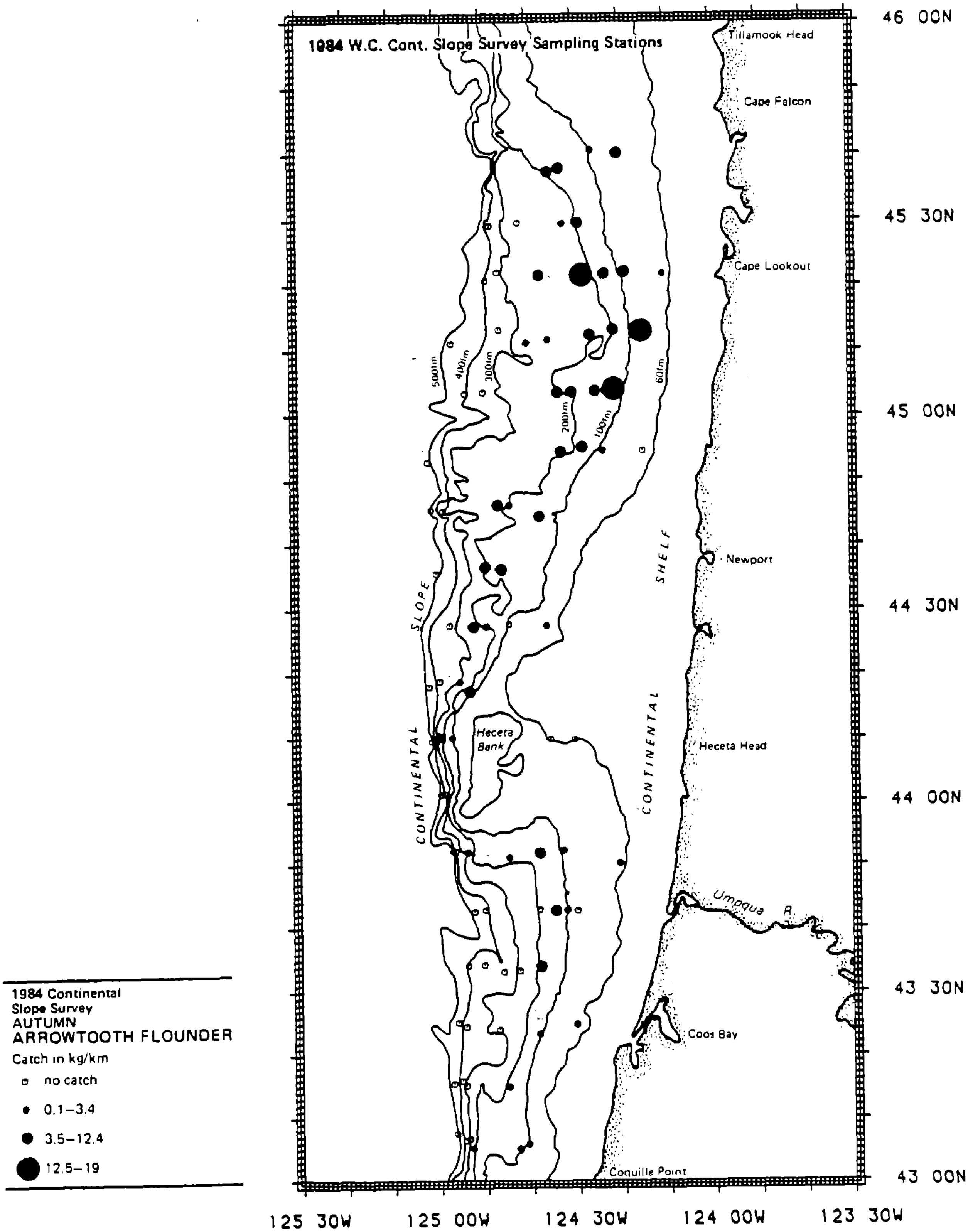


Figure 49.--Distribution and relative abundance (kg/km trawled) of arrow-tooth flounder during the 1984 autumn survey.

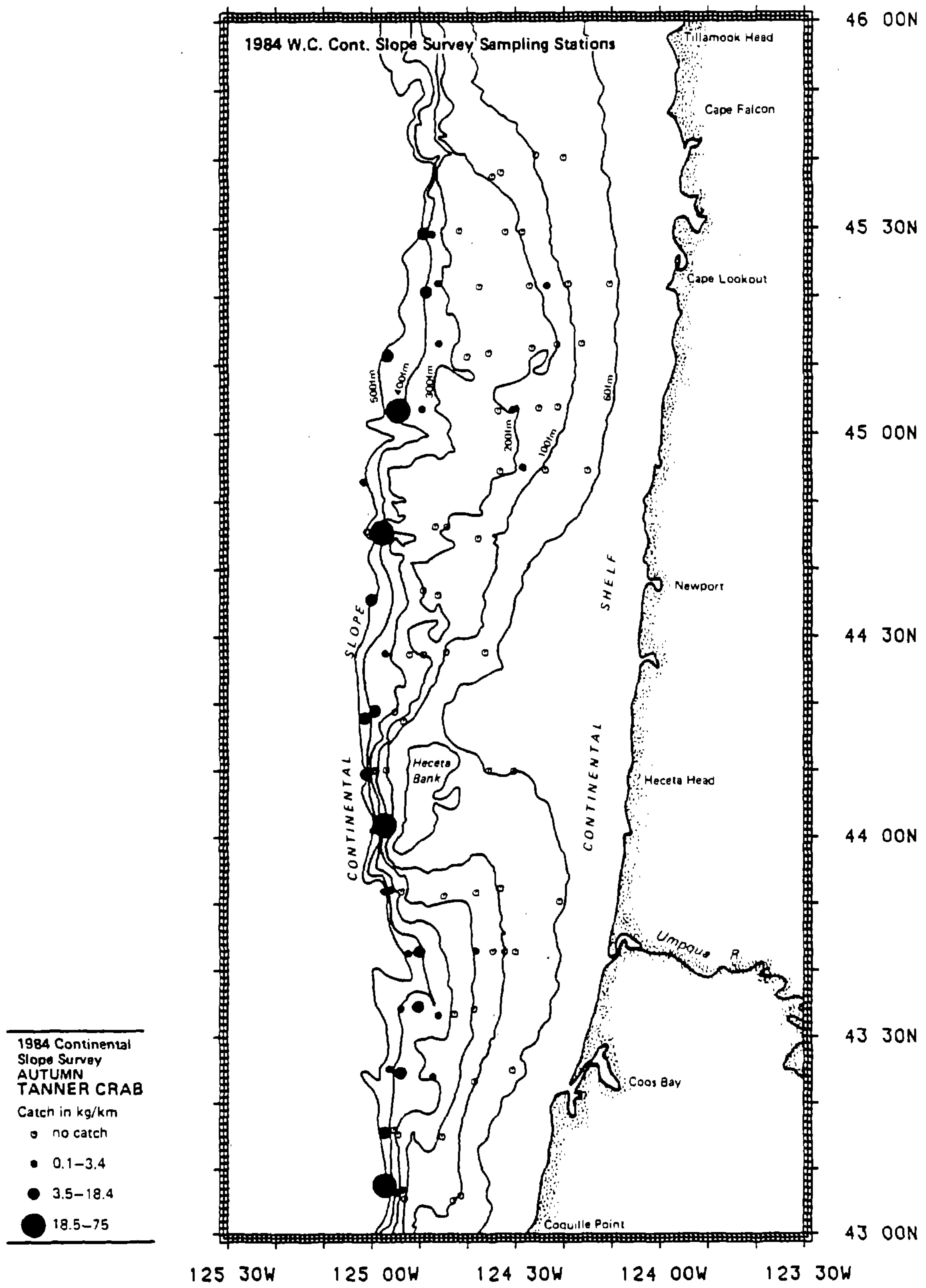


Figure 50.--Distribution and relative abundance (kg/km trawled) of Tanner crab during the 1984 autumn survey.

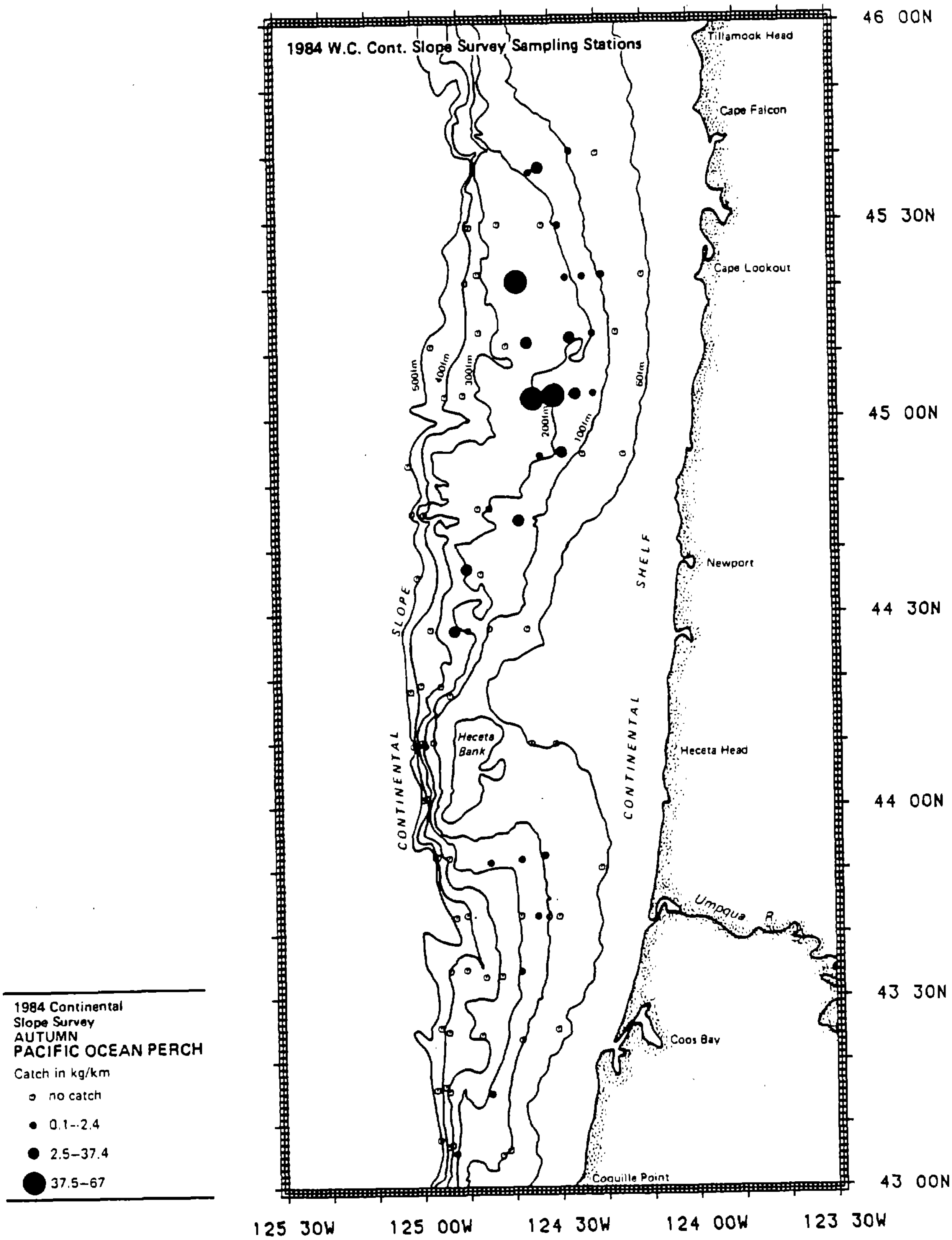


Figure 51.--Distribution and relative abundance (kg/km trawled) of Pacific ocean perch during the 1984 autumn survey.

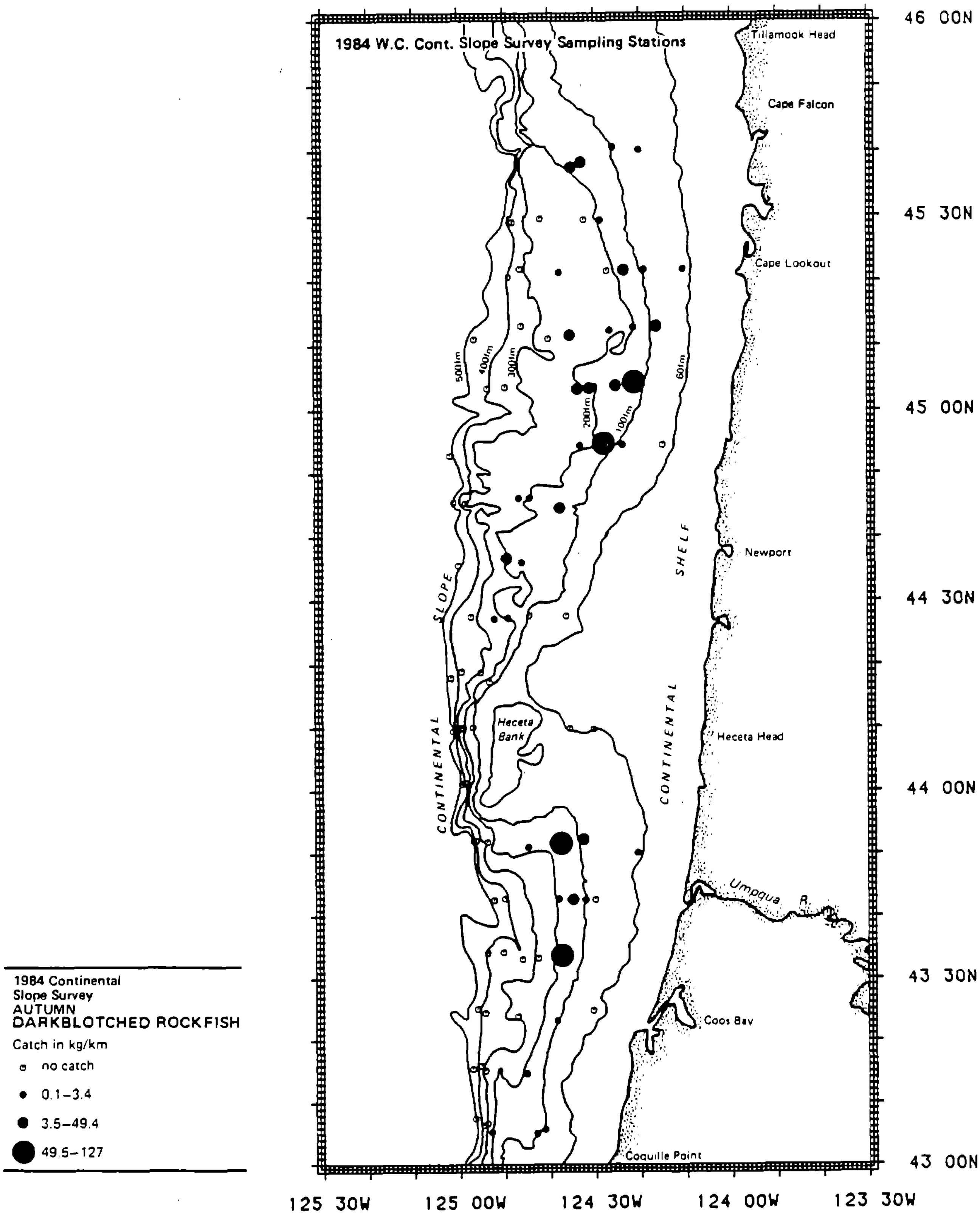


Figure 52.--Distribution and relative abundance (kg/km trawled) of darkblotched rockfish during the 1984 autumn survey.

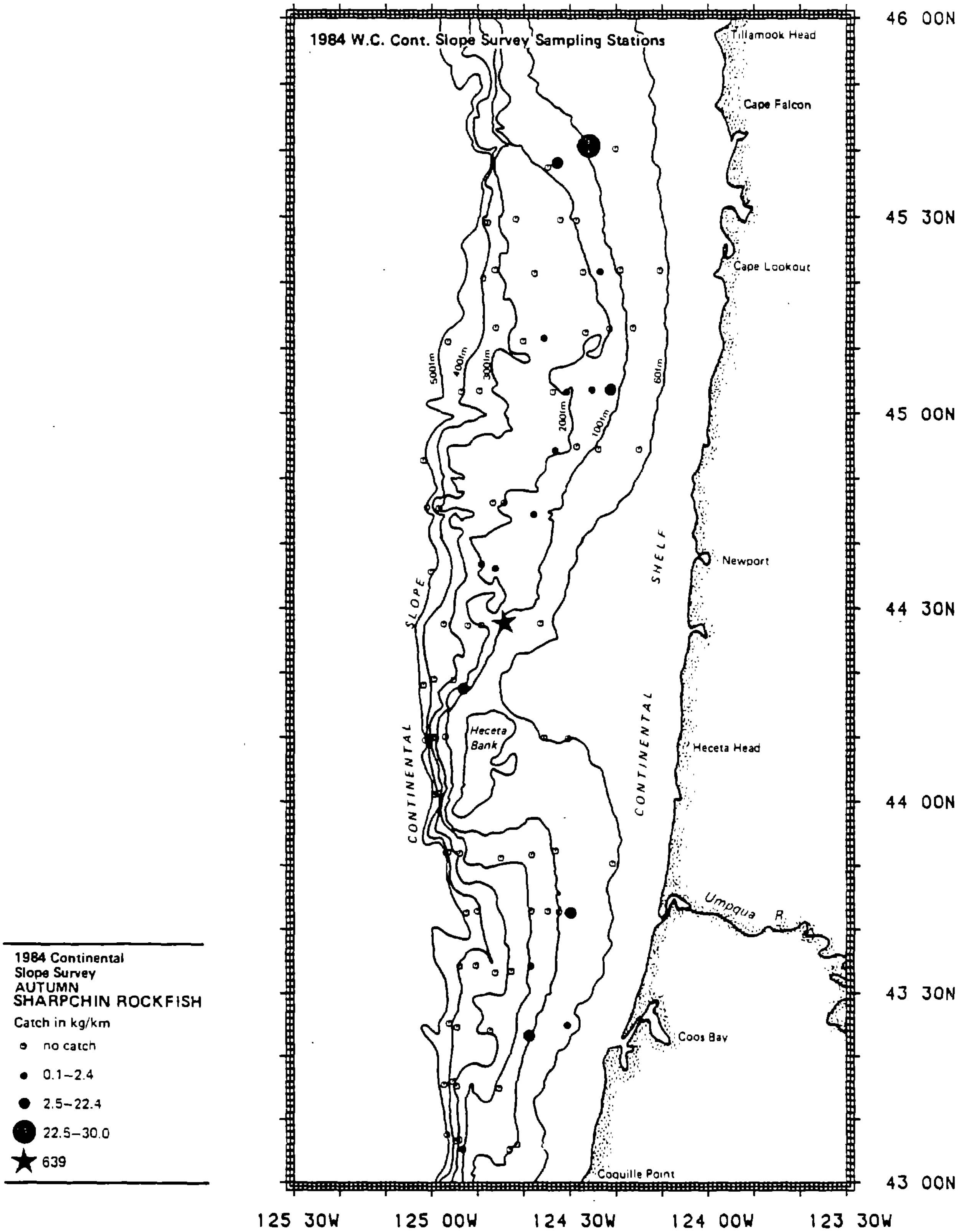


Figure 53.--Distribution and relative abundance (kg/km trawled) of sharpchin rockfish during the 1984 autumn survey.

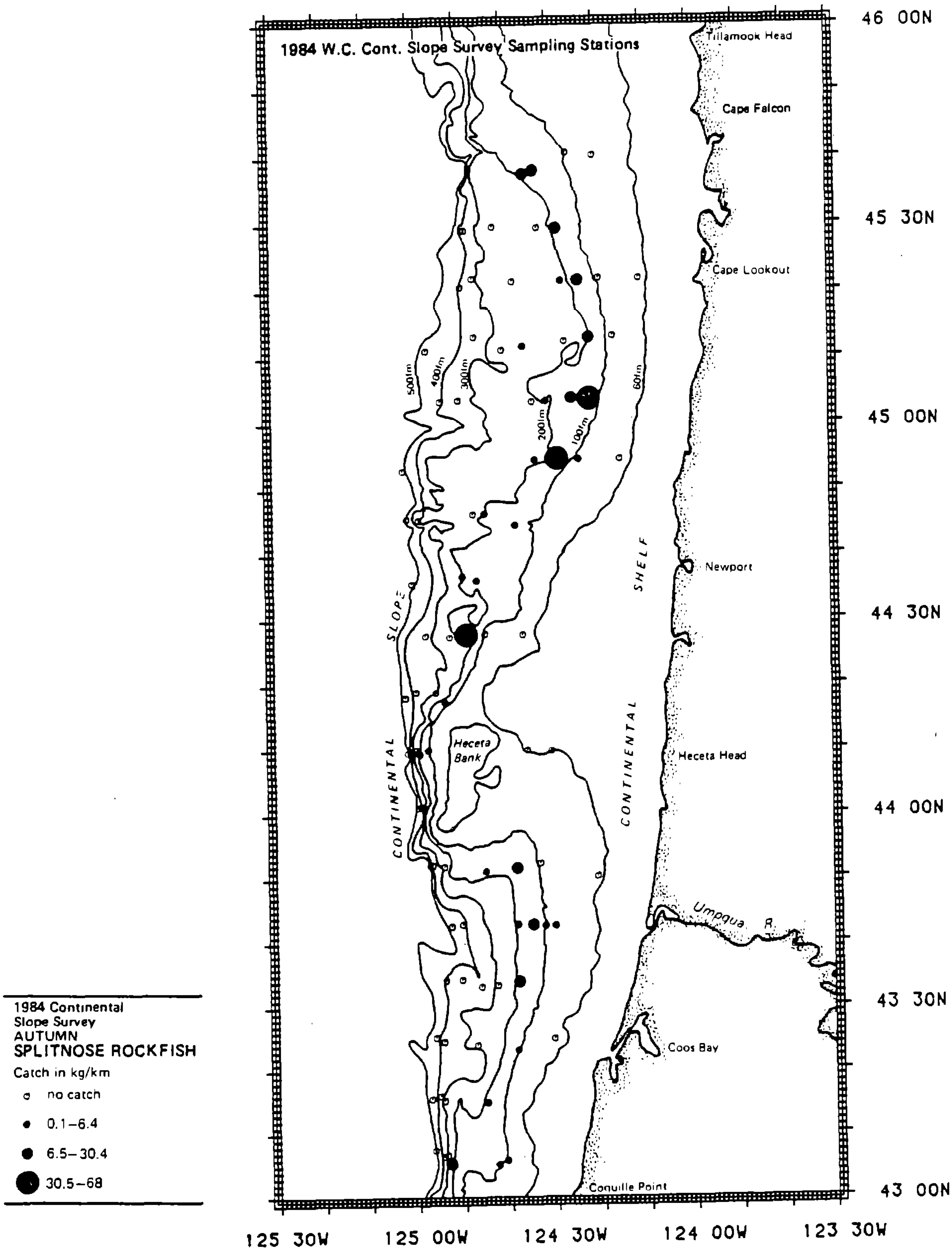


Figure 54.--Distribution and relative abundance (kg/km trawled) of splitnose rockfish during the 1984 autumn survey.

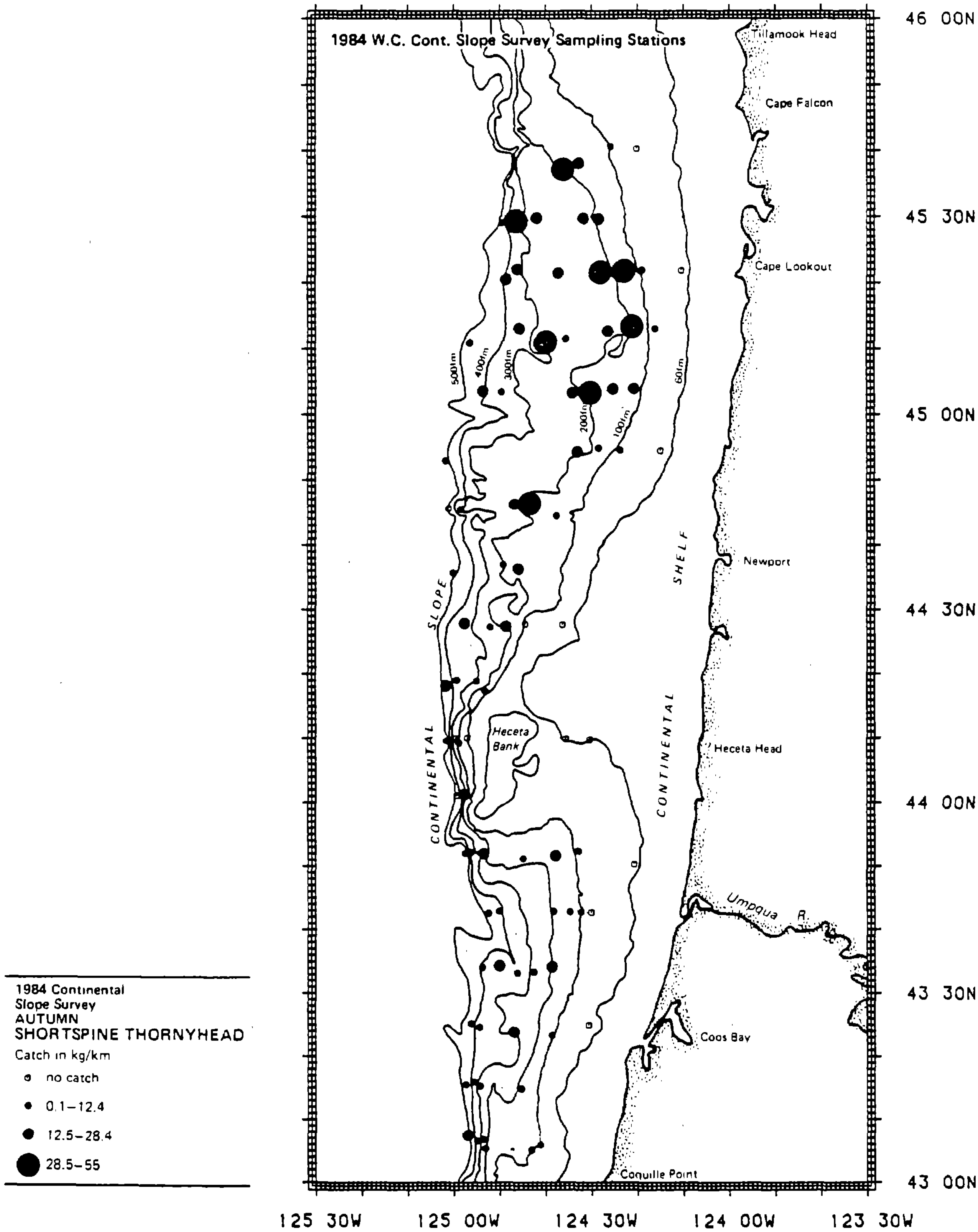


Figure 55.--Distribution and relative abundance (kg/km trawled) of shortspine thornyhead during the 1984 autumn survey.

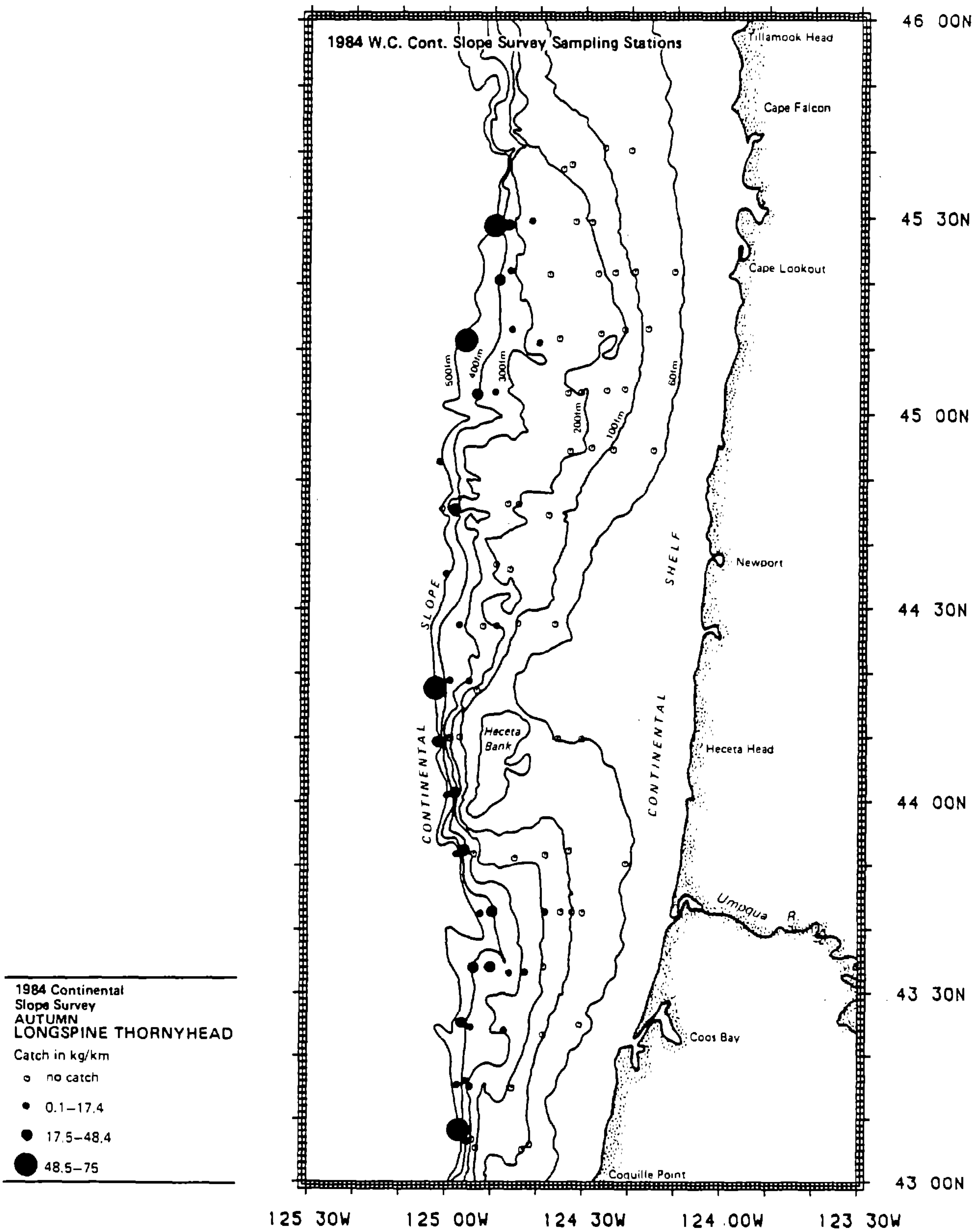


Figure 56.--Distribution and relative abundance (kg/km trawled) of longspine thornyhead during the 1984 autumn survey.

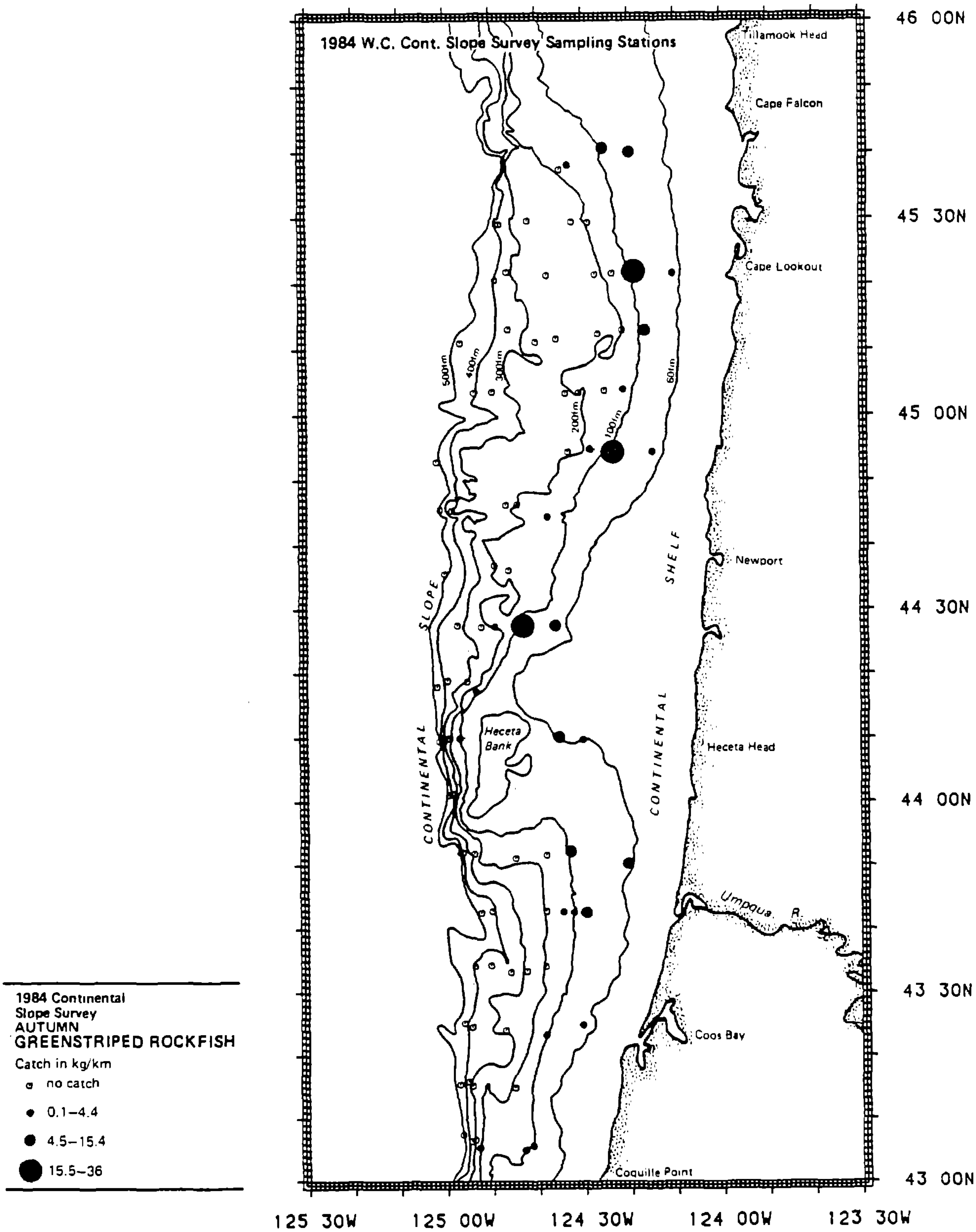


Figure 57.--Distribution and relative abundance (kg/km trawled) of greenstriped rockfish during the 1984 autumn survey.

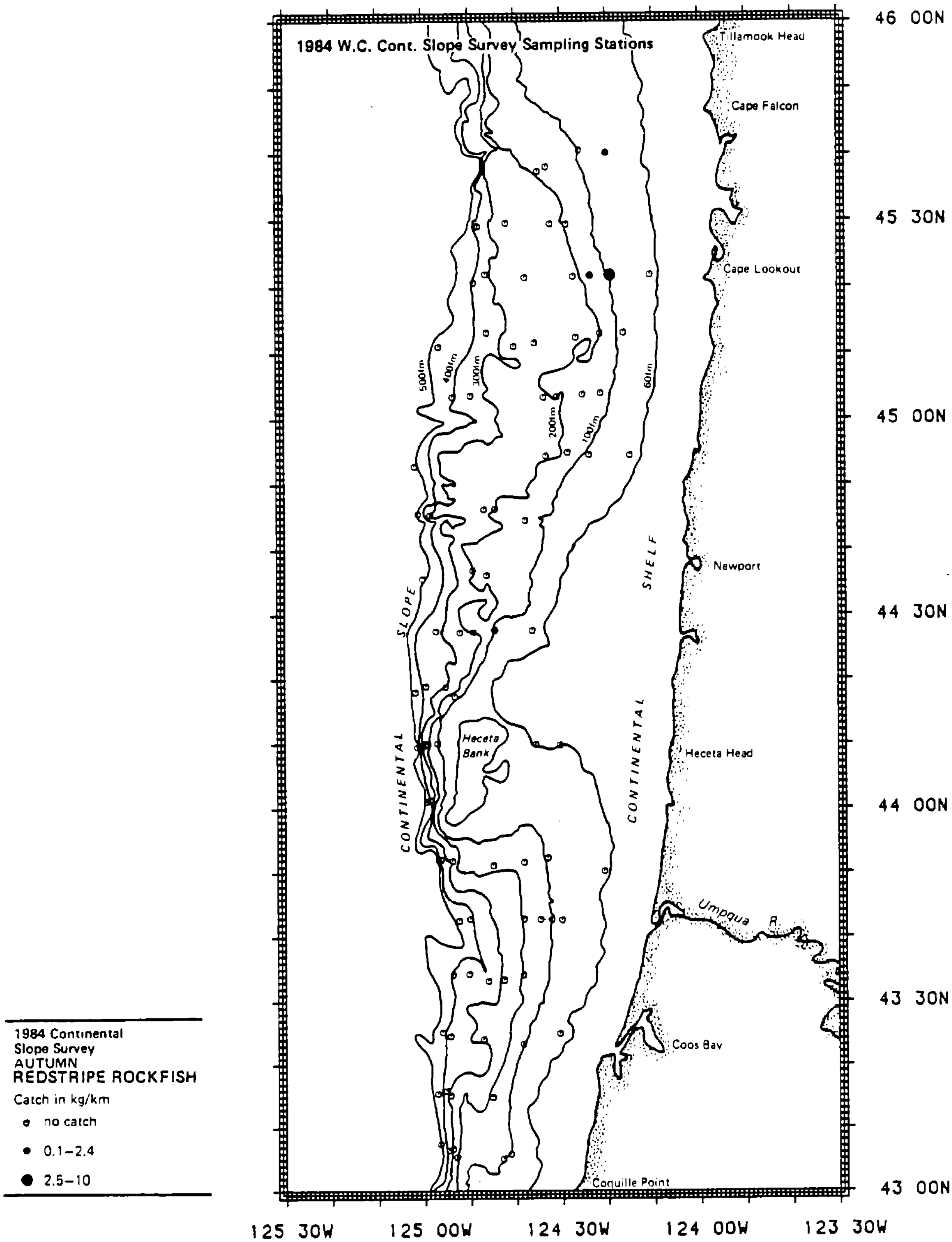


Figure 58.--Distribution and relative abundance (kg/km trawled) of redstripe rockfish during the 1984 autumn survey.

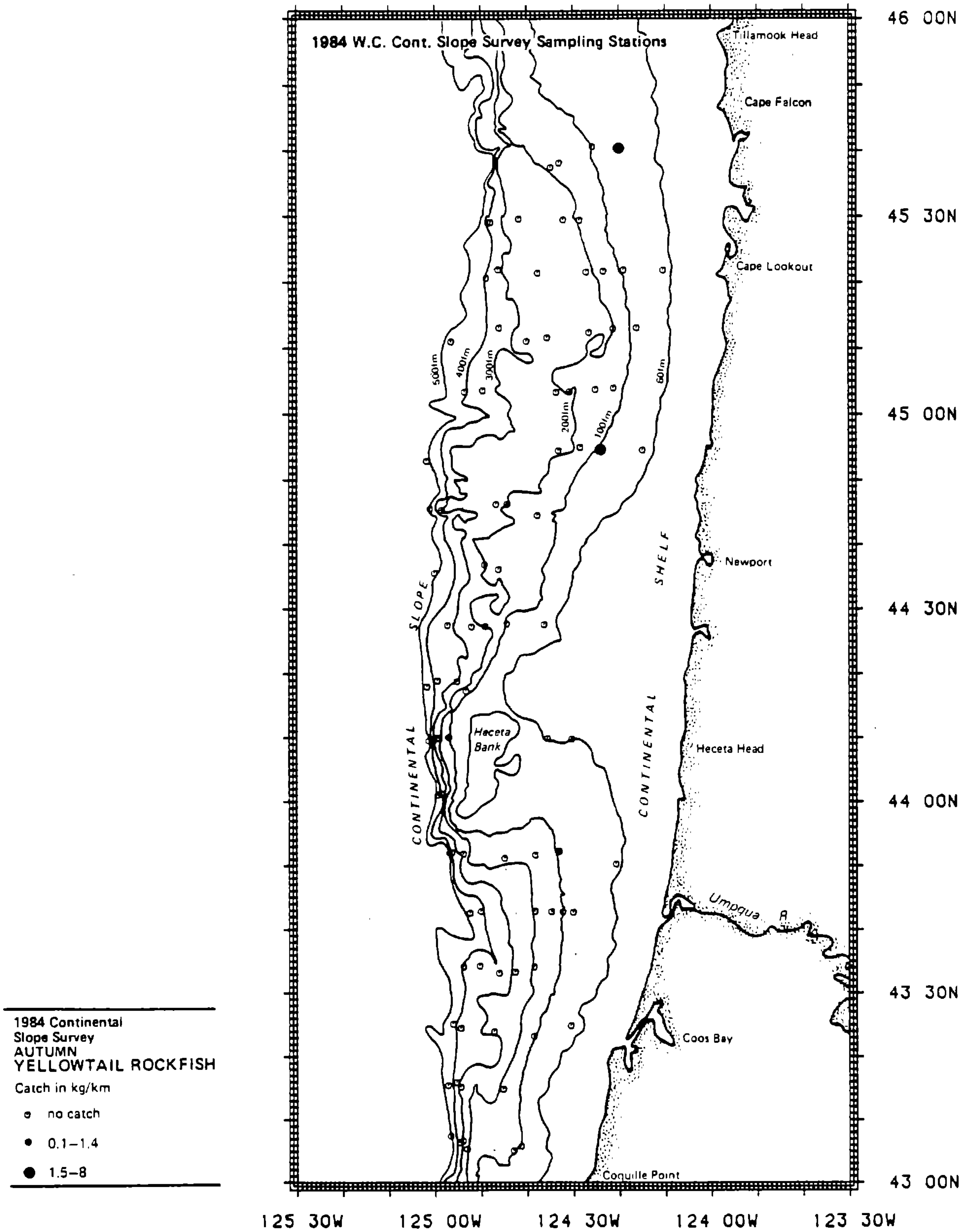


Figure 59.--Distribution and relative abundance (kg/km trawled) of yellowtail rockfish during the 1984 autumn survey.

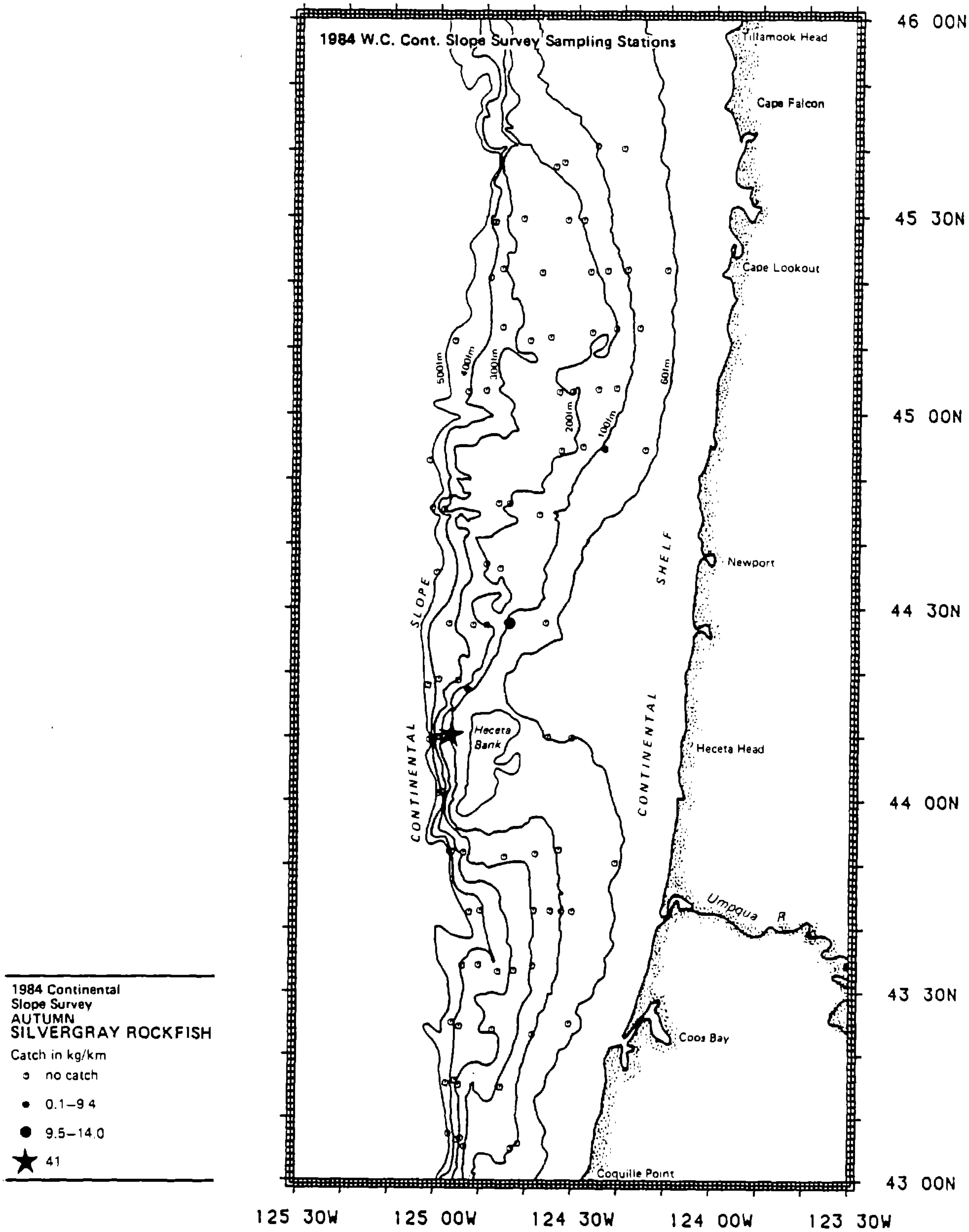


Figure 60.--Distribution and relative abundance (kg/km trawled) of silvergray rockfish during the 1984 autumn survey.

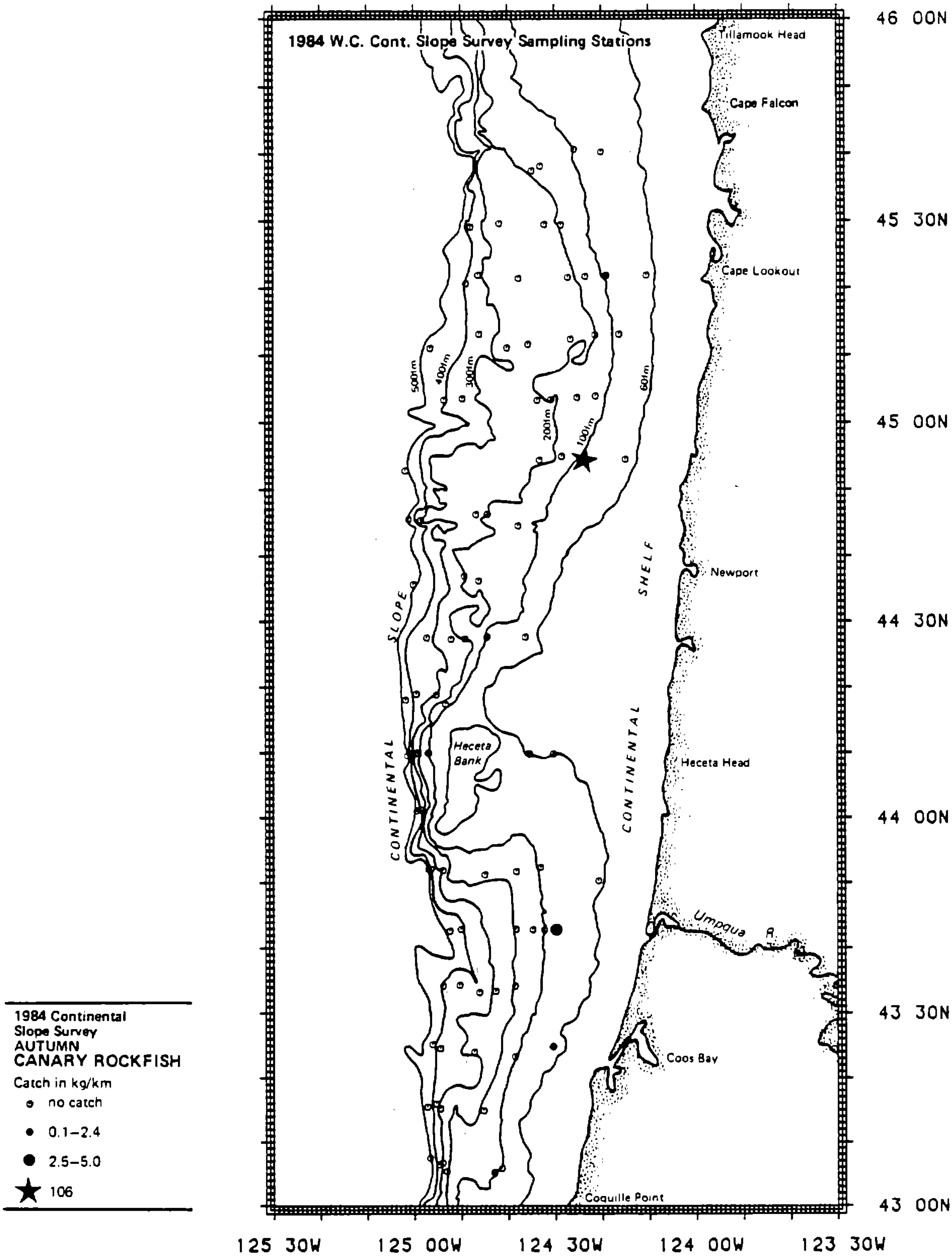


Figure 61.--Distribution and relative abundance (kg/km trawled) of canary rockfish during the 1984 autumn survey.

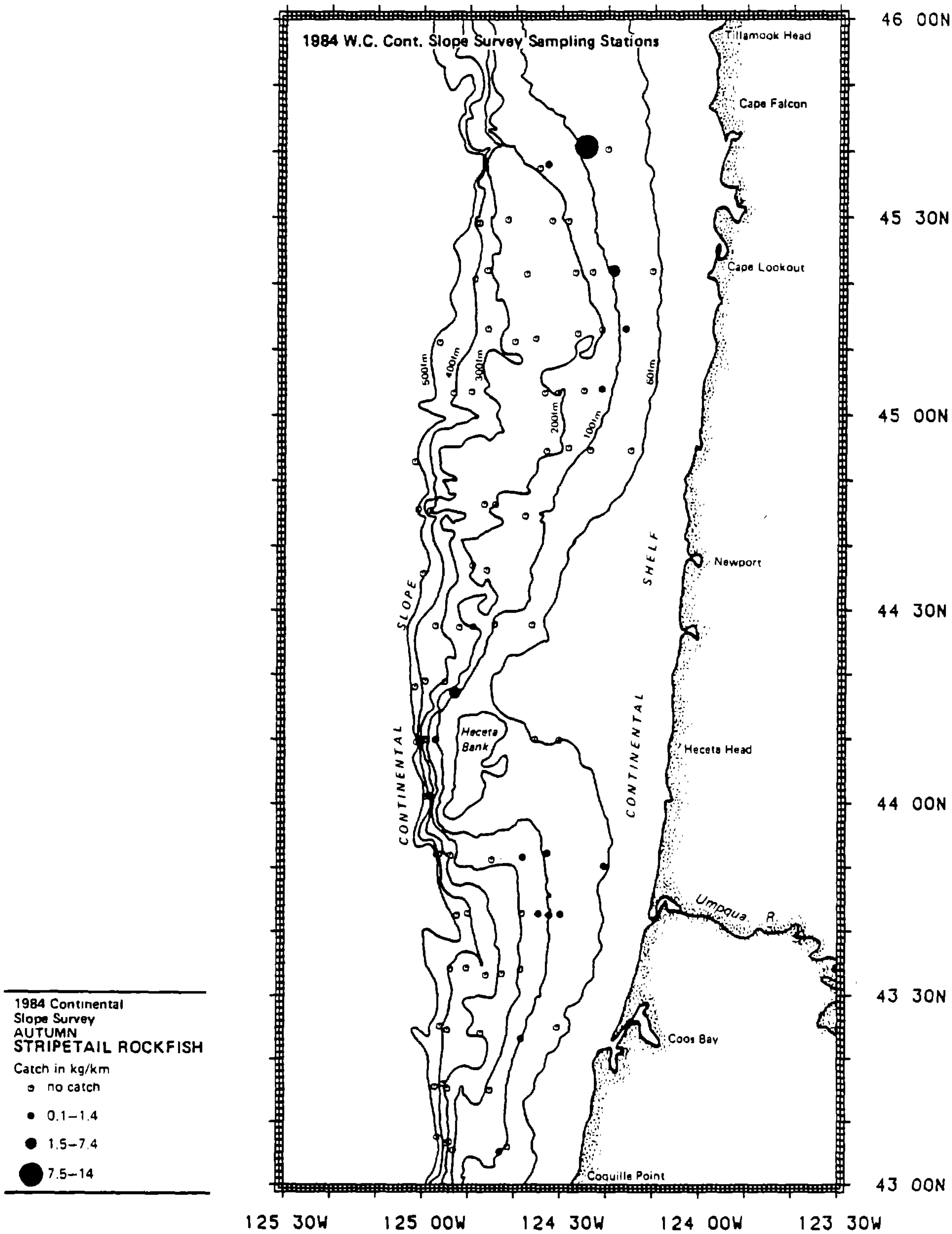


Figure 62.--Distribution and relative abundance (kg/km trawled) of stripetail rockfish during the 1984 autumn survey.

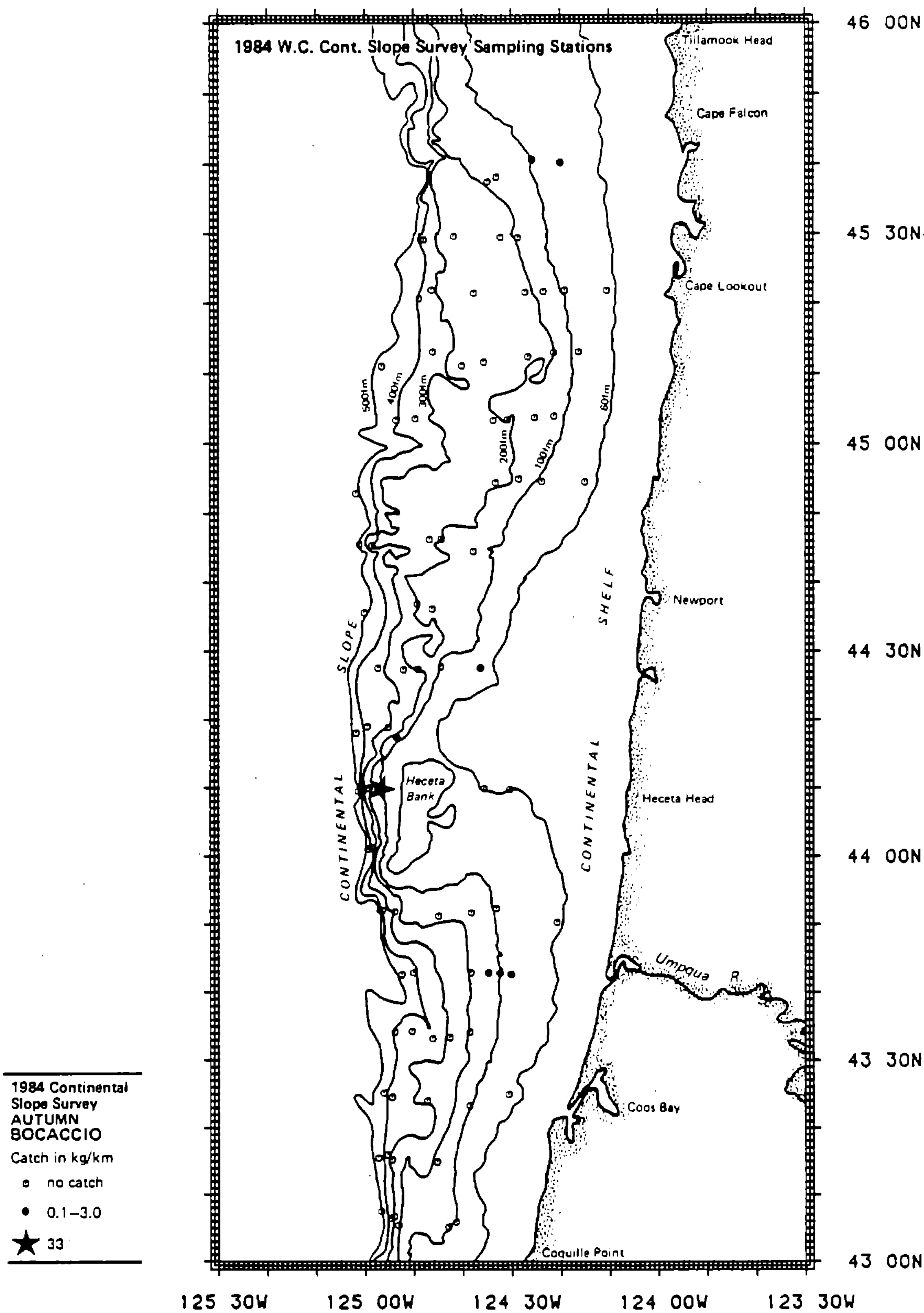


Figure 63.--Distribution and relative abundance (kg/km trawled) of bocaccio during the 1984 autumn survey.

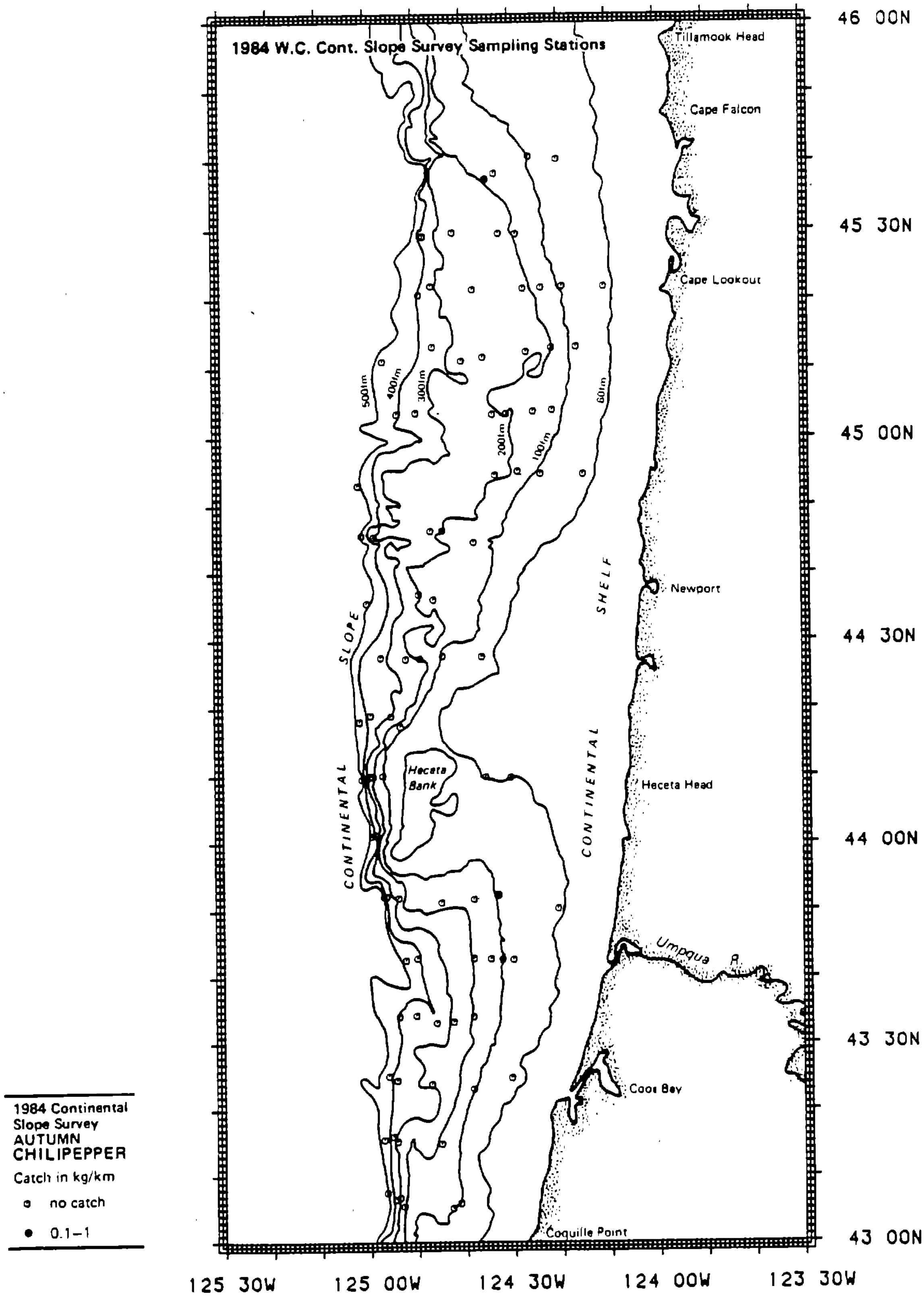


Figure 64.--Distribution and relative abundance (kg/km trawled) of chilipepper during the 1984 autumn survey.

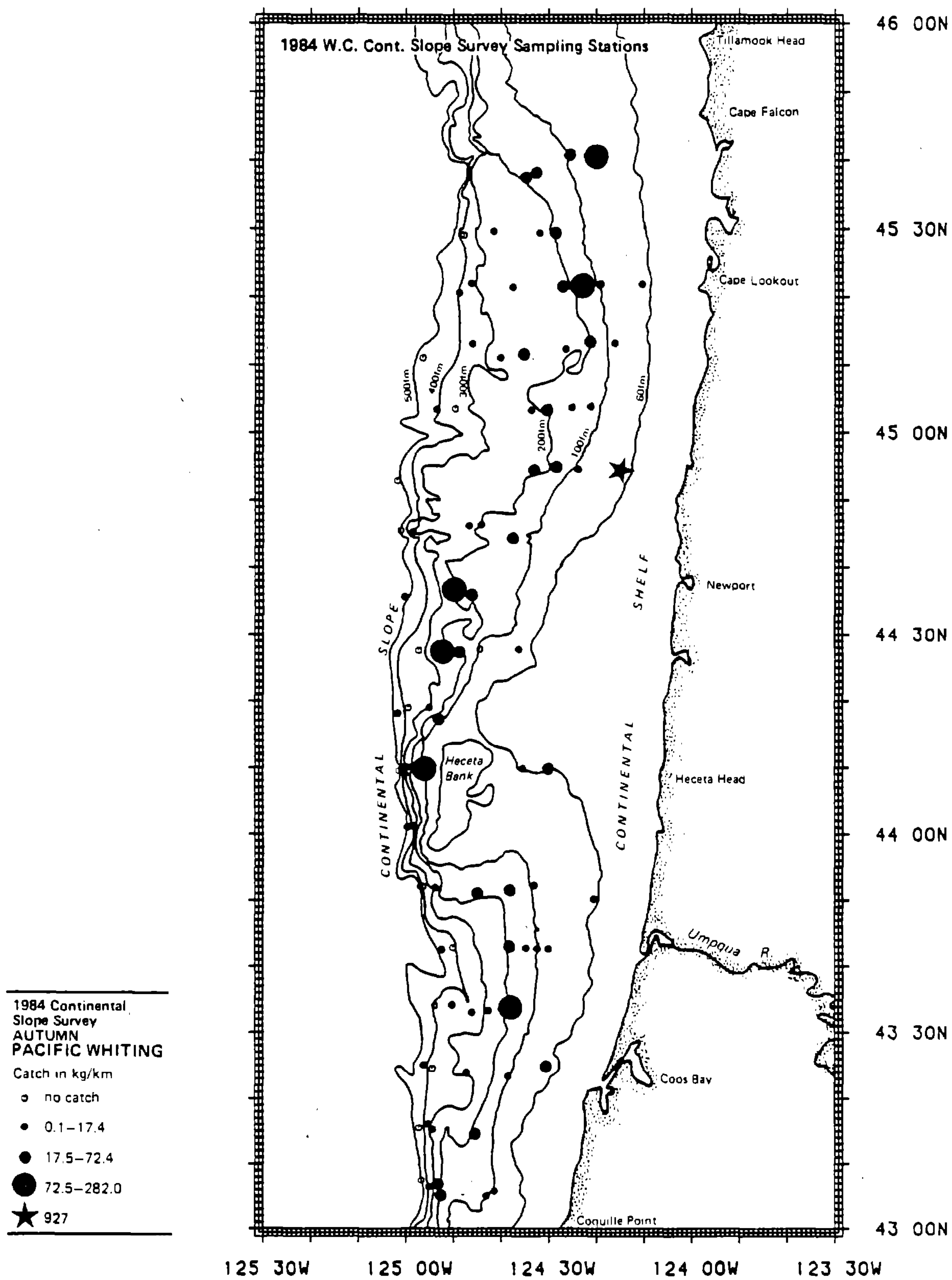


Figure 65.--Distribution and relative abundance (kg/km trawled) of Pacific whiting during the 1984 autumn survey.

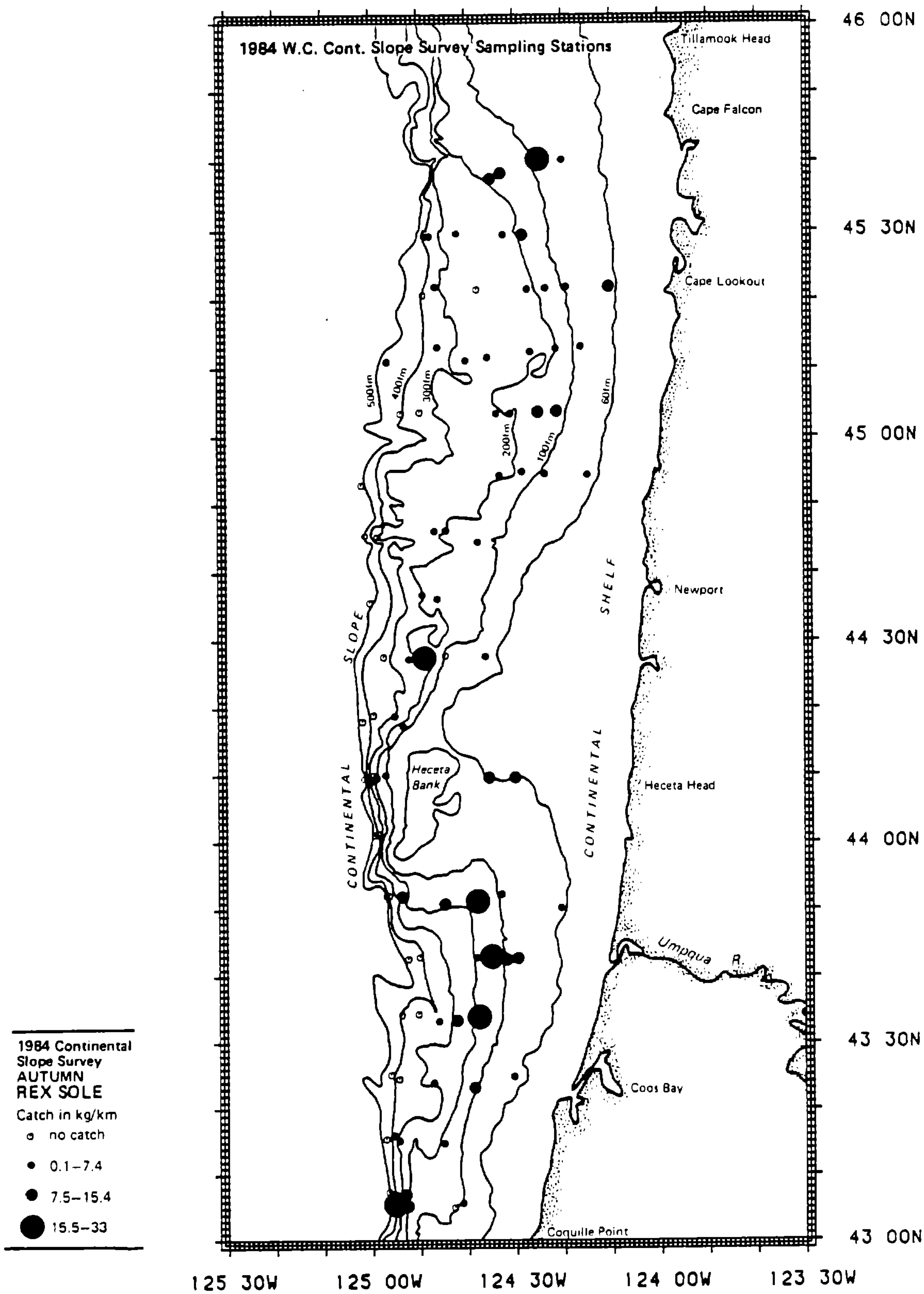


Figure 66.--Distribution and relative abundance (kg/km trawled) of rex sole during the 1984 autumn survey.

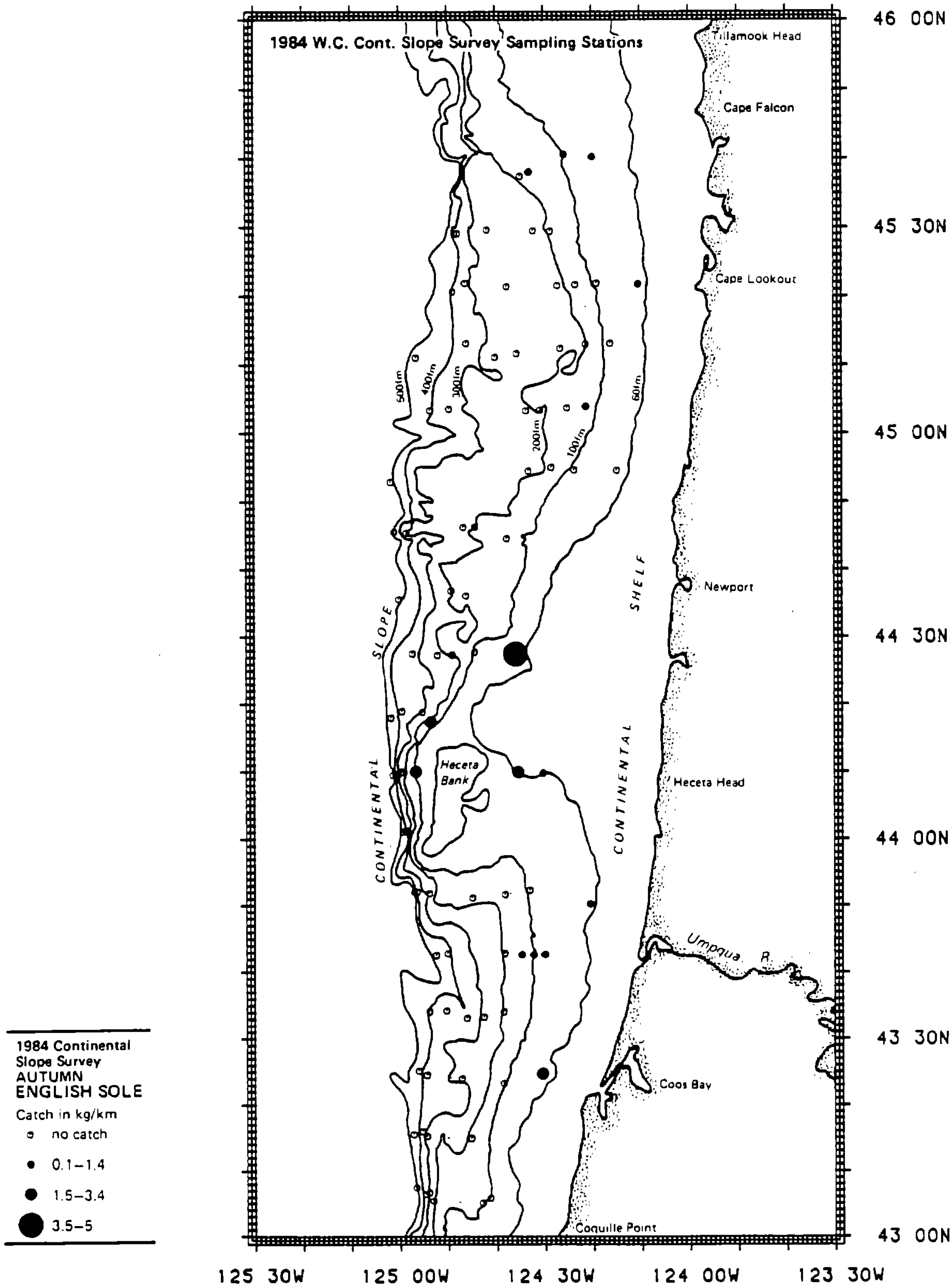


Figure 67.--Distribution and relative abundance (kg/km trawled) of English sole during the 1984 autumn survey.

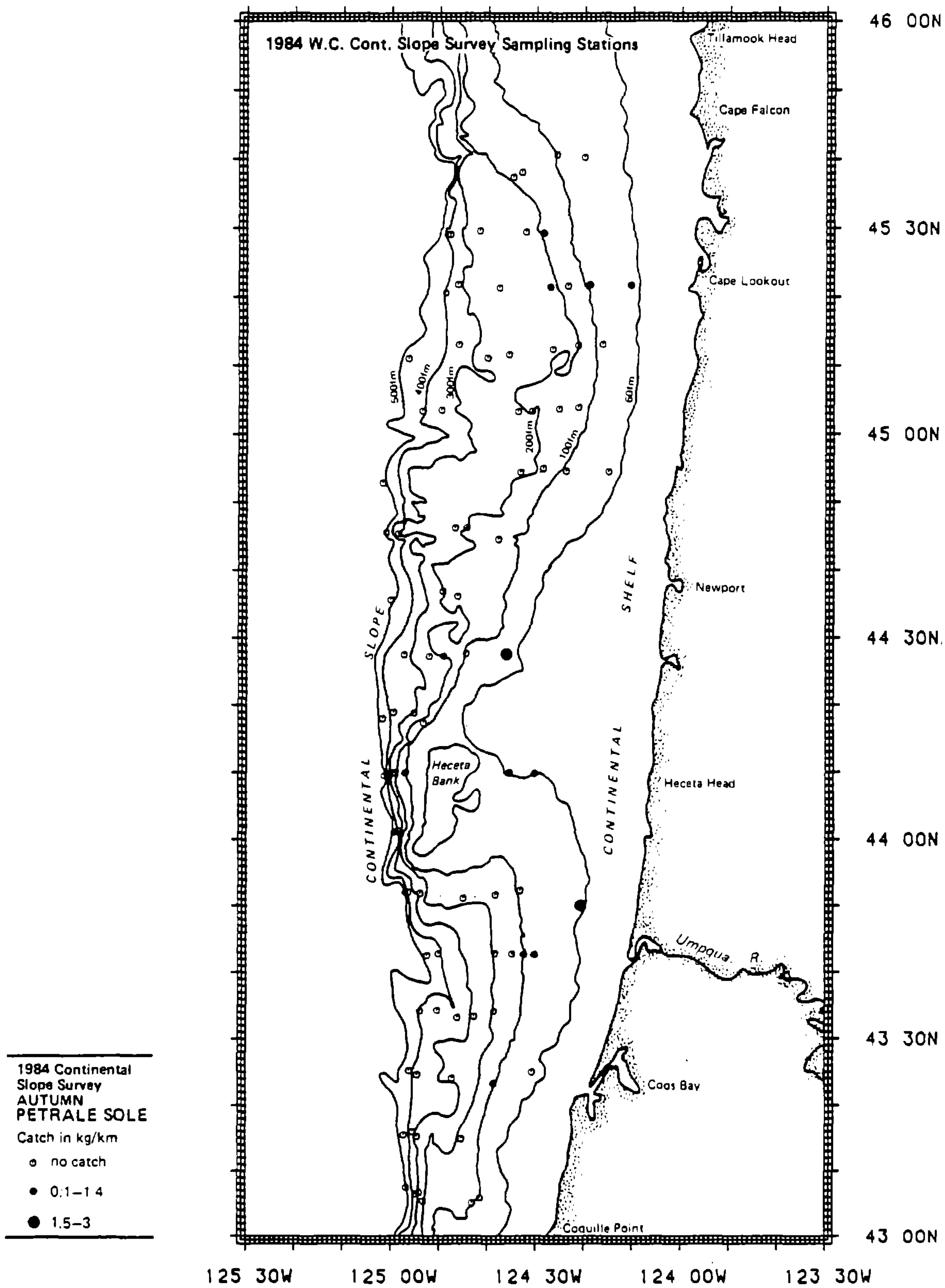


Figure 68.--Distribution and relative abundance (kg/km trawled) of petrale sole during the 1984 autumn survey.

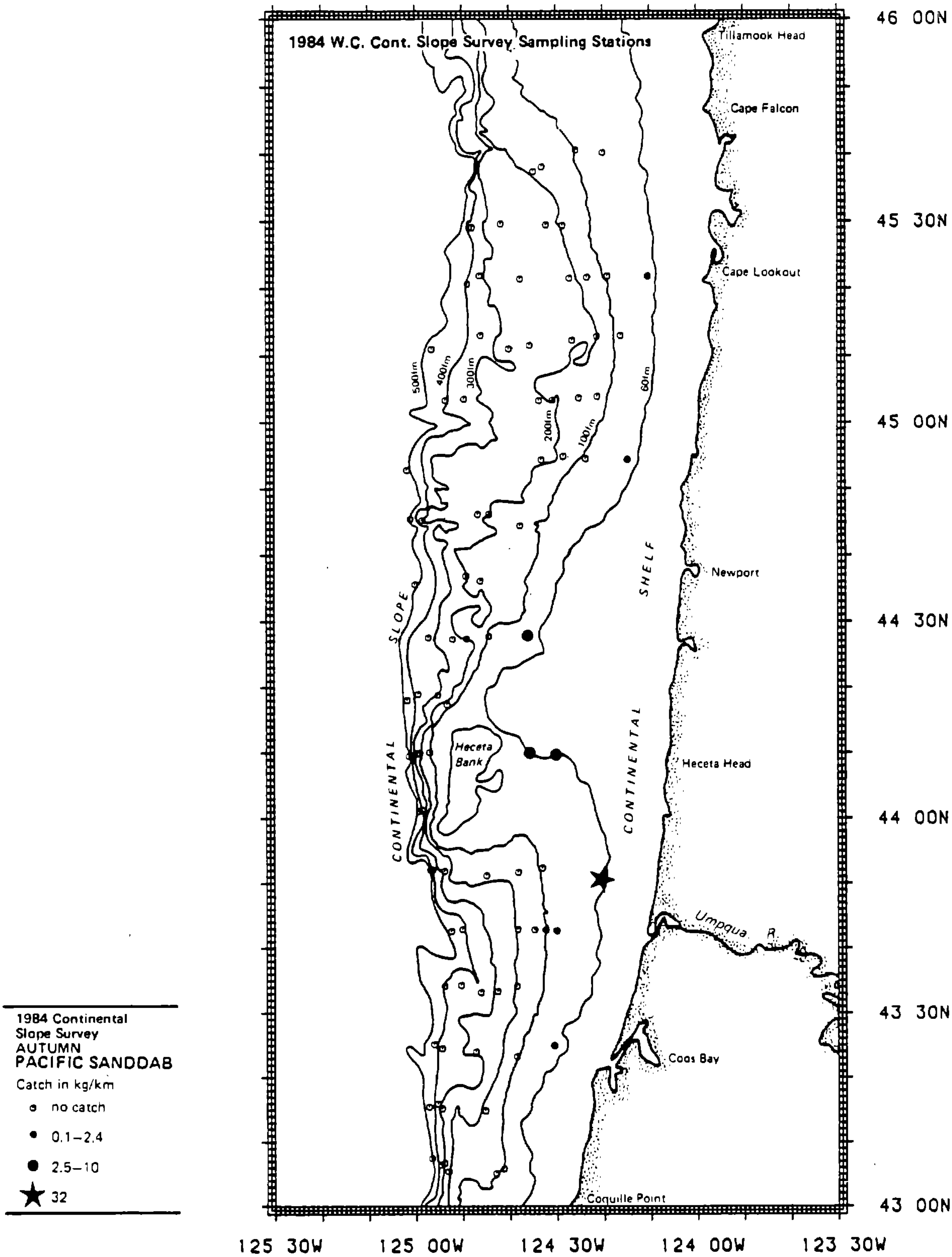


Figure 69.--Distribution and relative abundance (kg/km trawled) of Pacific sanddab during the 1984 autumn survey.

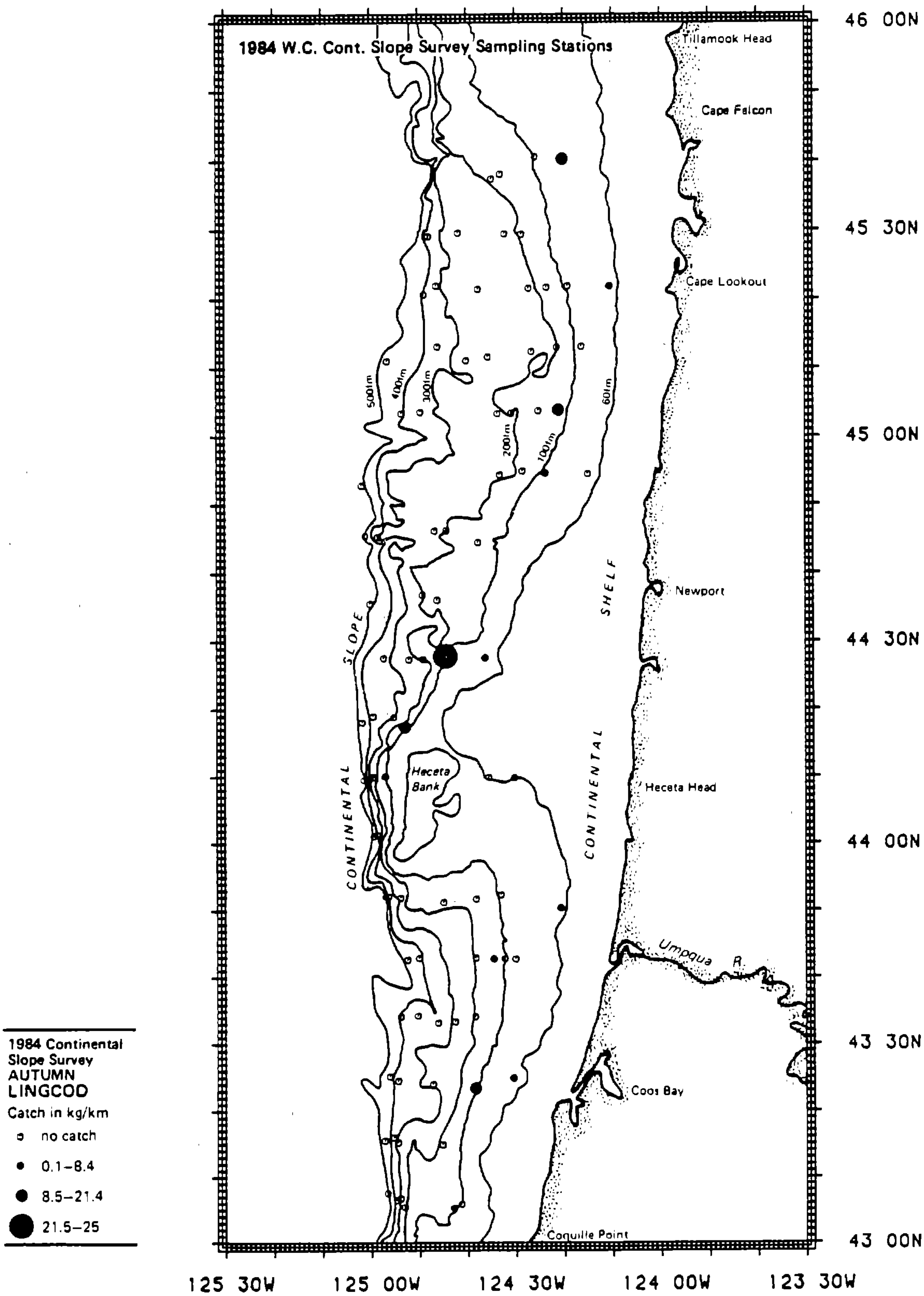


Figure 70.--Distribution and relative abundance (kg/km trawled) of lingcod during the 1984 autumn survey.

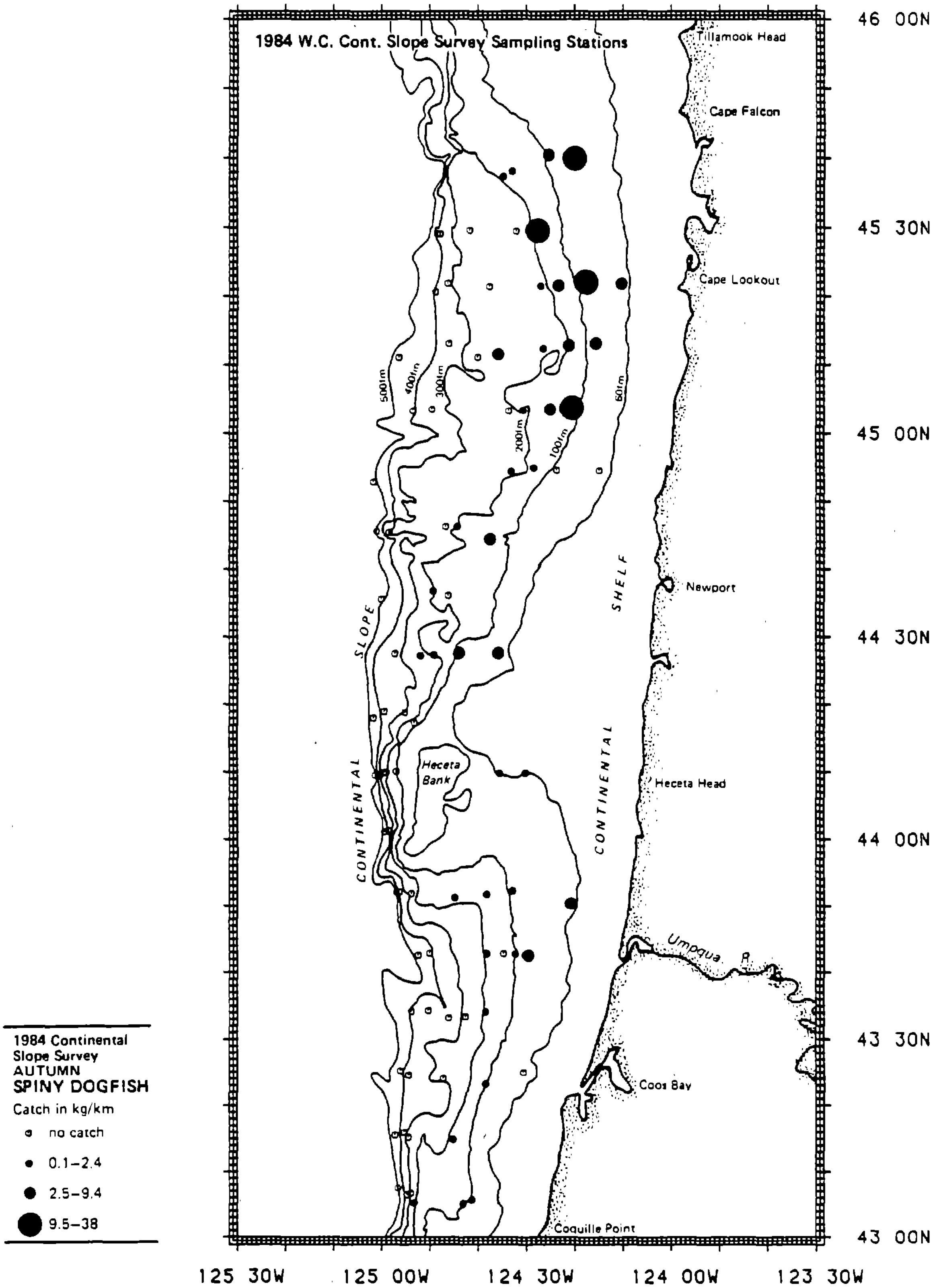


Figure 71.--Distribution and relative abundance (kg/km trawled) of spiny dogfish during the 1984 autumn survey.

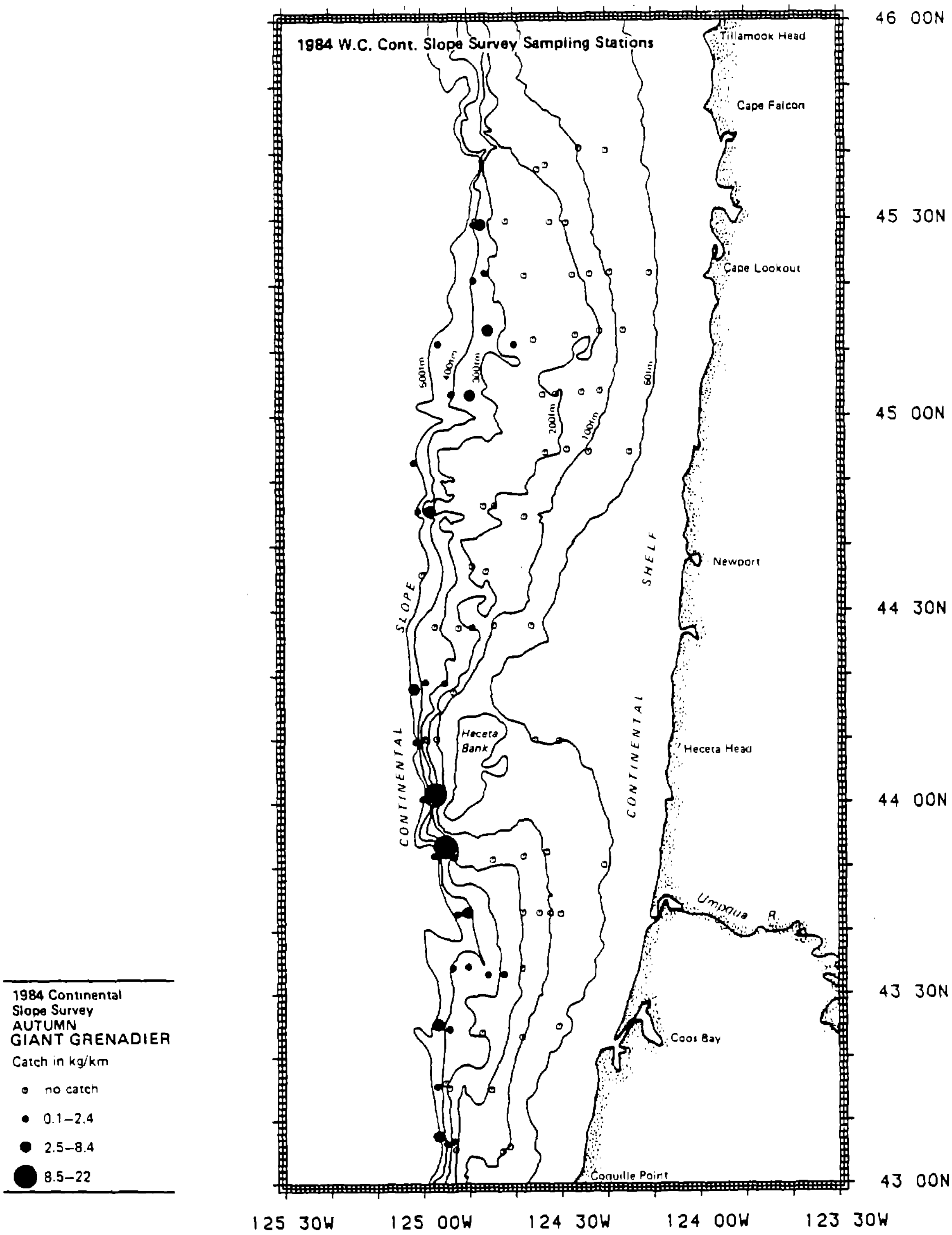


Figure 72.--Distribution and relative abundance (kg/km trawled) of giant grenadier during the 1984 autumn survey.

SABLEFISH
1984
AUTUMN

South Subarea (43° 00′ – 44° 22.5′ N) — Males —— Females···· | Total ——

North Subarea (44° 22.5′ – 45° 45′ N) — Males —— Females···· | Total ——

Total Area (43° 00′ – 45° 45′ N) — Males —— Females···· | Total ——

110–183 m (60–100 fm)

183–366 m (100–200 fm)

366–549 m (200–300 fm)

549–732 m (300–400 fm)

732–915 m (400–500 fm)

Total 110–915 m (60–500 fm)

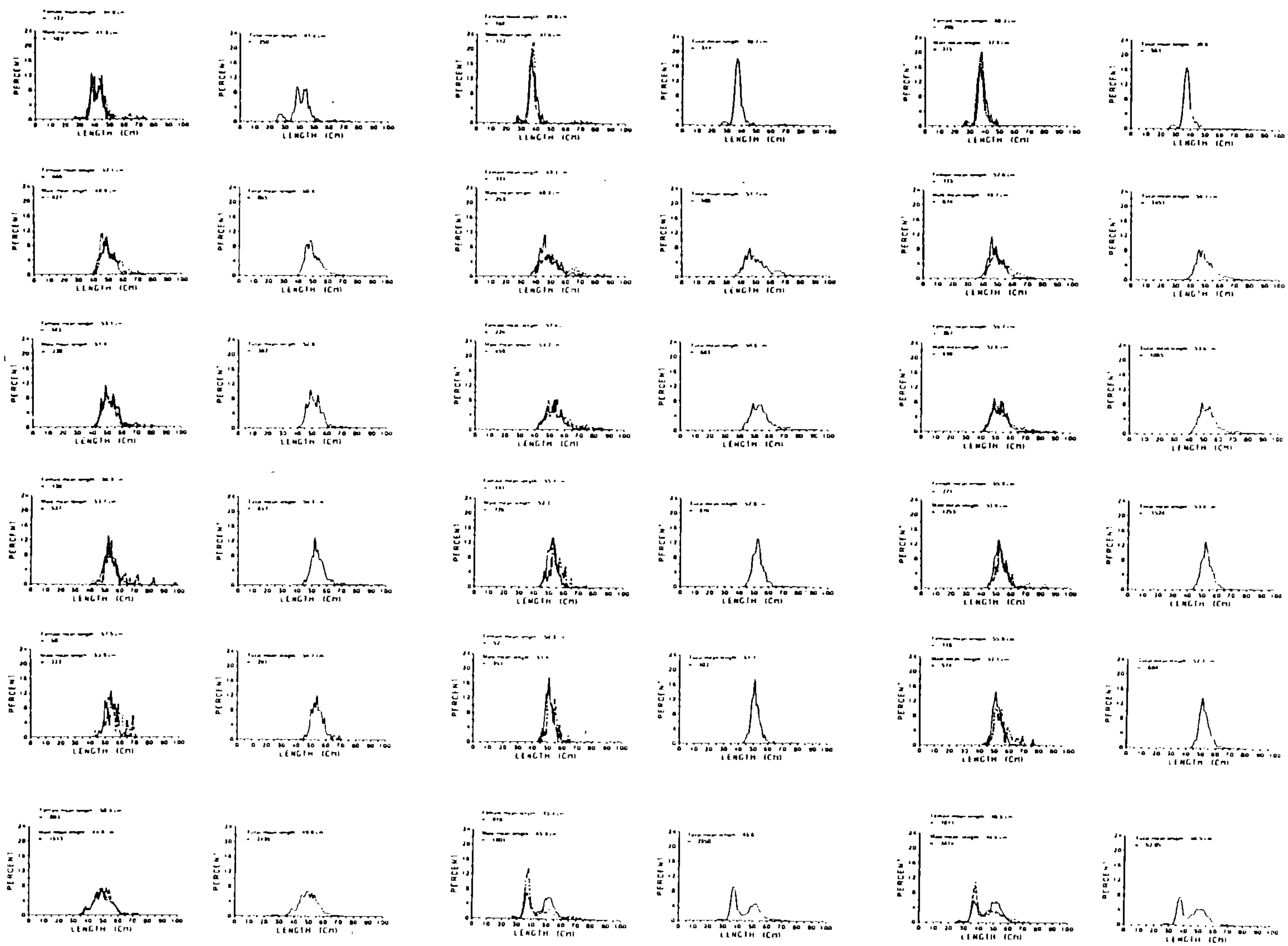


Figure 73.--Sablefish size composition during the 1984 autumn slope survey by sex and geographic subarea.

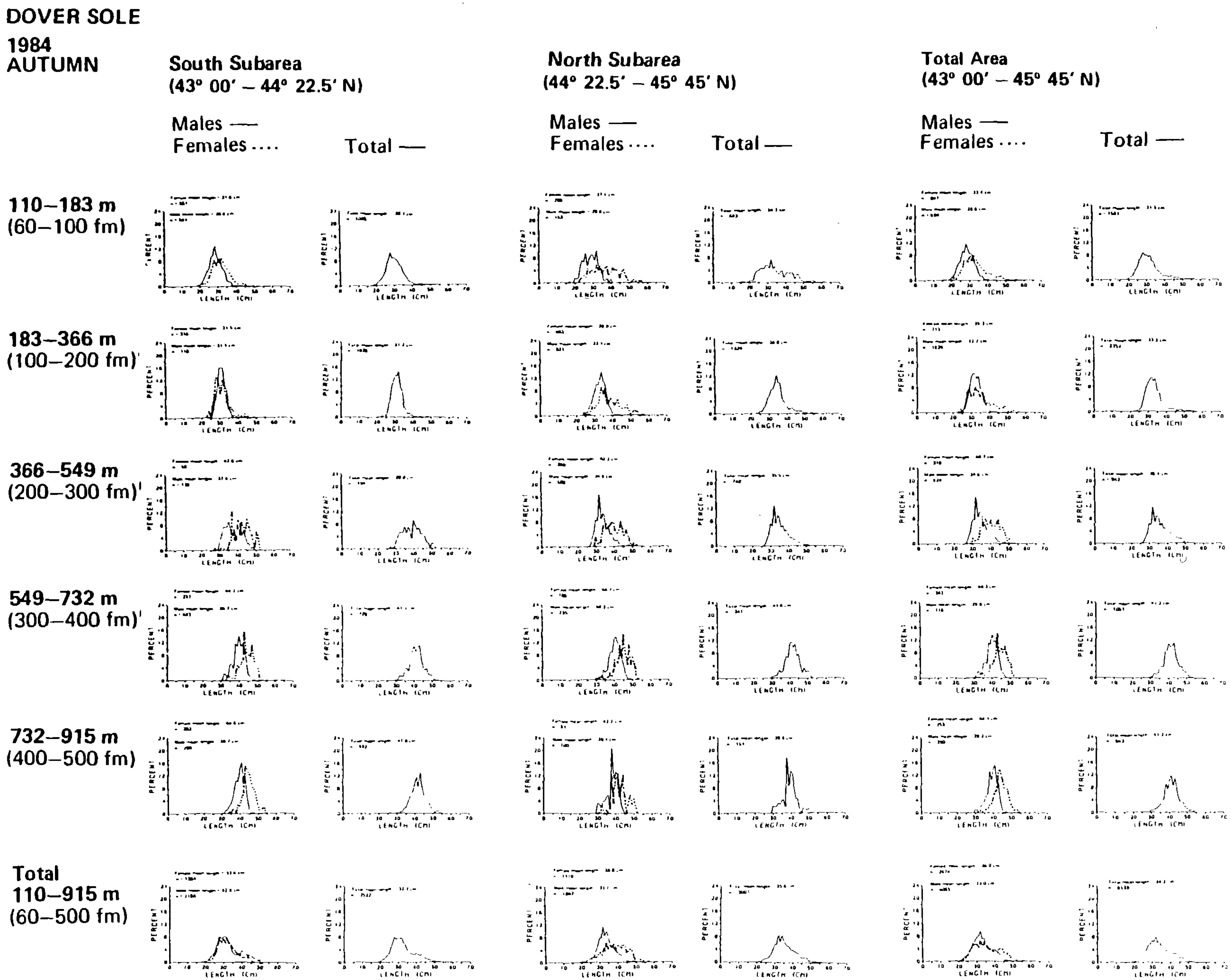


Figure 74.--Dover sole size composition during the 1984 autumn slope survey by sex and geographic subarea.

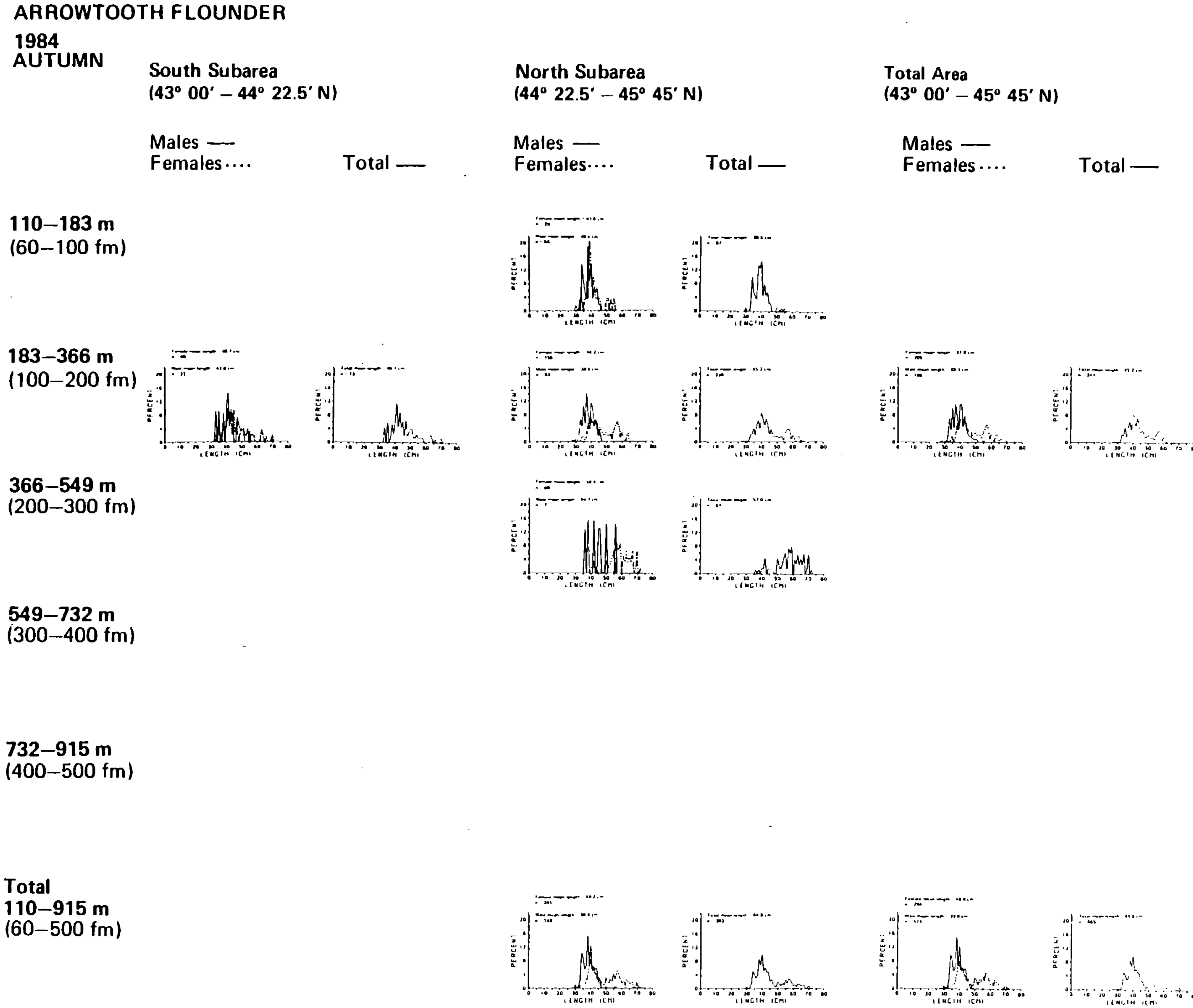


Figure 75--Arrowtooth flounder size composition during the 1984 autumn slope survey by sex and geographic subarea.

PACIFIC OCEAN PERCH

1984
AUTUMN

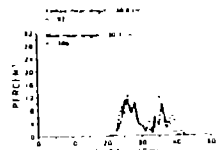
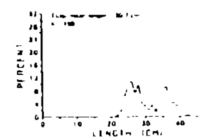
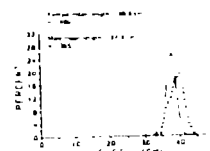
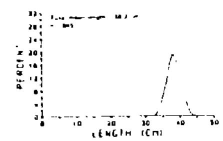
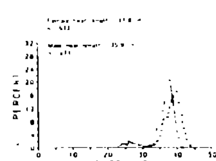
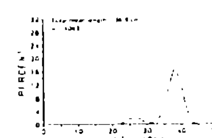
	South Subarea (43° 00′ – 44° 22.5′ N)		North Subarea (44° 22.5′ – 45° 45′ N)		Total Area (43° 00′ – 45° 45′ N)	
	Males —— Females····	Total ——	Males —— Females····	Total ——	Males —— Females ····	Total ——
110–183 m (60–100 fm)						
183–366 m (100–200 fm)						
366–549 m (200–300 fm)						
549–732 m (300–400 fm)						
732–915 m (400–500 fm)						
Total 110–915 m (60–500 fm)						

Figure 76.--Pacific ocean perch size composition during the 1984 autumn slope survey by sex and geographic subarea.

DARKBLOTCHED ROCKFISH

1984

AUTUMN

	South Subarea (43° 00′ – 44° 22.5′ N)		North Subarea (44° 22.5′ – 45° 45′ N)		Total Area (43° 00′ – 45° 45′ N)	
	Males —— Females····	Total ——	Males —— Females····	Total ——	Males —— Females····	Total ——
110–183 m (60–100 fm)						
183–366 m (100–200 fm)						
366–549 m (200–300 fm)						
549–732 m (300–400 fm)						
732–915 m (400–500 fm)						
Total 110–915 m (60–500 fm)						

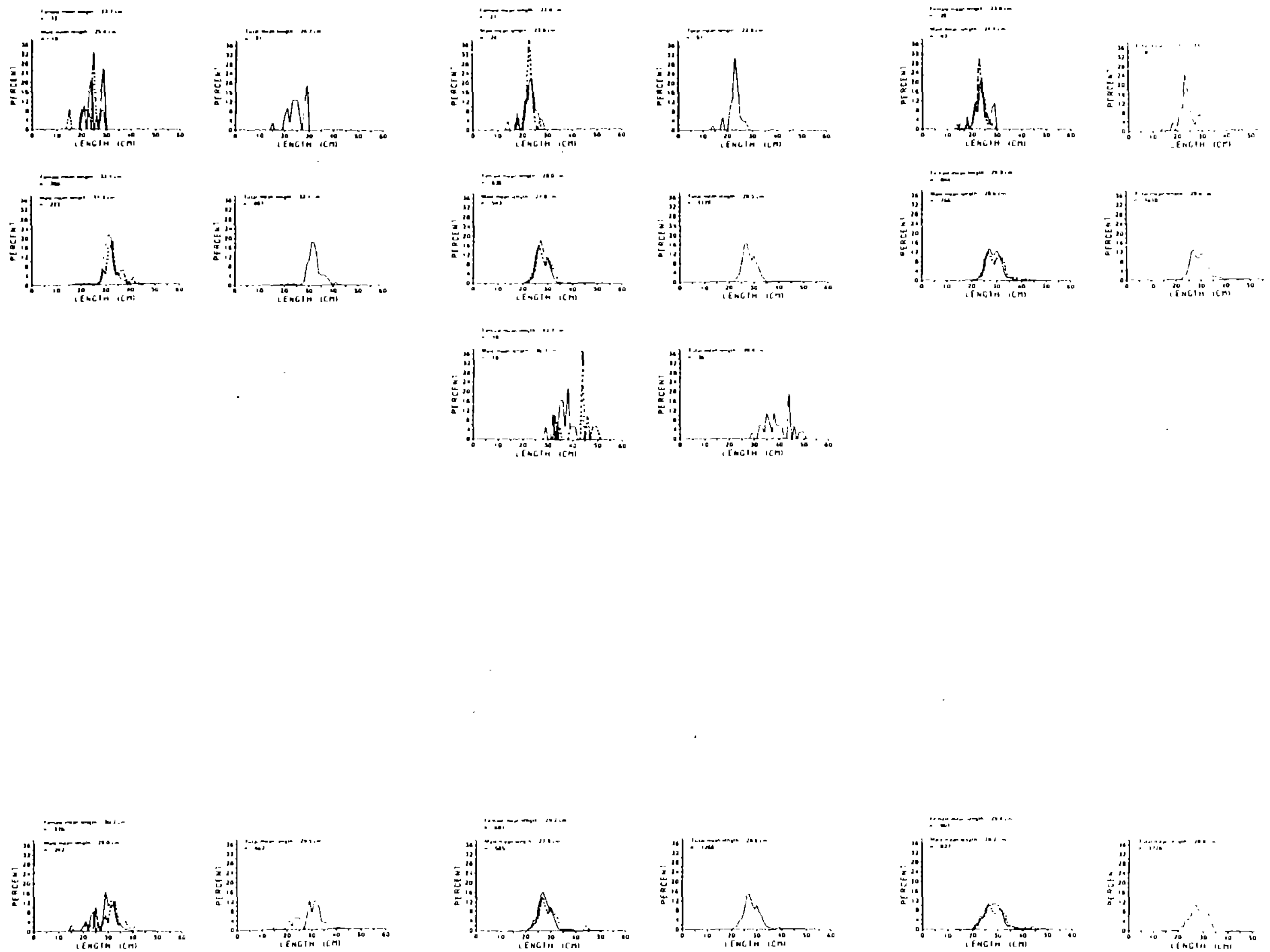


Figure 77.--Darkblotched rockfish size composition during the 1984 autumn slope survey by sex and geographic subarea.

SHARPCHIN ROCKFISH

1984
AUTUMN

	South Subarea (43° 00′ – 44° 22.5′ N)		North Subarea (44° 22.5′ – 45° 45′ N)		Total Area (43° 00′ – 45° 45′ N)	
	Males —— Females ····	Total ——	Males —— Females ····	Total ——	Males —— Females ····	Total ——

110–183 m (60–100 fm)

183–366 m (100–200 fm)

366–549 m (200–300 fm)

549–732 m (300–400 fm)

732–915 m (400–500 fm)

Total 110–915 m (60–500 fm)

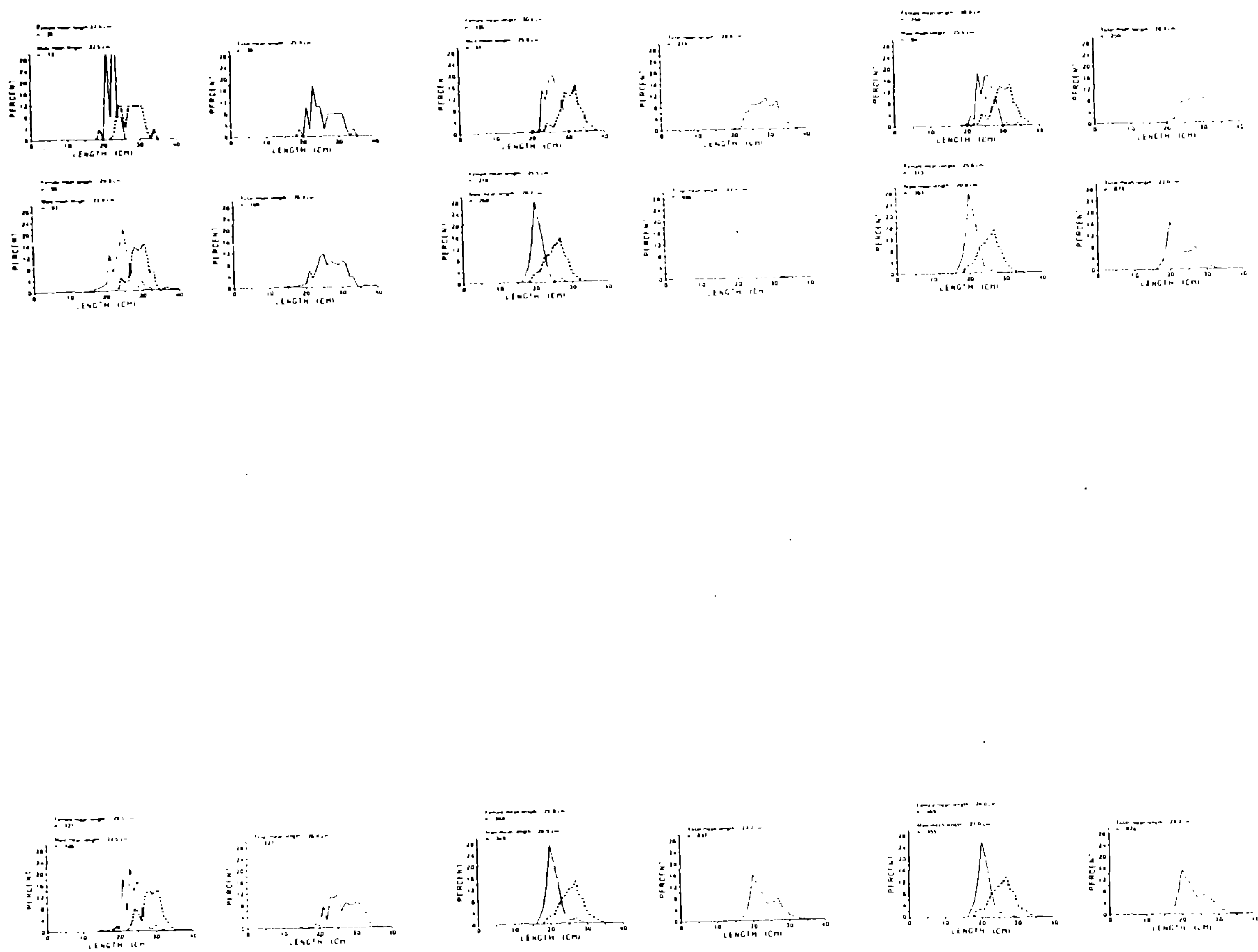


Figure 78.--Sharpchin rockfish size composition during the 1984 autumn slope survey by sex and geographic subarea.

SPLITNOSE ROCKFISH
1984
AUTUMN

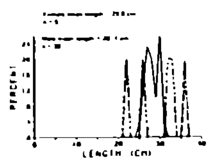
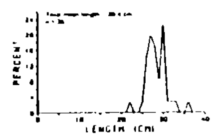
	South Subarea (43° 00' – 44° 22.5' N)		North Subarea (44° 22.5' – 45° 45' N)		Total Area (43° 00' – 45° 45' N)	
	Males —— Females ····	Total ——	Males —— Females ····	Total ——	Males —— Females ····	Total ——
110–183 m (60–100 fm)						
183–366 m (100–200 fm)						
366–549 m (200–300 fm)						
549–732 m (300–400 fm)						
732--915 m (400–500 fm)						
Total 110–915 m (60–500 fm)						

Figure 79.--Splitnose rockfish size composition during the 1984 autumn slope survey by sex and geographic subarea.

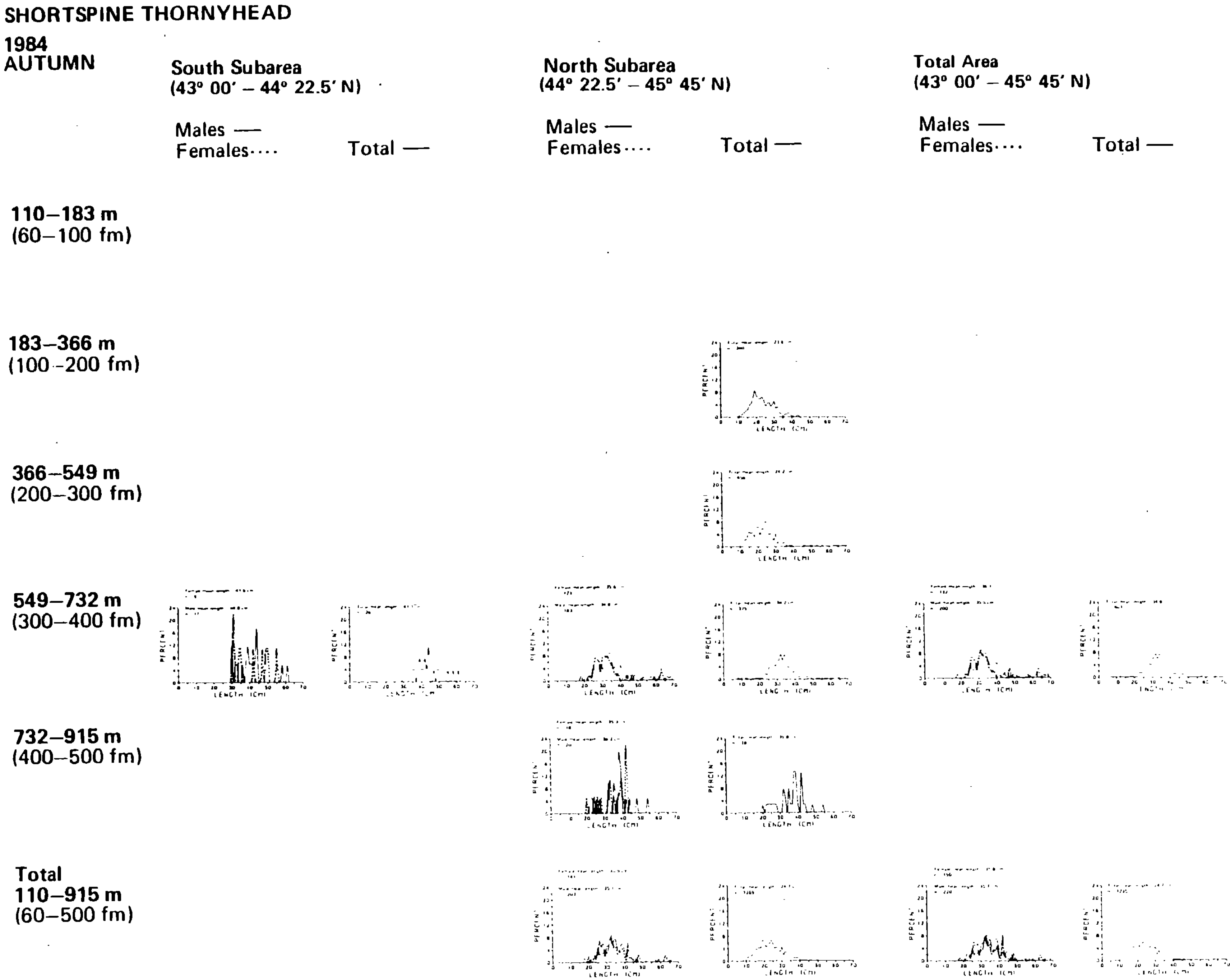


Figure 80.--Shortspine thornyhead size composition during the 1984 autumn slope survey by sex and geographic subarea.

LONGSPINE THORNYHEAD

1984
AUTUMN

South Subarea (43° 00′ – 44° 22.5′ N) — Males — Females ···· Total —

North Subarea (44° 22.5′ – 45° 45′ N) — Males — Females ···· Total —

Total Area (43° 00′ – 45° 45′ N) — Males — Females ···· Total —

110–183 m (60–100 fm)

183–366 m (100–200 fm)

366–549 m (200–300 fm)

549–732 m (300–400 fm)

732–915 m (400–500 fm)

Total 110–915 m (60–500 fm)

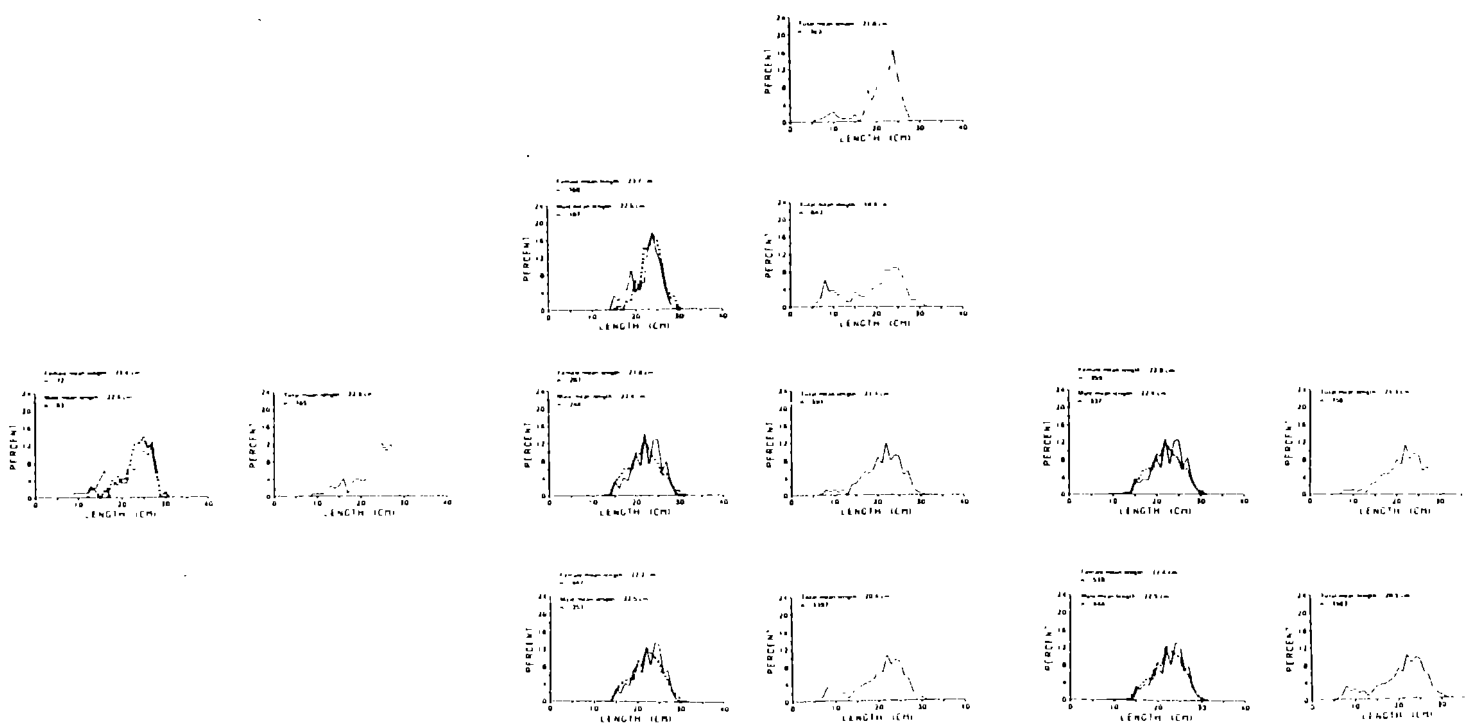


Figure 81.--Longspine thornyhead size composition during the 1984 autumn slope survey by sex and geographic subarea.

REDSTRIPE ROCKFISH

1984
AUTUMN

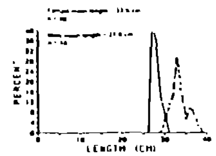
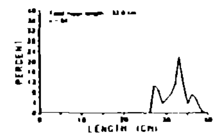
	South Subarea (43° 00' – 44° 22.5' N)		North Subarea (44° 22.5' – 45° 45' N)		Total Area (43° 00' – 45° 45' N)	
	Males —— Females ····	Total ——	Males —— Females ····	Total ——	Males —— Females····	Total ——
110–183 m (60–100 fm)						
183–366 m (100–200 fm)						
366–549 m (200–300 fm)						
549–732 m (300–400 fm)						
732–915 m (400–500 fm)						
Total 110–915 m (60–500 fm)						

Figure 82.--Redstripe rockfish size composition during the 1984 autumn slope survey by sex and geographic subarea.

CANARY ROCKFISH

1984
AUTUMN

South Subarea
(43° 00' – 44° 22.5' N)

Males —
Females····
Total —

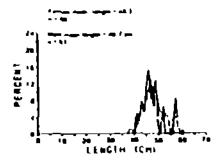
North Subarea
(44° 22.5' – 45° 45' N)

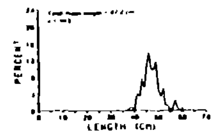
Males —
Females····
Total —

Total Area
(43° 00' – 45° 45' N)

Males —
Females····
Total —

110–183 m
(60–100 fm)





183–366 m
(100–200 fm)

366–549 m
(200–300 fm)

549–732 m
(300–400 fm)

732–915 m
(400–500 fm)

Total
110–915 m
(60–500 fm)

Figure 83.--Canary rockfish size composition during the 1984 autumn slope survey by sex and geographic subarea.

PACIFIC WHITING

1984
AUTUMN

South Subarea
(43° 00' – 44° 22.5' N)

Males —
Females····
Total —

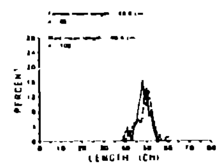
North Subarea
(44° 22.5' – 45° 45' N)

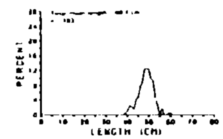
Males —
Females····
Total —

Total Area
(43° 00' – 45° 45' N)

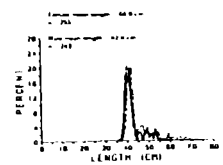
Males —
Females····
Total —

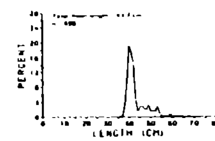
110–183 m
(60–100 fm)



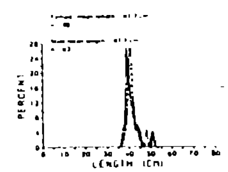


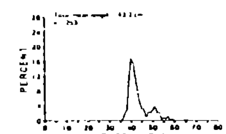
183–366 m
(100–200 fm)





366–549 m
(200–300 fm)

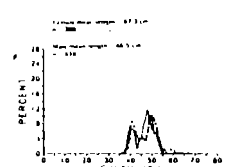




549–732 m
(300–400 fm)

732–915 m
(400–500 fm)

Total
110–915 m
(60–500 fm)



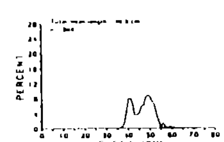


Figure 84.--Pacific whiting size composition during the 1984 autumn slope survey by sex and geographic

REX SOLE

1984
AUTUMN

	South Subarea (43° 00′ – 44° 22.5′ N)		North Subarea (44° 22.5′ – 45° 45′ N)		Total Area (43° 00′ – 45° 45′ N)	
	Males —— Females ····	Total ——	Males —— Females ····	Total ——	Males —— Females ····	Total ——
110–183 m (60–100 fm)						
183–366 m (100–200 fm)						
366–549 m (200–300 fm)						
549–732 m (300–400 fm)						
732–915 m (400–500 fm)						
Total 110–915 m (60–500 fm)						

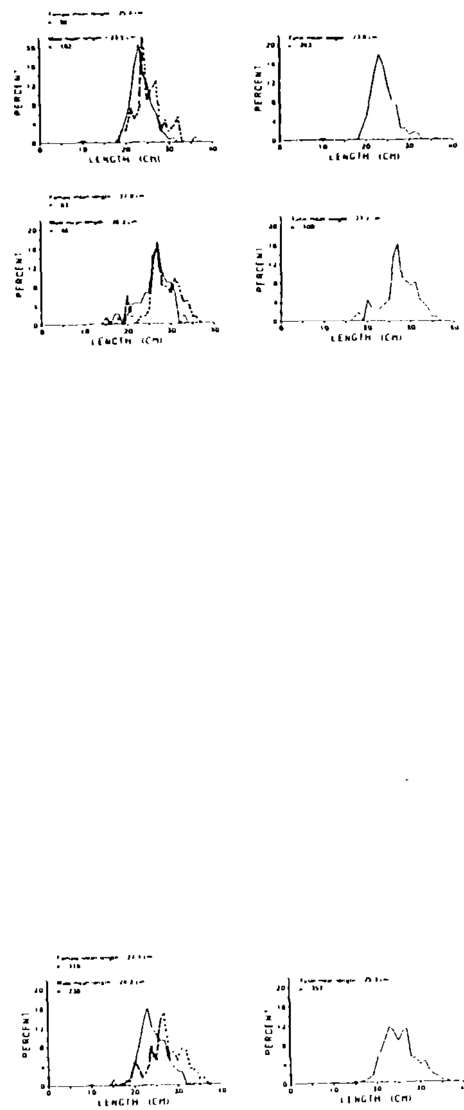


Figure 85.--Rex sole size composition during the 1984 autumn slope survey by sex and geographic

SABLEFISH
1984 Autumn

Total Area [43°00'N - 45°45'N]

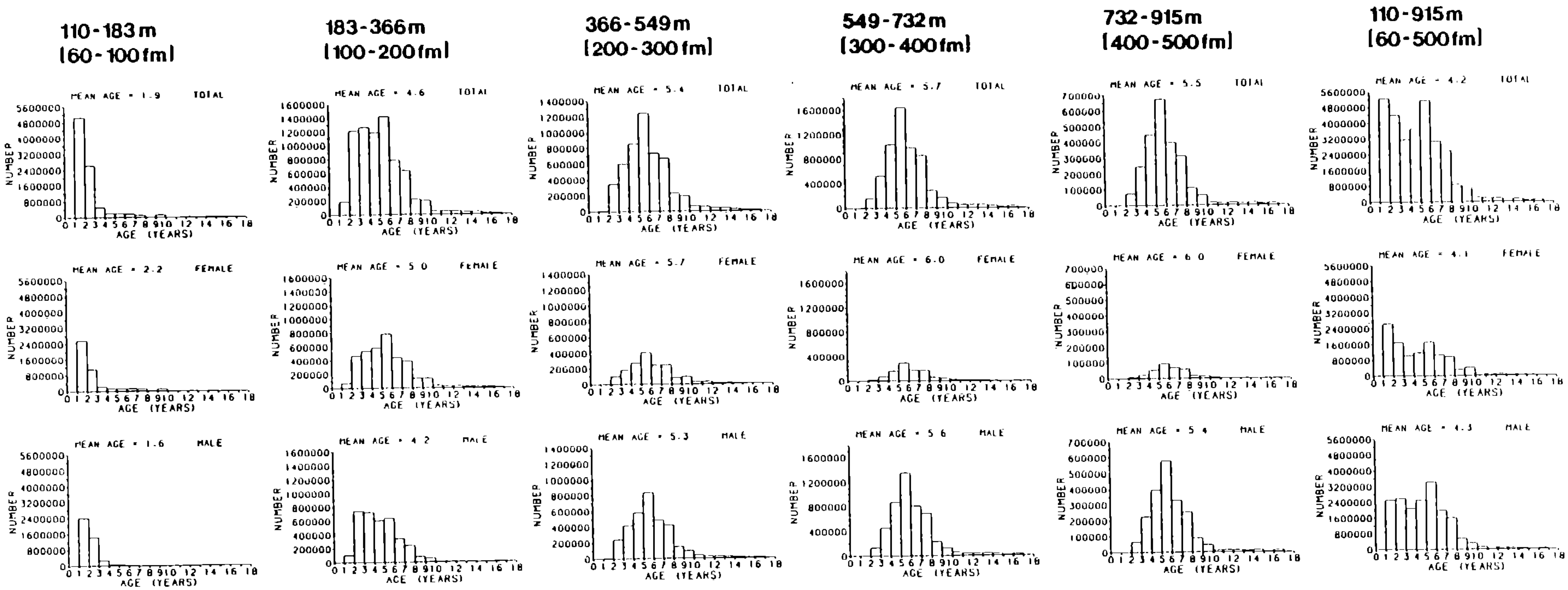


Figure 86.--Estimated sablefish age composition, by sex and depth stratum, for the entire 1984 autumn slope survey area.

SABLEFISH
1984 Autumn

North Subarea (44°22.5'N-45°45'N)

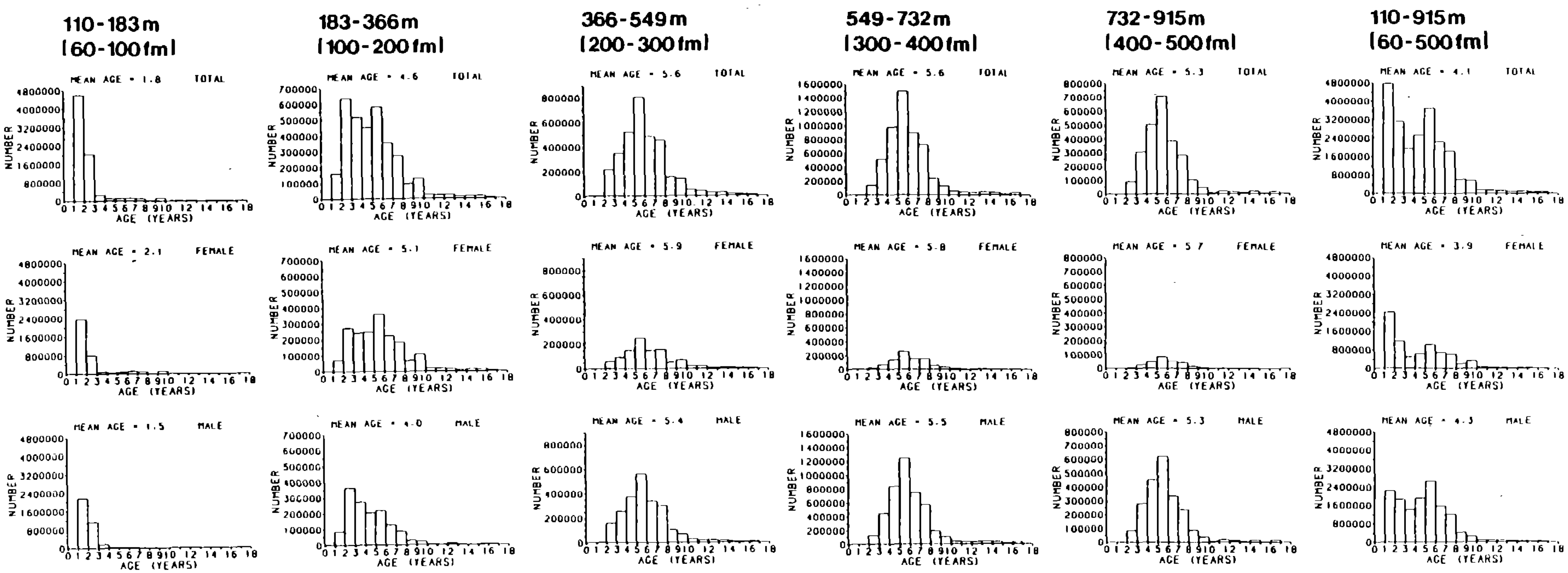


Figure 87.--Estimated sablefish age composition, by sex and depth stratum, for the 1984 autumn slope survey, north subarea.

SABLEFISH
1984 Autumn

South Subarea (43°00'N-44°22.5'N)

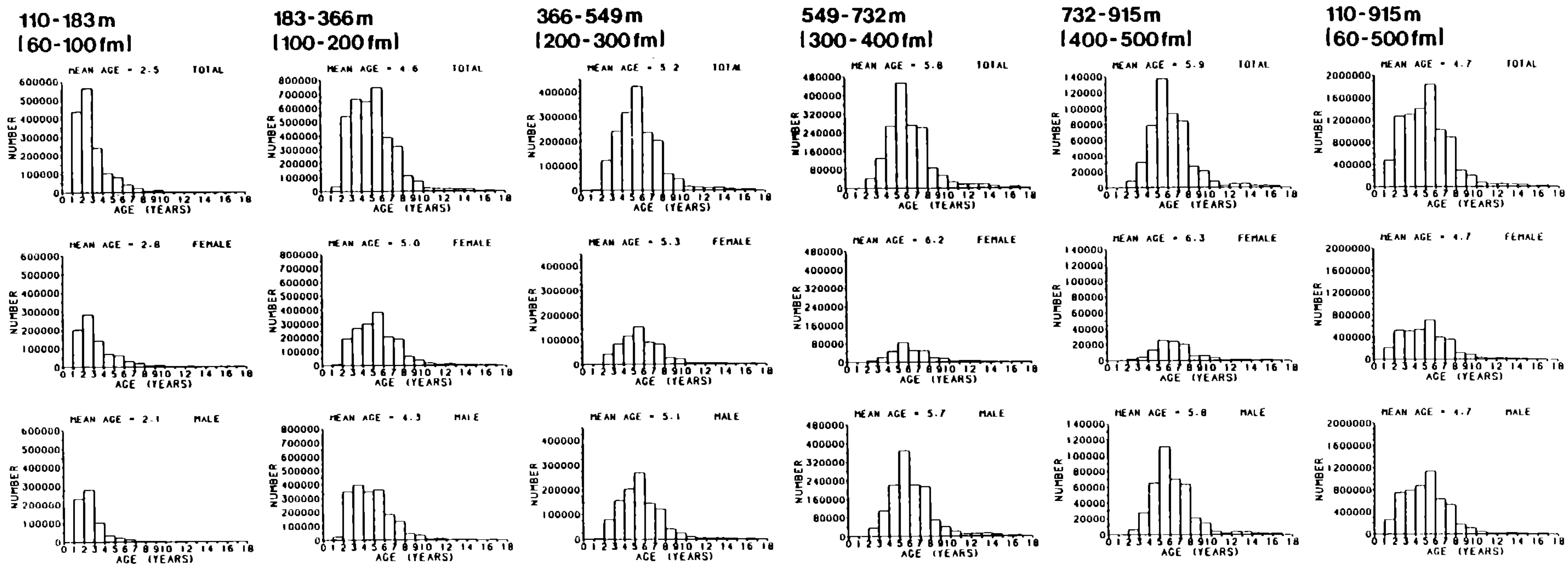


Figure 88.--Estimated sablefish age composition, by sex and depth stratum, for the 1984 autumn slope survey, south subarea.

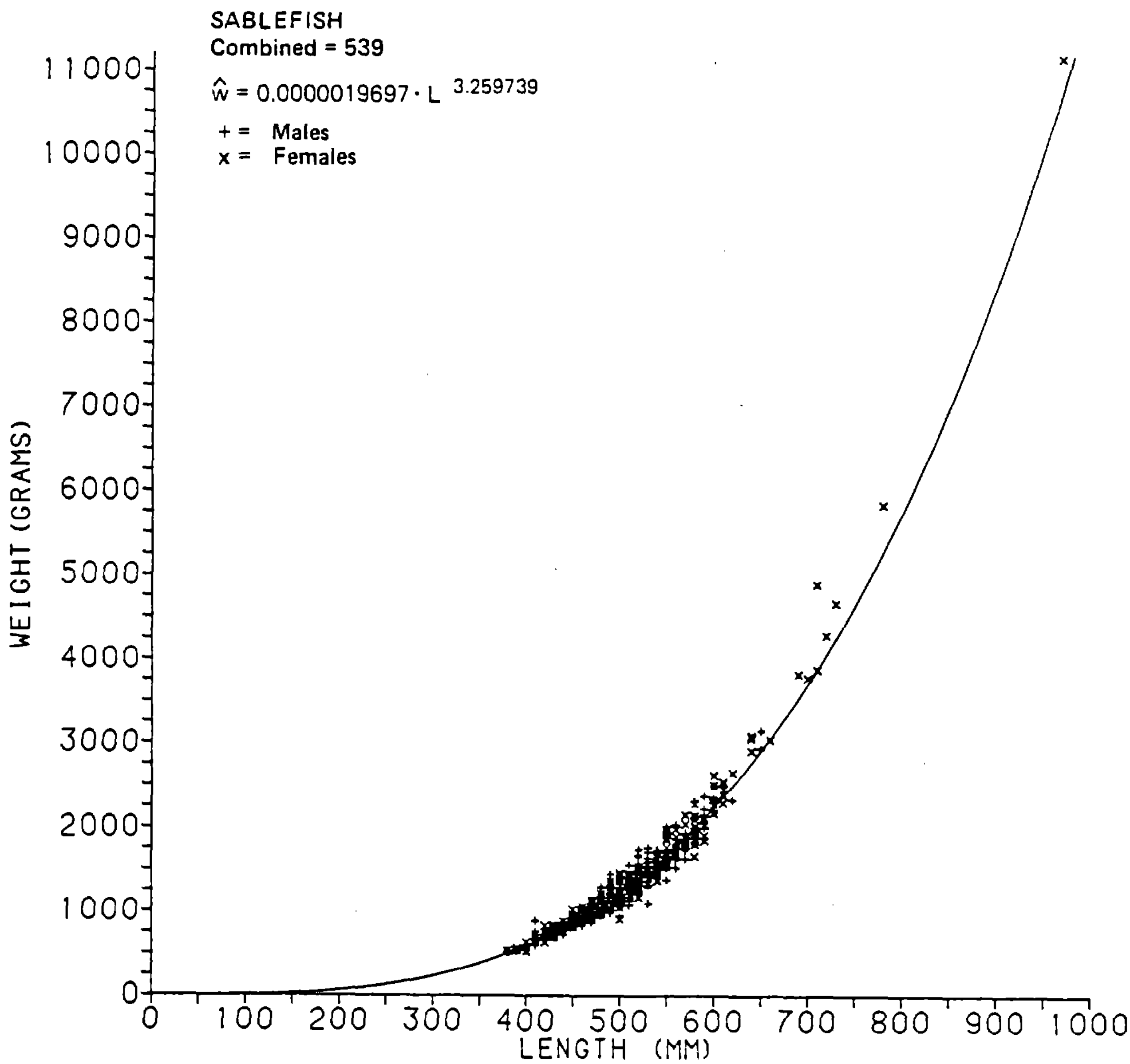


Figure 89.--Sablefish length-weight relationship from the 1984 autumn slope survey.

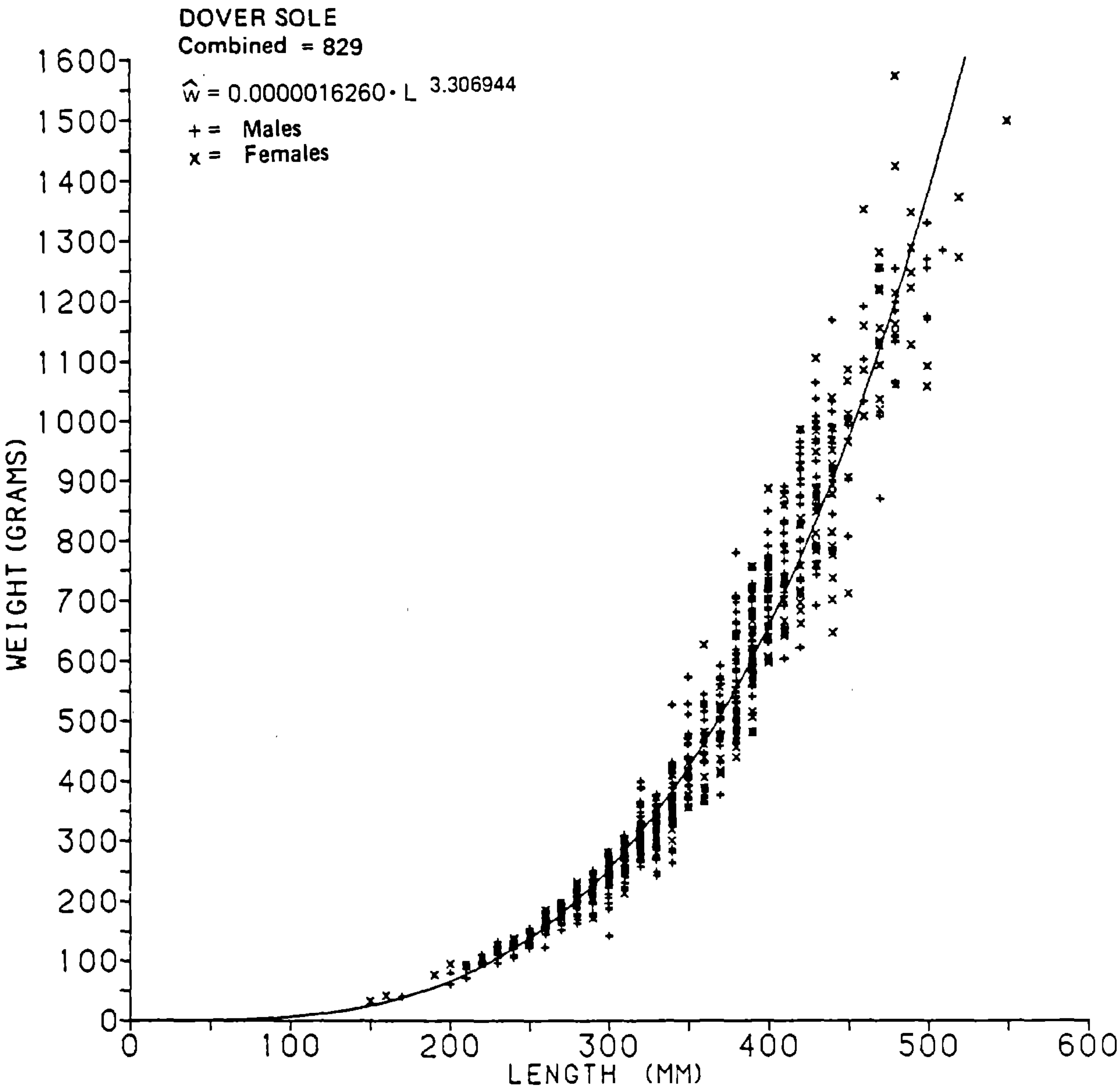


Figure 90.--Dover sole length-weight relationship from the 1984 autumn slope survey.

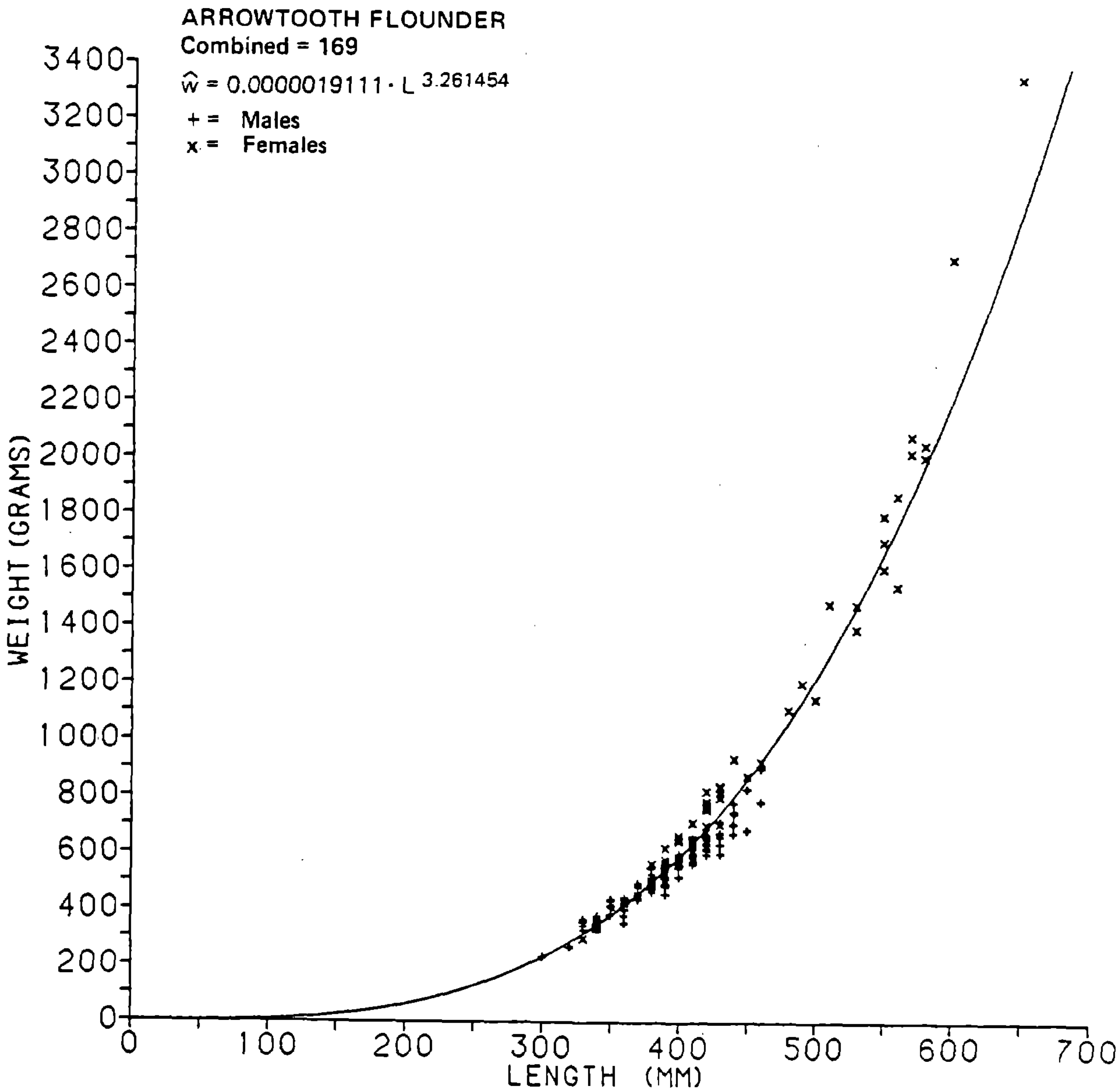


Figure 91.--Arrowtooth flounder length-weight relationship from the 1984 autumn slope survey.

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