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

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

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## 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.**

## 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

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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 |  |  | Latitudinal range sampled (North lat.) | No. of sets |
|---|---|---|---|---|
| No. | Year | Date |  |  |
| 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°11′ | 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 | $\underline{12}$ | $\underline{79}$ | $\underline{35}$ | −2 | 34 |
| June | $\underline{86}$ | $\underline{32}$ | $\underline{8}$ | $\underline{59}$ | $\underline{19}$ | $\underline{37}$ | 48 |
| July | 30 | 103 | $\underline{107}$ | 51 | 18 | $\underline{121}$ | 74 |
| Aug. | 31 | 96 | $\underline{40}$ | 38 | 35 | 37 | 50 |
| Sept. | 0 | 9 | −1 | $\underline{12}$ | $\underline{25}$ | $\underline{3}$ | 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 ($<30^{0}/_{00}$) 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 $<30^{0}/_{00}$.

***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 mid-shelf 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 | Rankings | | | |
|---|---|---|---|---|
| | 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 | Rankings | | | | | |
|---|---|---|---|---|---|---|
| | 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.

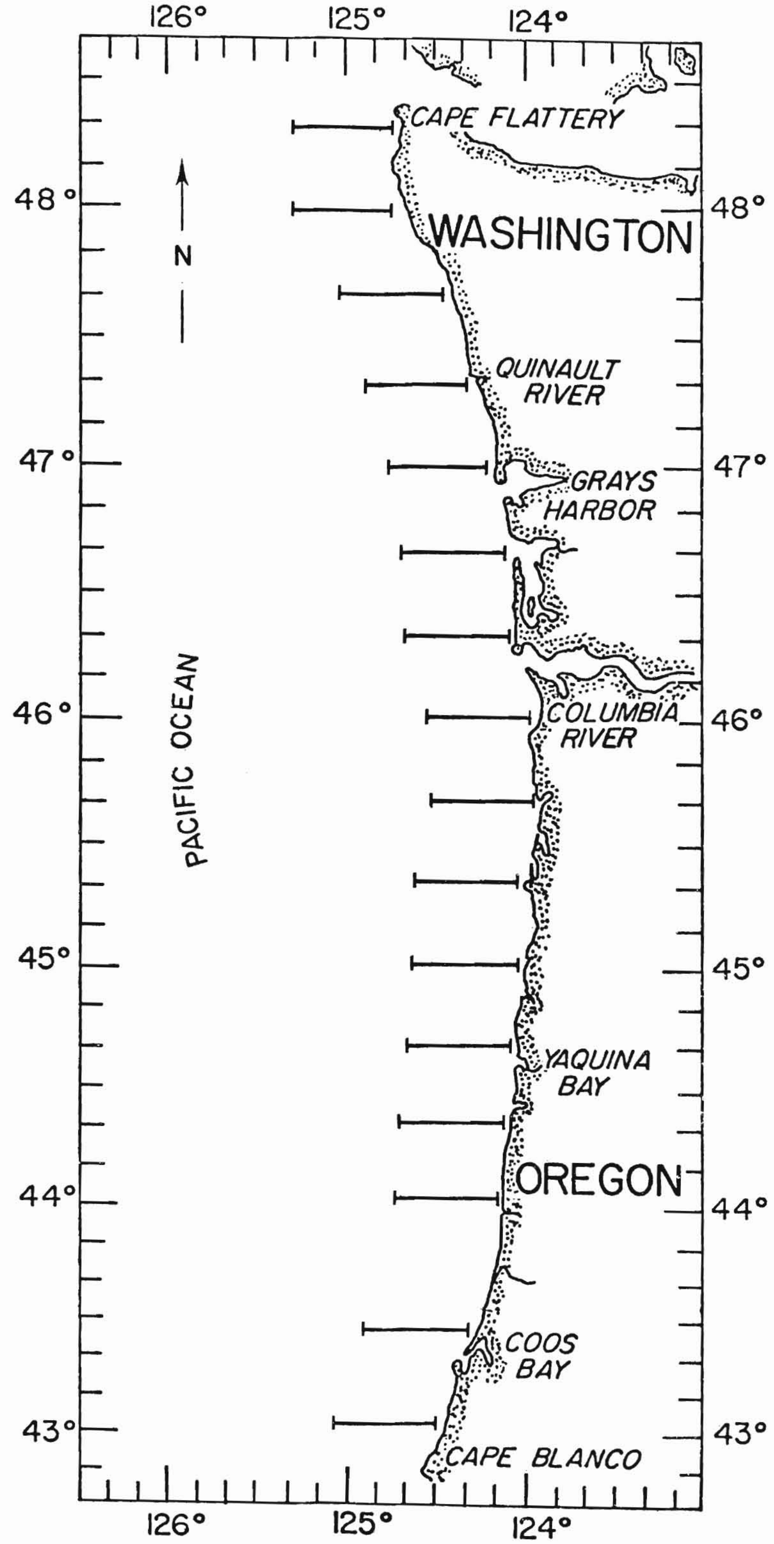


**Figure 1**
Location of sampling area and transect lines used in the study.

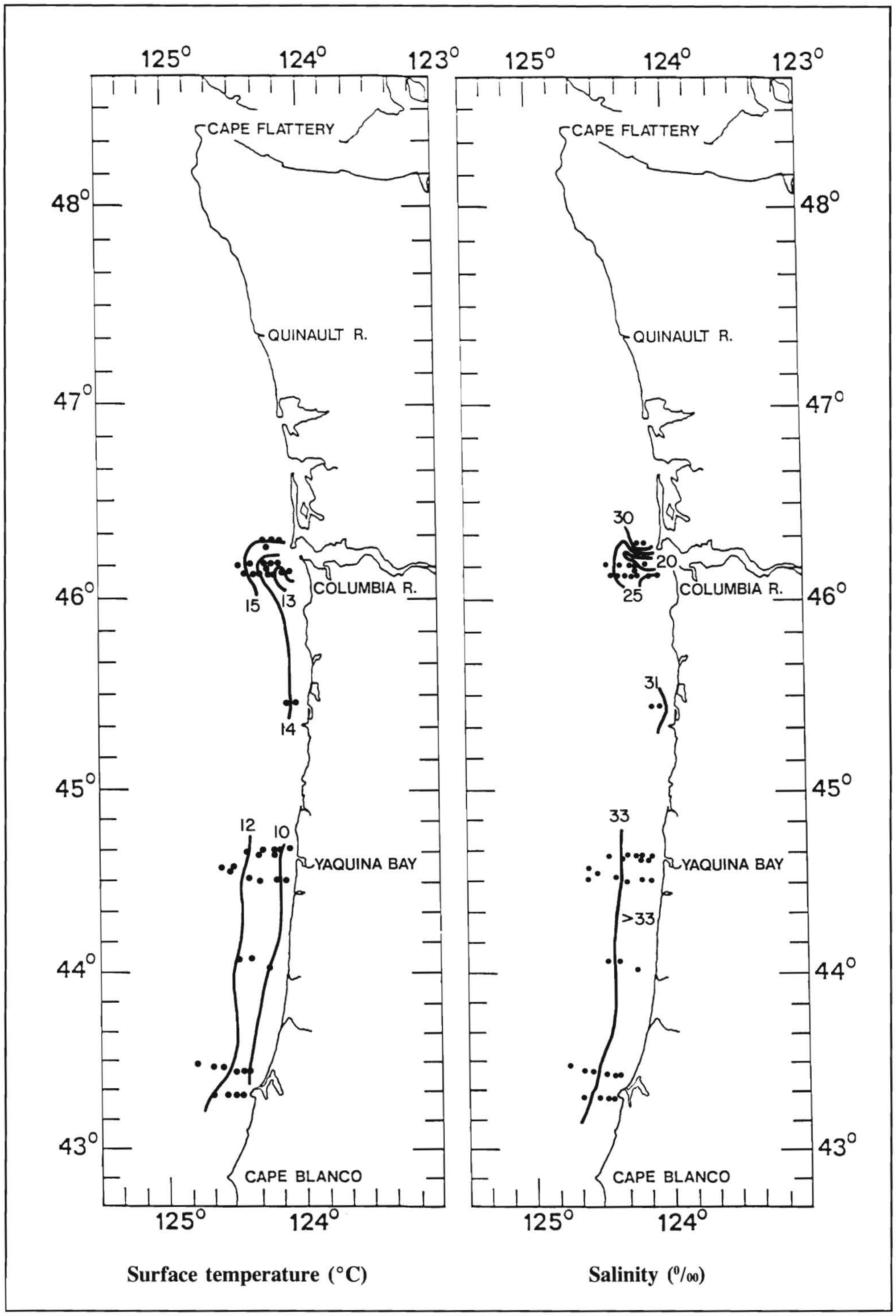


**Figure 2**

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

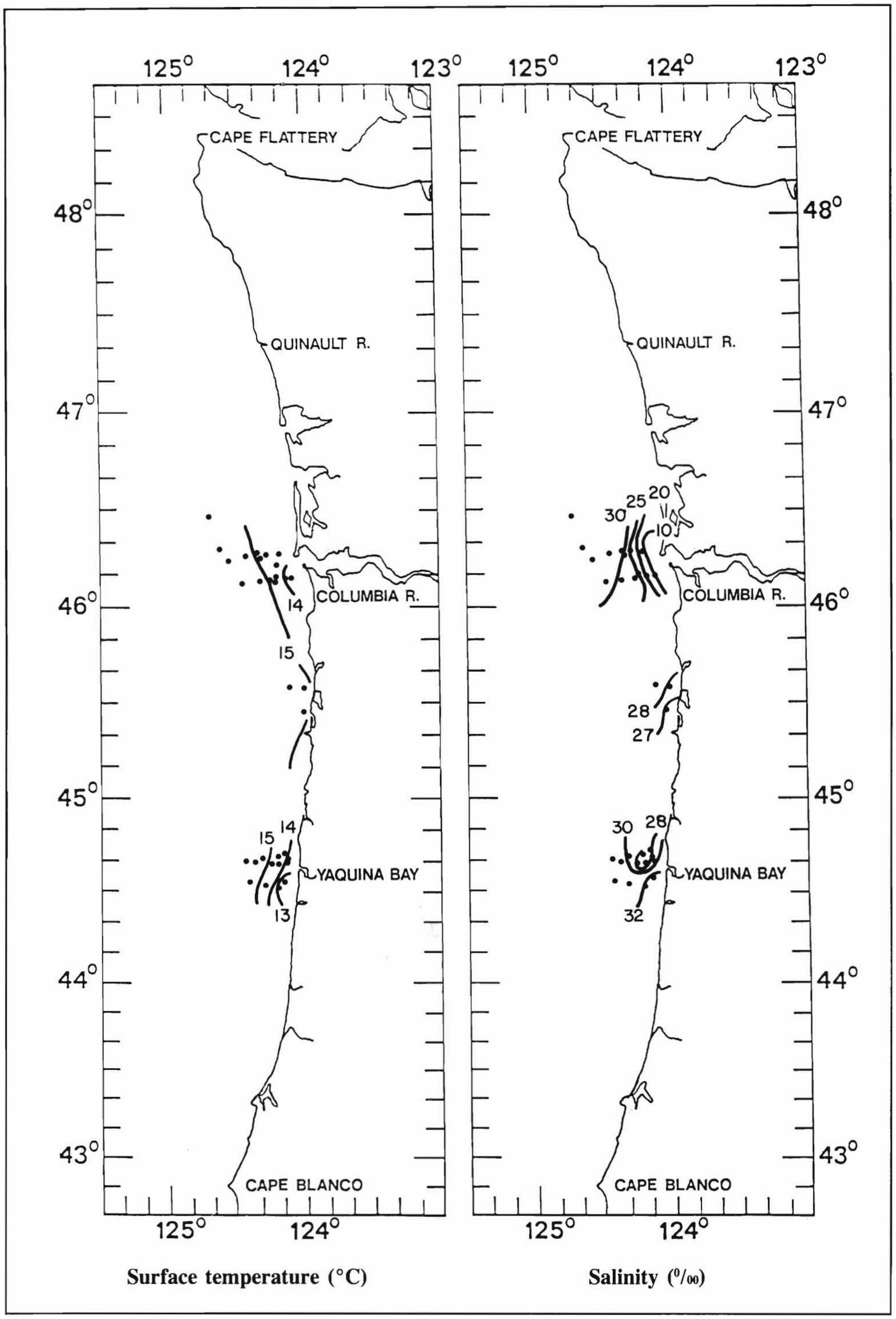
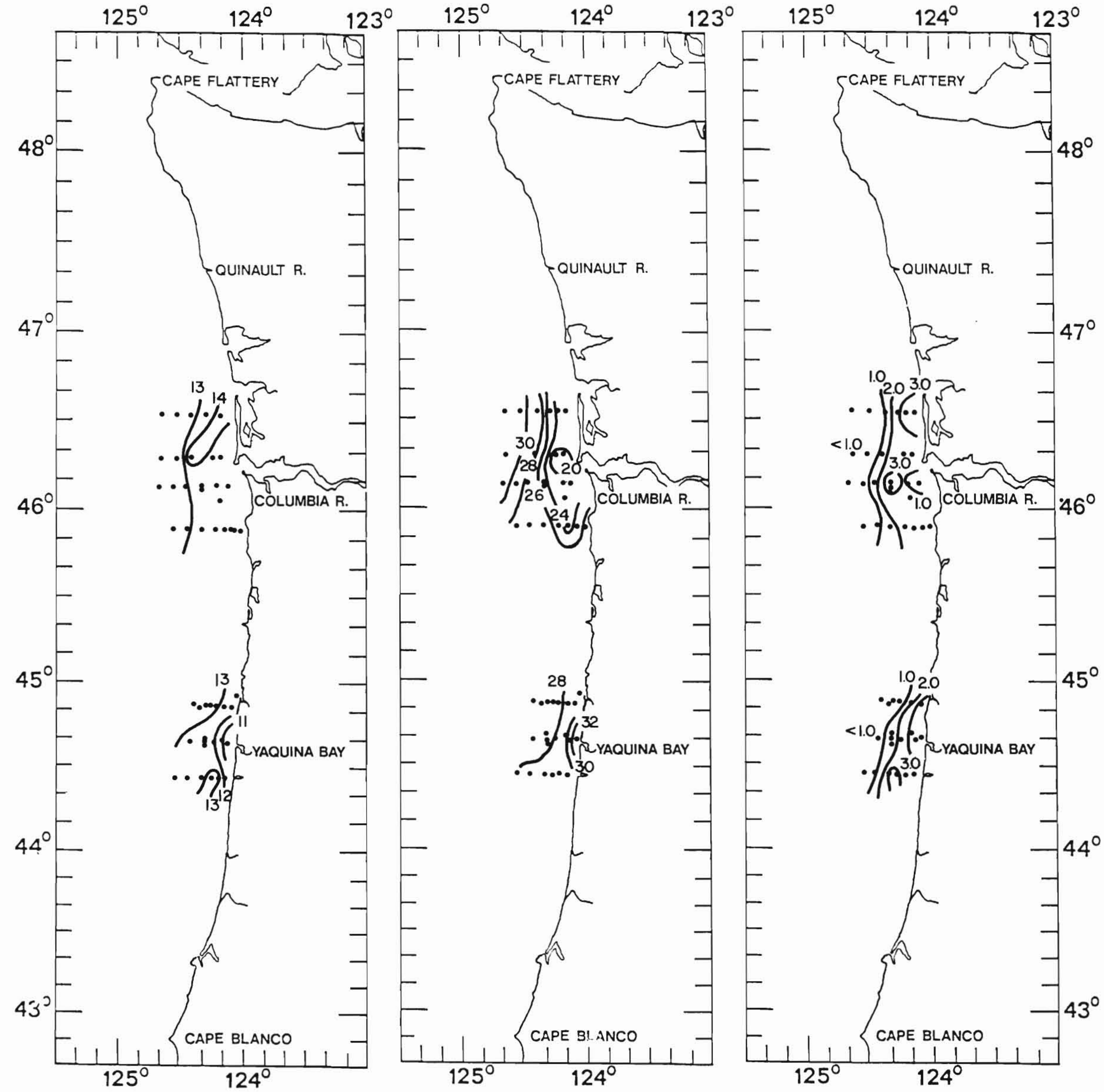


**Figure 3**

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.

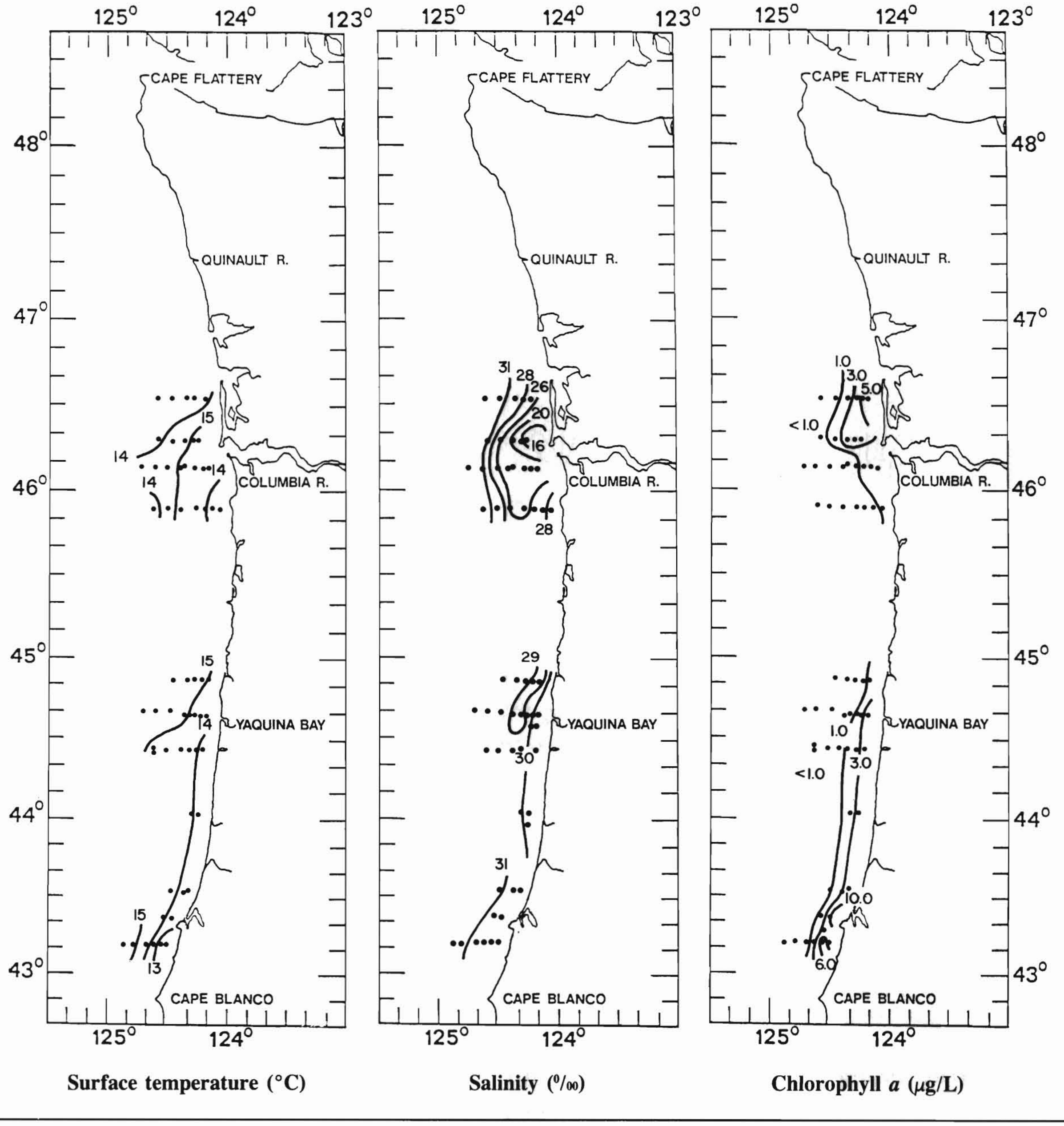


**MAY 1981**

**Surface temperature (°C)** **Salinity (⁰/₀₀)** **Chlorophyll *a* (μg/L)**

**Figure 4**

JUNE 1981



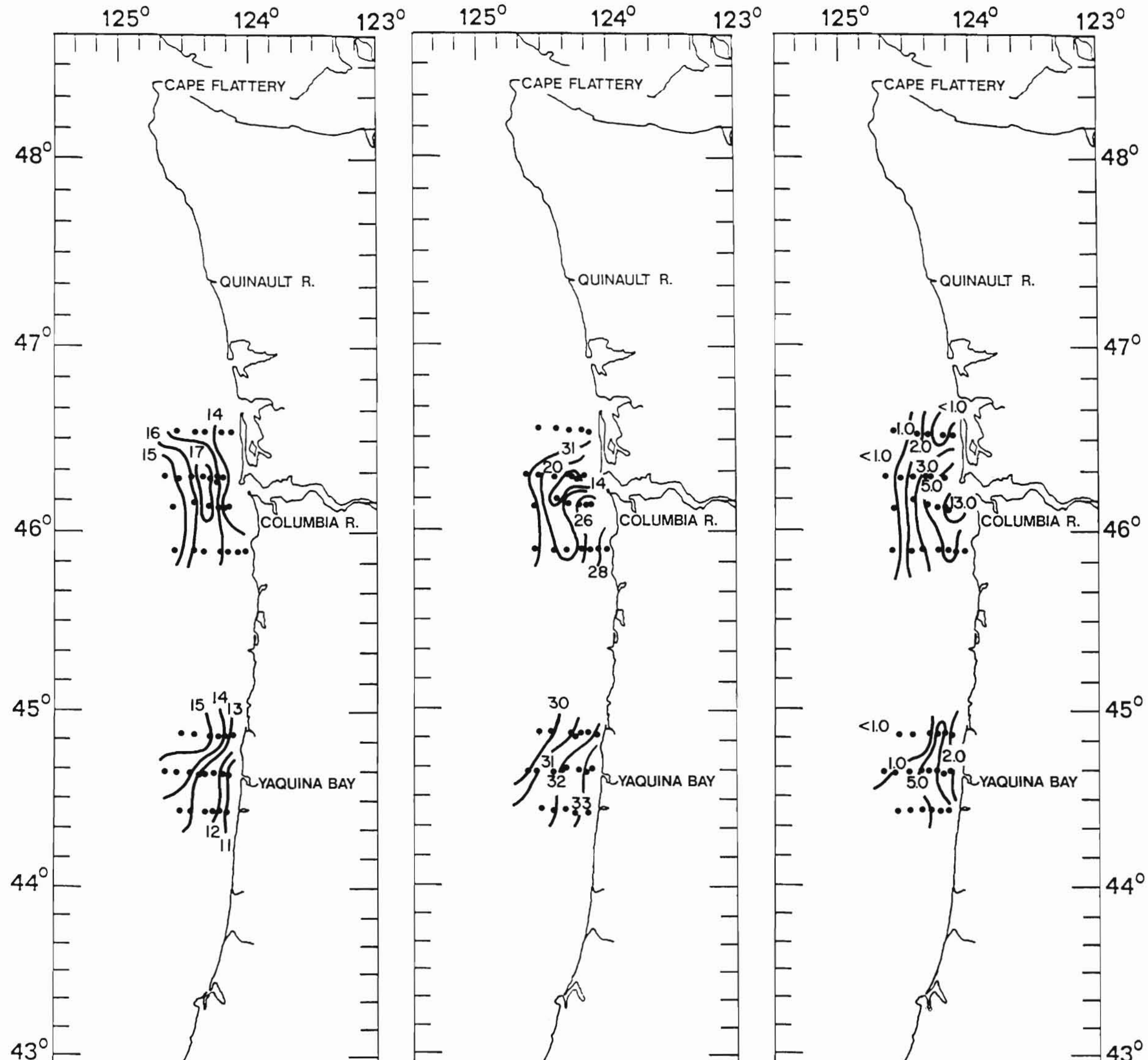
Surface temperature (°C)

Salinity (‰)

Chlorophyll *a* (μg/L)

Figure 5

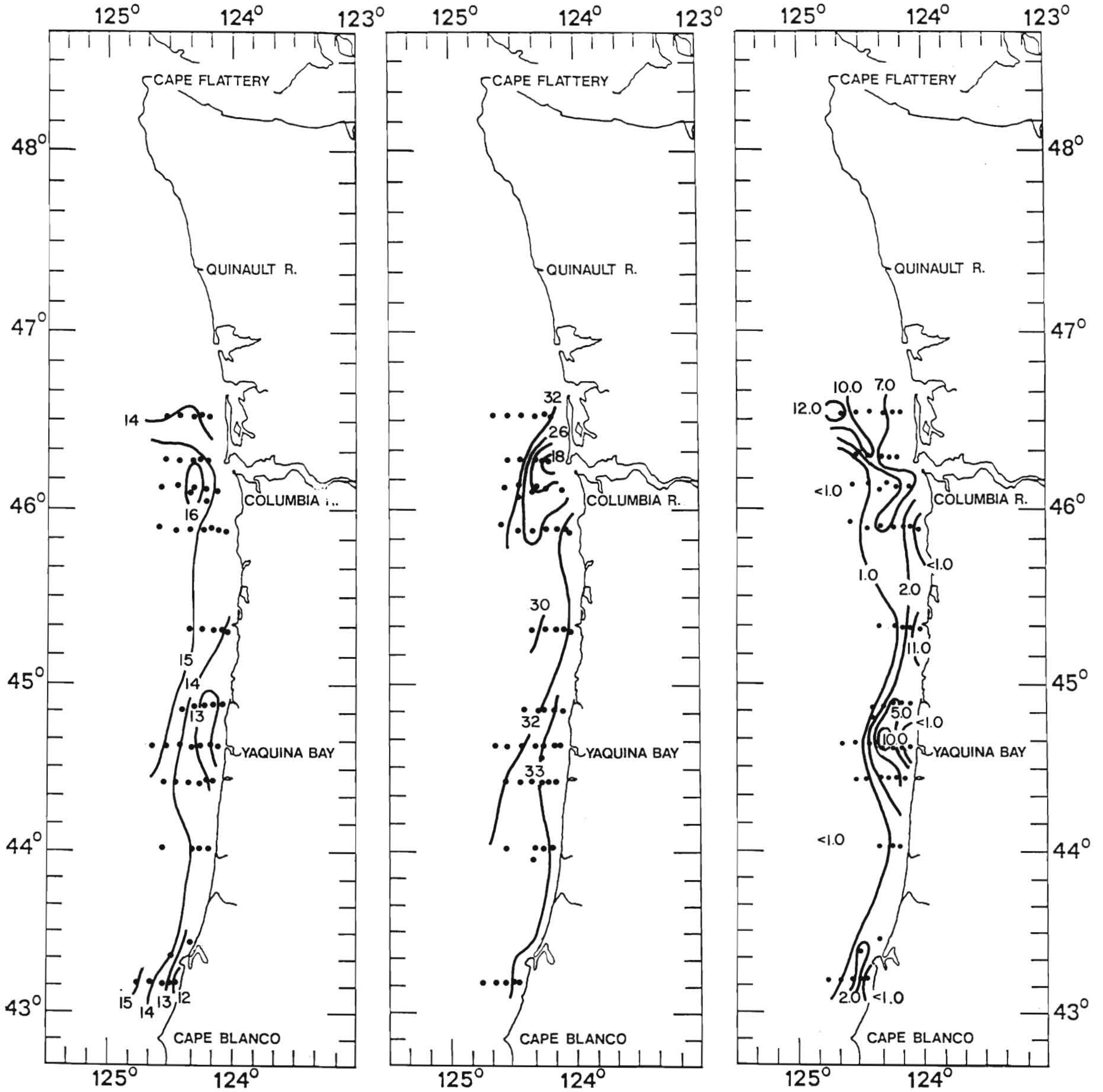
**JULY 1981**



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

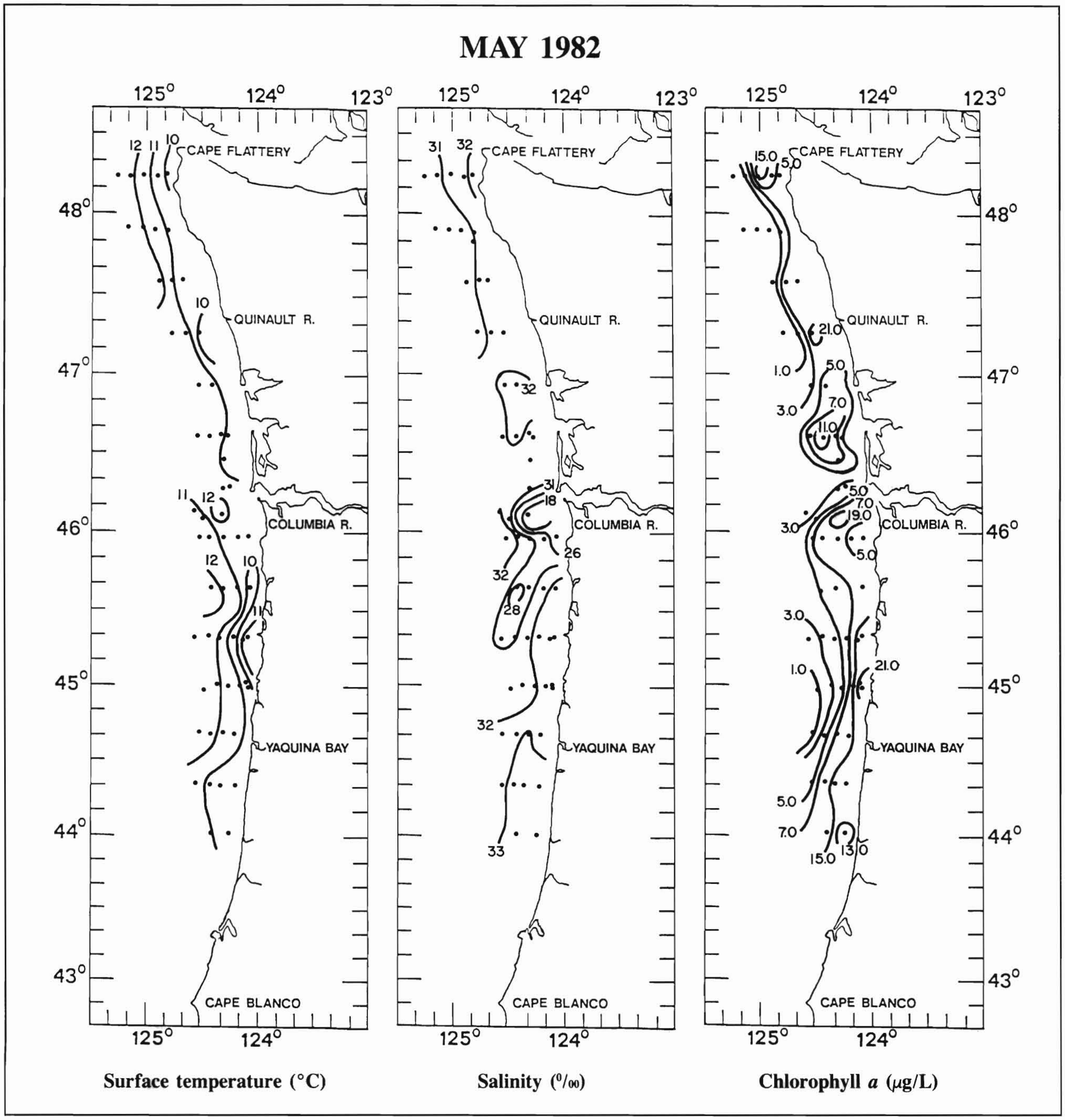
Figure 6

**AUGUST 1981**



Surface temperature (°C) Salinity (⁰/₀₀) Chlorophyll *a* (μg/L)

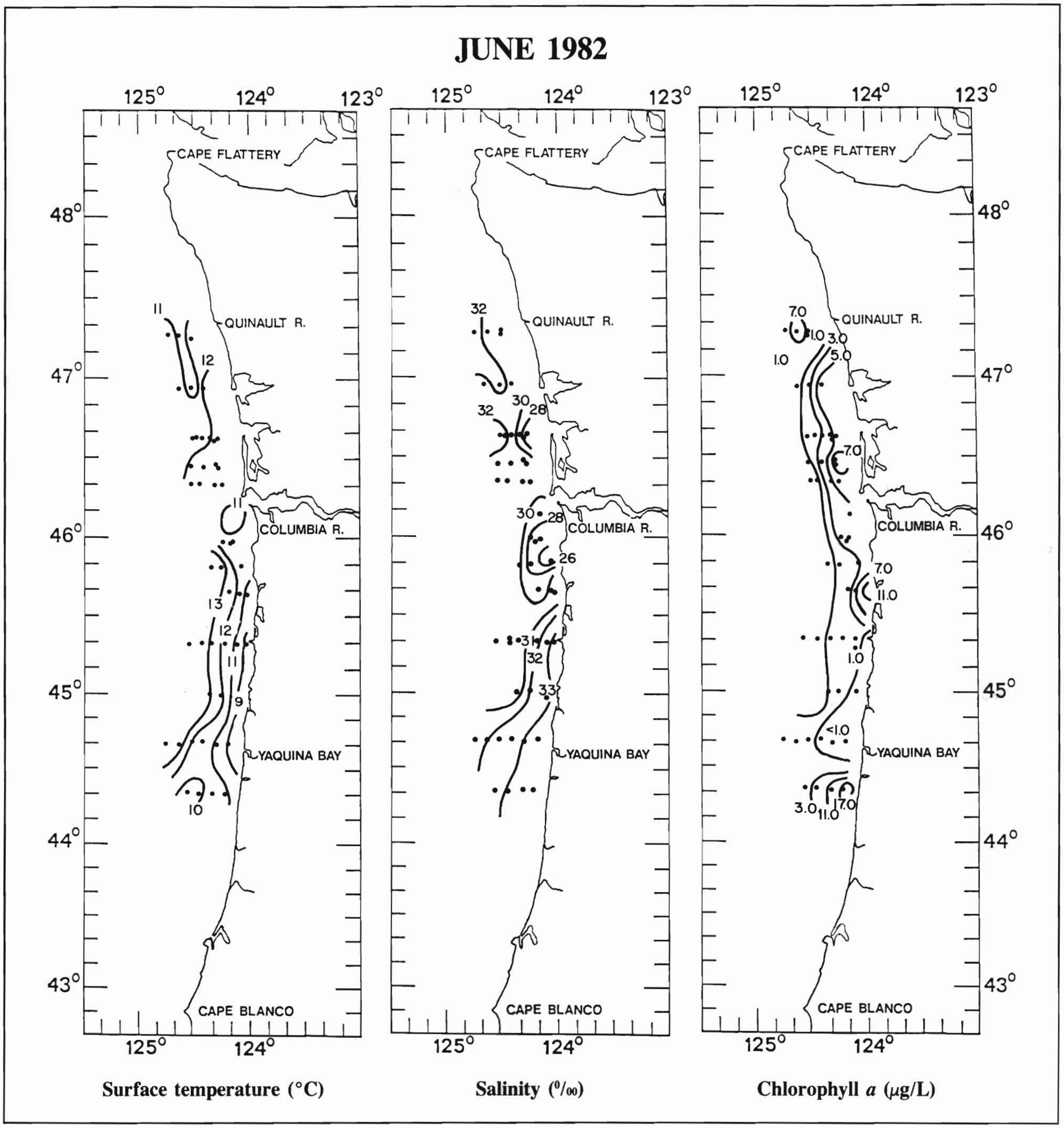
Figure 7



**MAY 1982**

Surface temperature (°C) Salinity (⁰/₀₀) Chlorophyll *a* (μg/L)

Figure 8



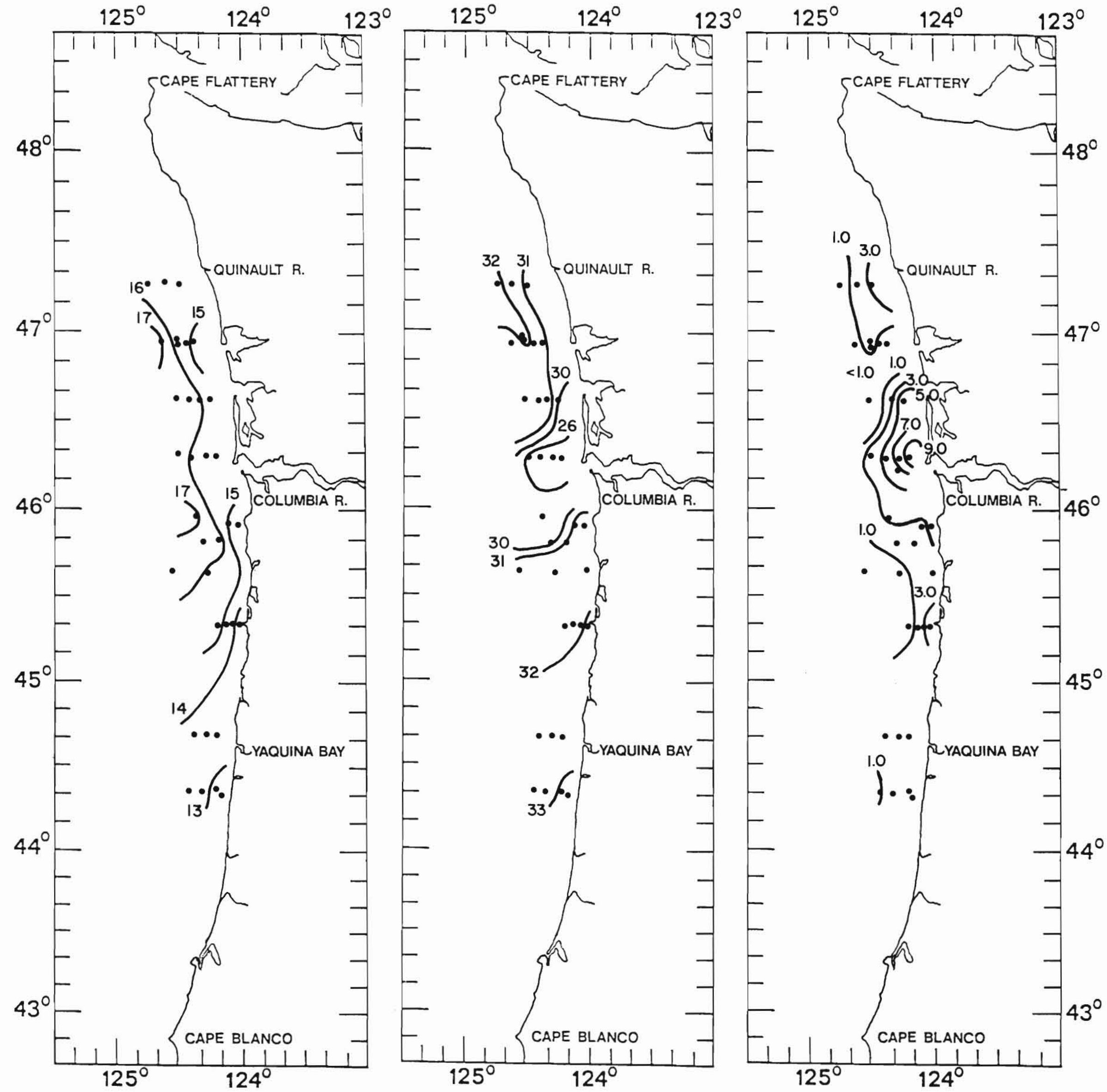
JUNE 1982

Surface temperature (°C)

Salinity (⁰/₀₀)

Chlorophyll *a* (µg/L)

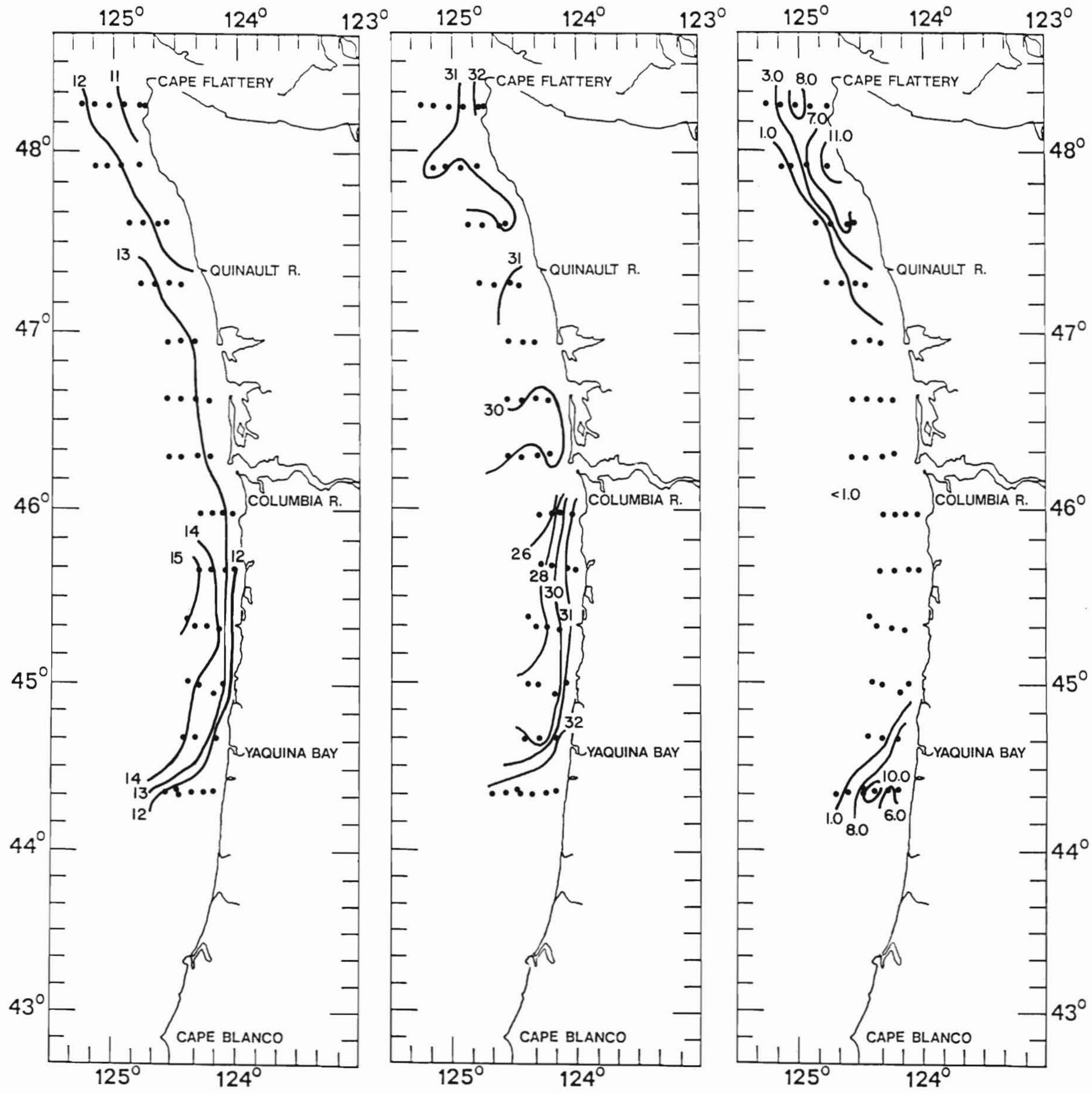
Figure 9



SEPTEMBER 1982

Surface temperature (°C)  Salinity (⁰/₀₀)  Chlorophyll *a* (μg/L)

**Figure 10**



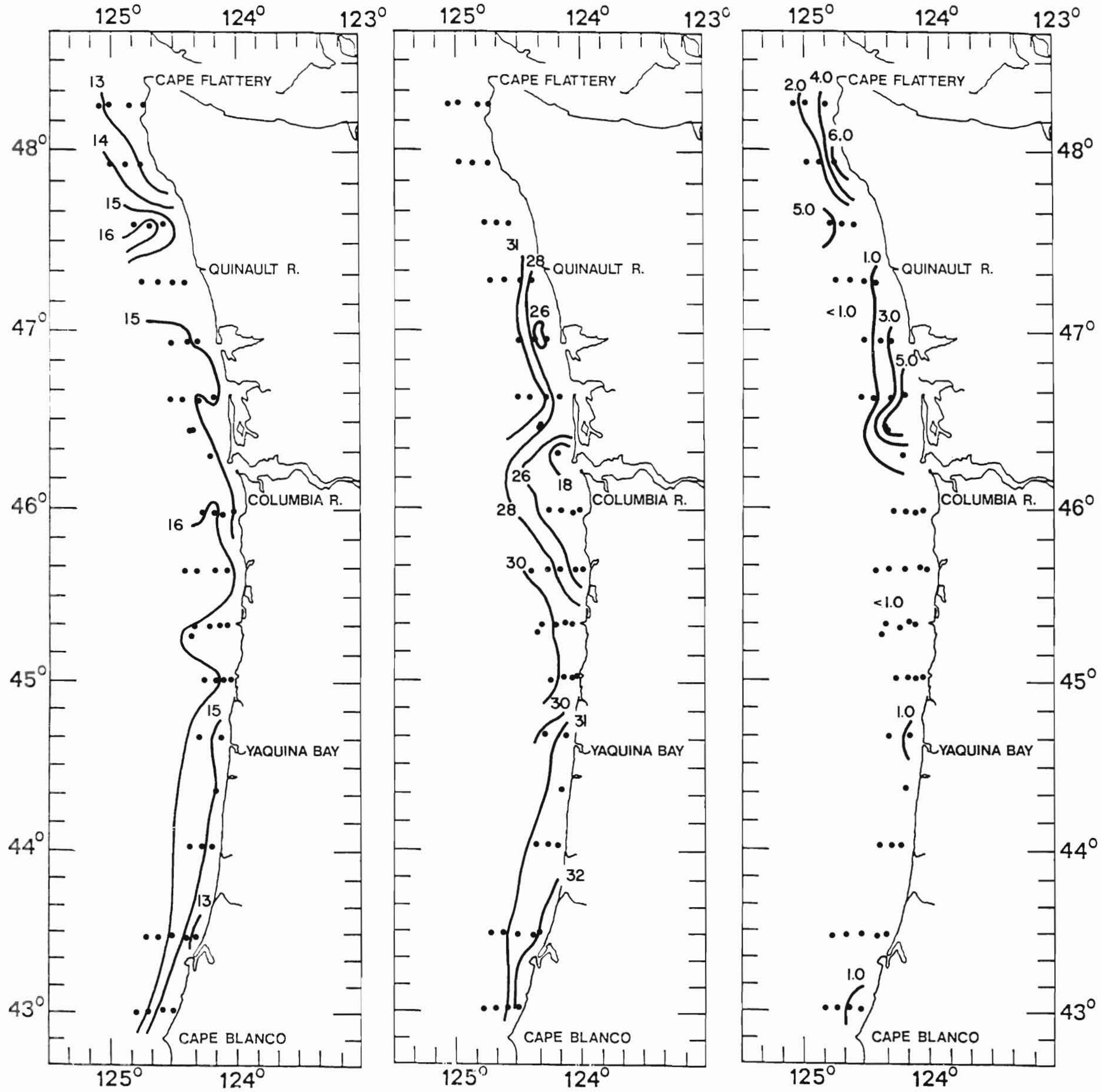
MAY 1983

Surface temperature (°C)

Salinity (‰)

Chlorophyll *a* (µg/L)

**Figure 11**



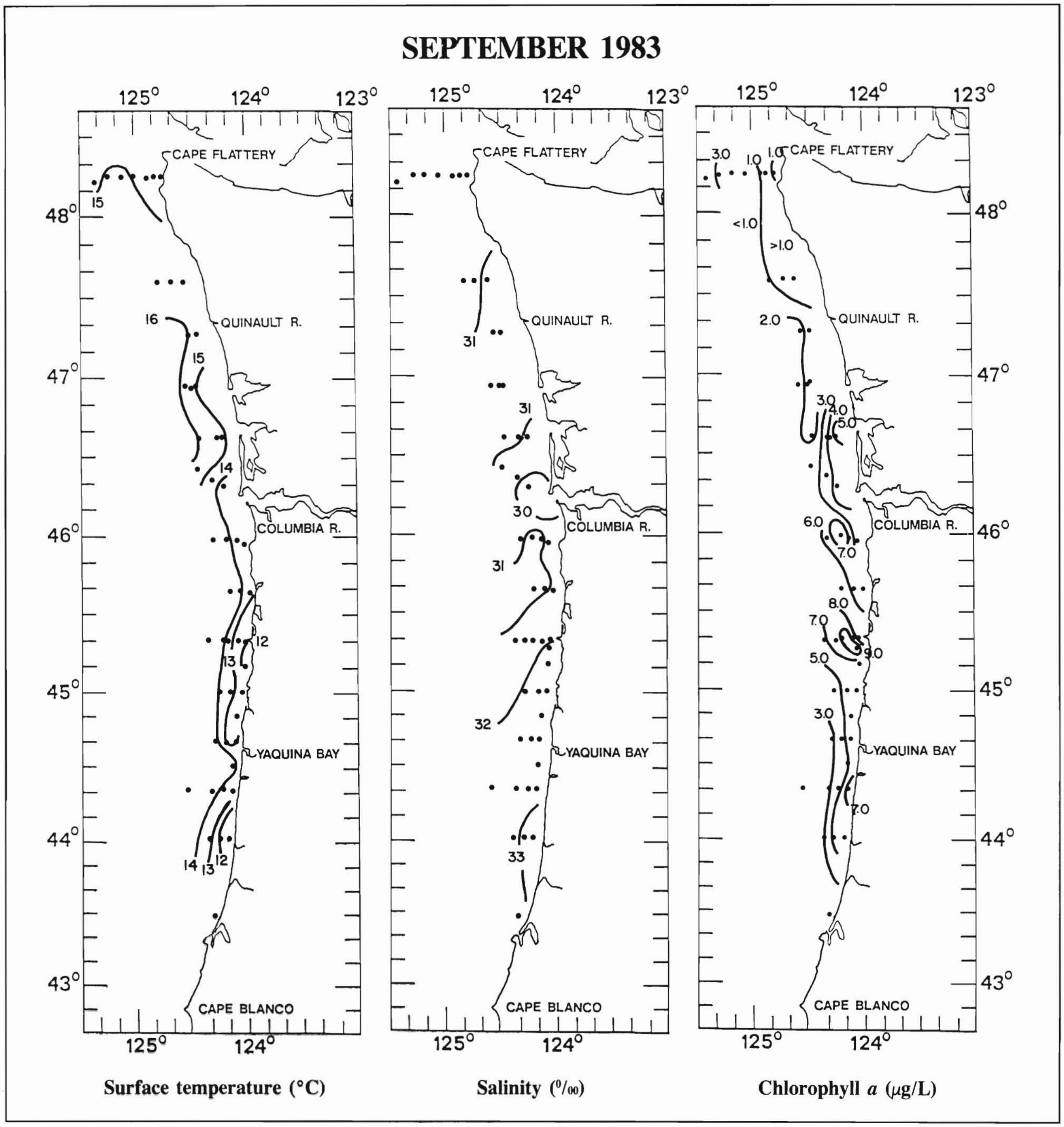
**JUNE 1983**

Surface temperature (°C)

Salinity (⁰/₀₀)

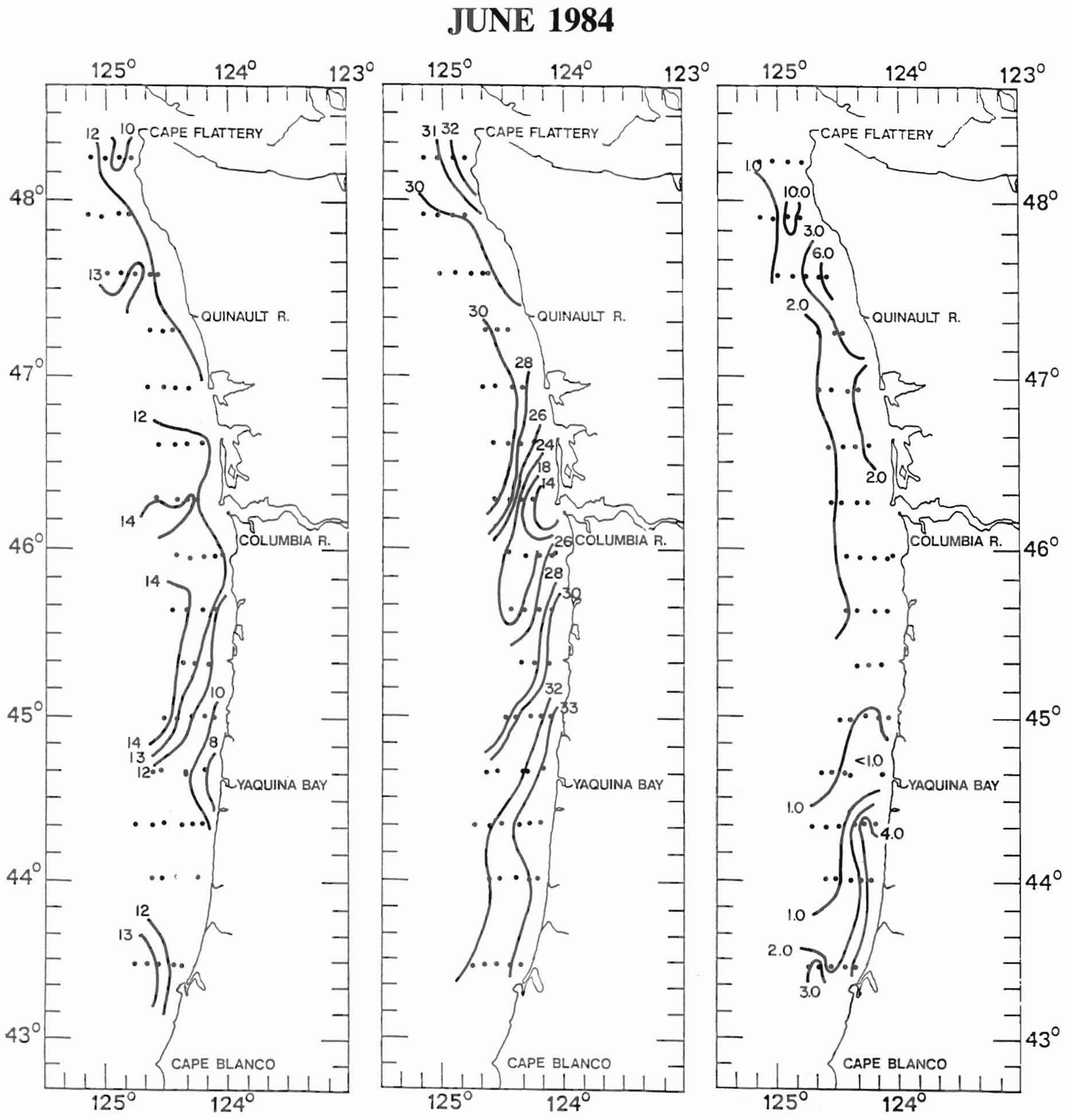
Chlorophyll *a* (μg/L)

**Figure 12**



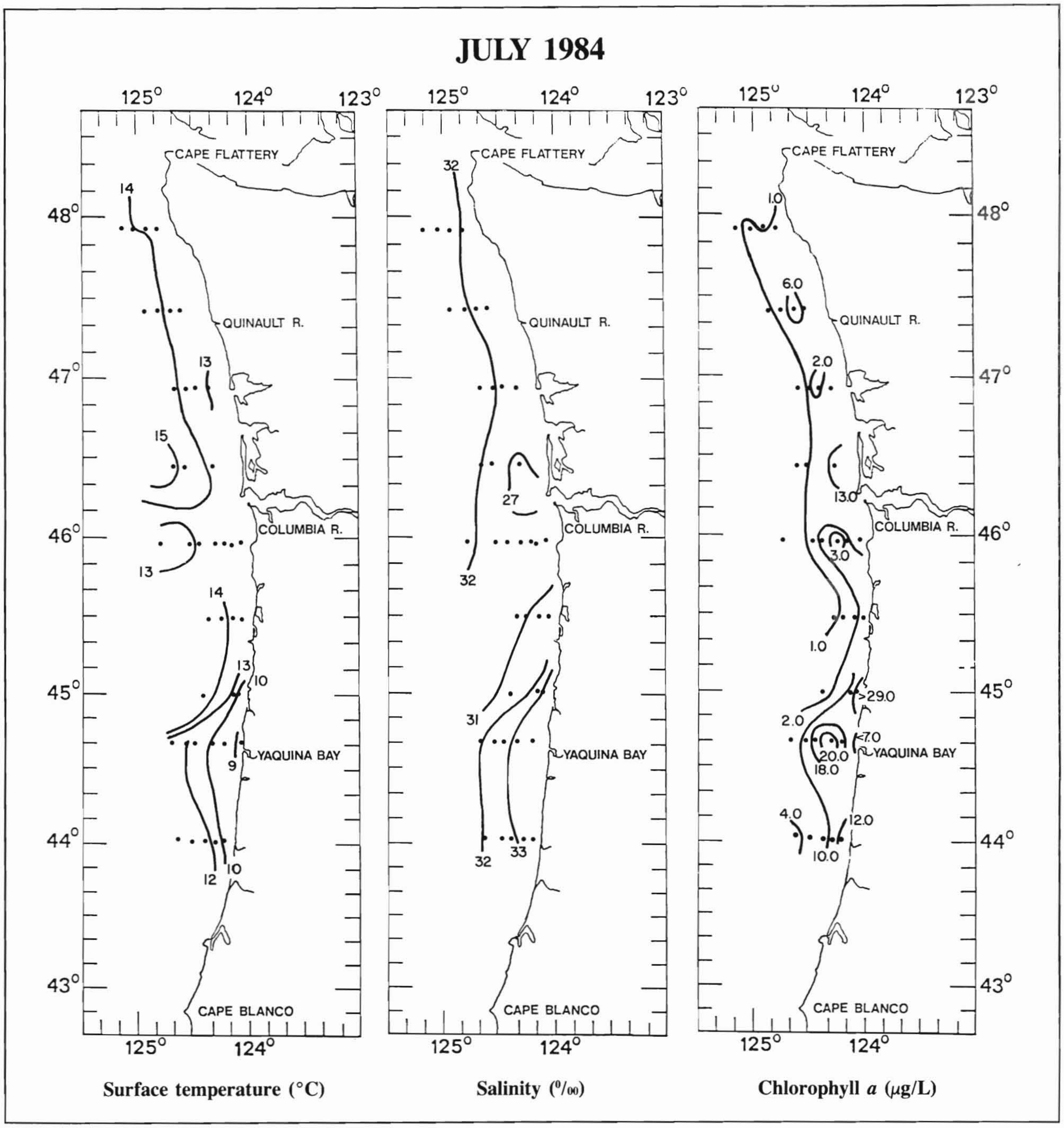
Surface temperature (°C) Salinity (⁰/₀₀) Chlorophyll *a* (μg/L)

**Figure 13**



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

**Figure 14**



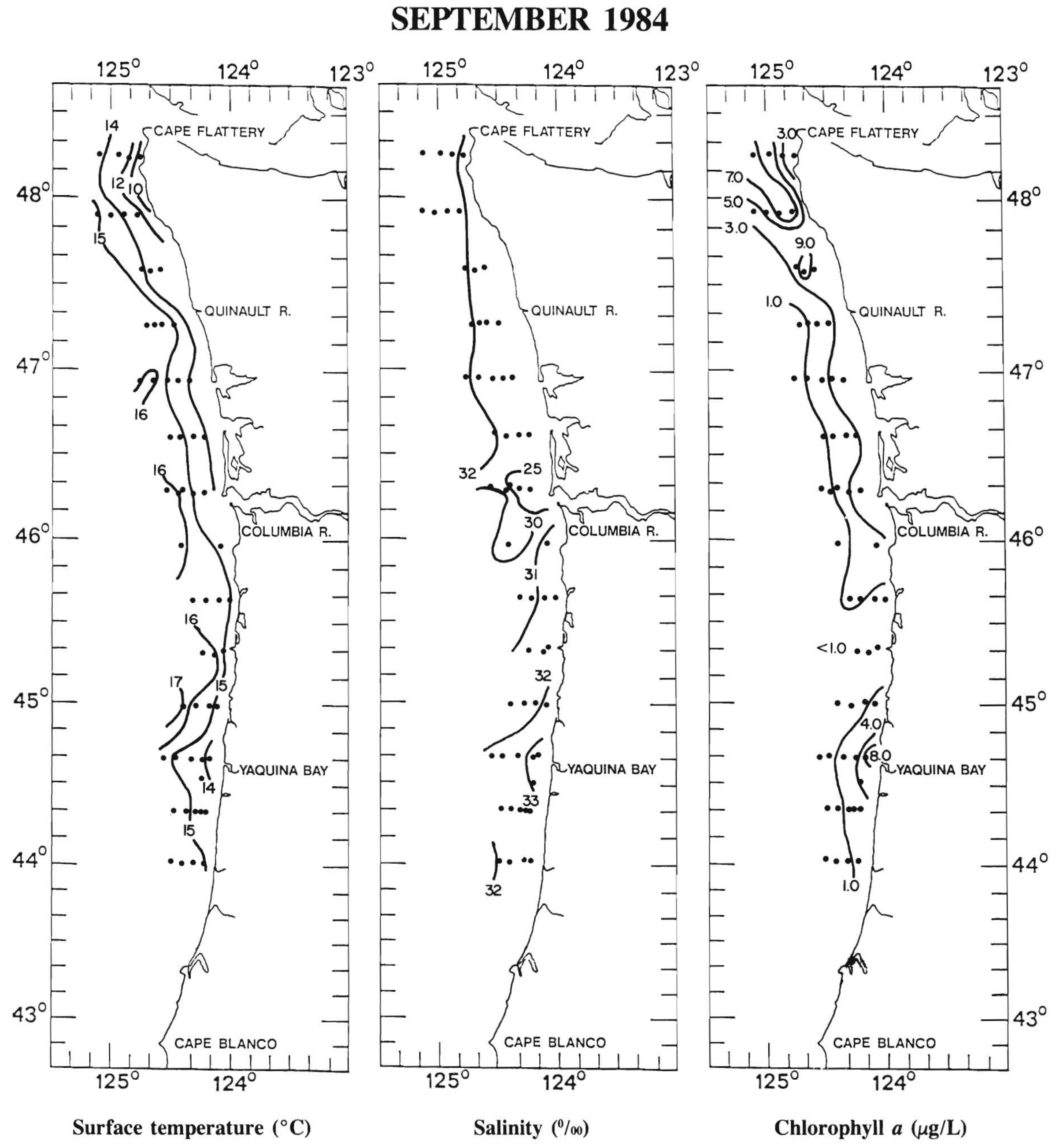
JULY 1984

Surface temperature (°C)

Salinity (⁰/₀₀)

Chlorophyll *a* (μg/L)

**Figure 15**


SEPTEMBER 1984

Surface temperature (°C)

Salinity (‰)

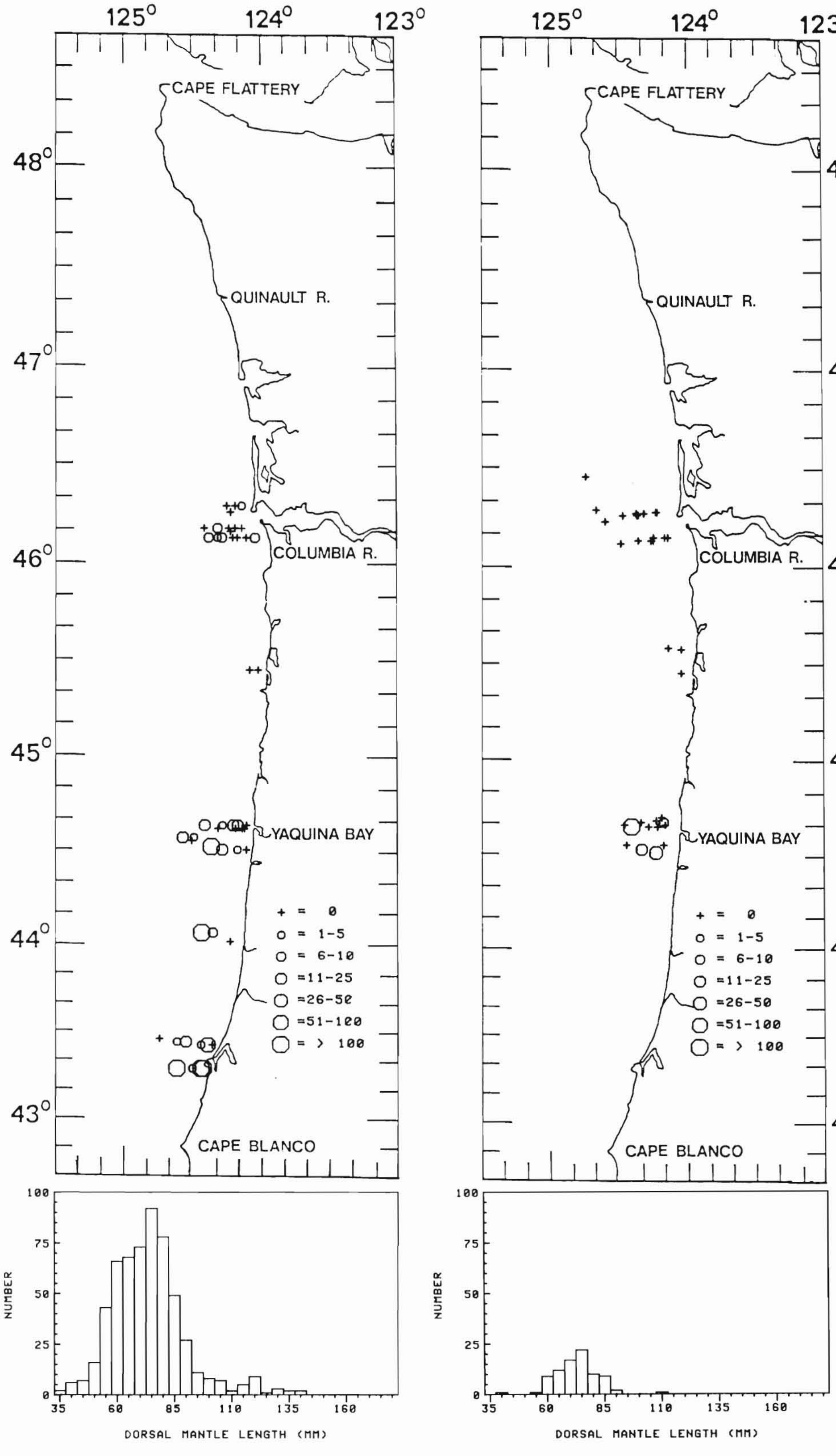
Chlorophyll *a* (μg/L)

Figure 16

# Figures 17 through 59

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

*Loligo opalescens*

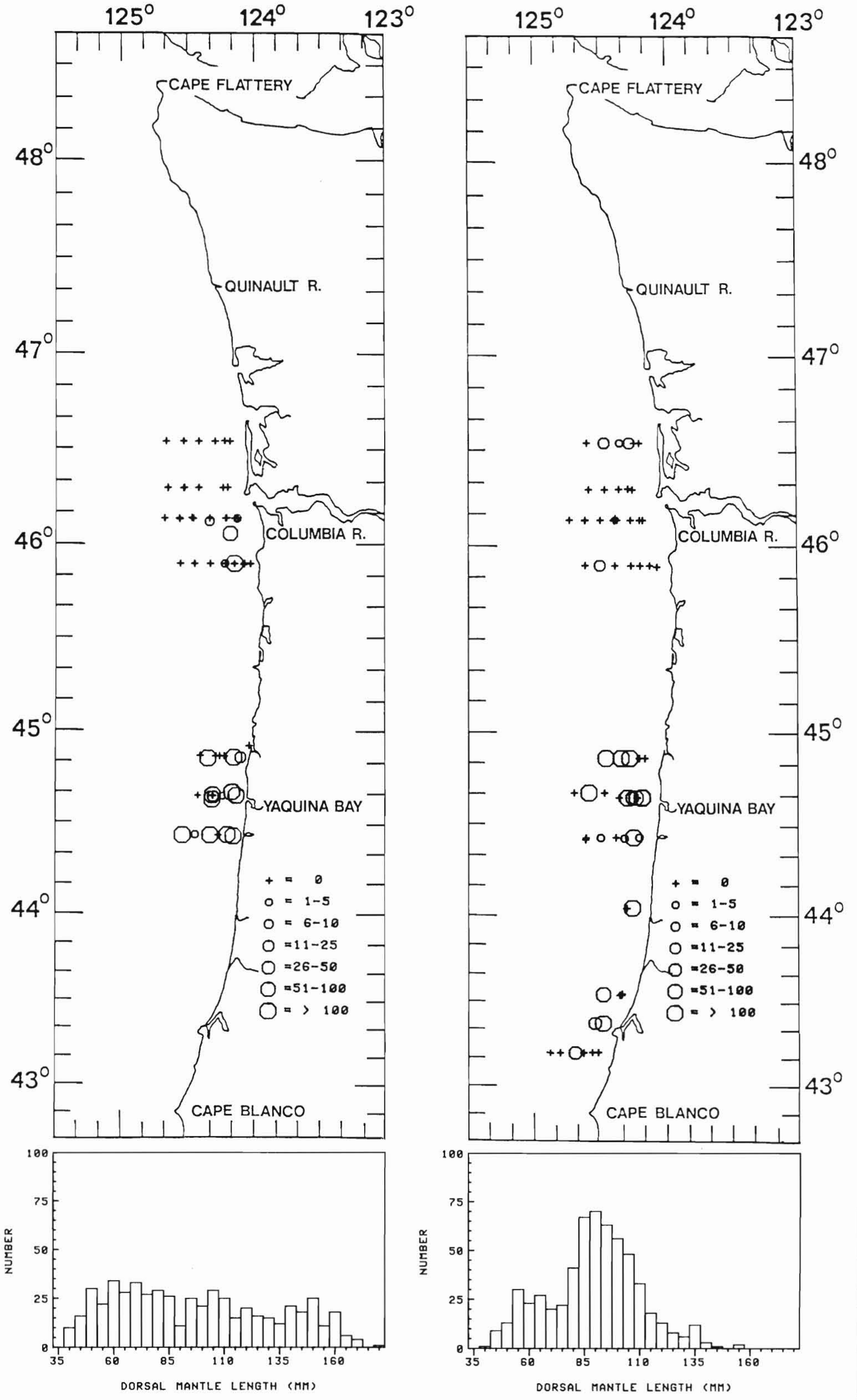


**June 1979**

**June 1980**

**Figure 17**

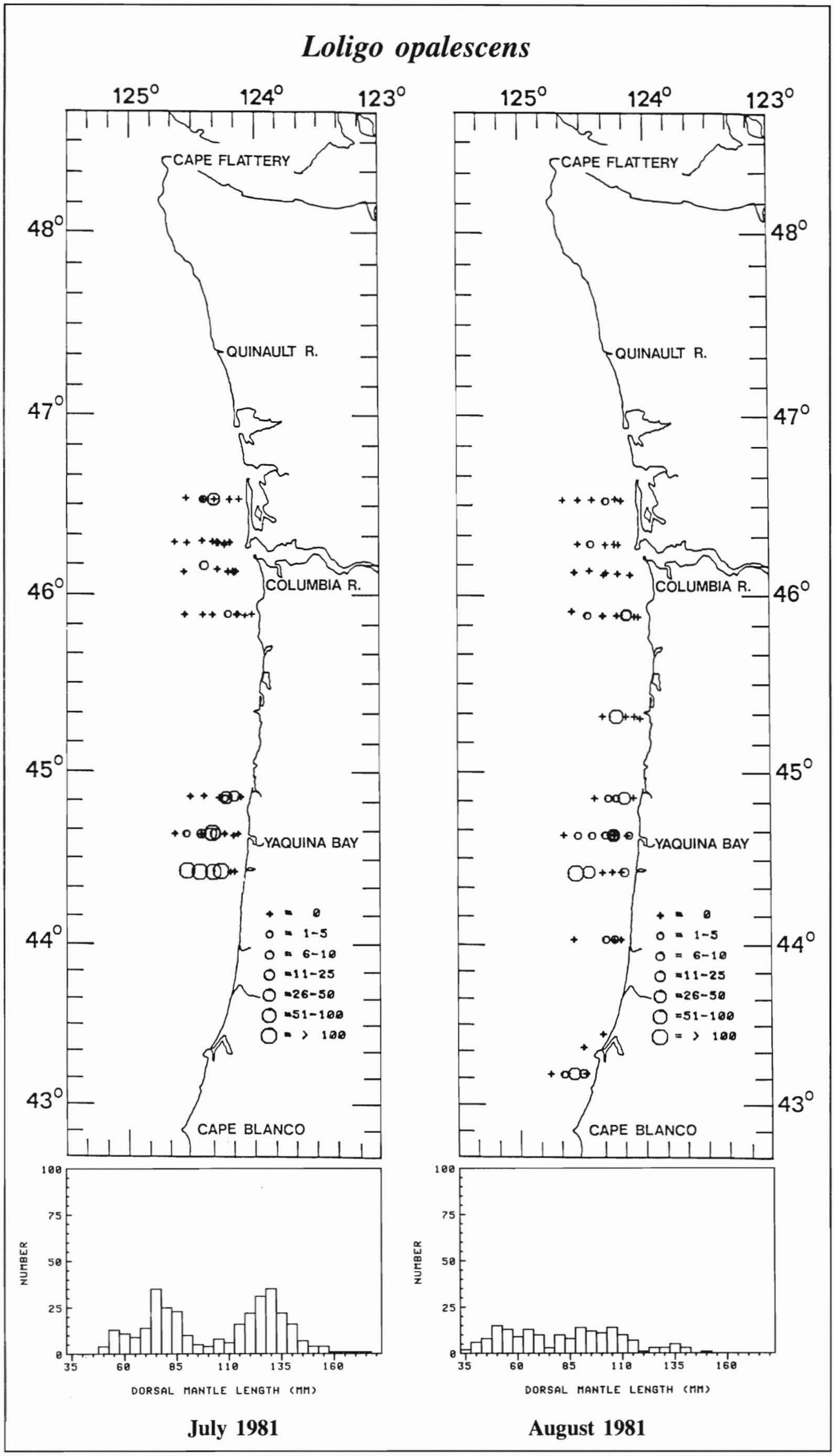
*Loligo opalescens*



**May 1981**

**June 1981**

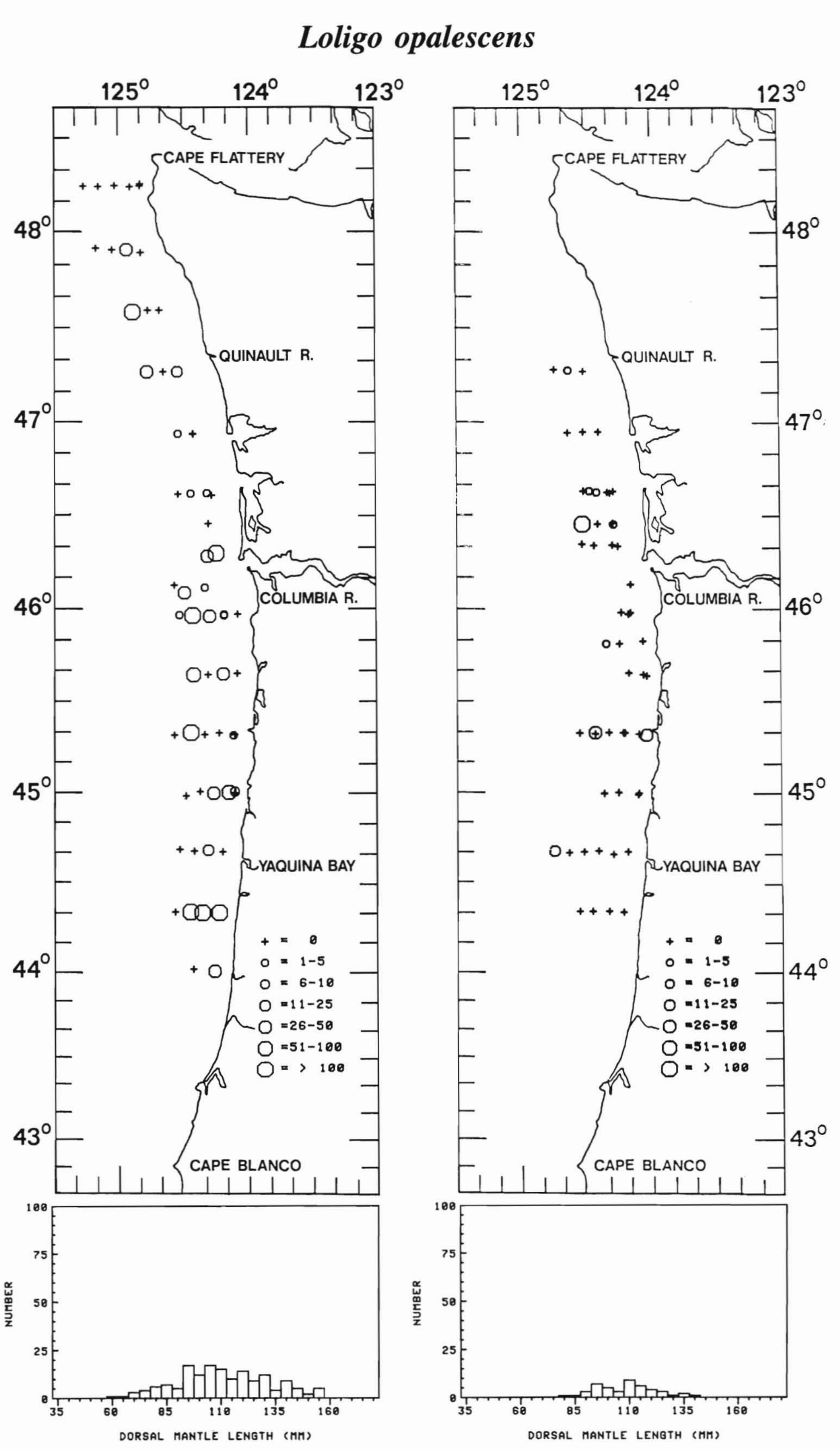
Figure 18



*Loligo opalescens*

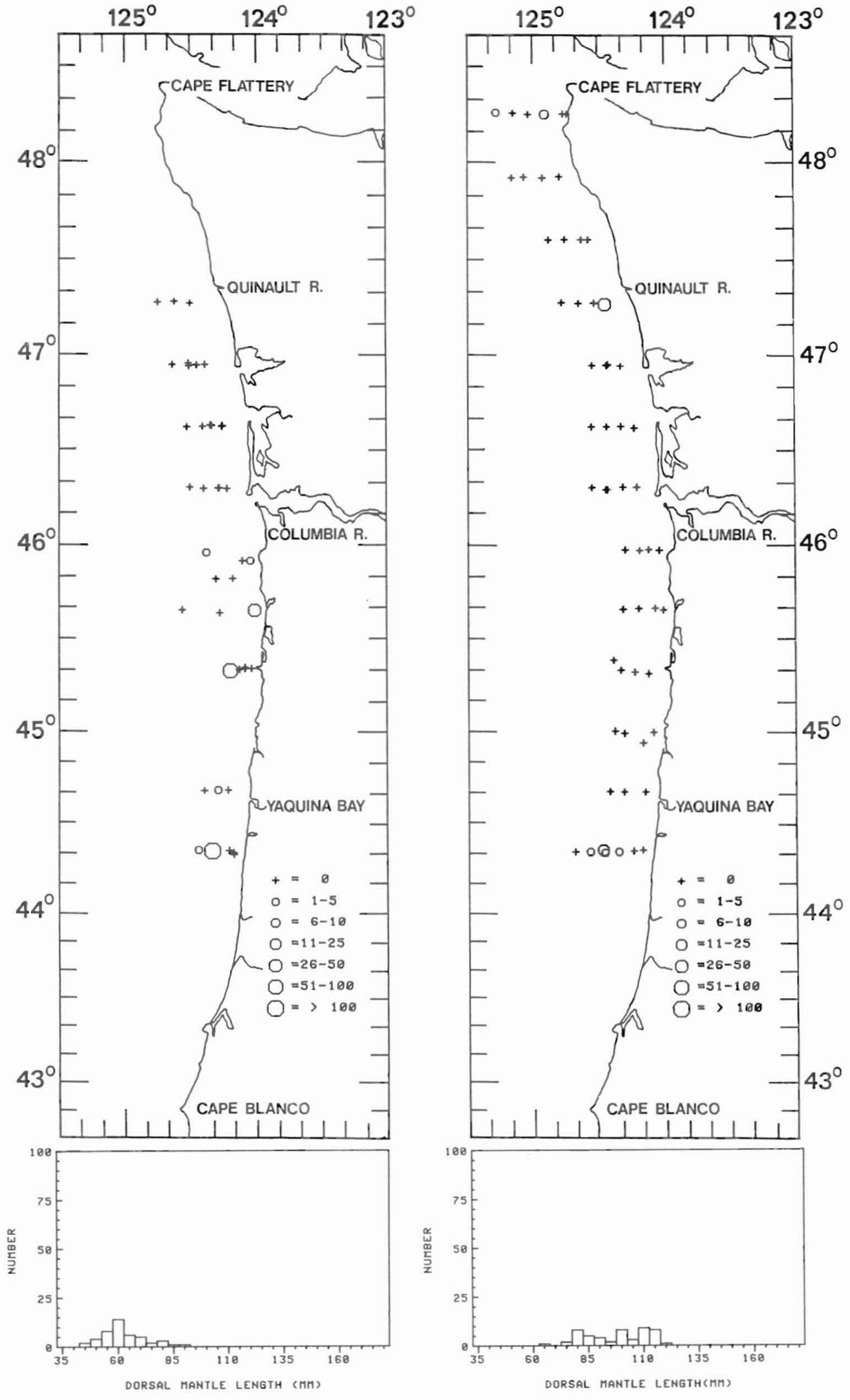
**July 1981** **August 1981**

**Figure 19**



**May 1982** **June 1982**

**Figure 20**



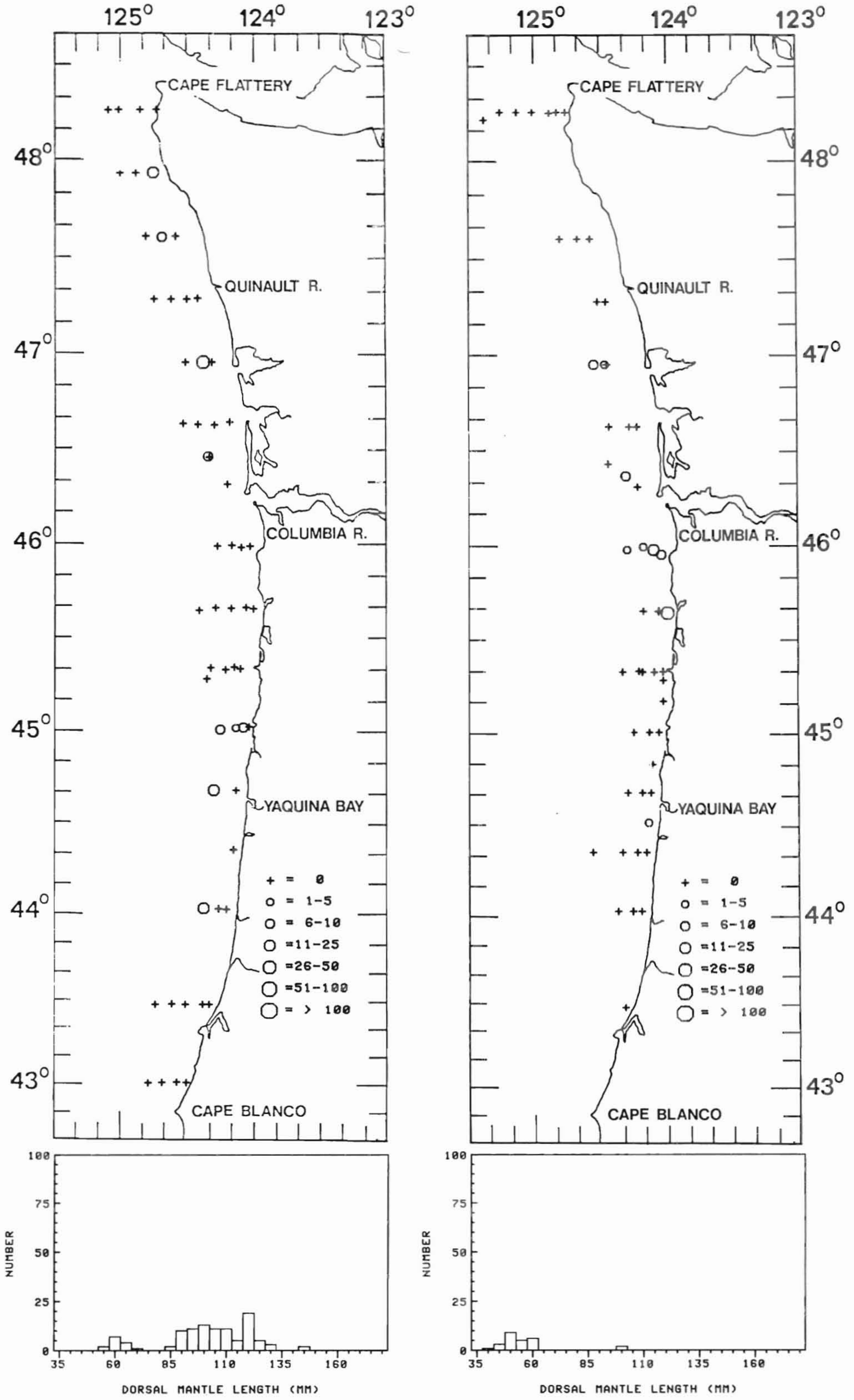
*Loligo opalescens*

September 1982

May 1983

Figure 21

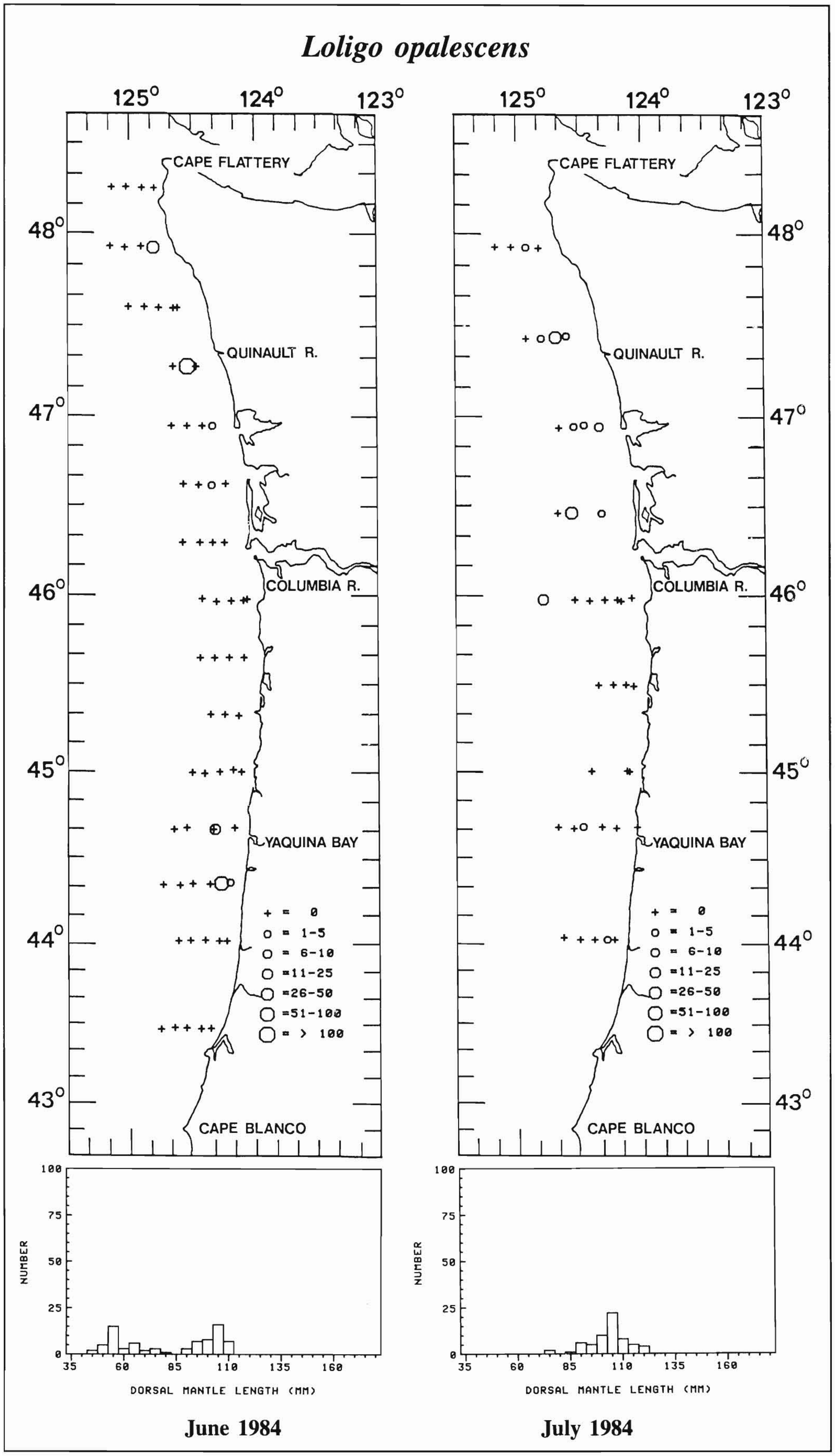
*Loligo opalescens*



**June 1983**

**September 1983**

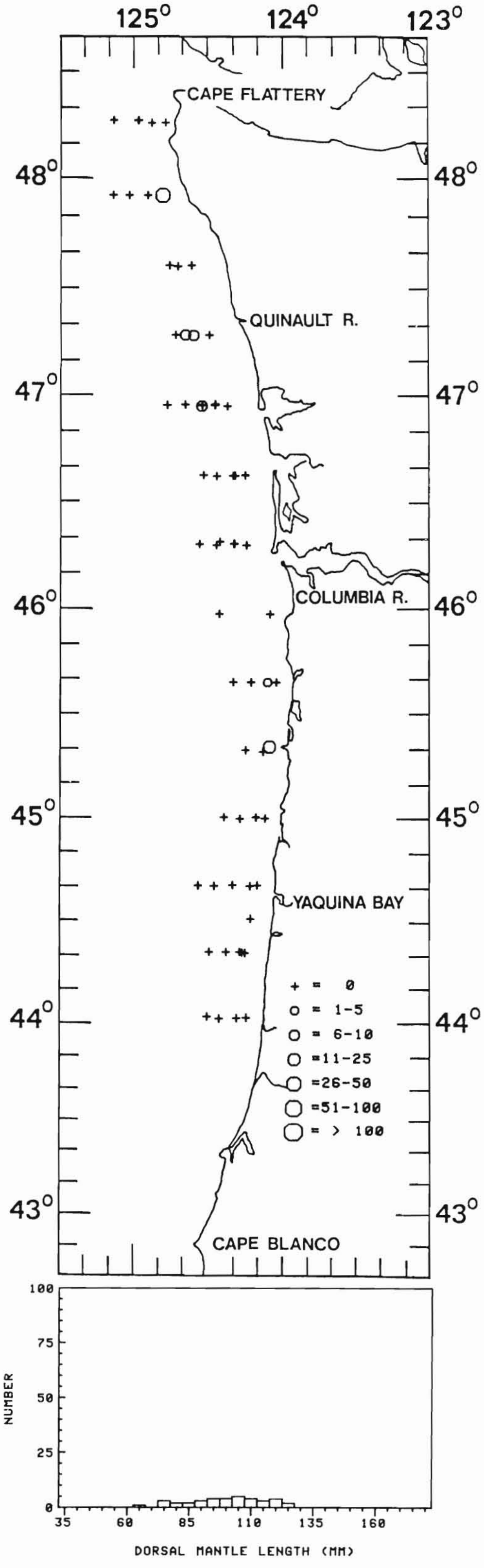
Figure 22



June 1984

July 1984

Figure 23

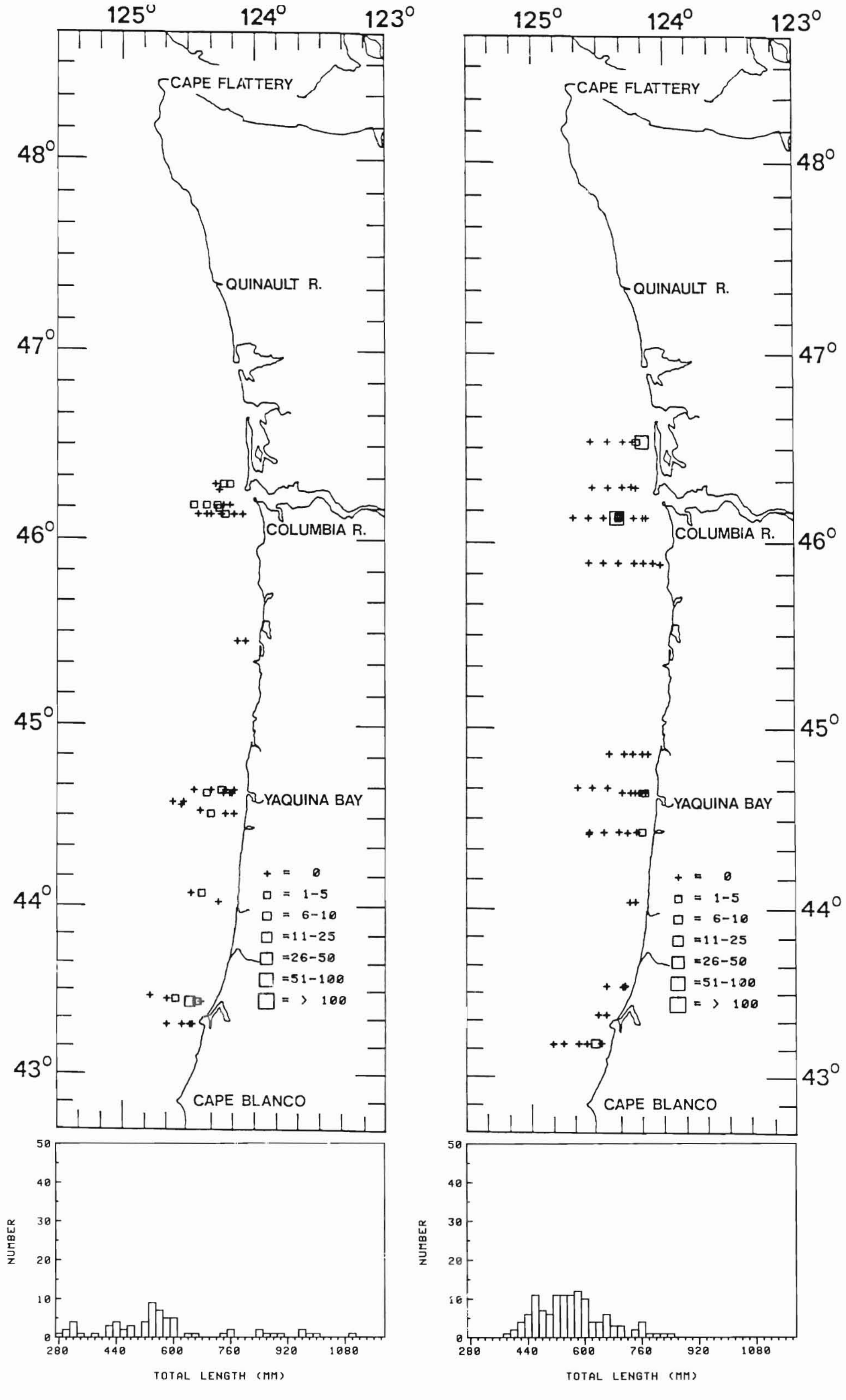


*Loligo opalescens*

**September 1984**

**Figure 24**

*Squalus acanthias*

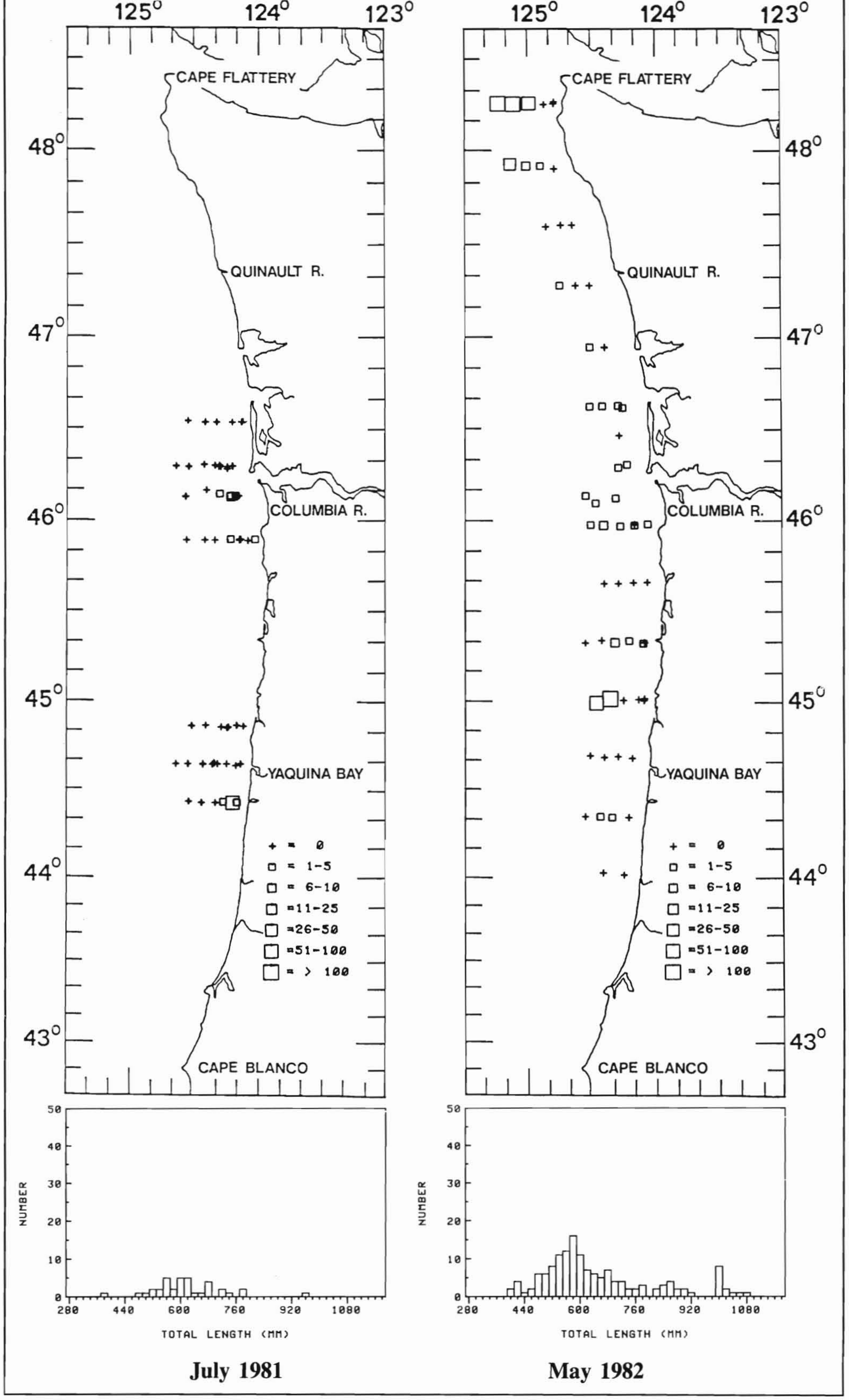


**June 1979**

**June 1981**

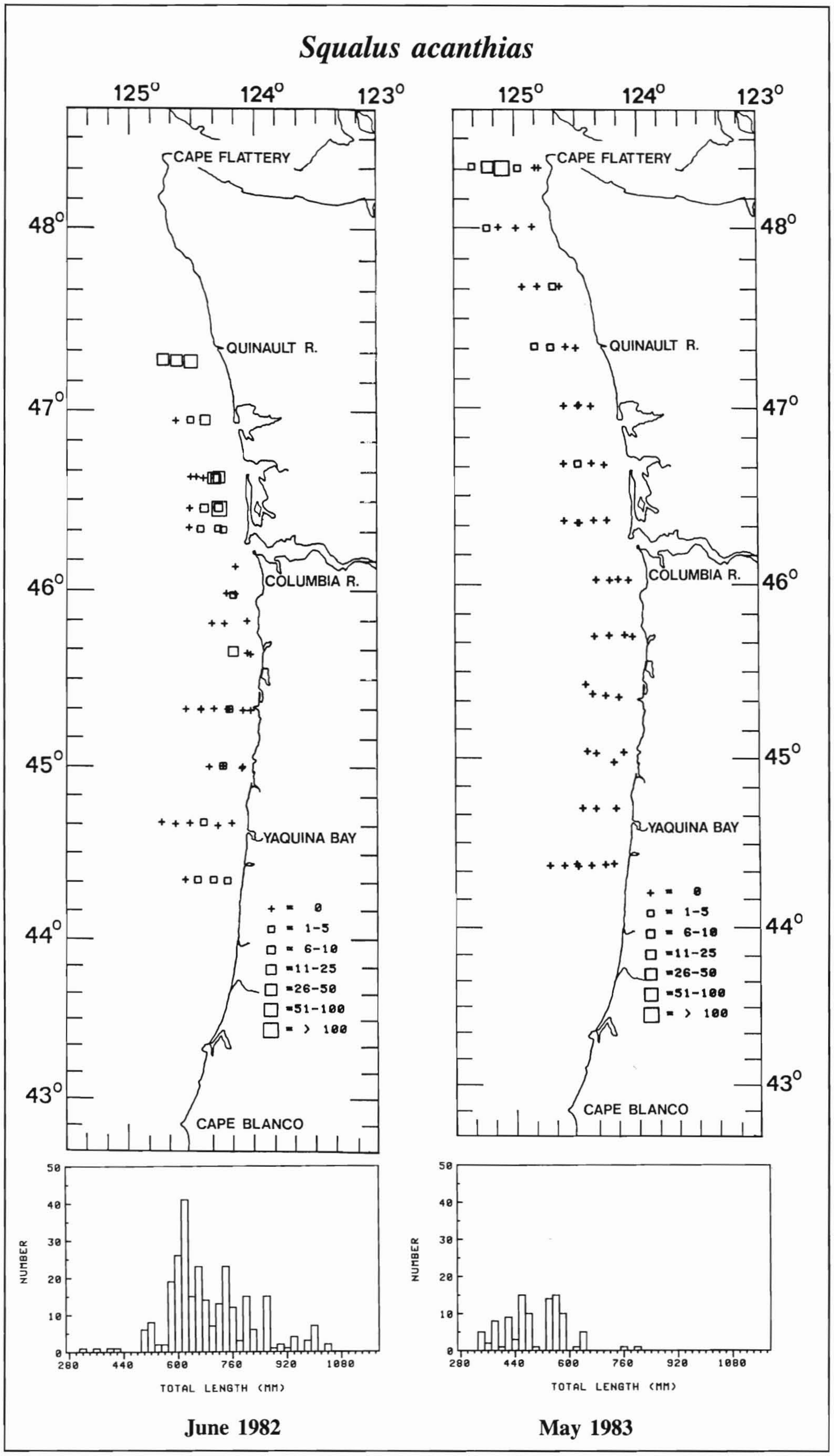
Figure 25

# *Squalus acanthias*



**July 1981** **May 1982**

## Figure 26



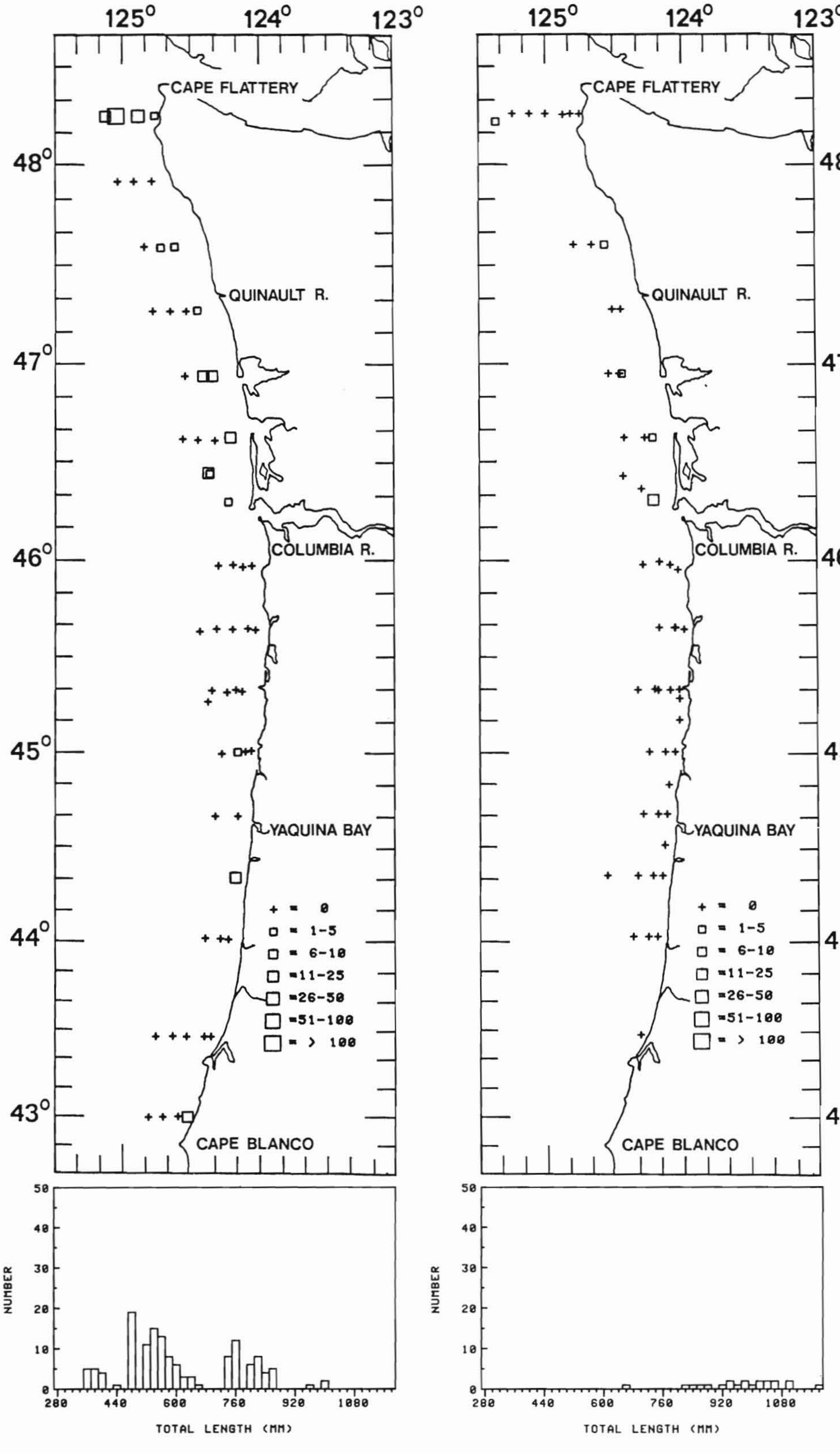
*Squalus acanthias*

June 1982

May 1983

**Figure 27**

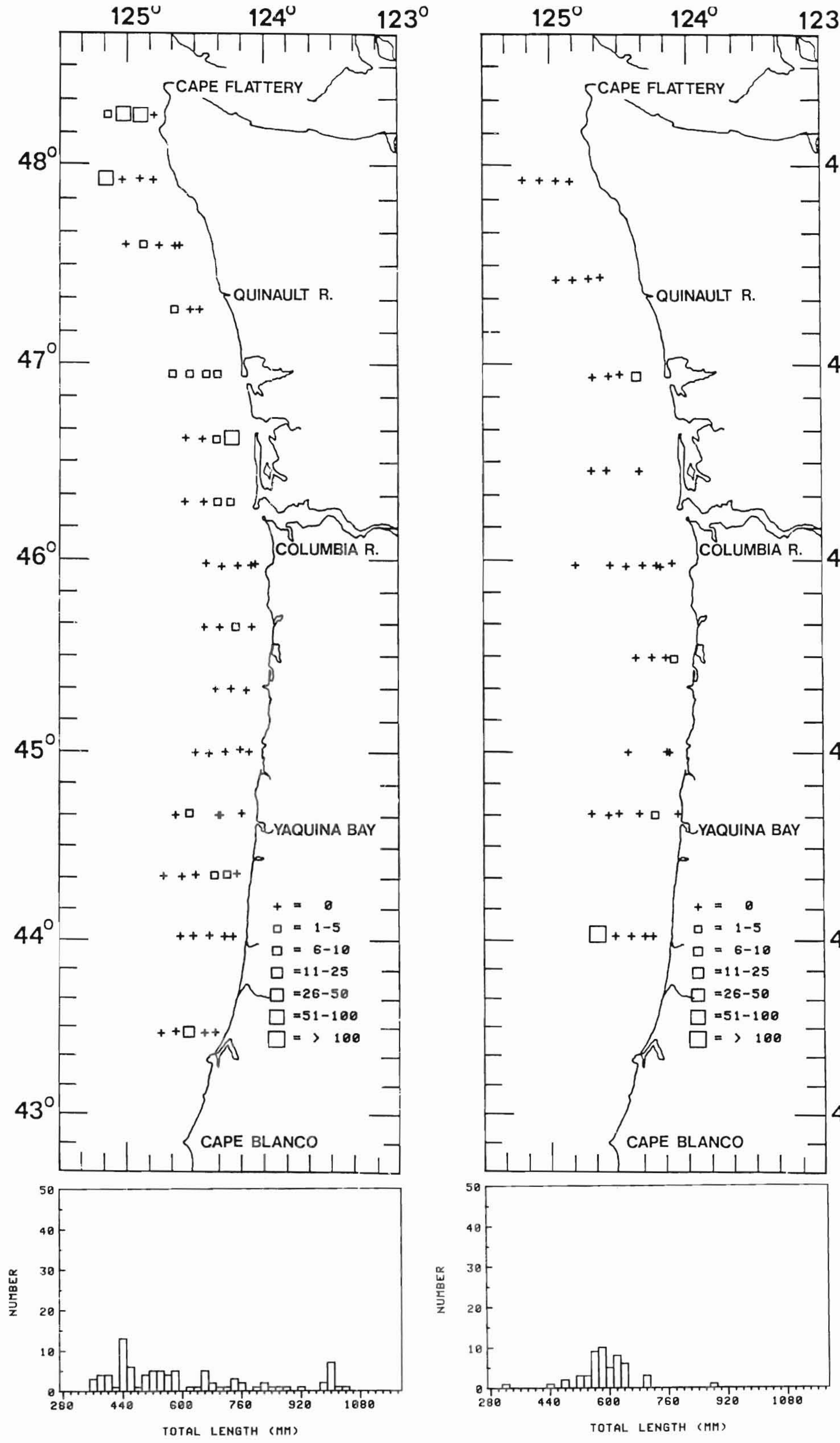
*Squalus acanthias*



**June 1983** **September 1983**

**Figure 28**

*Squalus acanthias*

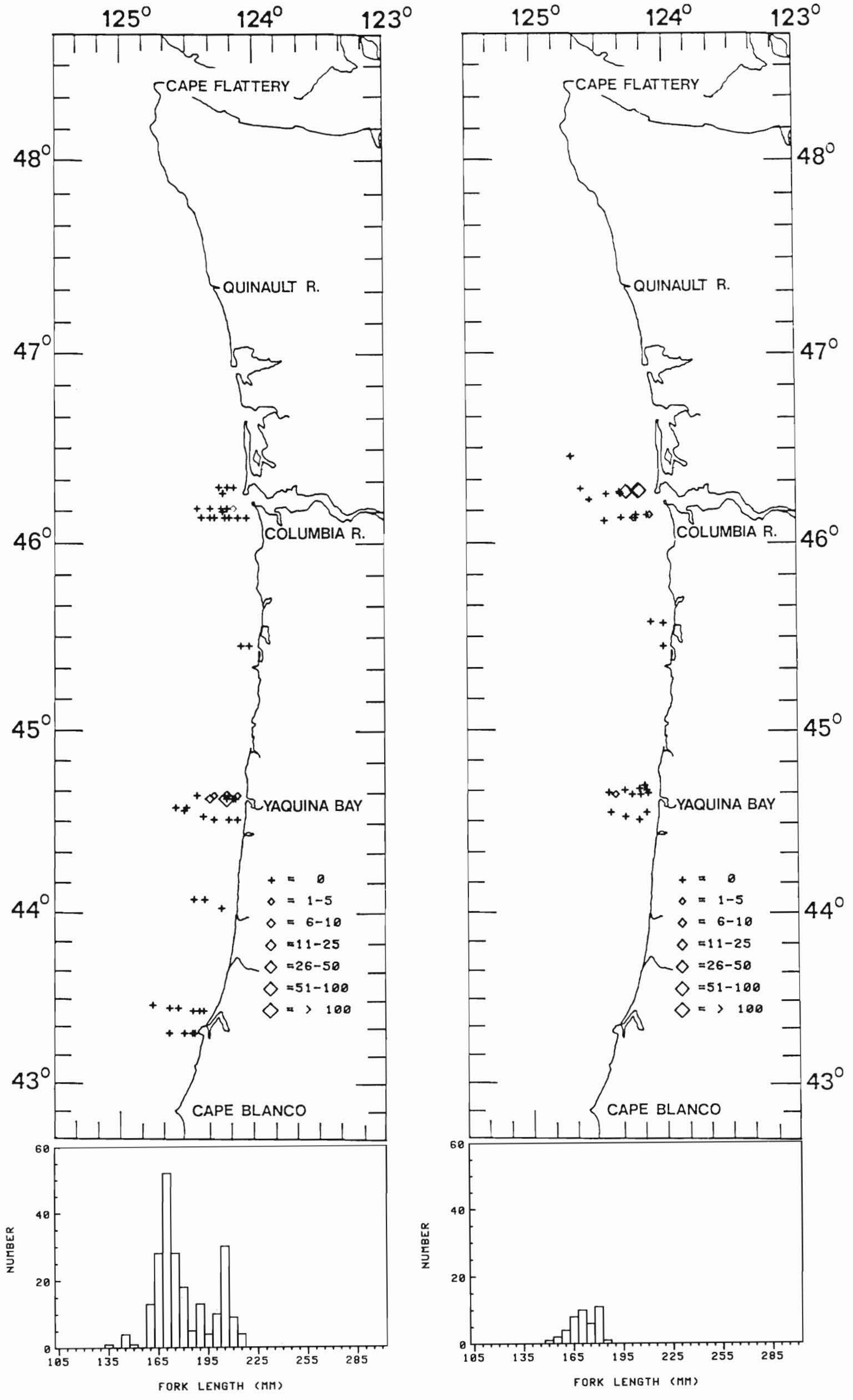


**June 1984**

**July 1984**

**Figure 29**

*Clupea harengus pallasi*

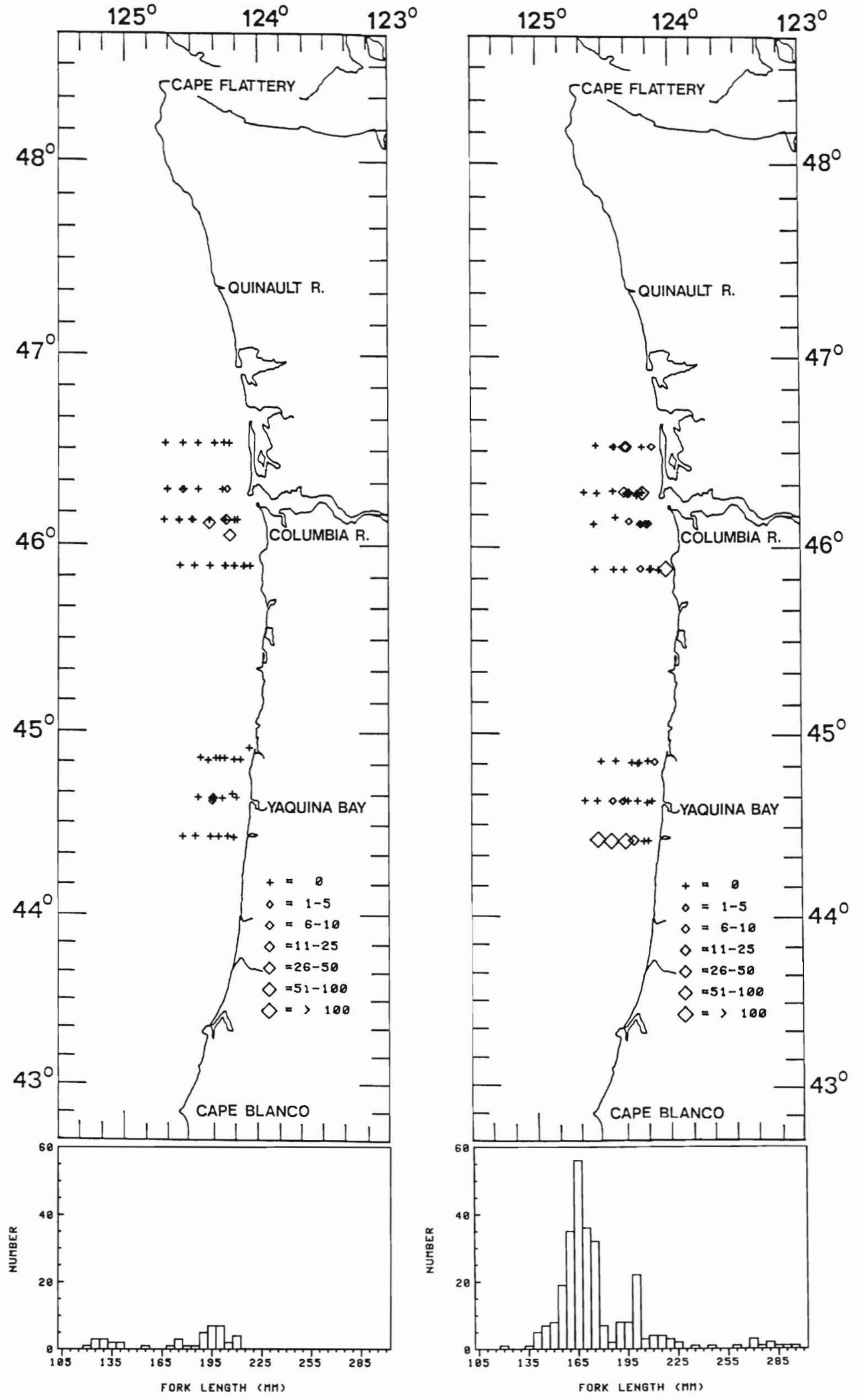


**June 1979**

**June 1980**

Figure 30

*Clupea harengus pallasi*



May 1981 July 1981

Figure 31

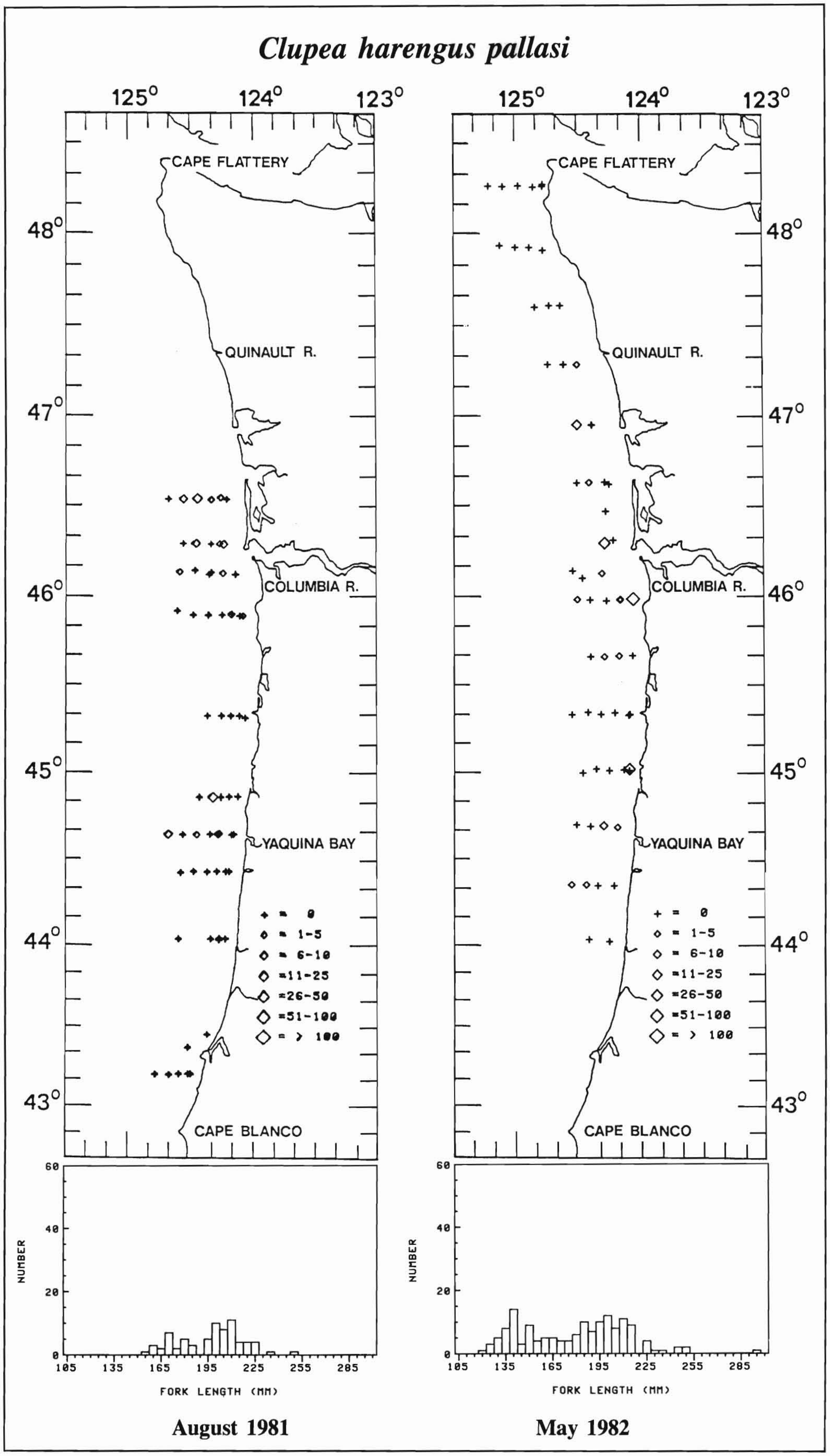
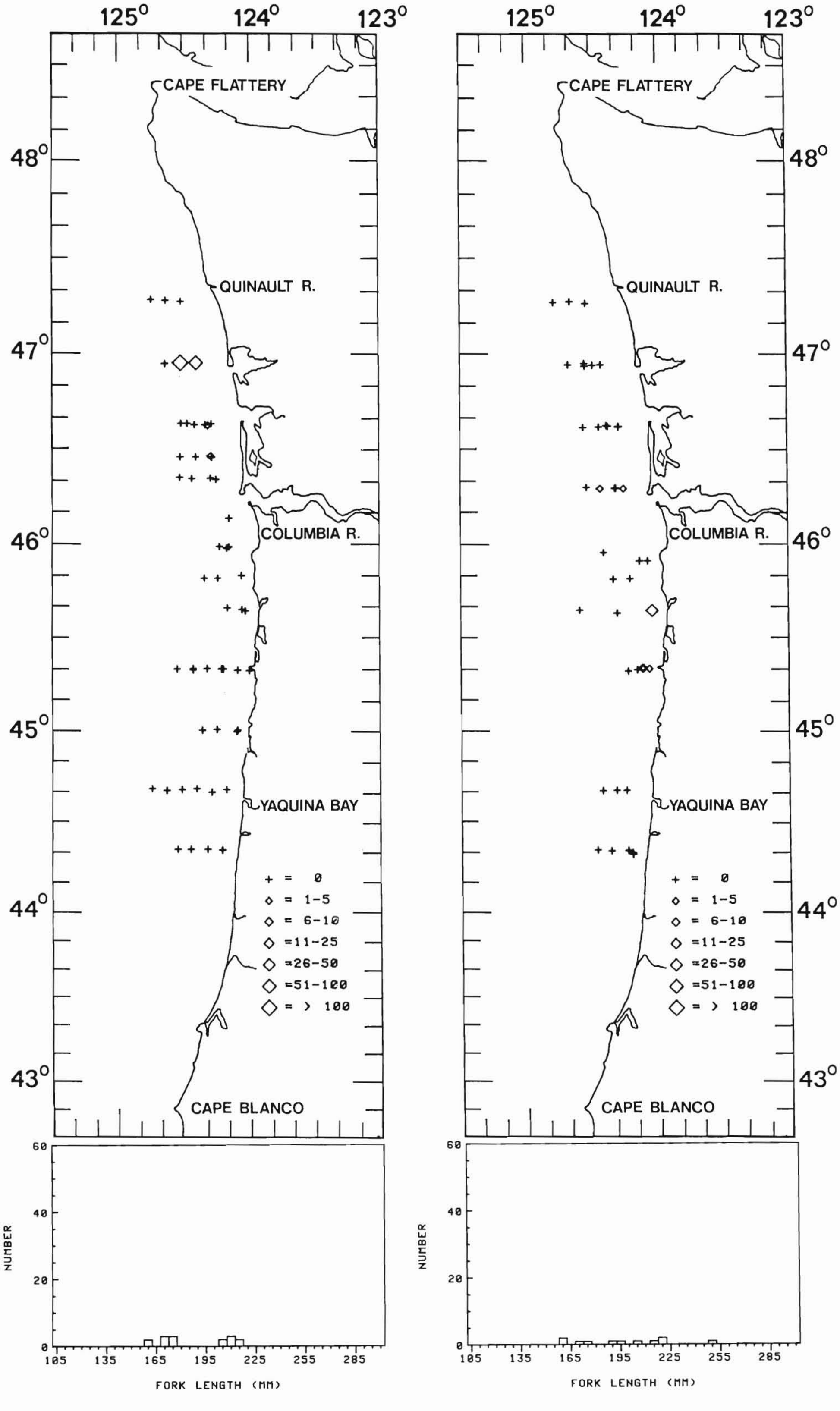

*Clupea harengus pallasi*
125°
124°
123°
48°
47°
46°
45°
44°
43°
CAPE FLATTERY
QUINAULT R.
COLUMBIA R.
YAQUINA BAY
CAPE BLANCO
+ = 0
◇ = 1-5
◇ = 6-10
◇ =11-25
◇ =26-50
◇ =51-100
◇ = > 100
60
40
20
0
NUMBER
105
135
165
195
225
255
285
FORK LENGTH (MM)
August 1981
May 1982

**Figure 32**

## *Clupea harengus pallasi*

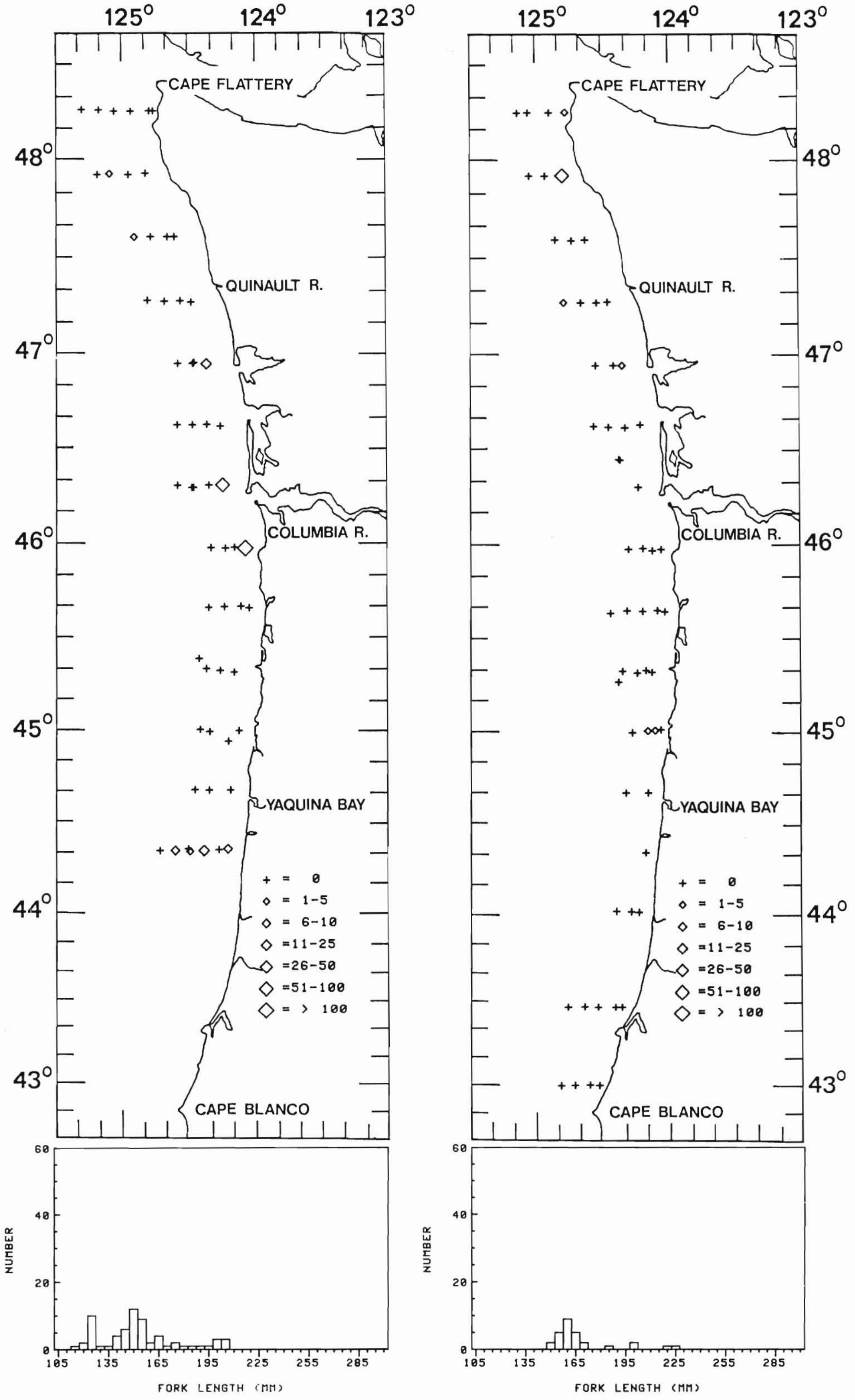


June 1982

September 1982

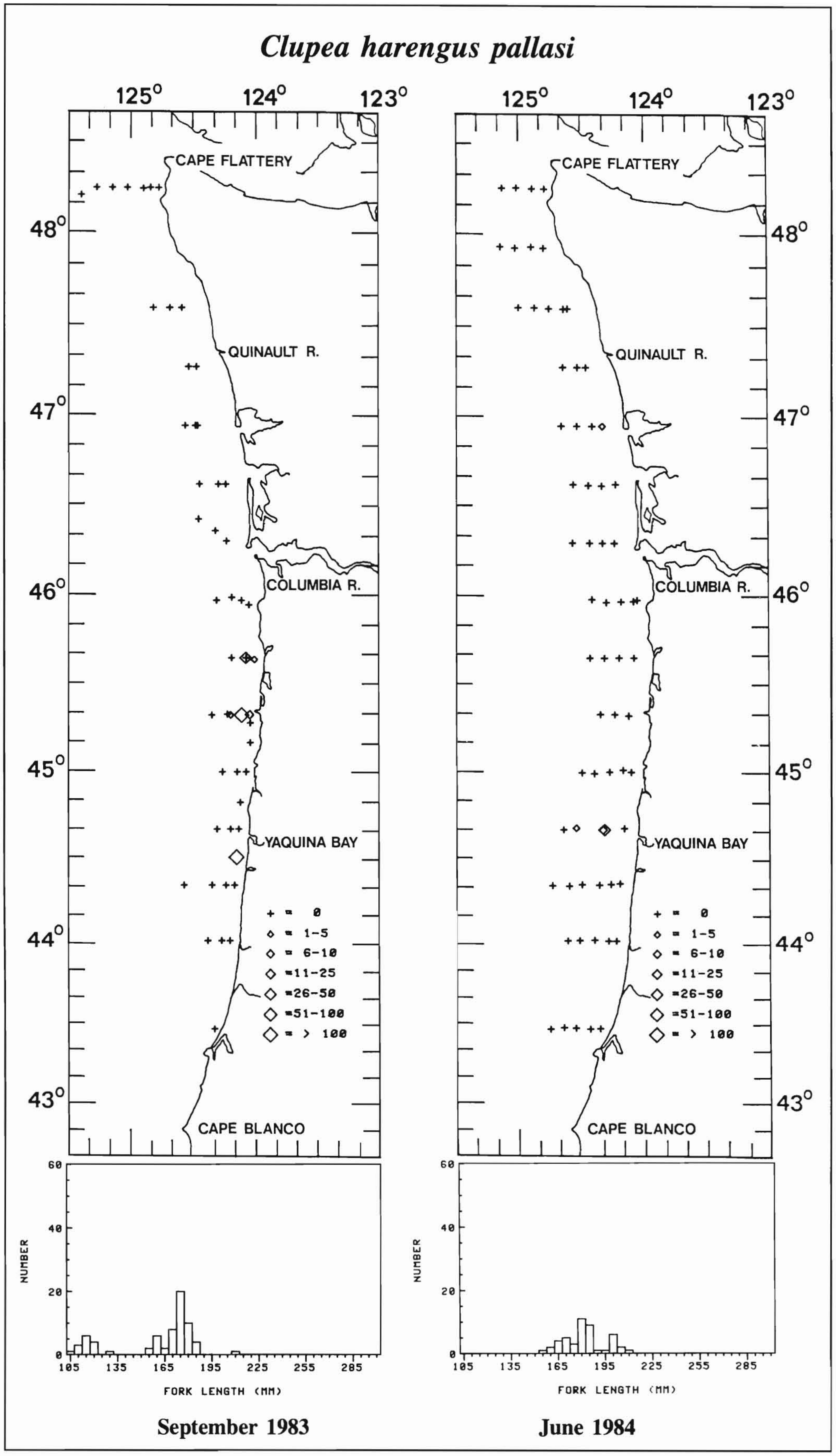
**Figure 33**

*Clupea harengus pallasi*



**May 1983** **June 1983**

Figure 34



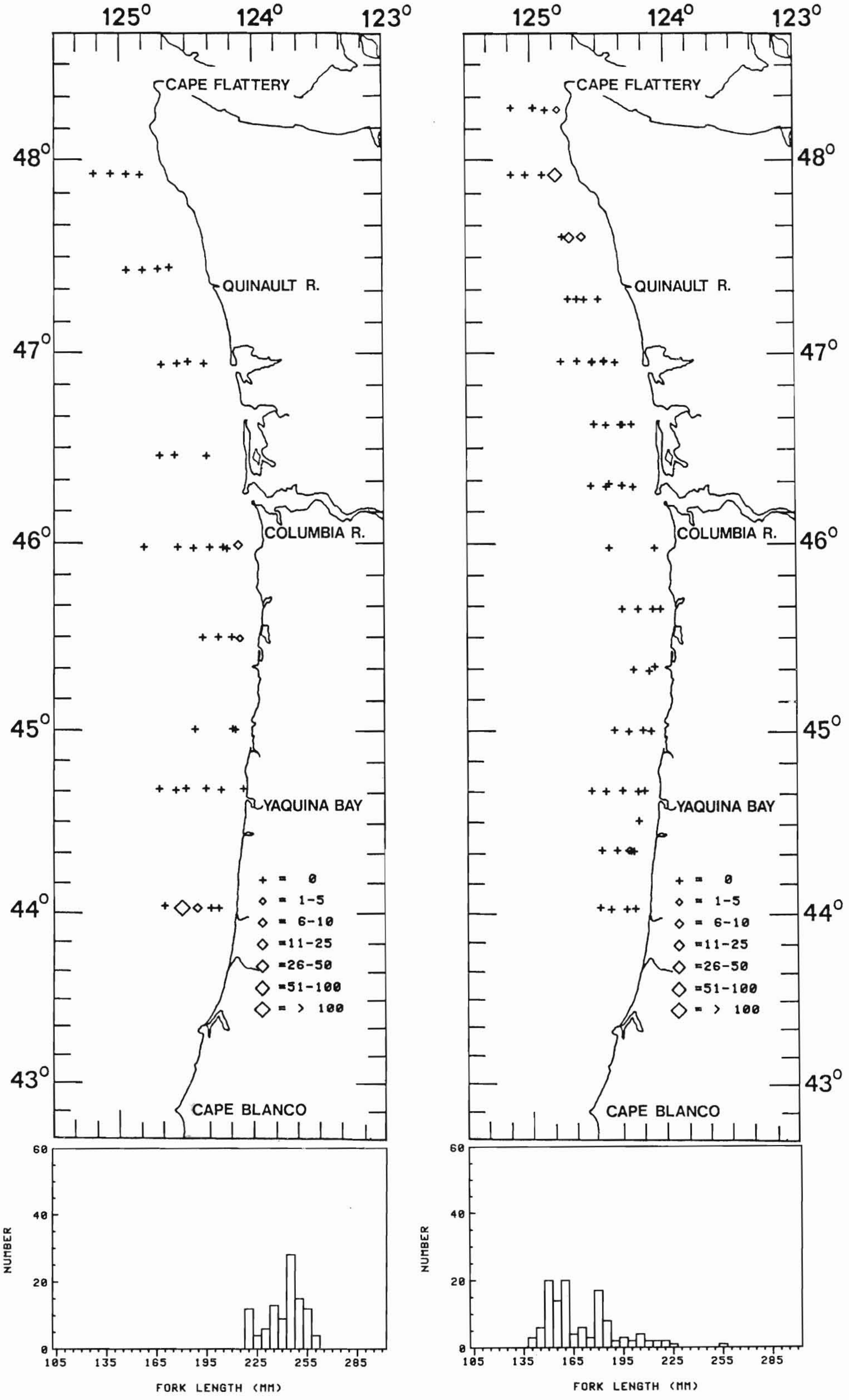
*Clupea harengus pallasi*

September 1983

June 1984

Figure 35

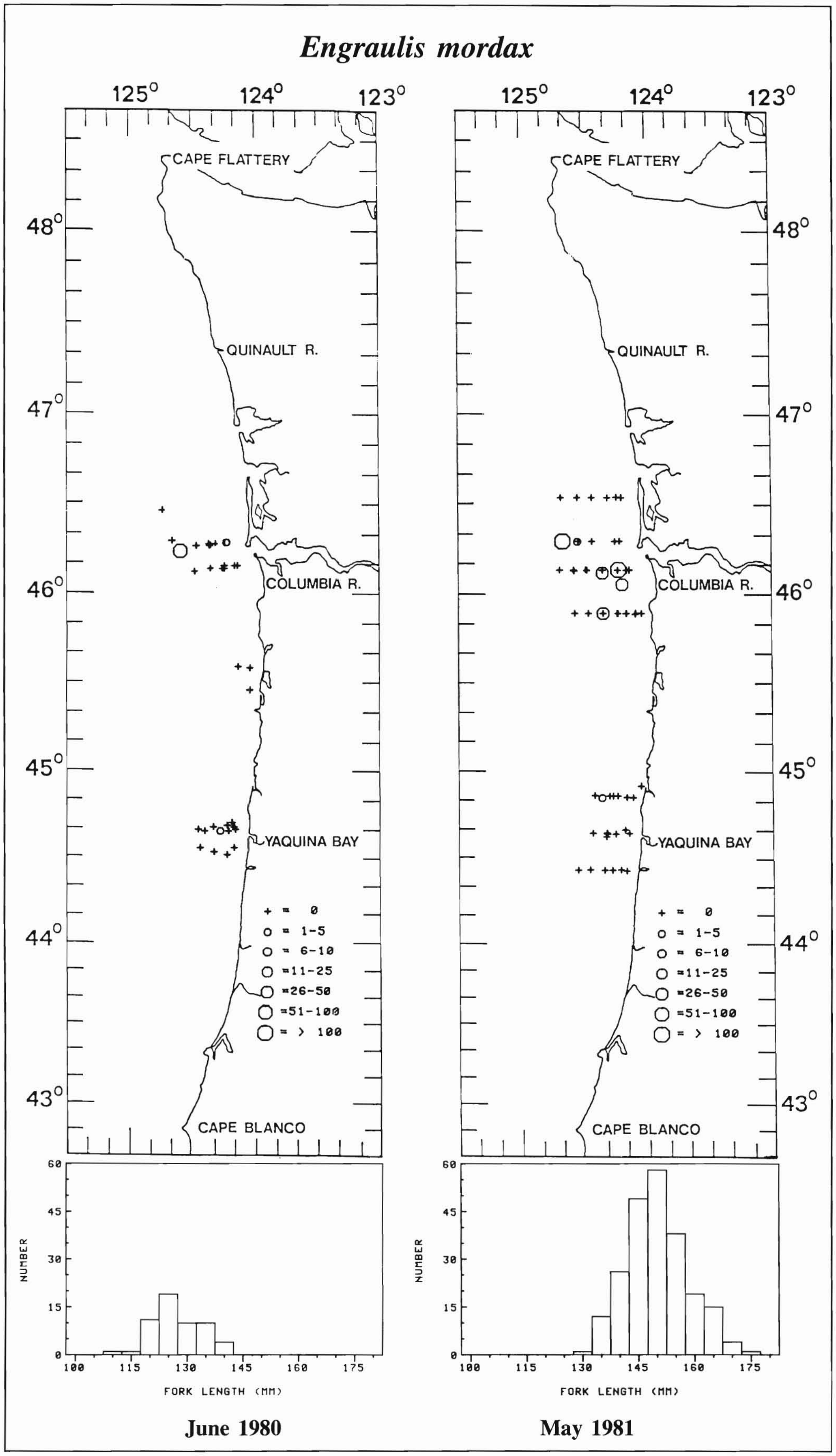
*Clupea harengus pallasi*



**July 1984** **September 1984**

Figure 36

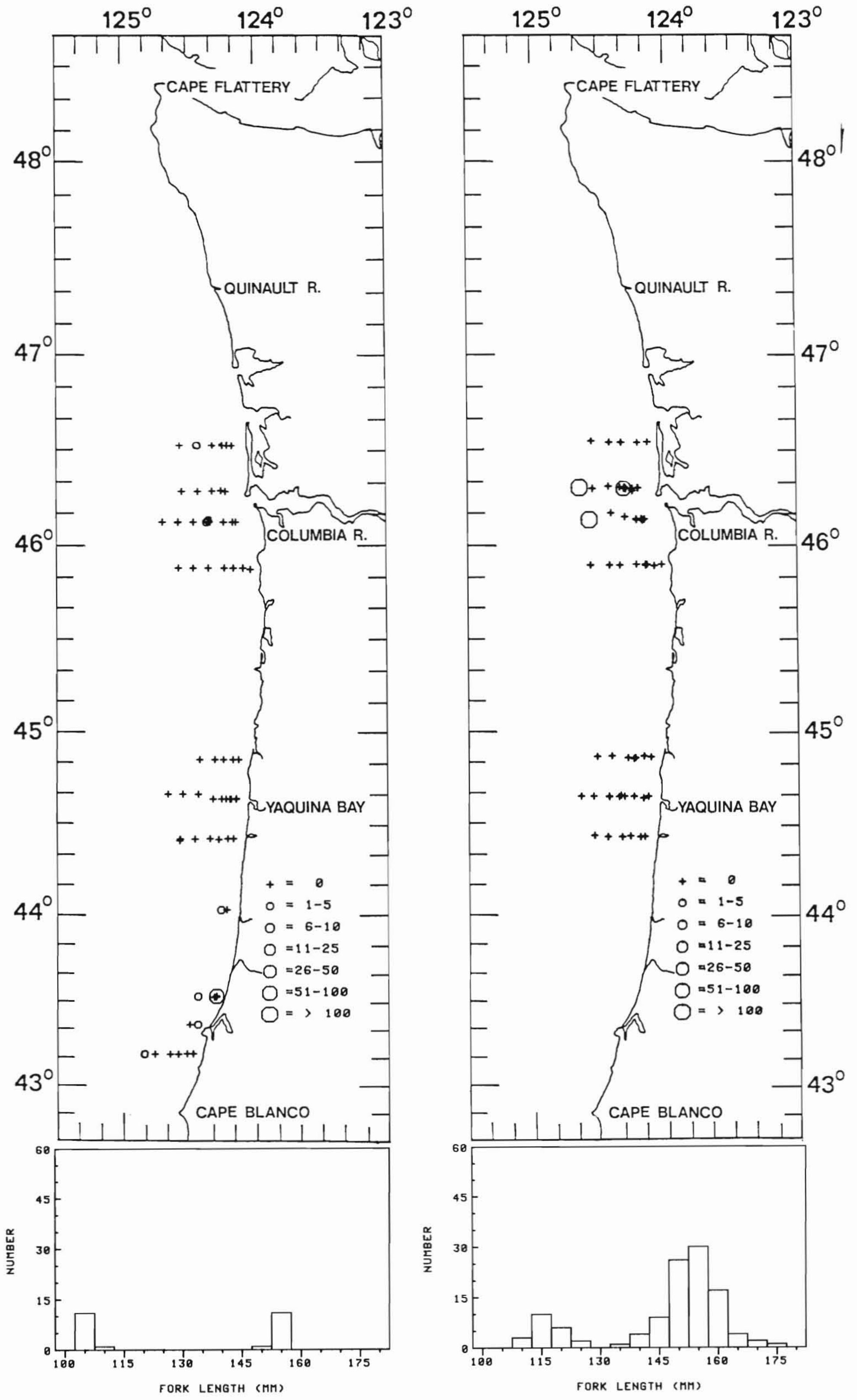
*Engraulis mordax*



June 1980

May 1981

**Figure 37**

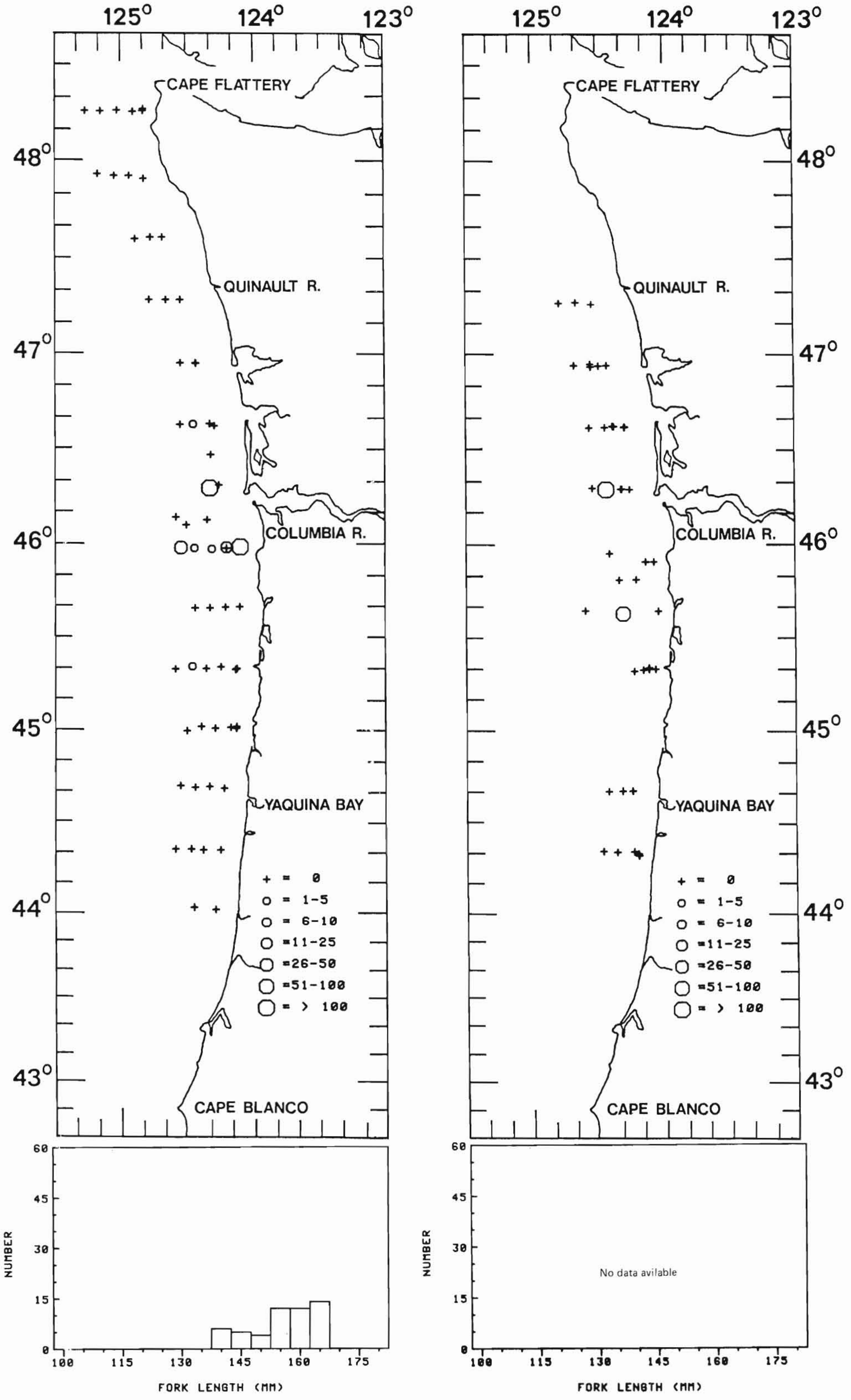


*Engraulis mordax*

**June 1981** **July 1981**

Figure 38

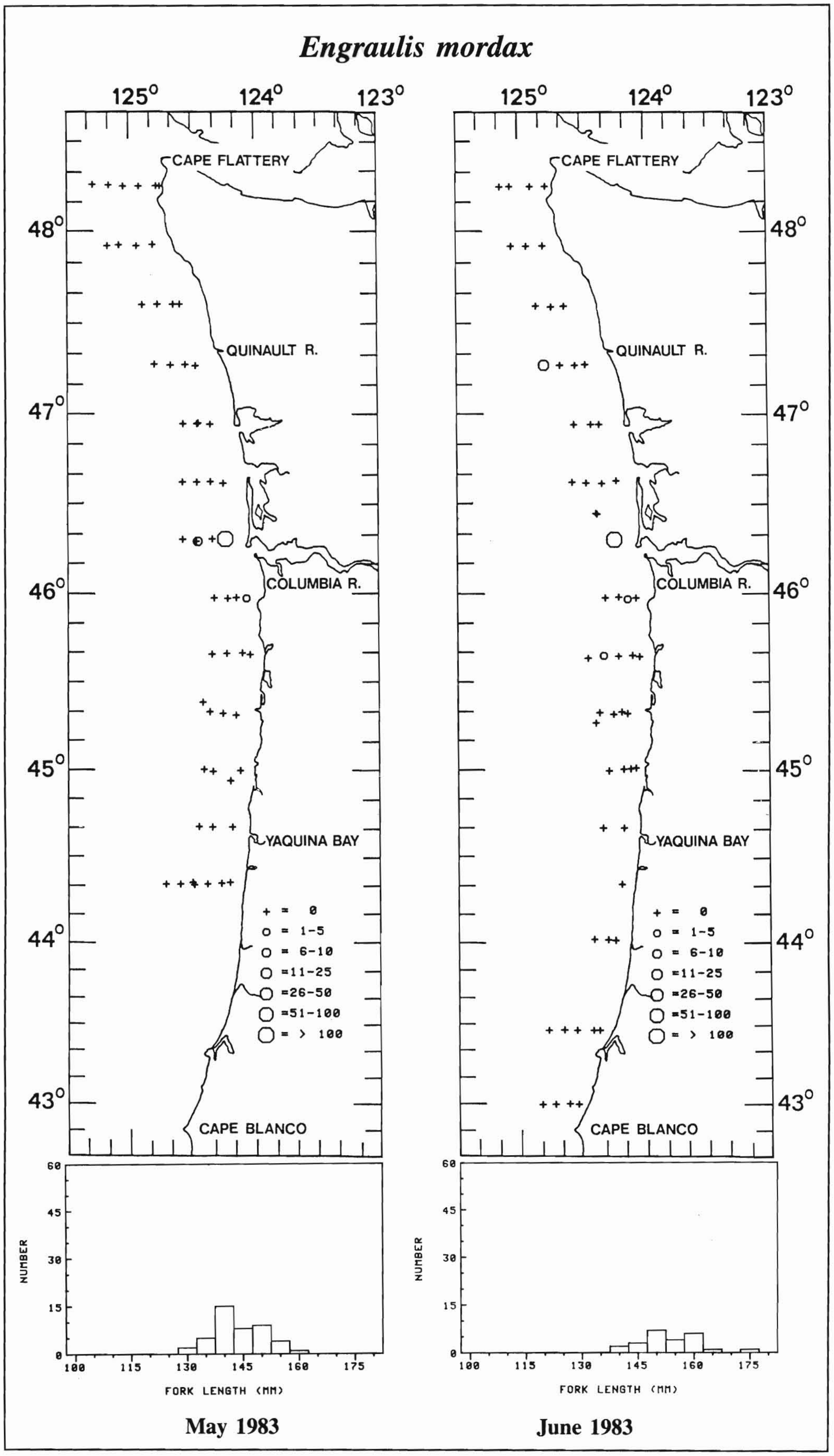
*Engraulis mordax*



May 1982

September 1982

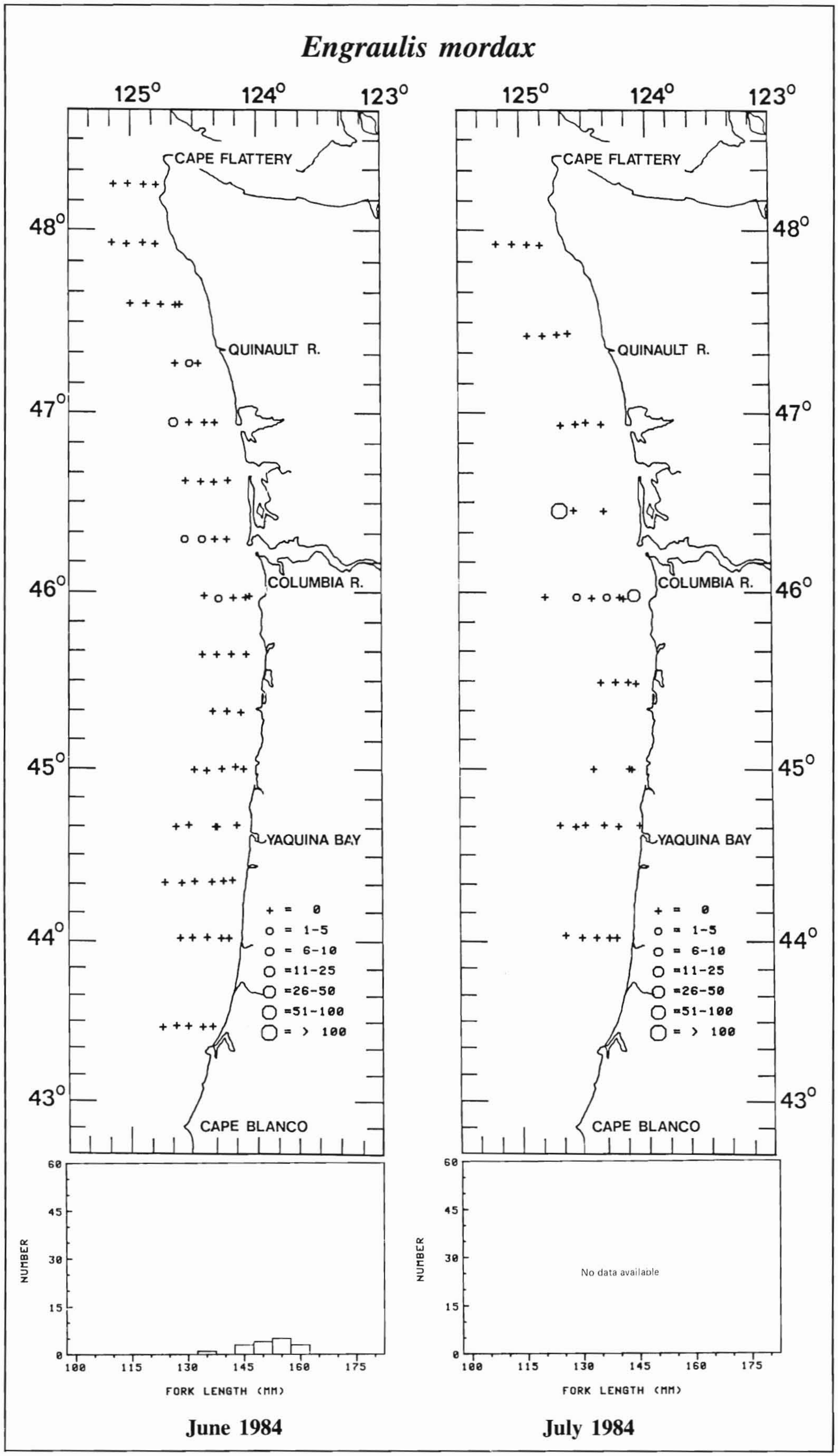
Figure 39


*Engraulis mordax*

**May 1983**

**June 1983**

**Figure 40**

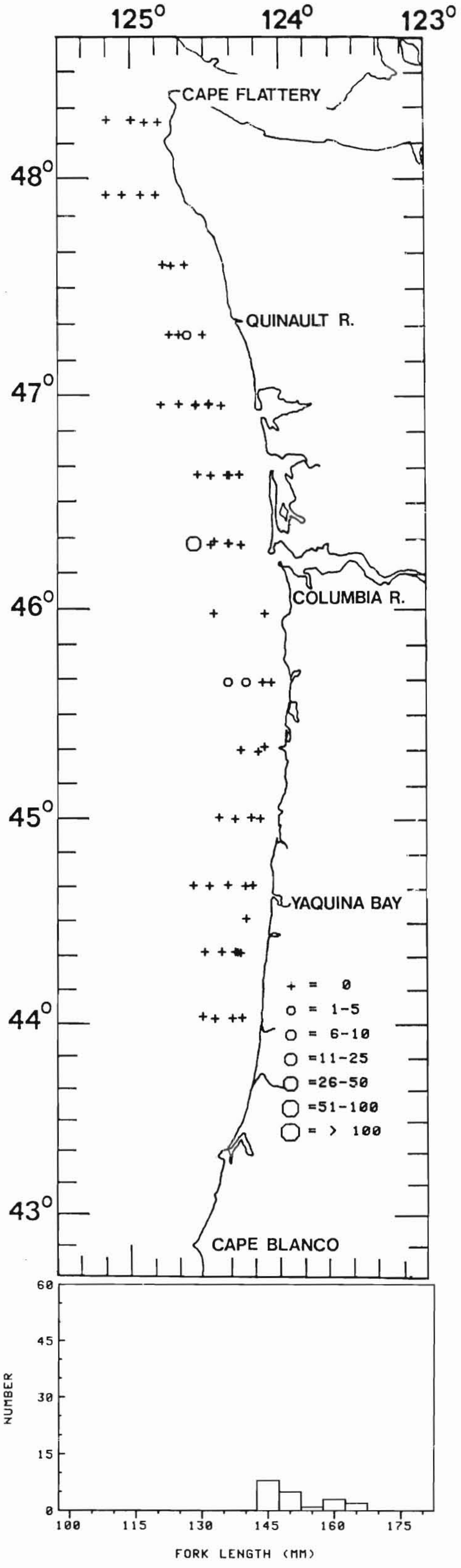

*Engraulis mordax*

June 1984

July 1984

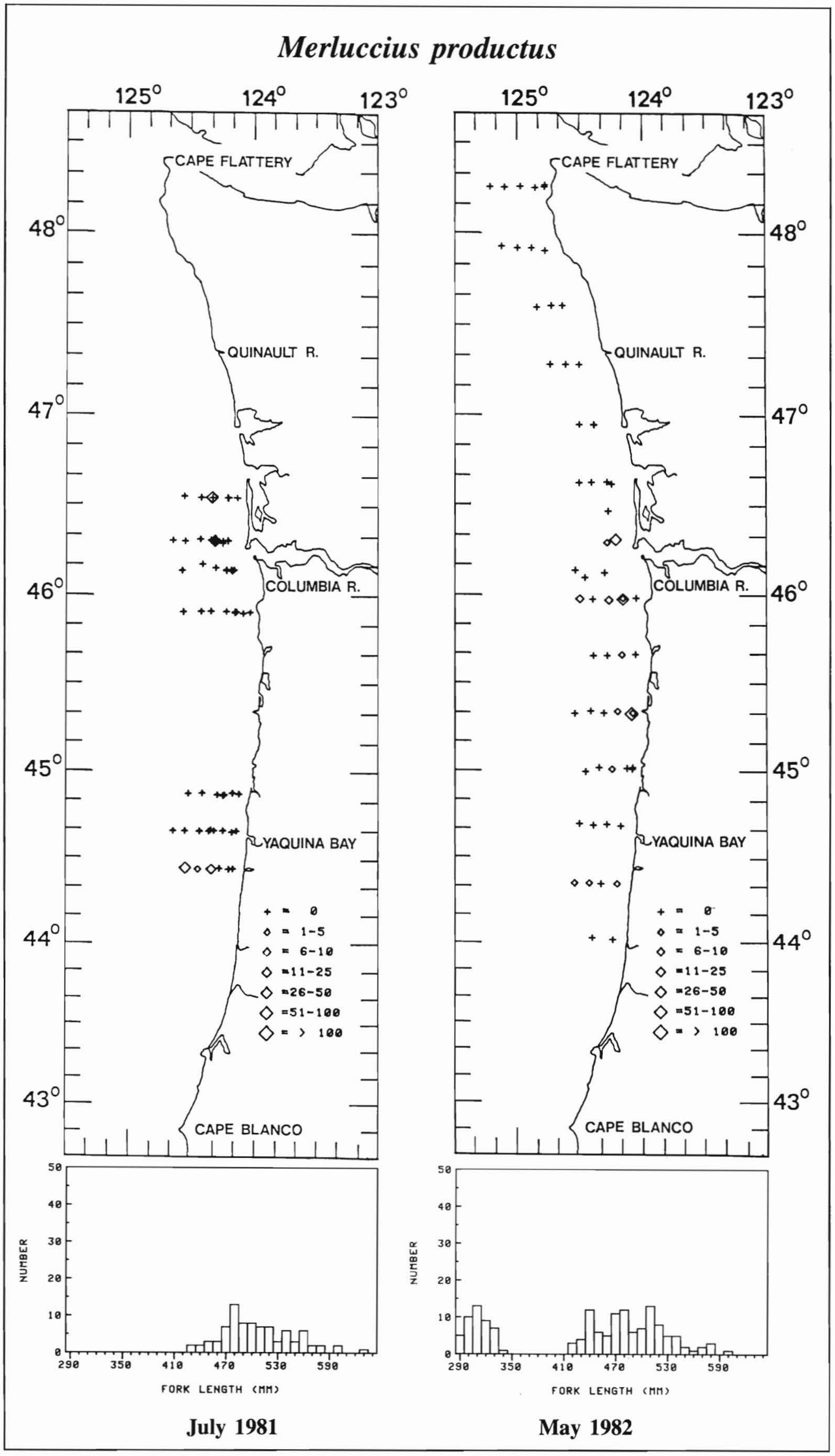
Figure 41

*Engraulis mordax*



**September 1984**

Figure 42

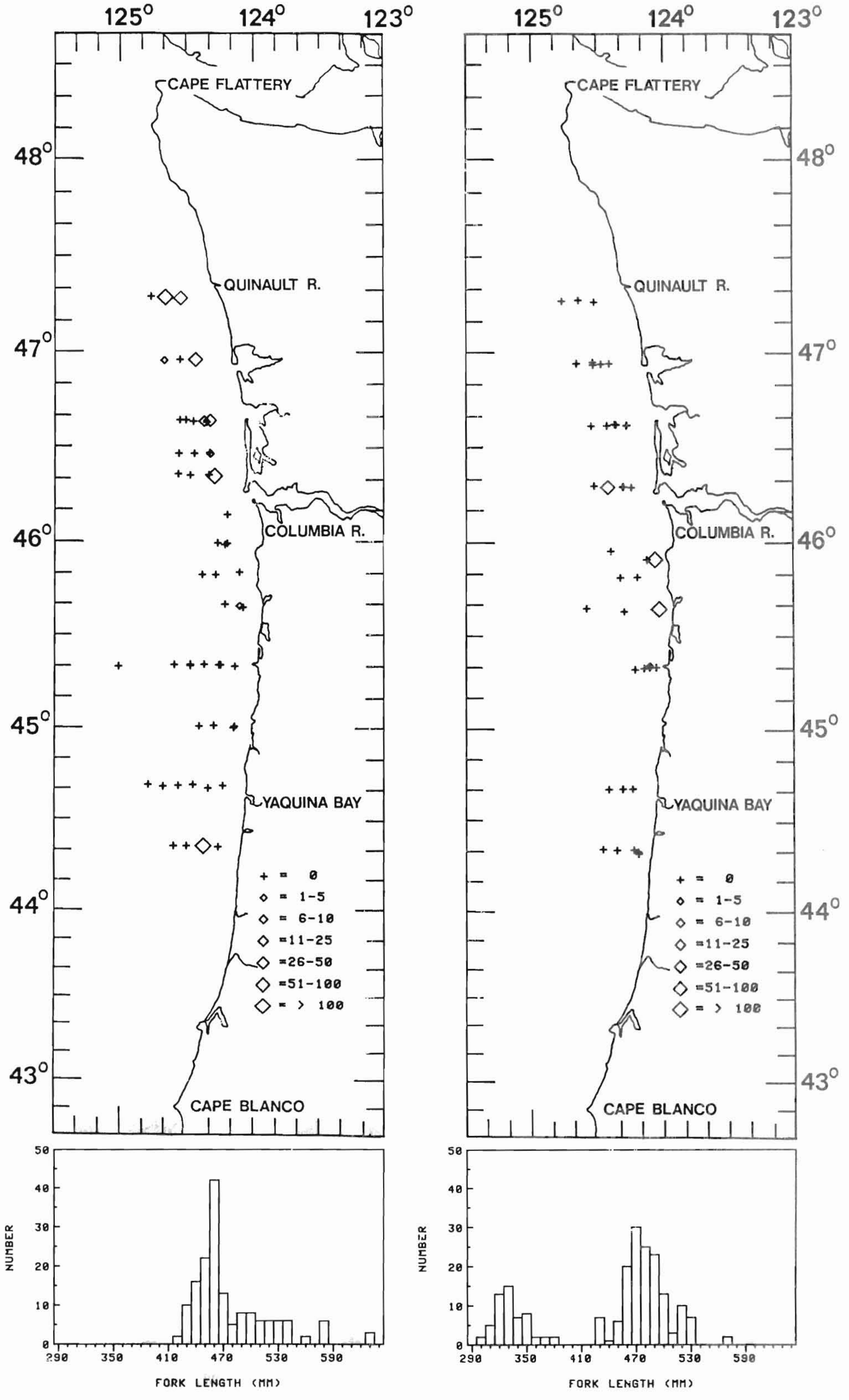


July 1981

May 1982

Figure 43

*Merluccius productus*

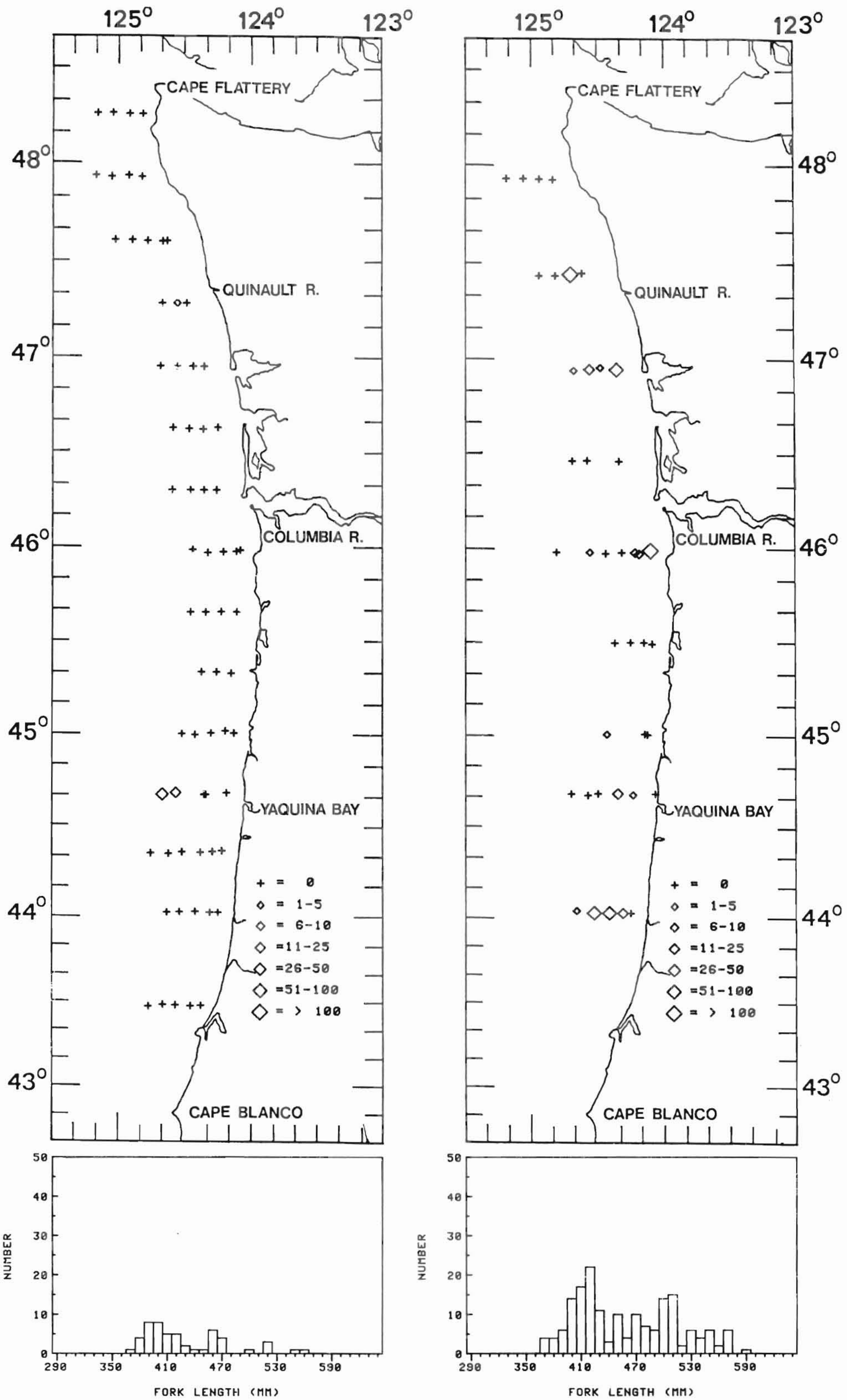


June 1982

September 1982

Figure 44

*Merluccius productus*

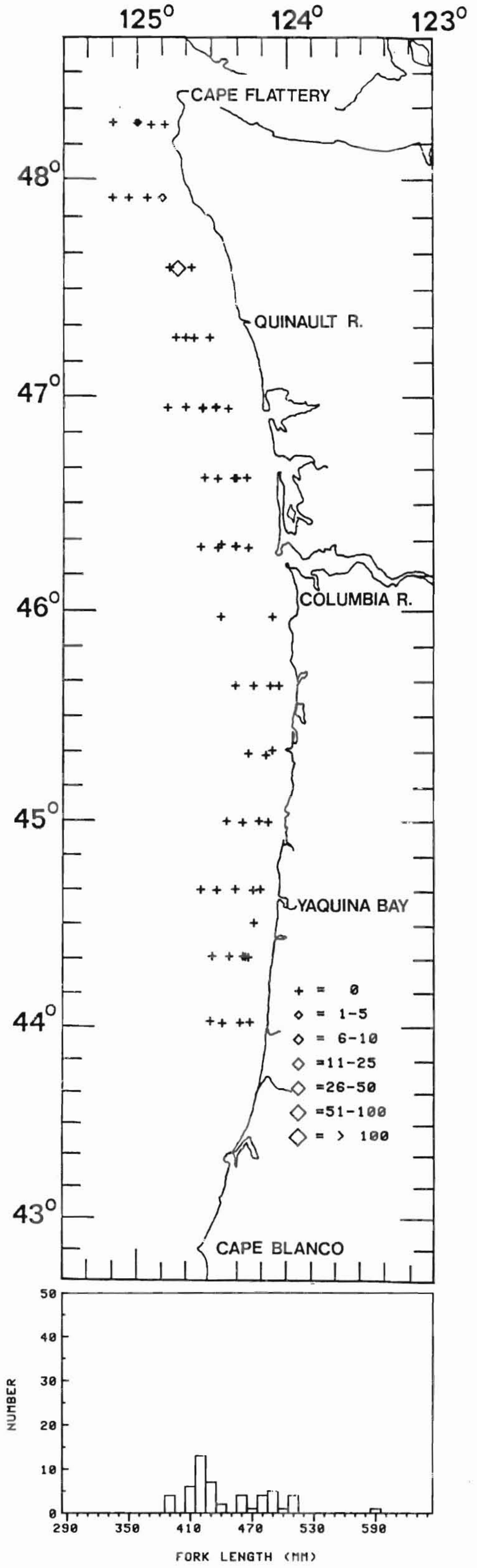


June 1984

July 1984

## Figure 45

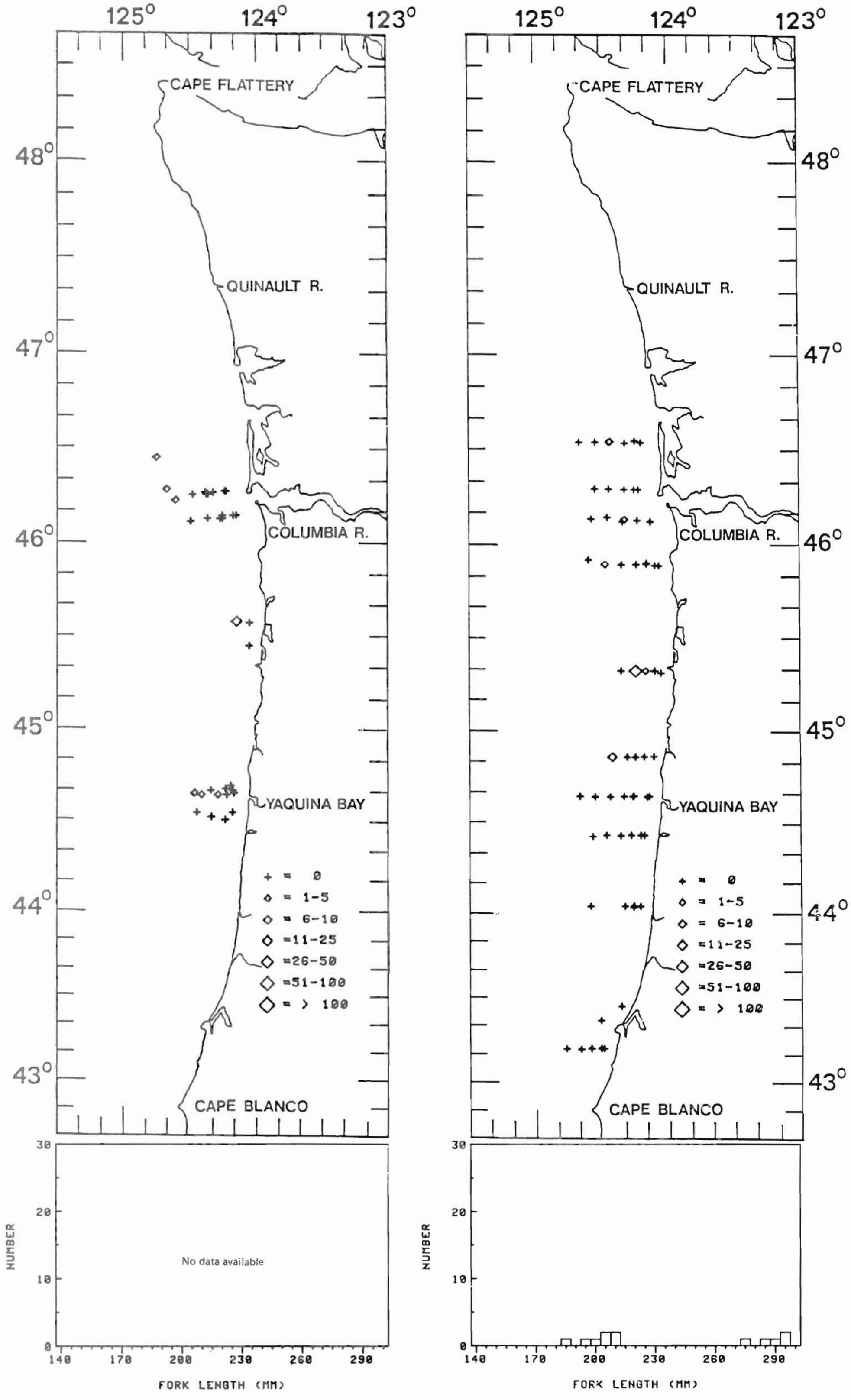
*Merluccius productus*



**September 1984**

**Figure 46**

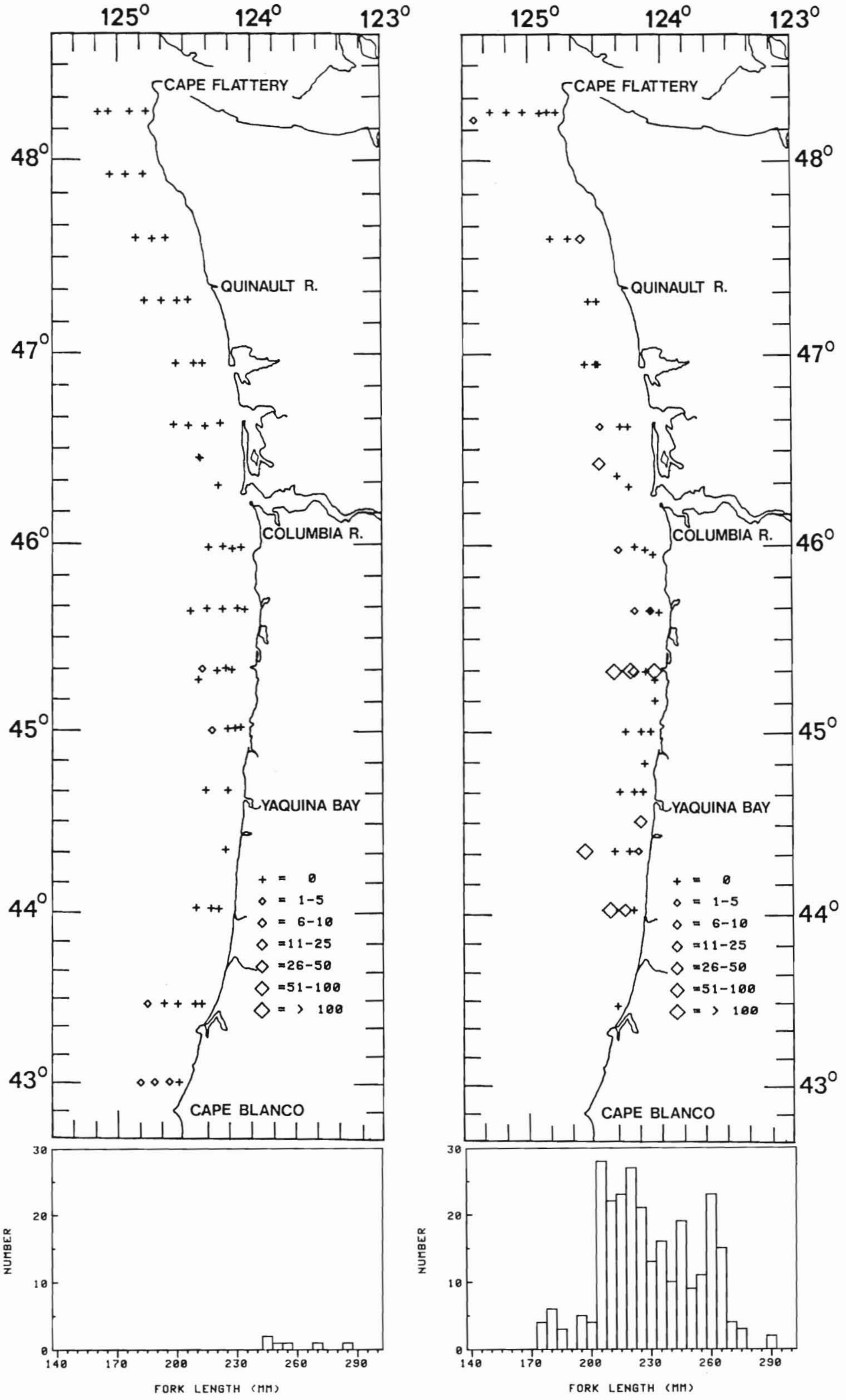
*Cololabis saira*



**June 1980** **August 1981**

**Figure 47**

*Cololabis saira*

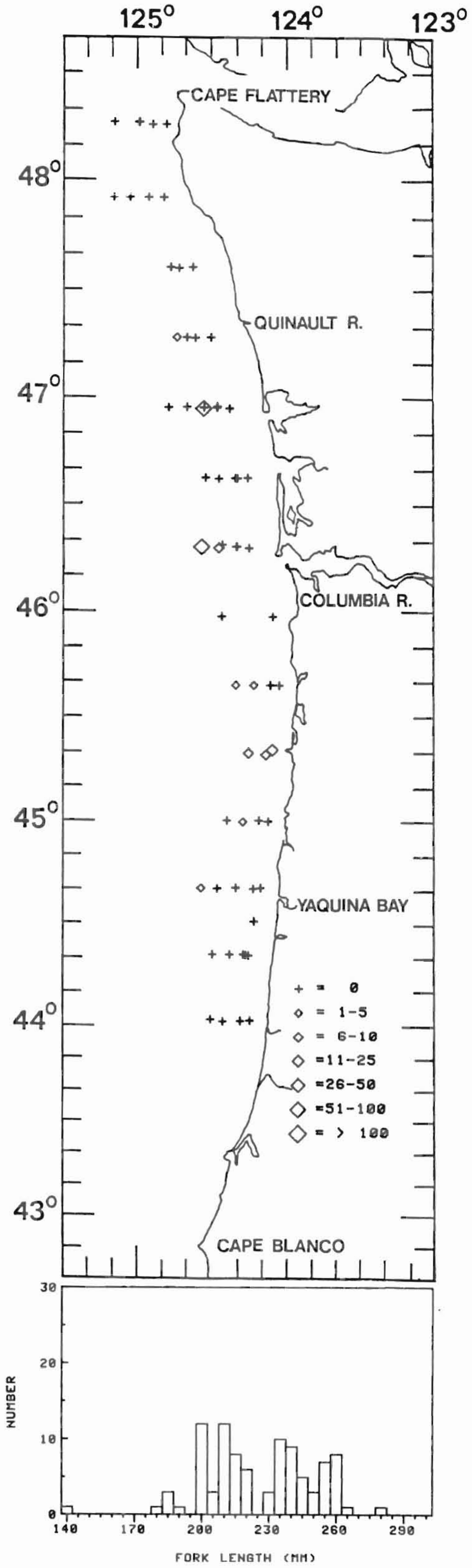


**June 1983**

**September 1983**

**Figure 48**

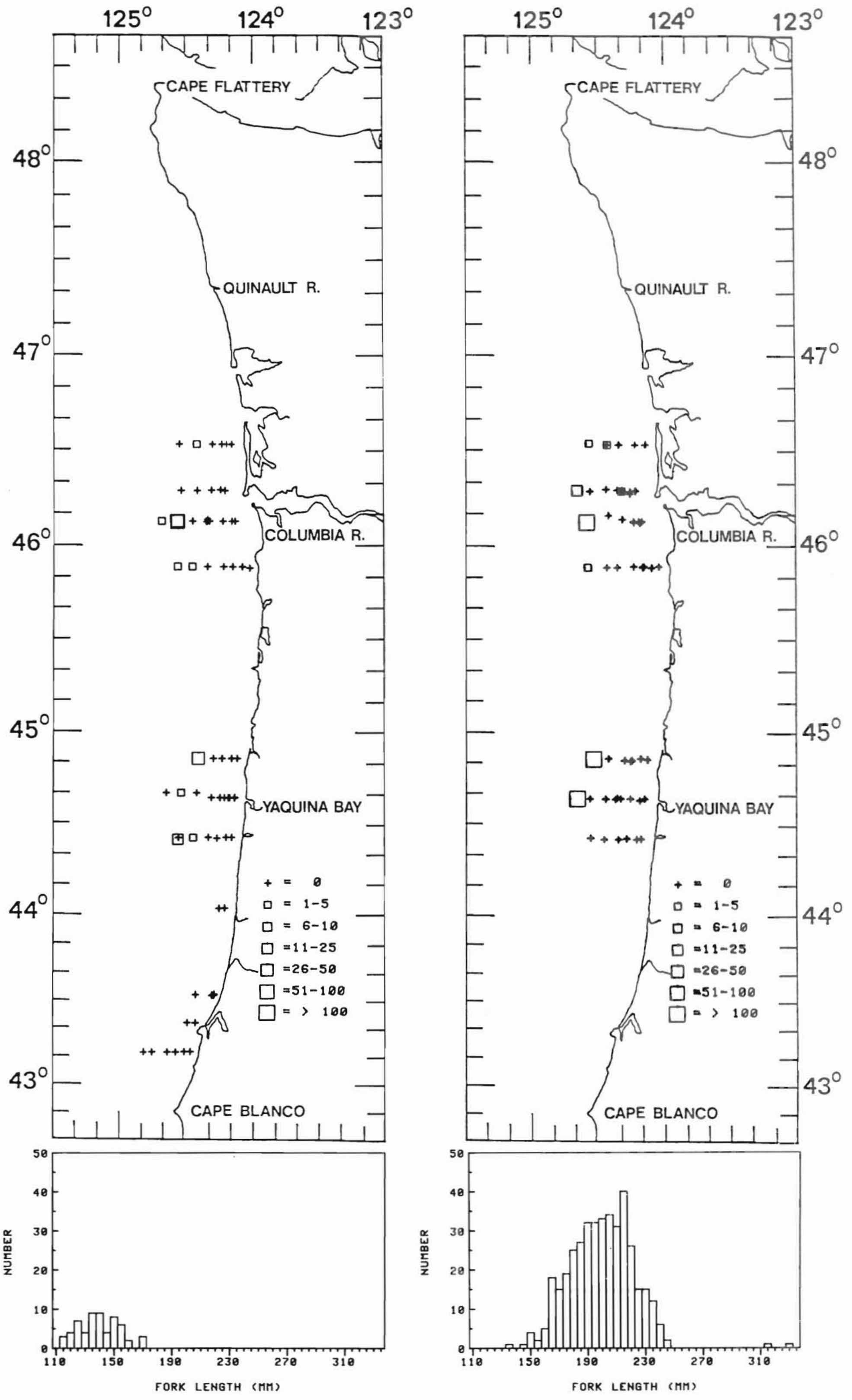
***Cololabis saira***



**September 1984**

Figure 49

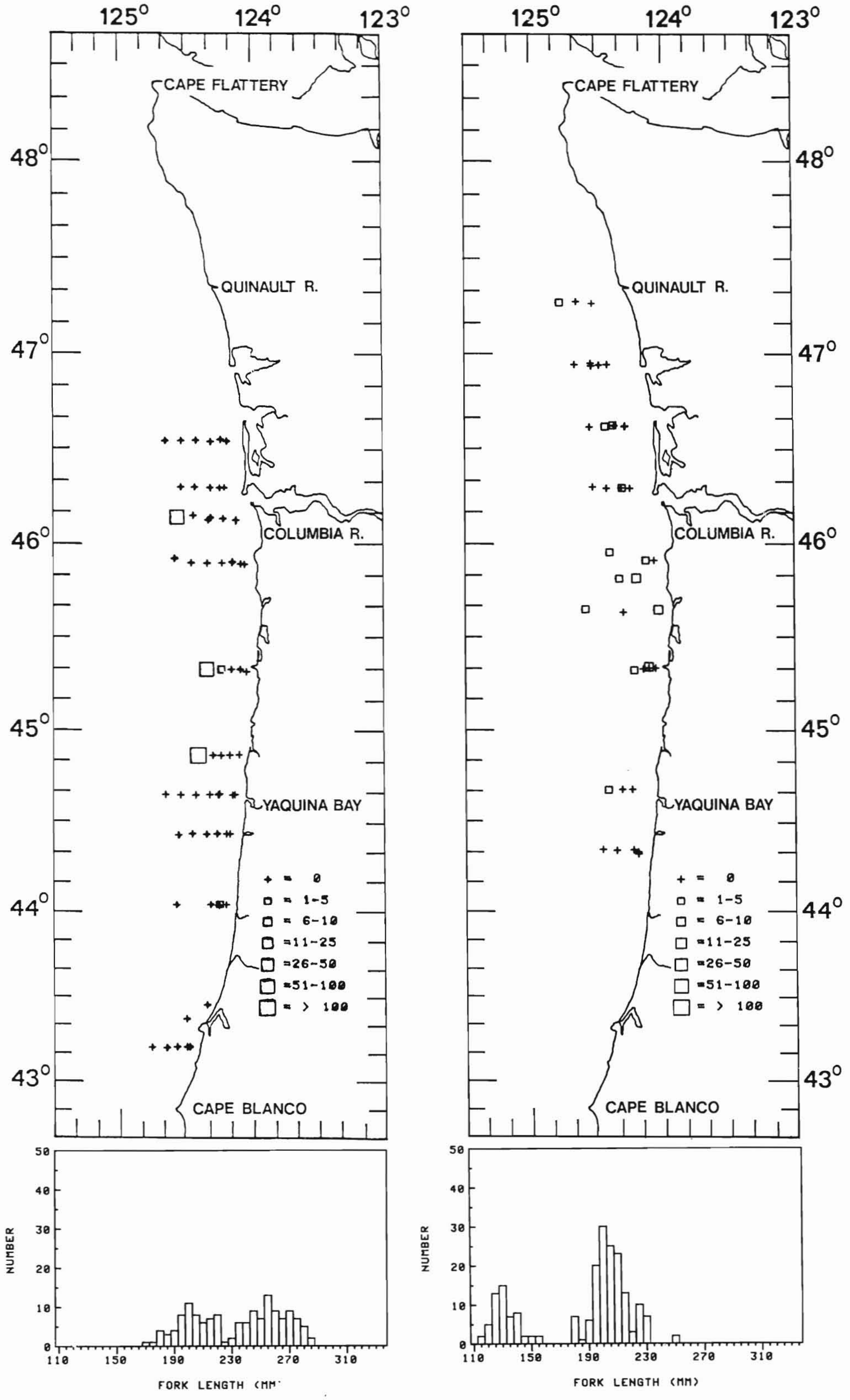
*Anoplopoma fimbria*



**June 1981** **July 1981**

**Figure 50**

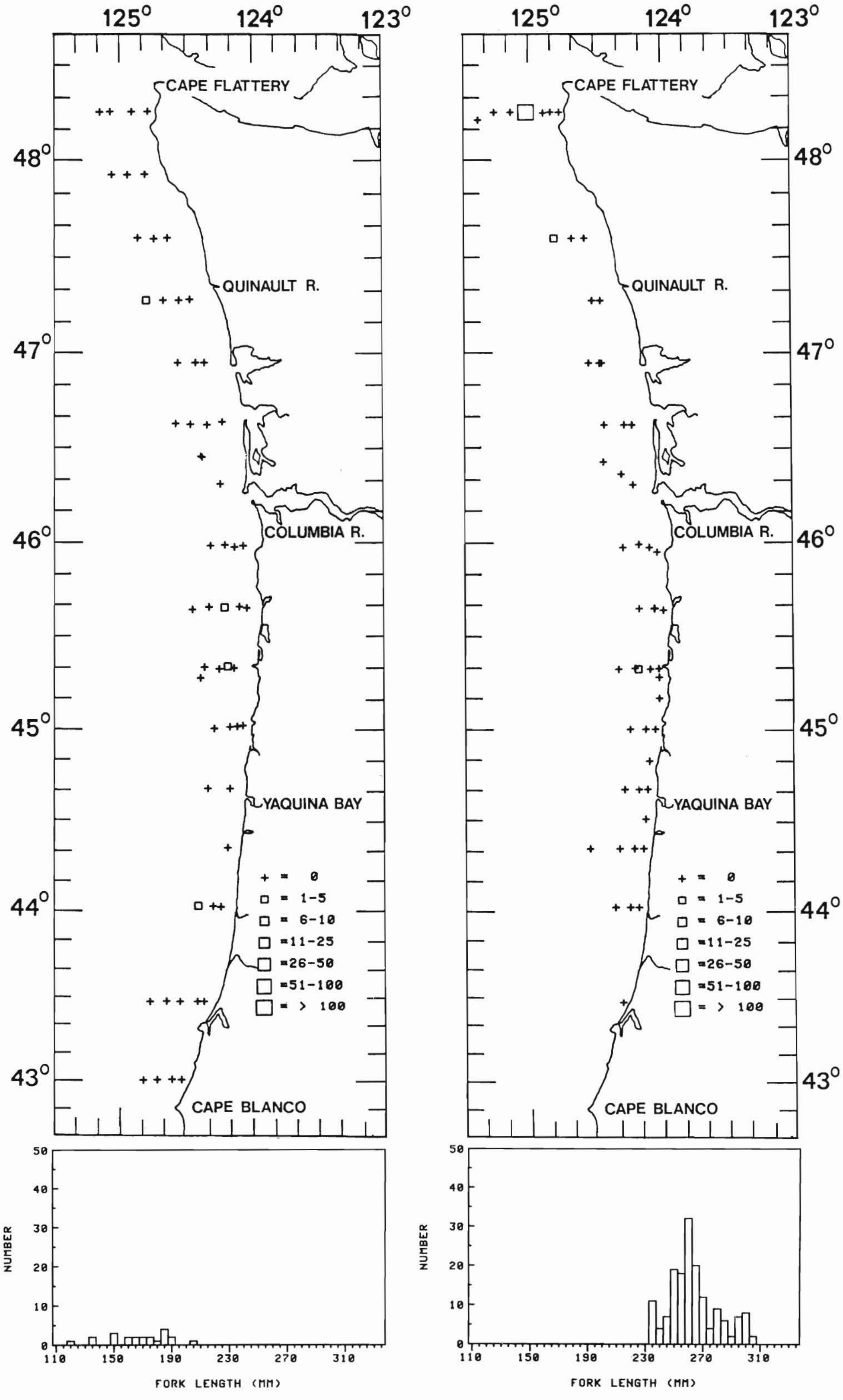
*Anoplopoma fimbria*



**August 1981** **September 1982**

**Figure 51**

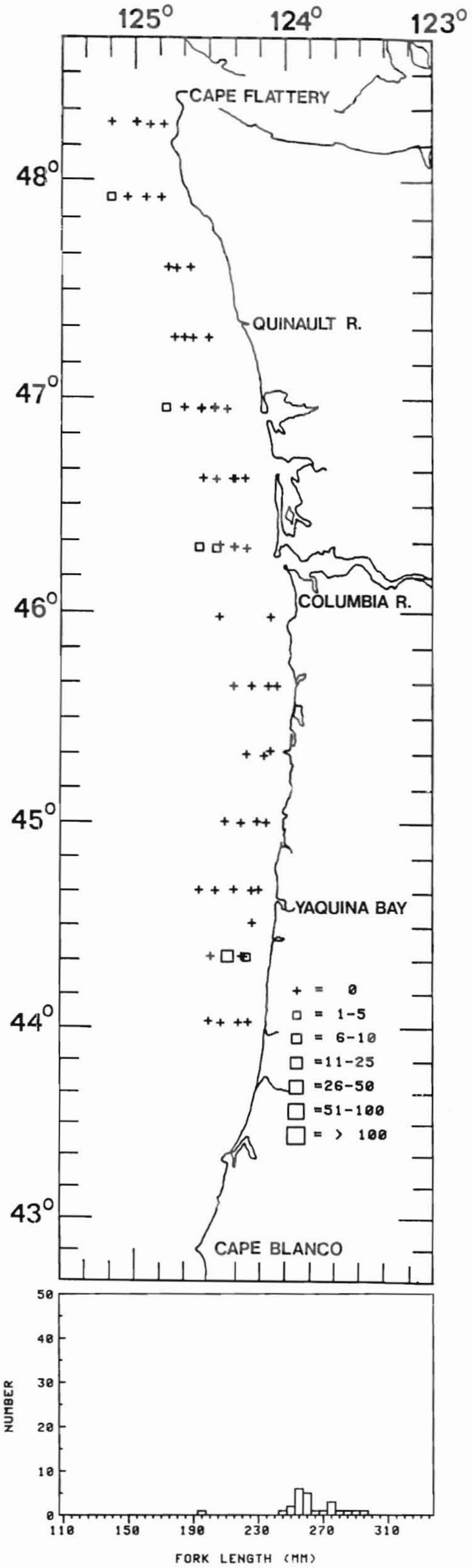
*Anoplopoma fimbria*



June 1983 September 1983

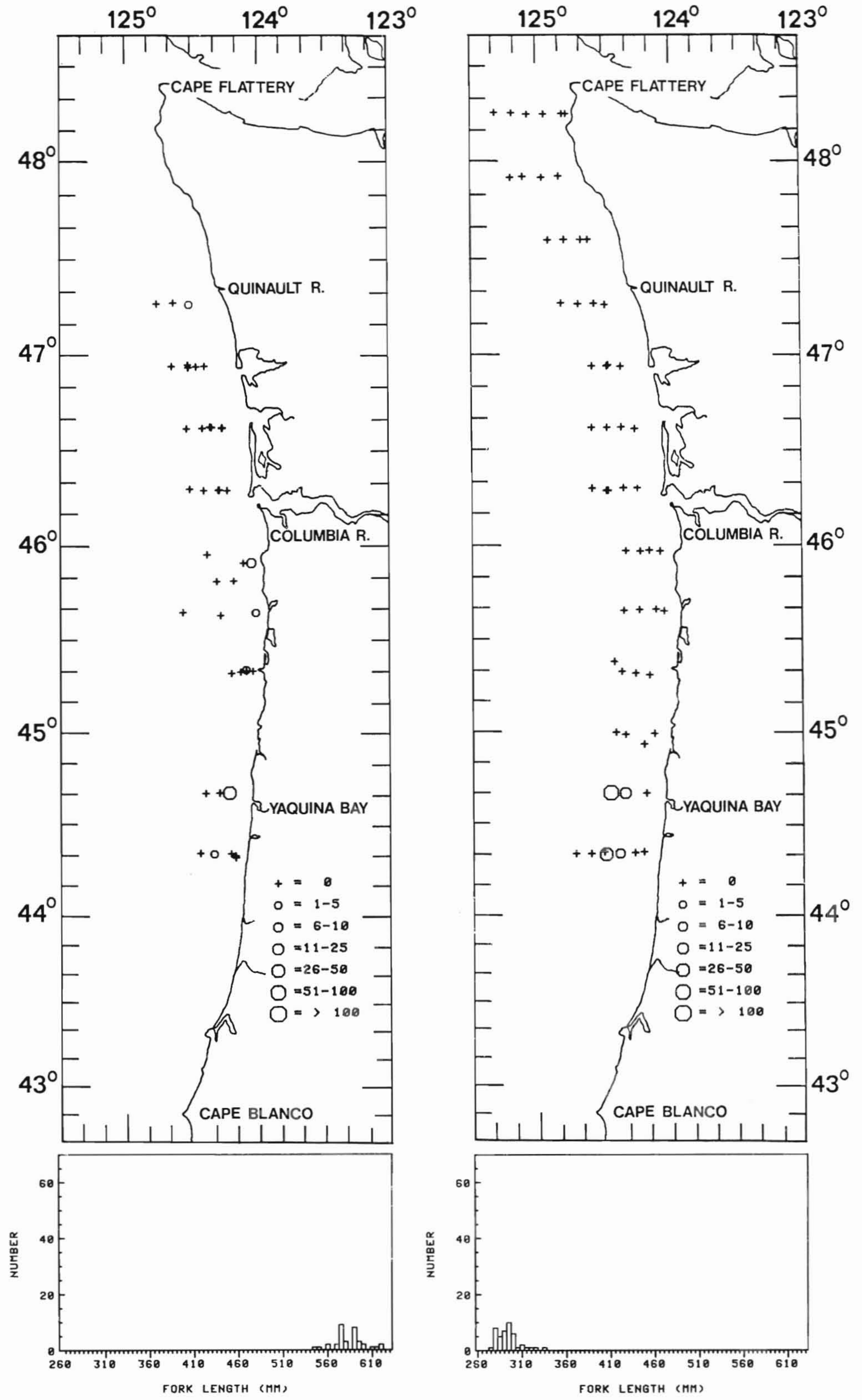
**Figure 52**

*Anoplopoma fimbria*



September 1984

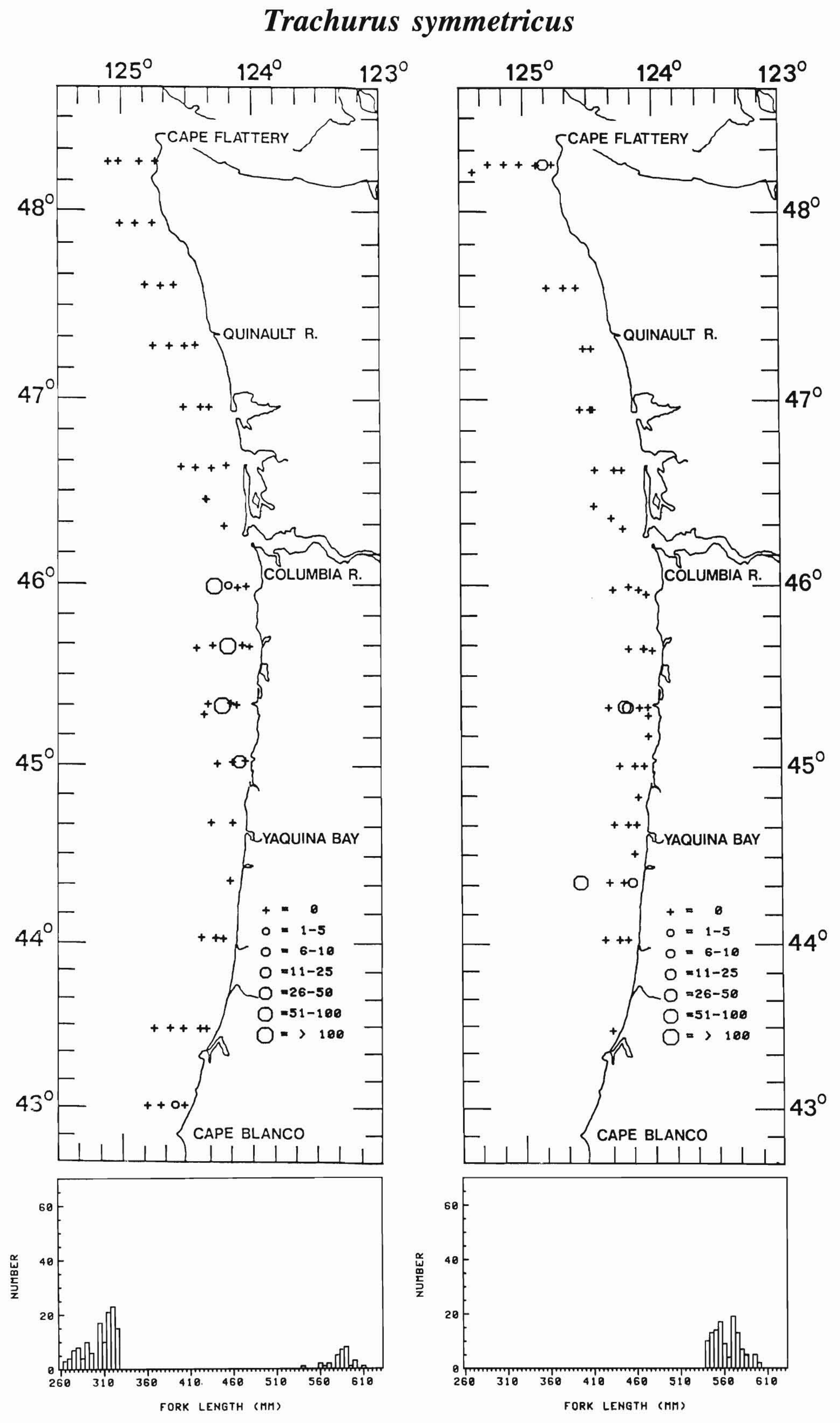
Figure 53


*Trachurus symmetricus*

**September 1982**

**May 1983**

Figure 54

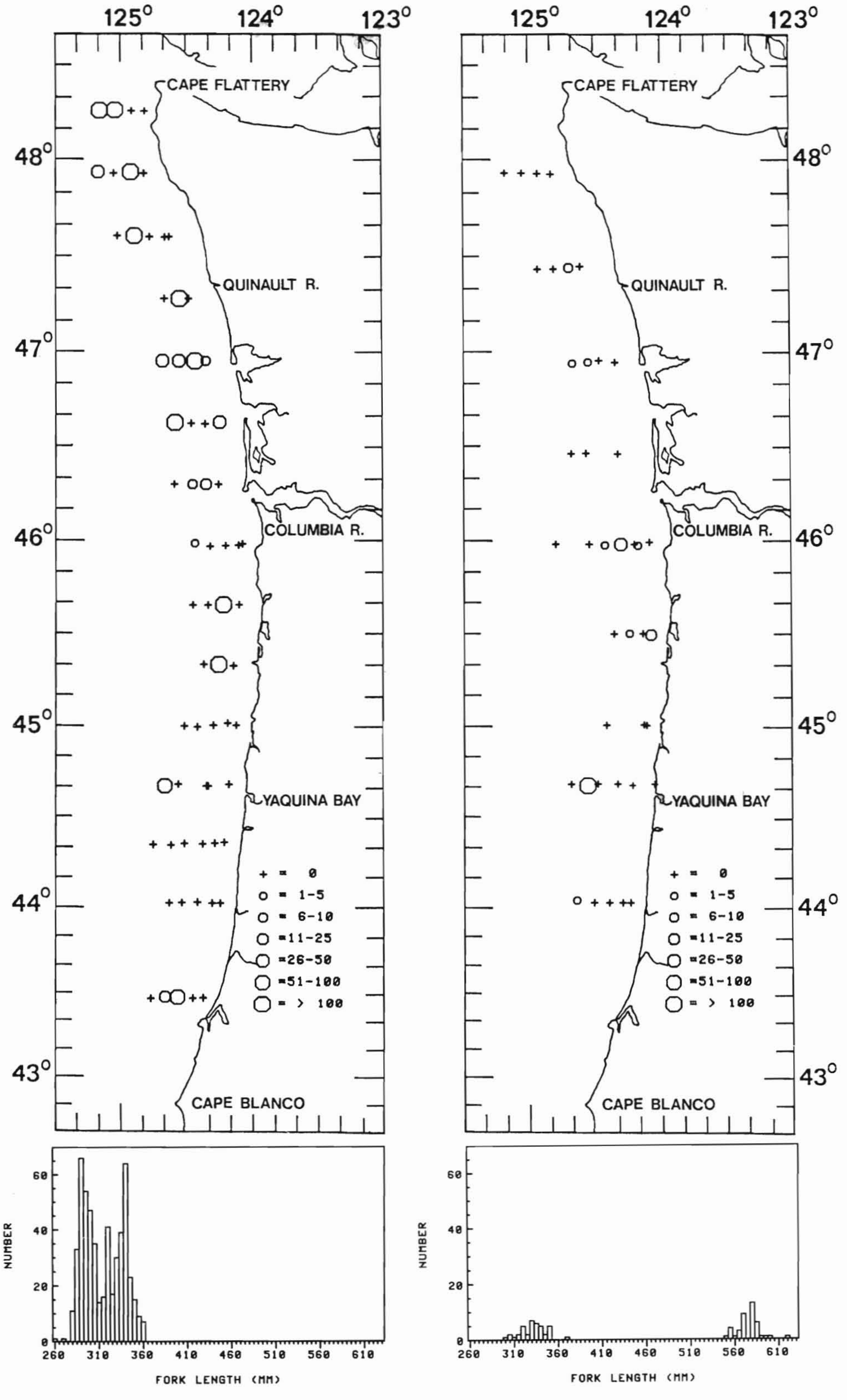


*Trachurus symmetricus*

**June 1983** **September 1983**

Figure 55

*Trachurus symmetricus*

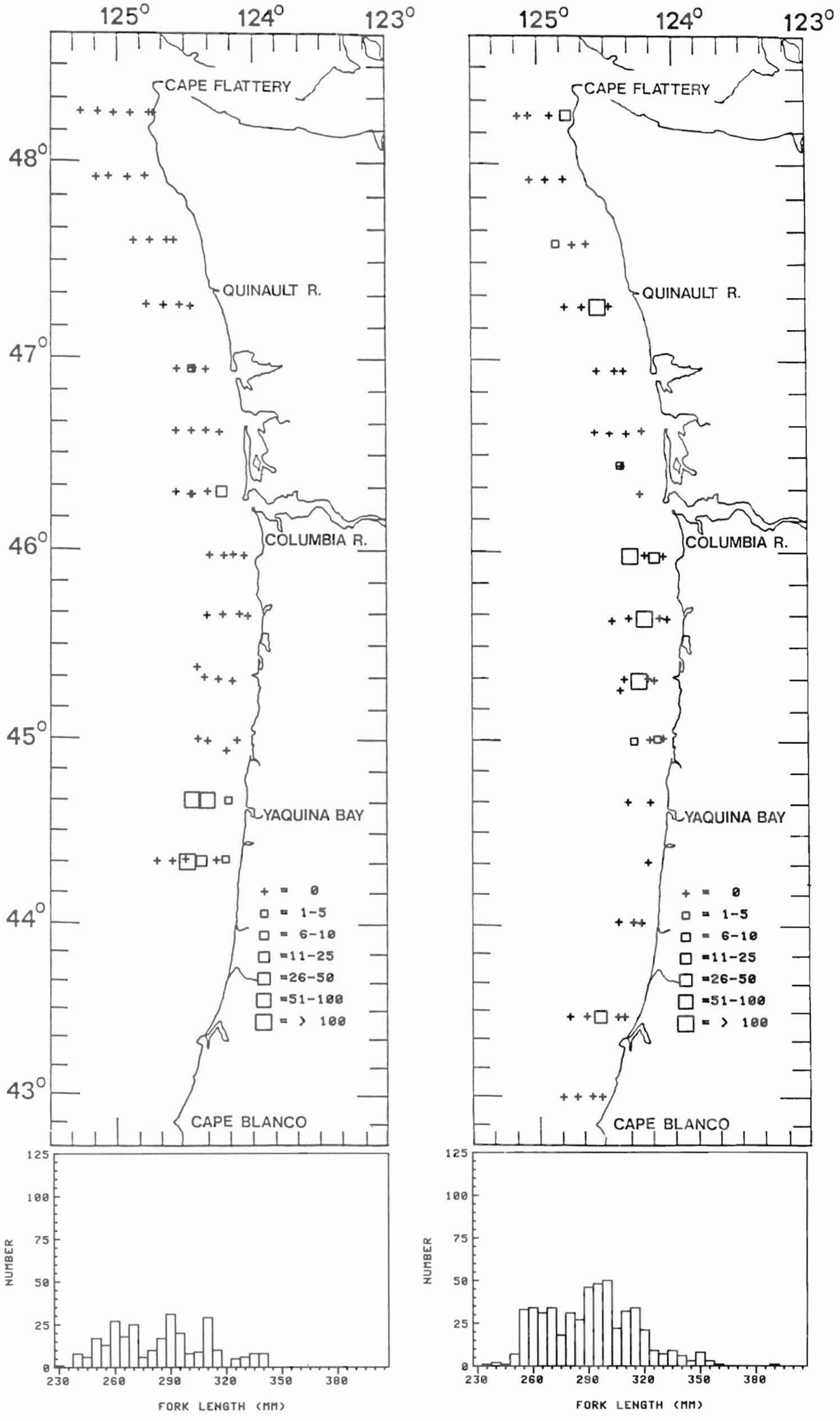


June 1984

July 1984

Figure 56

*Scomber japonicus*

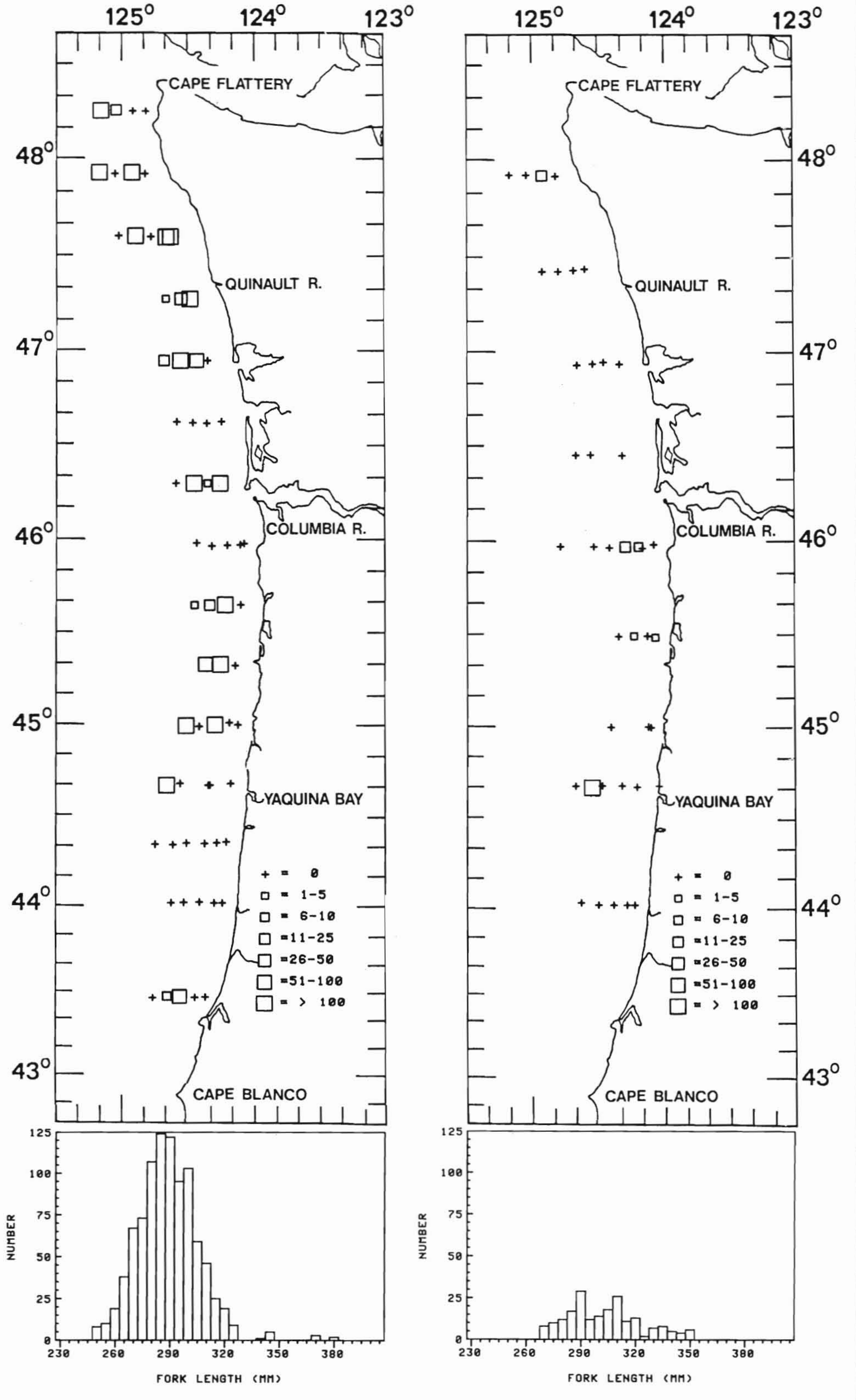


May 1983

June 1983

Figure 57

*Scomber japonicus*



June 1984

July 1984

**Figure 58**

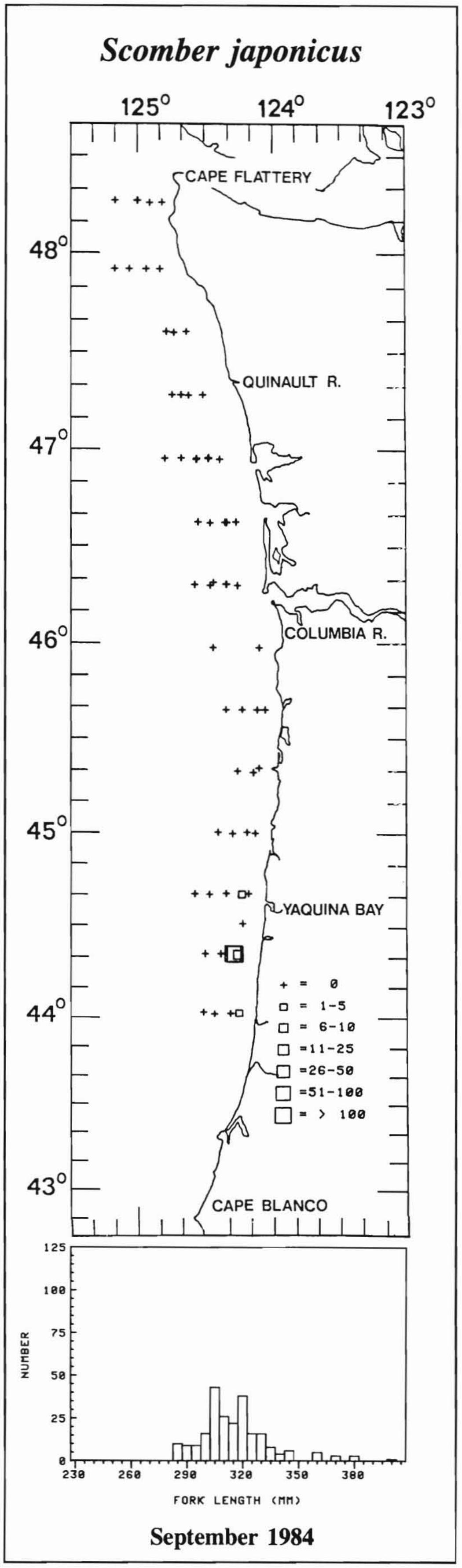

*Scomber japonicus*
125°
124°
123°
48°
47°
46°
45°
44°
43°
CAPE FLATTERY
QUINAULT R.
COLUMBIA R.
YAQUINA BAY
CAPE BLANCO
+ = 0
□ = 1-5
□ = 6-10
□ =11-25
□ =26-50
□ =51-100
□ = > 100
NUMBER
125
100
75
50
25
0
230
260
290
320
350
380
FORK LENGTH (MM)
September 1984

Figure 59

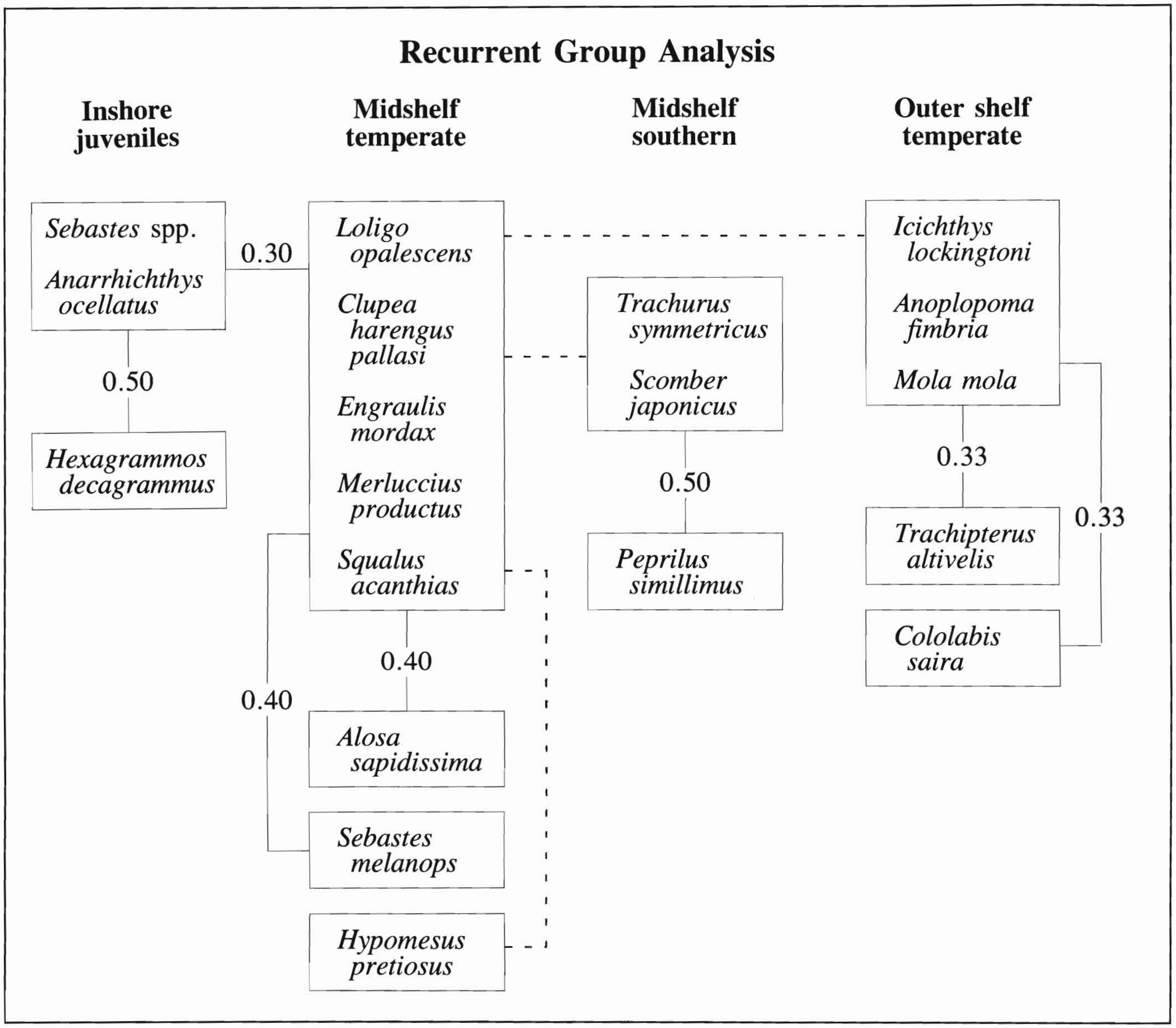


**Figure 60**

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 (⁰/₀₀) | 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 (⁰/₀₀) | 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 (⁰/₀₀) | 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) | Salin-ity (‰) | Chloro-phyll *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 (⁰/₀₀) | 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) | Salinity ($^0/_{00}$) | Chlorophyll *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

**Appendix Table 7—continued.**

## 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

**Appendix Table 7—continued.**

## 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

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