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Distribution and Relative Abundance of Pelagic Nonsalmonid Nekton Off Oregon and Washington, 1979-84

Richard D. Brodeur
William G. Pearcy

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

NOAA TECHNICAL REPORT NMFS

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RICHARD D. BRODEUR[1]
College of Oceanography
Oregon State University
Marine Science Center
Newport, Oregon 97365

WILLIAM G. PEARCY
College of Oceanography
Oregon State University
Corvallis, Oregon 97331

ABSTRACT

Fifteen fine-mesh (32-mm mesh) pelagic purse seine surveys were conducted between 1979 and 1984 off the Oregon and Washington coasts. Environmental conditions varied greatly among the years sampled, and even within years, due to variability in upwelling conditions and productivity and the effects of a strong El Niño from late 1982 to the middle of 1984. In the 843 sets made, a total of 115,891 specimens from 69 taxa was collected. Most individuals collected belonged to nine dominant taxa. Seasonal and interannual variations in the abundance and distribution patterns of these dominant taxa are presented in detail. A recurrent group analysis delineated four major groupings of nekton.

[1]Present address: Fisheries Research Institute, WH-10, University of Washington, Seattle, Washington 98195.

INTRODUCTION

The compilation of quantitative information on the abundance patterns of pelagic nekton, and the spatiotemporal variations in these patterns, lags far behind that available for demersal nekton in temperate shelf waters off the west coast of North America. Hydroacoustic and aerial surveys have been used with some success to determine location and approximate abundance of concentrations of pelagic species (Smith 1970; Mais 1974; Squire 1983), but these do not provide detailed information on species composition or biological characteristics of the nekton. Non-acoustic pelagic resource surveys are generally limited in geographic extent and duration of sampling. The pelagic fisheries that exist presently, such as troll fisheries for salmon and albacore tuna, are usually very selective as to species caught and thus do not provide much information on the pelagic ecosystem as a whole. Large purse seines and lampara nets are less selective and have been used to describe pelagic species compositions (Cailliet et al. 1979; Allen and DeMartini 1983), but their use has generally been restricted to nearshore environments. Large-scale assessment of pelagic resources is needed to determine latent fisheries resources and examine potential interactions, such as predation and competition, with presently utilized fishery stocks.

From 1979 to 1984, researchers from the College of Oceanography at Oregon State University conducted 15 cruises in coastal waters off Oregon and Washington. The primary purpose of these cruises was to assess the abundance and determine distribution patterns and migration routes of juvenile and adult salmonids. Small-mesh purse seines were used to quantitatively sample large volumes (up to one million m^3) of water. In addition to the salmonid catch, which has been summarized in various technical reports (Pearcy 1979, 1980, Wakefield et al. 1981; Fisher et al. 1983, 1984, Fisher and Pearcy 1985), many associated species of fishes and cephalopods were caught and biological data gathered on these species. This report summarizes the kinds, numbers, and size distribution of the nonsalmonid nekton catches and describes their distribution in relation to some hydrographic features of the sampling area. A species assemblage analysis is also given based on recurring groups of species caught in the seine sets.

MATERIALS AND METHODS

The purse seine surveys encompass the area from approximately Cape Flattery off northern Washington (48°20′) to Cape Blanco off southern Oregon (43°00′). Only those stations within 56 km (30 nautical miles) of the coast were considered in this study. The cruises conducted in 1979 and 1980 were exploratory, with stations selected to maximize the salmonid catch, and were not systematically arranged. From 1981 to 1984, stations were occupied along predetermined, parallel transects positioned along latitudinal lines and spaced approximately 37 km apart (Fig. 1). Purse seine sets were generally made beginning at the 37 m (20 fm) isobath and continuing at stations 6, 9, 18, 28, 37, 46, and 56 km from the coast. Additional sets were occasionally made in areas of interest such as oceanographic fronts or sites of substantial bird activity. The nets were set at various compass bearings, but the direction to which the net was opened was generally perpendicular to the coast.

The survey area was sampled at least once each month between May and September during the six years of sampling, with some part of June sampled every year (Table 1). These months were

Table 1—Summary of sampling by cruise, 1979-1984. Numbers of sets include only quantitative, round hauls taken within 56 km of the coast.

Cruise No.	Cruise Year	Cruise Date	Latitudinal range sampled (North lat.)	No. of sets
1	1979	June 18-29	46°20'-43°18'	49
2	1980	June 20-28	46°20'-44°30'	33
3	1981	May 16-25	46°35'-44°30'	63
4	1981	June 9-19	46°35'-43°11'	67
5	1981	July 9-19	46°35'-44°25	71
6	1981	August 8-19	46°35'-43°1[illegible]'	66
7	1982	May 19-June 2	48°20'-44°00'	62
8	1982	June 7-22	47°20'-44°20'	56
9	1982	Sept. 4-14	47°20'-44°20'	40
10	1983	May 16-27	48°20'-44°20'	57
11	1983	June 9-27	48°20'-43°00'	58
12	1983	Sept. 15-24	48°20'-43°28'	52
13	1984	June 6-20	48°20'-43°28'	66
14	1984	July 19-30	48°00'-44°00'	40
15	1984	Sept. 1-15	48°20'-44°00'	63
			Total	843

specifically selected to coincide with peak periods of juvenile salmonid migration through coastal waters off Oregon and Washington. Only successful, quantitative round-haul sets were included in the analysis, although fishes were often caught in nonquantitative sets. Most sets were made in full daylight or twilight because of the difficulties of setting the seine at night, although several complete diel series were made, mostly in 1981.

Four different purse seines were used in the sampling. The deployment circumferences of all the seine nets, including the main body and bunt, were similar and varied between 494 and 530 m. Fishing depth, measured by a depth meter attached to the lead line of the net, varied between 15 m (cruises 5 and 6) and 67 m (cruises 7-9). All seines were made of 32-mm (stretched) or finer mesh in the main body of the net. Additional details on net design and sampling are given in Pearcy (1984).

At the conclusion of each set, the catch was either reeled onto the stern or brailed over the side of the vessel when large volumes of gelatinous zooplankton made normal net retrieval difficult. All nonsalmonid nekton were sorted from the catch and retained for processing. Fork length (FL) measurements were taken on most species from the tip of the snout to the end of the middle caudal ray with the exception of some species where total length (TL; e.g., elasmobranchs and some teleosts) or dorsal mantle length (DML; e.g., cephalopods) were measured. Specimens ≥1000 mm in length were generally measured to the nearest centimeter, and those <1000 mm measured to the nearest millimeter.

Abundances and length-frequency distributions of large catches of a single species were estimated by subsampling the total catch and counting and measuring a randomly chosen subsample. An expansion factor (estimated number in whole catch/number in subsample) was applied to the subsampled length-frequency data to estimate the length-frequency distribution of the entire catch of these dominant species when a suitable subsample was obtained. Most fish were identified and measured at sea, although small or difficult to identify species were preserved and brought back to the laboratory for further identification. The abundances of some of the smaller individuals collected were probably underestimated due to escapement through the meshes.

Hydrographic data, collected at most stations, included surface temperature, salinity, and chlorophyll *a* (except 1979 and 1980) measurements. Water depth, ambient light intensity, and water transparency were measured at the beginning of each set. Surface-to-bottom CTD casts were made from 1982 through 1984 to obtain vertical profiles of temperature and salinity. A complete description of the sampling and results obtained for all cruises is given in Pearcy (1979, 1980), Wakefield et al. (1981), Fisher et al. (1983, 1984) and Fisher and Pearcy (1985). The station and pertinent hydrographic data are given in Appendices 1 through 6 for each year of sampling.

RESULTS

Physical and biotic environment

The general features of the summer coastal hydrography and productivity off Oregon and Washington have been described by Anderson (1964), Smith (1968), Bourke et al. (1971), Barnes et al. (1972), Huyer (1977), Huyer and Smith (1978), Peterson et al. (1979), and Small and Menzies (1981). The following brief description of the physical and biotic events occurring during the summer has been condensed from these sources.

Two processes dominate the physical oceanography of the area: upwelling and freshwater discharge, mainly from the Columbia River. Upwelling occurs when nearshore surface waters are displaced offshore by wind-induced Ekman transport. Mass balance is maintained by upwelling of colder, more saline and nutrient-rich deeper water. This upwelling activity is concentrated within bands usually oriented parallel to the coast 9 to 18 km offshore. Intermittent upwelling events may occur from April through September and vary in intensity and duration.

Alongshore current flow is generally much stronger than zonal flow. During the summer months, northwesterly winds set up driving a narrow coastal "jet" which flows equatorward at speeds close to 35 cm/s at the surface and a more diffuse undercurrent which flows northward at much slower speeds along the bottom. Inshore-offshore flow is highly variable and subject to wind and tidal variations. The zonal surface flow is generally offshore during the upwelling season with a compensatory onshore flow at intermediate depths.

The Columbia River plume may be distinguishable as a thin surface lens of warm, low-salinity water. It may extend up to 400 km to the southwest of the mouth of the Columbia River during the summer in response to the prevailing northwesterly winds and offshore Ekman transport. The inner edge of the plume forms a distinctive front where it contacts newly upwelled water. The outside boundaries of the plume are generally delineated by the 32.5‰ isohaline.

Primary productivity is generally high in the spring and fall months, but is often substantially lower in the summer due to the depletion of nutrients in the euphotic zone. The highest productivity occurs following moderate-to-weak upwelling events when sufficient nutrients and water column stability allow sustained phytoplankton growth. The Columbia River plume waters generally support lower production than neighboring upwelling areas, yet higher levels than adjacent oceanic waters.

Oceanographic conditions during 1979-84 were highly variable during the study period, both within years and between years for the same months. The monthly mean upwelling index for June was much higher during 1979 than 1980 (Table 2) and sea-surface temperatures were lower in 1979 both within and outside the Columbia River plume (Figs. 2 and 3). During 1979, newly upwelled water was apparent inshore in the southern part of the sampling area (Fig. 2). Some very low salinities (<10‰) were recorded north of the

Table 2—Comparison of mean monthly upwelling indices during May-September 1979-84[1] and the long-term (1948-67) mean upwelling index for 45°N, 125°W (Bakun 1973). Monthly values during which cruises occurred are underlined. All values are expressed as m^3/second/100 m of coastline.

Month	1979	1980	1981	1982	1983	1984	Long-term mean
May	34	52	12	79	35	−2	34
June	86	32	8	59	19	37	48
July	30	103	107	51	18	121	74
Aug.	31	96	40	38	35	37	50
Sept.	0	9	−1	12	25	3	16

[1]A. Bakun, Pacific Environ. Group, Natl. Mar. Fish. Serv., NOAA, Monterey, CA, unpubl.

Columbia River in June of 1980, indicating a possible northward flow of plume water, although salinities were low throughout the study area (Fig. 3).

There were few indications of strong upwelling occurring during May and June of 1981. The mean upwelling index for both months was substantially below normal (Table 2), and sea-surface temperatures throughout the study area were above those normally associated with upwelling (Figs. 4 and 5). Chlorophyll *a* concentrations were low during these months, except for the area north of Cape Blanco in June (Fig. 5). Strong upwelling conditions (Table 2) were evident during July at a few inshore stations off central Oregon, and higher chlorophyll *a* concentrations than the previous months were observed inshore (Fig. 6). The surface temperatures at most stations remained very high in July. Lack of runoff to the north and moderate upwelling to the south resulted in high surface salinities throughout much of the study area during August (Fig. 7). Surface chlorophyll *a* concentrations were very low south of Yaquina Bay, and clear oceanic water prevailed.

Unusually strong upwelling in May of 1982 (Table 2) led to cool sea-surface temperatures throughout the study area, with the coolest waters found inshore off southern Oregon (Fig. 8). Surface salinities were high except near the core of the Columbia River plume. High surface chlorophyll *a* concentrations were found offshore (10-15 mile stations) off Washington and were generally found inshore along the coast of Oregon. Chlorophyll *a* concentrations were average to low during the June cruise except along the southernmost transect (Fig. 9). There were sharp salinity gradients outlining the well-defined Columbia River plume which flowed to the southwest (Fig. 9). Sea-surface temperatures were much higher in September with low surface temperatures found only at the southernmost stations (Fig. 10). The highest chlorophyll *a* concentrations were associated with the Columbia River plume.

The strong El Niño of 1983 dominated ocean conditions off Oregon and Washington especially during the May and June cruises. Oceanic waters were advected onshore from the west and south and greatly depressed the thermocline. Upwelling conditions were apparent only at the southernmost stations of the May survey (Fig. 11). June sea-surface temperatures averaged 3-4°C above those of 1982 (Fig. 12). The Columbia River plume was evident over a much broader area and apparently contributed to much of the productivity occurring during these cruises. Greater than average upwelling occurred in September (Table 2) and sea-surface temperatures were slightly lower than in 1982 (Fig. 13). Chlorophyll *a* concentrations in surface waters were higher during September than May and June of 1983 and were generally higher than September of 1982 (Chung 1985).

The surface temperatures were slightly elevated during June 1984 due to lower than normal upwelling that month (Table 2) and the lingering effects of the El Niño. Newly upwelled water was evident only off central Oregon (Fig. 14). Few stations showed high chlorophyll *a* concentrations. Upwelling-favorable winds occurred though much of early July and were manifested in the low temperature and high salinity and chlorophyll values seen inshore along the central Oregon coast (Fig. 15). Sea-surface temperatures along the Washington Coast were only slightly higher than those registered in June. Sea-surface warming continued into September with values exceeding 14°C found throughout much of the study area south of the Quinault River (Fig. 16). Upwelling during September was well below that of the longterm mean (Table 2). Chlorophyll *a* concentrations were fairly high in the northern area but dropped off substantially to the south.

Summary of nekton collected

Three invertebrate and 66 nonsalmonid vertebrate taxa were collected in the 843 sets included in the study (Table 3). A total of 115,891 specimens was collected, of which 25.7% were cephalopods. The overwhelming majority (>99.9%) of the cephalopods were of one species, *Loligo opalescens*, which was the most frequently occurring and numerous species collected during the study (Table 3). The 86,059 fishes caught represented 3 classes, 12 orders, and 31 families.

The ten most abundant families made up only 39.7% of the total number of species but included 98.7% of the individuals collected during the study (Table 4). The greatest diversity was found in the family Scorpaenidae, represented by 15 species, all in the genus *Sebastes*. The majority of the species comprising these dominant families were schooling species, with the exception of the Scorpaenidae which were mostly juvenile stages. The numbers caught of these species often varied substantially between sets, and even between repeat sets, within the same area.

A systematic listing of all the nektonic taxa collected in our sampling that were identified to species is presented in Appendix Table 7. The nine most abundant species, representing 95.9% of the total specimens caught, all occurred in at least 5% of the collections. The distribution and relative abundance patterns and size distributions of these dominant species will be discussed in detail for each cruise in which they were an important part of the catch.

Dominant species

Loligo opalescens—We collected 29,793 specimens of *L. opalescens* at 211 stations. This species was found in substantial numbers during each of our 15 cruises. During 1979 and 1980, mostly smaller (<100 mm DML) individuals, probably less than 1 yr old (Hixon 1983), were collected in greatest numbers in the southern part of the study area (Fig. 17). *Loligo* had a much broader size range during 1981 and again were collected in the highest numbers off central and southern Oregon (Figs. 18 and 19). Adult *L. opalescens* occurred throughout much of the study area in May of 1982 (Fig. 20), but by September of that year this species was represented only by juveniles and was distributed south of the Columbia River (Fig. 21). The distribution of this species was much more limited during the warm year of 1983 and appeared to be found farther to the north (Figs. 21 and 22). Catches were much lower than in previous years, especially off southern Oregon. These trends continued during 1984

Table 3—Phylogenetic listing of nonsalmonid pelagic nekton captured in purse seines 1979-84, including percent frequency of occurrence and total number caught. Common and scientific names of fishes follow Robins et al. (1980), and cephalopods follow Roper et al. (1984).

Common Name	Scientific Name	% Frequency of occurrence	Total no. caught
Market squid	*Loligo opalescens*	25.2	29,793
Pacific clubhook squid	*Onychoteuthis borealijaponicus*	0.4	10
Giant octopus	*Octopus dofleini*	0.1	1
Pacific lamprey	*Lampetra tridentata*	1.8	16
Spiny dogfish	*Squalus acanthias*	18.4	5,738
Thresher shark	*Alopias vulpinus*	0.6	5
Soupfin shark	*Galeorhinus zyopterus*	1.8	19
Blue shark	*Prionace glauca*	3.6	38
Big skate	*Raja binoculata*	0.6	5
Longnose skate	*R. rhina*	0.2	2
Pacific electric ray	*Torpedo californica*	0.4	3
American shad	*Alosa sapidissima*	3.8	1,185
Pacific herring	*Clupea harengus pallasi*	14.9	7,803
Pacific sardine	*Sardinops sagax*	0.2	2
Northern anchovy	*Engraulis mordax*	7.8	15,592
Whitebait smelt	*Allosmerus elongatus*	0.8	33
Surf smelt	*Hypomesus pretiosus*	1.7	491
Night smelt	*Spirinchus starksi*	0.2	6
Eulachon	*Thaleichthys pacificus*	0.2	2
Northern clingfish	*Gobiesox maeandricus*	0.1	1
Pacific tomcod	*Microgadus proximus*	3.0	89
Pacific hake	*Merluccius productus*	8.5	2,680
Pacific saury	*Cololabis saira*	6.9	1,436
King-of-the-salmon	*Trachipterus altivelis*	2.5	42
Darkblotched rockfish	*Sebastes crameri*	0.1	1
Splitnose rockfish	*S. diploproa*	0.5	13
Puget Sound rockfish	*S. emphaeus*	0.1	1
Widow rockfish	*S. entomelas*	2.7	276
Yellowtail rockfish	*S. flavidus*	4.0	555
Chilipepper	*S. goodei*	0.2	2
Shortbelly rockfish	*S. jordani*	2.9	82
Quillback rockfish	*S. maliger*	0.1	1
Black rockfish	*S. melanops*	9.3	538
Blue rockfish	*S. mystinus*	3.8	429
Tiger rockfish	*S. nigrocinctus*	0.2	18
Bocaccio	*S. paucispinis*	0.7	12
Canary rockfish	*S. pinniger*	0.8	9
Redstripe rockfish	*S. proriger*	0.2	14
Stripetail rockfish	*S. saxicola*	0.6	17
Sablefish	*Anoplopoma fimbria*	7.1	12,967
Kelp greenling	*Hexagrammos decagrammus*	2.9	90
Lingcod	*Ophiodon elongatus*	1.3	88
Brown Irish lord	*Hemilepidotus spinosus*	0.8	15
Pac. staghorn sculpin	*Leptocottus armatus*	0.4	7
Cabezon	*Scorpaenichthys marmoratus*	0.8	8
N. spearnose poacher	*Agonopsis vulsa*	0.6	5
Showy snailfish	*Liparis pulchellus*	0.1	1
Jack mackerel	*Trachurus symmetricus*	6.9	5,700
Halfmoon	*Medialuna californiensis*	0.1	12
Pacific sandfish	*Trichodon trichodon*	0.1	1
Wolf-eel	*Anarrhichthys ocellatus*	7.7	142
Prowfish	*Zaprora silenus*	0.1	1
Pacific sand lance	*Ammodytes hexapterus*	0.1	1
Pacific bonito	*Sarda chiliensis*	0.2	2
Chub mackerel	*Scomber japonicus*	7.0	29,466
Pacific pompano	*Peprilus simillimus*	1.2	31
Medusafish	*Icichthys lockingtoni*	7.4	136
Ragfish	*Icosteus aenigmaticus*	0.6	5
Pacific sanddab	*Citharichthys sordidus*	1.6	114
Speckled sanddab	*C. stigmaeus*	0.2	3
Arrowtooth flounder	*Atheresthes stomias*	0.1	2
Rex sole	*Glyptocephalus zachirus*	0.1	1
Butter sole	*Isopsetta isolepis*	0.1	1
Slender sole	*Lyopsetta exilis*	0.6	7
Dover sole	*Microstomus pacificus*	0.1	1
English sole	*Parophrys vetulus*	0.5	28
Starry flounder	*Platichthys stellatus*	1.7	33
Sand sole	*Psettichthys melanostictus*	0.1	7
Ocean sunfish	*Mola mola*	2.4	28

Table 4—Contribution to the total catch by the ten most abundant families caught in purse seines, 1979-84, in order of abundance.

Family	No. of species	No. of specimens	% of total specimens
Loliginidae	1	29,793	25.7
Scombridae	2	29,468	25.4
Engraulidae	1	15,592	13.5
Anoplomomatidae	1	12,967	11.2
Clupeidae	3	8,990	7.8
Squalidae	1	5,738	5.0
Carangidae	1	5,700	4.9
Gadidae	2	2,769	2.4
Scorpaenidae	15	1,982	1.7
Scomberesocidae	1	1,436	1.2
		Total	98.8

with few large individuals caught in our sampling (Figs. 23 and 24). Overall, the highest catches of *L. opalescens* occurred in waters with surface temperatures between 10° and 13°C.

Squalus acanthias—We collected 5,738 specimens of *S. acanthias* at 154 stations in our sampling. They were collected during every cruise but were generally not abundant during the August and September cruises. A broad size range of *S. acanthias* was found over much of the sampling area in June of 1979, but abundances were low at all stations (Fig. 25). Low abundances of mostly smaller individuals were found during June and July of 1981 (Figs. 25 and 26). In contrast, high numbers of *S. acanthias* were found in 1982, especially in the northern transects (Figs. 26 and 27). Several distinct size classes were collected during 1983 but the numbers were lower and the distributions compressed shoreward relative to other years (Figs. 27 and 28). The number of *S. acanthias* caught during June of 1984 was close to that of previous cruises, but numbers again declined by July (Fig. 29). The highest concentrations of *S. acanthias* occurred in waters with surface temperatures between 10° and 14°C.

Clupea harengus pallasi—A total of 7,803 specimens of *Clupea* was collected at 125 stations during this study. They occurred during every cruise, although the number of occurrences during June of 1981 was limited ($n = 2$) and therefore not included as a figure.

Most *C. harengus pallasi* were collected off Yaquina Bay in central Oregon and off the Columbia River in June of 1979 and 1980, respectively (Fig. 30). During 1981, the highest numbers were found close to shore off the Columbia River but were farther offshore off central Oregon (Figs. 31 and 32). Abundances were lower and occurrences closer to shore in the three cruises made during 1982 (Figs. 32 and 33). The distribution was limited during 1983 to the few areas that had relatively cold (<14°C) surface temperatures (Figs. 34 and 35). Abundances were low in 1984, and again the catches were restricted to colder waters, especially in September (Figs. 35 and 36). Overall, the highest catches of *Clupea* were found in waters of relatively cold (10°-14°C) surface temperatures and low (<30⁰/₀₀) surface salinities.

Engraulis mordax—We collected 15,592 specimens of *E. mordax* at 65 stations during our cruises. This species was collected during each of our cruises, although the occurrences during June of 1979, August of 1981, June of 1982, and September of 1983 were few and these were not plotted. In addition, an insufficient number of length measurements was taken on two cruises to present length-frequency diagrams. The distribution of *E. mordax* was similar for most cruises and was centered within the Columbia River plume (Figs. 37 to 42), where the northern subpopulation of northern anchovy is known to spawn (Richardson 1980). During June of 1981, however, this species occurred in high numbers off southern Oregon (Fig. 38), but many of these were juveniles and were possibly advected to the south at this time. The distribution of this species appears to be confined for the most part to waters of surface salinity <30⁰/₀₀.

Merluccius productus—Throughout our survey, we collected 2,680 specimens of *M. productus* at 71 stations. Our catches of this species were highly variable between years, with some years showing high apparent abundances (1982 and 1984) and other years having no catches (1980) or very low catches (1979, 1981, and 1983). During 1982 the catches in May were distributed mostly south of the Columbia River, whereas in June they were found mostly off Washington (Figs. 43 and 44). By September, the catches were centered off the Columbia River (Fig. 44). A similar migration was apparent during the summer of 1984, but the catches were still distributed far to the north in September (Figs. 45 and 46). The highest catches of *M. productus* occurred where surface temperatures fell between 10° and 13°C during most cruises.

Cololabis saira—A total of 1,436 specimens of *C. saira* was collected at 58 stations in this study. This species was not collected in any of the three cruises made during May and was infrequently caught during June and only at the offshore stations where higher water temperatures prevailed. *Cololabis saira* was more abundant during the warmer months of August and September, mostly at the offshore stations (Fig. 47). During the warm years of 1983 and 1984, it was found fairly close to shore (Figs. 48 and 49). A wide size range of *C. saira* was caught and, in some cases, several size classes were evident (Figs. 47 and 49). This species was generally associated with offshore waters with surface temperatures >13°C.

Anoplopoma fimbria—Juveniles of this species were found in very high abundances when they did occur in our samples. We collected 12,967 specimens of *A. fimbria* at 59 stations, mostly from June to September. During June through August of 1981, *A. fimbria* juveniles were found almost exclusively at the outermost one or two stations along each transect (Figs. 50 and 51). There was a steady increase in modal size through these months, which represented the progression of a single (age 0) year class (Boehlert and Yoklavich 1985). Their distribution was closer to shore during September of 1982 and during June and September of 1983 (Figs. 51 and 52). They were again distributed farther offshore during September of 1984 (Fig. 53). Collections of *A. fimbria* were made at stations with surface temperatures ⩾14°C.

Trachurus symmetricus—During our study we collected 5,700 *T. symmetricus* at 58 stations. There were, however, only four occurrences prior to September of 1982, when it occurred in low numbers mostly south of the Columbia River (Fig 54). This species was very abundant thereafter with the exception of the September cruise of 1984. During May of 1983, *T. symmetricus* was found only at the southernmost stations, but by June it was found in large numbers south of the Columbia River (Figs. 54 and 55). By September, this species had reached the northernmost transect, but the bulk of the catches was still south of the Columbia River (Fig. 55). This species was widely dispersed throughout much of the study area during June of 1984 (Fig. 56) and was caught at most stations with surface temperatures exceeding 14°C. Two widely separated length groups were evident during some months (Figs. 55 and 56), representing both juveniles (2-3 yr old) and adults (> 7 yr old; Mallicoate and Parrish 1981). The majority of *T. symmetricus* caught throughout the study were caught in temperatures exceeding 13°C.

Scomber japonicus—This species occurred in very dense concentrations during the warmer years of the study. Altogether, we collected 29,466 specimens of *S. japonicus* at 59 stations. Only two of these specimens, both collected at a single station in June of 1982, were taken prior to 1983. The largest collections of this species in May of 1983 were along the southernmost transects (Fig. 57). By June of 1983, they were distributed throughout much of the study area with very large concentrations located south of the Columbia River. Very high numbers of *S. japonicus* were taken along almost every transect in June of 1984, with the notable exception of a large upwelling area off the central Oregon coast (Fig. 58). Concentrations of this species were less evident during July, and its distribution was restricted to a relatively small area to the south by September (Figs. 58 and 59). Based on our length-frequency data, the majority of the individuals captured were approximately 2-3 years old (Mallicoate and Parrish 1981). Surface temperature appears to be the dominant factor governing the distibution of this species. The majority of *S. japonicus* collected during this survey were taken at stations with water temperatures exceeding 13°C.

Pelagic assemblage analysis

To determine which species tend to be associated together in a similar environment, we used recurrent group analysis (Fager 1957, 1963) to group species according to their co-occurrences. In this analysis, an index of affinity (I) is calculated for all possible species pairs as follows:

$$I = [J_{ab}/[N_a N_b]^{.5}] - \frac{1}{2}[N_b]^{.5}$$

where J_{ab} is the number of joint occurrences, N_a and N_b are the total occurrences of species *a* and *b*, and $N_b \geqslant N_a$. This index ranges from 0.0 (the species pair was never caught in the same sample) to 1.0 (the species pair always co-occurred). Only species which occurred in more than 1.0% of the total number of collections were included in the analysis. All species of juvenile *Sebastes* were combined in our analysis.

Although only occurrence rather than abundance data are used in this analysis, it was considered appropriate for this data set due to slightly different sampling gear used on some cruises and the high variances associated with the numbers of many of the pelagic species sampled. Recurrent group analysis has previously been used with apparent success for pelagic (Cailliet et al. 1979), mesopelagic (McKelvie 1985), and demersal fishes (Fager and Longhurst 1968; Allen 1982).

We initially grouped our species at several different affinity levels and decided that the 0.3 level gave the most biologically interpretable groupings. This level is somewhat lower than that used in most of the previously mentioned studies. The generally low affinity values we found were probably a result of patchiness in the distributions of many of the schooling species and the low number of species per collection. Once the recurrent groups were formed containing all the possible species pairs showing positive affinities, intergroup connections were calculated based on the number of positive affinities divided by the total number of possible pairings between members of the groups.

The results of our analysis for all our collections (Fig. 60) showed several main groups and species that were affiliated with these groups (i.e., showing positive affinities with only some members of the group). A small group of inshore pelagic juvenile fishes was formed containing rockfishes (*Sebastes* spp.) and wolfeels (*A. ocellatus*) and associated kelp greenling (*H. decagrammus*). This inshore juvenile fish group was weakly connected to a large midshelf group which contained many of the dominant species collected in this study. Strongly associated with this main group were American shad (*A. sapidissima*) and black rockfish adults (*S. melanops*). Surf smelt (*H. pretiosus*) and two other main groupings were found to be weakly associated. The first of these includes two main species (*T. symmetricus* and *S. japonicus*) and one associated species (*P. simillimus*) which have centers of distribution south of the study area and tended to occur in our samples only during warm years. The second main grouping consisted of three species (*I. lockingtoni*, *A. fimbria*, and *Mola mola*) which were generally found along the outer shelf region. Associated with this grouping were Pacific saury (*C. saira*) and the king-of-the-salmon (*T. altivelis*) which have centers of distribution offshore of the study area.

DISCUSSION

This study represents the first large-scale survey of the pelagic nekton off Oregon and Washington and presents new information on the abundance and distribution of many epipelagic species of nekton. Many of these species have not been adequately sampled by previous midwater and bottom trawl surveys (e.g., Gabriel 1983). By systematically sampling at predetermined stations during most cruises and by knowing the area sampled, we could make crude estimates of the abundances of many species which are quantitatively sampled by the purse seines. Unfortunately, we do not have precise estimates of the vulnerability of most of the species to our gear. For some midwater and demersal species (i.e., *Merluccius productus* and *Squalus acanthias*), we may be sampling only the upper layers of the population. Diel vertically migrating species, such as *Engraulis mordax*, may be substantially underestimated during daytime collections compared with bottom trawl collections (Laroche and Richardson 1980). Moreover, highly attenuated species (*Cololabis saira*) and juveniles of most species were observed to escape through the meshes during pursing and retrieval of the net, and captures of these species may be considered only as incidental.

The usefulness of this study lies not in estimating precise absolute abundances, but rather in examining seasonal, interannual, and geographic changes in the relative abundance of the various species, particularly those which dominate the catches. Many species of pelagic and demersal fishes are known to show substantial variation in year-class strength (Hollowed et al. in press) and independent (nonfishery) estimates of the stock size are important in characterizing the variability in recruitment patterns.

Along with the substantial environmental changes that occurred within one sampling year were major changes in the relative rank order of abundance (ROA) for the different cruise months. The ROA of the dominant species for May, June, July-August, and September for all years combined are given in Table 5. Although some species were among the ten most abundant for each of the four time periods examined, several trends were apparent in the relative rankings. Several species with cold-water affinities (*Loligo opalescens*, *Squalus acanthias*, *Hypomesus pretiosus*, and *Sebastes* spp. juveniles) generally decreased in relative ROA through the summer. Other species with more warm-water affinities (*Anoplopoma fimbria* juveniles and *Cololabis saira*) generally increased in relative importance through the sampling season. The remainder of the dominant species either showed no change or were inconsistent in their relative ROA patterns. Seasonal variations in the abundance of *Sebastes* spp. and *A. fimbria* may also reflect ontogenetic changes as the juveniles settle out to the adult demersal habitat.

Although some differences in sampling effort occurred among years, the June cruises provided us with a time series of observations with which to make interannual comparisons (Table 6). The rankings during 1978, 1980, and 1981 were similar despite some differences in environmental conditions among the three years. During June of 1982, juvenile rockfishes (*Sebastes* spp.) and northern anchovy (*E. mordax*) decreased in relative importance while two highly migratory species (*M. productus* and *T. symmetricus*) became more important. Major interannual changes in the ROA were associated with the occurrence of the strong El Niño event during June of 1983 and 1984 (Table 6). The dominant taxa (*Loligo opalescens* and *Sebastes* spp.) from 1979-82 had much lower ROA's during the final two years. They were replaced in relative rankings by two species (*Scomber japonicus* and *Trachurus symmetricus*) that usually have centers of distribution off California. Other species with warm-water southern or offshore affinities (*Peprilus simillimus*, *Icichthys lockingtoni*, and *Mola mola*) showed increased abundances during the latter two years (Pearcy et al. 1985).

Spatial variations in abundance may be difficult to interpret because of the many different migration patterns exhibited by these pelagic species. The marine distribution of several anadromous osmerids and estuarine-spawning *C. harengus pallasi* may change seasonally depending on the spawning cycle. Adult *Loligo opalescens* are known to move southward and shoreward in late spring and early summer to spawn off Oregon (Starr 1985), whereas adult *E. mordax* move offshore to spawn, apparently within the Columbia River plume, during summer (Laroche and Richardson 1980). Other species undergo north-south seasonal migrations associated with feeding. For instance, *M. productus* spawn off southern California in the winter, and the juveniles move northward along the shelf in the spring and occupy feeding grounds within our study area during the summer (Bailey et al. 1982). During August, they begin to move offshore and occupy greater depths before migrating south in the fall. During the warm year of 1983, there was a well-

Table 5—Rankings of relative abundance of dominant nonsalmonid nekton by cruise month. Only those species ranked among the most abundant at least two months are listed. Rankings below the top ten are indicated by a dashed line. Numbers of cruises in each sampling period are given in parentheses.

Species	May (3)	June (6)	July-August (3)	September (3)
Scomber japonicus	3	1	6	1
Loligo opalescens	2	2	4	6
Clupea harengus pallasi	5	6	2	4
Engraulis mordax	1	8	3	7
Anoplopoma fimbria	—	9	1	3
Squalus acanthias	4	5	5	—
Merluccius productus	7	7	8	5
Trachurus symmetricus	8	3	9	8
Cololabis saira	—	—	10	2
Sebastes sp.[1]	10	4	—	—
Hypomesus pretiosus	6	10	—	—

[1]Includes juveniles of several species.

Table 6—Rankings of relative abundance of dominant nonsalmonid nekton for June cruises, 1979-84. Only those species ranked among the most abundant at least two years are listed. Rankings below the top ten are indicated by a dashed line.

Species	1979	1980	1981	1982	1983	1984
Loligo opalescens	1	1	1	1	5	4
Squalus acanthias	5	6	4	3	3	3
Clupea harengus pallasi	3	3	9	4	6	5
Sebastes sp.[1]	2	2	2	7	10	—
Trachurus symmetricus	—	—	—	5	2	2
Engraulis mordax	—	4	5	—	4	8
Scomber japonicus	—	—	—	—	1	1
Merluccius productus	—	—	—	2	—	6
Anoplopoma fimbria	—	—	3	—	8	—
Sebastes melanops	—	—	—	6	9	9
Cololabis saira	—	5	10	—	—	—
Alosa sapidissima	8	—	8	—	—	10

[1]Includes juveniles of several species.

defined northward movement of *S. japonicus* and *T. symmetricus* schools through the study area. Some evidence exists that these schools remained within the study area during the winter of 1983-84 (Pearcy et al. 1985); both species were widely distributed throughout the study area in 1984 and *S. japonicus* was found in large numbers off the Canadian coast (Ashton et al. 1985).

Oceanographic measurements taken concurrently with our collections allow us to examine the environmental preferences of these species and may be used to predict which species are likely to occur in a particular water type. Our results suggest that seemingly small changes in surface temperature may be associated with drastic changes in species composition and abundance. For instance, a 1-4°C increase in mean surface temperature between May and June of 1982 and 1983 (Fisher et al. 1984) was associated with a complete shift from an assemblage dominated by northern temperate species (*Loligo opalescens* and *Squalus acanthias*) to an assemblage dominated by more southern fauna (*Scomber japonicus* and *Trachurus symmetricus*). Surface temperature alone, however, may not be an accurate indicator of environmental conditions. A major northward shift in the location of the subarctic boundary caused by an intensification of the northward-flowing Davidson Current during the El Niño resulted in numerous biological anomalies at all trophic levels (Wooster and Fluharty 1985; Mysak 1986). In essence, our study illustrates the indirect effects of a major environmental perturbation, such as the 1982-84 El Niño, on nektonic organisms.

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CITATIONS

ALLEN, L. G., and E. E. DeMARTINI.
1983. Temporal and spatial patterns of nearshore distribution and abundance of the pelagic fishes off San Onofre-Oceanside, California. Fish. Bull., U.S. 81:569-586.

ALLEN, M. J.
1982. Functional structure of soft-bottom fish communities of the Southern California shelf. Ph.D. Thesis, Univ. California, San Diego, 577 p.

ANDERSON, G. C.
1964. The seasonal and geographic distribution of primary productivity off the Washington and Oregon coasts. Limnol. Oceanogr. 9:284-302.

ASHTON, H. J., V. HAIST, and D. M. WARE.
1985. Observations on abundance and diet of Pacific mackerel (*Scomber japonicus*) caught off the west coast of Vancouver Island, September 1984. Can. Tech. Rep. Fish. Aquat. Sci. 1394, 11 p.

BAILEY, K. M., R. C. FRANCIS, and P. R. STEVENS.
1982. The life history and fishery of Pacific whiting, *Merluccius productus*. Calif. Coop. Oceanic Fish. Invest. Rep. 23:81-98.

BARNES, C. A., A. C. DUXBURY, and B. A. MORSE.
1972. Circulation and selected properties of the Columbia River effluent at sea. *In*, A. T. Pruter and D. L. Alverson (eds.), The Columbia River estuary and adjacent ocean waters, p. 41-80. Univ. Wash. Press, Seattle.

BAKUN, A.
1973. Coastal upwelling indices, west coast of North America, 1946-71. U.S. Dep. Commer., NOAA Tech. Rep. NMFS SSRF-671, 103 p.

BOEHLERT, G. W., and M. M. YOKLAVICH.
1985. Larval and juvenile growth of sablefish, *Anoplopoma fimbria*, as determined from otolith increments. Fish. Bull., U.S. 83:475-481.

BOURKE, R. H., B. GLENNE, and B. W. ADAMS.
1971. The nearshore physical oceanographic environment of the Pacific Northwest Coast. Oregon State Univ. Oceanogr. Ref. 71-45, 127 p.

CAILLIET, G. M., K. A. KARPOV, and D. A. AMBROSE.
1979. Pelagic assemblages as determined from purse seine and large midwater trawl catches in Monterey Bay and their affinities with the market squid, *Loligo opalescens*. Calif. Coop. Oceanic. Fish. Invest. Rep. 20:21-30.

CHUNG, A. W.
1985. Relationships between oceanographic factors and the distribution of juvenile coho salmon (*Oncorhynchus kisutch*) off Oregon and Washington, 1982-1983. M.S. Thesis, Oregon State University, Corvallis, 116 p.

FAGER, E. W.
1957. Determination and analysis of recurrent groups. Ecology 38:586-595.
1963. Communities of organisms. *In* M. N. Hill (ed.), The sea, Vol. 2, p. 415-437. New York Interscience Publishers, New York.

FAGER, E. W., and A. R. LONGHURST.
1968. Recurrent group analysis of species assemblages of demersal fish in the Gulf of Guinea. J. Fish. Res. Board Can. 25:1405-1421.

FISHER, J. P., and W. G. PEARCY.
1985. Studies of juvenile salmonids off Northern California, Oregon, Washington and Vancouver Island, 1984. Oregon State Univ. Lab. Ref. 85-2, 24 p.
FISHER, J. P., W. G. PEARCY, and A. W. CHUNG.
1983. Studies of juvenile salmonids off the Oregon and Washington coast, 1982. Oregon State Univ. Lab. Ref. 83-2, 41 p.
1984. Studies of juvenile salmonids off the Oregon and Washington coast, 1983. Oregon State Univ. Lab. Ref. 84-2, 29 p.
GABRIEL, W. L.
1983. Structure and dynamics of Northeastern Pacific demersal fish assemblages. PhD Thesis, Oregon State Univ., Corvallis, 298 p.
HIXON, R. F.
1983. *Loligo opalescens*. *In* P. R. Boyle (ed.), Cephalopod life cycles, Vol. 1, p. 95-114. Academic Press, London.
HOLLOWED, A. B., K. M. BAILEY, and W. S. WOOSTER.
In press. Patterns in recruitment of marine fishes in the Northeast Pacific Ocean. Biol. Oceanogr.
HUYER, A.
1977. Seasonal variation in temperature, salinity, and density over the continental shelf off Oregon. Limnol. Oceanogr. 22:442-453.
HUYER, A., and R. L. SMITH.
1978. Physical characteristics of Pacific Northwestern coastal waters. *In* R. Knauss (ed.), The marine plant biomass of the Pacific Northwest Coast, p. 37-55. Oregon State Univ. Press, Corvallis.
LAROCHE, J. L., and S. L. RICHARDSON.
1980. Reproduction of northern anchovy, *Engraulis mordax*, off Oregon and Washington. Fish. Bull., U.S. 78:603-618.
MAIS, K. F.
1974. Pelagic fish surveys in the California Current. Calif. Dep. Fish Game Fish Bull. 162:1-79.
MALLICOATE, D. L., and R. H. PARRISH.
1981. Seasonal growth patterns of California stocks of northern anchovy, *Engraulis mordax*, Pacific mackerel, *Scomber japonicus*, and jack mackerel, *Trachurus symmetricus*. Calif. Coop. Oceanic Fish. Invest. Rep. 22:69-81.
McKELVIE, D. S.
1985. Discreteness of pelagic faunal regions. Mar. Biol. (Berl.) 88:125-133.
MYSAK, L. A.
1986. El Niño, interannual variability and fisheries in the northeast Pacific Ocean. Can. J. Fish. Aquat. Sci. 43:464-497.
PEARCY, W. G.
1979. Preliminary results on the juvenile salmonids caught on the cruise of the F/V *Flamingo*, June 18-29, 1979. Unpubl. rep., College of Oceanography, Oregon State University, Corvallis, OR 97331.
1980. Cruise report: F/V *Flamingo*, June 20-28, 1980. Unpubl. rep., College of Oceanography, Oregon State University, Corvallis, OR 97331.
1984. Where do all the coho go? The biology of juvenile coho salmon off the coasts of Oregon and Washington. *In*, W. G. Pearcy (ed.), The influence of ocean conditions on the production of salmonids in the North Pacific, p. 50-60. Sea Grant Oregon State Univ. Publ. ORESU-W-83-001, Corvallis.
PEARCY, W., J. FISHER, R. BRODEUR, and S. JOHNSON.
1985. Effects of the 1983 El Niño on coastal nekton off Oregon and Washington. *In*. W. S. Wooster and D. L Fluharty (eds.), El Niño North: Niño effects in the Eastern Subarctic Pacific Ocean, p. 188-204. Wash. Sea Grant Prog. Publ. 85-3, Seattle, Wash.
PETERSON, W. T., C. B. MILLER, and A. HUTCHINSON.
1979. Zonation and maintenance of copepod populations in the Oregon upwelling zone Deep-sea Res. 26:467-494.
RICHARDSON, S. L.
1980. Spawning biomass and early life history of northern anchovy, *Engraulis mordax*, in the northern subpopulation off Oregon and Washington. Fish. Bull., U.S. 78:855-876.
ROBINS, C. R., R. M. BAILEY, C. E. BOND, J. R. BROOKER, E. A. LACHNER, R. N. LEA, and W. B. SCOTT.
1980. A list of the common and scientific names of fishes from the United States and Canada. Am. Fish. Soc., Spec. Publ. 12, Bethesda, Md., 174 p.
ROPER C. F. E., M. J. SWEENEY, and C. E. NAUEN.
1984. Cephalopods of the world. FAO Fish. Synop. 125 (3), 277 p.
SMALL, L. F., and D. W. MENZIES.
1981. Patterns of primary productivity and biomass in a coastal upwelling region. Deep-sea Res. 28:123-149.
SMITH, P. E.
1970. The horizontal dimensions and abundance of fish schools in the upper mixed layer as measured by sonar. *In* G. B. Farquhar (ed.), Proc. Int. Symp. on Biological Sound Scattering in the Ocean, p. 563-600. Maury Cent. Ocean Sci., Wash., D.C.
SMITH, R. L.
1968. Upwelling. Oceanogr. Mar. Biol. Annu. Rev. 6:11-46.
SQUIRE, J. L., Jr.
1983. Abundance of pelagic resources off California, 1963-78, as measured by an airborne fish monitoring program. U.S. Dep. Commer., NOAA Tech. Rep. NMFS SSRF-762, 75 p.
STARR, R. M.
1985. Hydroacoustic estimates of squid (*Loligo opalescens*) abundance off Oregon in 1985. Oregon Dep. Fish. Wildl. Inf. Rep. 85-9, 41 p.
WAKEFIELD, W. W., J. P. FISHER, and W. G. PEARCY.
1981. Studies of juvenile salmonids off the Oregon and Washington coast, 1981. Oregon State Univ. Lab. Ref. 81-13, 51 p.
WOOSTER, W. S., and D. L. FLUHARTY (editors).
1985. El Niño North: Niño effects in the Eastern Subarctic Pacific Ocean. Wash. Sea Grant Prog. Publ. 85-3, Seattle, Wash., 312 p.

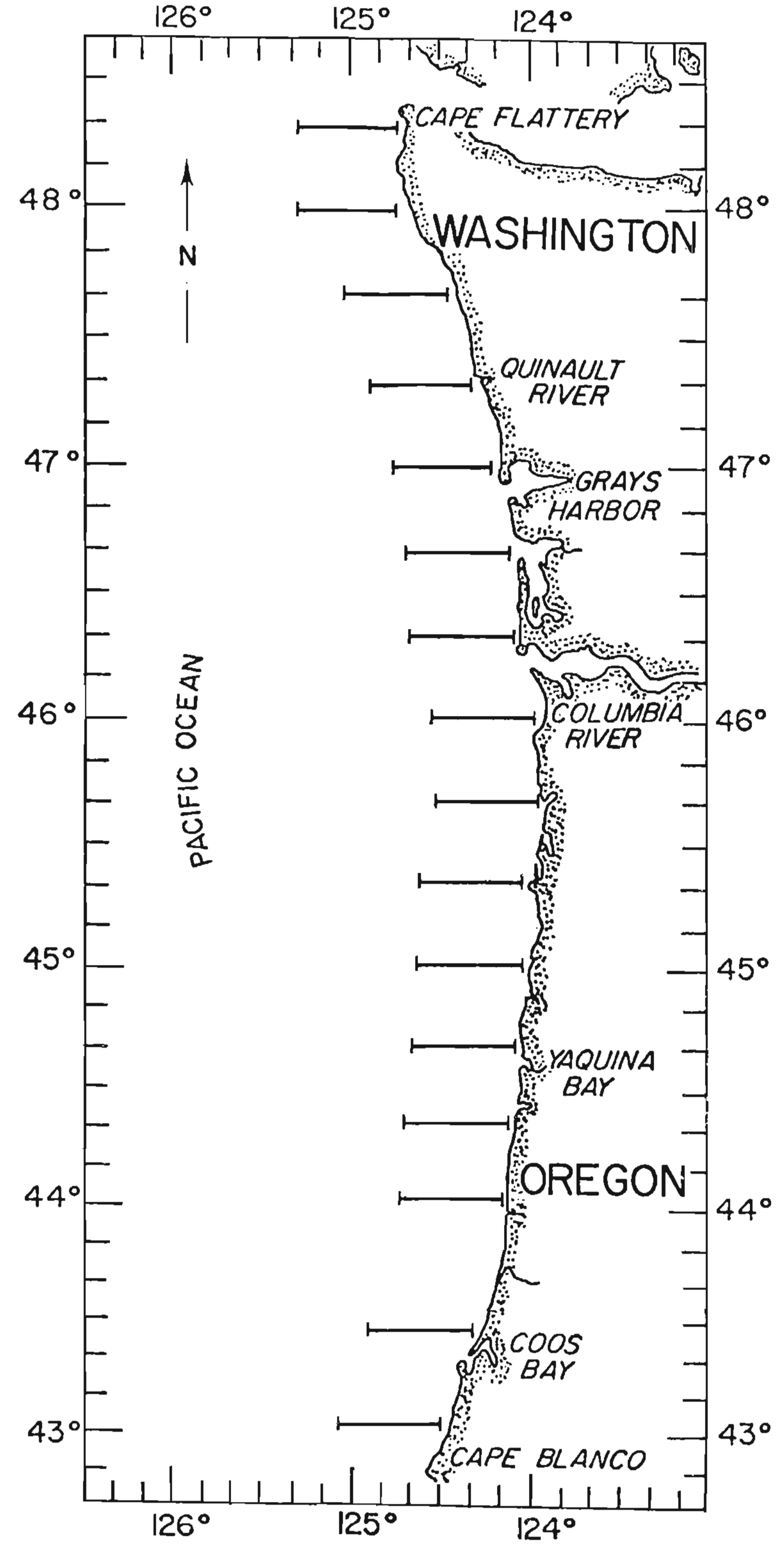


Figure 1
Location of sampling area and transect lines used in the study.

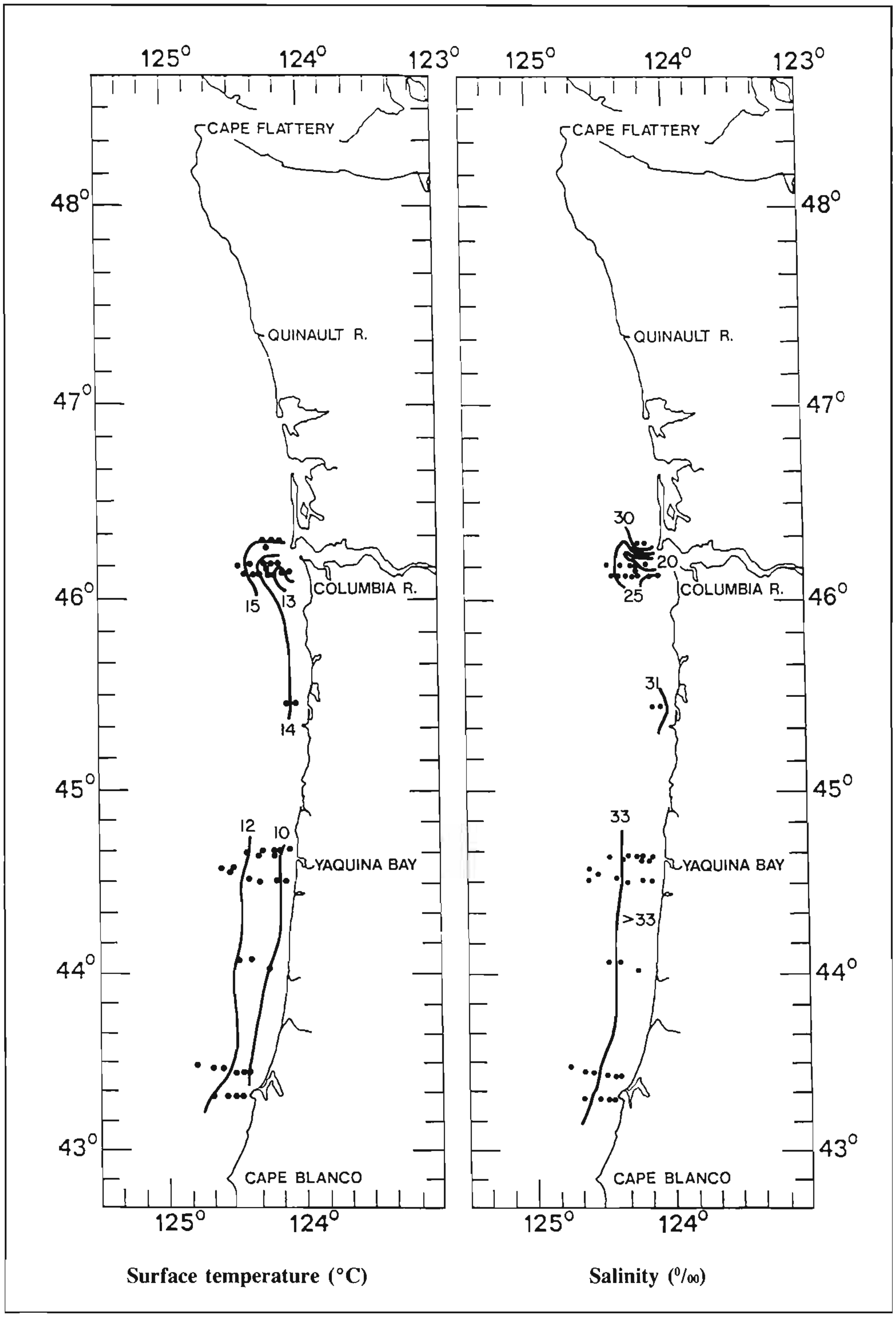


Figure 2
Station locations and isopleths of surface temperature and salinity, June 1979.

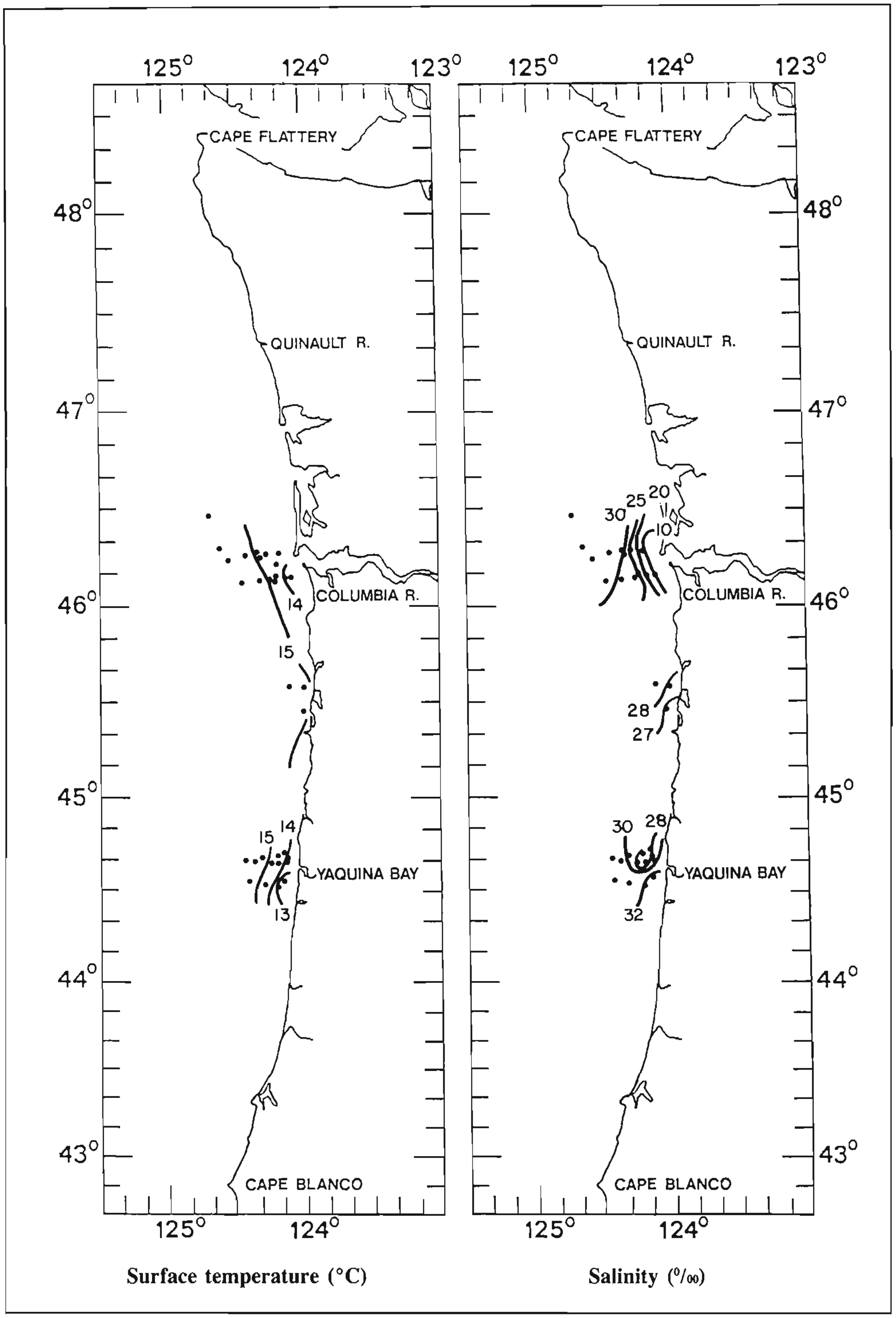


Figure 3

Station locations and isopleths of surface temperature and salinity, June 1980.

Figures 4 through 16

Station locations and isopleths of surface temperature, salinity, and chlorophyll *a*, summer 1981-84.

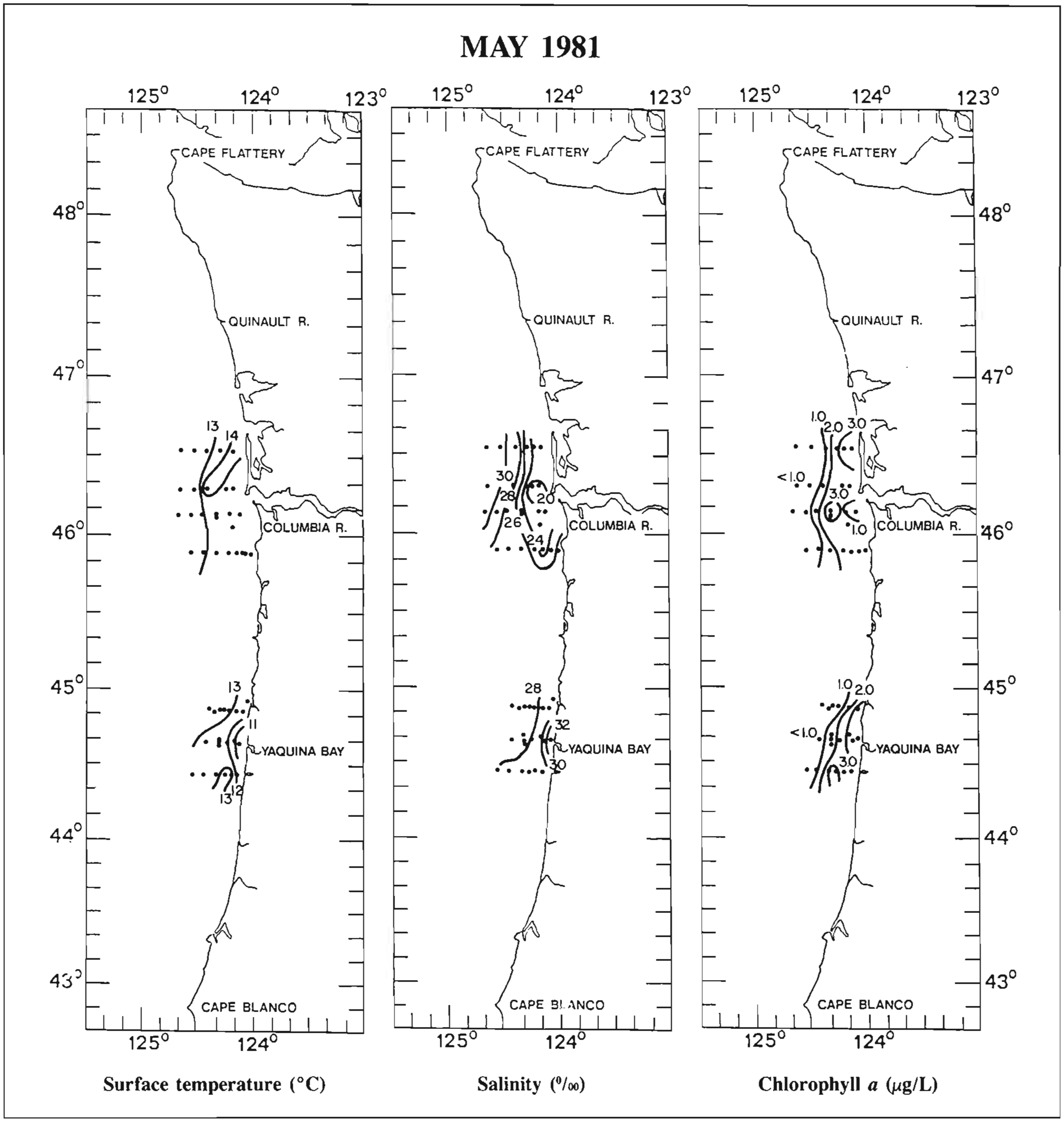


Figure 4

JUNE 1981

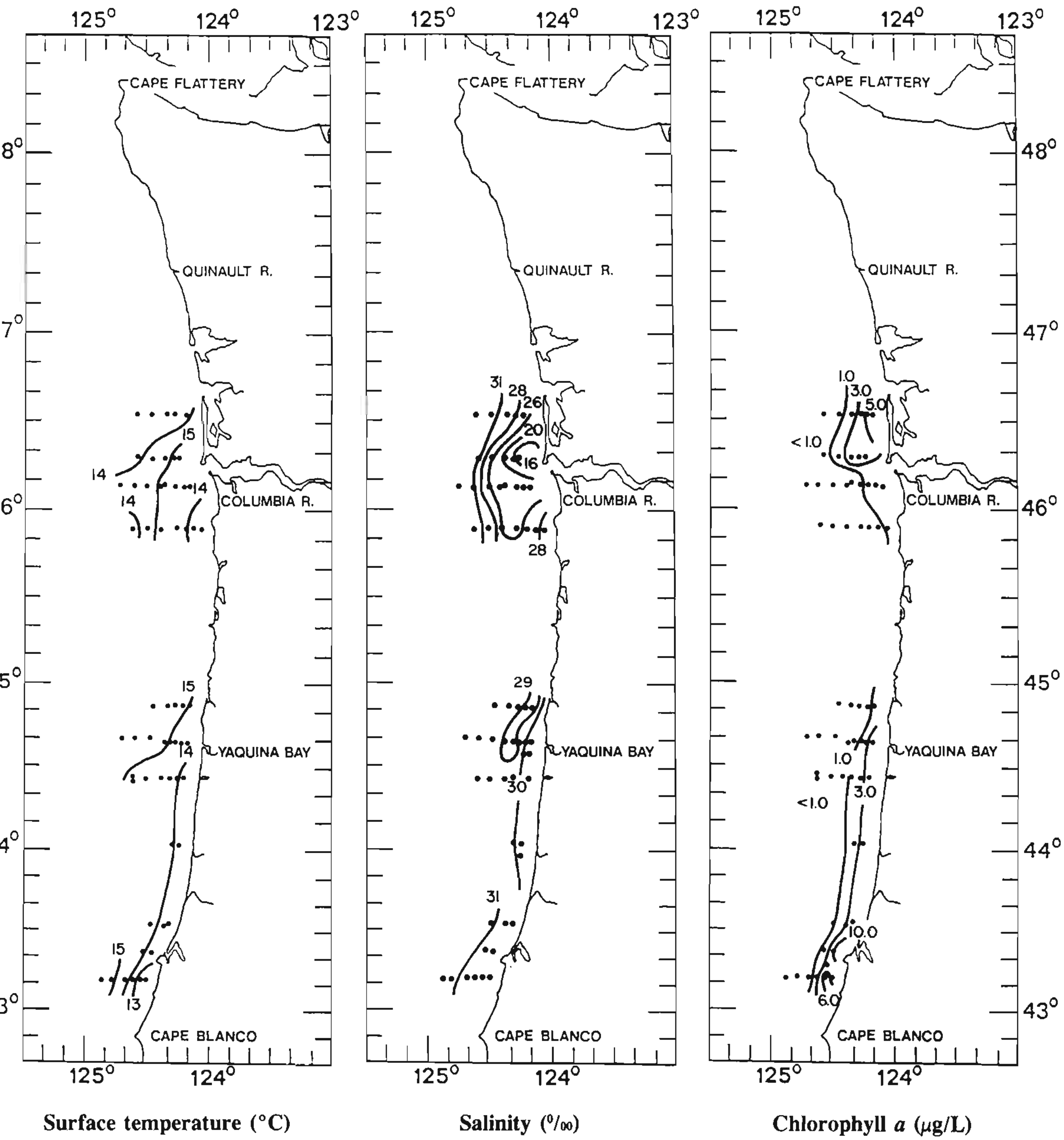
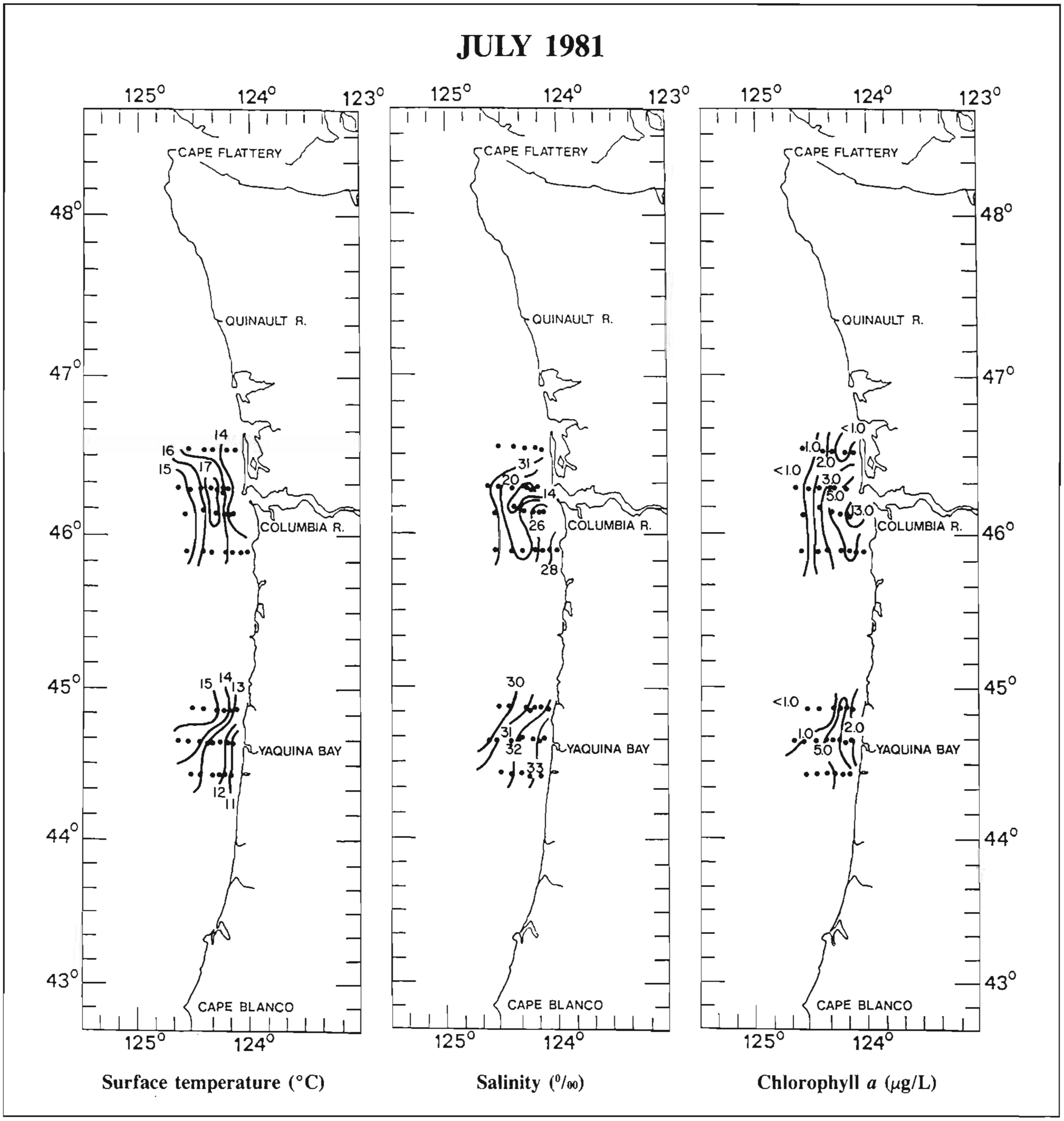
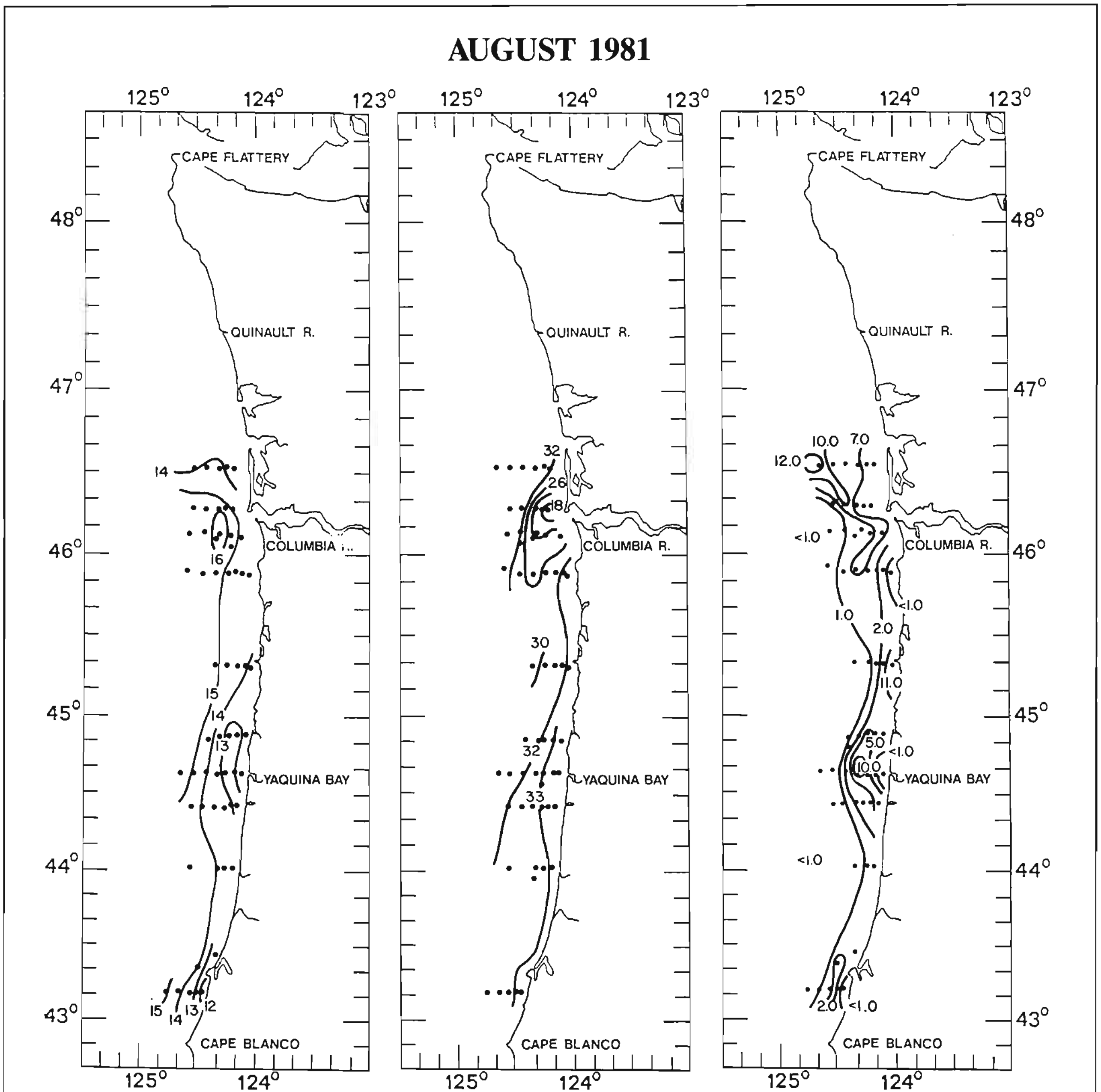


Figure 5



JULY 1981
125° 124° 123°
CAPE FLATTERY
QUINAULT R.
COLUMBIA R.
YAQUINA BAY
CAPE BLANCO
48° 47° 46° 45° 44° 43°
Surface temperature (°C)
Salinity (‰)
Chlorophyll a (μg/L)

Figure 6



Surface temperature (°C)   Salinity (‰)   Chlorophyll *a* (μg/L)

Figure 7

MAY 1982

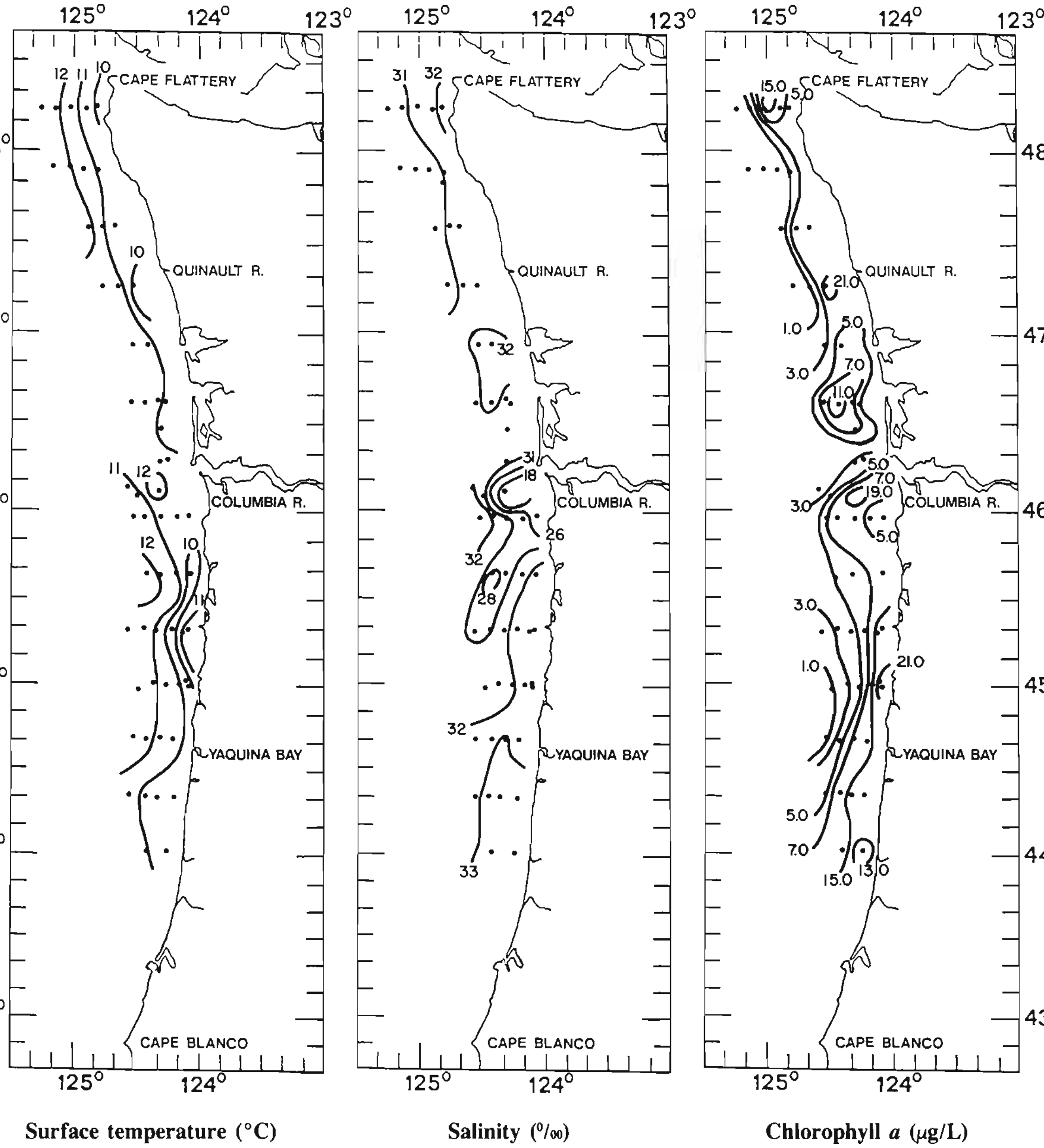


Figure 8

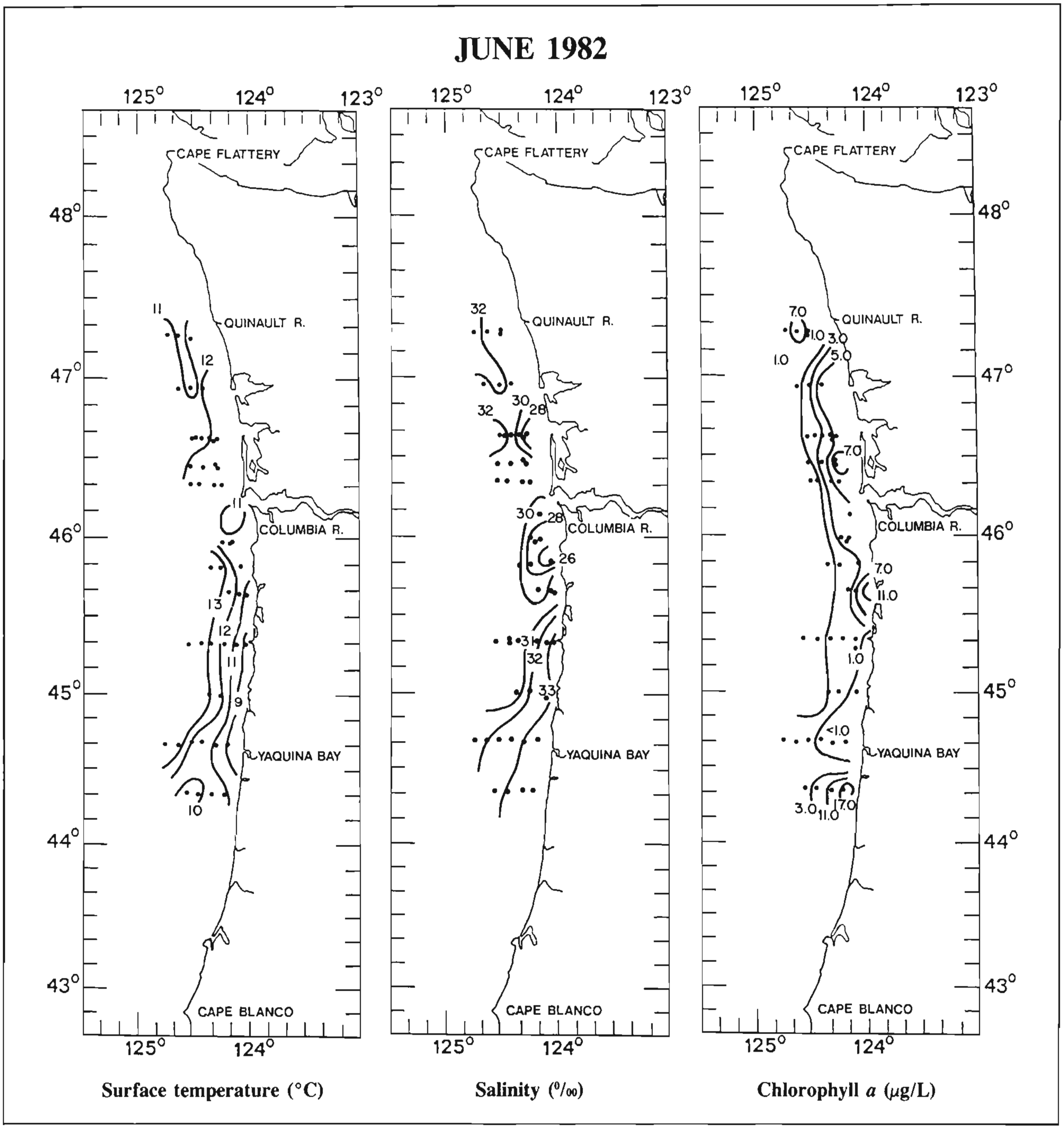

JUNE 1982
125°
124°
123°
CAPE FLATTERY
QUINAULT R.
COLUMBIA R.
YAQUINA BAY
CAPE BLANCO
48°
47°
46°
45°
44°
43°
Surface temperature (°C)
Salinity (‰)
Chlorophyll a (µg/L)

Figure 9

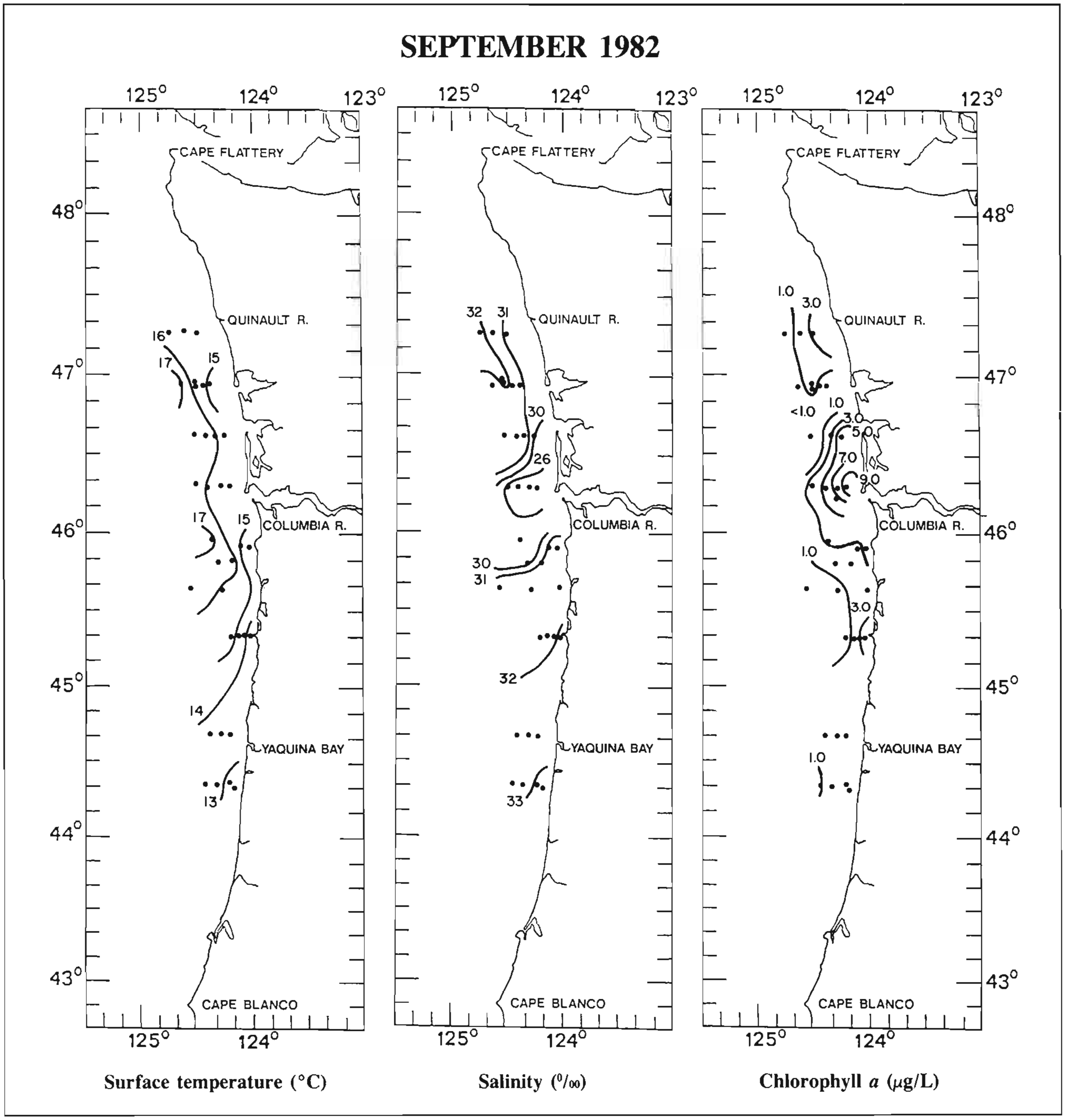

SEPTEMBER 1982
125°
124°
123°
CAPE FLATTERY
48°
47°
46°
45°
44°
43°
QUINAULT R.
COLUMBIA R.
YAQUINA BAY
CAPE BLANCO
16
17
15
17
15
14
13
32
31
30
26
30
31
32
33
1.0
3.0
<1.0
1.0
3.0
5.0
7.0
9.0
1.0
3.0
1.0
Surface temperature (°C)
Salinity (‰)
Chlorophyll *a* (μg/L)

Figure 10

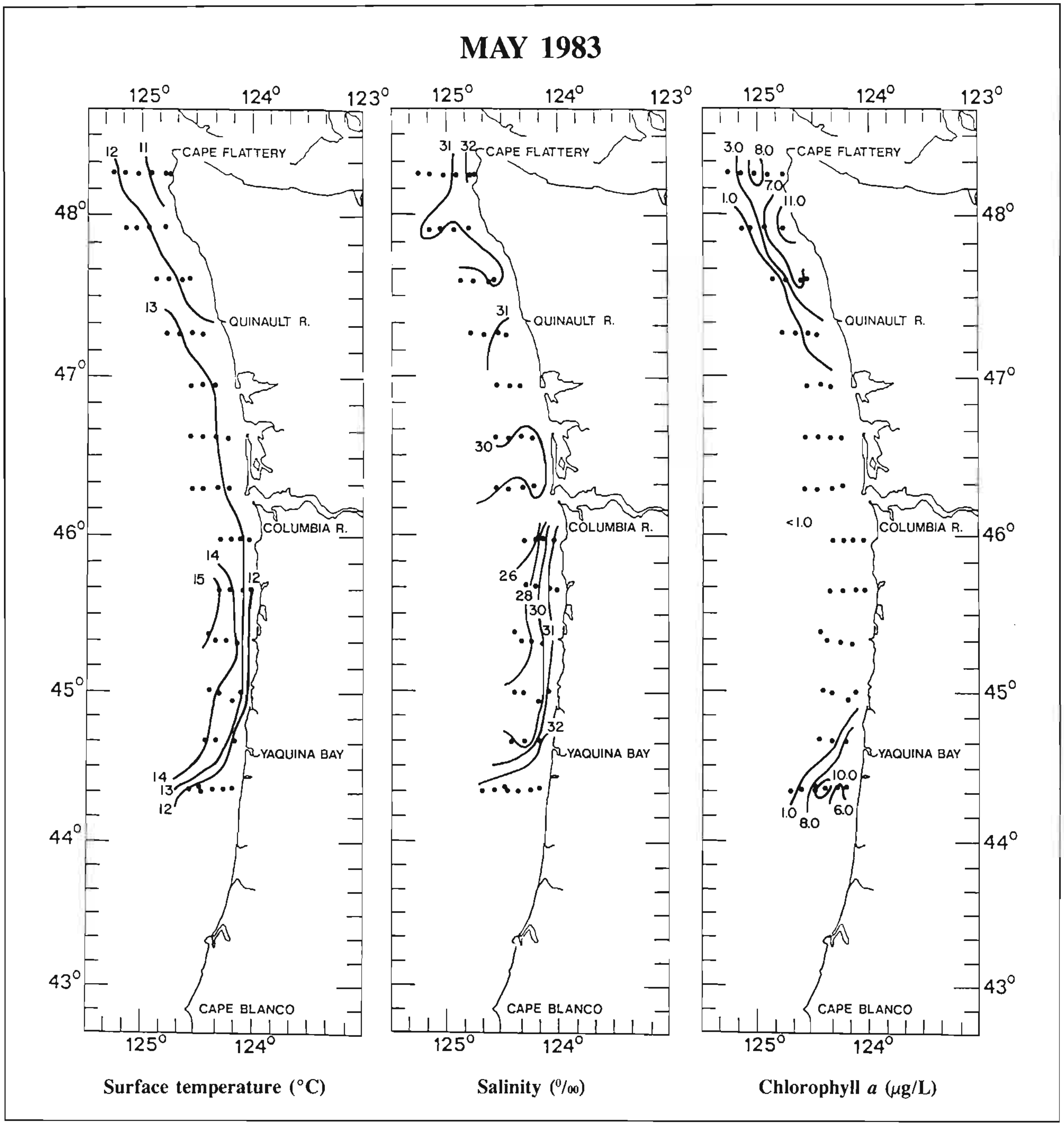

MAY 1983
125°
124°
123°
48°
47°
46°
45°
44°
43°
CAPE FLATTERY
QUINAULT R.
COLUMBIA R.
YAQUINA BAY
CAPE BLANCO
Surface temperature (°C)
Salinity (⁰/₀₀)
Chlorophyll *a* (µg/L)

Figure 11

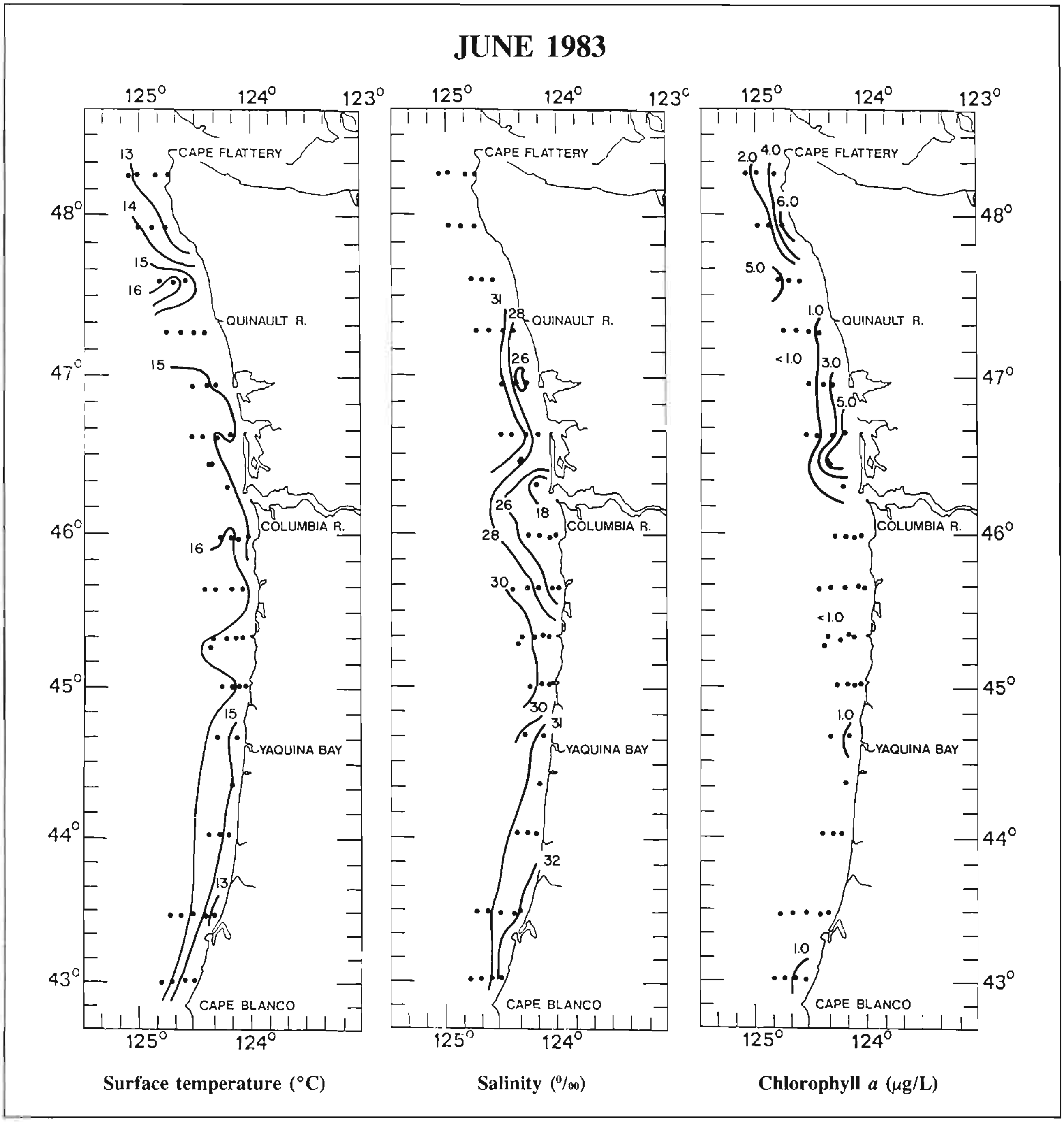

JUNE 1983
125°
124°
123°
CAPE FLATTERY
QUINAULT R.
COLUMBIA R.
YAQUINA BAY
CAPE BLANCO
48°
47°
46°
45°
44°
43°
13
14
15
16
15
16
15
13
31
28
26
26
18
28
30
30
31
32
2.0
4.0
6.0
5.0
1.0
<1.0
3.0
5.0
<1.0
1.0
1.0
Surface temperature (°C)
Salinity (°/oo)
Chlorophyll a (μg/L)

Figure 12

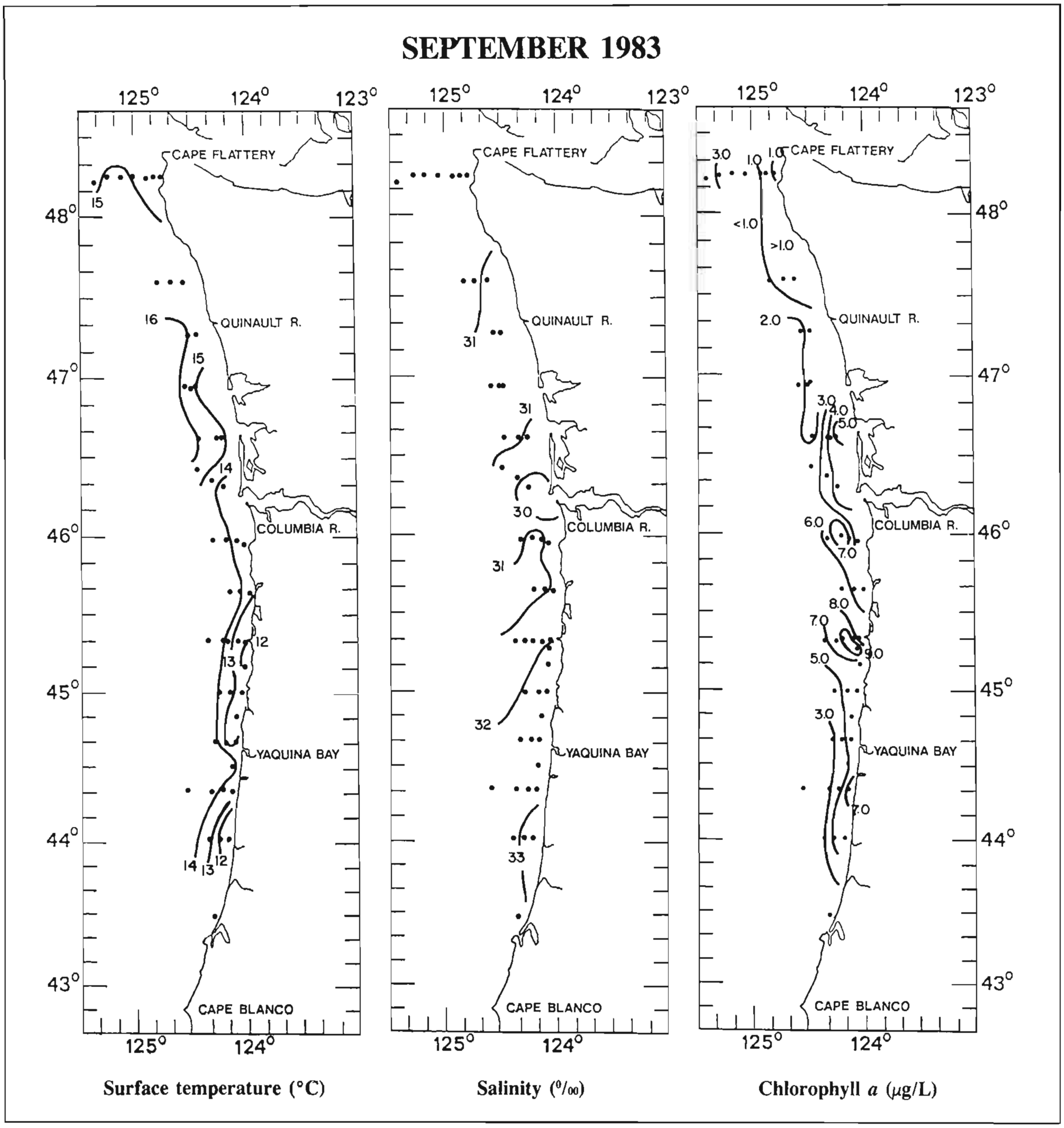

SEPTEMBER 1983
CAPE FLATTERY
QUINAULT R.
COLUMBIA R.
YAQUINA BAY
CAPE BLANCO
125°
124°
123°
48°
47°
46°
45°
44°
43°
Surface temperature (°C)
Salinity (‰)
Chlorophyll *a* (μg/L)

Figure 13

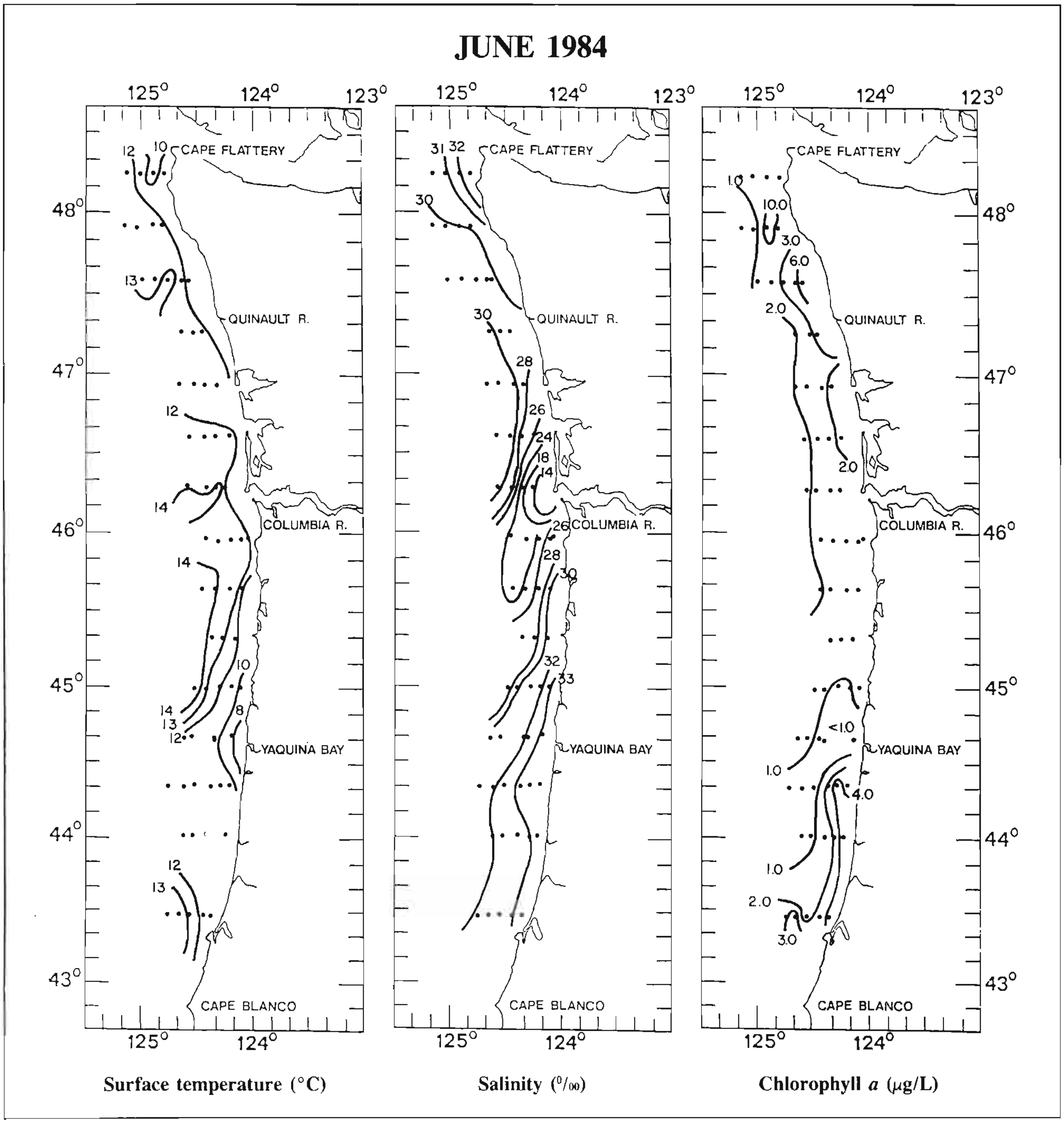

JUNE 1984
125°
124°
123°
CAPE FLATTERY
QUINAULT R.
COLUMBIA R.
YAQUINA BAY
CAPE BLANCO
48°
47°
46°
45°
44°
43°
Surface temperature (°C)
Salinity (°/₀₀)
Chlorophyll *a* (μg/L)

Figure 14

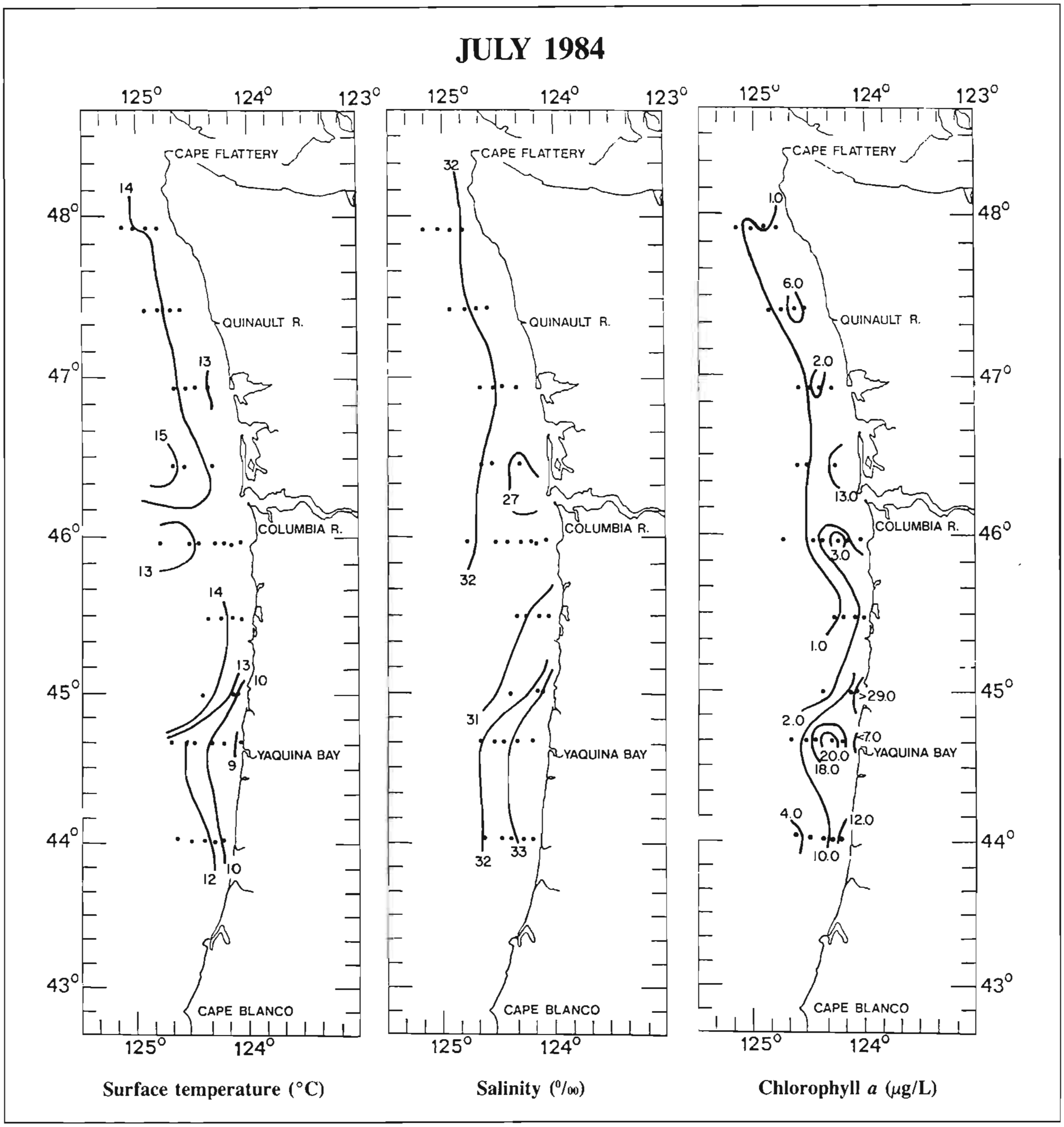
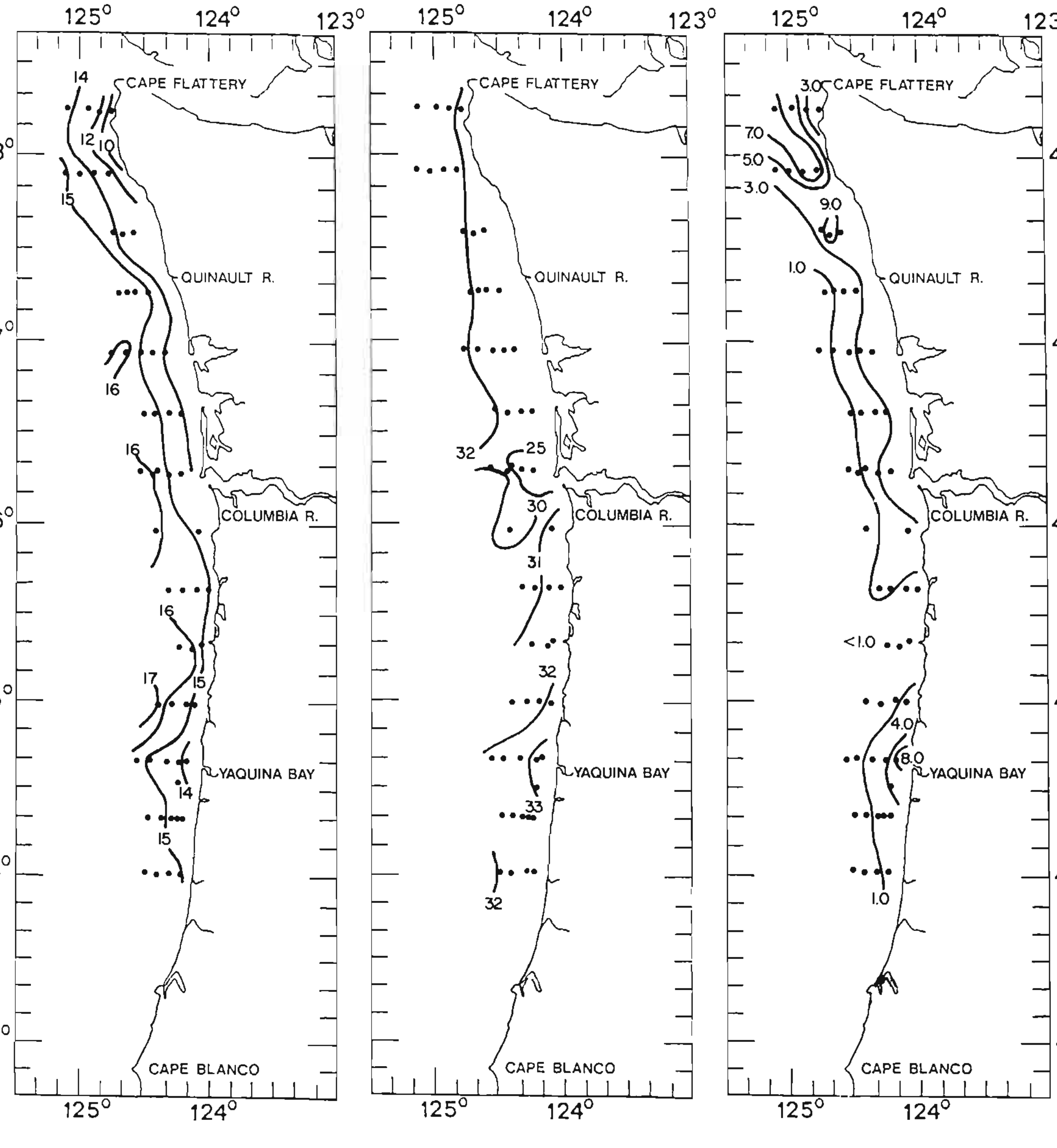

JULY 1984
125°
124°
123°
48°
47°
46°
45°
44°
43°
CAPE FLATTERY
QUINAULT R.
COLUMBIA R.
YAQUINA BAY
CAPE BLANCO
14
13
15
13
14
13
10
9
12
10
32
27
32
31
32
33
1.0
6.0
2.0
13.0
3.0
1.0
>29.0
2.0
<7.0
20.0
18.0
4.0
12.0
10.0
Surface temperature (°C)
Salinity (‰)
Chlorophyll a (μg/L)

Figure 15

SEPTEMBER 1984



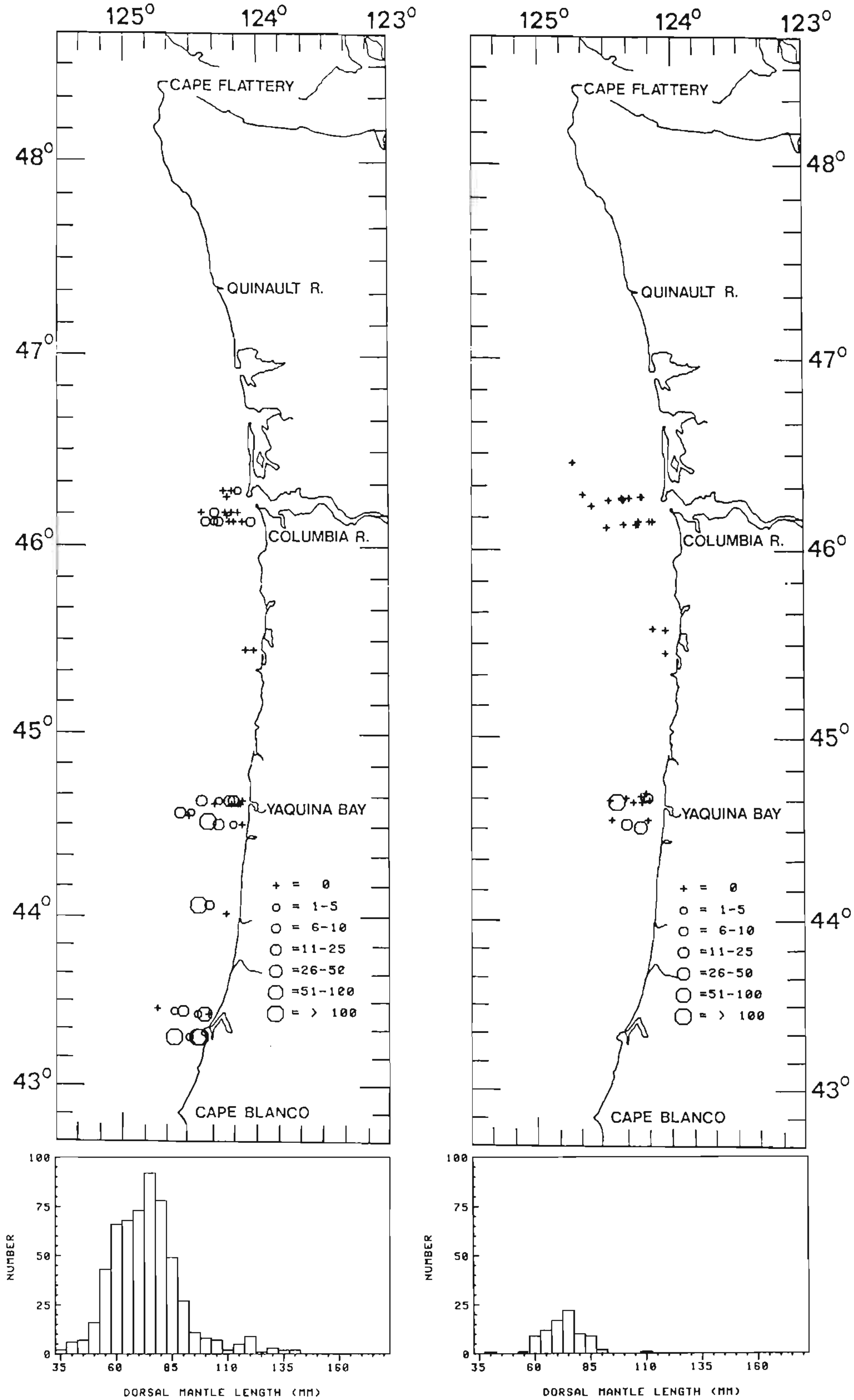
Surface temperature (°C) — Salinity (‰) — Chlorophyll *a* (µg/L)

Figure 16

Figures 17 through 59

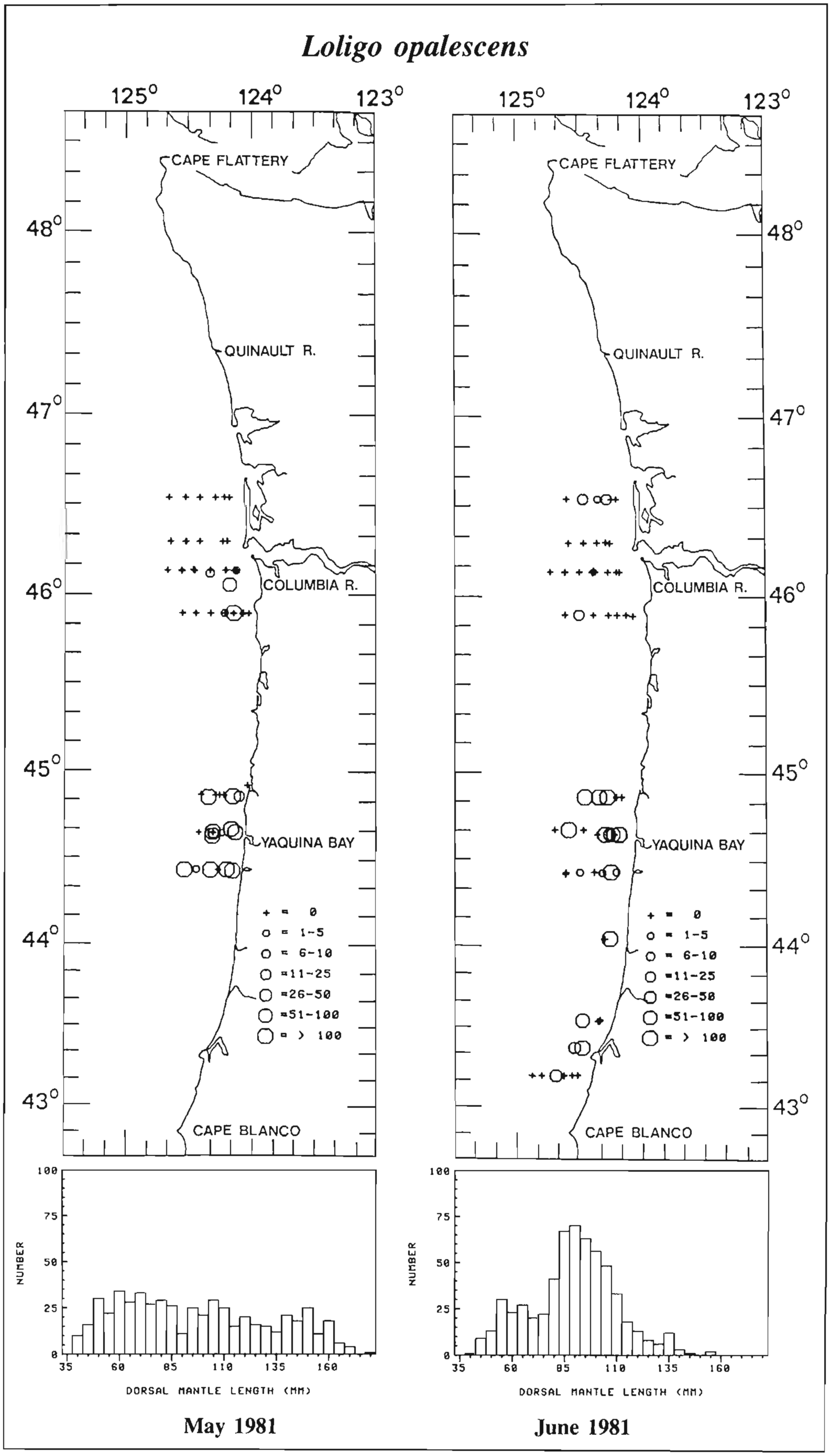
Distribution, relative abundance and length-frequency distributions of dominant species in summer catches, 1979-84.

Loligo opalescens



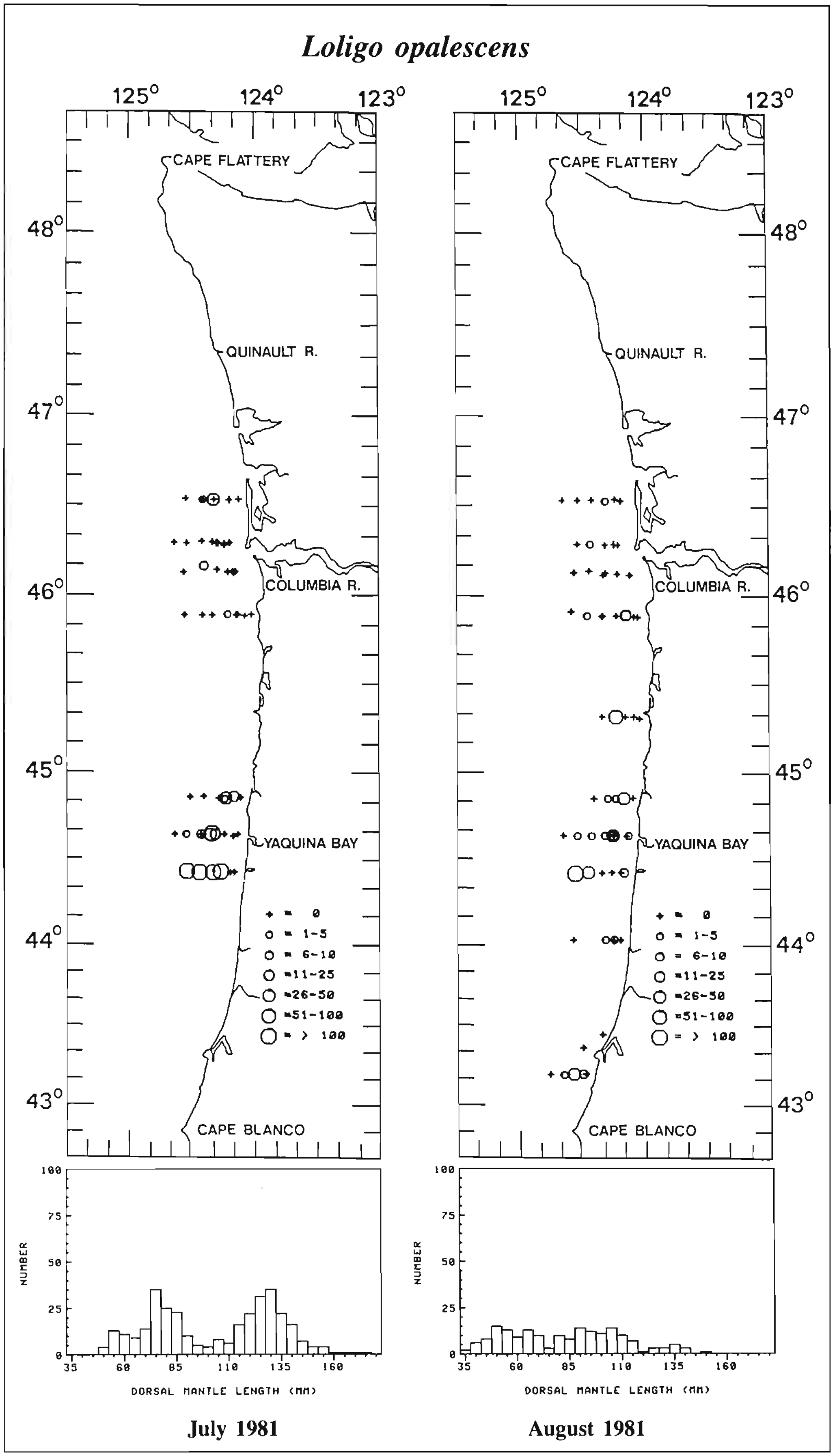
June 1979 **June 1980**

Figure 17



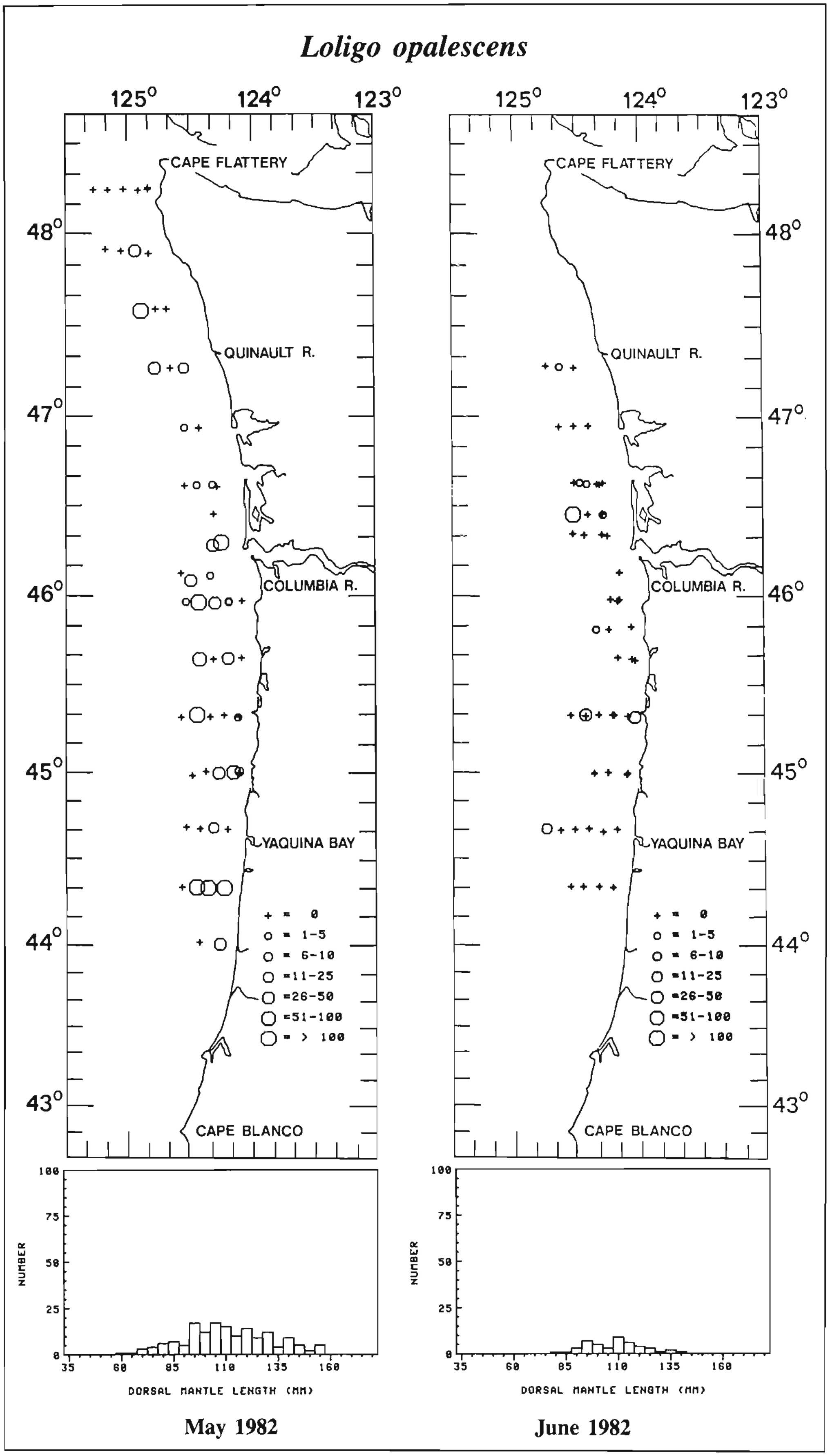
Loligo opalescens
125°
124°
123°
CAPE FLATTERY
QUINAULT R.
COLUMBIA R.
YAQUINA BAY
CAPE BLANCO
48°
47°
46°
45°
44°
43°
+ = 0
○ = 1-5
○ = 6-10
○ =11-25
○ =26-50
○ =51-100
○ = > 100
NUMBER
DORSAL MANTLE LENGTH (MM)
May 1981
June 1981

Figure 18



Loligo opalescens
125°
124°
123°
48°
47°
46°
45°
44°
43°
CAPE FLATTERY
QUINAULT R.
COLUMBIA R.
YAQUINA BAY
CAPE BLANCO
+ = 0
o = 1-5
O = 6-10
O =11-25
O =26-50
O =51-100
O = > 100
NUMBER
DORSAL MANTLE LENGTH (MM)
July 1981
August 1981

Figure 19



Loligo opalescens
125°
124°
123°
48°
47°
46°
45°
44°
43°
CAPE FLATTERY
QUINAULT R.
COLUMBIA R.
YAQUINA BAY
CAPE BLANCO
+ = 0
o = 1-5
O = 6-10
O =11-25
O =26-50
O =51-100
O = > 100
NUMBER
DORSAL MANTLE LENGTH (MM)
May 1982
June 1982

Figure 20

Loligo opalescens

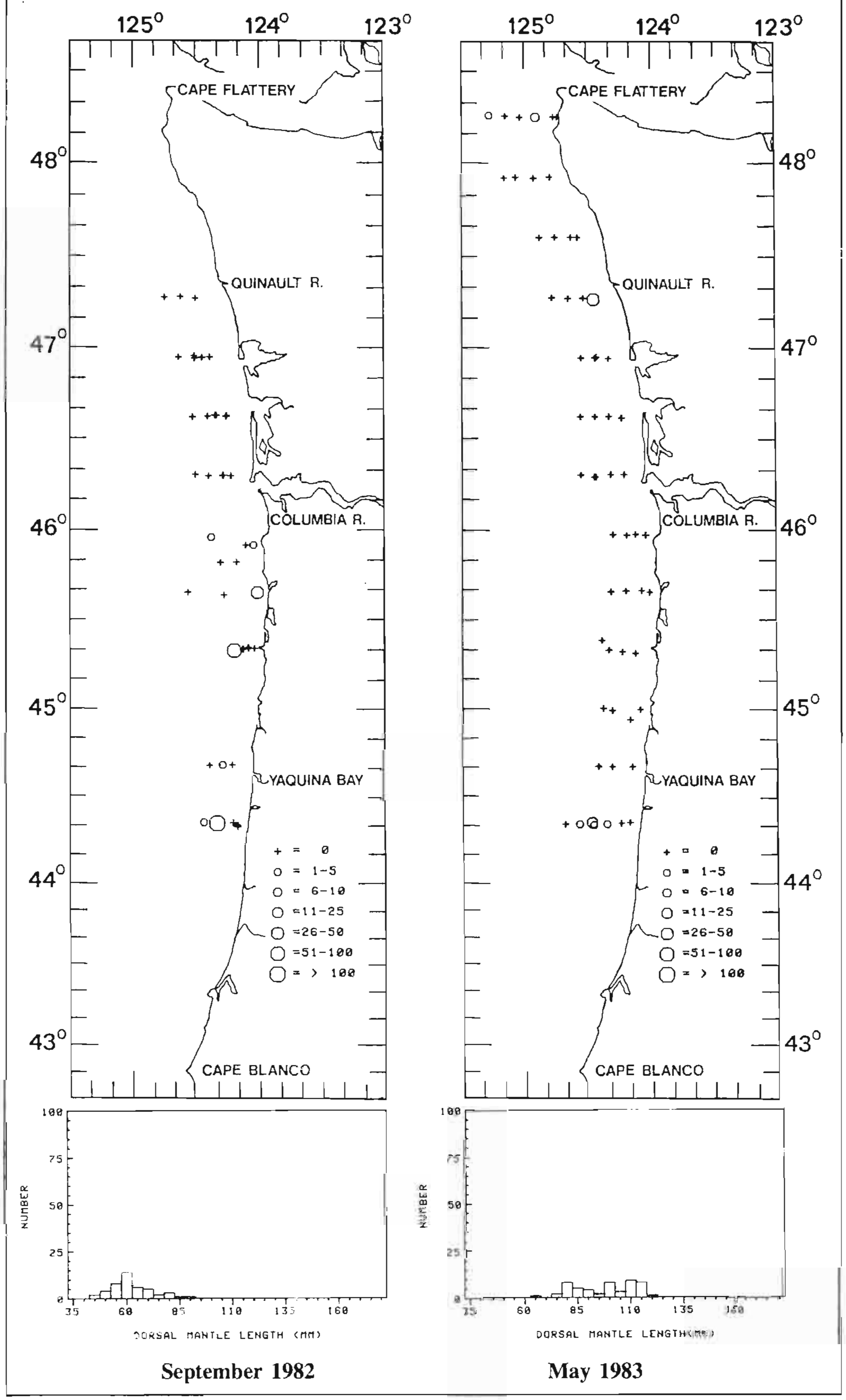


Figure 21

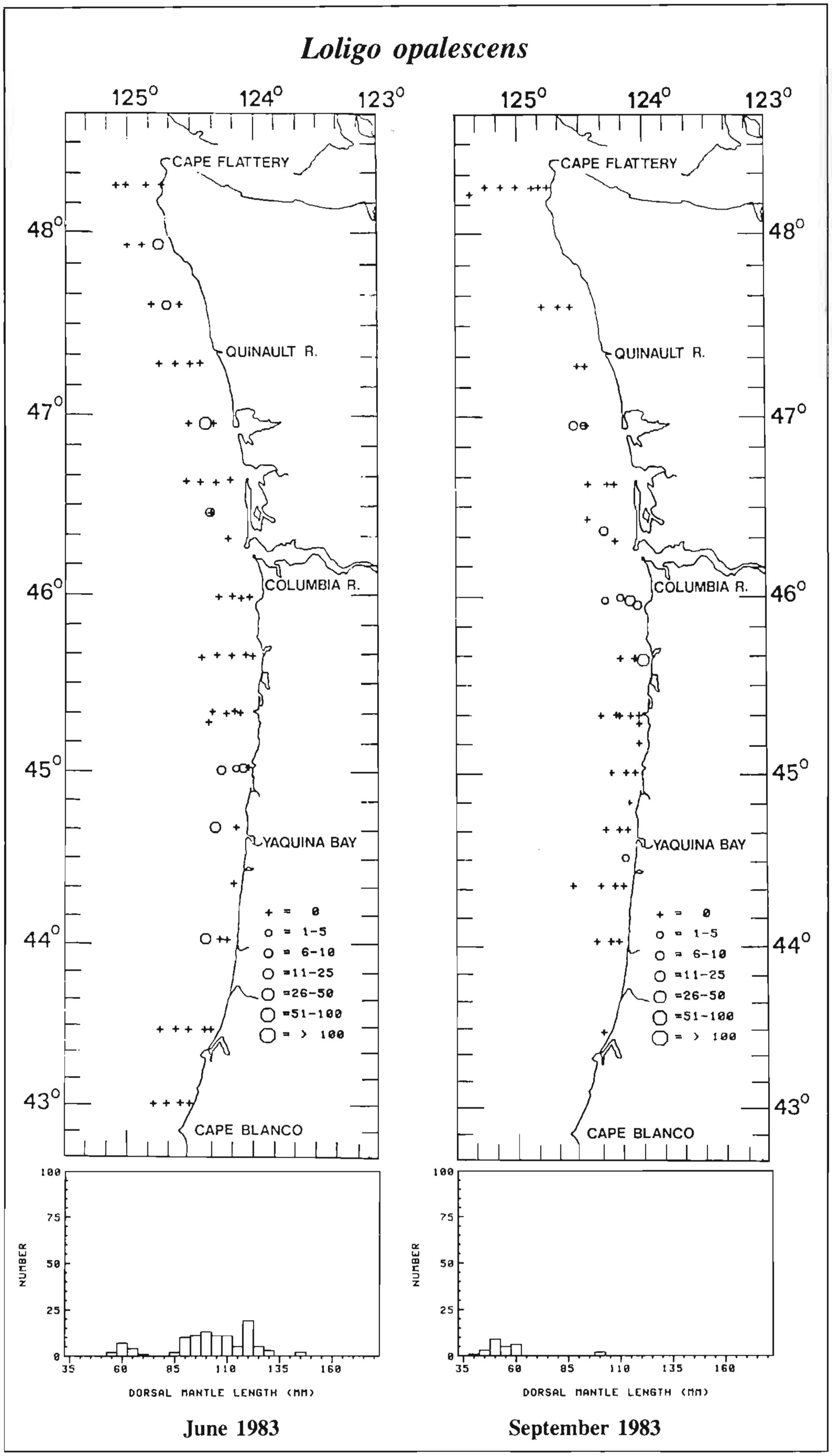
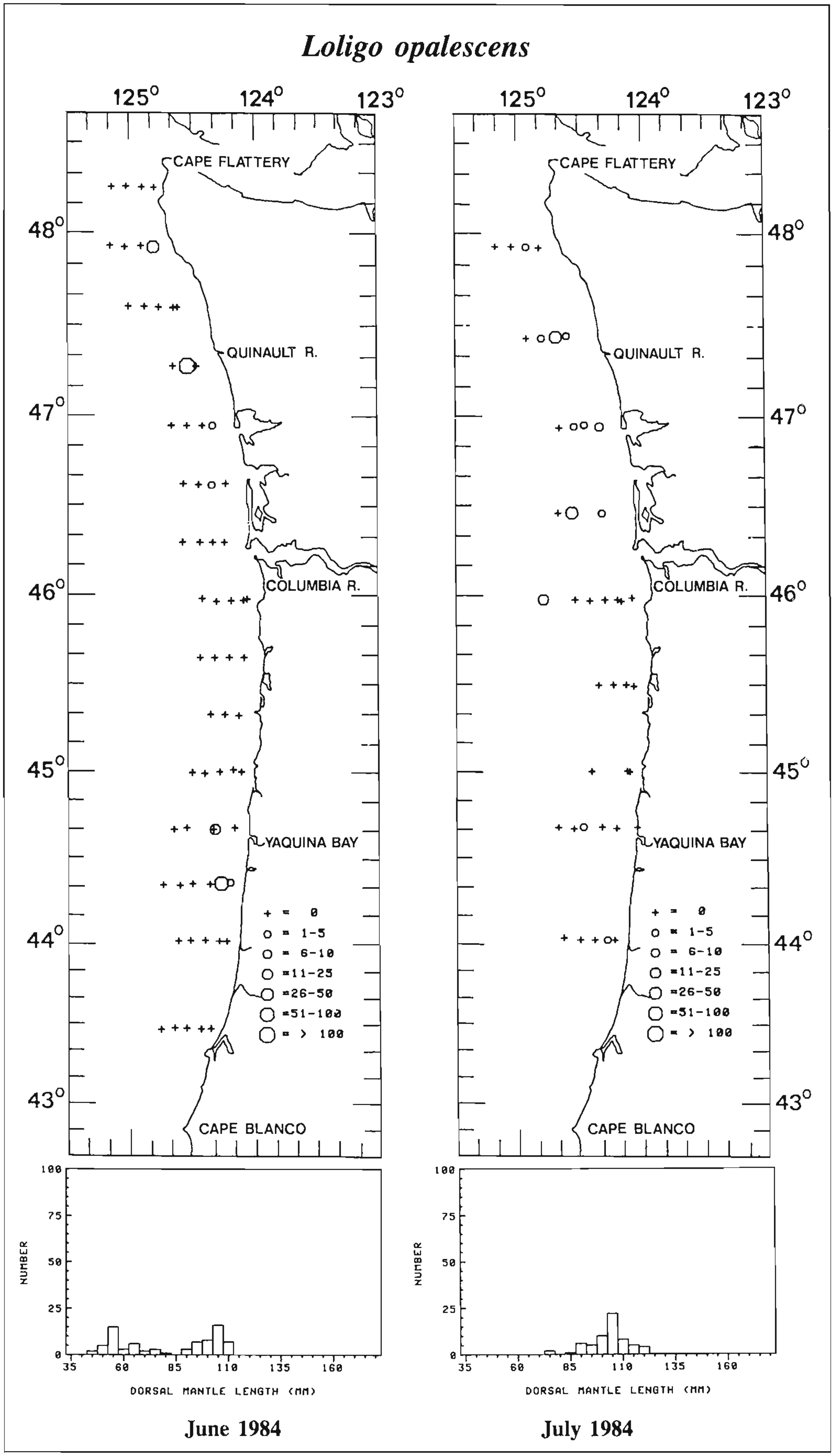

Loligo opalescens
125°
124°
123°
CAPE FLATTERY
QUINAULT R.
COLUMBIA R.
YAQUINA BAY
CAPE BLANCO
48°
47°
46°
45°
44°
43°
+ = 0
o = 1-5
O = 6-10
O =11-25
O =26-50
O =51-100
O = > 100
NUMBER
DORSAL MANTLE LENGTH (MM)
June 1983
September 1983

Figure 22



Loligo opalescens
125°
124°
123°
CAPE FLATTERY
QUINAULT R.
COLUMBIA R.
YAQUINA BAY
CAPE BLANCO
48°
47°
46°
45°
44°
43°
+ = 0
○ = 1-5
○ = 6-10
○ =11-25
○ =26-50
○ =51-100
○ = > 100
NUMBER
DORSAL MANTLE LENGTH (MM)
June 1984
July 1984

Figure 23

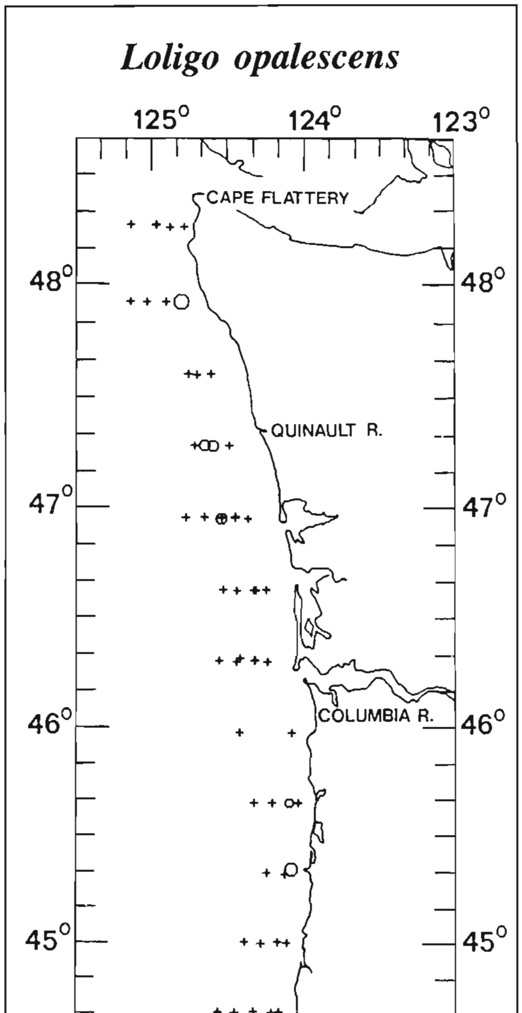
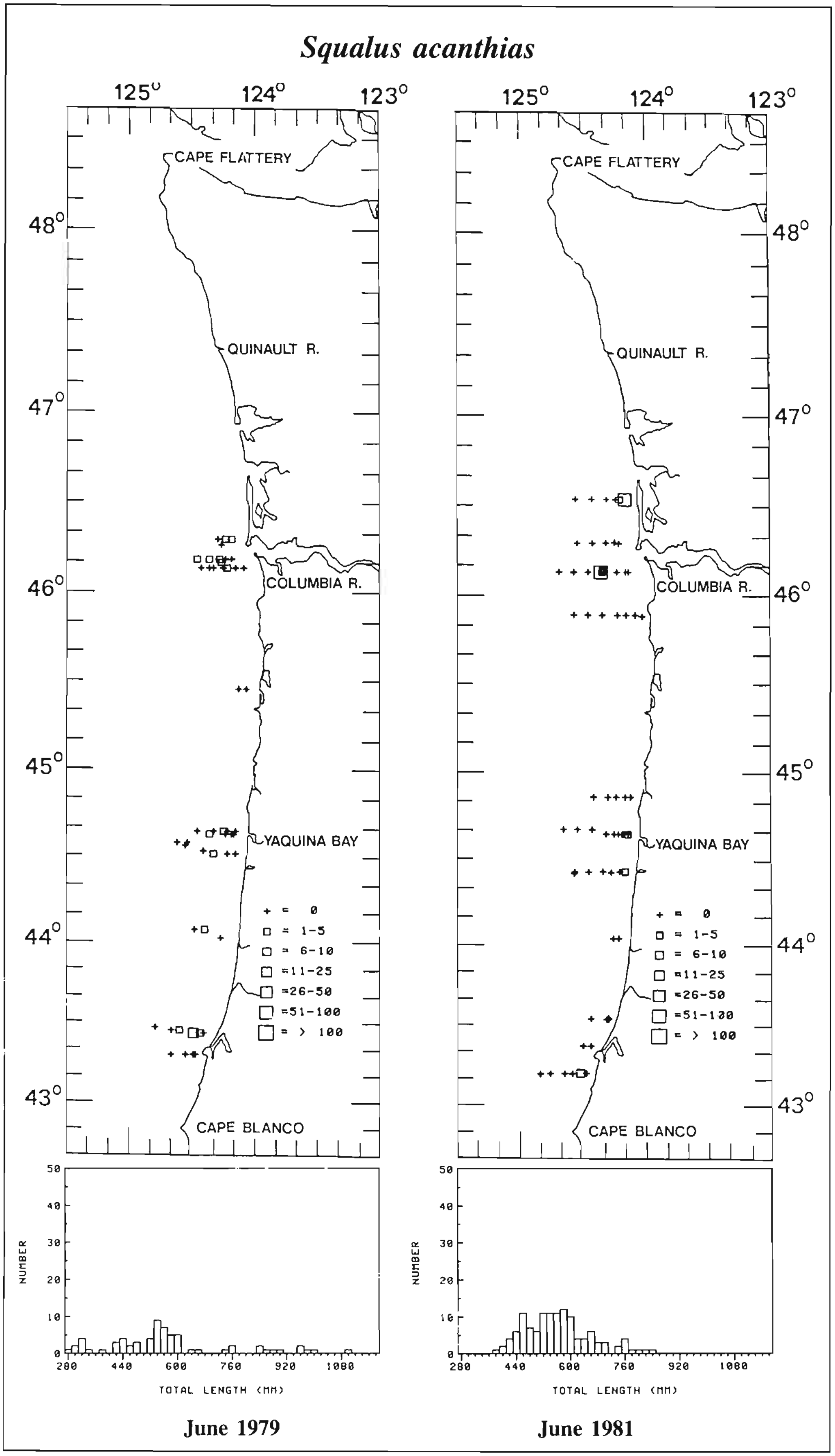
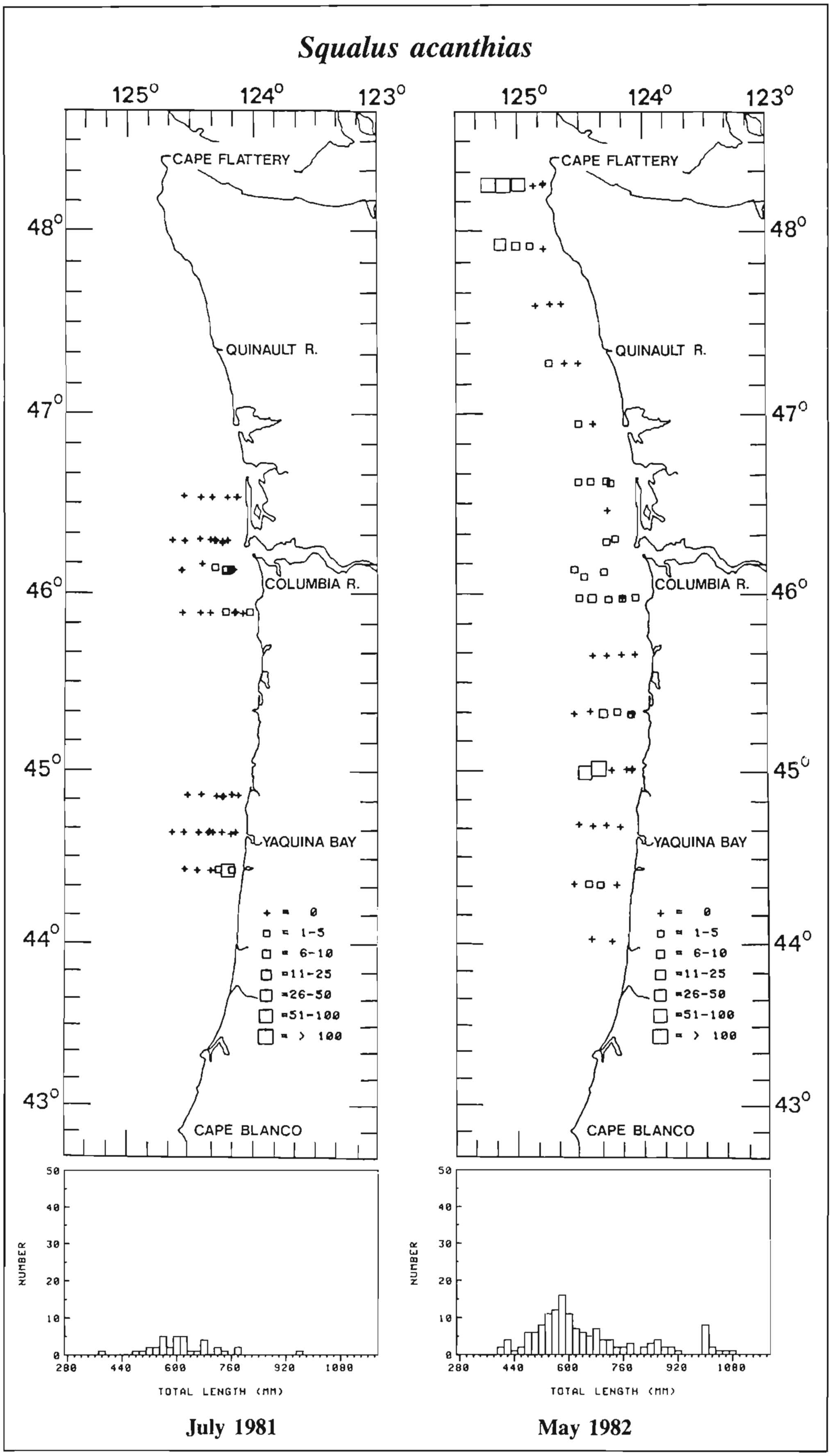

Loligo opalescens
125°
124°
123°
CAPE FLATTERY
48°
48°
QUINAULT R.
47°
47°
COLUMBIA R.
46°
46°
45°
45°
YAQUINA BAY
+ = 0
o = 1-5
O = 6-10
O =11-25
O =26-50
O =51-100
O = > 100
44°
44°
43°
43°
CAPE BLANCO
100
75
50
25
0
NUMBER
35
60
85
110
135
160
DORSAL MANTLE LENGTH (MM)
September 1984

Figure 24



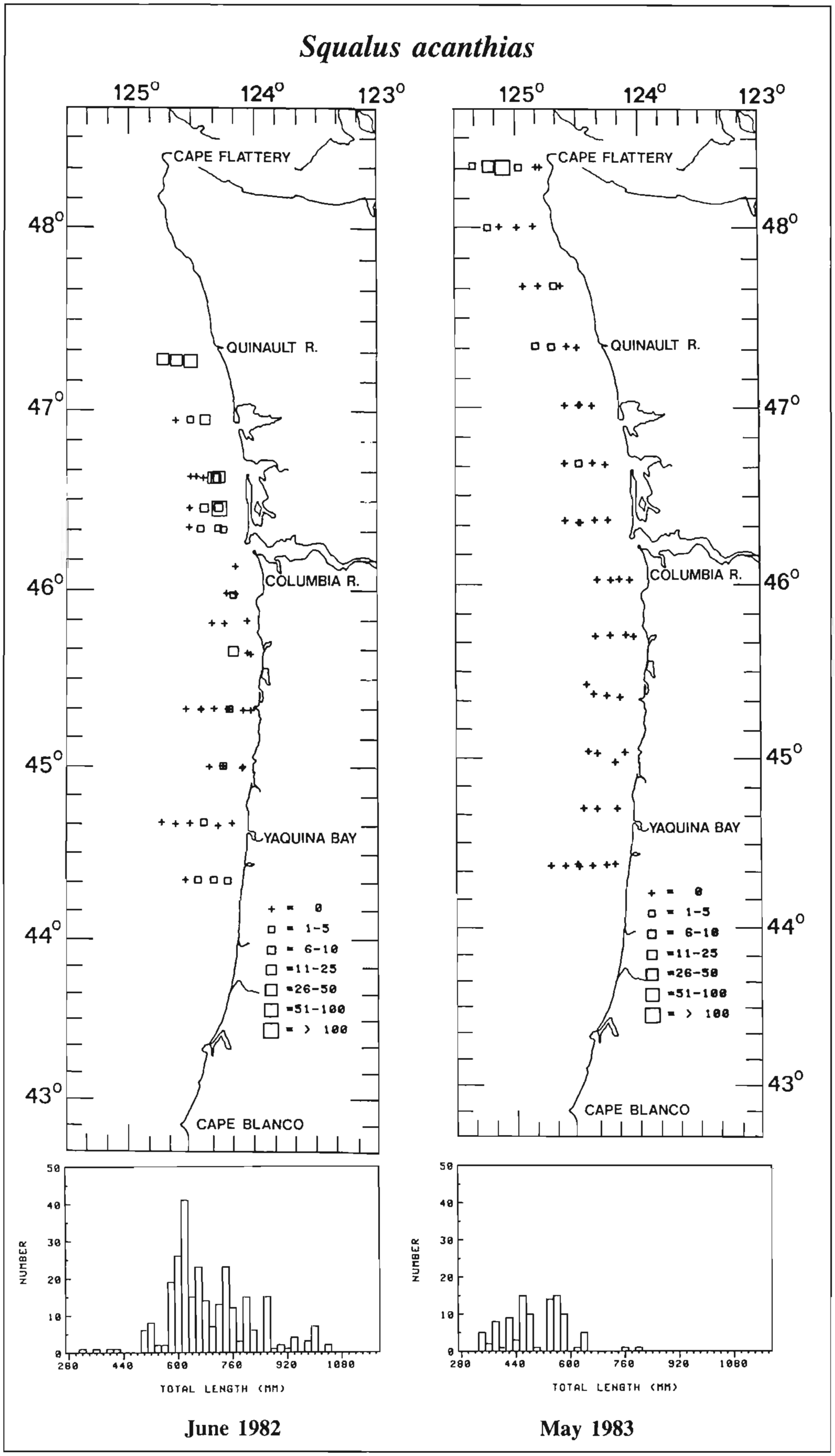
Squalus acanthias
125°
124°
123°
48°
47°
46°
45°
44°
43°
CAPE FLATTERY
QUINAULT R.
COLUMBIA R.
YAQUINA BAY
CAPE BLANCO
+ = 0
□ = 1-5
□ = 6-10
□ =11-25
□ =26-50
□ =51-100
□ = > 100
NUMBER
TOTAL LENGTH (MM)
June 1979
June 1981

Figure 25



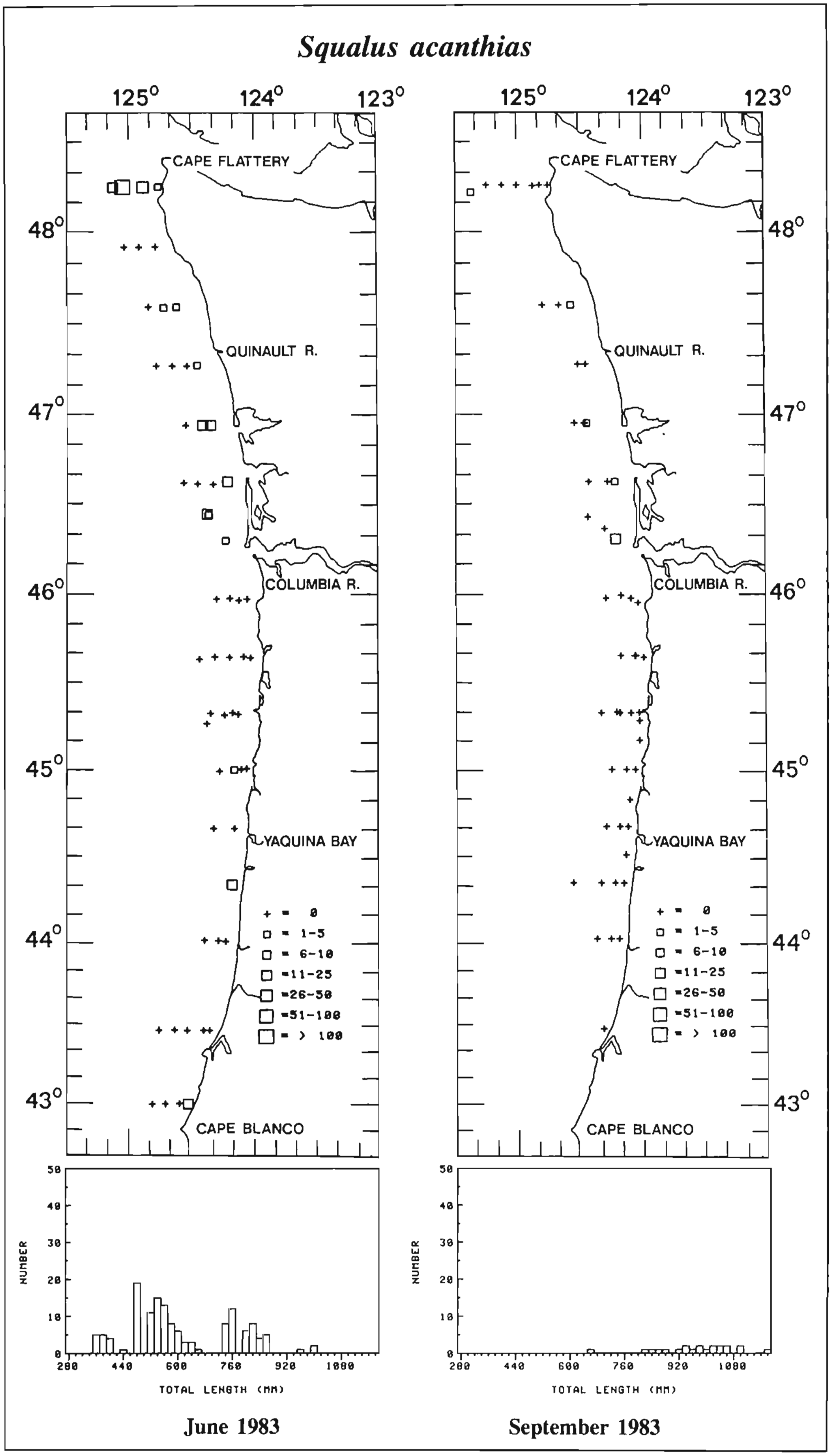
Squalus acanthias
125°
124°
123°
CAPE FLATTERY
QUINAULT R.
COLUMBIA R.
YAQUINA BAY
CAPE BLANCO
48°
47°
46°
45°
44°
43°
+ = 0
□ = 1-5
□ = 6-10
□ =11-25
□ =26-50
□ =51-100
□ = > 100
NUMBER
TOTAL LENGTH (MM)
280
440
600
760
920
1080
July 1981
May 1982

Figure 26



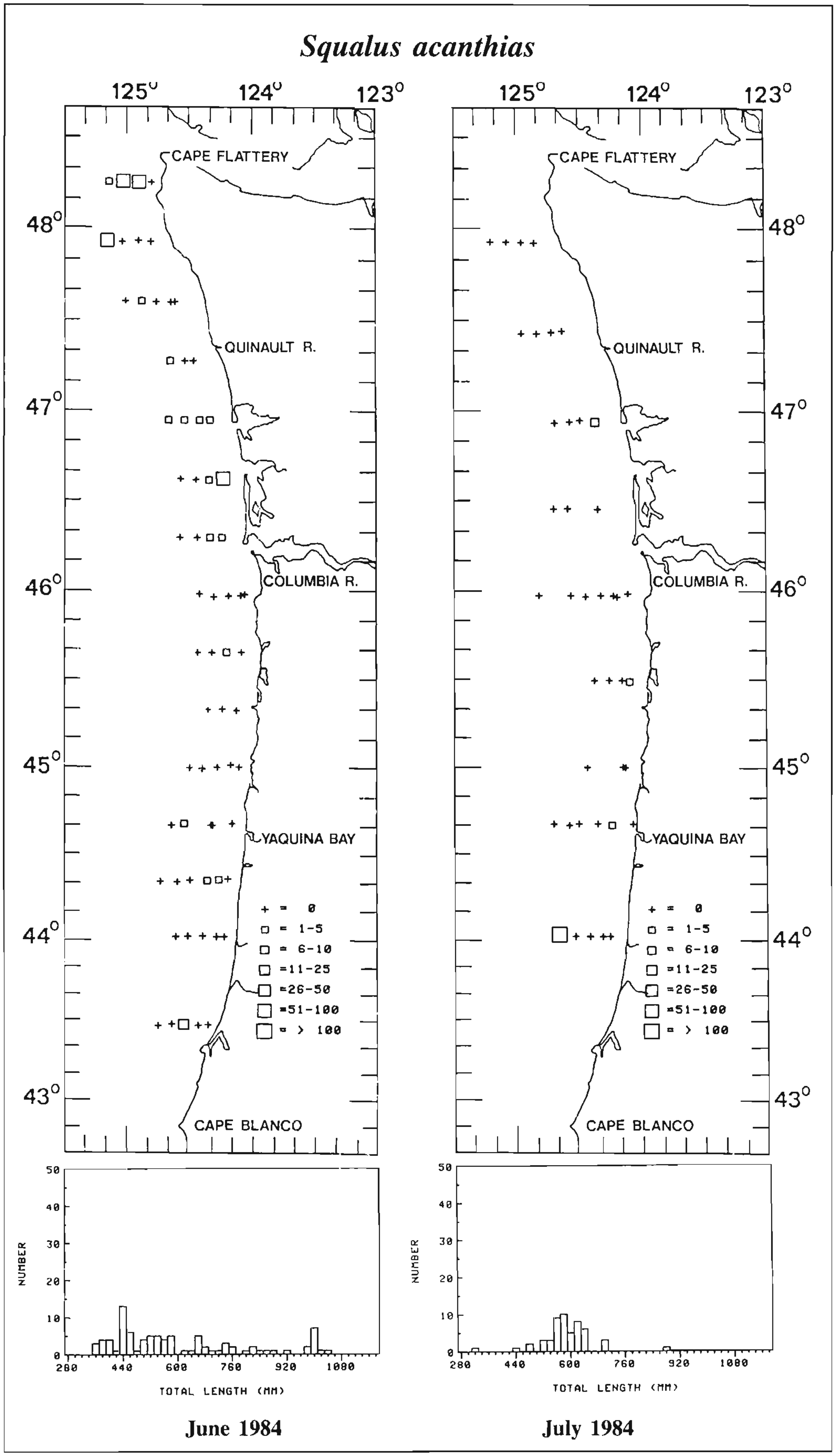
Squalus acanthias
125°
124°
123°
CAPE FLATTERY
48°
QUINAULT R.
47°
COLUMBIA R.
46°
45°
YAQUINA BAY
44°
43°
CAPE BLANCO
+ = 0
= 1-5
= 6-10
=11-25
=26-50
=51-100
= > 100
NUMBER
TOTAL LENGTH (MM)
June 1982
May 1983

Figure 27



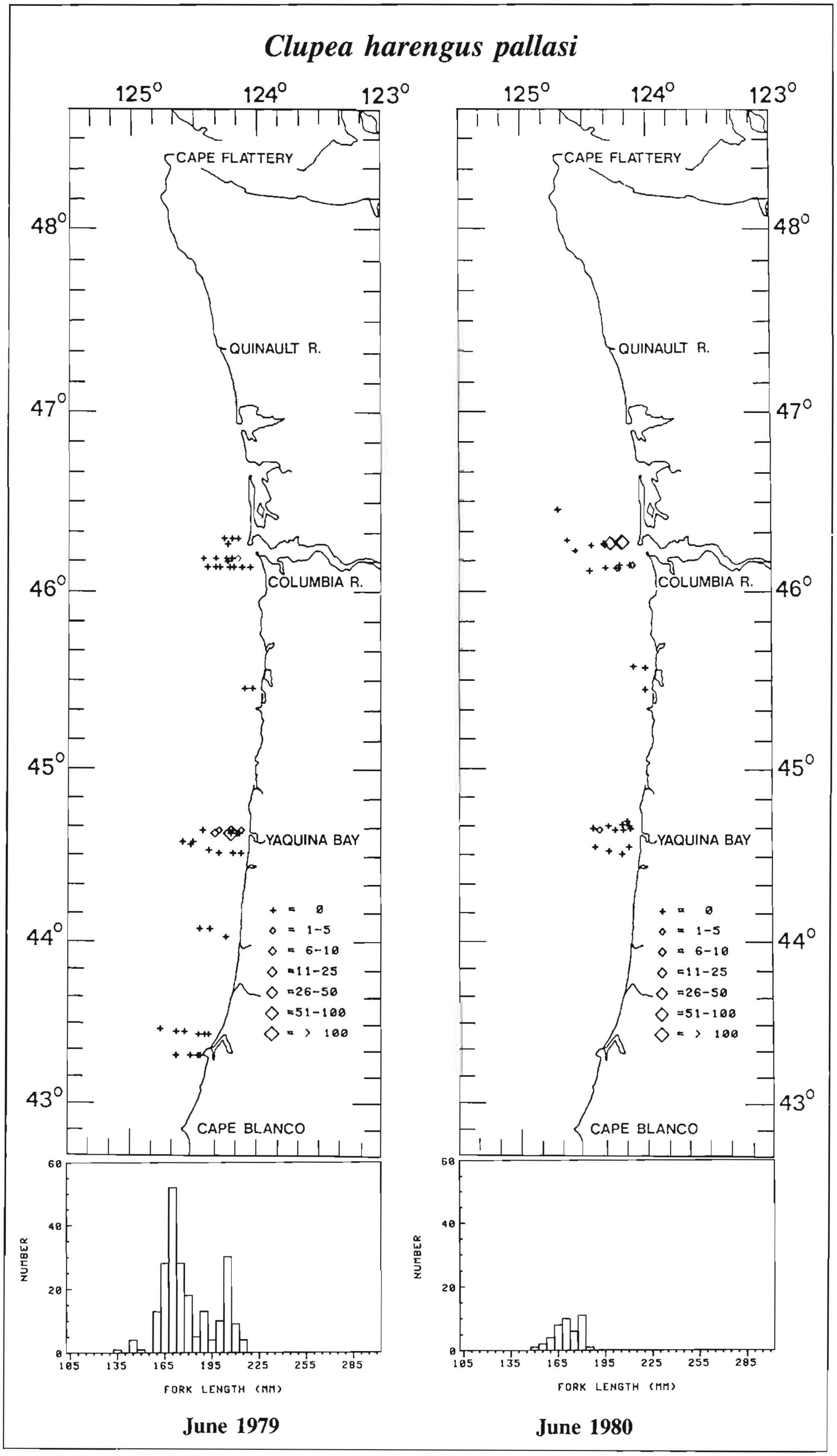
Squalus acanthias
125°
124°
123°
CAPE FLATTERY
QUINAULT R.
COLUMBIA R.
YAQUINA BAY
CAPE BLANCO
48°
47°
46°
45°
44°
43°
+ = 0
□ = 1-5
□ = 6-10
□ =11-25
□ =26-50
□ =51-100
□ = > 100
NUMBER
TOTAL LENGTH (MM)
June 1983
September 1983

Figure 28



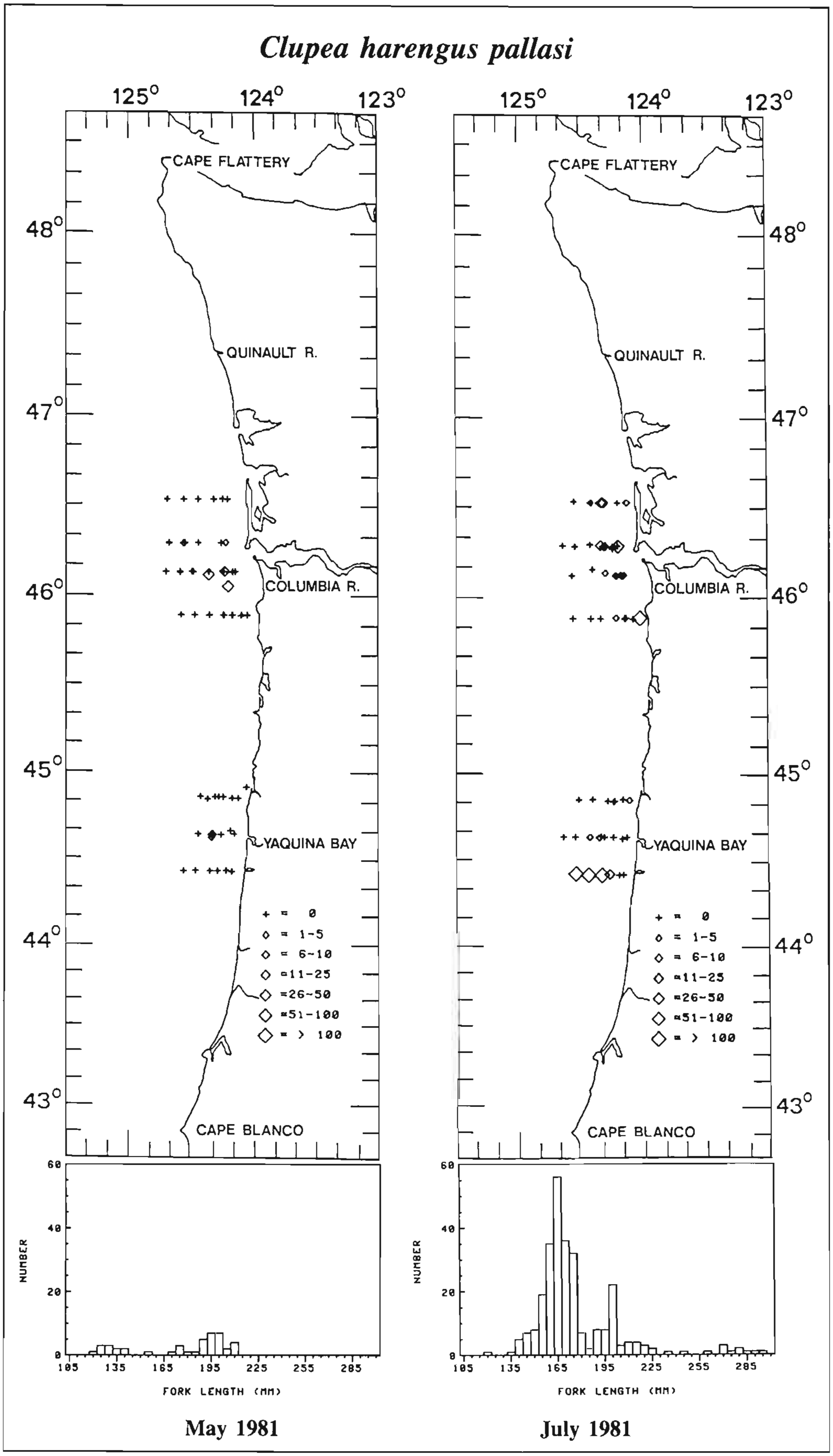
Squalus acanthias
125°
124°
123°
48°
47°
46°
45°
44°
43°
CAPE FLATTERY
QUINAULT R.
COLUMBIA R.
YAQUINA BAY
CAPE BLANCO
+ = 0
= 1-5
= 6-10
=11-25
=26-50
=51-100
= > 100
NUMBER
TOTAL LENGTH (MM)
June 1984
July 1984

Figure 29



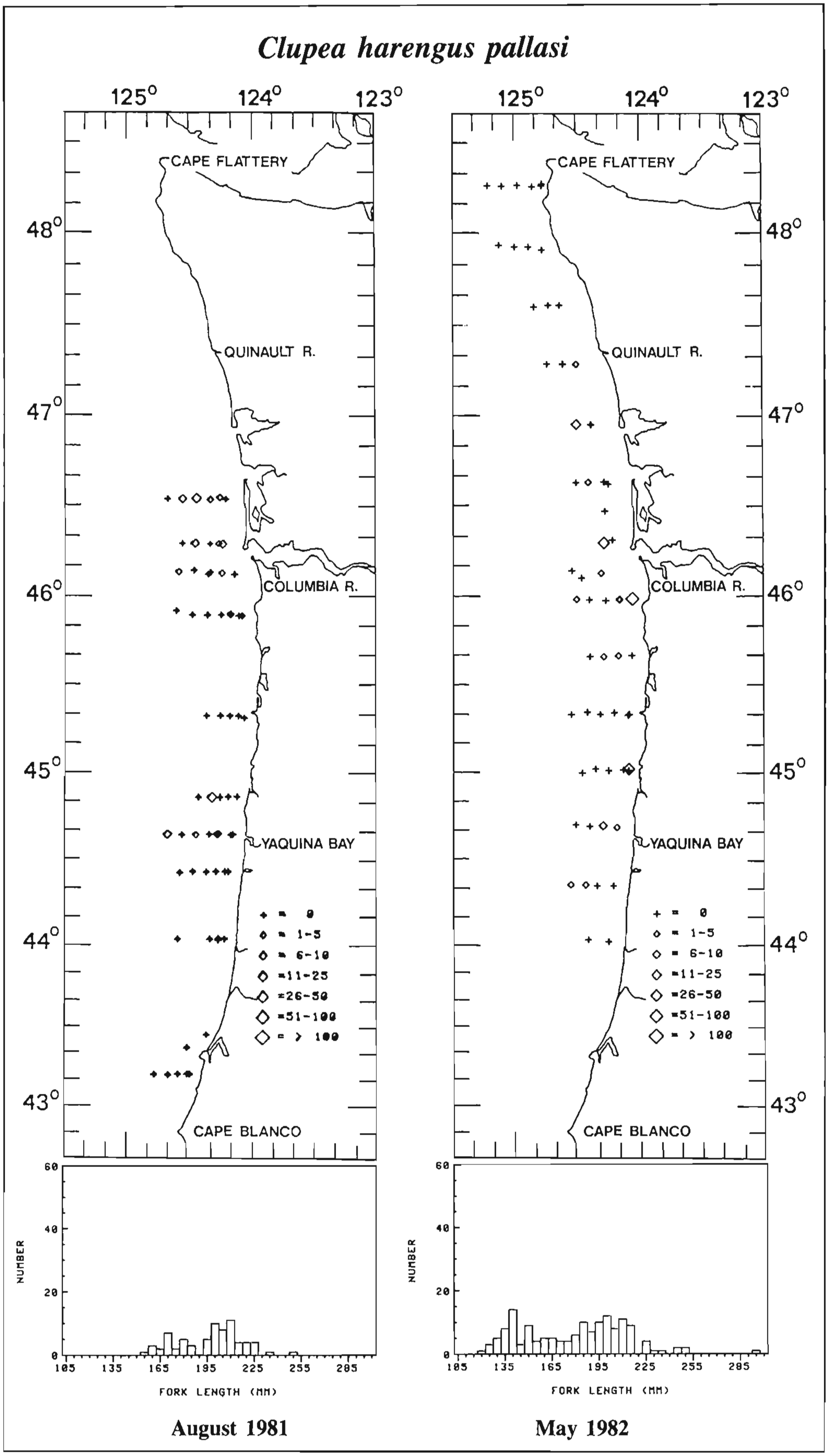
Clupea harengus pallasi
125°
124°
123°
48°
47°
46°
45°
44°
43°
CAPE FLATTERY
QUINAULT R.
COLUMBIA R.
YAQUINA BAY
CAPE BLANCO
+ = 0
◇ = 1-5
◇ = 6-10
◇ =11-25
◇ =26-50
◇ =51-100
◇ = > 100
NUMBER
FORK LENGTH (MM)
June 1979
June 1980

Figure 30



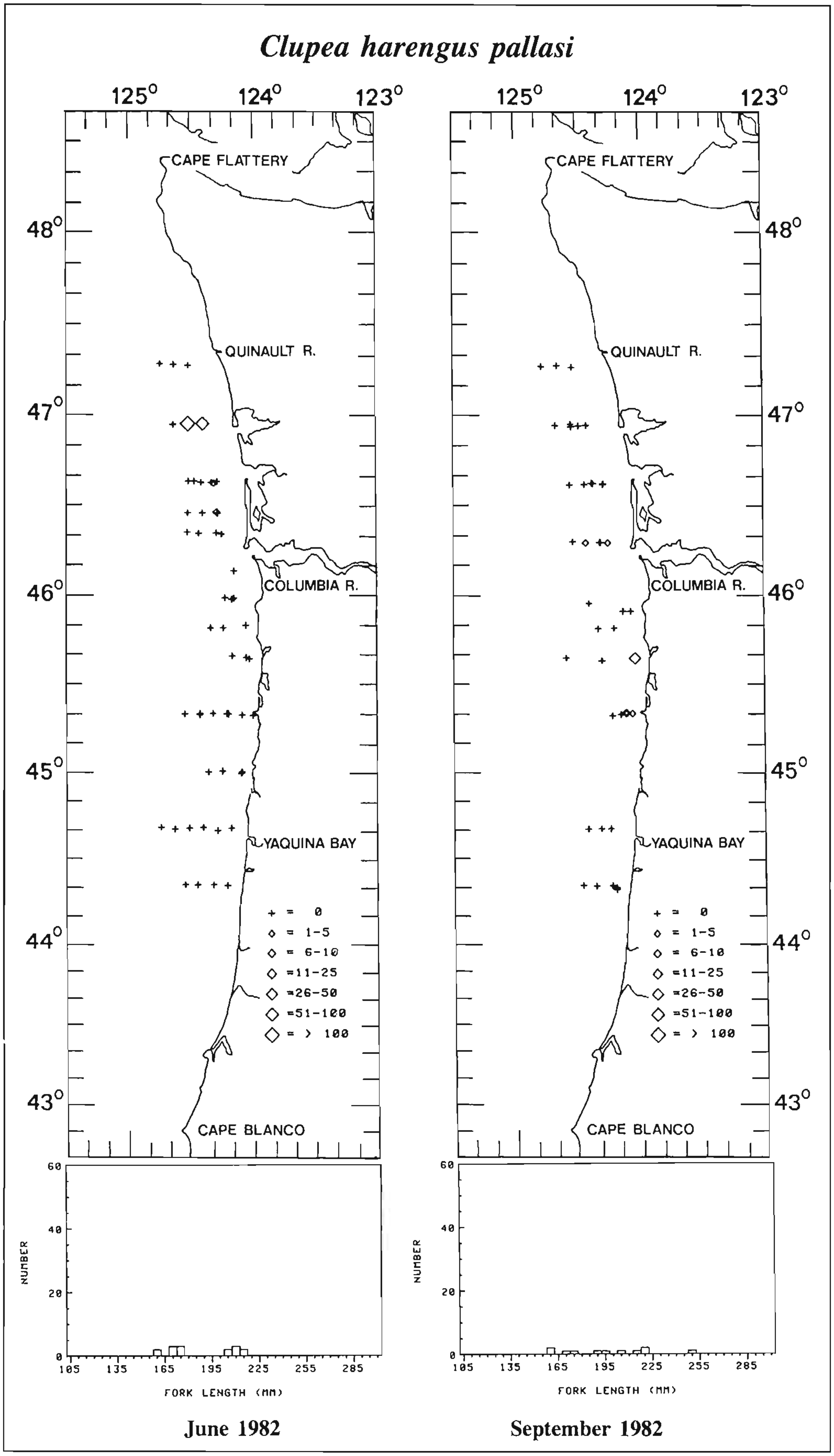
Clupea harengus pallasi
125°
124°
123°
48°
47°
46°
45°
44°
43°
CAPE FLATTERY
QUINAULT R.
COLUMBIA R.
YAQUINA BAY
CAPE BLANCO
+ = 0
◇ = 1-5
◇ = 6-10
◇ =11-25
◇ =26-50
◇ =51-100
◇ = > 100
NUMBER
FORK LENGTH (MM)
May 1981
July 1981

Figure 31



Clupea harengus pallasi
125° 124° 123°
48° 47° 46° 45° 44° 43°
CAPE FLATTERY
QUINAULT R.
COLUMBIA R.
YAQUINA BAY
CAPE BLANCO
+ = 0
◇ = 1-5
◇ = 6-10
◇ =11-25
◇ =26-50
◇ =51-100
◇ = > 100
NUMBER
FORK LENGTH (MM)
August 1981
May 1982

Figure 32



Clupea harengus pallasi
125°
124°
123°
48°
47°
46°
45°
44°
43°
CAPE FLATTERY
QUINAULT R.
COLUMBIA R.
YAQUINA BAY
CAPE BLANCO
+ = 0
◇ = 1-5
◇ = 6-10
◇ =11-25
◇ =26-50
◇ =51-100
◇ = > 100
NUMBER
FORK LENGTH (MM)
June 1982
September 1982

Figure 33

Clupea harengus pallasi

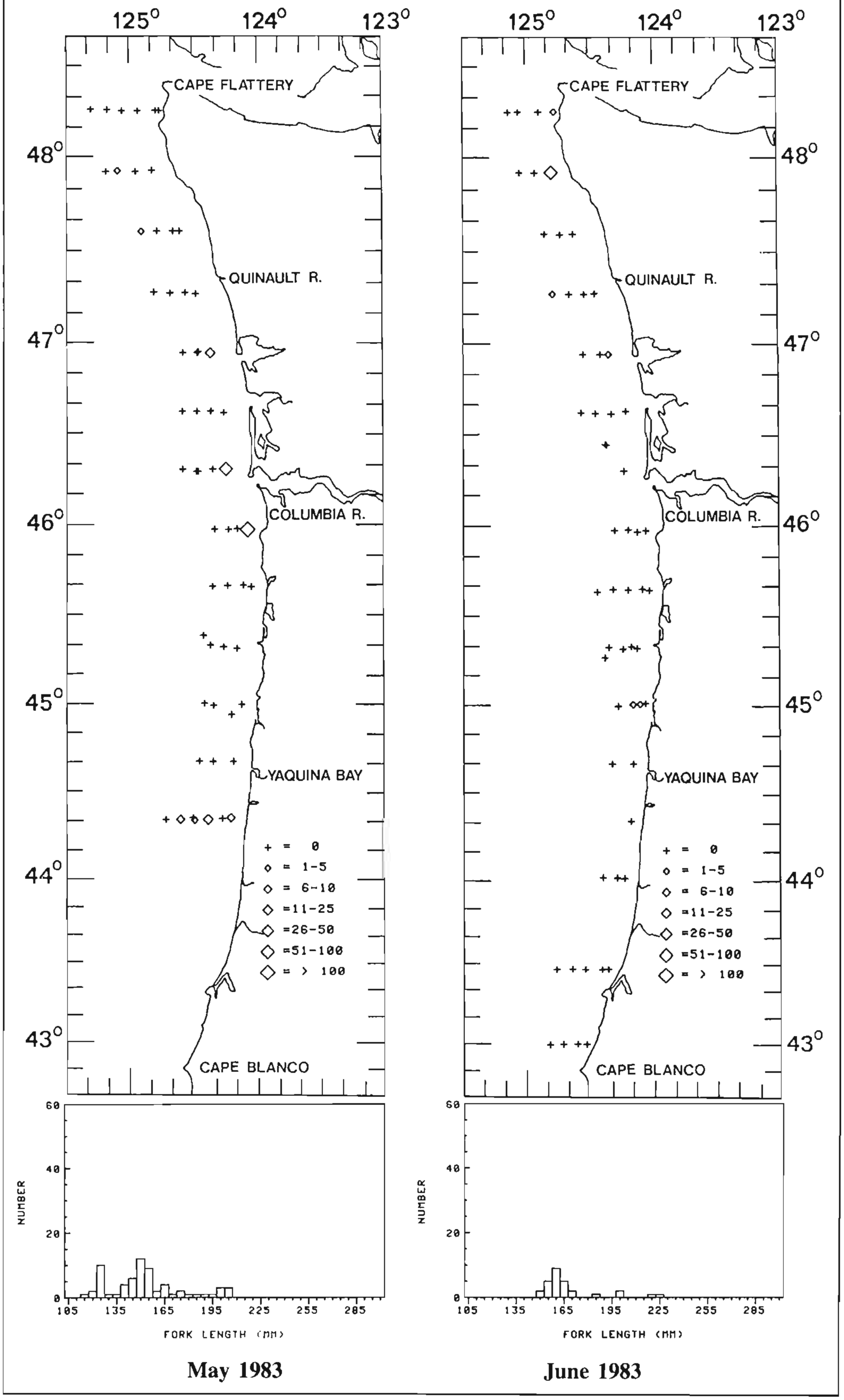


Figure 34

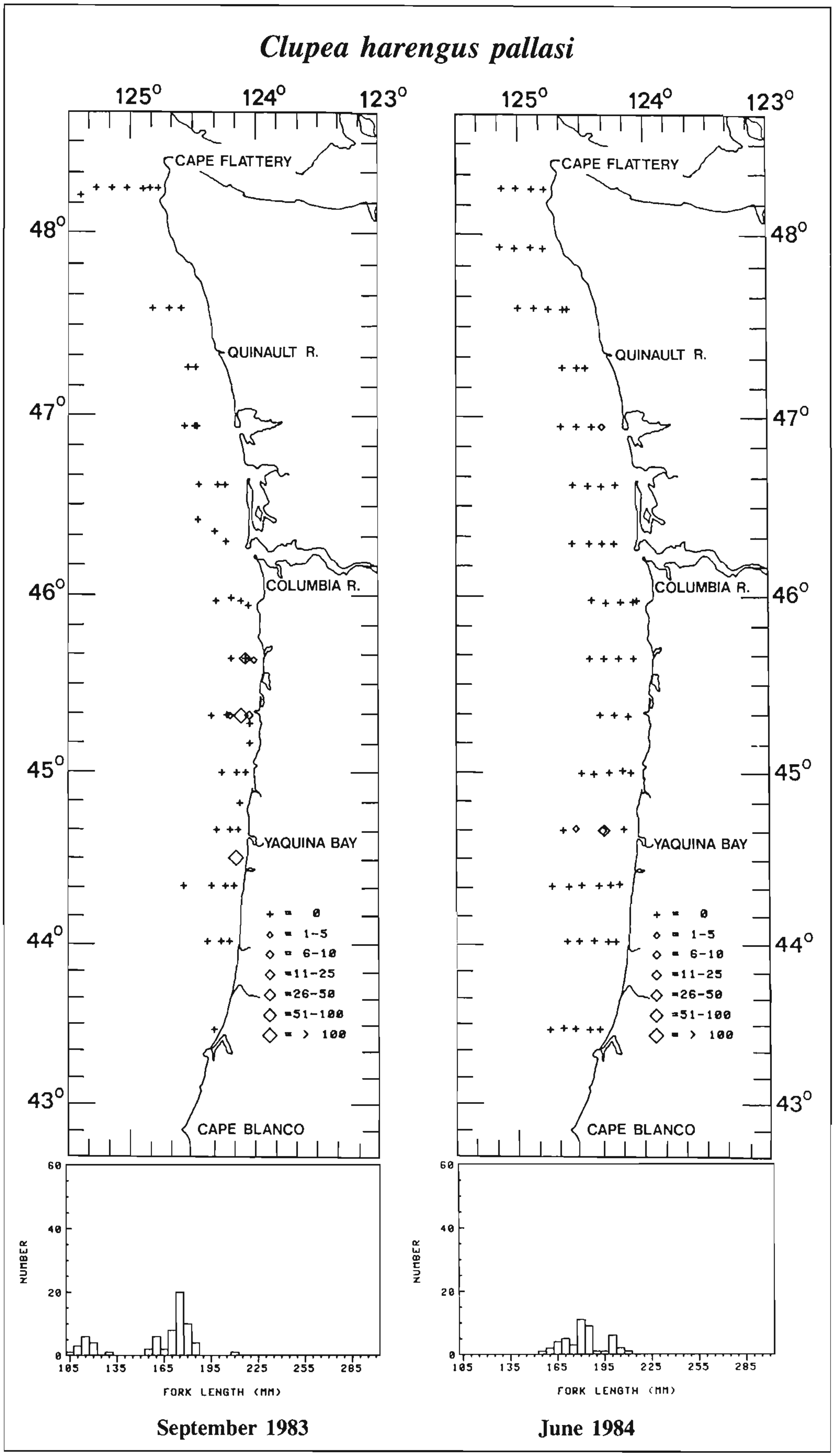
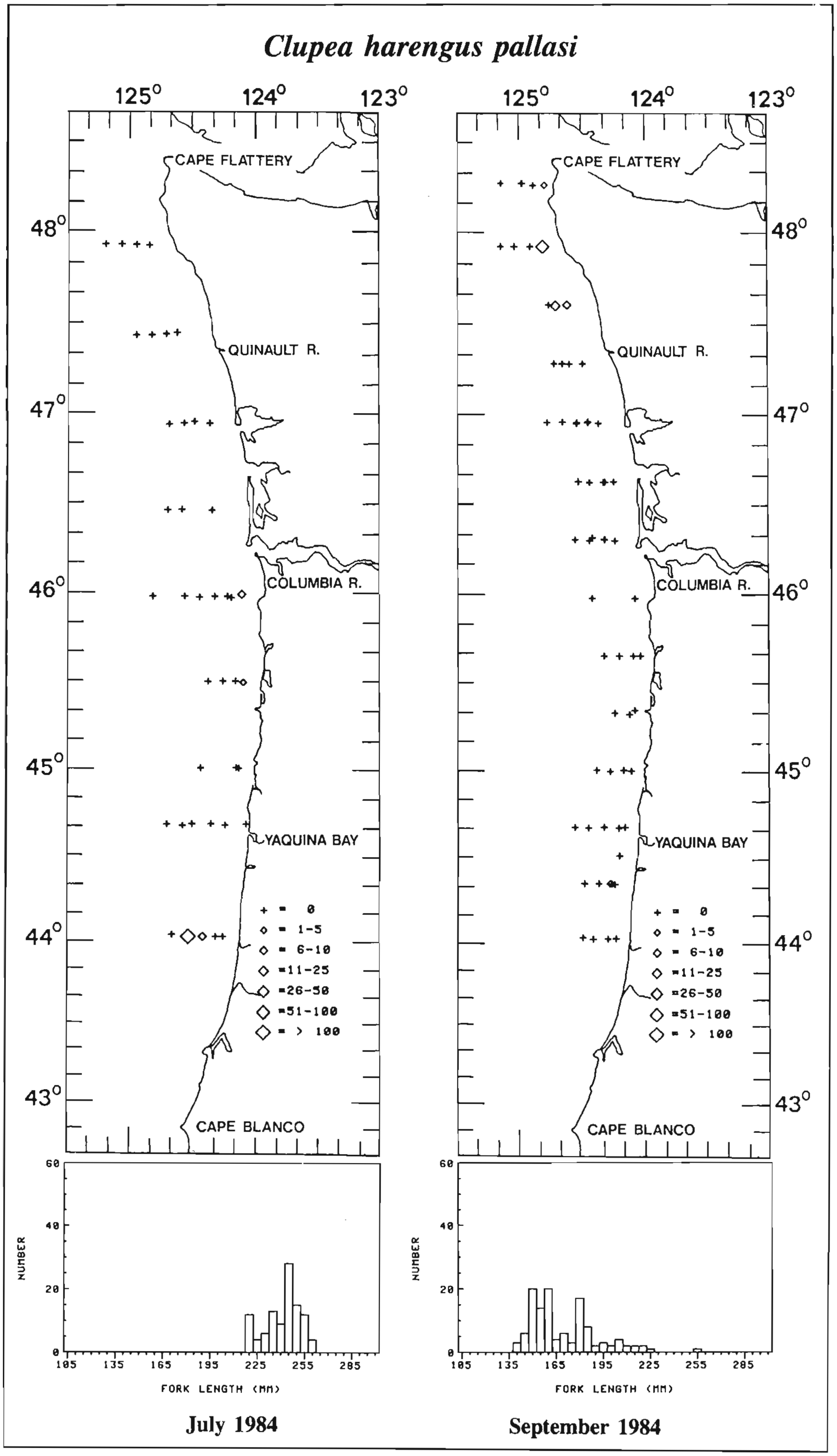

Clupea harengus pallasi
125°
124°
123°
48°
47°
46°
45°
44°
43°
CAPE FLATTERY
QUINAULT R.
COLUMBIA R.
YAQUINA BAY
CAPE BLANCO
+ = 0
◇ = 1-5
◇ = 6-10
◇ =11-25
◇ =26-50
◇ =51-100
◇ = > 100
NUMBER
FORK LENGTH (MM)
September 1983
June 1984

Figure 35



Clupea harengus pallasi
125°
124°
123°
48°
47°
46°
45°
44°
43°
CAPE FLATTERY
QUINAULT R.
COLUMBIA R.
YAQUINA BAY
CAPE BLANCO
+ = 0
◇ = 1-5
◇ = 6-10
◇ =11-25
◇ =26-50
◇ =51-100
◇ = > 100
NUMBER
FORK LENGTH (MM)
July 1984
September 1984

Figure 36

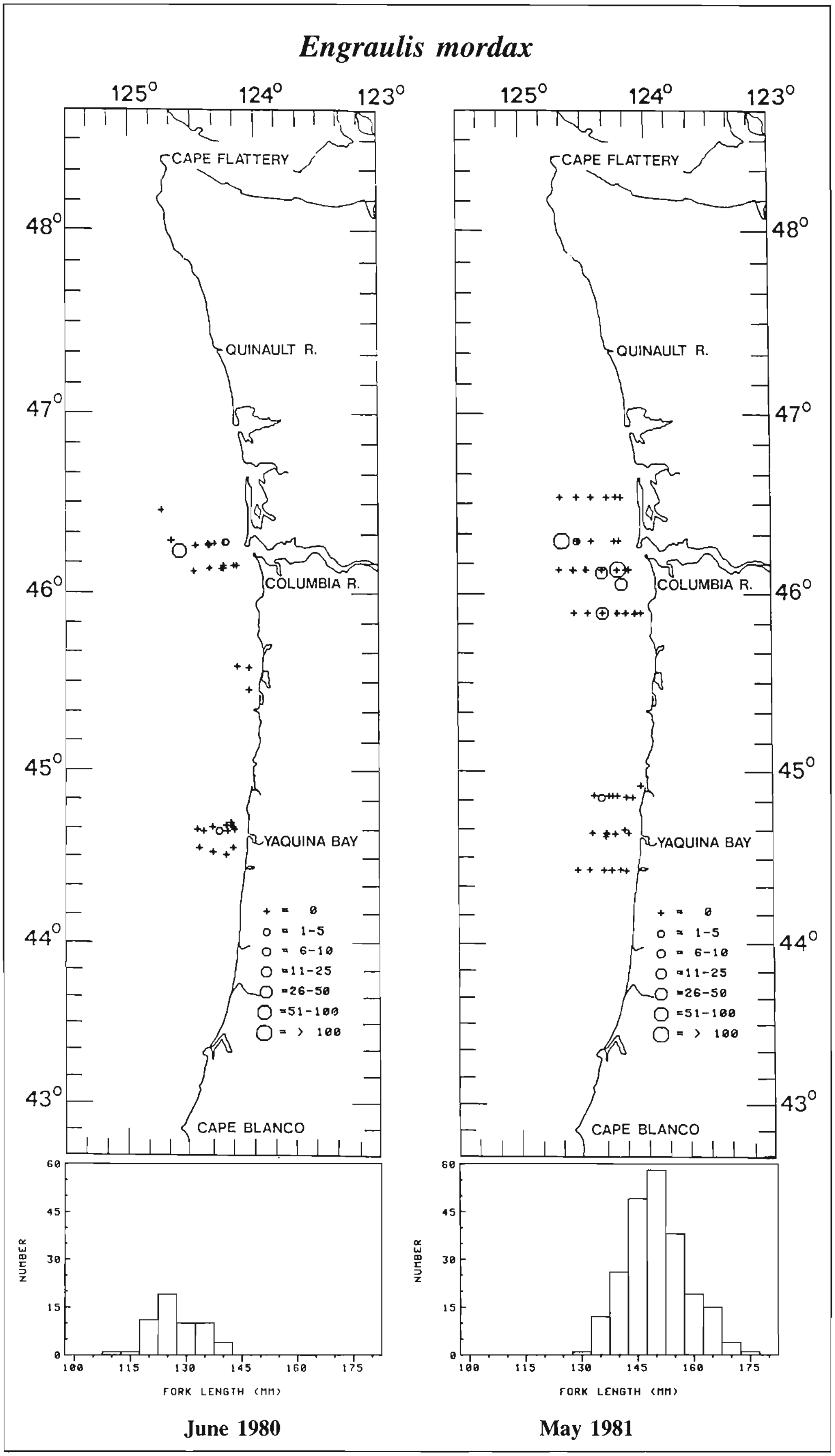
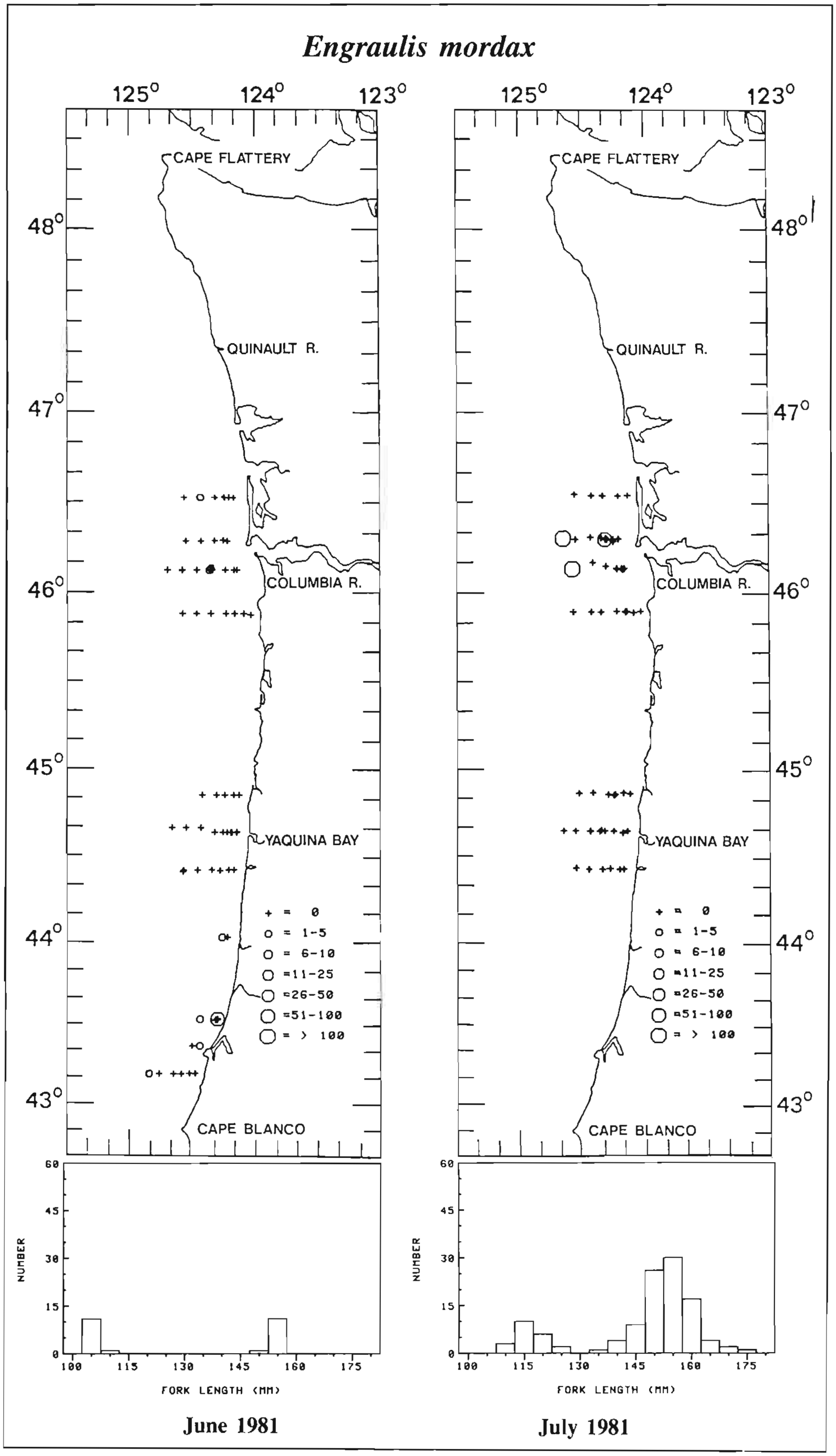
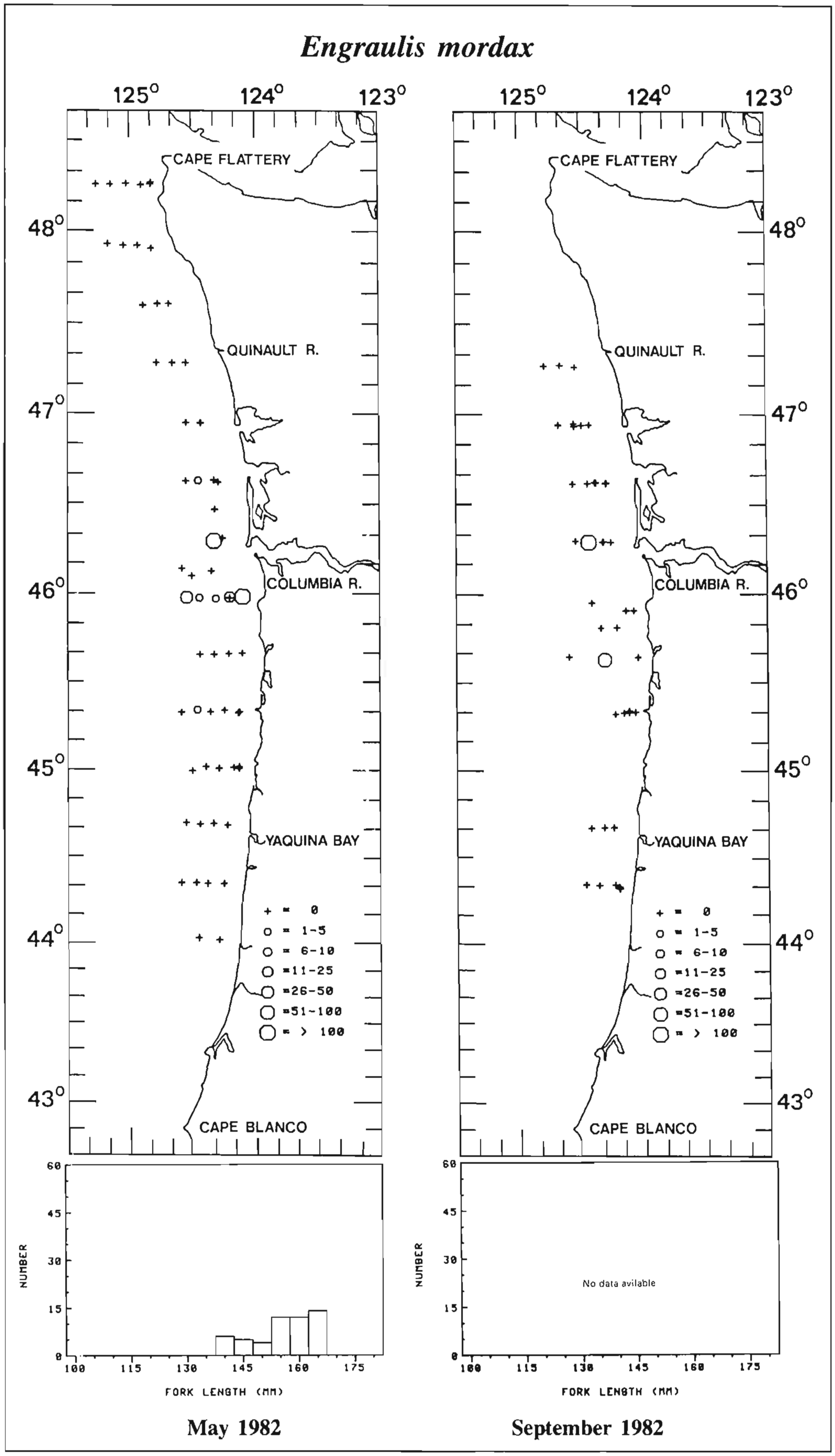

Engraulis mordax
125°
124°
123°
48°
47°
46°
45°
44°
43°
CAPE FLATTERY
QUINAULT R.
COLUMBIA R.
YAQUINA BAY
CAPE BLANCO
+ = 0
o = 1-5
o = 6-10
O =11-25
O =26-50
O =51-100
O = > 100
NUMBER
FORK LENGTH (MM)
June 1980
May 1981

Figure 37



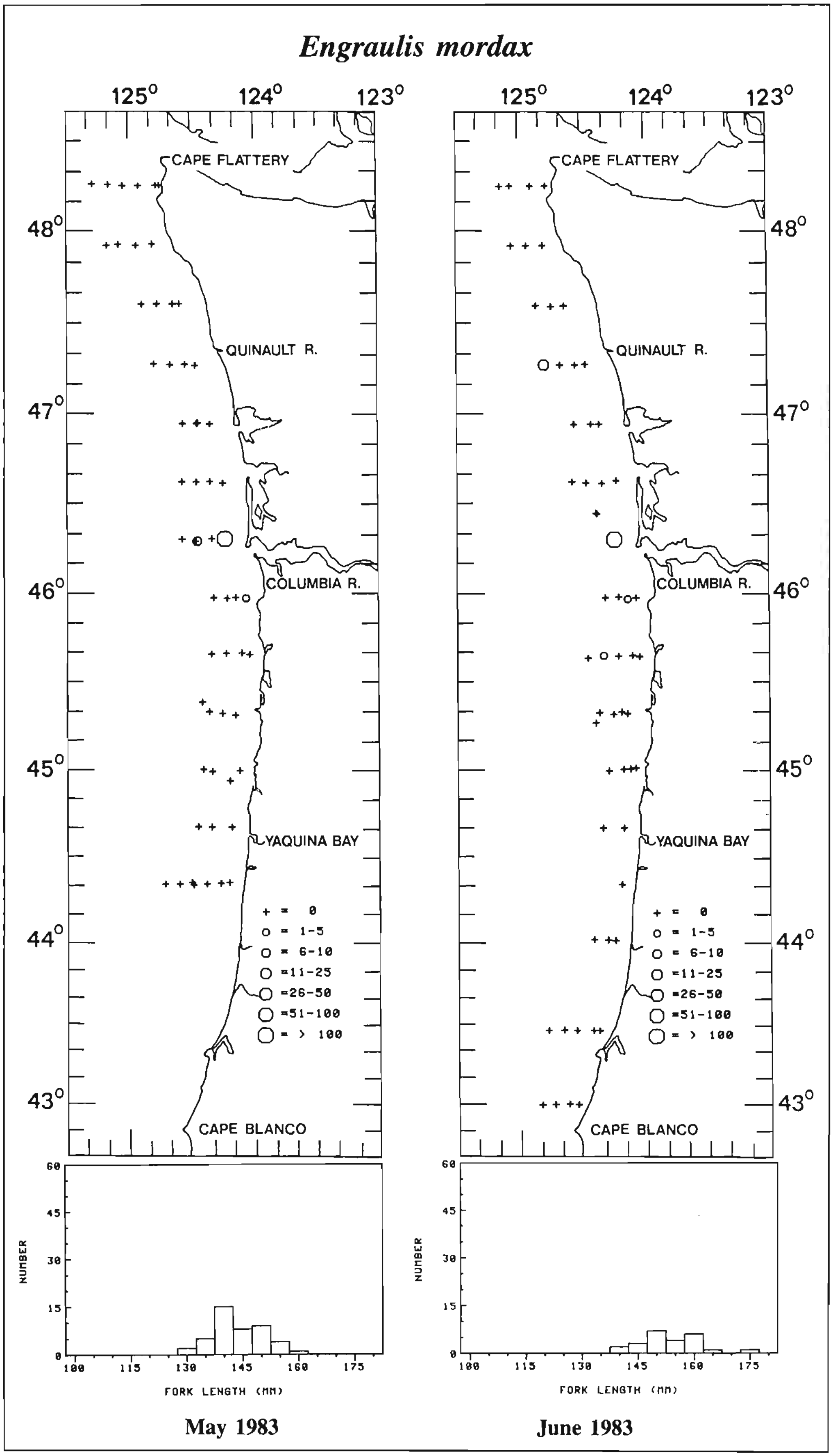
Engraulis mordax
125°
124°
123°
48°
47°
46°
45°
44°
43°
CAPE FLATTERY
QUINAULT R.
COLUMBIA R.
YAQUINA BAY
CAPE BLANCO
+ = 0
o = 1-5
O = 6-10
O =11-25
O =26-50
O =51-100
O = > 100
NUMBER
FORK LENGTH (MM)
June 1981
July 1981

Figure 38



Engraulis mordax
125° 124° 123°
CAPE FLATTERY
QUINAULT R.
COLUMBIA R.
YAQUINA BAY
CAPE BLANCO
48° 47° 46° 45° 44° 43°
+ = 0
○ = 1-5
○ = 6-10
○ =11-25
○ =26-50
○ =51-100
○ = > 100
NUMBER
FORK LENGTH (MM)
No data avilable
May 1982
September 1982

Figure 39



Engraulis mordax
125°
124°
123°
48°
47°
46°
45°
44°
43°
CAPE FLATTERY
QUINAULT R.
COLUMBIA R.
YAQUINA BAY
CAPE BLANCO
+ = 0
o = 1-5
O = 6-10
O =11-25
O =26-50
O =51-100
O = > 100
NUMBER
FORK LENGTH (MM)
May 1983
June 1983

Figure 40

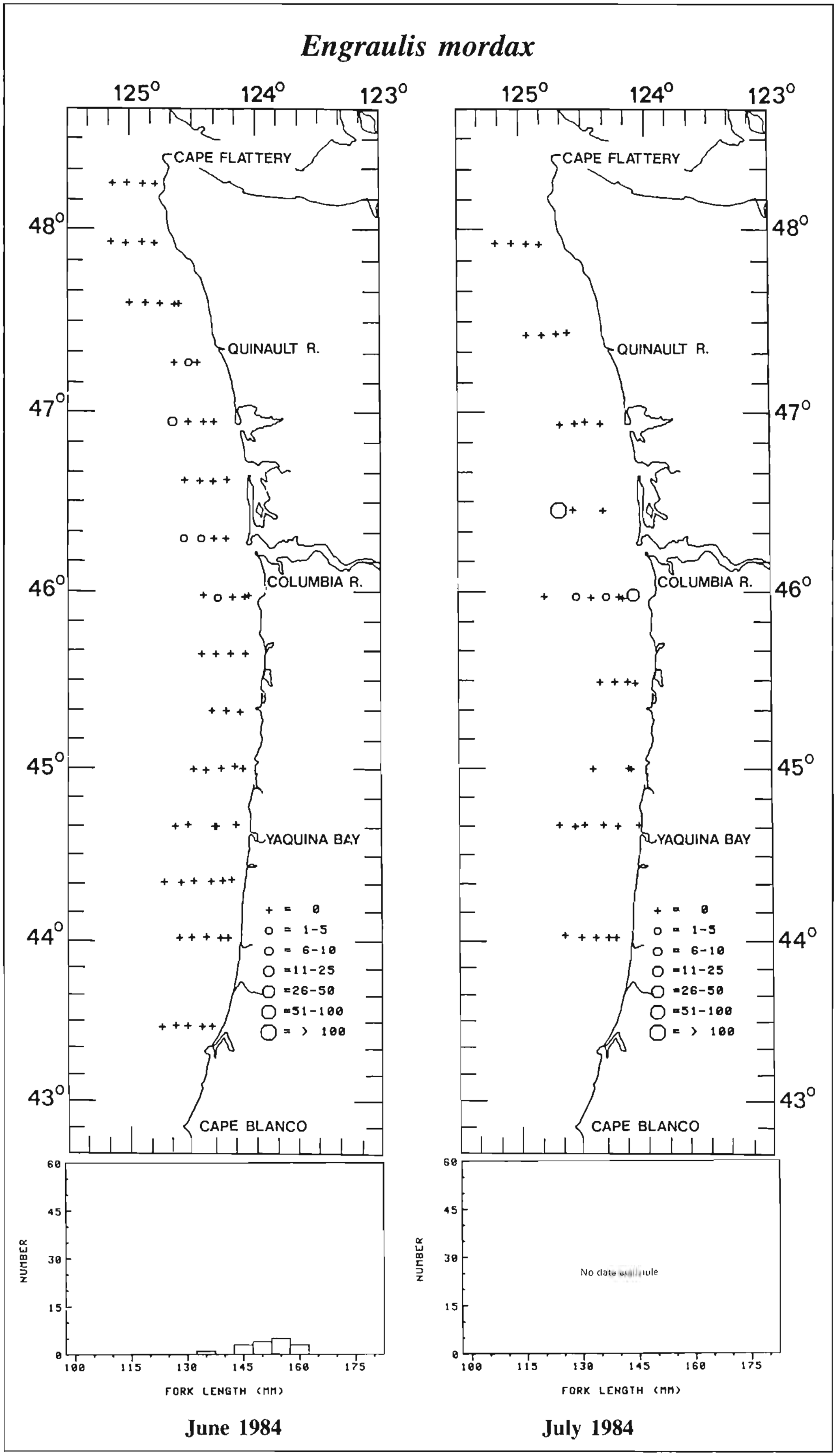
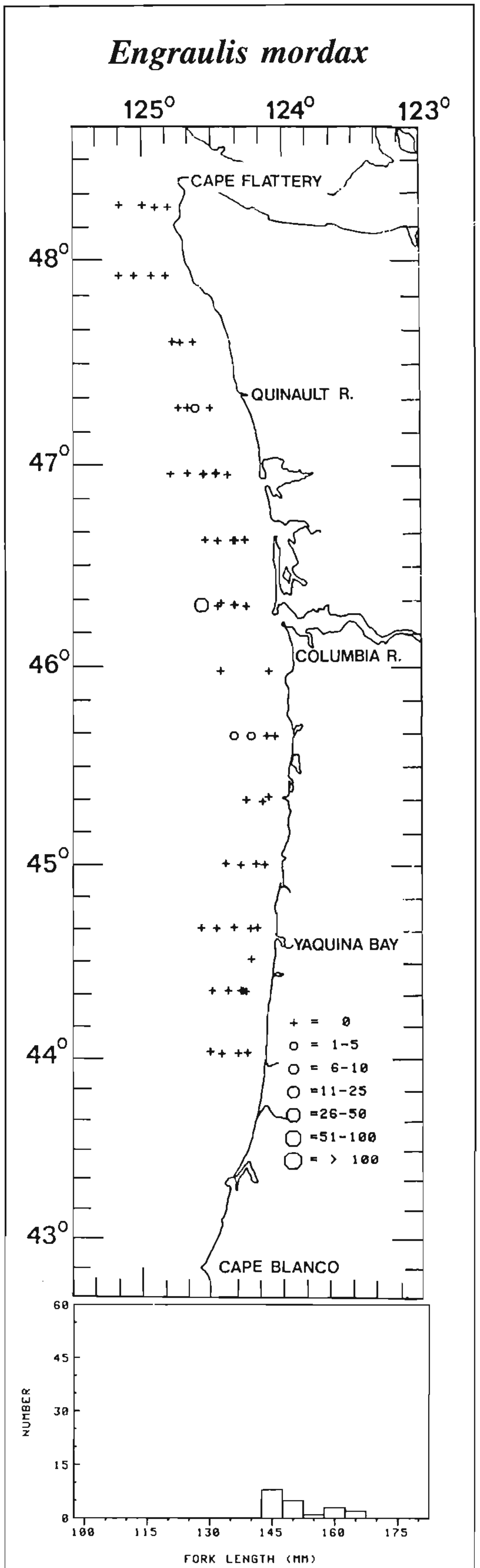

Engraulis mordax
125°
124°
123°
48°
47°
46°
45°
44°
43°
CAPE FLATTERY
QUINAULT R.
COLUMBIA R.
YAQUINA BAY
CAPE BLANCO
+ = 0
○ = 1-5
○ = 6-10
○ =11-25
○ =26-50
○ =51-100
○ = > 100
NUMBER
FORK LENGTH (MM)
June 1984
July 1984

Figure 41



September 1984

Figure 42

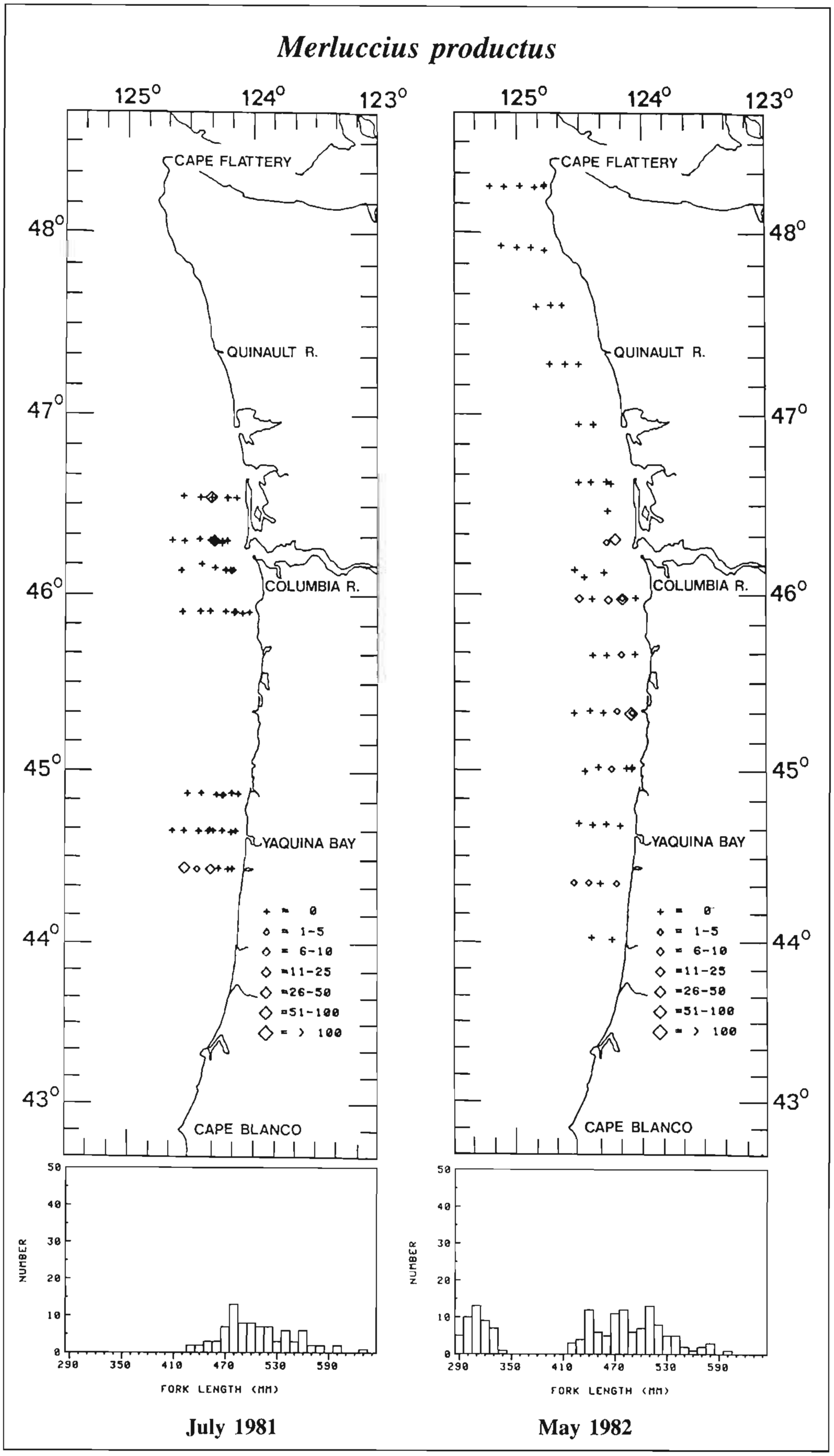

Merluccius productus
125°
124°
123°
CAPE FLATTERY
QUINAULT R.
COLUMBIA R.
YAQUINA BAY
CAPE BLANCO
48°
47°
46°
45°
44°
43°
+ = 0
◇ = 1-5
◇ = 6-10
◇ =11-25
◇ =26-50
◇ =51-100
◇ = > 100
NUMBER
FORK LENGTH (MM)
July 1981
May 1982

Figure 43

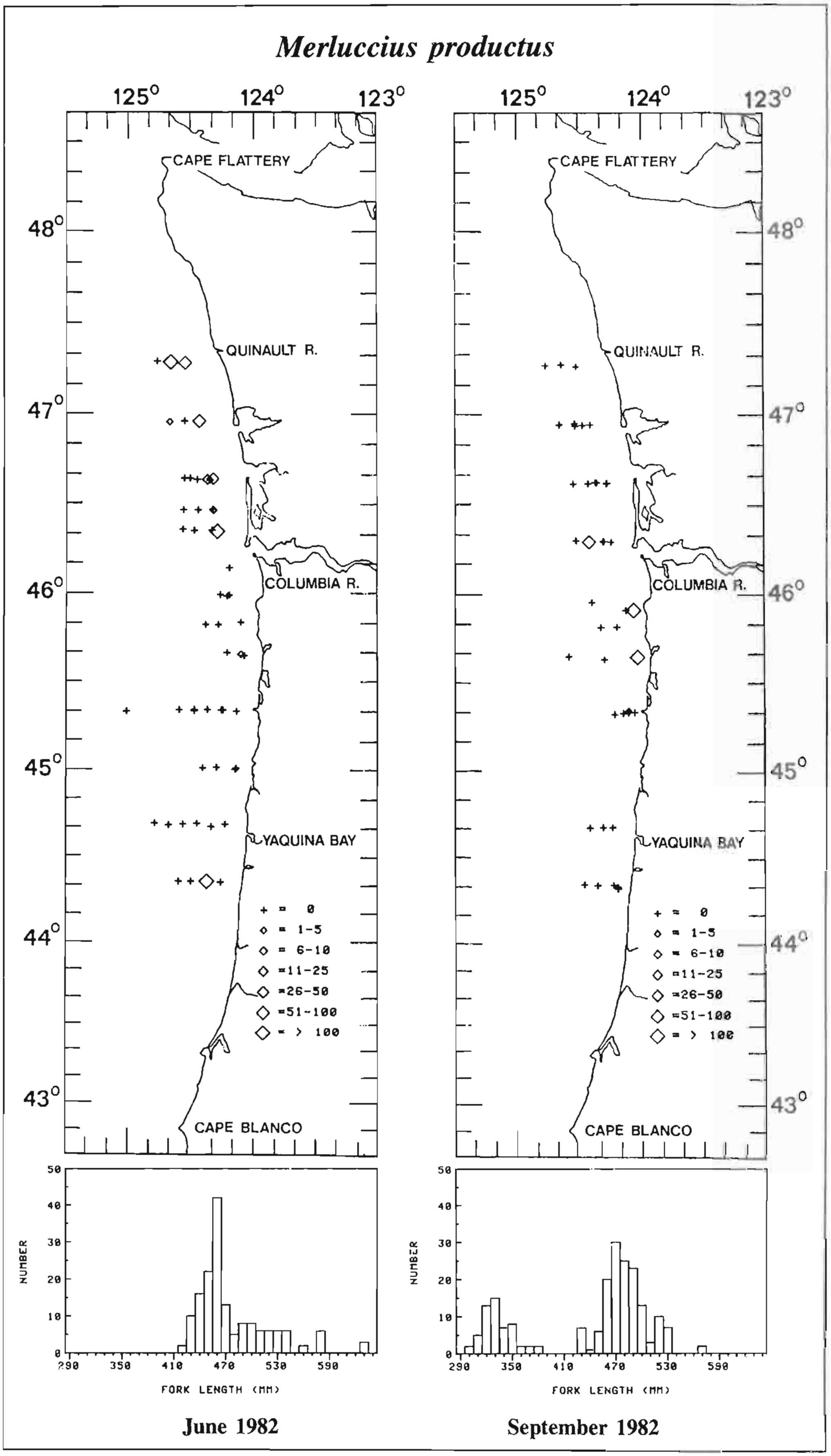
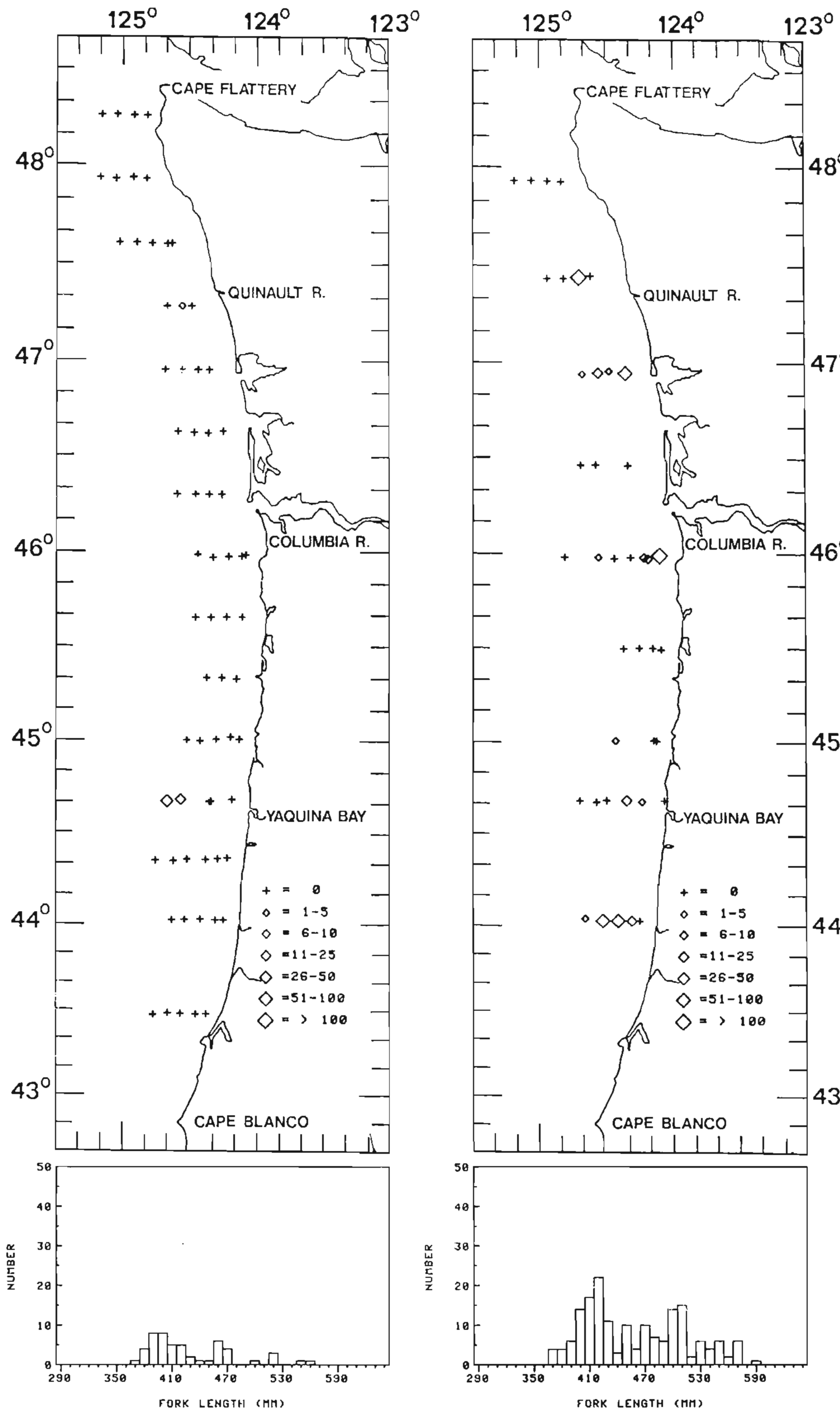

Merluccius productus
125°
124°
123°
48°
47°
46°
45°
44°
43°
CAPE FLATTERY
QUINAULT R.
COLUMBIA R.
YAQUINA BAY
CAPE BLANCO
+ = 0
◇ = 1-5
◇ = 6-10
◇ =11-25
◇ =26-50
◇ =51-100
◇ = > 100
NUMBER
FORK LENGTH (MM)
June 1982
September 1982

Figure 44

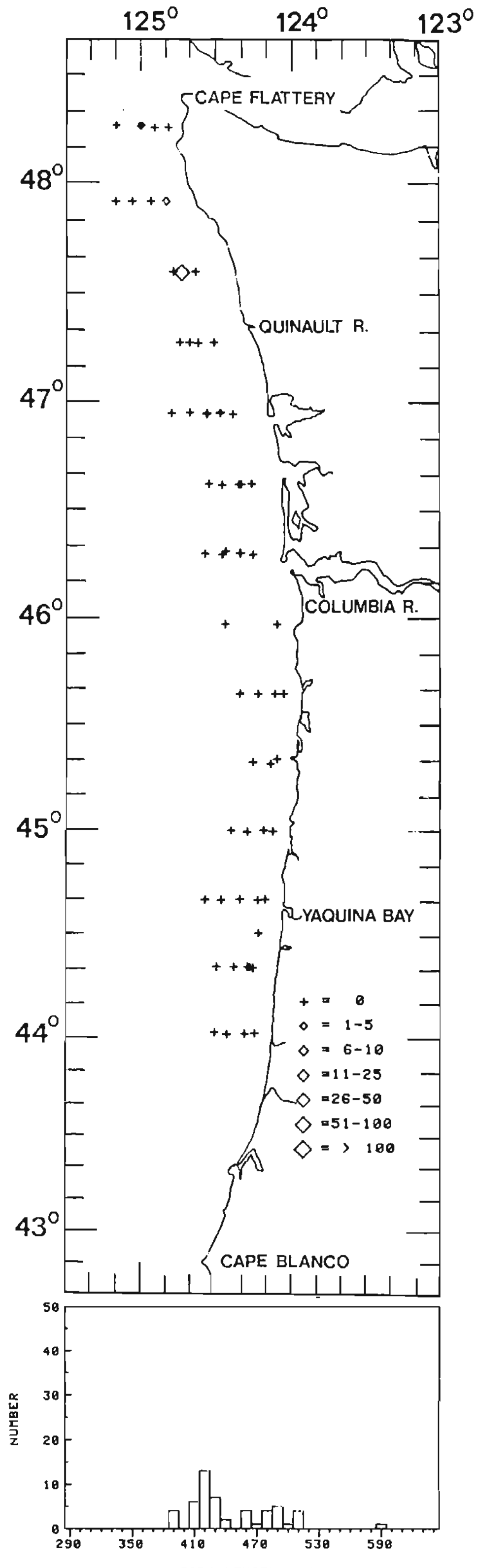
Merluccius productus



June 1984 **July 1984**

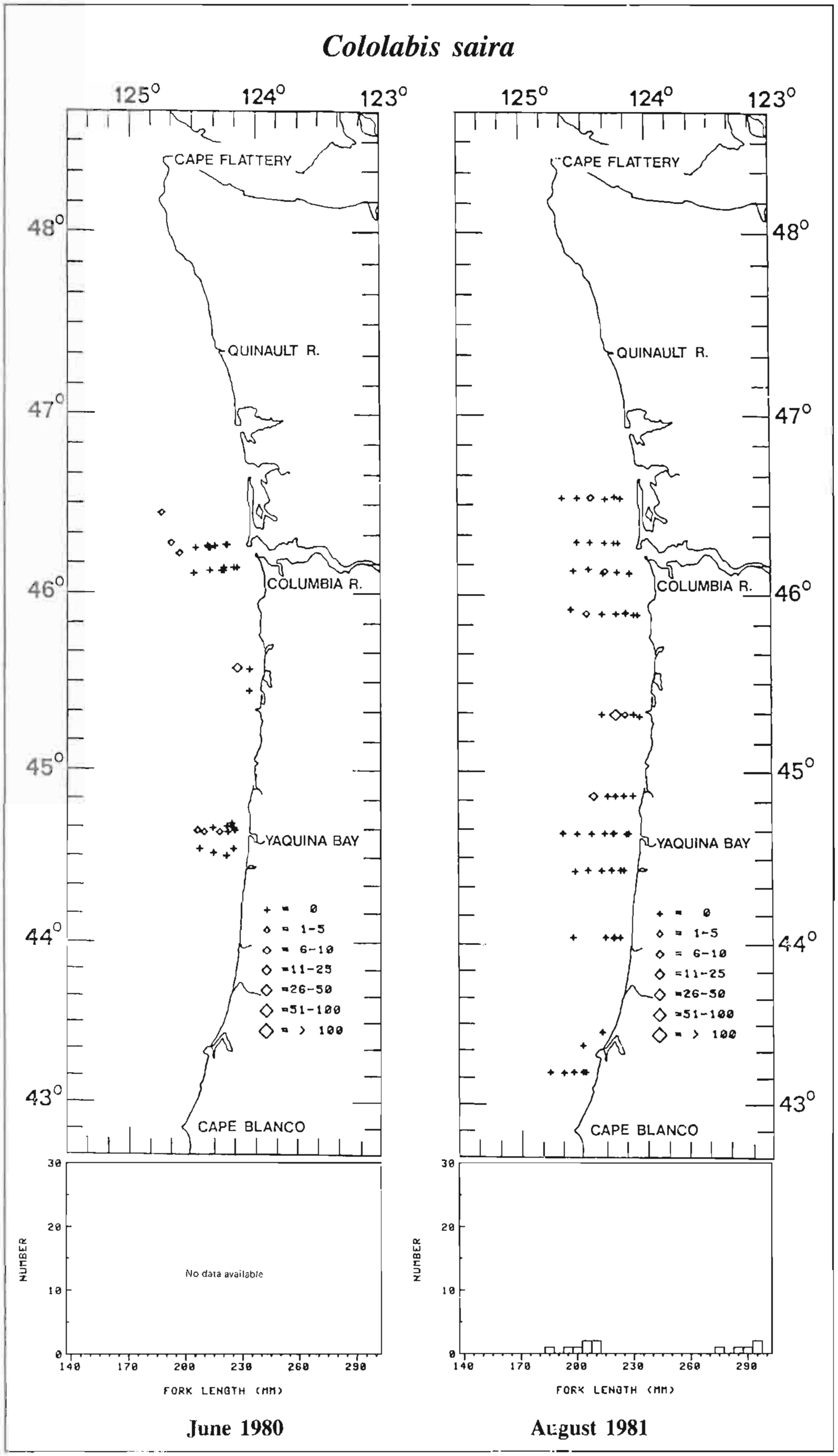
Figure 45

Merluccius productus



September 1984

Figure 46



Cololabis saira
125°
124°
123°
CAPE FLATTERY
QUINAULT R.
COLUMBIA R.
YAQUINA BAY
CAPE BLANCO
48°
47°
46°
45°
44°
43°
+ = 0
◇ = 1-5
◇ = 6-10
◇ =11-25
◇ =26-50
◇ =51-100
◇ = > 100
NUMBER
No data available
FORK LENGTH (MM)
June 1980
August 1981

Figure 47

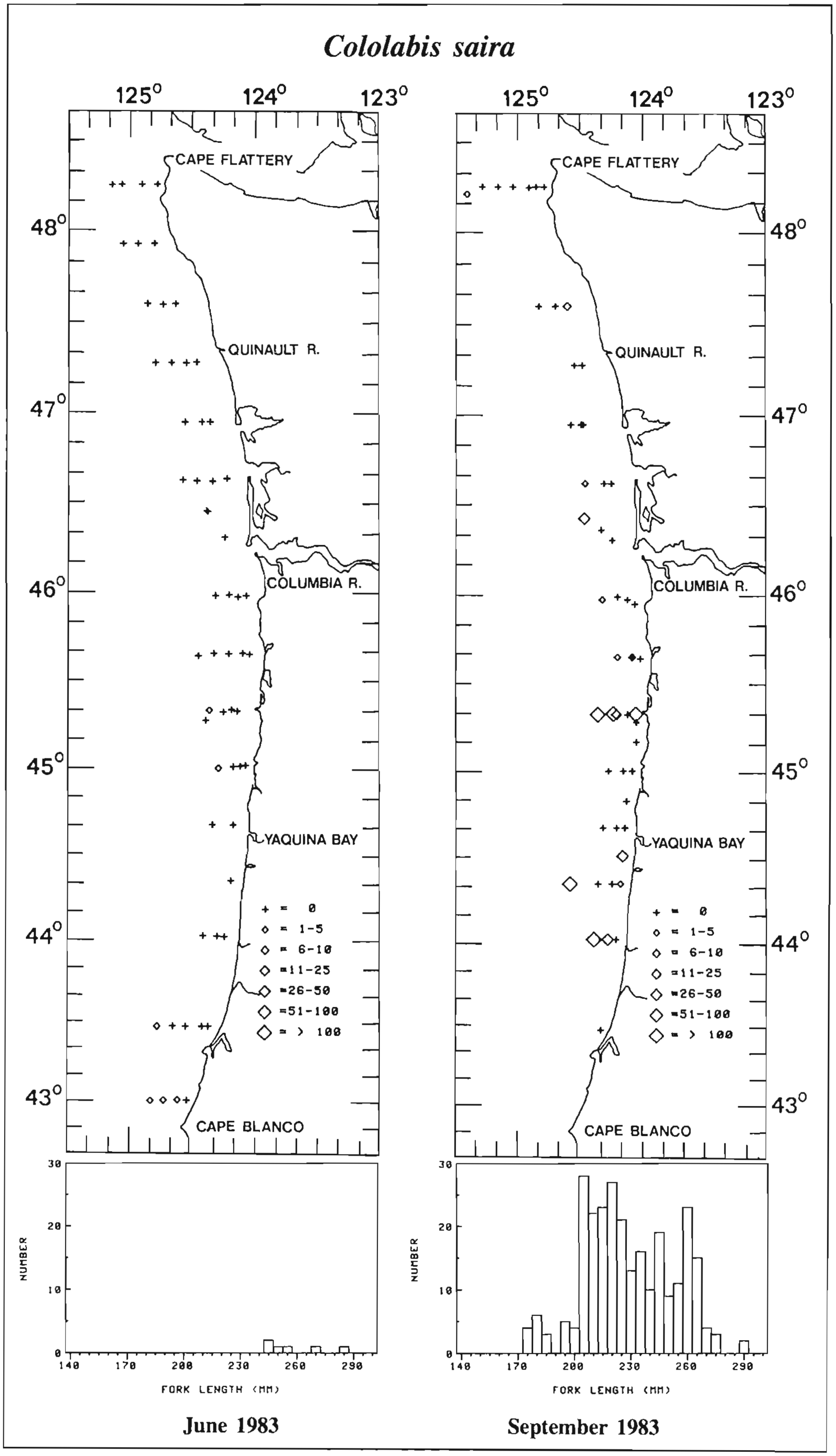
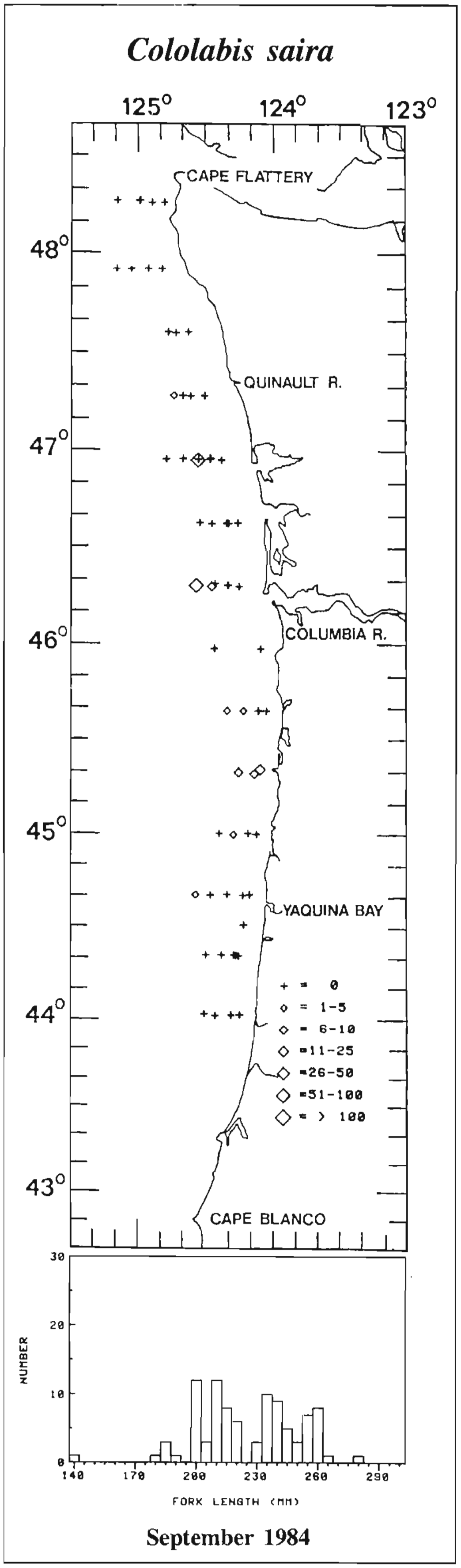

Cololabis saira
125°
124°
123°
CAPE FLATTERY
QUINAULT R.
COLUMBIA R.
YAQUINA BAY
CAPE BLANCO
48°
47°
46°
45°
44°
43°
+ = 0
◇ = 1-5
◇ = 6-10
◇ =11-25
◇ =26-50
◇ =51-100
◇ = > 100
NUMBER
FORK LENGTH (MM)
June 1983
September 1983

Figure 48



Cololabis saira
125°
124°
123°
CAPE FLATTERY
48°
QUINAULT R.
47°
46°
COLUMBIA R.
45°
YAQUINA BAY
44°
43°
CAPE BLANCO
+ = 0
◇ = 1-5
◇ = 6-10
◇ =11-25
◇ =26-50
◇ =51-100
◇ = > 100
NUMBER
FORK LENGTH (MM)
September 1984

Figure 49

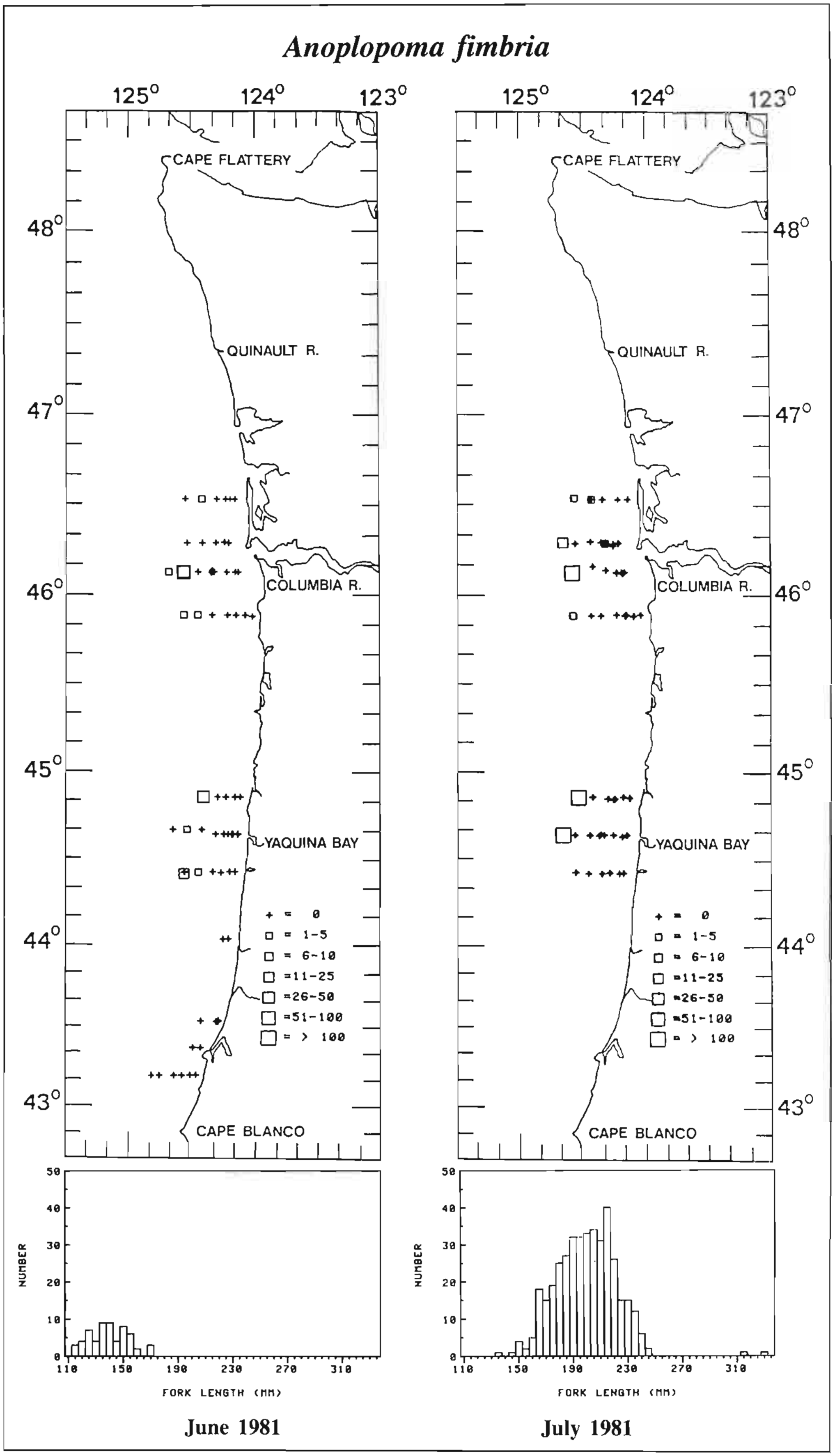

Anoplopoma fimbria
125°
124°
123°
48°
47°
46°
45°
44°
43°
CAPE FLATTERY
QUINAULT R.
COLUMBIA R.
YAQUINA BAY
CAPE BLANCO
+ = 0
□ = 1-5
□ = 6-10
□ =11-25
□ =26-50
□ =51-100
□ = > 100
NUMBER
FORK LENGTH (MM)
June 1981
July 1981

Figure 50

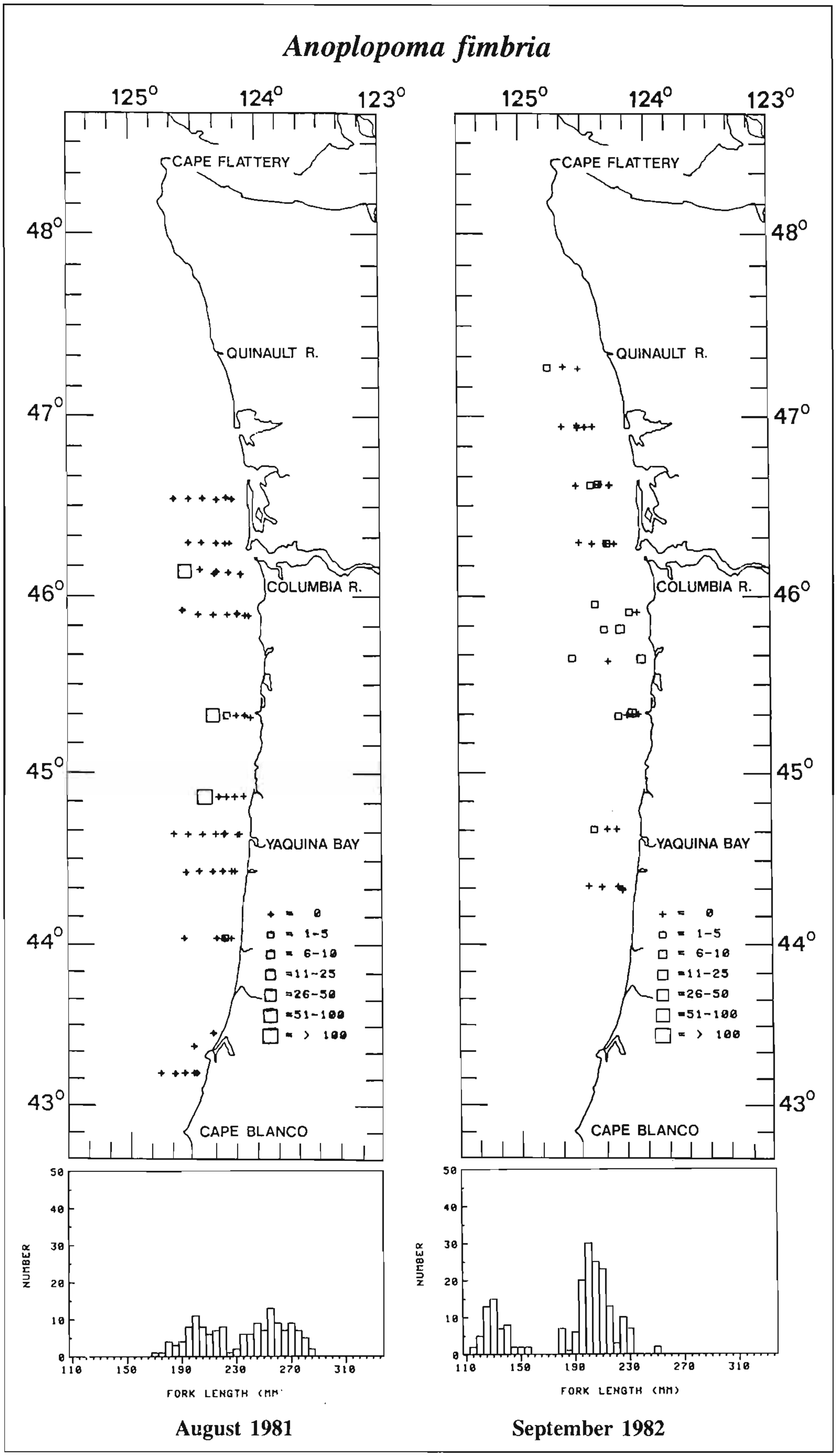

Anoplopoma fimbria
125°
124°
123°
CAPE FLATTERY
48°
QUINAULT R.
47°
COLUMBIA R.
46°
45°
YAQUINA BAY
44°
43°
CAPE BLANCO
+ = 0
= 1-5
= 6-10
=11-25
=26-50
=51-100
= > 100
NUMBER
FORK LENGTH (MM)
August 1981
September 1982

Figure 51

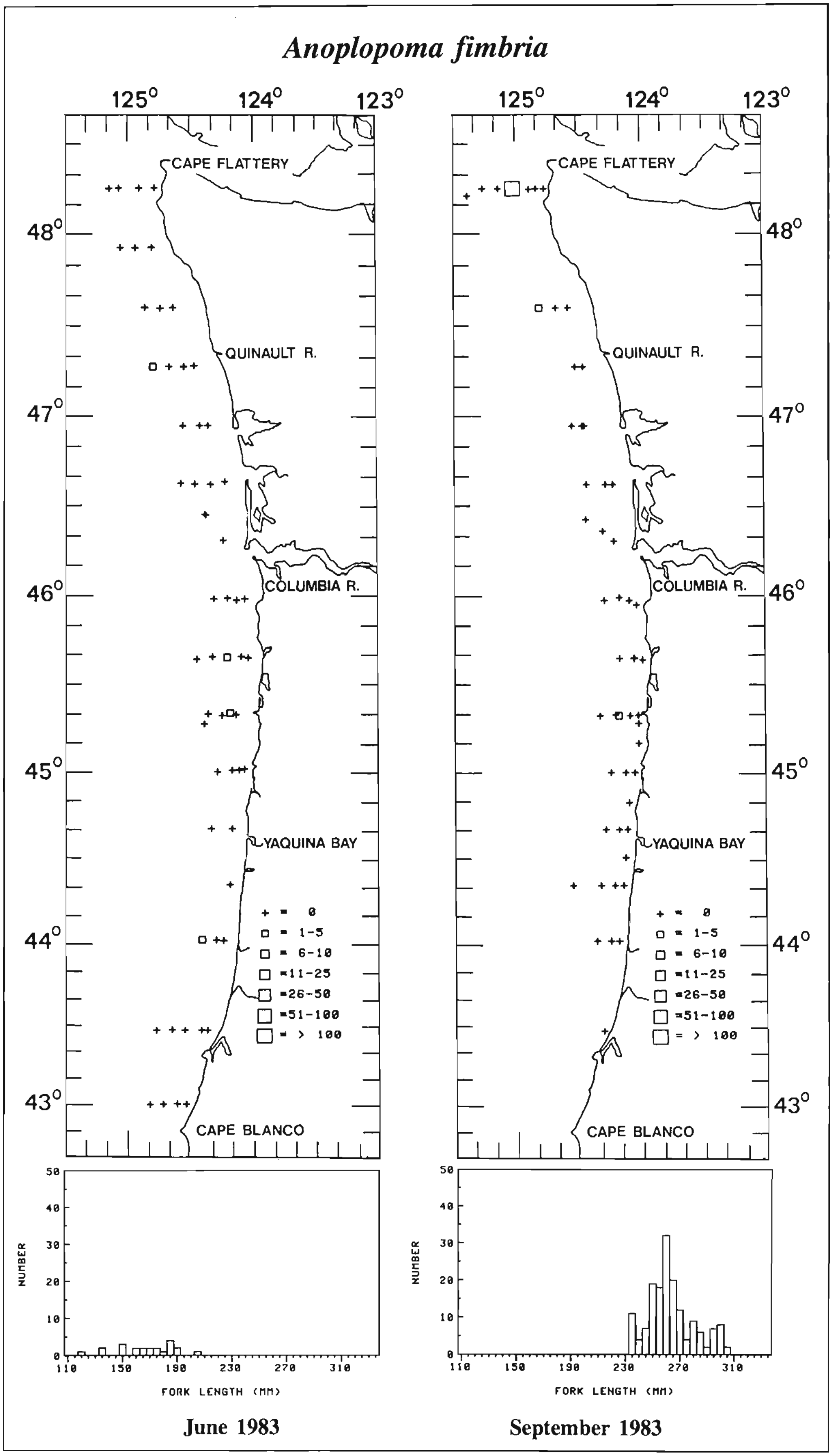
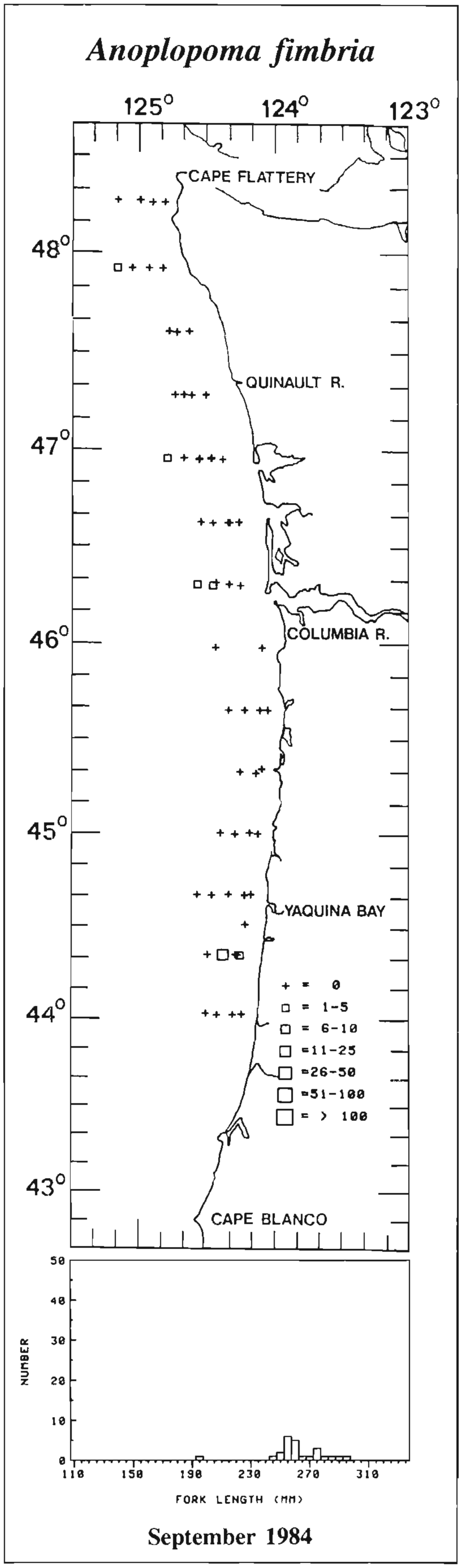

Anoplopoma fimbria
125°
124°
123°
48°
47°
46°
45°
44°
43°
CAPE FLATTERY
QUINAULT R.
COLUMBIA R.
YAQUINA BAY
CAPE BLANCO
+ = 0
= 1-5
= 6-10
=11-25
=26-50
=51-100
= > 100
NUMBER
FORK LENGTH (MM)
June 1983
September 1983

Figure 52



Anoplopoma fimbria
125°
124°
123°
48°
47°
46°
45°
44°
43°
CAPE FLATTERY
QUINAULT R.
COLUMBIA R.
YAQUINA BAY
CAPE BLANCO
+ = 0
□ = 1-5
□ = 6-10
□ =11-25
□ =26-50
□ =51-100
□ = > 100
NUMBER
FORK LENGTH (MM)
September 1984

Figure 53

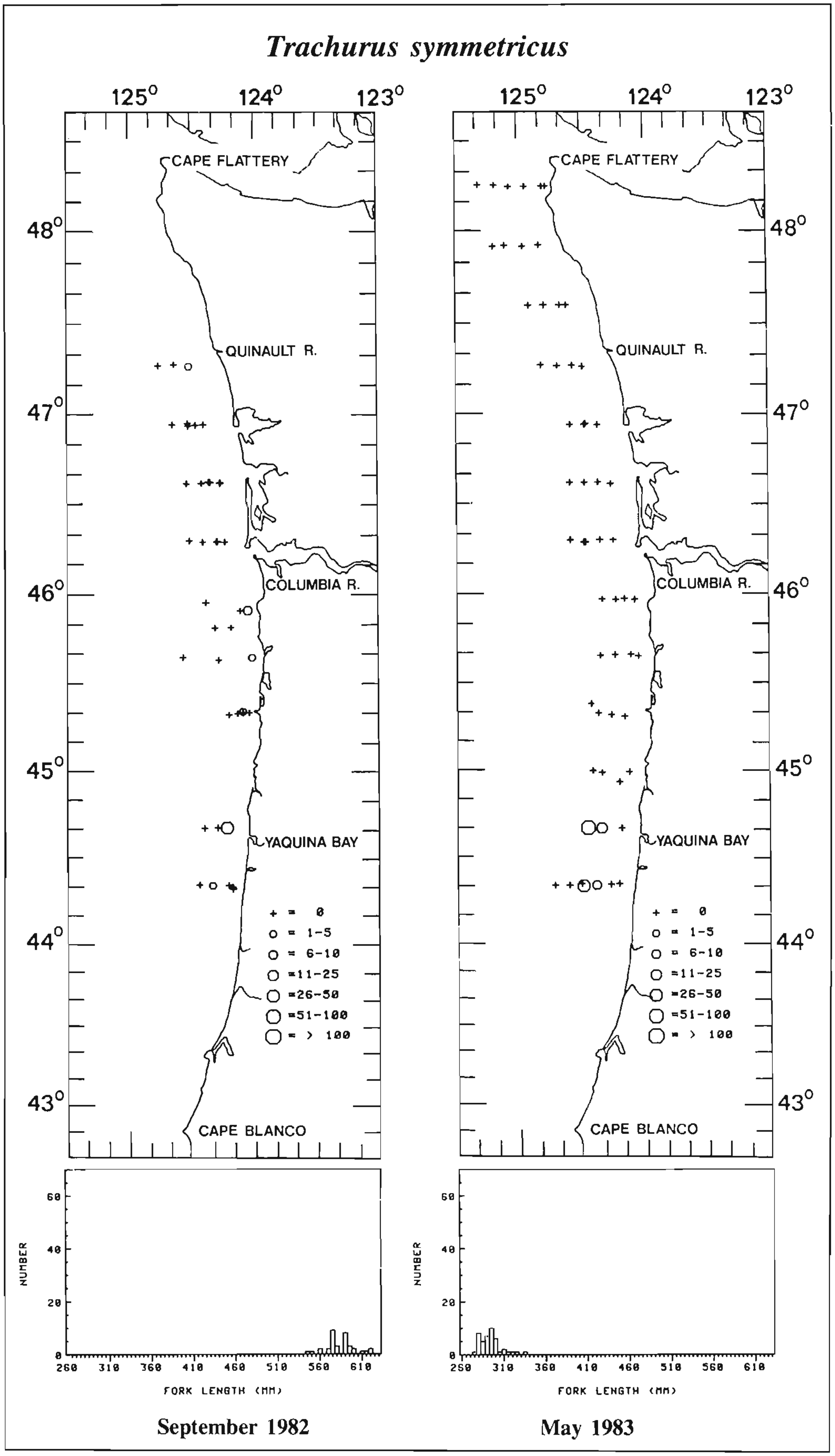

Trachurus symmetricus
125°
124°
123°
CAPE FLATTERY
QUINAULT R.
COLUMBIA R.
YAQUINA BAY
CAPE BLANCO
48°
47°
46°
45°
44°
43°
+ = 0
o = 1-5
O = 6-10
O =11-25
O =26-50
O =51-100
O = > 100
NUMBER
60
40
20
0
260
310
360
410
460
510
560
610
FORK LENGTH (MM)
September 1982
May 1983

Figure 54

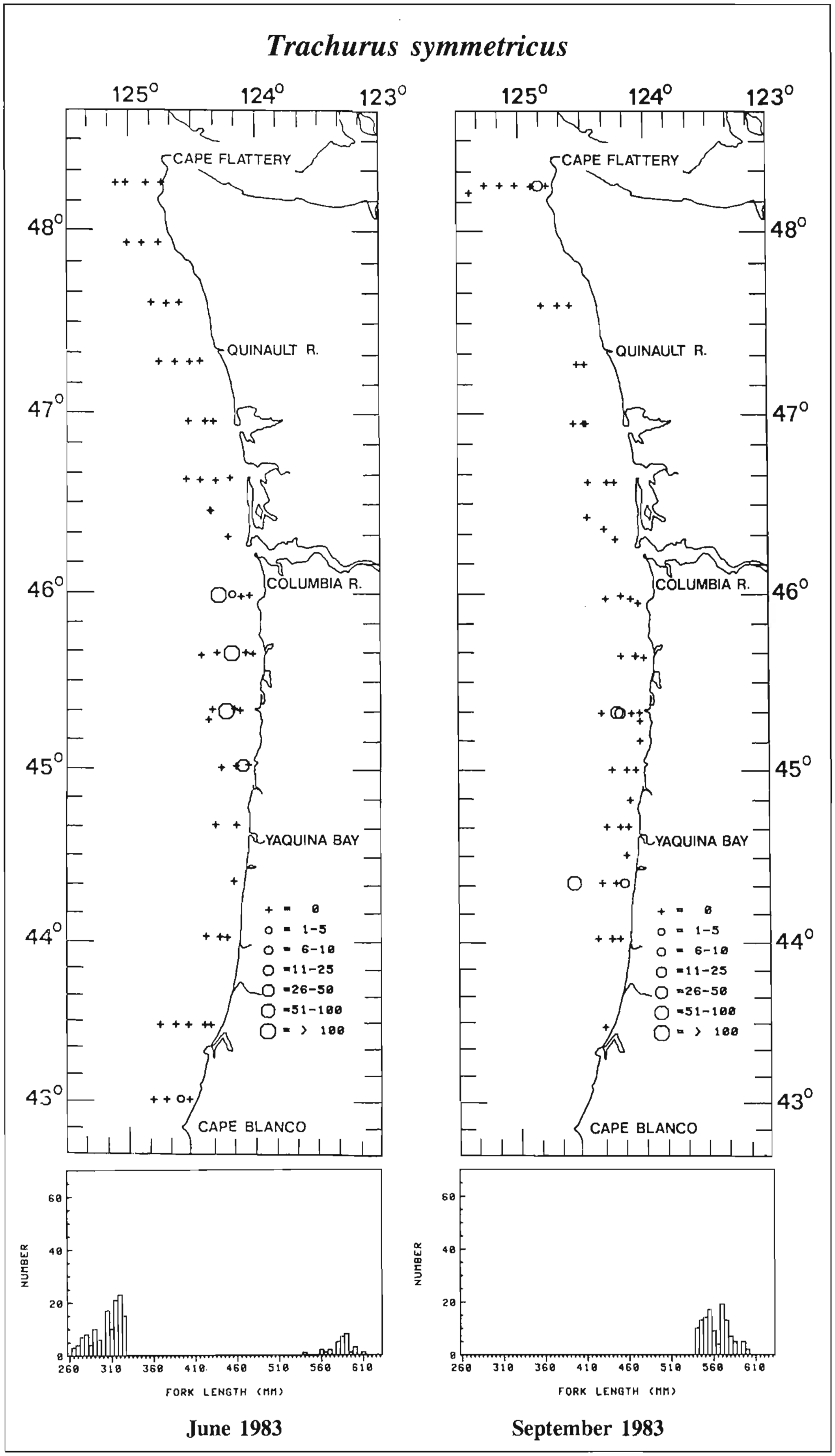
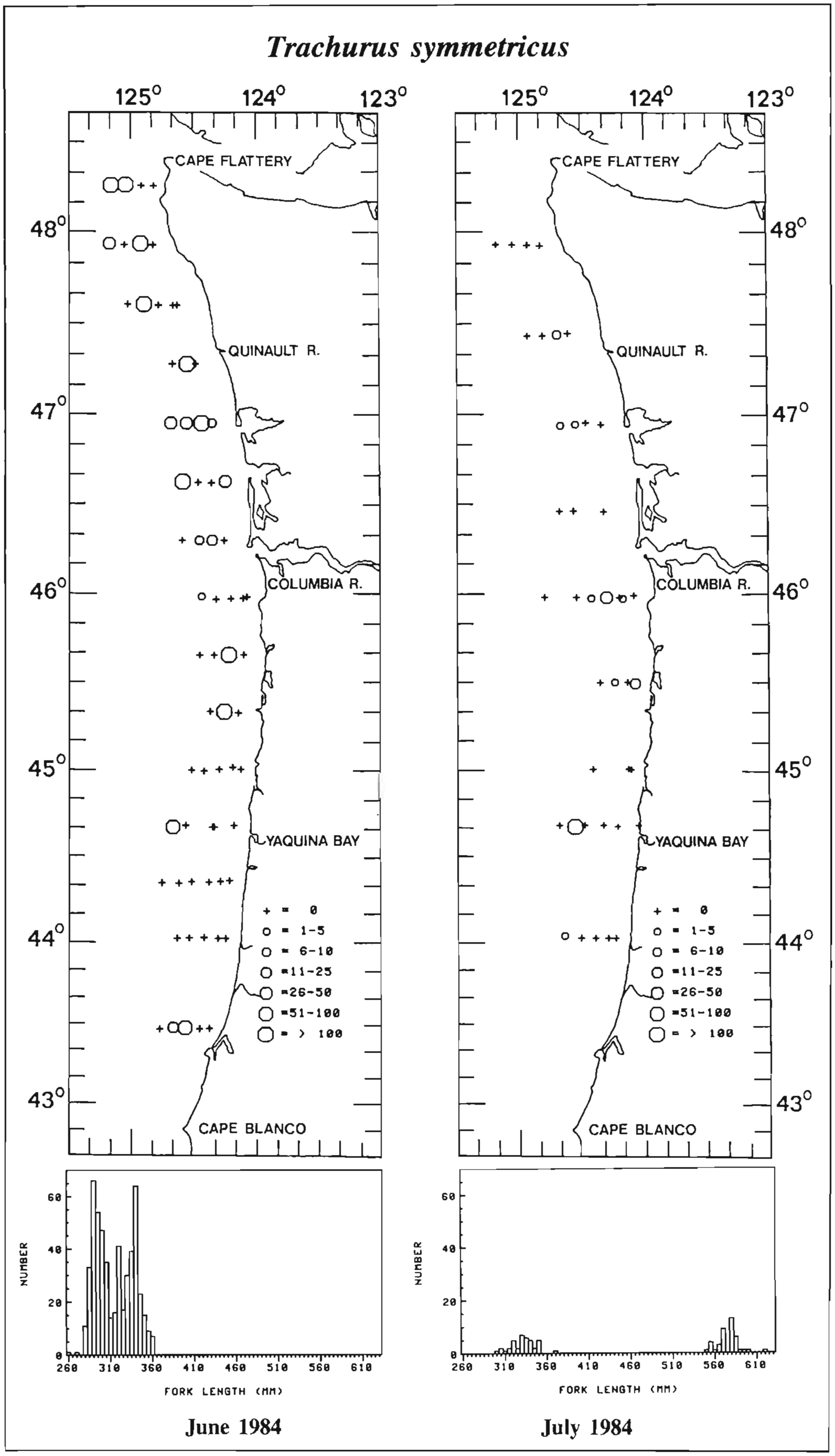

Trachurus symmetricus
125°
124°
123°
48°
47°
46°
45°
44°
43°
CAPE FLATTERY
QUINAULT R.
COLUMBIA R.
YAQUINA BAY
CAPE BLANCO
+ = 0
o = 1-5
O = 6-10
O =11-25
O =26-50
O =51-100
O = > 100
NUMBER
FORK LENGTH (MM)
June 1983
September 1983

Figure 55



Trachurus symmetricus
125°
124°
123°
CAPE FLATTERY
QUINAULT R.
COLUMBIA R.
YAQUINA BAY
CAPE BLANCO
48°
47°
46°
45°
44°
43°
+ = 0
○ = 1-5
○ = 6-10
○ =11-25
○ =26-50
○ =51-100
○ = > 100
NUMBER
FORK LENGTH (MM)
June 1984
July 1984

Figure 56

Scomber japonicus

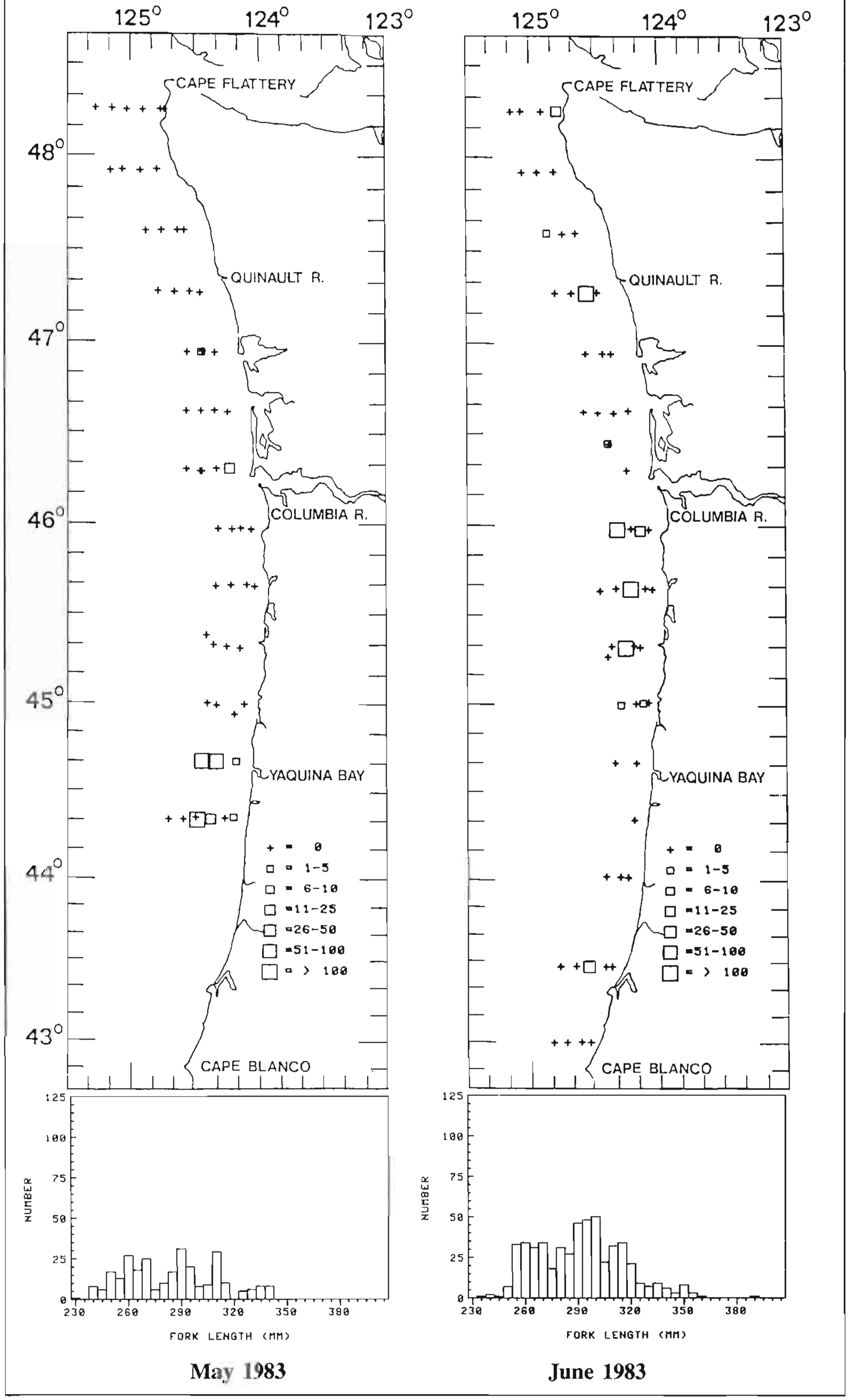
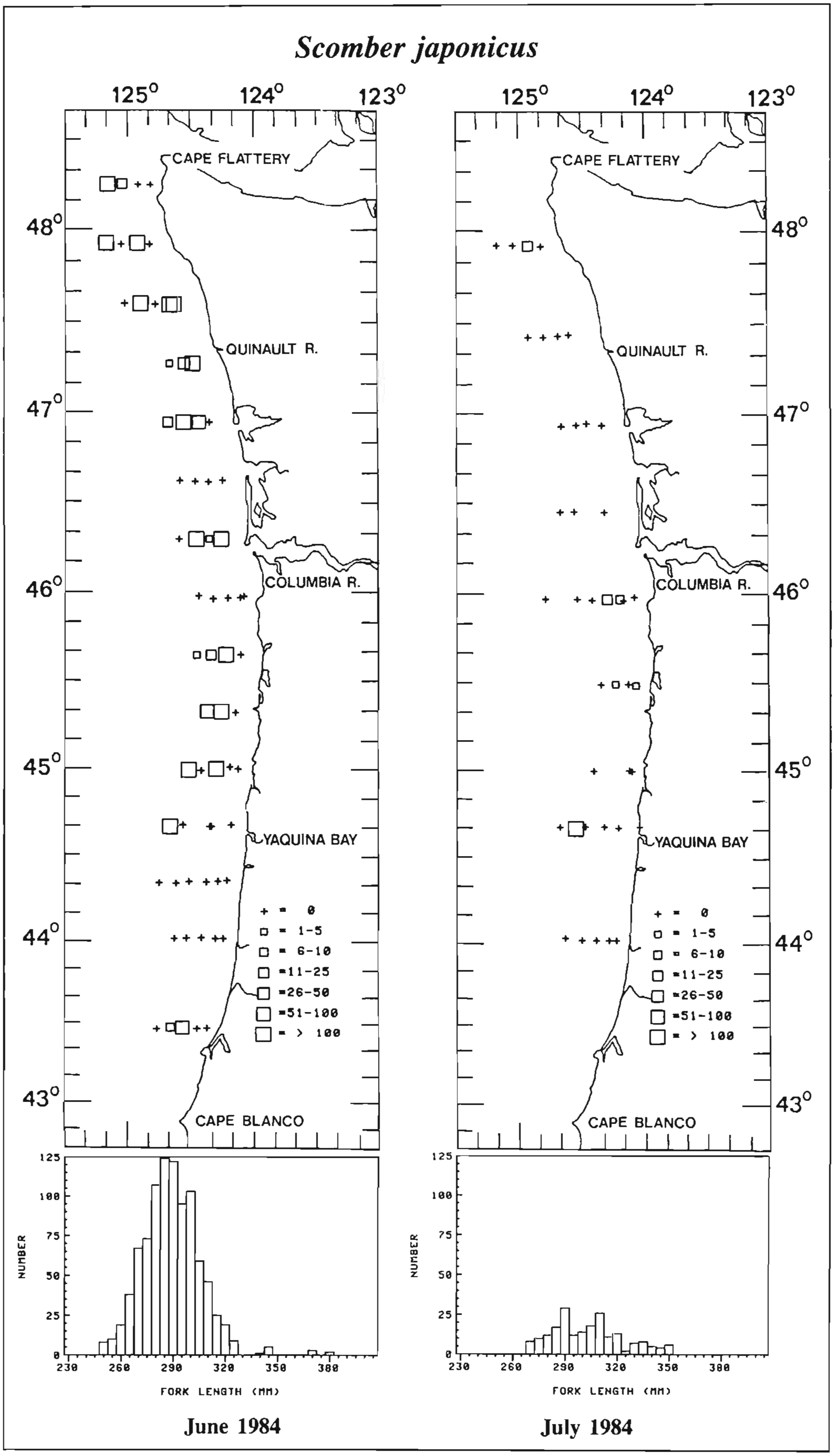


Figure 57



Scomber japonicus
125°
124°
123°
48°
47°
46°
45°
44°
43°
CAPE FLATTERY
QUINAULT R.
COLUMBIA R.
YAQUINA BAY
CAPE BLANCO
+ = 0
□ = 1-5
□ = 6-10
□ =11-25
□ =26-50
□ =51-100
□ = > 100
NUMBER
FORK LENGTH (MM)
June 1984
July 1984

Figure 58

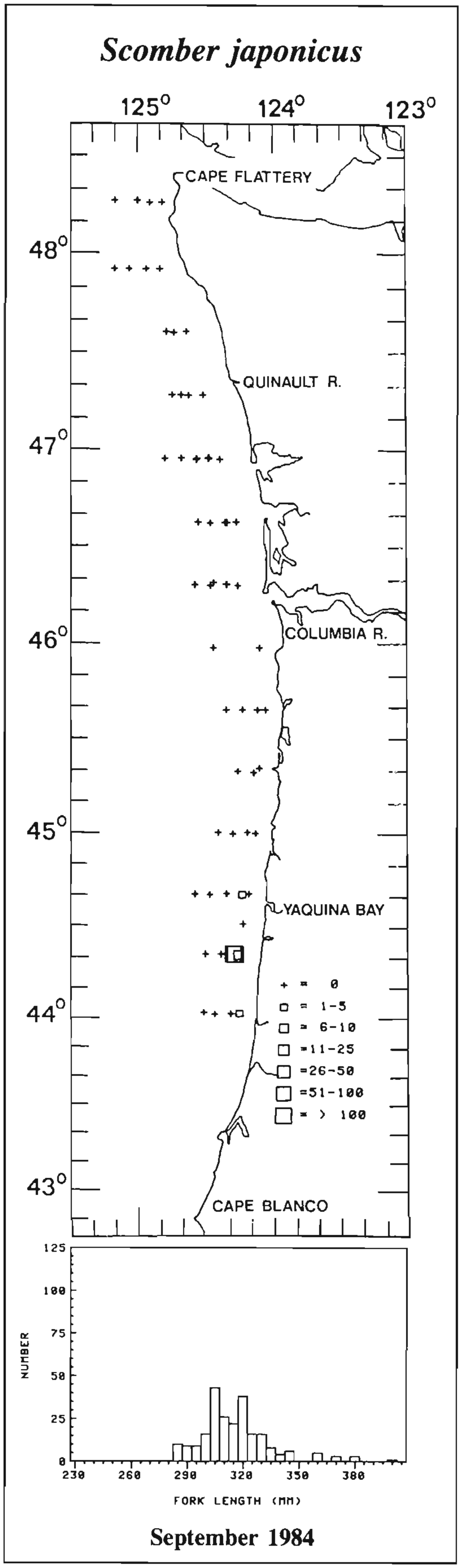

Scomber japonicus
125°
124°
123°
CAPE FLATTERY
48°
QUINAULT R.
47°
46°
COLUMBIA R.
45°
YAQUINA BAY
44°
+ = 0
□ = 1-5
□ = 6-10
□ =11-25
□ =26-50
□ =51-100
□ = > 100
43°
CAPE BLANCO
NUMBER
125
100
75
50
25
0
230
260
290
320
350
380
FORK LENGTH (MM)
September 1984

Figure 59

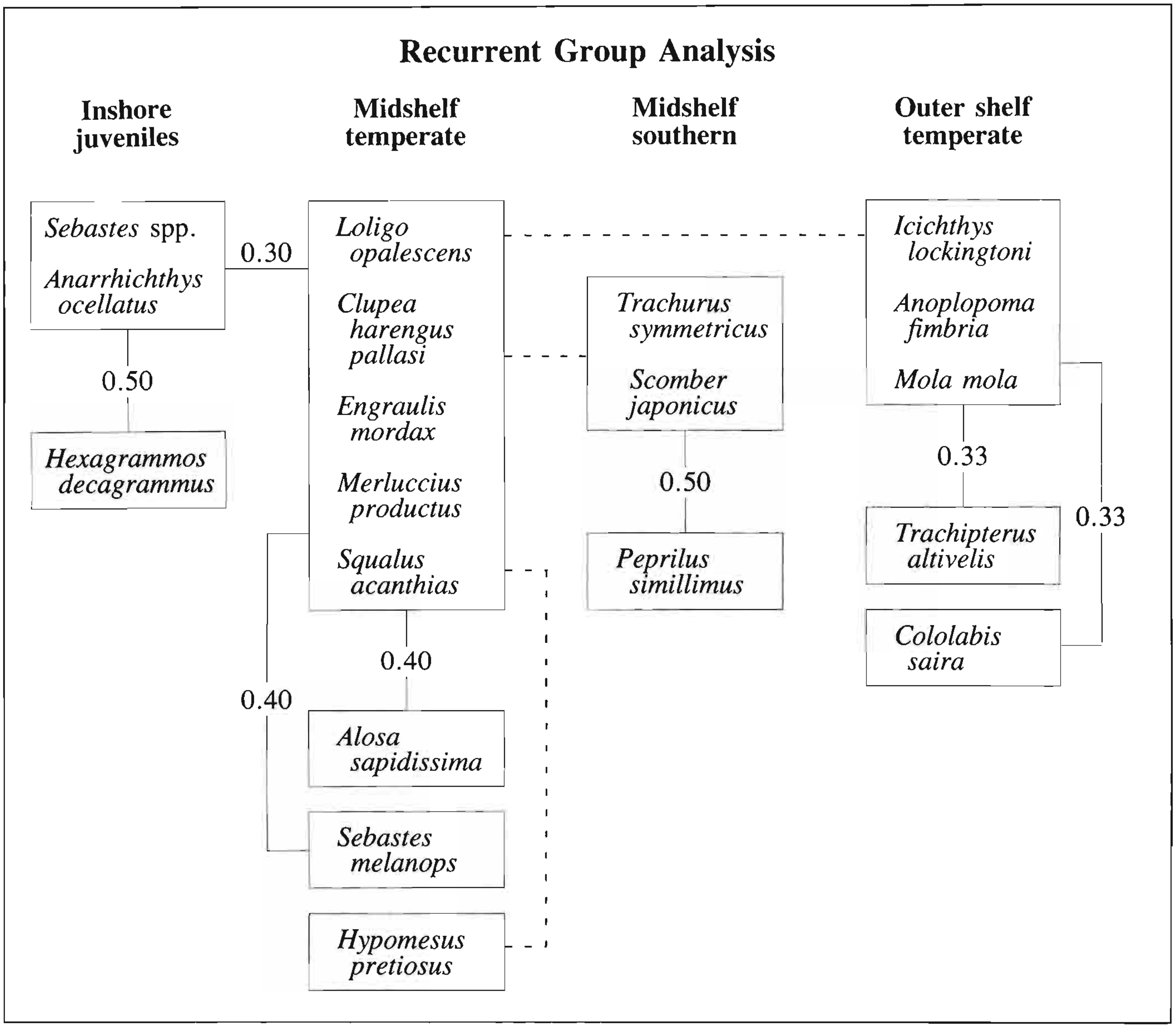


Figure 60

Species associations of marine nekton off Washington and Oregon, 1979-84, according to Fager's recurrent group analysis (affinity level = 0.30; sample size = 843). Species within squares show positive affinities to all others within the square. Intergroup affinities are shown with connecting lines between squares. Intergroup affinities above 0.25 are given, and those below 0.25 are shown as dashed lines.

Appendix Table 1—Station and environmental data, June 1979.

Set	Date (June)	Lat. (N)	Long. (W)	Off-shore (km)	Depth (m)	Time at start	Temp. (°C)	Salin-ity (‰)
1	18	46°13′	124°10′	10.2	40	0630	13.5	28.2
2	18	46°13′	124°16′	16.8	77	0855	13.5	—
3	18	46°13′	124°21′	22.4	102	1014	13.5	22.9
4	18	46°13′	124°27′	29.8	117	1125	14.0	24.4
7	19	46°20′	124°10′	6.7	26	1310	15.0	28.8
8	19	46°20′	124°13′	9.6	38	1417	15.0	28.5
9	19	46°20′	124°17′	15.2	73	1605	15.0	22.3
10	19	46°18′	124°15′	11.5	66	1730	15.0	16.2
11	19	46°13′	124°13′	14.8	68	1915	16.0	18.8
12	20	46°12′	124°15′	16.4	77	0752	14.5	24.8
16	21	46°10′	124°04′	6.4	22	0724	13.3	27.8
17	21	46°10′	124°08	10.4	40	0843	13.5	27.1
18	21	46°10′	124°12′	15.2	73	0957	13.8	24.5
19	21	46°10′	124°14′	17.1	75	1107	12.9	26.5
20	21	46°10′	124°19′	22.2	99	1219	13.9	23.2
21	21	46°10′	124°21′	24.3	112	1325	15.1	22.3
22	21	46°10′	124°25′	28.8	130	1444	15.2	21.5
23	22	45°28′	124°02′	1.6	26	1300	13.4	31.7
24	22	45°28′	124°06′	6.4	75	1417	14.5	31.3
25	23	44°38′	124°07′	2.7	27	0704	10.2	33.5
26	23	44°38′	124°11′	6.2	46	0800	10.4	33.3
27	23	44°38′	124°13′	8.6	55	0924	11.2	33.3
28	23	44°38′	124°18′	14.1	77	1130	11.2	32.7
29	23	44°38′	124°26′	23.4	73	1300	12.7	32.3
30	26	44°34′	124°31′	30.6	135	1000	11.8	32.1
31	26	44°34′	124°36′	37.4	196	1111	12.6	32.0
32	26	44°33′	124°32′	31.8	135	1232	12.3	32.1
33	26	44°31′	124°23′	21.1	53	1411	11.2	32.6
34	26	44°30′	124°18′	14.4	80	1539	11.3	32.2
35	26	44°30′	124°11′	6.2	55	1656	11.2	33.6
36	26	44°30′	124°07′	2.2	31	1825	11.2	33.6
37	27	44°37′	124°08′	3.0	35	0602	9.4	33.7
38	27	44°37′	124°09′	3.2	37	0807	9.4	—
39	27	44°37′	124°12′	8.2	55	0921	10.7	33.6
42	27	44°37′	124°20′	16.0	79	1432	10.3	33.0
43	28	44°37′	124°12′	8.1	57	0410	10.0	33.6
44	28	44°00′	124°14′	5.8	55	0943	9.2	33.6
45	28	44°03′	124°22′	14.2	92	1103	10.5	33.4
46	28	44°03′	124°27′	20.5	112	1310	10.5	33.4
47	29	43°25′	124°22′	4.8	27	0607	10.1	33.5
48	29	43°25′	124°24′	6.4	73	0717	11.0	33.2
49	29	43°25′	124°27′	10.4	102	0820	11.1	33.2
50	29	43°26′	124°34′	19.2	141	0905	12.6	32.9
51	29	43°26′	124°38′	24.0	249	1101	12.5	32.8
52	29	43°27′	124°46′	32.6	520	1220	13.2	32.4
53	29	43°17′	124°38′	16.0	128	1420	12.0	32.7
54	29	43°17′	124°31′	8.1	92	1538	10.5	33.6
55	29	43°17′	124°27′	3.2	53	1647	10.6	33.5
56	29	43°17′	124°26′	1.9	29	1739	10.5	33.5

Appendix Table 2—Station and environmental data, June 1980.

Set	Date (June)	Lat. (N)	Long. (W)	Off-shore (km)	Depth (m)	Time at start	Temp. (°C)	Salin-ity (‰)
1	20	46°16′	124°35′	37.0	463	1410	14.9	30.2
9	21	46°30′	124°44′	50.0	732	1230	15.1	30.5
10	21	46°20′	124°39′	42.6	183	1446	15.2	29.8
11	21	46°18′	124°27′	31.5	183	1539	15.4	29.7
12	21	46°19′	124°21′	23.1	110	1636	15.2	30.4
13	21	46°18′	124°21′	21.3	110	1713	14.6	30.7
14	21	46°18′	124°20′	20.3	110	1753	15.2	9.9
15	21	46°19′	124°18′	17.6	82	1857	15.1	8.2
16	21	46°19′	124°12′	10.1	37	2002	14.9	10.9
17	22	46°11′	124°07′	9.8	37	0803	13.3	24.4
18	22	46°11′	124°13′	18.5	73	0911	14.0	16.2
19	22	46°10′	124°20′	27.8	110	1027	14.4	18.8
20	22	46°09′	124°28′	37.0	132	1140	15.2	29.9
24	22	46°10′	124°14′	21.2	73	1620	—	—
25	23	46°19′	124°12′	9.3	38	0755	14.0	17.7
26	23	46°11′	124°08′	10.2	37	0912	14.1	28.1
27	25	46°10′	124°13′	18.5	88	1032	13.4	29.0
28	26	45°36′	124°00′	3.1	37	1332	15.3	27.7
29	26	45°36′	124°06′	12.0	82	1420	15.2	28.7
30	26	45°28′	124°00′	2.4	33	1551	15.3	26.7
31	27	44°39′	124°07′	5.5	38	0655	13.8	31.1
32	27	44°41′	124°11′	9.3	55	0746	14.6	29.6
33	27	44°40′	124°18′	18.5	77	0857	14.9	28.0
34	27	44°39′	124°26′	27.8	81	1005	14.8	28.7
36	27	44°39′	124°22′	23.1	88	1200	—	—
37	27	44°39′	124°15′	17.5	73	1310	15.4	28.9
38	27	44°39′	124°11′	9.3	53	1425	15.1	29.9
39	27	44°40′	124°08′	6.5	68	1514	14.7	31.0
40	27	44°42′	124°09′	6.5	54	1605	14.3	31.2
41	28	44°33′	124°08′	3.7	37	0730	12.3	32.2
42	28	44°30′	124°11′	9.3	55	0837	12.7	32.2
43	28	44°32′	124°18′	16.7	79	0943	13.1	31.9
44	28	44°33′	124°25′	25.9	44	1058	14.0	30.8

Appendix Table 3—Station and environmental data, summer 1981.

Set	Date	Lat. (N)	Long. (W)	Off-shore (km)	Depth (m)	Time at start	Temp. (°C)	Salin-ity (‰)	Chloro-phyll *a* (μg/L)
	May								
1	16	44°38′	124°07′	3.9	40	0640	10.7	32.7	3.6
2	16	44°40′	124°09′	7.0	48	1020	11.1	32.5	—
3	16	44°38′	124°13′	12.8	67	1229	12.1	29.1	3.9
4	16	44°38′	124°18′	28.3	79	1425	12.6	26.9	1.1
5	16	44°38′	124°25′	28.3	67	1703	12.8	27.2	0.6
6	16	44°38′	124°18′	18.7	77	1854	12.4	27.5	2.3
7	16	44°38′	124°18′	18.9	77	2053	12.9	26.3	—
8	16	44°37′	124°18′	18.5	79	2342	12.6	26.1	—
9	17	44°39′	124°18′	19.1	77	0425	12.2	27.3	—
10	17	44°38′	124°18′	18.9	75	0702	12.3	—	0.6
11	17	44°38′	124°18′	18.5	75	0904	12.4	27.3	0.7
12	18	44°25′	124°08′	4.1	40	1157	12.6	—	2.1
13	18	44°25′	124°11′	8.0	49	1307	13.0	27.6	1.0
15	18	44°25′	124°15′	13.1	62	1718	12.9	27.9	—
16	18	44°25′	124°19′	18.5	68	1834	12.1	29.7	5.9
17	18	44°25′	124°26′	28.0	79	2051	12.7	—	0.7
18	18	44°25′	124°32′	35.7	97	2305	12.3	29.8	—
19	19	44°51′	124°05′	3.1	37	0745	12.3	28.2	3.3
20	19	44°51′	124°08′	7.0	60	0904	12.7	27.4	0.8
21	19	44°52′	124°13′	13.0	99	1055	13.2	28.8	0.3
22	19	44°52′	124°17′	18.3	124	1258	13.6	27.7	0.2
23	19	44°52′	124°24′	27.8	152	1430	12.9	27.9	0.2
25	19	44°51′	124°20′	22.8	135	1707	13.4	28.5	0.2
26	19	44°52′	124°15′	15.5	112	1928	13.5	27.6	—
27	20	44°55′	124°01′	3.5	37	0621	13.3	27.5	1.3
28	20	45°55′	124°04′	7.4	66	0742	13.5	25.6	1.9
29	20	45°55′	124°08′	13.3	81	0919	13.3	17.0	1.8
30	20	45°55′	124°13′	18.5	104	1105	13.2	26.2	2.1
31	20	45°55′	124°20′	27.8	135	1505	13.5	26.5	1.9
32	20	45°55′	124°27′	37.2	146	1718	13.4	27.6	1.4
33	20	45°55′	124°34′	46.1	165	1933	12.9	—	0.2
35	21	46°10′	124°28′	38.3	130	0550	12.1	29.7	1.2
36	21	46°10′	124°34′	46.6	152	0815	12.4	29.2	0.1
37	21	46°10′	124°34′	46.6	152	0854	12.4	29.2	0.1
38	21	46°10′	124°41′	54.0	194	1105	12.8	30.7	0.2
39	21	46°10′	124°29′	38.7	130	1250	12.4	—	2.1
40	21	46°10′	124°20′	28.1	110	1431	13.4	22.9	3.0
41	21	46°10′	124°13′	18.3	73	1630	12.9	22.9	1.7
42	21	46°10′	124°08′	12.8	48	1747	13.2	24.3	1.6
43	21	46°10′	124°07′	11.3	38	1850	13.4	24.3	1.3
44	22	46°20′	124°12′	10.4	37	1119	13.7	—	2.4
45	22	46°20′	124°14′	13.0	51	1242	13.8	15.2	2.9
47	22	46°20′	124°25′	27.8	124	1814	12.9	29.3	1.0
48	22	46°20′	124°32′	37.0	134	2018	13.0	15.2	—
49	22	46°20′	124°33′	37.0	134	2103	13.0	30.8	0.1
50	22	46°20′	124°40′	47.7	915	2315	12.9	31.5	0.1
51	23	46°20′	124°40′	46.6	915	0019	12.8	31.4	—
52	23	46°35′	124°41′	46.6	640	0620	12.8	30.8	—
53	23	46°35′	124°33′	37.0	320	0755	12.7	30.9	0.2
54	23	46°35′	124°26′	28.0	95	0932	12.9	29.5	0.9
55	23	46°35′	124°18′	18.1	119	1131	12.8	24.9	3.4
56	23	46°35′	124°14′	12.6	46	1326	13.9	22.0	3.3
57	23	46°35′	124°11′	9.6	37	1508	14.2	22.6	—
58	24	45°55′	124°13′	18.7	104	1016	12.8	29.2	0.5
59	24	45°55′	124°08′	12.9	81	1140	12.8	29.1	0.7
61	24	45°55′	124°04′	7.0	64	1504	13.4	29.1	0.8
62	24	45°55′	124°01′	3.5	38	1619	13.6	27.5	1.0
63	24	45°55′	124°20′	28.0	135	1865	12.7	30.7	0.2
64	24	46°05′	124°10′	18.9	79	2232	13.2	27.8	1.4
65	25	46°09′	124°20′	28.0	110	0047	13.7	23.4	1.5
66	25	46°10′	124°12′	18.5	70	0325	13.3	25.3	2.4
67	25	46°10′	124°07′	11.1	38	0542	13.3	25.5	—
68	25	46°10′	124°08′	12.6	0	0643	12.9	27.4	—
	June								
69	9	46°35′	124°11′	9.6	37	1052	13.8	26.9	5.3
70	9	46°35′	124°09′	7.2	26	1255	13.7	28.0	4.9
71	9	46°35′	124°14′	12.6	46	1417	13.4	29.4	3.0
72	9	46°35′	124°18′	18.3	66	1550	13.2	—	1.0
73	9	46°35′	124°25′	27.8	95	1804	13.7	1.0	0.4
	June								
74	9	46°35′	124°34′	38.3	201	2102	13.6	31.4	0.2
75	10	46°20′	124°33′	37.0	134	0640	13.4	31.1	0.3
76	10	46°20′	124°25′	28.1	126	0821	14.2	24.9	2.0
77	10	46°20′	124°18′	18.5	44	1102	14.8	20.1	3.2
78	10	46°20′	124°14′	13.3	51	1329	15.1	12.0	3.7
79	10	46°20′	124°12′	10.6	37	1452	15.2	14.7	4.1
80	10	46°10′	124°07′	9.3	37	1718	15.1	23.2	1.4
81	10	46°10′	124°09′	13.3	49	1842	15.2	24.9	1.4
82	10	46°10′	124°13′	18.5	73	2052	15.0	26.7	0.6
83	11	46°10′	124°20′	28.1	110	0638	14.8	25.2	0.3
84	11	46°10′	124°27′	37.0	128	0917	14.8	24.6	0.5
85	11	46°10′	124°34′	46.3	152	1112	14.1	31.0	0.4
86	11	46°10′	124°34′	46.3	154	1159	14.3	29.6	—
87	11	46°10′	124°42′	56.2	366	1402	14.4	31.6	0.2
88	11	46°10′	124°19′	26.8	104	1710	15.3	25.7	0.3
89	11	46°10′	124°20′	15.0	27	1929	15.1	26.1	0.3
90	11	46°10′	124°21′	8.8	61	2030	15.0	26.0	—
91	11	46°11′	124°20′	27.4	60	2322	15.1	25.5	—
92	12	45°55′	124°34′	46.3	170	0846	13.8	31.3	0.7
93	12	45°55′	124°27′	37.0	146	1014	14.2	28.1	0.8
94	12	45°55′	124°20′	28.5	135	1205	15.0	24.9	0.7
95	12	45°55′	124°13′	18.9	103	1400	15.2	25.5	0.5
96	12	45°55′	124°08′	12.6	81	1605	14.8	27.3	0.7
97	12	45°55′	124°04′	7.2	66	1719	15.2	27.4	0.5
98	12	45°55′	124°00′	3.2	33	2010	14.4	28.7	0.8
99	13	44°51′	124°06′	3.7	46	1213	14.9	28.3	1.3
100	13	44°51′	124°08′	7.0	62	1426	14.8	29.5	0.2
101	13	44°51′	124°13′	13.0	99	1632	14.7	29.7	0.4
102	13	44°52′	124°17′	18.5	124	1835	14.8	29.5	0.4
103	13	44°52′	124°24′	27.8	150	2108	14.7	29.7	0.3
104	14	44°40′	124°32′	37.6	135	0648	14.4	29.2	—
105	14	44°40′	124°39′	45.5	278	0821	14.7	29.3	0.1
106	14	44°40′	124°24′	27.8	90	1021	14.9	29.2	0.2
107	14	44°38′	124°18′	17.9	75	1215	15.7	28.4	0.4
108	14	44°38′	124°13′	13.0	64	1352	15.4	28.7	0.3
109	14	44°38′	124°09′	6.9	48	1530	15.3	—	1.1
110	14	44°39′	124°06′	3.7	40	1722	15.3	29.2	1.4
111	15	44°25′	124°08′	3.9	38	0738	13.9	30.0	3.9
112	15	44°25′	124°10′	8.1	48	0912	14.6	29.9	1.0
113	15	44°25′	124°15′	13.0	64	1110	15.7	29.4	0.3
114	15	44°25′	124°19′	18.5	68	1226	15.9	29.2	—
115	15	44°25′	124°26′	27.8	77	1431	15.9	29.4	1.1
116	15	44°25′	124°33′	37.2	101	1622	15.6	29.5	0.3
117	15	44°24′	124°33′	37.2	99	1707	15.6	29.5	0.2
118	16	44°11′	124°51′	36.2	293	0550	15.4	30.9	—
119	16	43°11′	124°45′	27.8	247	0740	15.4	30.0	—
120	16	43°11′	124°38′	18.5	123	1010	14.8	30.2	0.2
121	16	43°11′	124°33′	13.0	84	1301	14.8	30.1	—
122	16	43°11′	124°30′	6.9	60	1441	12.8	31.4	6.0
123	16	43°11′	124°27′	3.7	40	1640	12.8	31.7	4.2
124	16	43°22′	124°24′	3.7	40	1954	13.6	30.7	10.8
125	16	43°22′	124°28′	10.7	93	2128	14.1	30.4	1.5
126	17	43°31′	124°16′	2.6	38	0635	14.4	30.0	1.2
127	17	43°32′	124°16′	1.8	22	0745	13.2	30.4	3.1
128	17	43°31′	124°16′	1.8	24	0835	13.2	30.4	3.1
129	17	43°32′	124°16′	1.8	22	1034	13.3	30.7	3.8
130	17	43°32′	124°25′	13.3	110	1252	13.4	31.0	1.0
131	17	44°01′	124°11′	3.5	46	1840	14.2	29.8	4.0
132	17	44°01′	124°14′	7.4	62	2001	14.9	30.3	1.1
133	18	44°38′	124°07′	4.3	40	0501	14.6	29.8	3.0
134	18	44°38′	124°10′	7.4	48	0646	14.8	30.1	3.3
135	18	44°38′	124°12′	10.4	57	0917	14.6	29.2	1.3
	July								
140	9	46°35′	124°08′	9.6	37	1115	13.9	—	—
141	9	46°35′	124°12′	15.9	56	1253	13.8	31.5	2.2
142	9	46°35′	124°20′	19.4	68	1412	14.7	31.4	0.7
143	9	46°35′	124°26′	27.8	101	1655	14.7	31.6	2.8
144	9	46°35′	124°34′	38.5	223	1826	14.7	31.3	0.3
145	9	46°35′	124°25′	27.6	95	2029	14.2	31.4	1.4

Appendix Table 3—Continued.

Set	Date	Lat. (N)	Long. (W)	Off-shore (km)	Depth (m)	Time at start	Temp. (°C)	Salin-ity (‰)	Chloro-phyll *a* (μg/L)
	July								
146	9	46°35′	124°20′	20.9	71	2149	13.7	31.8	—
147	10	46°20′	124°12′	10.6	37	0750	15.3	11.6	2.0
148	10	46°20′	124°20′	12.4	48	0927	14.8	13.8	3.7
149	11	46°10′	124°10′	11.1	40	0906	13.7	27.1	13.7
150	11	46°10′	124°10′	14.4	51	0958	13.4	26.3	12.8
151	11	46°10′	124°09′	11.7	53	1111	14.2	26.0	8.7
152	11	46°11′	124°18′	25.0	103	1257	17.8	18.1	2.7
153	11	46°10′	124°13′	18.3	73	1435	16.9	22.2	5.5
154	11	46°10′	124°12′	18.3	73	1510	14.6	26.3	—
156	11	46°12′	124°24′	31.8	130	1908	15.8	20.8	5.4
157	11	46°10′	124°35′	47.0	476	2057	14.8	31.1	0.2
158	12	46°20′	124°39′	45.7	824	0621	14.7	31.2	0.4
159	12	46°20′	124°33′	37.5	135	0758	14.7	16.4	3.3
160	12	46°21′	124°26′	28.3	117	0919	15.4	13.3	4.0
161	12	46°20′	124°18′	18.5	75	1145	16.2	14.6	3.0
162	12	46°20′	124°18′	17.8	75	1233	16.0	15.0	3.8
163	12	46°20′	124°18′	17.6	75	1317	16.4	14.9	2.9
164	12	46°20′	124°14′	13.3	55	1459	16.4	16.5	3.6
166	12	46°19′	124°14′	13.1	53	1601	16.7	16.4	—
167	12	46°20′	124°12′	10.6	37	1709	17.3	15.2	2.7
168	12	46°20′	124°18′	18.5	81	2134	16.4	14.0	—
169	12	46°20′	124°18′	18.5	81	2346	15.0	17.1	—
171	13	46°20′	124°19′	18.7	81	0329	15.1	17.6	—
172	13	46°20′	124°18′	18.7	77	0525	15.0	18.8	5.1
173	13	46°20′	124°19′	18.7	81	0612	15.0	17.4	—
174	13	46°20′	124°18′	18.5	79	0659	15.0	18.4	—
175	13	45°55′	124°01′	2.6	37	1525	14.5	28.6	2.7
176	13	45°55′	124°04′	7.8	70	1633	15.2	28.8	4.4
177	13	45°55′	124°08′	13.0	82	1725	16.3	24.5	3.2
178	13	45°55′	124°08′	11.7	82	1819	15.4	22.9	3.1
179	13	45°55′	124°08′	13.0	84	1924	16.3	22.7	3.6
180	13	45°55′	124°08′	13.0	84	2132	16.4	19.9	—
181	14	45°55′	124°08′	13.0	82	0517	15.1	27.0	2.9
182	14	45°55′	124°13′	18.1	104	0625	14.9	23.3	5.0
183	14	45°55′	124°20′	28.5	137	0909	15.8	17.4	2.9
184	14	45°55′	124°25′	34.8	146	1026	16.0	19.9	2.7
185	15	45°55′	124°34′	46.4	168	1146	15.4	31.4	0.3
186	17	44°38′	124°09′	8.9	46	0718	9.1	33.4	1.3
187	17	44°38′	124°14′	12.8	64	0812	11.3	32.5	9.5
188	17	44°38′	124°18′	18.9	77	0912	11.6	32.3	7.5
189	17	44°38′	124°18′	18.9	77	0939	11.9	32.3	—
190	17	44°39′	124°20′	20.9	77	1052	12.5	32.0	4.0
191	17	44°38′	124°20′	21.6	73	1136	12.2	31.9	3.5
192	17	44°38′	124°25′	28.1	73	1513	14.0	31.7	3.2
193	17	44°38′	124°25′	28.3	71	1551	14.2	31.8	—
194	17	44°38′	124°32′	37.6	135	1726	14.2	31.1	3.7
195	17	44°38′	124°38′	45.5	258	1840	14.3	29.1	1.1
196	18	44°52′	124°31′	37.4	209	0800	15.3	28.5	—
197	18	44°52′	124°24′	27.8	154	0906	15.0	30.0	0.6
198	18	44°51′	124°16′	18.0	126	1016	15.1	31.0	0.5
199	18	44°51′	124°13′	13.3	104	1210	14.4	30.9	1.0
200	18	44°51′	124°13′	13.9	103	1245	14.6	33.2	0.9
201	18	44°51′	124°06′	3.7	37	1357	12.4	32.1	2.5
202	18	44°52′	124°09′	9.7	66	1459	13.9	32.1	5.7
203	18	44°38′	124°07′	3.7	37	1702	11.7	33.3	3.0
204	18	44°25′	124°08′	4.3	42	2003	12.9	32.8	5.6
205	18	44°24′	124°11′	7.1	49	2052	10.6	33.1	6.4
206	18	44°25′	124°15′	13.5	64	2203	12.9	32.3	—
207	18	44°25′	124°19′	18.5	71	2300	12.6	32.2	—
208	19	44°25′	124°26′	27.2	77	0025	13.2	31.9	—
209	19	44°25′	124°32′	35.9	97	0140	13.6	31.7	—
	Aug.								
211	10	46°20′	124°12′	9.9	37	0851	15.0	19.1	—
212	10	46°20′	124°14′	13.3	53	1006	15.7	17.6	—
	Aug.								
213	10	46°20′	124°19′	18.9	79	1148	15.9	18.8	10.0
214	10	46°20′	124°26′	28.5	128	1314	15.1	32.4	2.4
215	10	46°20′	124°32′	36.8	135	1430	15.1	32.4	1.1
216	11	46°35′	124°40′	46.1	640	0957	14.1	32.0	12.8
217	11	46°35′	124°32′	36.5	183	1109	13.7	32.3	7.3
218	11	46°35′	124°26′	27.9	97	1214	15.0	32.7	1.4
219	11	46°35′	124°19′	18.9	64	1435	14.1	32.7	7.7
220	11	46°36′	124°14′	13.0	48	1614	13.8	32.8	6.2
221	11	46°35′	124°11′	9.4	37	1721	13.4	32.7	6.5
222	12	46°10′	124°34′	45.9	150	0709	15.3	32.0	0.5
223	12	46°11′	124°26′	35.5	130	0856	15.0	32.1	0.7
224	12	46°10′	124°19′	27.4	108	1011	15.7	20.7	9.9
225	12	46°10′	124°19′	27.4	108	1048	15.6	22.2	—
226	12	46°10′	124°18′	25.5	106	1426	16.3	23.0	5.0
227	12	46°10′	124°13′	18.1	73	1536	16.5	22.2	13.1
228	12	46°10′	124°06′	10.7	37	1813	14.7	24.8	7.4
229	13	45°57′	124°35′	46.3	146	0700	15.6	32.4	0.7
230	13	45°55′	124°27′	37.0	145	0826	15.3	28.9	4.9
231	13	45°55′	124°20′	27.2	135	1019	15.4	25.1	8.0
232	13	45°55′	124°20′	27.4	137	1217	15.6	25.7	6.0
233	13	45°55′	124°13′	18.7	104	1329	14.5	31.0	2.7
234	13	45°56′	124°08′	12.0	82	1543	14.2	31.8	2.4
235	13	45°56′	124°08′	12.9	82	1644	14.2	31.9	3.1
236	13	45°55′	124°04′	7.8	70	1753	14.6	32.1	1.3
237	13	45°55′	124°02′	5.2	55	2000	14.4	32.1	0.9
238	14	45°20′	124°20′	28.3	183	0723	15.5	28.5	3.7
239	14	45°20′	124°13′	18.9	152	0850	14.5	31.7	0.7
240	14	45°20′	124°08′	12.8	108	1026	14.5	31.8	1.1
241	14	45°20′	124°04′	7.2	73	1118	14.3	31.9	2.6
242	14	45°19′	124°01′	4.1	44	1206	13.5	32.3	11.5
243	15	44°38′	124°06′	3.3	37	1117	13.4	33.0	1.3
244	15	44°38′	124°07′	4.6	46	1216	13.3	33.1	1.0
245	15	44°38′	124°14′	13.3	66	1406	13.0	33.1	6.7
246	15	44°38′	124°18′	19.2	81	1506	12.5	33.0	10.1
247	15	44°38′	124°25′	27.6	66	1641	13.9	32.3	3.3
248	15	44°38′	124°32′	36.5	132	1843	15.0	31.8	1.0
249	15	44°38′	124°39′	46.6	238	1952	15.0	31.6	0.7
250	15	44°38′	124°14′	13.1	68	2252	12.7	34.9	—
251	16	44°38′	124°14′	12.8	66	0143	12.1	32.9	—
252	16	44°39′	124°13′	12.8	66	0430	12.2	32.8	—
253	16	44°38′	124°14′	13.3	64	0803	12.1	32.8	6.6
254	16	44°52′	124°04′	2.4	37	1429	13.2	33.1	4.5
255	16	44°52′	124°09′	8.0	64	1540	12.9	33.0	1.9
257	16	44°51′	124°13′	13.3	103	1716	12.5	33.0	3.4
258	17	44°52′	124°17′	18.5	114	0621	12.6	32.9	5.7
259	17	44°52′	124°24′	29.1	148	0732	14.5	31.4	0.6
260	17	44°25′	124°33′	36.8	103	1108	14.6	32.4	0.5
261	17	44°25′	124°26′	28.1	81	1217	14.0	32.4	0.6
262	17	44°25′	124°20′	19.1	70	1353	13.2	32.6	2.8
263	17	44°25′	124°15′	13.0	66	1530	13.3	33.4	0.7
264	17	44°25′	124°10′	7.2	49	1659	13.1	33.4	2.1
265	17	44°25′	124°09′	4.6	37	1814	12.5	33.4	5.3
266	18	43°11′	124°45′	28.1	311	0926	15.0	32.4	0.6
267	18	43°11′	124°38′	19.2	128	1034	14.1	32.7	0.5
268	18	43°12′	124°33′	12.4	81	1133	13.3	32.8	1.8
169	18	43°12′	124°28′	7.2	60	1318	12.6	33.0	1.9
270	18	43°12′	124°27′	4.1	46	1359	11.7	33.4	0.4
271	18	43°21′	124°29′	10.9	95	1557	14.3	32.7	2.5
272	18	43°26′	124°19′	2.8	44	1736	12.7	32.9	1.3
273	19	44°01′	124°34′	34.4	143	0704	14.5	32.3	0.4
274	19	44°01′	124°18′	12.6	86	0915	13.9	32.7	0.7
275	19	44°01′	124°13′	6.7	58	1005	13.5	32.6	1.1
276	19	44°01′	124°13′	7.0	58	1037	13.5	32.6	1.0
277	19	44°01′	124°10′	2.6	39	1118	13.1	32.8	1.0

Appendix Table 4—Station and environmental data, summer 1982.

Set	Date	Lat. (N)	Long. (W)	Off-shore (km)	Depth (m)	Time at start	Temp. (°C)	Salin-ity (‰)	Chloro-phyll *a* (μg/L)
	May								
1	19	48°21′	124°50′	9.8	62	1123	10.8	32.2	5.5
2	19	48°20′	124°55′	18.3	318	1256	10.4	31.7	3.9
3	19	48°20′	125°02′	27.2	218	1426	11.5	31.4	14.6
4	19	48°20′	125°10′	37.2	143	1600	12.2	30.9	0.8
5	19	48°20′	125°17′	45.7	137	1734	11.8	30.8	0.8
6	19	48°20′	124°50′	10.5	59	2025	9.5	32.7	2.8
7	20	47°59′	124°49′	11.5	55	0837	11.0	31.0	0.9
8	20	48°00′	124°56′	19.2	93	1320	11.7	30.7	0.4
9	20	48°00′	125°03′	36.8	121	1505	12.0	30.8	0.3
10	20	48°00′	125°11′	37.4	154	1839	11.9	30.9	0.3
13	21	47°40′	124°41′	20.7	59	0921	10.0	31.6	9.7
14	21	47°40′	124°46′	27.9	80	1113	11.2	31.2	4.3
15	21	47°40′	124°53′	37.6	115	1335	12.1	30.9	0.3
16	21	47°20′	124°47′	36.8	329	1700	11.7	30.9	0.6
17	21	47°20′	124°39′	27.0	93	1849	11.4	31.3	0.5
18	21	47°20′	124°32′	18.3	57	2024	10.1	31.9	21.3
19	22	47°00′	124°25′	18.7	57	1305	11.6	32.1	5.8
20	22	47°00′	124°32′	27.4	79	1646	11.7	32.2	2.9
21	22	47°00′	124°25′	18.3	55	2016	11.4	32.1	—
22	23	46°40′	124°18′	18.0	62	1023	10.5	31.6	1.5
23	23	46°40′	124°18′	18.0	62	1137	10.5	31.6	5.9
25	23	46°40′	124°26′	27.9	90	1406	11.4	32.3	12.1
26	23	46°40′	124°32′	37.0	124	1715	11.5	31.5	10.1
27	23	46°40′	124°16′	15.4	51	2000	11.2	31.8	2.0
28	24	46°30′	124°18′	17.8	62	0702	10.8	31.5	7.4
29	24	46°21′	124°14′	13.0	49	0903	11.4	31.1	2.9
31	24	46°20′	124°18′	18.1	150	1408	11.8	31.0	4.6
33	27	46°00′	124°04′	10.6	57	1235	10.4	31.2	—
34	27	46°00′	124°10′	18.7	86	1413	10.4	30.0	5.4
35	27	46°00′	124°10′	18.5	88	1555	11.0	31.2	5.4
36	27	45°60′	124°17′	27.2	119	1816	11.4	32.2	8.2
37	27	46°00′	124°25′	37.9	143	2002	10.6	32.2	—
38	27	46°00′	124°31′	46.3	152	2131	10.3	31.9	8.9
39	28	46°09′	124°19′	27.4	106	1212	12.3	17.6	3.4
41	28	46°08′	124°29′	41.3	134	1736	10.8	32.0	—
42	28	46°10′	124°34′	45.5	155	1920	11.2	31.8	4.9
44	30	45°41′	124°04′	10.0	71	1005	9.3	33.1	8.5
45	30	45°41′	124°10′	18.5	108	1121	11.4	31.5	6.5
46	30	45°40′	124°18′	28.1	141	1305	12.0	29.2	6.7
47	30	45°40′	124°25′	36.8	166	1506	12.2	27.4	5.0
48	30	45°20′	124°06′	9.6	88	1921	10.6	32.0	16.9
49	30	45°20′	124°05′	8.5	88	2021	10.4	32.0	—
50	31	45°21′	124°12′	17.2	148	0742	9.8	32.3	7.1
51	31	45°20′	124°19′	27.4	192	0952	10.8	31.3	3.1
52	31	45°21′	124°26′	35.5	366	1140	11.3	31.0	2.3
53	31	45°20′	124°34′	46.4	454	1400	11.7	30.8	2.3
54	31	45°00′	124°28′	36.5	346	1659	11.8	31.8	0.8
55	31	45°01′	124°22′	27.8	201	1841	11.2	31.6	1.1
56	31	45°00′	124°15′	19.1	146	2109	10.2	31.6	1.4
	June								
57	1	45°01′	124°05′	5.9	59	0748	9.7	32.7	21.3
58	1	45°00′	124°05′	6.1	60	0852	—	—	—
59	1	45°01′	124°08′	9.4	88	1124	10.6	32.4	15.0
60	1	44°40′	124°11′	9.6	60	1425	10.8	32.3	10.1
61	1	44°41′	124°18′	18.0	82	1545	10.8	33.1	7.5
62	1	44°41′	124°24′	26.8	90	1711	11.3	31.8	1.9
63	1	44°41′	124°31′	36.1	137	1850	11.5	32.5	0.4
64	2	44°20′	124°34′	36.6	93	0534	10.4	32.2	4.2
65	2	44°20′	124°26′	26.8	90	0715	9.9	33.2	17.4
66	2	44°20′	124°21′	19.2	79	0846	9.3	32.9	12.3
67	2	44°20′	124°12′	8.3	59	1041	9.4	33.2	16.4
68	2	44°00′	124°15′	8.5	73	1400	9.9	32.9	8.9
69	2	44°00′	124°25′	18.3	110	1550	10.2	33.0	13.3
71	7	47°20′	124°32′	18.5	57	0626	11.3	32.8	0.4
72	7	47°20′	124°39′	28.0	95	0815	10.8	32.4	7.9
73	7	47°21′	124°46′	35.5	159	1028	11.7	31.8	0.7
75	7	47°00′	124°40′	37.2	104	1608	11.5	31.8	0.8
76	7	47°00′	124°32′	27.9	79	1736	10.8	32.3	4.6
77	7	47°00′	124°25′	18.5	57	1907	12.3	31.3	—
	June								
78	7	47°00′	124°25′	18.5	57	2002	12.3	31.3	—
79	8	46°41′	124°18′	17.4	62	0646	12.1	28.2	—
80	8	46°41′	124°21′	21.1	71	0851	12.4	27.0	4.8
81	8	46°41′	124°29′	31.8	97	1045	11.6	30.9	6.5
82	10	46°40′	124°19′	19.8	70	0723	11.9	31.4	2.3
83	10	46°40′	124°26′	27.6	88	0902	11.6	32.2	3.0
84	10	46°41′	124°32′	35.3	119	1041	11.7	32.1	1.5
85	10	46°30′	124°32′	37.2	560	1243	11.7	32.1	0.2
86	10	46°30′	124°25′	27.6	99	1430	12.3	31.6	1.5
87	10	46°30′	124°18′	18.5	68	1616	11.8	31.7	8.1
88	10	46°30′	124°18′	18.1	66	1705	11.7	—	—
89	11	46°23′	124°16′	15.4	60	0730	11.6	31.4	5.8
90	11	46°23′	124°18′	19.1	71	0940	12.5	31.6	3.6
91	11	46°23′	124°27′	30.0	110	1128	12.4	32.0	1.1
92	11	46°23′	124°33′	37.4	139	1259	12.0	31.8	0.4
93	11	46°10′	124°10′	14.4	57	1609	10.8	29.0	2.4
95	12	46°11′	124°09′	18.0	84	0840	12.4	26.5	4.2
96	12	46°00′	124°11′	19.2	88	1000	12.4	26.3	—
97	12	46°01′	124°14′	23.7	95	1113	12.6	26.5	3.2
98	13	45°51′	124°04′	7.4	68	0959	12.6	26.1	2.5
100	13	45°50′	124°21′	30.3	137	1521	13.3	30.0	0.9
101	13	45°50′	124°15′	22.4	124	1647	13.0	26.6	1.8
102	14	45°40′	124°02′	6.9	59	1945	11.5	30.1	11.0
103	14	45°40′	124°03′	9.1	68	0736	10.9	30.9	8.7
104	14	45°41′	124°10′	18.3	108	1040	12.1	28.9	2.0
106	16	45°20′	124°05′	9.3	146	0621	8.8	33.0	0.6
107	16	45°20′	124°12′	16.1	148	0818	11.1	31.8	1.1
108	16	45°20′	124°13′	16.8	15	1037	11.2	—	—
109	17	45°00′	124°05′	6.5	62	1455	9.2	33.0	0.6
110	17	45°00′	124°15′	19.1	152	1723	10.6	32.1	1.1
111	18	44°41′	124°25′	26.5	93	0949	9.7	32.5	0.5
112	18	44°40′	124°32′	37.0	134	1130	11.8	32.1	1.0
113	18	44°40′	124°39′	46.6	285	1316	13.4	31.9	1.7
114	18	44°41′	124°46′	54.2	95	1512	13.8	31.5	1.2
115	19	44°39′	124°18′	18.7	77	1856	9.2	33.0	0.4
116	19	44°40′	124°11′	9.4	60	2033	8.9	33.8	0.4
117	19	44°20′	124°13′	8.7	60	1427	11.3	33.5	17.1
118	19	44°20′	124°20′	18.1	77	1600	11.4	33.5	10.7
119	19	44°20′	124°28′	28.7	93	1750	9.8	33.2	3.4
120	19	44°20′	124°34′	36.8	95	1920	9.6	32.8	1.4
121	20	45°00′	124°06′	6.7	64	0945	10.3	32.8	1.1
122	20	45°00′	124°15′	19.2	148	1310	12.9	30.2	1.7
123	20	45°00′	124°22′	28.1	205	1454	13.1	30.6	1.1
124	20	45°00′	124°22′	28.1	203	1652	13.1	—	—
125	21	45°21′	124°26′	35.2	22	0848	12.7	30.4	1.3
126	21	45°21′	124°34′	44.4	59	1133	13.3	30.4	0.9
127	21	45°20′	124°26′	36.6	26	1405	13.2	30.0	—
128	21	45°20′	124°00′	2.4	11	1850	9.0	33.6	—
129	22	45°20′	124°12′	15.2	141	0633	11.4	31.6	3.3
130	22	45°21′	124°20′	26.8	190	0849	12.1	31.1	3.1
	Sept.								
131	4	47°20′	124°32′	18.3	57	0810	15.2	30.9	4.3
132	4	47°20′	124°39′	27.2	93	1204	15.4	31.5	1.5
133	4	47°20′	124°47′	37.4	571	1452	15.1	—	0.5
136	5	47°00′	124°25′	18.1	55	0703	14.8	31.5	0.6
137	5	47°00′	124°29′	23.5	70	0925	15.0	31.8	0.5
138	5	47°00′	124°32′	28.1	77	1041	15.5	32.1	1.1
139	5	47°00′	124°32′	27.9	79	1157	15.6	31.9	—
140	5	47°00′	124°40′	37.6	106	1452	17.0	31.4	0.3
141	5	46°40′	124°17′	16.1	55	1843	16.2	30.0	1.0
142	6	46°40′	124°16′	15.4	55	0638	15.8	29.0	5.4
143	6	46°40′	124°22′	22.9	77	0835	16.1	—	2.7
144	6	46°40′	124°22′	22.2	77	0945	16.1	—	—
145	6	46°40′	124°26′	27.6	88	1105	16.1	31.1	1.0
146	6	46°40′	124°33′	37.4	126	1309	16.5	31.4	0.4
147	6	46°20′	124°32′	35.9	137	1730	15.4	25.8	7.9
148	6	46°20′	124°25′	27.6	126	2007	15.5	25.4	5.9
149	7	46°20′	124°14′	13.0	53	0643	15.6	24.9	7.7
150	7	46°20′	124°18′	18.5	79	0948	15.8	25.2	9.2

Appendix Table 4—Continued.

Set	Date	Lat. (N)	Long. (W)	Off-shore (km)	Depth (m)	Time at start	Temp. (°C)	Salin-ity (‰)	Chloro-phyll *a* (μg/L)
	Sept.								
151	7	46°20′	124°18′	17.0	77	1050	—	—	—
153	7	45°59′	124°24′	35.7	137	1634	17.4	—	3.0
154	8	45°56′	124°03′	4.4	57	0744	14.1	31.8	4.1
155	8	45°56′	124°07′	9.4	79	1002	15.0	31.5	1.1
156	9	45°51′	124°11′	17.2	104	1046	16.5	1.0	1.6
157	9	45°50′	124°19′	27.9	144	1345	16.6	29.1	1.2
158	9	45°40′	124°35′	37.2	172	1640	16.7	31.2	0.5
159	9	45°39′	124°17′	27.4	143	1810	15.9	31.4	0.9
160	9	45°40′	124°01′	5.7	55	2050	15.2	31.5	1.0
161	11	45°21′	124°02′	3.7	55	1707	13.9	32.0	—
162	11	45°21′	124°05′	9.1	88	1903	14.4	31.8	—
163	12	45°21′	124°05′	7.8	84	0717	14.8	31.7	4.1
164	12	45°20′	124°12′	18.1	143	0912	15.8	31.5	0.8
165	12	45°21′	124°08′	10.4	104	1104	14.5	31.9	3.0
166	13	44°40′	124°13′	12.4	68	1705	14.0	32.3	2.0
167	14	44°40′	124°18′	19.1	80	0706	13.4	32.9	2.3
168	14	44°40′	124°25′	27.6	93	0900	13.7	32.1	1.6
169	14	44°20′	124°27′	27.9	93	1217	13.9	32.8	1.0
170	14	44°20′	124°21′	19.4	79	1402	13.5	2.0	2.5
171	14	44°20′	124°13′	8.7	55	1534	13.0	32.9	1.1
172	14	44°19′	124°11′	5.7	51	1629	13.0	33.1	2.7
173	14	44°19′	124°10′	5.2	51	1735	12.4	2.0	2.8

Appendix Table 5—Station and environmental data, summer 1983.

Set	Date	Lat. (N)	Long. (W)	Off-shore (km)	Depth (m)	Time at start	Temp. (°C)	Salin-ity (‰)	Chloro-phyll *a* (μg/L)
	May								
1	16	48°20′	124°44′	5.9	42	1245	10.1	32.2	2.0
2	16	48°20′	124°46′	9.1	41	1445	10.6	31.9	2.6
3	16	48°20′	124°55′	18.7	302	1643	10.9	31.3	2.9
4	16	48°20′	125°02′	27.6	181	1830	11.1	30.7	8.2
5	16	48°20′	125°10′	36.0	191	2005	11.7	30.2	3.8
6	16	48°21′	125°18′	45.8	112	2218	12.2	30.9	2.1
7	17	48°00′	124°48′	8.9	35	0920	11.2	31.2	11.1
8	17	48°00′	124°56′	18.5	88	1100	11.9	30.4	7.0
9	17	48°00′	125°04′	28.7	123	1236	13.0	31.3	1.0
10	17	48°00′	125°10′	35.8	146	1414	12.5	31.4	0.2
11	17	47°40′	124°53′	36.7	115	1744	12.7	31.0	0.2
12	17	47°41′	124°45′	27.1	77	1910	12.4	31.0	0.8
13	17	47°41′	124°38′	15.8	46	2033	11.8	31.0	8.8
14	18	47°40′	124°35′	13.5	35	0637	11.9	30.7	2.7
15	18	47°20′	124°27′	11.9	38	1026	12.9	30.2	1.3
16	18	47°20′	124°32′	18.0	54	1317	12.9	30.5	1.6
17	18	47°20′	124°39′	27.4	91	1510	13.0	31.0	0.6
18	18	47°20′	124°47′	36.9	549	1659	13.1	30.7	0.3
19	18	47°00′	124°19′	11.3	37	2043	12.6	30.9	0.3
20	19	47°00′	124°25′	18.7	53	1423	13.3	30.6	0.2
21	19	47°00′	124°26′	19.6	55	1728	13.3	—	—
22	19	47°00′	124°33′	28.4	79	1900	13.1	30.6	0.2
23	20	46°40′	124°13′	11.3	40	0829	12.8	30.7	0.6
24	20	46°40′	124°19′	18.9	66	1021	13.0	30.9	0.3
25	20	46°40′	124°26′	27.4	84	1153	12.9	29.7	0.1
26	20	46°40′	124°33′	36.7	119	1342	13.4	30.0	0.3
28	21	46°21′	124°11′	10.0	35	0902	12.3	30.1	1.6
29	21	46°21′	124°18′	18.5	81	1344	13.2	31.2	0.3
30	21	46°20′	124°26′	28.5	128	1545	13.7	30.4	0.1
31	21	46°21′	124°33′	37.1	137	1718	13.9	29.9	0.1
32	21	46°20′	124°25′	27.6	128	1850	13.4	30.6	0.1
33	22	46°00′	124°01′	6.5	37	0900	12.4	31.1	0.5
34	22	46°00′	124°06′	13.5	73	1036	13.6	29.1	0.5
35	22	46°00′	124°10′	18.7	86	1154	13.9	25.6	1.1
36	22	46°00′	124°17′	27.6	117	1317	13.8	24.6	2.0
37	23	45°41′	123°59′	3.9	38	0907	11.9	31.8	0.5
38	23	45°41′	124°03′	8.9	68	1024	12.9	31.3	0.6
39	23	45°41′	124°11′	18.5	106	1154	14.1	29.4	0.1
40	23	45°41′	124°18′	28.5	143	1325	15.3	27.6	0.2
41	23	45°24′	124°23′	32.1	421	1606	15.0	26.6	0.7
42	23	45°21′	124°19′	26.9	183	1834	14.5	26.9	0.2
43	23	45°20′	124°13′	18.7	146	1949	14.6	26.9	0.2
45	24	45°19′	124°06′	7.8	78	1012	14.0	28.5	0.1
46	24	45°00′	124°04′	4.1	37	1312	13.5	31.6	1.2
47	24	45°00′	124°17′	21.5	141	1449	13.8	29.3	0.2
48	24	45°00′	124°22′	27.8	201	1619	13.9	29.6	0.1
49	24	44°56′	124°09′	9.1	82	1815	13.9	28.3	0.2
50	25	44°40′	124°08′	5.6	42	1028	11.8	32.6	8.5
51	25	44°40′	124°18′	18.7	81	1315	14.0	28.9	0.2
52	25	44°40′	124°24′	27.4	95	1546	14.1	30.1	0.1
53	26	44°20′	124°09′	3.7	37	0745	11.1	32.8	8.8
54	26	44°20′	124°13′	9.3	60	0920	11.9	32.7	5.8
56	27	44°20′	124°20′	18.5	77	0648	11.4	32.8	0.2
57	27	44°20′	124°27′	28.5	90	0824	11.6	32.8	7.0
58	27	44°19′	124°27′	27.1	92	0958	11.7	—	—
59	27	44°20′	124°33′	36.5	92	1105	11.9	32.8	8.0
60	27	44°20′	124°41′	46.0	82	1240	12.2	32.1	0.3
	June								
61	9	46°30′	124°22′	23.2	81	1046	12.6	31.8	5.0
62	12	46°29′	124°20′	22.2	73	1102	15.9	29.4	5.5
63	12	46°41′	124°12′	9.1	37	1324	15.2	26.8	5.0
65	13	46°40′	124°19′	18.5	62	0750	14.7	31.5	1.2
66	13	46°40′	124°26′	28.4	82	0935	15.4	31.4	0.4
67	13	46°40′	124°33′	36.9	124	1055	15.9	31.6	0.3
68	13	47°00′	124°32′	28.1	77	1348	15.5	31.3	0.2
69	13	47°00′	124°24′	17.4	53	1509	15.3	25.5	2.0
70	13	47°00′	124°20′	12.4	48	1945	14.9	26.7	3.1
71	14	48°20′	124°47′	8.5	40	0605	12.9	31.6	4.4
72	14	48°20′	125°04′	30.2	187	1055	12.9	31.7	2.1
	June								
73	14	48°20′	125°09′	36.3	119	1242	13.2	31.4	1.3
74	14	48°20′	124°54′	18.0	302	1500	12.7	31.4	3.2
75	15	48°00′	124°48′	9.3	38	0951	12.9	31.1	6.1
76	15	48°00′	124°56′	18.9	90	1132	13.5	31.3	1.3
77	15	48°00′	125°03′	28.0	123	1300	14.0	31.1	1.7
78	15	47°40′	124°51′	34.5	106	1708	15.4	31.1	5.2
79	15	47°40′	124°44′	25.0	71	1815	16.0	31.5	1.4
80	15	47°40′	124°38′	15.9	42	1940	15.5	31.5	—
81	16	47°20′	124°47′	37.8	549	1102	14.2	31.5	0.2
82	16	47°20′	124°39′	27.8	92	1215	14.5	31.6	0.9
83	16	47°20′	124°32′	18.5	59	1310	14.2	31.6	0.3
84	16	47°20′	124°27′	11.7	33	1410	14.7	28.2	1.7
85	22	46°21′	124°12′	10.7	38	0610	15.9	18.1	1.6
87	23	46°00′	124°01′	7.6	37	0717	15.4	26.5	0.4
88	23	46°01′	124°10′	18.7	84	0917	15.7	25.2	0.3
89	23	46°00′	124°17′	27.4	112	1045	15.2	25.3	0.8
90	23	46°00′	124°06′	13.0	68	1240	16.3	25.2	0.3
91	23	45°39′	124°25′	37.4	165	1616	16.3	29.7	—
92	23	45°40′	124°17′	27.4	141	1727	16.4	29.8	0.1
93	23	45°40′	124°10′	18.0	104	1831	16.2	27.2	0.2
94	23	45°41′	124°03′	8.9	68	1942	16.1	25.3	0.3
95	23	45°40′	124°00′	4.3	38	2039	16.0	25.1	0.3
96	24	45°20′	124°19′	27.4	192	1036	15.9	29.9	0.1
97	24	45°20′	124°13′	18.9	145	1200	15.5	30.3	0.1
98	24	45°21′	124°08′	13.2	110	1327	15.5	29.0	0.3
99	24	45°20′	124°06′	9.5	84	1437	15.7	28.8	0.2
100	24	45°17′	124°21′	4.4	44	1557	15.7	28.1	0.4
101	24	45°01′	124°01′	27.2	198	1910	16.0	30.5	0.1
102	24	45°00′	124°15′	18.2	143	2029	16.0	29.7	0.1
103	24	45°01′	124°07′	9.1	84	2145	15.8	29.7	0.1
104	24	45°01′	124°04′	4.4	42	2245	15.3	29.4	0.2
105	25	44°40′	124°07′	5.0	45	1046	14.9	31.1	1.2
106	25	44°40′	124°18′	18.7	79	1221	15.4	30.8	0.3
107	26	43°28′	124°19′	3.3	41	0615	12.6	32.2	0.7
108	26	43°28′	124°22′	8.9	90	0719	14.5	31.2	0.5
109	26	43°28′	124°30′	18.5	117	0841	15.6	31.2	0.2
110	26	43°28′	124°30′	18.5	119	1016	15.9	—	—
111	26	43°28′	124°36′	27.1	187	1131	16.3	31.0	0.1
112	26	43°28′	124°44′	37.4	516	1254	16.4	30.1	0.1
113	26	43°00′	124°47′	27.1	150	1637	16.2	30.5	0.2
114	26	43°00′	124°41′	18.2	135	1748	16.4	30.7	0.3
115	26	43°00′	124°34′	8.5	90	1902	14.5	32.0	1.2
116	26	43°00′	124°29′	2.6	42	2016	14.1	32.9	1.7
117	27	44°00′	124°11′	4.1	42	0859	14.8	31.7	0.5
118	27	44°00′	124°14′	8.9	71	1009	15.6	31.6	0.3
119	27	44°00′	124°22′	18.3	110	1153	15.8	31.3	0.1
120	27	44°20′	124°08′	2.8	42	1531	15.4	31.9	0.4
	Sept.								
121	15	48°20′	124°47′	8.9	38	0808	14.1	31.8	1.3
122	15	48°20′	124°51′	13.2	71	0934	14.6	31.5	0.8
123	15	48°20′	124°54′	18.3	307	1107	14.5	31.8	1.7
124	15	48°20′	125°02′	27.8	225	1234	14.9	31.6	1.3
125	15	48°20′	125°10′	37.1	121	1451	15.1	31.6	—
126	15	48°20′	125°17′	46.3	178	1602	15.2	31.5	1.4
127	15	48°18′	125°25′	55.6	113	1735	14.5	31.6	3.2
128	16	47°40′	124°36′	14.8	42	0732	15.9	30.8	0.6
129	16	47°40′	124°41′	23.2	70	1004	15.8	31.0	0.7
130	16	47°40′	124°50′	32.4	104	1155	15.8	31.0	1.0
131	16	47°20′	124°32′	18.5	60	1635	16.2	30.6	2.8
132	16	47°20′	124°28′	13.3	44	1748	15.6	30.7	1.9
133	17	47°00′	124°28′	13.0	42	0821	14.7	30.9	2.1
134	17	47°00′	124°29′	23.2	71	1037	15.8	30.8	1.7
135	17	47°00′	124°34′	29.7	88	1146	15.9	30.6	2.4
136	17	46°40′	124°27′	29.0	90	1451	16.4	30.9	1.0
137	17	46°40′	124°17′	16.7	59	1624	15.8	30.8	3.6
138	17	46°40′	124°14′	11.1	40	1834	15.6	31.1	5.2
139	19	46°21′	124°13′	11.6	42	0755	13.3	—	4.4
140	19	46°24′	124°19′	18.9	71	0943	14.4	31.2	3.6
142	19	46°28′	124°27′	29.7	101	1220	15.1	31.1	2.5

Appendix Table 5—Continued.

Set	Date	Lat. (N)	Long. (W)	Off-shore (km)	Depth (m)	Time at start	Temp. (°C)	Salinity (‰)	Chlorophyll *a* (μg/L)
	Sept.								
143	20	45°59′	124°01′	8.0	44	0846	13.8	30.6	2.5
144	20	46°00′	124°06′	13.0	71	1000	13.8	30.6	7.4
145	20	46°01′	124°11′	18.5	88	1111	14.1	30.8	7.4
146	20	46°00′	124°18′	27.8	119	1251	14.0	31.3	6.6
147	20	45°40′	124°10′	18.5	107	1519	14.4	30.4	5.0
148	20	45°40′	124°03′	9.3	70	1710	14.6	30.4	5.2
149	20	45°40′	124°03′	8.9	70	1800	14.7	—	—
150	20	45°39′	123°59′	3.7	40	1903	14.0	30.8	6.1
151	21	45°20′	124°20′	28.7	192	1920	14.9	31.2	6.9
152	21	45°20′	124°12′	18.5	145	2034	14.2	31.5	8.8
153	21	45°20′	124°11′	13.9	110	2132	13.4	31.4	8.8
154	22	45°20′	124°05′	9.3	82	0648	12.9	31.6	9.4
155	22	45°20′	124°01′	3.7	45	0747	12.9	31.5	7.7
156	22	45°17′	124°01′	3.7	41	0850	12.1	31.9	8.8
157	22	45°10′	124°01′	3.2	43	1031	11.3	32.3	5.0
158	22	45°00′	124°03′	3.3	41	1227	12.2	32.6	3.3
159	22	45°00′	124°08′	9.3	88	1357	13.7	32.0	4.7
160	22	45°00′	124°15′	18.5	148	1505	14.3	31.8	2.6
161	22	44°49′	124°06′	2.3	41	1713	12.5	32.6	4.7
163	23	44°40′	124°07′	4.3	40	0923	13.0	32.5	5.7
164	23	44°40′	124°11′	9.6	60	1025	12.6	32.5	4.4
165	23	44°40′	124°18′	18.7	82	1133	14.0	32.2	2.0
166	23	44°20′	124°20′	18.5	77	1426	15.4	32.0	0.4
167	23	44°20′	124°13′	9.3	62	1544	14.6	32.2	2.7
168	23	44°20′	124°34′	3.2	38	1647	13.2	32.6	7.3
169	23	44°20′	124°09′	3.7	38	1737	13.9	—	—
170	23	44°30′	124°08′	3.7	44	1922	14.1	32.2	1.9
171	24	44°00′	124°11′	3.9	44	0821	12.4	32.8	6.4
172	24	44°00′	124°15′	9.3	73	0912	12.3	33.0	5.8
173	24	44°00′	124°22′	18.5	112	1042	13.6	32.7	0.9
174	24	43°28′	124°19′	3.0	47	1719	13.3	32.8	0.7

Appendix Table 6—Station and environmental data, summer 1984.

Set	Date	Lat. (N)	Long. (W)	Off-shore (km)	Depth (m)	Time at start	Temp. (°C)	Salin-ity (‰)	Chloro-phyll *a* (μg/L)
	June								
1	4	48°20′	124°49′	11.4	91	1755	11.8	32.3	1.2
2	5	48°20′	124°55′	18.8	305	0555	9.8	32.3	0.9
3	5	48°20′	125°03′	28.4	183	0850	10.8	31.0	1.8
4	5	48°20′	125°10′	37.0	179	1126	12.8	30.3	1.2
5	5	48°00′	125°10′	36.6	153	1615	12.7	30.0	0.7
6	5	48°00′	125°03′	27.1	117	1750	12.5	29.7	0.6
7	5	48°00′	124°55′	17.7	89	1910	12.5	29.7	10.1
8	5	48°00′	124°49′	10.1	43	2103	12.1	30.0	1.4
9	6	47°40′	124°37′	16.6	43	0813	11.9	30.4	6.3
10	6	47°40′	124°39′	19.2	51	1015	12.4	30.4	3.8
11	6	47°40′	124°46′	28.1	80	1405	13.3	29.5	0.9
12	6	47°40′	124°53′	37.5	113	1545	12.7	30.1	3.3
13	6	47°40′	125°01′	47.3	170	1731	12.6	30.1	1.8
15	8	47°20′	124°28′	13.1	42	0930	12.3	29.5	3.2
16	8	47°20′	124°32′	18.5	58	1200	12.1	29.2	0.8
17	8	47°20′	124°39′	27.3	89	1300	12.4	30.3	1.9
18	8	47°00′	124°40′	37.3	100	1550	12.0	30.2	2.6
19	8	47°00′	124°32′	27.7	73	1735	12.1	30.4	2.2
20	8	47°00′	124°25′	18.3	54	1920	12.0	30.0	2.0
21	8	47°00′	124°19′	11.6	40	2050	12.2	28.1	1.5
22	9	46°40′	124°13′	10.3	40	1220	13.3	25.9	2.9
23	9	46°40′	124°20′	17.5	64	1345	13.0	27.0	0.8
24	9	46°40′	124°26′	27.3	89	1509	13.0	30.5	1.5
25	9	46°40′	124°34′	37.3	124	1654	12.8	30.3	2.7
26	10	46°20′	124°13′	11.8	40	0915	12.9	14.2	1.6
27	10	46°20′	124°34′	38.2	137	1710	13.9	30.1	2.1
28	10	46°20′	124°25′	27.5	124	1850	12.9	29.1	1.4
29	11	46°20′	124°19′	19.4	82	1350	14.3	17.5	1.6
30	11	46°00′	124°01′	7.9	40	1750	13.7	26.9	2.2
31	11	46°00′	124°04′	9.9	49	1855	13.4	26.8	1.8
32	12	46°00′	124°24′	36.8	139	1030	13.2	19.6	2.3
33	12	46°00′	124°17′	27.7	118	1223	13.1	22.9	2.0
34	12	46°00′	124°10′	18.1	84	1447	13.3	25.1	2.6
35	12	45°40′	124°10′	18.3	104	1740	13.2	27.8	1.2
36	12	45°40′	124°03′	9.2	67	1918	11.8	30.5	1.4
37	13	45°40′	124°18′	27.9	142	1600	14.1	24.8	1.8
38	13	45°40′	124°25′	37.0	170	1722	13.9	22.9	3.4
39	13	45°20′	124°06′	9.8	82	2027	12.0	30.6	1.8
40	14	45°20′	124°13′	18.3	142	0906	12.9	27.2	1.3
41	14	45°20′	124°20′	27.7	184	1026	13.2	27.9	1.0
44	16	45°00′	124°04′	4.6	45	0829	9.4	33.1	0.6
45	16	45°01′	124°08′	9.8	84	1007	10.4	32.0	1.1
46	16	45°00′	124°15′	18.8	144	1131	11.9	30.7	1.0
47	16	45°00′	124°22′	28.4	203	1304	12.9	30.0	1.3
48	16	45°00′	124°29′	36.4	345	1440	14.0	27.0	0.9
49	18	44°40′	124°07′	4.9	43	0517	8.4	33.7	0.2
51	19	44°40′	124°17′	17.9	76	0032	8.9	32.7	0.3
52	19	44°40′	124°18′	19.2	87	0154	10.3	31.8	0.3
53	19	44°40′	124°31′	36.4	135	0320	11.2	31.1	1.2
54	19	44°40′	124°38′	44.7	252	0435	11.6	30.8	1.7
55	19	44°20′	124°43′	46.9	100	0755	10.5	31.5	1.1
56	19	44°20′	124°34′	35.8	89	1001	10.4	32.0	0.5
57	19	44°20′	124°28′	29.0	89	1122	10.9	32.7	0.4
58	19	44°20′	124°20′	17.9	73	1250	11.4	33.3	2.2
59	19	44°20′	124°14′	9.0	54	1414	12.1	33.2	4.5
60	19	44°20′	124°10′	4.8	43	1513	10.8	33.3	1.8
61	19	44°00′	124°11′	3.7	42	1829	11.3	33.1	5.9
62	20	44°00′	124°15′	8.6	73	0549	10.2	32.6	1.8
63	20	44°00′	124°22′	17.9	111	0726	10.8	31.9	1.4
64	20	44°00′	124°29′	27.7	128	0848	10.5	32.1	0.7
65	20	44°00′	124°35′	36.0	150	1006	10.2	31.9	0.8
66	20	43°27′	124°43′	35.1	512	1430	12.8	32.6	2.4
67	20	43°28′	124°37′	26.8	208	1540	13.4	31.8	3.4
68	20	43°28′	124°31′	19.0	122	1648	13.1	31.9	1.1
69	20	43°27′	124°24′	9.8	95	1803	11.0	32.9	3.0
70	20	43°28′	124°19′	2.9	43	1913	11.8	33.1	4.7
	July								
80	19	44°40′	124°08′	5.7	45	0608	8.3	33.6	7.0
81	23	44°40′	124°10′	9.0	58	0557	9.5	33.5	20.9
	July								
82	23	44°40′	124°18′	18.1	76	0730	9.4	33.5	18.0
84	23	44°40′	124°26′	29.0	100	1611	11.9	32.3	21.7
85	23	44°40′	124°32′	37.0	131	1737	11.9	32.2	16.6
86	23	44°40′	124°39′	46.8	274	1908	12.4	31.9	6.1
87	24	44°01′	124°36′	37.9	146	0051	12.0	32.8	2.2
88	24	44°28′	124°28′	26.8	126	0330	12.0	32.7	4.2
89	24	44°00′	124°21′	17.3	106	0458	12.2	32.9	3.1
90	24	44°00′	124°15′	9.0	73	0610	11.6	33.2	10.4
91	24	44°00′	124°11′	4.0	45	0709	9.9	33.9	12.5
92	25	45°00′	124°04′	4.4	49	0748	10.0	33.4	29.4
94	25	45°00′	124°08′	9.6	82	1846	13.7	31.2	1.8
95	25	45°00′	124°05′	18.6	142	2008	14.1	30.9	1.2
96	25	45°00′	124°23′	29.2	215	2138	14.4	31.3	0.6
97	26	45°30′	124°02′	5.3	47	0852	13.2	31.4	2.2
98	26	45°31′	124°06′	10.9	80	1002	13.7	31.1	1.4
99	26	45°31′	124°12′	19.0	128	1116	14.0	30.4	1.1
100	26	45°30′	124°19′	28.6	164	1228	14.4	30.9	0.7
101	26	46°00′	124°24′	36.4	142	1608	13.8	31.3	2.8
102	26	46°00′	124°31′	45.8	155	1724	12.2	32.2	1.5
103	26	46°00′	124°16′	27.1	111	1918	12.8	31.5	3.7
104	26	46°00′	124°10′	18.6	87	2040	13.3	31.2	0.6
105	26	46°01′	124°03′	9.8	47	2205	13.3	31.9	1.2
106	27	46°30′	124°18′	18.5	65	1211	13.8	27.2	13.7
109	27	46°30′	124°33′	37.9	219	1759	14.4	31.9	0.6
110	27	46°30′	124°40′	46.8	457	1907	15.5	31.8	0.2
111	28	47°00′	124°19′	13.6	47	1437	12.9	32.6	1.2
112	28	47°00′	124°27′	21.0	64	1545	13.2	32.7	2.5
114	29	47°00′	124°32′	27.7	78	0606	13.3	32.0	2.2
115	29	46°59′	124°39′	36.6	102	0812	13.8	31.9	1.5
116	29	47°00′	124°47′	46.2	142	1030	14.9	31.8	0.5
117	29	47°30′	124°56′	44.4	197	1540	14.2	31.8	0.3
118	29	47°30′	124°48′	34.7	126	1707	14.5	31.8	1.9
119	29	47°30′	124°41′	25.9	82	1833	13.5	32.2	5.9
120	29	47°30′	124°36′	18.8	49	2000	13.2	32.8	1.0
121	30	48°00′	124°50′	11.1	47	0807	13.8	32.0	1.4
122	30	48°00′	124°56′	18.8	87	0952	14.0	32.1	0.6
123	30	48°00′	125°03′	27.9	120	1150	13.5	32.0	1.4
124	30	48°00′	125°11′	37.5	155	1325	14.3	32.1	0.8
	Sept.								
140	1	48°20′	124°49′	10.7	54	0711	10.1	32.5	1.8
141	1	48°20′	124°54′	17.5	290	0916	12.5	31.5	3.0
142	1	48°21′	125°00′	22.2	252	1034	13.4	31.8	5.5
143	1	48°21′	125°00′	22.2	241	1139	12.4	—	—
144	1	48°21′	125°10′	37.0	186	1316	14.9	31.8	7.4
145	1	48°00′	125°11′	37.1	159	1624	15.2	31.2	2.5
146	1	48°00′	125°03′	27.7	122	1753	14.8	31.5	4.7
147	1	48°00′	124°56′	18.3	89	1921	14.1	31.2	7.1
148	1	48°00′	124°49′	10.7	43	2054	13.2	31.7	7.1
149	2	47°40′	124°37′	16.6	43	0823	12.4	32.5	3.3
150	2	47°40′	124°43′	24.0	65	0942	12.4	32.3	9.3
151	2	47°40′	124°46′	28.4	82	1054	14.5	31.9	3.3
152	2	47°20′	124°43′	36.2	549	1403	15.4	31.9	0.8
153	2	47°20′	124°39′	27.5	93	1521	15.3	32.1	—
154	2	47°20′	124°36′	23.3	73	1630	15.0	32.4	2.7
155	2	47°20′	124°29′	14.6	45	1737	15.5	32.1	1.3
157	3	47°00′	124°21′	13.6	43	0849	14.0	32.4	—
158	3	47°01′	124°27′	20.7	62	1027	14.6	32.4	3.9
159	3	47°00′	124°27′	21.0	60	1124	14.6	32.6	—
160	3	47°00′	124°32′	27.9	76	1326	15.4	32.2	2.5
161	3	47°00′	124°39′	36.8	98	1457	16.3	32.2	0.9
162	3	47°00′	124°47′	46.4	140	1614	15.0	31.9	1.3
163	3	47°00′	124°32′	27.5	76	1806	16.0	32.2	1.3
164	4	46°40′	124°14′	12.0	45	0907	14.2	32.0	2.5
165	4	46°40′	124°19′	18.5	65	1043	14.4	32.4	2.3
166	4	46°40′	124°18′	17.9	64	1142	14.8	32.2	0.4
167	4	46°40′	124°26′	28.3	86	1326	15.0	32.4	1.6
168	4	46°40′	124°31′	37.1	122	1502	15.8	31.8	0.5
169	4	46°20′	124°13′	11.4	45	1835	15.4	21.2	3.6
170	5	46°20′	124°18′	18.1	73	1841	14.9	25.3	2.7

Appendix Table 6—Continued.

Set	Date	Lat. (N)	Long. (W)	Off-shore (km)	Depth (m)	Time at start	Temp. (°C)	Salin-ity (‰)	Chloro-phyll *a* (μg/L)
	Sept.								
171	5	46°21′	124°24′	26.0	109	1956	16.5	30.0	0.8
172	6	46°20′	124°25′	27.7	122	0816	14.2	24.1	2.7
173	6	46°20′	124°33′	37.1	137	0931	16.1	30.1	0.7
174	6	46°20′	124°18′	19.6	76	1131	15.6	20.1	3.0
175	10	46°00′	124°03′	9.2	43	0907	14.8	30.8	1.8
176	10	46°00′	124°24′	37.0	144	1143	16.5	31.5	0.3
178	11	45°40′	124°00′	4.8	45	0644	15.5	31.0	0.5
179	11	45°40′	124°04′	9.2	69	0748	15.3	31.3	0.5
180	11	45°40′	124°11′	18.5	104	0927	15.6	30.7	1.1
181	11	45°40′	124°18′	28.4	140	1045	15.4	30.8	1.2
182	11	45°20′	124°13′	17.3	137	1430	16.1	31.8	0.5
183	11	45°20′	124°05′	9.2	80	1600	16.0	31.6	0.5
184	11	45°21′	124°02′	5.3	45	1833	15.9	31.6	0.5
186	12	45°00′	124°08′	9.2	84	1212	15.3	32.3	0.9
187	12	45°00′	124°15′	18.5	139	1343	15.7	31.9	0.5
188	12	45°00′	124°22′	27.7	195	1500	17.2	31.8	0.3
189	12	45°00′	124°04′	4.6	45	1714	15.1	32.9	1.1
190	13	44°20′	124°14′	11.1	43	1040	14.8	32.8	1.5
191	13	44°20′	124°12′	9.2	60	1132	14.8	32.8	1.8
192	13	44°20′	124°20′	18.5	76	1245	15.2	32.5	0.5
193	13	44°20′	124°28′	27.9	91	1352	15.5	32.7	0.5
194	13	44°20′	124°13′	9.4	58	1550	14.9	32.8	1.8
195	13	44°30′	124°10′	6.2	45	1819	14.3	33.0	4.1
196	14	44°40′	124°07′	4.9	43	0807	13.4	33.1	8.5
197	14	44°40′	124°10′	9.2	56	0917	14.4	32.9	2.7
198	14	44°40′	124°18′	18.6	80	1030	14.4	32.9	2.1
199	14	44°40′	124°25′	28.6	93	1141	14.8	32.2	1.1
200	14	44°40′	124°32′	38.1	139	1258	15.6	32.1	0.8
201	15	44°00′	124°28′	26.2	124	1305	15.0	31.9	0.8
202	15	44°00′	124°23′	19.2	111	1417	15.3	32.1	0.7
203	15	44°00′	124°15′	9.6	76	1524	15.3	32.3	0.7
204	15	44°00′	124°11′	4.0	43	1622	15.3	32.7	1.8
205	15	44°00′	124°11′	3.8	45	1655	—	—	—

Appendix Table 7—Individual accounts for all taxa collected in purse seines off the coast of Oregon and Washington, 1979-84. The nine most abundant taxa are discussed in detail in the text. Capture data on the less common species are listed in the following abbreviated sequence: year and set number, followed by lengths of specimens taken. For those sets which contained 10 or more individuals of a species, the number collected is followed by a hyphen and the mean length and range in lengths (in parentheses). Specimens for which no lengths are available are designated by NLA. All lengths given are fork length in mm unless otherwise specified. The systematic arrangement and common and scientific nomenclature used below follow Roper et al. (1984) for cephalopods and Robins et al. (1980) for fishes.

CEPHALOPODA

Teuthoidea (dorsal mantle lengths)

Loliginidae

Loligo opalescens Berry, market squid
See text for catch and length-distribution data.

Onychoteuthidae

Onychoteuthis borealijaponicus Okada, Pacific clubhook squid
80-012; 72
81-050; 242
84-096; 155,164,186,196,198,211,NLA,NLA

Octopoda

Octopodidae

Octopus dofleini (Wulker), giant octopus
84-148; 1 - NLA

AGNATHA

Petromyzontiformes (total lengths)

Petromyzontidae

Lampetra tridentata (Gairdner), Pacific lamprey
79-045; 552
80-028; 1 - NLA
82-034; 186
82-042; 650
82-060; 605
82-079; 192
82-106; 600
82-117; 565
83-045; 2 - NLA
83-061; 590
83-118; 1 - NLA
84-039; 596
84-055; 570
84-089; 251
84-143; 215

CHONDRICHTHYES

Squaliformes (total lengths)

Squalidae

Squalus acanthias Linnaeus, spiny dogfish
See text for catch and length-distribution data.

Alopiidae

Alopias vulpinus (Bonnaterre), thresher shark
79-046; 3650
82-139; 3910
82-157; 3350
84-024; 3750
84-027; 2015

Carcharhinidae

Galeorhinus zyopterus Jordan and Gilbert, soupfin shark
80-020; 1490
81-090; 1590
82-139; 1420
82-143; 1830
82-151; 1610
82-157; 1270,1620,1650
82-165; 1550,1570,1651
83-067; 1680
83-085; 1500
83-104; 1320
84-101; 1575
84-109; 1520
84-124; 1580
84-168; 1530
84-169; 1625

Prionace glauca (Linnaeus), blue shark
80-020; 1370,1570
81-141; 1190
81-195; 1170
81-196; 1170,1660
81-200; 1750
81-209; 1250
81-215; 1170
81-217; 1310
81-223; 1780
81-232; 1750
81-249; 920,1520
81-267; 1520
81-273; 950
82-055; 1740
82-154; 1520
82-165; 1370,1520
83-123; 1980
83-163; 1310
83-164; 1320
83-165; 940
83-166; 1490,1450
83-167; 1540,1930
83-172; 1350
84-100; 1115
84-101; 1040,1880
84-110; 2 - NLA
84-160; 1830
84-167; 1440
84-171; 1525
84-180; 995

Rajiformes (total lengths)

Rajidae

Raja binoculata (Girard), big skate
82-086; 1200
82-138; 1490
83-080; 610
84-003; 1400
84-106; 1270

Raja rhina Jordan and Gilbert, longnose skate
82-118; 898
84-114; 1290

Torpedinidae

Torpedo californica Ayres, Pacific electric ray
81-234; 527
83-153; 480
84-095; 635

OSTEICHTHYES

Clupeiformes

Clupeidae

Alosa sapidissima (Wilson), American shad
79-001; 360,364,369,389,440,489,492
79-016; 400
79-023; 419,462,470,480
79-043; 484
80-016; 2 - NLA
80-018; 3 - NLA
80-025; 1 - NLA
81-041; 282
81-065; 274,286
81-078; 271,294,353
81-079; 271,272,276,277,283,301
81-146; 264,270,270,271,275,282,286,290
81-148; 278,300
81-150; 312
81-151; 276,287,295,339
81-168; 26 - 323.0 (267-435)
81-169; 25 - 314.4 (269-472)
81-171; 39 - 372.7 (270-494)
81-172; 286,297,300,377,384,421
81-173; 285,290,397
81-180; 286,292,297,298,299,300,302,306
81-181; 361,418
81-211; 883 - 304.8 (263-409)
81-212; 76 - 305.1 (274-426)
82-131; 12 - 327.8 (285-384)
83-028; 320
83-062; 364
83-152; 312,318,408
83-153; 235,392,435
84-030; 350,351,355,360,
362,388,402,415,440
84-097; 425
84-114; 357,9 (303-446)

Appendix Table 7—continued.

Clupea harengus pallasi Valenciennes, Pacific herring
See text for catch and length-distribution data.

Sardinops sagax (Jenyns), Pacific sardine
84-048; 250
84-194; 243,248,250,265

Engraulidae

Engraulis mordax Girard, northern anchovy
See text for catch and length-distribution data.

Salmoniformes

Osmeridae

Allosmerus elongatus (Ayres), whitebait smelt
79-043; 110,111,117,126,126
80-017; 20 - 3 lengths available, 102,102,104
82-023; 123
82-029; 89,96
82-128; 99
83-070; 3 - NLA
83-128; 104

Hypomesus pretiosus (Girard), surf smelt
79-037; 134
79-038; 161
80-018; 143
81-001; 128,130,137,140,141,151,154,159
81-147; 160
81-186; 158,164
82-039; 151
82-057; 47 - 147.0 (135-156)
83-014; 27 - 174.0 (159-190)
83-028; 36 - 66.3 (39-84)
83-033; 300 - 165.9 (151-178)
83-053; 20 - 165.7 (162-170)
83-075; 50 - 173.0 (165-187)
84-049; 140,141,145,149,154,154,160
84-060; 155

Spirinchus starksi (Fisk), night smelt
82-079; 140
83-006; 143,146,150,151,162

Thaleichthys pacificus (Richardson), eulachon
84-148; 120
84-199; 164

Gobiesociformes

Gobiesocidae

Gobiesox maeandricus (Girard), northern clingfish
83-128; 32

Gadiformes

Gadidae

Merluccius productus (Ayres), Pacific hake
See text for catch and length-distribution data.

Microgadus proximus (Girard), Pacific tomcod
79-003; 154
79-019; 57
79-020; 64
79-021; 32,50,50,55
81-079; 46
81-083; 1 - NLA
81-089; 1 - NLA
81-152; 3 - NLA
81-162; 1 - NLA
81-163; 1 - NLA
81-168; 5 - NLA
81-263; 56
82-132; 25 - 3 lengths available, 54,63,71
82-138; 5 - NLA
83-121; 91,93
84-009; 53,55
84-015; 1 - NLA
84-020; 20 - 8 lengths avail., 38,42,44,45,47,49,50,53
84-147; 73
84-148; 87,90,103
84-190; 57,61
84-191; 64
84-196; 45
84-203; 44,50,51,52

Antheriniformes

Scomberesocidae

Cololabis saira (Brevoort), Pacific saury
See text for catch and length-distribution data.

Lampriformes

Trachipteridae (standard lengths)

Trachipterus altivelis Kner, king-of-the-salmon
81-038; 1 - NLA
81-043; 1 - NLA
81-051; 183
81-105; 92
81-118; 267
81-119; 93,142,154,192
81-120; 70,94
81-130; 91,113,114,122,160,161,170,176,210
81-271; 135
82-143; 385
82-145; 121
82-148; 110,120,200,220
82-157; 1 - NLA
82-168; 156
83-101; 188
83-102; 108
83-112; 193,221
84-169; 1 - NLA
84-180; 95,115
84-187; 180,198
84-193; 143,205,245
84-198; 224,282

Perciformes

Scorpaenidae (standard lengths)

Sebastes crameri (Jordan), darkblotched rockfish
81-107; 51

Sebastes diploproa (Gilbert), splitnose rockfish
83-124; 32,33,34,36,38,38,39,44,45
83-130; 28,33
84-165; 48
84-200; 35

Sebastes emphaeus (Starks), Puget Sound rockfish
81-048; 37

Sebastes entomelas (Jordan and Gilbert), widow rockfish
79-024; 52,55,59,60
79-025; 61,61,68,68
79-031; 56
79-032; 48 - 61.1 (54-68)
79-036; 65
79-044; 12 - 60.5 (49-68)
79-051; 16 - 69.5 (61-75)
79-053; 41 - 69.9 (56-78)
79-054; 69,71
80-001; 25 - 54.6 (51-58)
81-102; 10 - 51.9 (48-55)
81-105; 46
81-113; 52,52,54
81-115; 54
81-118; 40,43,44,45,45
81-119; 23 - 46.7 (40-51)
81-120; 49 - 51.5 (39-57)
81-121; 13 - 53.3 (48-58)
81-125; 10 - 51.8 (46-57)
82-053; 49
82-079; 50,50
82-083; 50,53
84-027; 52

OSTEICHTHYES (continued)

Perciformes

Scorpaenidae (continued)

Sebastes flavidus (Ayres), yellowtail rockfish
Juveniles:
79-024; 53,54
79-024; 59 - 53.3 (47-58)
79-044; 48,51,55
79-052; 52,55
79-053; 54,54,55,55,55,56,57,59
80-001; 220 - 48.9 (45-53)
80-010; 45,47,47,48,50
80-014; 46,49,50,50,50
80-032; 48
80-033; 11 - 47.8 (41-54)
81-102; 40
81-104; 41,43,47,48
81-105; 46,46,46,47,48
81-113; 44,47
81-117; 37,45,45,48
81-118; 29 - 42.0 (35-47)
81-119; 35 - 41.1 (31-47)
81-120; 114 - 45.5 (30-50)
81-121; 12 - 47.0 (40-52)
81-125; 47,48
82-083; 44
83-071; 44
83-078; 46
83-107; 49
84-054; 47

Adults:
82-034; 442
82-037; 1 - NLA
82-072; 490
82-076; 290,485,586
82-113; 420
84-082; 465
84-084; 16 - 412.0 (356-472)
84-150; 1 - NLA
84-189; 387

Sebastes goodei (Eigenmann and Eigenmann), chilipepper
81-062; 36
81-098; 45

Sebastes jordani (Gilbert), shortbelly rockfish
79-025; 65
79-053; 69,70
80-032; 60
81-049; 44
81-075; 55,57,58
81-102; 10 - 57.1 (54-60)
81-107; 53,53,57,59
81-113; 23 - 56.4 (50-60)
81-115; 52,55,55,57,57,57,58,58
81-119; 45
81-121; 55,56,58,63
81-125; 55,59,59
81-201; 56
82-046; 49,54
82-052; 58
82-053; 47,51,52,53
82-054; 55
82-085; 53
82-091; 63
82-100; 61
83-081; 55,56,58,60,61,63
84-027; 52
84-055; 61
84-066; 58

Sebastes maliger (Jordan and Gilbert), quillback rockfish
79-051; 22

Sebastes melanops Girard, black rockfish
Juveniles:
79-024; 22 - 51.3 (43-55)
79-025; 48,50,50,52,53,53,53,55,57
79-028; 43,51,52,52,53,54,56
79-032; 49 - 52.8 (48-56)
79-035; 54
79-036; 54
79-043; 53
79-044; 50,51,53,54
79-047; 54
79-050; 52
79-051; 10 - 54.7 (48-58)
79-053; 10 - 55.5 (51-60)
80-001; 103 - 47.2 (43-51)
80-009; 50
80-011; 44,45,47
80-014; 47
80-033; 23 - 48.0 (43-53)
81-031; 42
81-102; 44,44
81-104; 1 - NLA
81-105; 10 - 44.8, (40-49)
81-118; 28 - 42.9 (38-48)
81-119; 23 - 44.7 (40-50)
81-120; 28 - 45.2 (41-50)
81-121; 46,47,47,47,47,48,48,50
81-125; 44
81-126; 48
81-127; 45
82-068; 40
83-071; 46

Adults:
79-007; 482
79-025; 489
80-015; 292
80-016; 1 - NLA
80-031; 1 - NLA
80-041; 1 - NLA
80-044; 1 - NLA
81-151; 2 - 504,NLA
81-154; 395
81-221; 504
81-254; 491
82-008; 347
82-016; 380
82-018; 362
82-019; 470,484,515
82-027; 492
82-051; 171
82-056; 425
82-071; 450,481,510,508
82-072; 11 - 493.8 (440-530)
82-077; 535
82-088; 488,512,530
82-131; 476,477,510,512,517
82-161; 532
83-007; 294
83-018; 305
83-057; 400
83-070; 10 - 437.3 (392-490)
83-080; 411,437,438,490,511
83-116; 505
84-015; 520
84-020; 470,489,492,515,530,532,540,558
84-021; 476,490
84-080; 492
84-097; 470
84-105; 475
84-111; 425,430,465,490
84-112; 425,474,488
84-114; 441
84-119;497
84-121; 1 - NLA
84-123; 356
84-149; 520
84-150; 365,455,470,480,495
84-157; 75 - 423.0 (375-485)
84-175; 502
84-186; 512

Appendix Table 7—continued.

Sebastes mystinus (Jordan and Gilbert), blue rockfish

Juveniles:
79-023; 57
79-024; 12 - 57.1 (51-60)
79-025; 53,57,58,58,58,59
79-026; 54
79-027; 60
79-028; 51,53,56,56,58,59,59,59
79-032; 83 - 58.1, (51-63)
79-042; 51,52,66
79-043; 55
79-044; 53,54,58,59,59,60,60,64
79-047; 60
79-051; 13 - 61.5 (58-71)
79-052; 55
79-053; 58 - 60.6 (53-66)
79-054; 65
80-001; 123 - 51.3 (45-58)
80-011; 51
80-014; 51,53
80-033; 11 - 54.0 (50-57)
81-005; 47
81-102; 49,49,56
81-104; 58
81-113; 1 - NLA
81-115; 54
81-117; 47
81-118; 47,47,49
81-119; 21 - 46.5 (42-50)
81-120; 34 - 48.0 (45-51)
81-121; 23 - 50.7 (47-58)
81-201; 48,48

Adults:
82-160; 440
82-170; 386,407

Sebastes nigrocinctus Ayres, tiger rockfish
83-124; 17 - 44.3 (30-56)
84-157;42

Sebastes paucispinis Ayres, bocaccio
79-051; 80
79-053; 79,83,86,86,89,89
81-119; 53
81-120; 53,60
81-121; 41
81-125; 65

Sebastes pinniger (Gill), canary rockfish
79-026; 44
79-030; 46
79-031; 39
79-032; 46
79-044; 45,46,47
79-052; 45
82-052; 38

Sebastes proriger (Jordan and Gilbert) redstripe rockfish
84-192; 27
84-201; 13 - 27.7 (23-35)

Sebastes saxicola (Gilbert), stripetail rockfish
81-075; 35
81-098; 35,35,36
81-105; 35,35,35,35
81-119; 29
81-120; 30,33,34,35,36,36,37,38

Anoplopomatidae

Anoplopoma fimbria (Pallas), sablefish
See text for catch and length-distribution data.

Hexagrammidae

Hexagrammos decagrammus (Pallas), kelp greenling
79-031; 19 - 57.3 (53-60)
79-042; 63,64,65
79-044; 64
81-048; 61
81-049; 67
81-062; 63,65,66,68
81-071; 61,61,64,64,64,65,67,67,68
81-098; 60,67,67,71
81-121; 63,66,67
81-132; 27 - 65.1 (54-72)
82-060; 73
82-062; 72
82-064; 3 - NLA
82-069; 68
82-092; 58
82-102; 65
83-053; 48
84-016; 54
84-029; 65
84-038; 62,65
84-056; 65,69
84-061; 67
84-067; 65
84-068; 68

Ophiodon elongatus Girard, lingcod

Juveniles:
81-022; 67
81-036; 53,59,60,61,61,63,66
81-037; 11 - 53.1 (48-66)
81-038; 50 - 58.6 (48-66)
81-042; 71
81-048; 59,60,61,64,65,65,65,69
81-049; 65
81-093; 76
82-085; 51,54,59,60,62,63
82-125; 1 - NLA

Adults:
84-158; 635

Cottidae

Hemilepidotus spinosus (Ayres), brown Irish lord (standard lengths)
79-044; 25,26,29
79-053; 43
80-030; 1 - NLA
81-048; 27
81-049; 28,28
82-092; 23,24,25,25,25,26
83-043; 27

Leptocottus armatus Girard, Pacific staghorn sculpin
79-026; 175
82-160; 198,213,226,226,228
83-037; 195

Scorpaenichthys marmoratus (Ayres), cabezon (standard lengths)
80-001; 46
80-013; 41
80-014; 49
80-092; 46
83-045; 35
83-064; 41,43
83-112; 43

OSTEICHTHYES (continued)

Perciformes

Agonidae

Agonopsis vulsa (Jordan and Gilbert), northern spearnose poacher
82-052; 58
82-100; 68
82-120; 63
84-084; 73
84-116; 65

Cyclopteridae (total lengths)

Liparis pulchellus Ayres, showy snailfish
84-148; 99

Carangidae

Trachurus symmetricus (Ayres), jack mackerel
See text for catch and length-distribution data.

Kyphosidae

Medialuna californiensis (Steindachner), halfmoon
83-135; 12 - 231.9 (210-247)

Trichodontidae

Trichodon trichodon (Tilesius), Pacific sandfish
79-047; 178

Anarhichadidae

Anarrhichthys ocellatus Ayres, wolf-eel
79-001; 457
79-002; 506
79-003; 477
79-012; 1 - NLA
79-016; 464,487
79-020; 463
79-024; 505
79-025; 458
79-026; 458,460,472,508,518
79-027; 494,503,532,548,599
79-028; 520
79-029; 492
79-030; 478
79-033; 425,485,610
79-034; 487,496,577,587
79-035; 18 - 488.9 (432-546)
79-037; 510,620
79-038; 502,508,508,512,528
79-039; 458,463,473,487,489,492,494,533,548
79-043; 457,481,483,500,512,532,557,586
79-044; 437,475,480,488,493
79-045; 418,443,453,477,509,512
79-046; 436,475
79-047; 432,505
79-048; 434,482,560
79-049; 418,501,NLA
79-050; 413,438,453,463,468,483,502,502,509
79-051; 277,328,357,387,397,405,452
79-053; 451,455,511
79-054; 458
79-055; 405,540
80-037; 591
80-043; 521
80-044; 537
81-099; 1 - NLA
81-110; 1 - NLA
81-188; 530
81-190; 438
81-214; 456
81-241; 472
82-028; 1 - NLA
82-044; 1200
82-068; 516,613
82-079; 495
82-098; 1440
82-101; 399
82-103; 610
82-117; 490
82-118; 460
82-121; 2 - NLA
82-151; 490
82-160; 640
83-025; 1252
83-042; 480
83-065; 1220
83-094; 1 - NLA
83-102; 1 - NLA
83-104; 1 - NLA
83-108; 580
84-082; 525
84-092; 500
84-094; 570
84-097; 515,530
84-102; 515
84-150; 600
84-203; 452

Zaproridae

Zaprora silenus Jordan, prowfish (total length)
82-155; 200

Ammodytidae

Ammodytes hexapterus Pallas, Pacific sand lance
82-128; 79

Scombridae

Sarda chiliensis (Cuvier), Pacific bonito
83-133; 640,653

Scomber japonicus Houttuyn, chub mackerel
See text for catch and length-distribution data.

Stromateidae

Peprilus simillimus (Ayres), Pacific pompano
79-037; 173
82-039; 166
83-014; 176
83-020; 196
83-021; 179
83-050; 6 - NLA
83-056; 192
83-058; 155,163,169,170,175,179,180
84-015; 168,170,180,183,185,190,191,195,195
84-155; 175,179,189

Icichthys lockingtoni Jordan and Gilbert, medusafish
79-038; 110
81-119; 58
81-125; 60
81-175; 101
81-220; 116
81-272; 1 - NLA
82-002; 175
82-004; 139
82-085; 155
82-132; 127
82-143; 170,183
82-144; 91
82-150; 151,153
82-153; 154
82-155; 189
82-156; 150
82-157; 67,86
82-160; 2 - NLA
82-162; 160,170,172
82-165; 185
82-167; 124
82-168; 110,155
82-170; 120
82-172; 117,142,161
83-033; 152
83-037; 125
83-107; 90,94,100
83-110; 90,95,114
83-111; 103
83-112; 65,110
83-114; 95
83-130; 95,151
83-131; 84,134,162
83-135; 47
83-137; 121
83-140; 138
83-142; 178
83-143; 98
83-147; 71,113,121
83-148; 119,125,134,194
83-149; 132
83-150; 86,89
83-153; 79,80,105,138
83-154; 128
83-155; 110,119,130,132
83-156; 82,130
83-158; 61
83-159; 95,96,98,102,104,136,147
83-160; 169
83-161; 83,100,117,163,187
83-163; 75,80,118
83-164; 195
83-165; 130,163,176
83-166; 86,104,120
83-167; 66,68,80,87,97,124,144
83-170; 103,105,111,113,132,150
83-171; 91
83-172; 95,114,169,174
83-173; 107,110
84-189; 83
84-191; 113
84-203; 80

Appendix Table 7—continued.

Icosteidae

Icosteus aenigmaticus Lockington, ragfish
79-012; 1 - NLA
81-112; 69
82-135; 134
82-138; 272
83-107; 270

Pleuronectiformes

Bothidae (total length)

Citharichthys sordidus (Girard), Pacific sanddab
79-017; 208
79-044; 28 - 258.8 (233-315)
80-001; 39
81-010; 39
81-109; 165
81-211; 220
81-250; 272
82-068; 1 - NLA
83-172; 268,282,299,316
84-061; 190,270
84-105; 265,300
84-169; 263
84-191; 70 - 236.2 (203-281)

Citharichthys stigmaeus Jordan and Gilbert, speckled sanddab
80-033; 37
82-128; 59,63

Pleuronectidae (total lengths)

Atheresthes stomias (Jordan and Gilbert), arrowtooth flounder
83-006; 120,130

Glyptocephalus zachirus Lockington, rex sole
81-125; 80

Isopsetta isolepis (Lockington), butter sole
79-049; 210

Lyopsetta exilis (Jordan and Gilbert), slender sole
79-030; 136
82-038; 3 - NLA
82-114; 53
84-089; 132
84-091; 165

Microstomus pacificus (Lockington), Dover sole
82-114; 52

Parophrys vetulus Girard, English sole
82-160; 232,NLA
83-056; 208
84-105; 240
84-148; 24 - 173.0 (120-191)

Platichthys stellatus (Pallas), starry flounder
79-027; 415,418,420,431,445,460,463
79-047; 331,340,530
80-041; 389
81-042; 215
81-124; 311
81-204; 408,475
81-228; 316,410
82-060; 407,493,517,547
82-116; 477,490,517,523,540,542,589
82-117; 450
82-122; 1 - NLA
82-161, 603
83-075; 509
84-148; 456,565

Psettichthys melanostictus Girard, sand sole
82-128; 125,130,152,185,197,NLA,NLA

Tetraodontiformes

Molidae (total lengths)

Mola mola (Linnaeus), ocean sunfish
81-103; 650
81-146; 666
81-239; 2235
82-138; 660
82-143; 737,838,864
82-145; 610
83-114; 405
83-115; 470
83-117; 425
83-130; 450
83-136; 340,360,430
84-033; 1780
84-110; 1675
84-163; 350,380
84-165; 440
84-167; 400
84-173; 440
84-184; 680
84-188; 375,660,695,995
84-201; 415