

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

Richard D. Brodeur  
William G. Pearcy

---



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

## NOAA TECHNICAL REPORT NMFS

The major responsibilities of the National Marine Fisheries Service (NMFS) are to monitor and assess the abundance and geographic distribution of fishery resources, to understand and predict fluctuations in the quantity and distribution of these resources, and to establish levels for their optimum use. NMFS is also charged with the development and implementation of policies for managing national fishing grounds, development and enforcement of domestic fisheries regulations, surveillance of foreign fishing off United States coastal waters, and the development and enforcement of international fishery agreements and policies. NMFS also assists the fishing industry through marketing service and economic analysis programs, and mortgage insurance and vessel construction subsidies. It collects, analyzes, and publishes statistics on various phases of the industry.

The NOAA Technical Report NMFS series was established in 1983 to replace two subcategories of the Technical Reports series: "Special Scientific Report—Fisheries" and "Circular." The series contains the following types of reports: Scientific investigations that document long-term continuing programs of NMFS; intensive scientific reports on studies of restricted scope; papers on applied fishery problems; technical reports of general interest intended to aid conservation and management; reports that review in considerable detail and at a high technical level certain broad areas of research; and technical papers originating in economics studies and from management investigations. Since this is a formal series, all submitted papers receive peer review and those accepted receive professional editing before publication.

Copies of NOAA Technical Reports NMFS are available free in limited numbers to governmental agencies, both Federal and State. They are also available in exchange for other scientific and technical publications in the marine sciences. Individual copies may be obtained from: U.S. Department of Commerce, National Technical Information Service, 5285 Port Royal Road, Springfield, VA 22161. Although the contents have not been copyrighted and may be reprinted entirely, reference to source is appreciated.

1. Synopsis of biological data on the Blue Crab, *Callinectes sapidus* Rathbun, by Mark R. Millikin and Austin B. Williams. March 1984, 39 p.
2. Development of hexagrammids (Pisces: Scorpaeniformes) in the Northeastern Pacific Ocean, by Arthur W. Kendall, Jr., and Beverly Vinter. March 1984, 44 p.
3. Configurations and relative efficiencies of shrimp trawls employed in southeastern United States waters, by John W. Watson, Jr., Ian K. Workman, Charles W. Taylor, and Anthony F. Serra. March 1984, 12 p.
4. Management of northern fur seals on the Pribilof Islands, Alaska, 1786-1981, by Alton Y. Roppel. April 1984, 26 p.
5. Net phytoplankton and zooplankton in the New York Bight, January 1976 to February 1978, with comments on the effects of wind, Gulf Stream eddies, and slope water intrusions, by Daniel E. Smith and Jack W. Jossi. May 1984, 41 p.
6. Ichthyoplankton survey of the estuarine and inshore waters of the Florida Everglades, May 1971 to February 1972, by L. Alan Collins, and John H. Finucane. July 1984, 75 p.
7. The feeding ecology of some zooplankters that are important prey items of larval fish, by Jefferson T. Turner. July 1984, 28 p.
8. Proceedings of the International Workshop on Age Determination of Oceanic Pelagic Fishes: Tunas, Billfishes, and Sharks, by Eric D. Prince (convener and editor), and Lynn M. Pulos (editor). December 1983, 211 p.
9. Sampling statistics in the Atlantic menhaden fishery, by Alexander J. Chester. August 1984, 16 p.
10. Proceedings of the Seventh U.S.-Japan Meeting on Aquaculture, Marine Finfish Culture, Tokyo, Japan, October 3-4, 1978, by Carl J. Sindermann (editor). August 1984, 31 p.
11. Taxonomy of North American fish Eimeriidae, by Steve J. Upton, David W. Rediker, William L. Current, and Donald W. Duszynski. August 1984, 18 p.
12. Soviet-American Cooperative Research on Marine Mammals. Volume 1—Pinnipeds, by Francis H. Fay, and Gennadii A. Fedoseev (editors). September 1984, 104 p.
13. Guidelines for reducing porpoise mortality in tuna purse seining, by James M. Coe, David B. Holts, and Richard W. Butler. September 1984, 16 p.
14. Synopsis of biological data on shortnose sturgeon, *Acipenser brevirostrum* LeSueur 1818, by Michael J. Dadswell, Bruce D. Taubert, Thomas S. Squiers, Donald Marchette, and Jack Buckley. October 1984, 45 p.
15. Chaetognaths of the Caribbean sea and adjacent areas, by Harding B. Michel. October 1984, 33 p.
16. Proceedings of the Ninth and Tenth U.S.-Japan Meetings on Aquaculture, by Carl J. Sindermann (editor). November 1984, 92 p.
17. Identification and estimation of size from the beaks of 18 species of cephalopods from the Pacific Ocean, by Gary A. Wolff. November 1984, 50 p.
18. A temporal and spatial study of invertebrate communities associated with hard-bottom habitats in the South Atlantic Bight, by E. L. Wenner, P. Hinde, D. M. Knott, and R. F. Van Dolah. November 1984, 104 p.
19. Synopsis of biological data on spottail pinfish, *Diplodus holbrooki* (Pisces: Sparidae), by George H. Darcy. January 1985, 11 p.
20. Ichthyoplankton of the Continental Shelf near Kodiak Island, Alaska, by Arthur W. Kendall, Jr., and Jean R. Dunn. January 1985, 89 p.
21. Annotated bibliography on hypoxia and its effects on marine life, with emphasis on the Gulf of Mexico, by Maurice L. Renaud. February 1985, 9 p.
22. Congrid eels of the eastern Pacific and key to their Leptocephali, by Solomon N. Raju. February 1985, 19 p.
23. Synopsis of biological data on the pinfish, *Lagodon rhomboides* (Pisces: Sparidae), by George H. Darcy. February 1985, 32 p.
24. Temperature conditions in the cold pool 1977-81: A comparison between southern New England and New York transects, by Steven K. Cook. February 1985, 22 p.
25. Parasitology and pathology of marine organisms of the world ocean, by William J. Hargis, Jr. (editor). March 1985, 135 p.
26. Synopsis of biological data on the sand perch, *Diplectrum formosum* (Pisces: Serranidae), by George H. Darcy. March 1985, 21 p.
27. Proceedings of the Eleventh U.S.-Japan Meeting on Aquaculture, Salmon Enhancement, Tokyo, Japan, October 19-20, 1982, by Carl J. Sindermann (editor). March 1985, 102 p.
28. Review of geographical stocks of tropical dolphins (*Stenella* spp. and *Delphinus delphis*) in the eastern Pacific, by William F. Perrin, Michael D. Scott, G. Jay Walker, and Virginia L. Cass. March 1985, 28 p.
29. Prevalence, intensity, longevity, and persistence of *Anisakis* sp. larvae and *Lacis-torhynchus tenuis* metacystodes in San Francisco striped bass, by Mike Moser, Judy A. Sakanari, Carol A. Reilly, and Jeannette Whipple. April 1985, 4 p.
30. Synopsis of biological data on the pink shrimp, *Pandalus borealis* Krøyer, 1838, by Sandra E. Shumway, Herbert C. Perkins, Daniel F. Schick, and Alden P. Stickney. May 1985, 57 p.
31. Shark catches from selected fisheries off the U.S. east coast, by Emory D. Anderson, John G. Casey, John J. Hoey, and W. N. Witzell. July 1985, 22 p.
32. Nutrient Distributions for Georges Bank and adjacent waters in 1979, by A. F. J. Draxler, A. Matte, R. Waldhauer, and J. E. O'Reilly. July 1985, 34 p.
33. Marine flora and fauna of the Northeastern United States. Echinodermata: Echinoidea, by D. Keith Serafy and F. Julian Fell. September 1985, 27 p.
34. Additions to a revision of the shark genus *Carcharhinus*: Synonymy of *Aprionodon* and *Hypoprion*, and description of a new species of *Carcharhinus* (Carcharhinidae), by J. A. F. Garrick. November 1985, 26 p.
35. Synoptic review of the literature on the Southern oyster drill *Thais haemastoma floridana*, by Philip A. Butler. November 1985, 9 p.

NOAA Technical Report NMFS 46

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

Richard D. Brodeur  
William G. Pearcy

December 1986



U.S. DEPARTMENT OF COMMERCE  
Malcolm Baldrige, Secretary  
National Oceanic and Atmospheric Administration  
Anthony J. Calio, Administrator  
National Marine Fisheries Service  
William E. Evans, Assistant Administrator for Fisheries

The National Marine Fisheries Service (NMFS) does not approve, recommend or endorse any proprietary product or proprietary material mentioned in this publication. No reference shall be made to NMFS, or to this publication furnished by NMFS, in any advertising or sales promotion which would indicate or imply that NMFS approves, recommends or endorses any proprietary product or proprietary material mentioned herein, or which has as its purpose an intent to cause directly or indirectly the advertised product to be used or purchased because of this NMFS publication.

# CONTENTS

---

Introduction	1
Materials and Methods	1
Results	
Physical and biotic environment	2
Summary of nekton collected	3
Dominant species	
<i>Loligo opalescens</i>	3
<i>Squalus acanthias</i>	4
<i>Clupea harengus pallasii</i>	4
<i>Engraulis mordax</i>	5
<i>Merluccius productus</i>	5
<i>Cololabis saira</i>	5
<i>Anoplopoma fimbria</i>	5
<i>Trachurus symmetricus</i>	5
<i>Scomber japonicus</i>	5
Pelagic assemblage analysis	5
Discussion	6
Acknowledgments	7
Citations	7
Figures	
1 - Sampling area	9
2-16 - Hydrographic data	10
17-24 - <i>Loligo opalescens</i>	26
25-29 - <i>Squalus acanthias</i>	34
30-36 - <i>Clupea harengus pallasii</i>	39
37-42 - <i>Engraulis mordax</i>	46
43-46 - <i>Merluccius productus</i>	52
47-49 - <i>Cololabis saira</i>	56
50-53 - <i>Anoplopoma fimbria</i>	59
54-56 - <i>Trachurus symmetricus</i>	63
57-59 - <i>Scomber japonicus</i>	66
60 - Species associations	69
Appendix Tables 1-6 - Environmental data	71
7 - Species accounts	80



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

RICHARD D. BRODEUR<sup>1</sup>

*College of Oceanography  
Oregon State University  
Marine Science Center  
Newport, Oregon 97365*

WILLIAM G. PEARCY

*College of Oceanography  
Oregon State University  
Corvallis, Oregon 97331*

## ABSTRACT

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

## 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<sup>3</sup>) 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

<sup>1</sup>Present address: Fisheries Research Institute, WH-10, University of Washington, Seattle, Washington 98195.

**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  $\geq 1000$  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 escape 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<sup>1</sup> 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<sup>3</sup>/second/100 m of coastline.**

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

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

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
Anoplomatidae	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 pallasii***—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 pallasii* 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‰) 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‰.

***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 distribution 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  $N_b \geq N_a$ . 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. alivelis*) 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 (*Colo-*

*labis 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 (Percy 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)
<i>Scomber japonicus</i>	3	1	6	1
<i>Loligo opalescens</i>	2	2	4	6
<i>Clupea harengus pallasii</i>	5	6	2	4
<i>Engraulis mordax</i>	1	8	3	7
<i>Anoplopoma fimbria</i>	—	9	1	3
<i>Squalus acanthias</i>	4	5	5	—
<i>Merluccius productus</i>	7	7	8	5
<i>Trachurus symmetricus</i>	8	3	9	8
<i>Cololabis saira</i>	—	—	10	2
<i>Sebastes</i> sp. <sup>1</sup>	10	4	—	—
<i>Hypomesus pretiosus</i>	6	10	—	—

<sup>1</sup>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
<i>Loligo opalescens</i>	1	1	1	1	5	4
<i>Squalus acanthias</i>	5	6	4	3	3	3
<i>Clupea harengus pallasii</i>	3	3	9	4	6	5
<i>Sebastes</i> sp. <sup>1</sup>	2	2	2	7	10	—
<i>Trachurus symmetricus</i>	—	—	—	5	2	2
<i>Engraulis mordax</i>	—	4	5	—	4	8
<i>Scomber japonicus</i>	—	—	—	—	1	1
<i>Merluccius productus</i>	—	—	—	2	—	6
<i>Anoplopoma fimbria</i>	—	—	3	—	8	—
<i>Sebastes melanops</i>	—	—	—	6	9	9
<i>Cololabis saira</i>	—	5	10	—	—	—
<i>Alosa sapidissima</i>	8	—	8	—	—	10

<sup>1</sup>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.

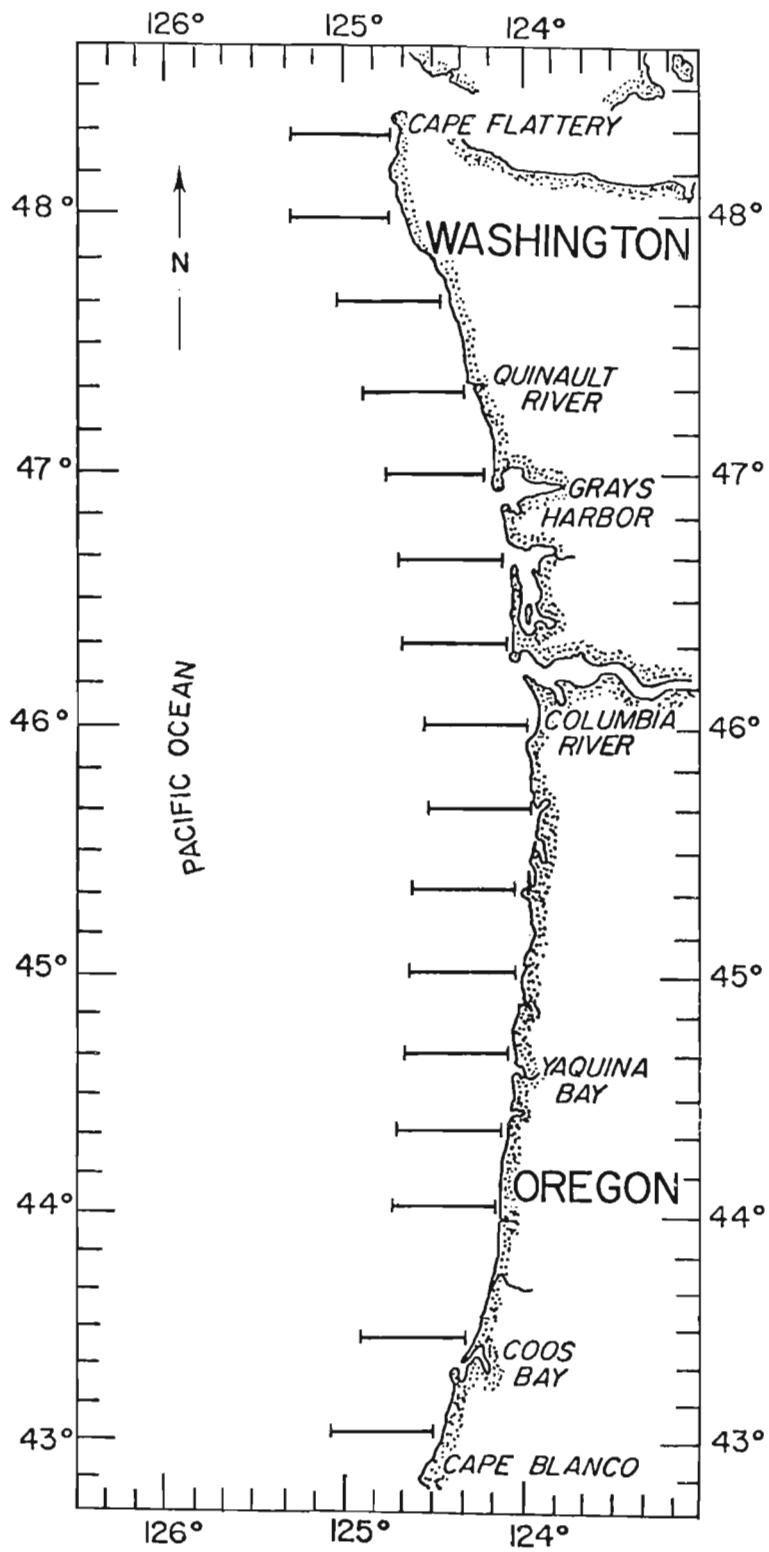
## ACKNOWLEDGMENTS

We thank Craig Banner, Alton Chung, Joe Fisher, Dean Gushee, Jon Shenker, and Waldo Wakefield for their generous assistance in the field. We are indebted to Wayne Laroche for identifying and measuring the juvenile rockfishes. Alton Chung, Joe Fisher, Harriet Lorz, and Eric Rexstad assisted with the data compilation, computer analysis, and figure preparation. This study is the result of research funded by the Northwest and Alaska Fisheries Center of the National Marine Fisheries Service, NOAA.

## CITATIONS

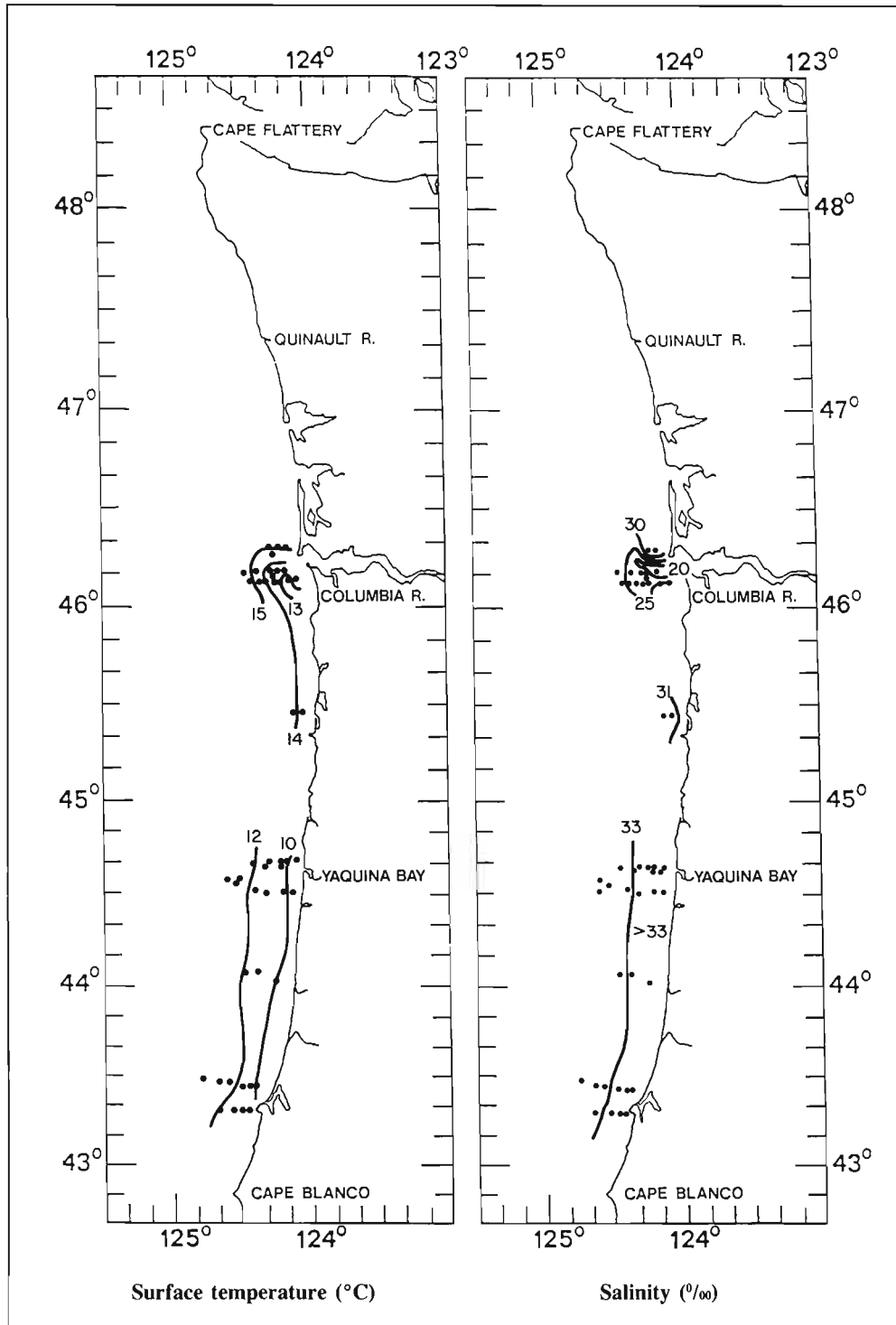
- ALLEN, L. G., and E. E. DeMARTINI.  
1983. Temporal and spatial patterns of nearshore distribution and abundance of the pelagic fishes off San Onofre-Oceanside, California. *Fish. Bull.*, U.S. 81:569-586.
- ALLEN, M. J.  
1982. Functional structure of soft-bottom fish communities of the Southern California 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**

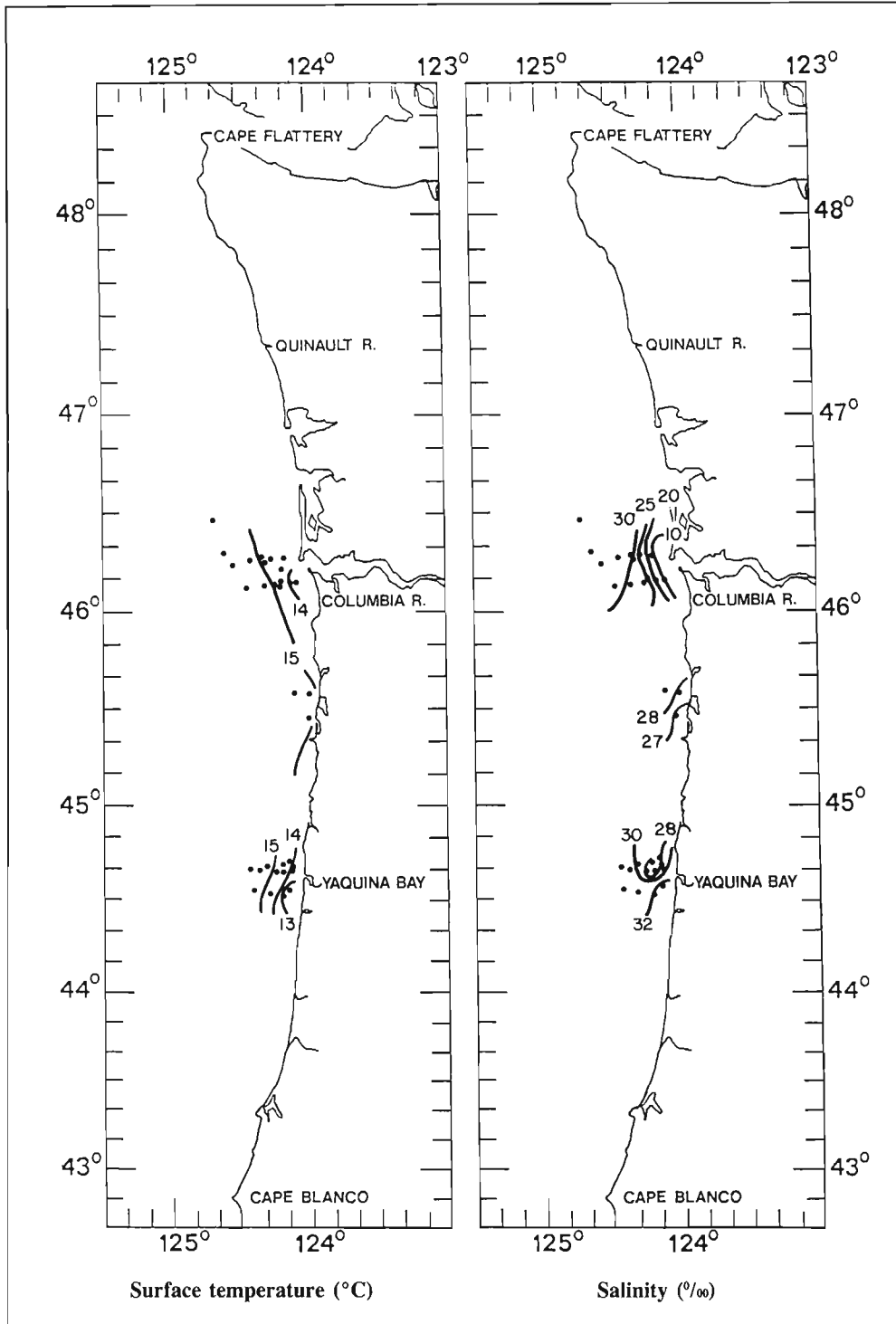
Location of sampling area and transect lines used in the study.



**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.



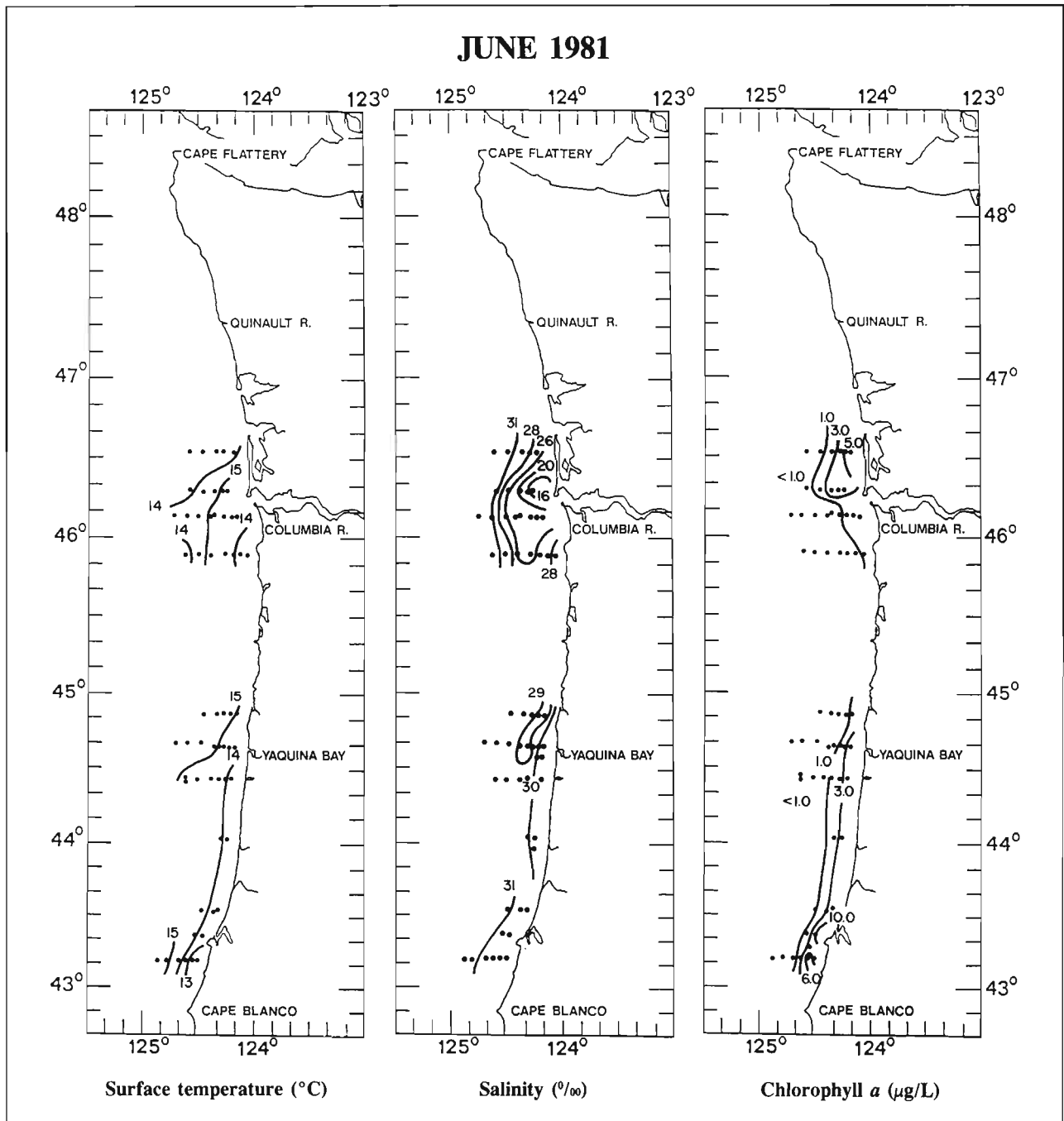


Figure 5

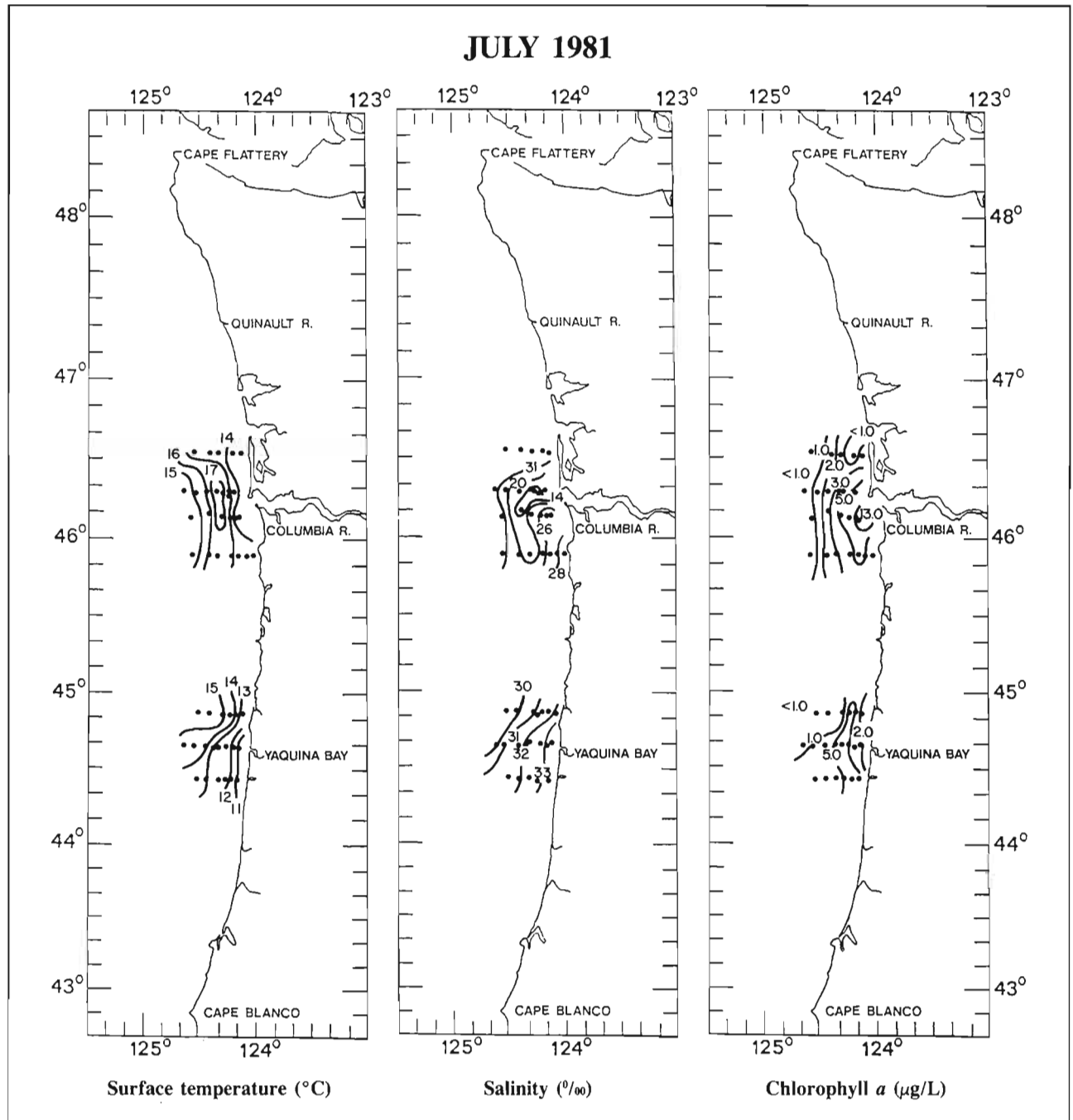


Figure 6

# AUGUST 1981

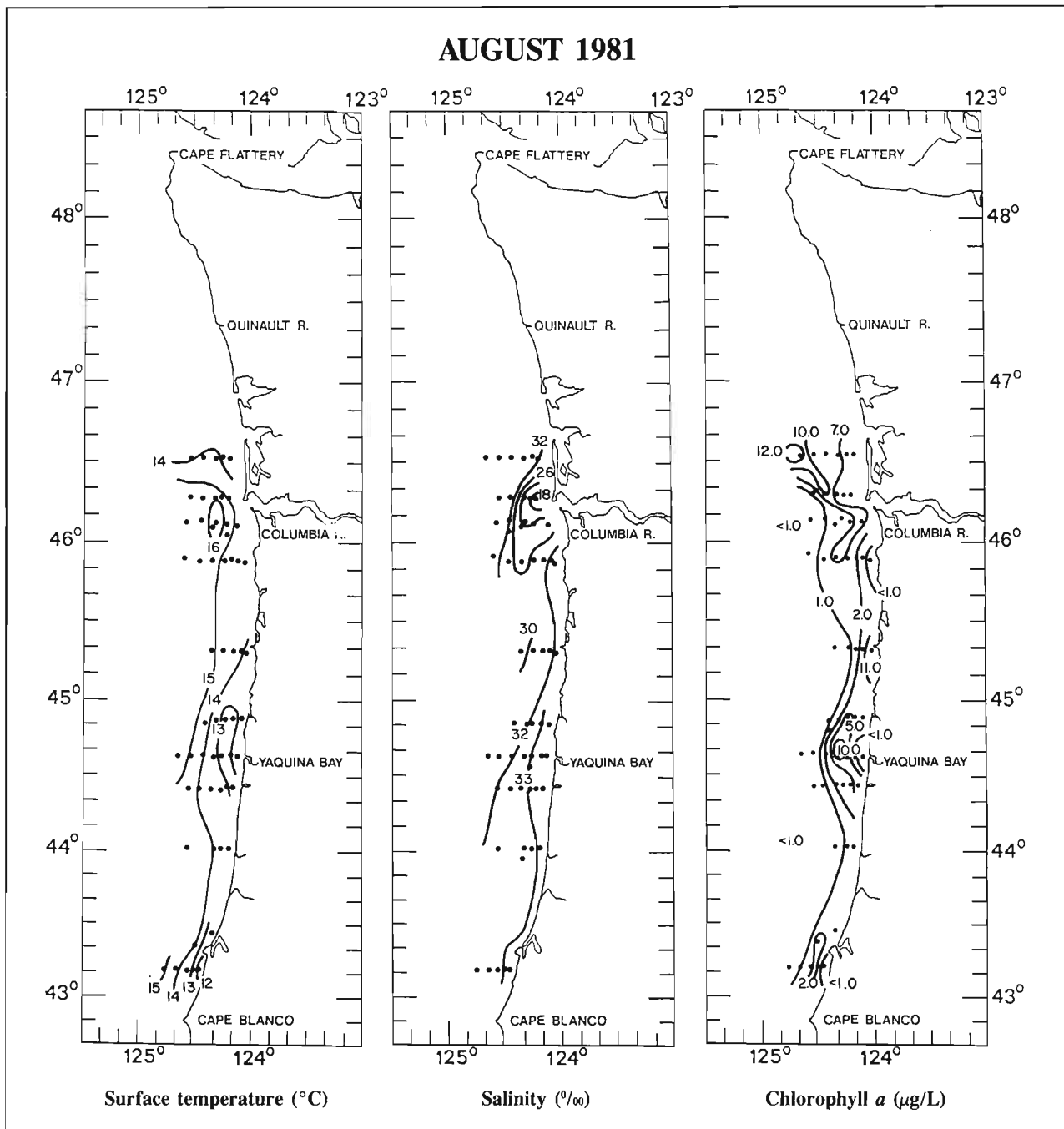


Figure 7

MAY 1982

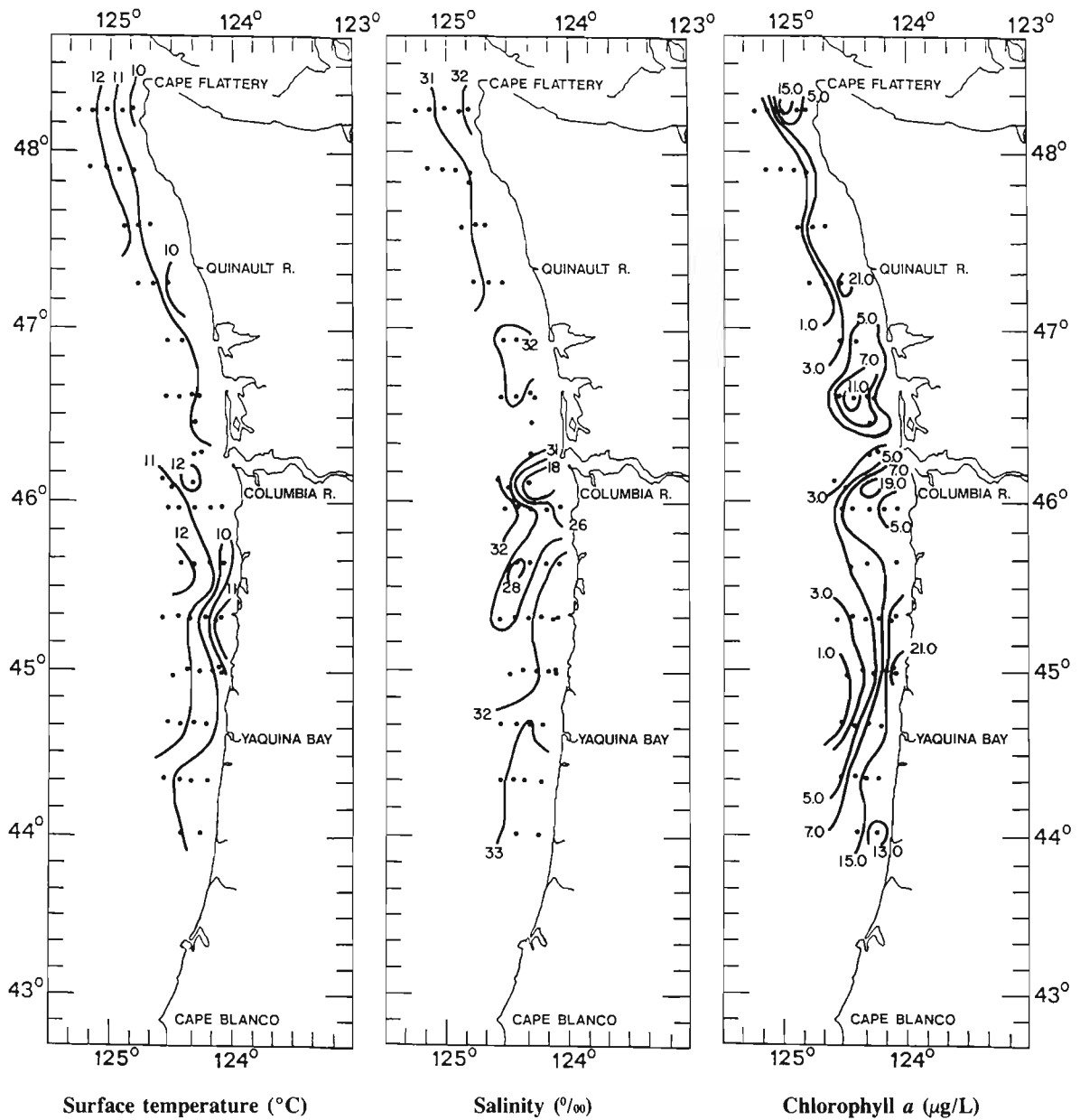
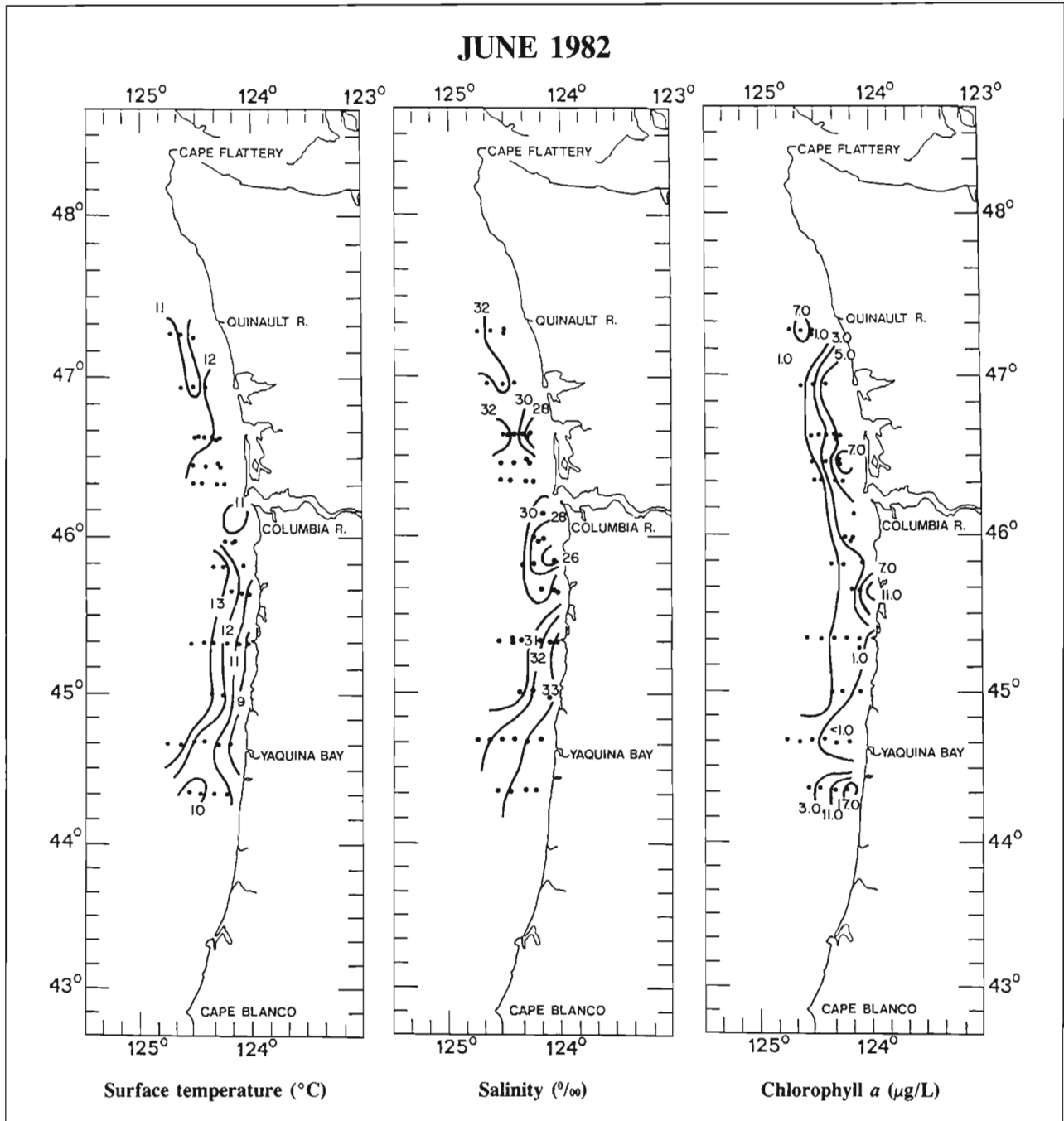


Figure 8



**Figure 9**

# SEPTEMBER 1982

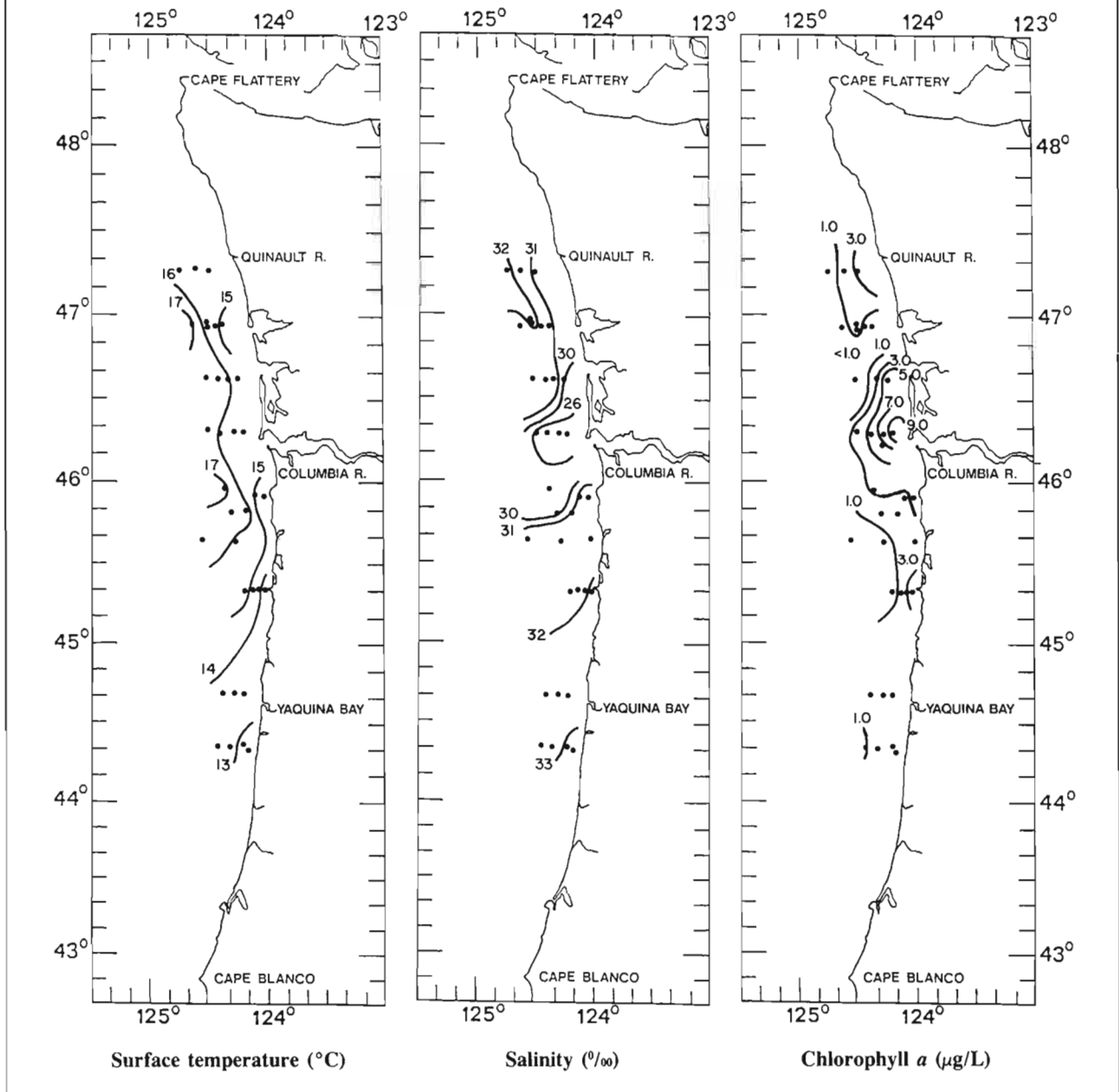
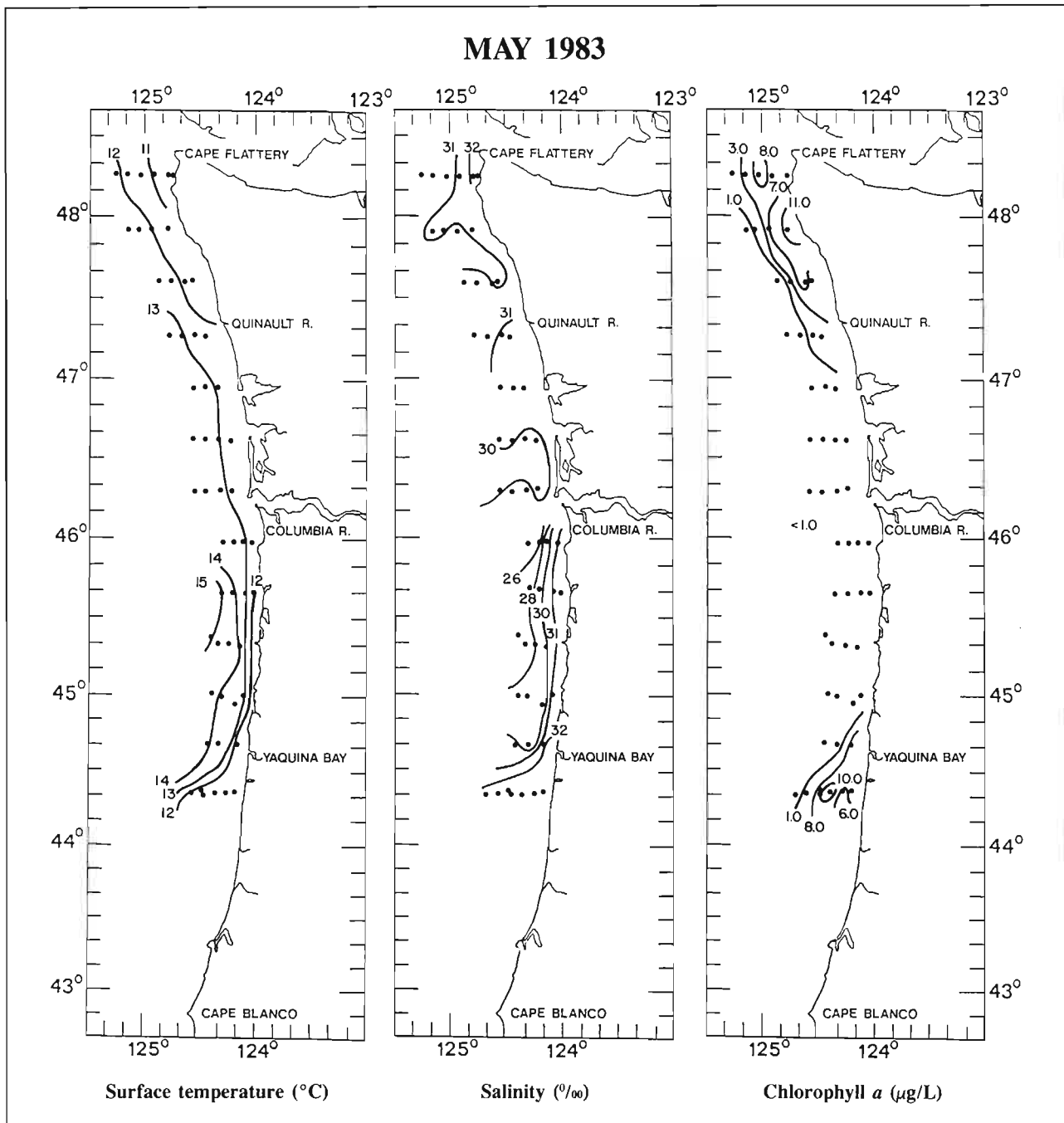


Figure 10





**Figure 11**

# JUNE 1983

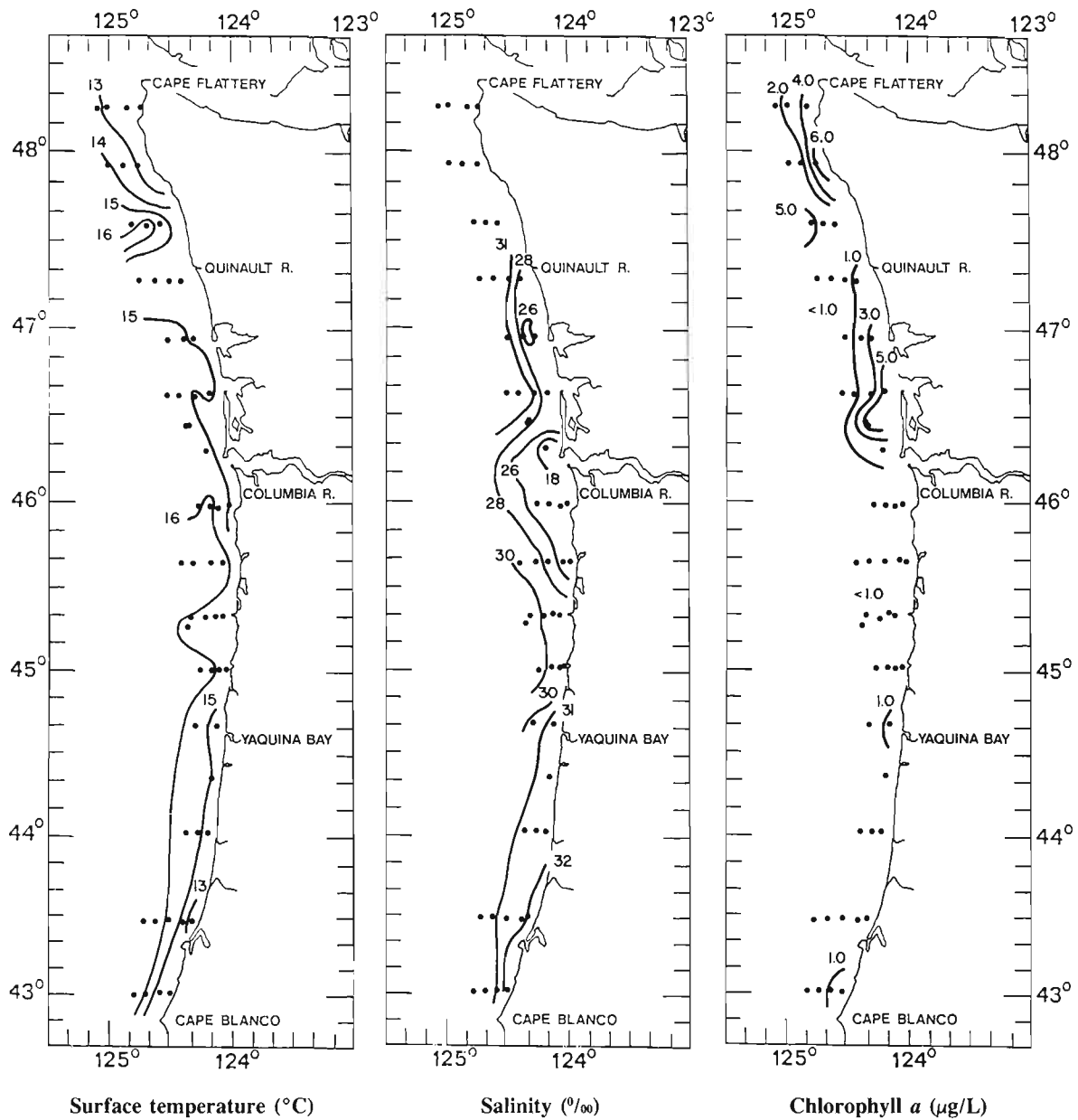


Figure 12

SEPTEMBER 1983

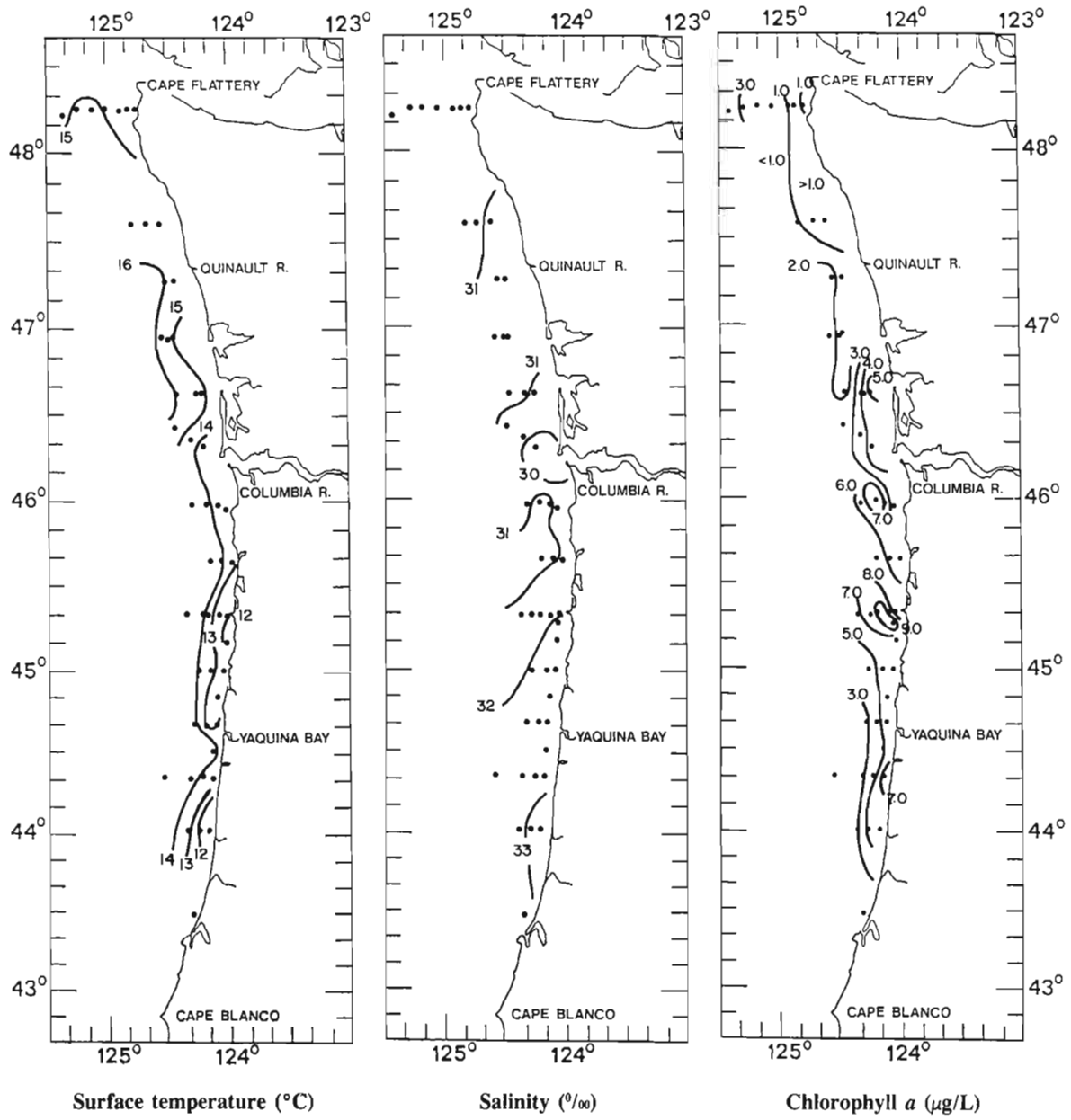


Figure 13

# JUNE 1984

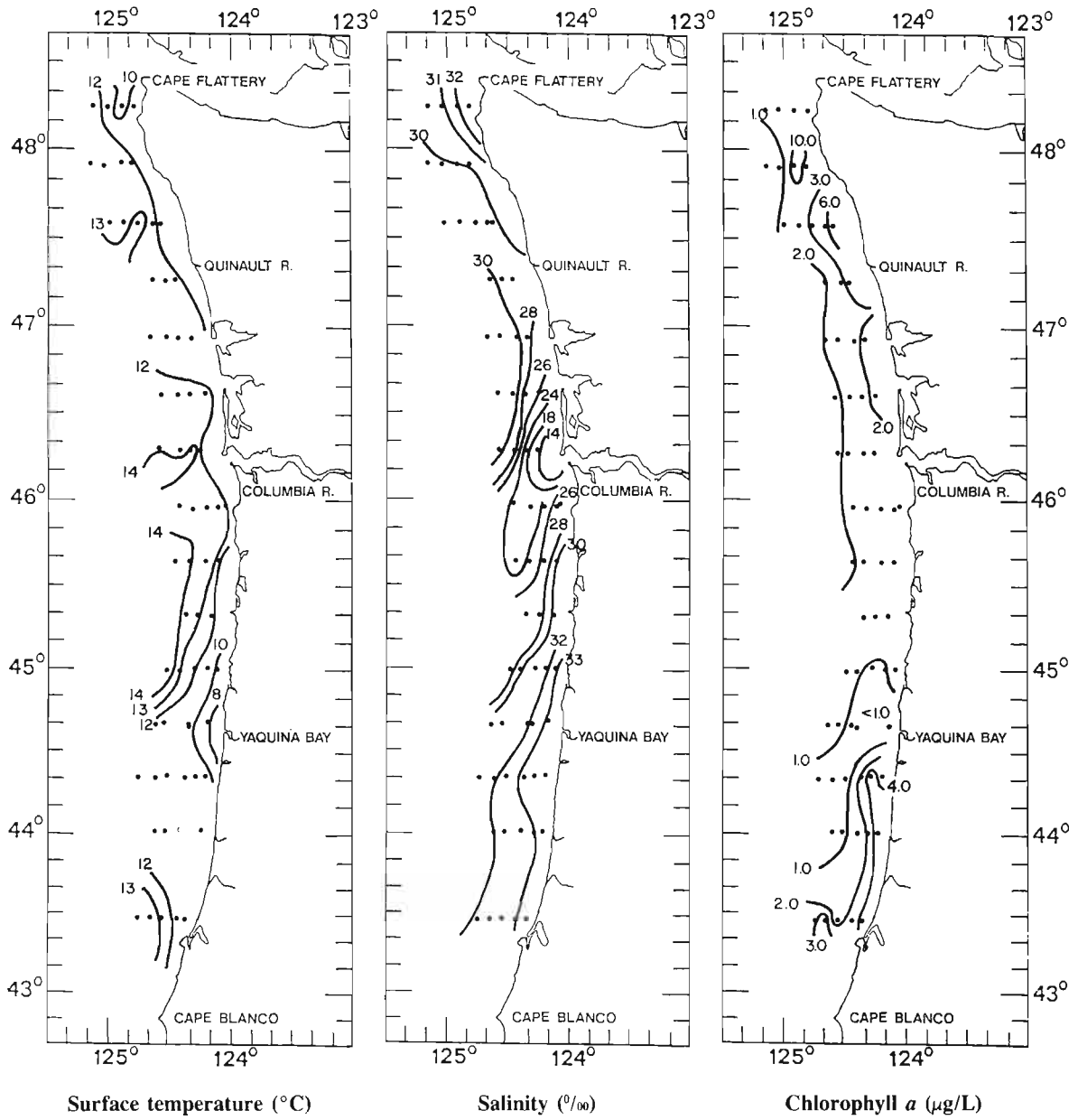
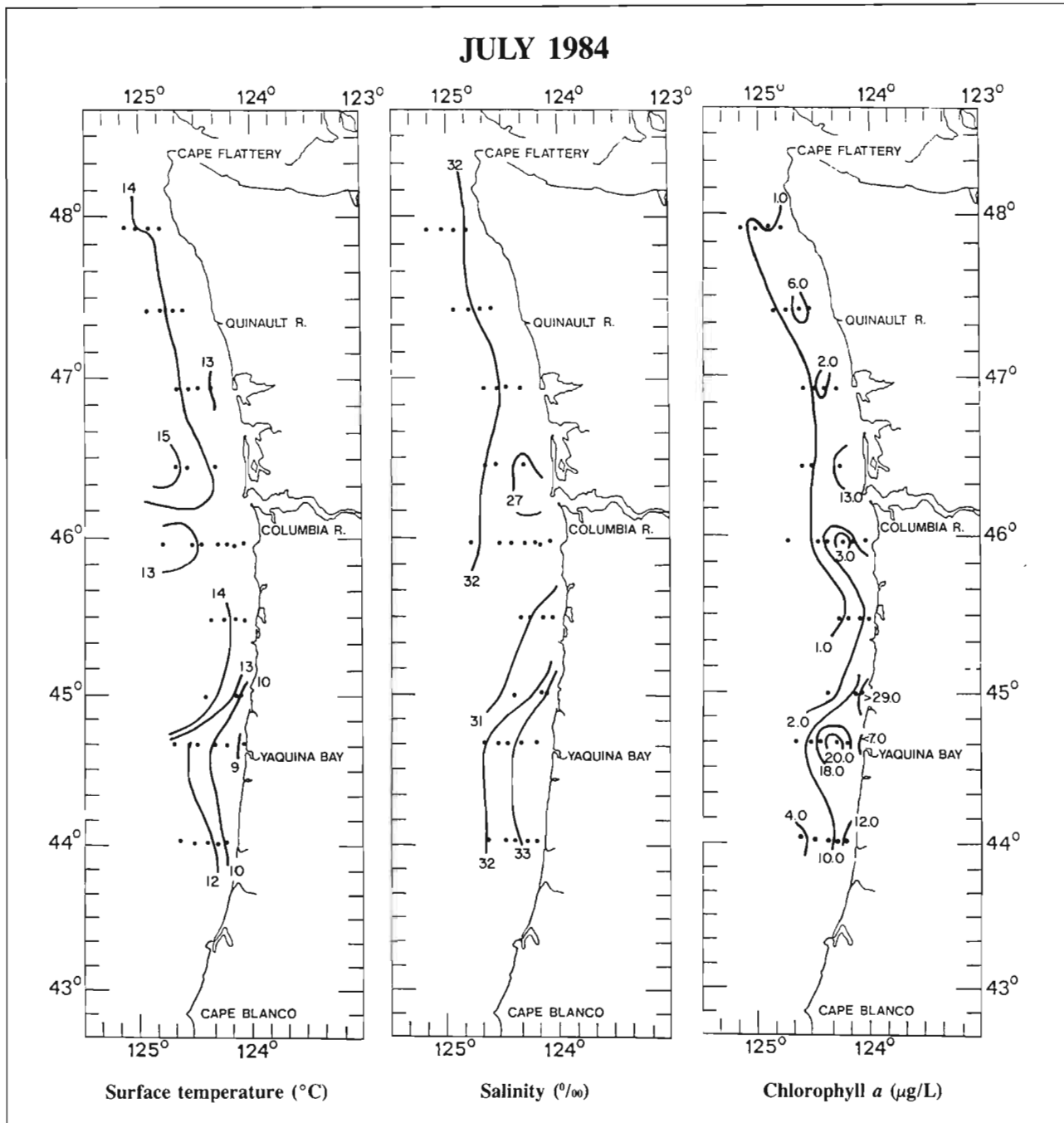


Figure 14



**Figure 15**

# SEPTEMBER 1984

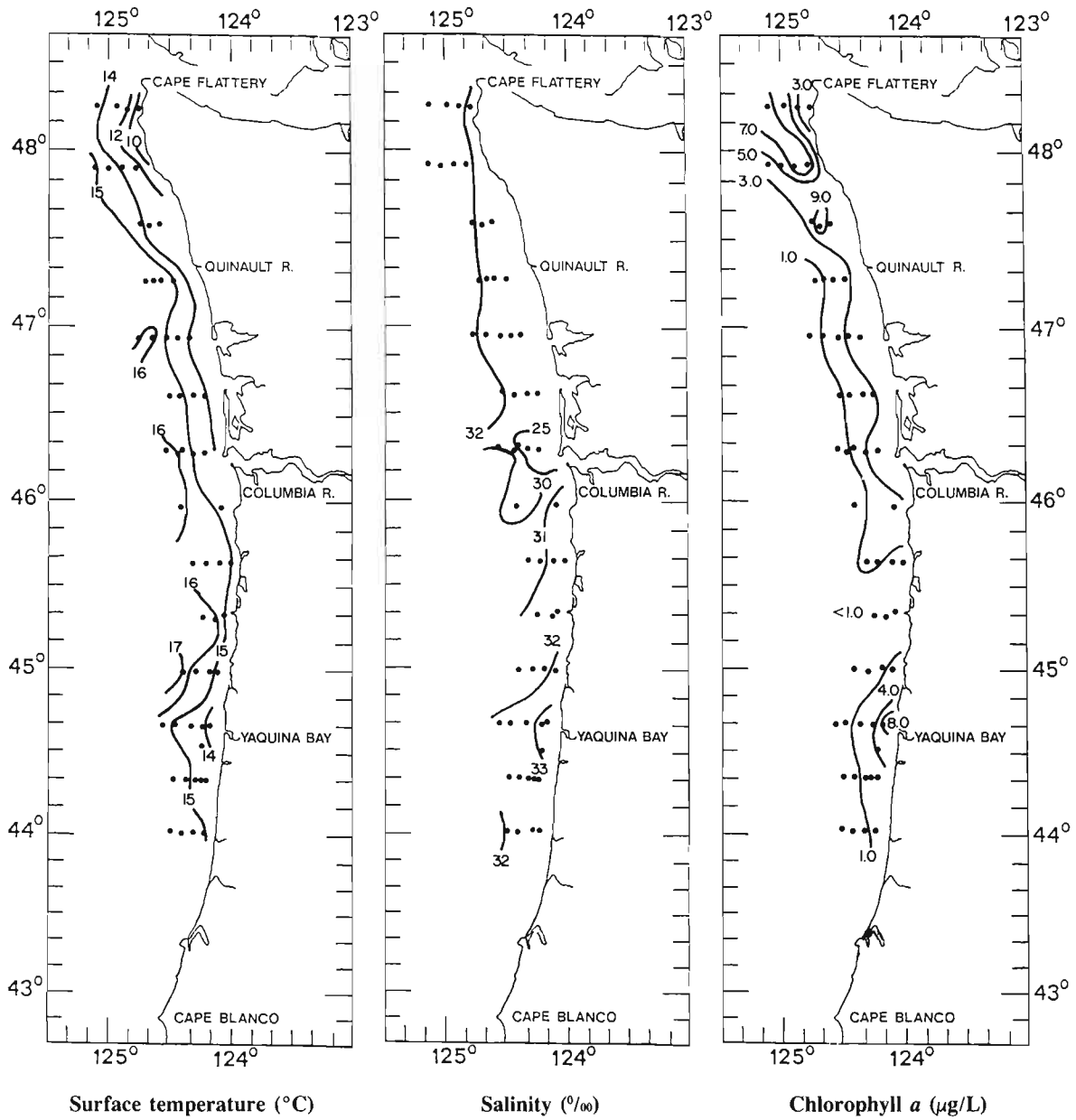


Figure 16

**Figures 17 through 59**

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

*Loligo opalescens*

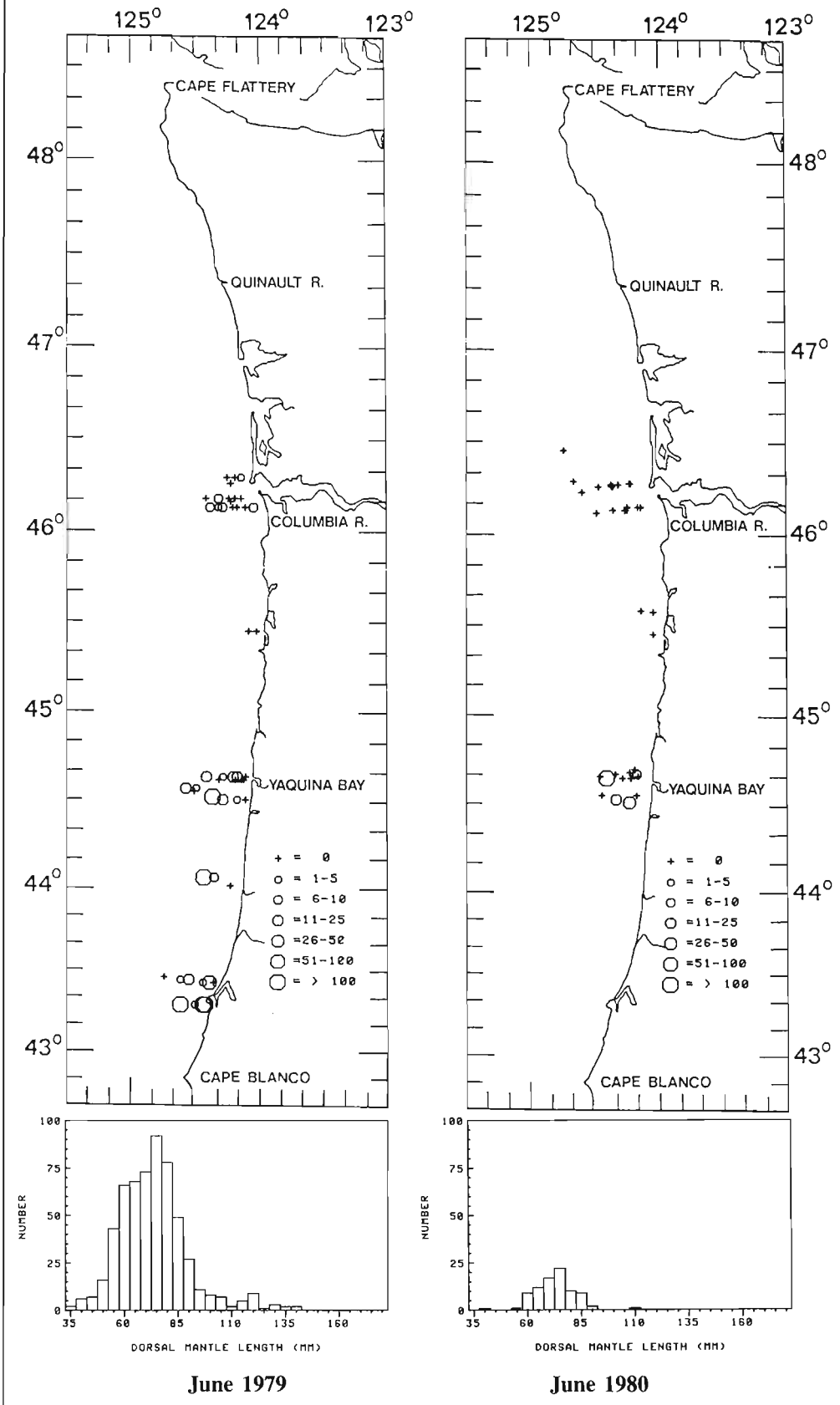


Figure 17



*Loligo opalescens*

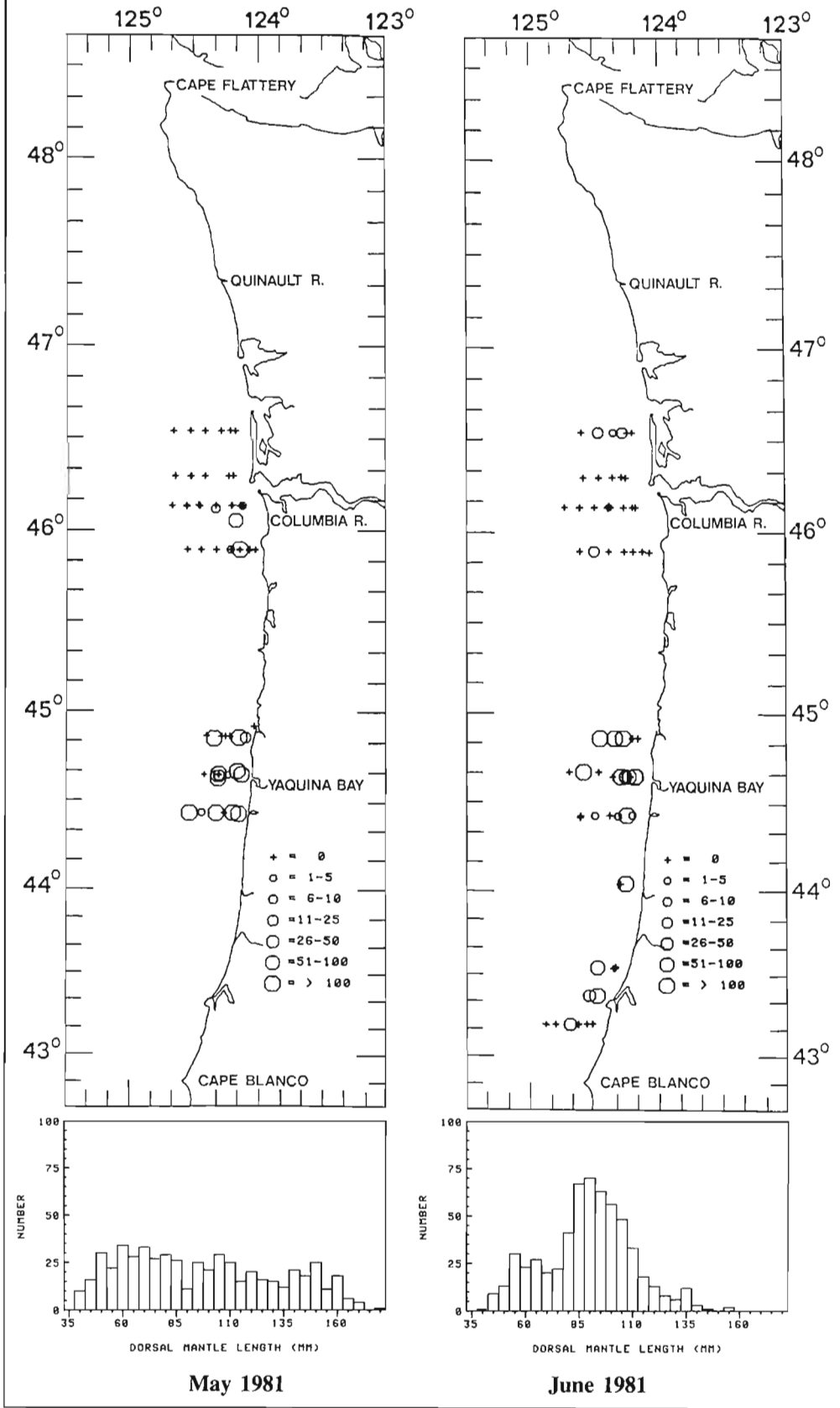


Figure 18

*Loligo opalescens*

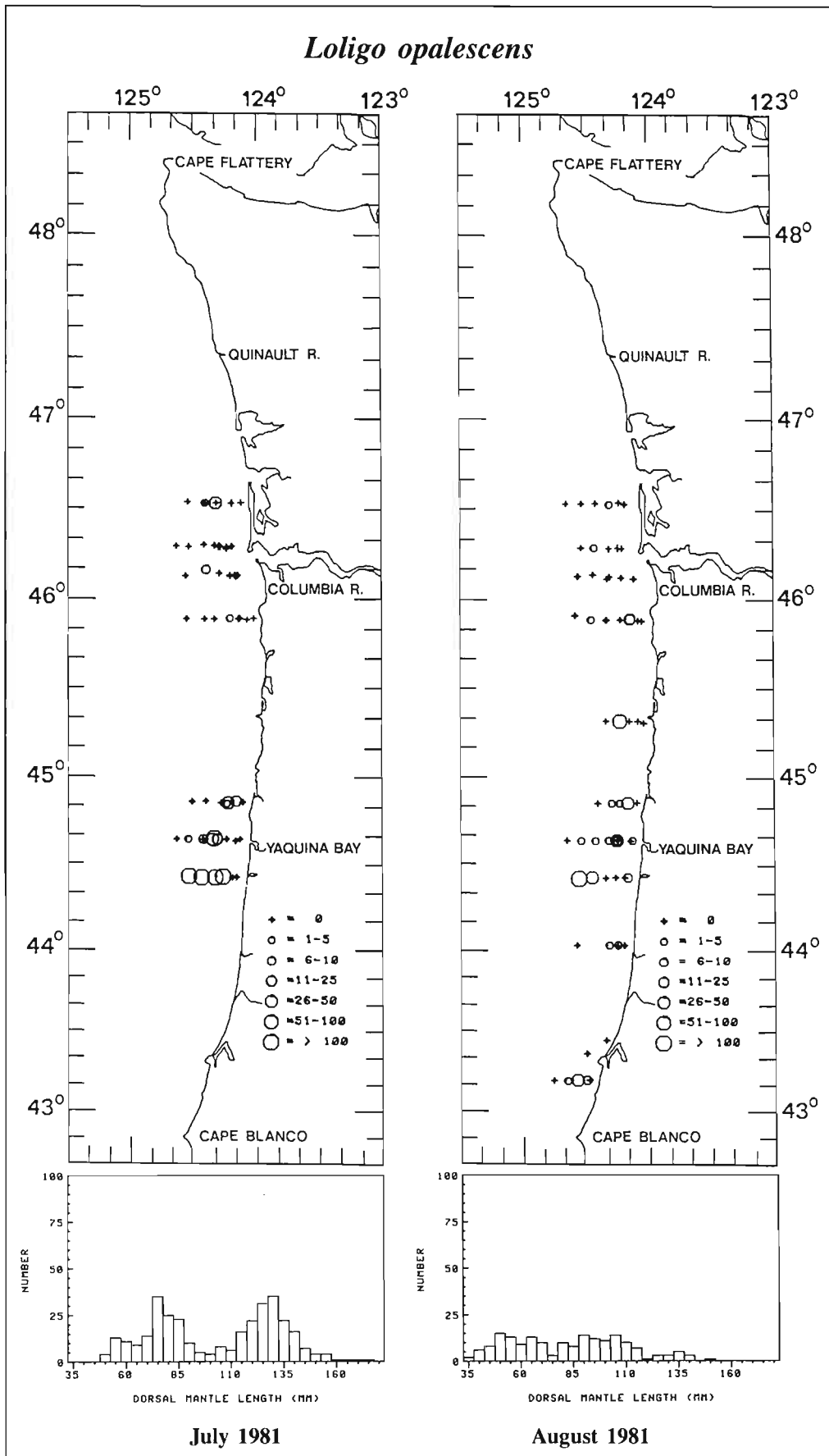


Figure 19

*Loligo opalescens*

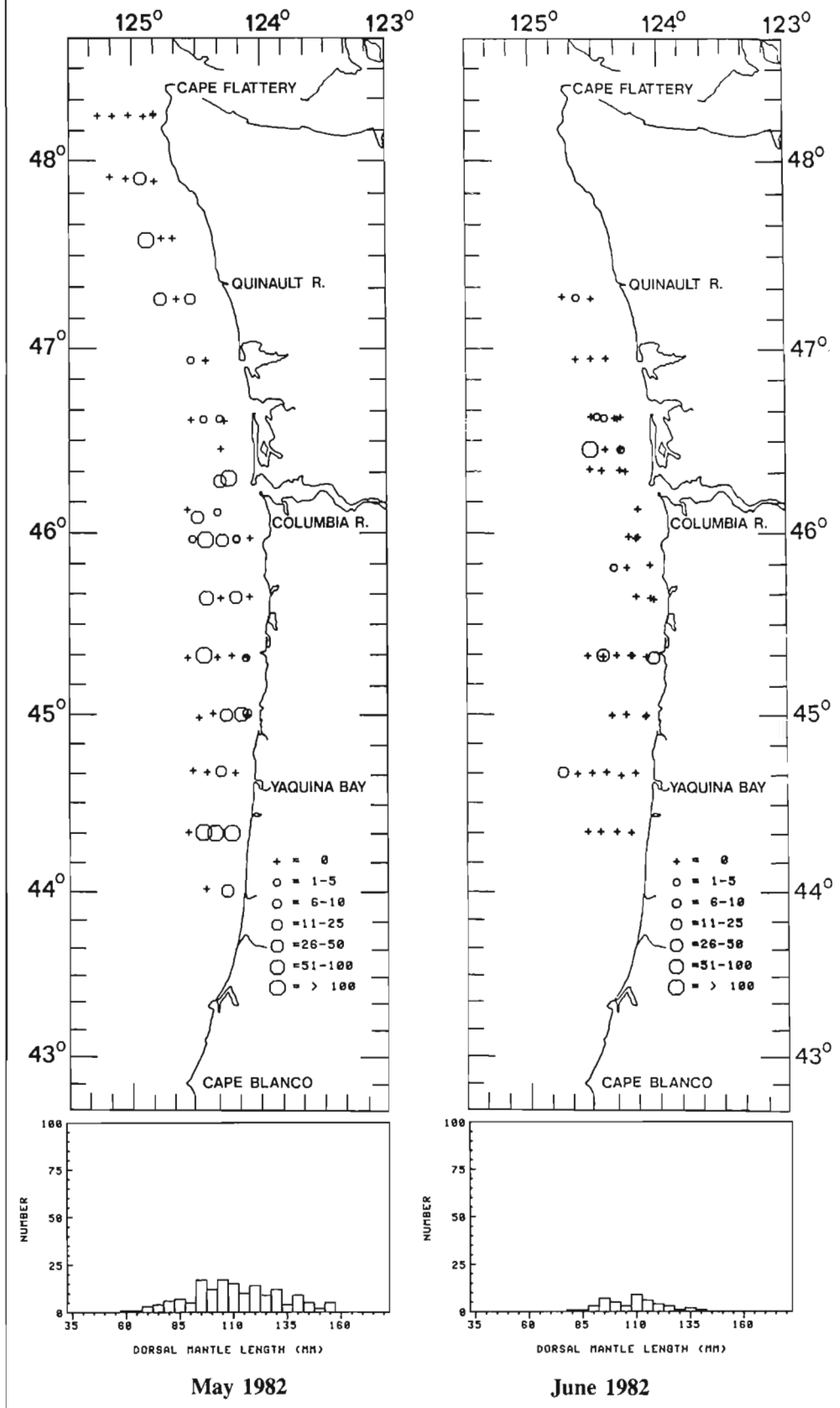


Figure 20

*Loligo opalescens*

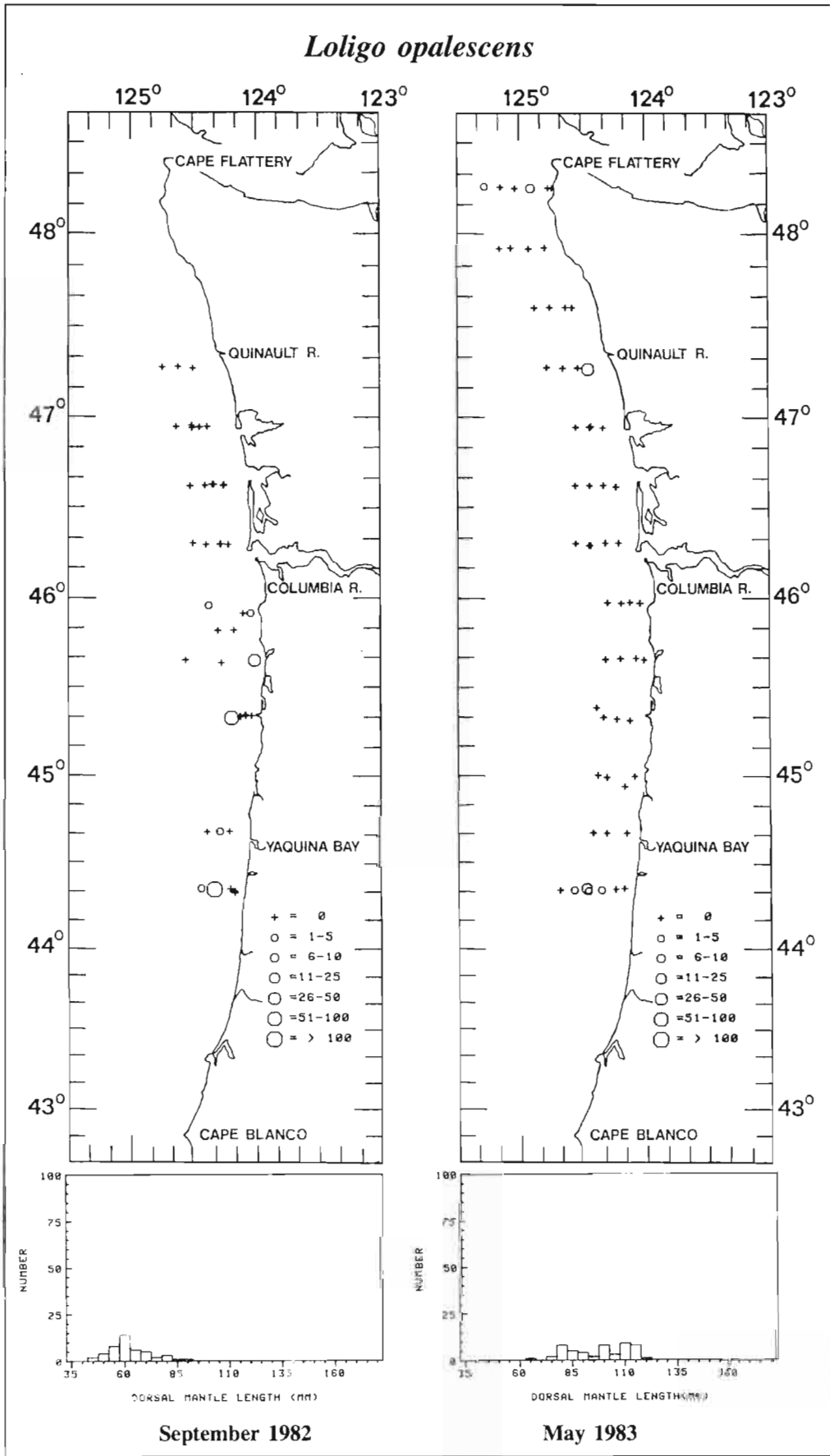


Figure 21

*Loligo opalescens*

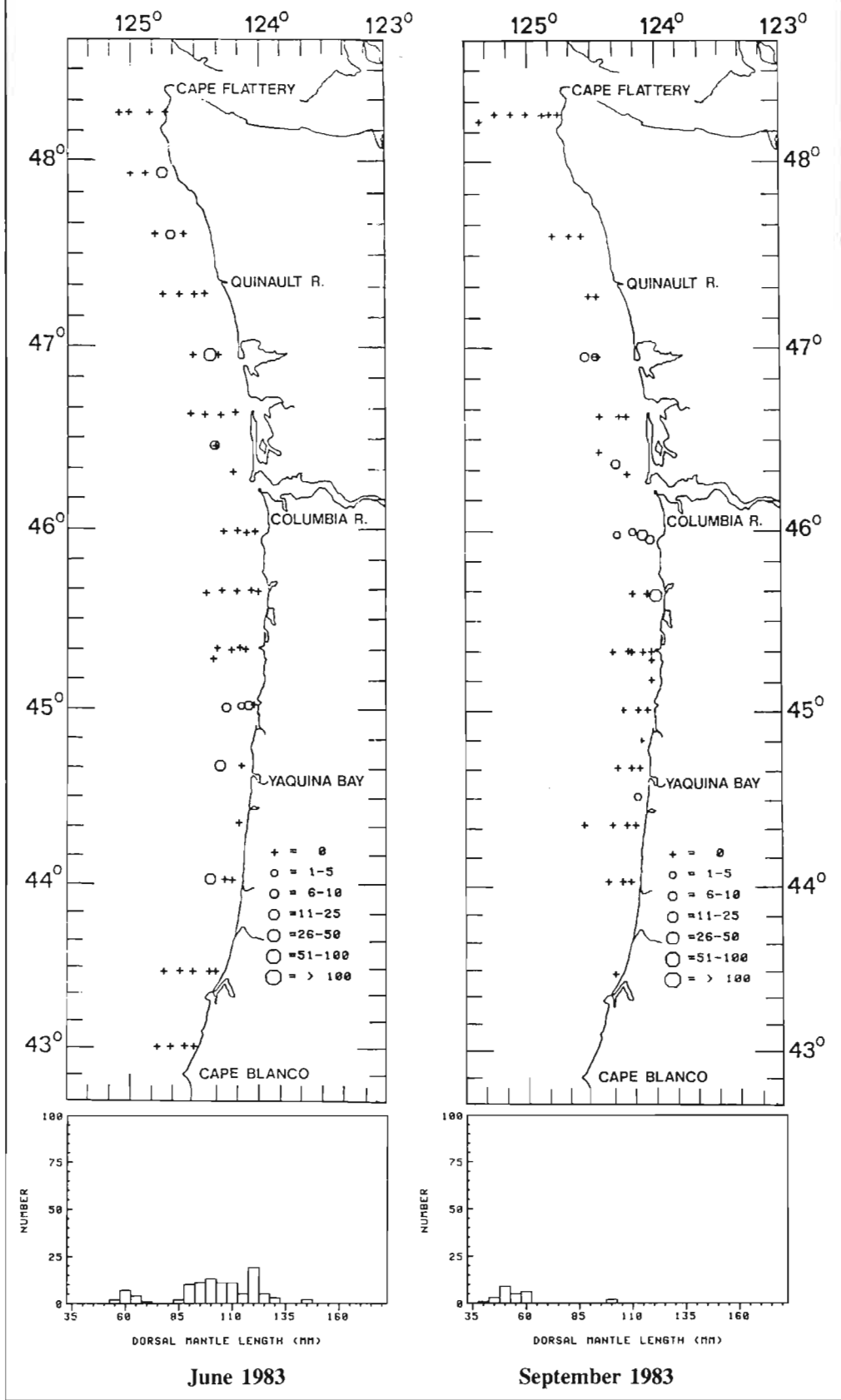
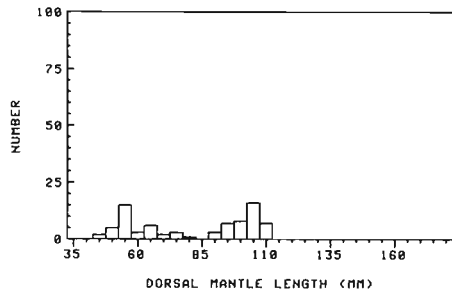
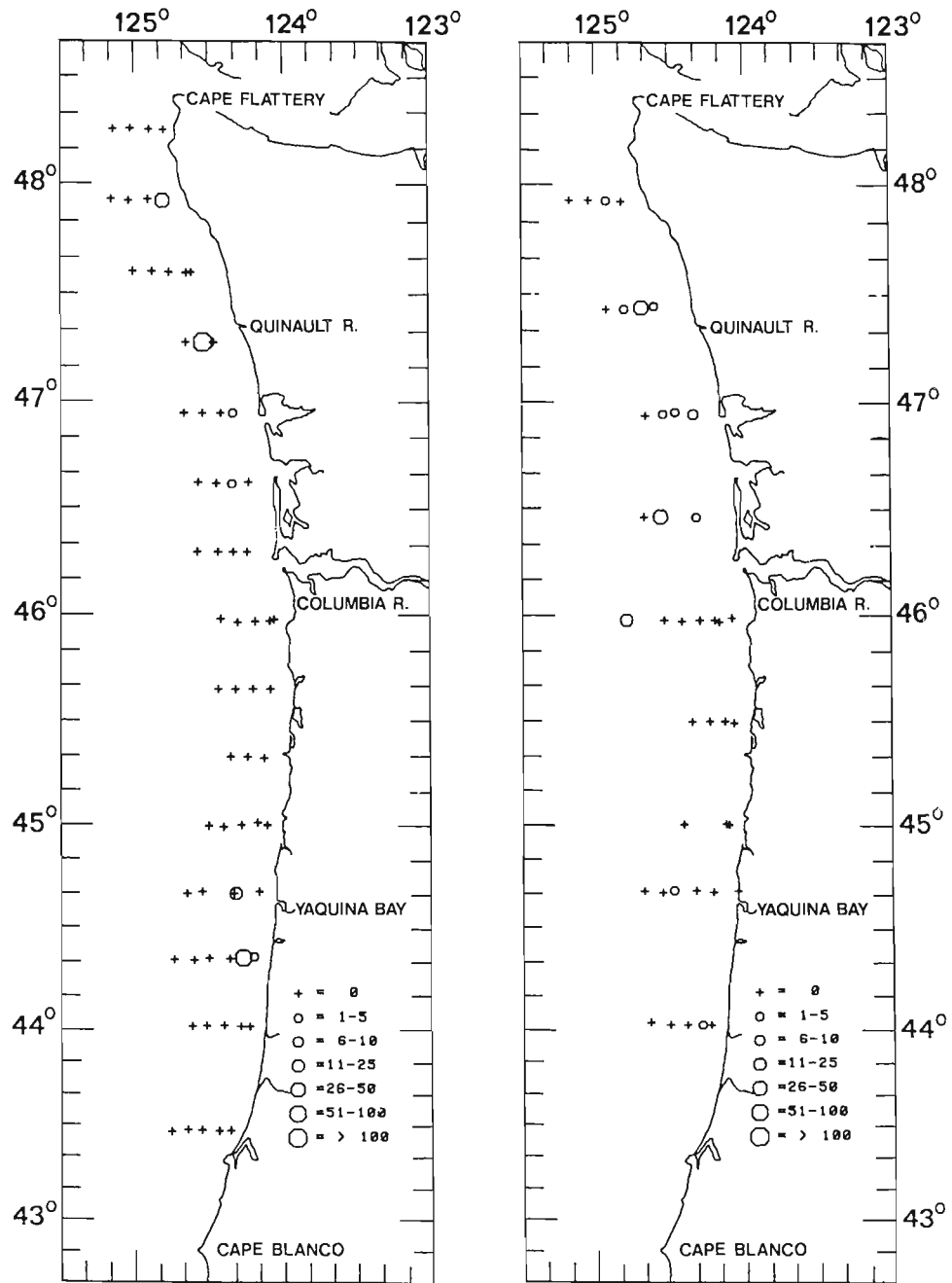
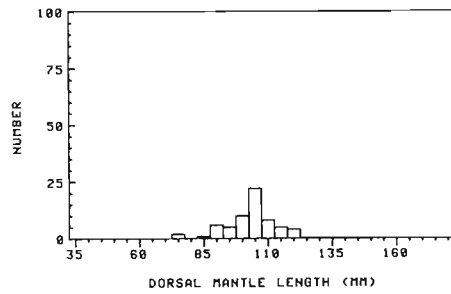


Figure 22

*Loligo opalescens*



June 1984



July 1984

Figure 23



*Squalus acanthias*

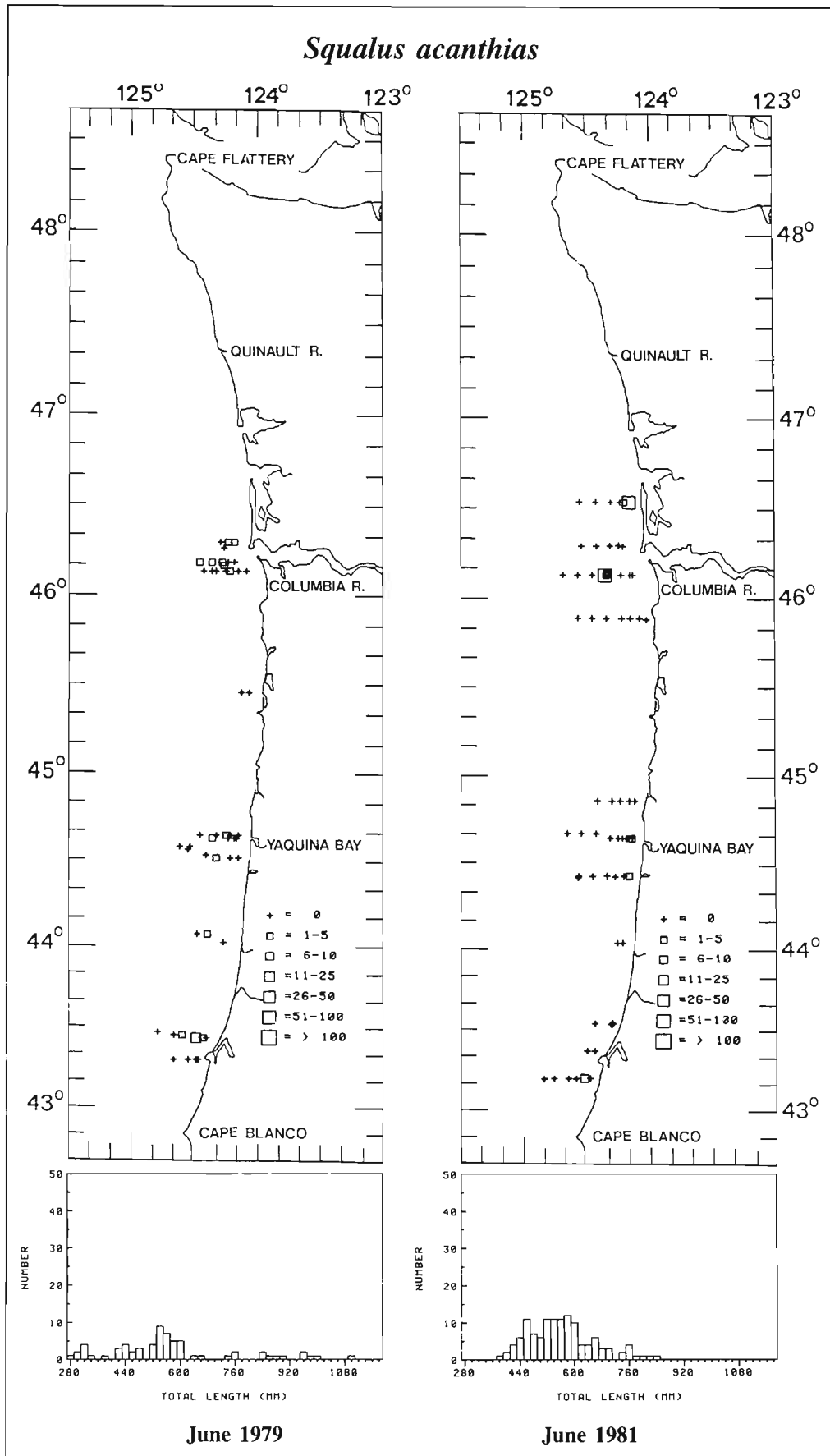


Figure 25



*Squalus acanthias*

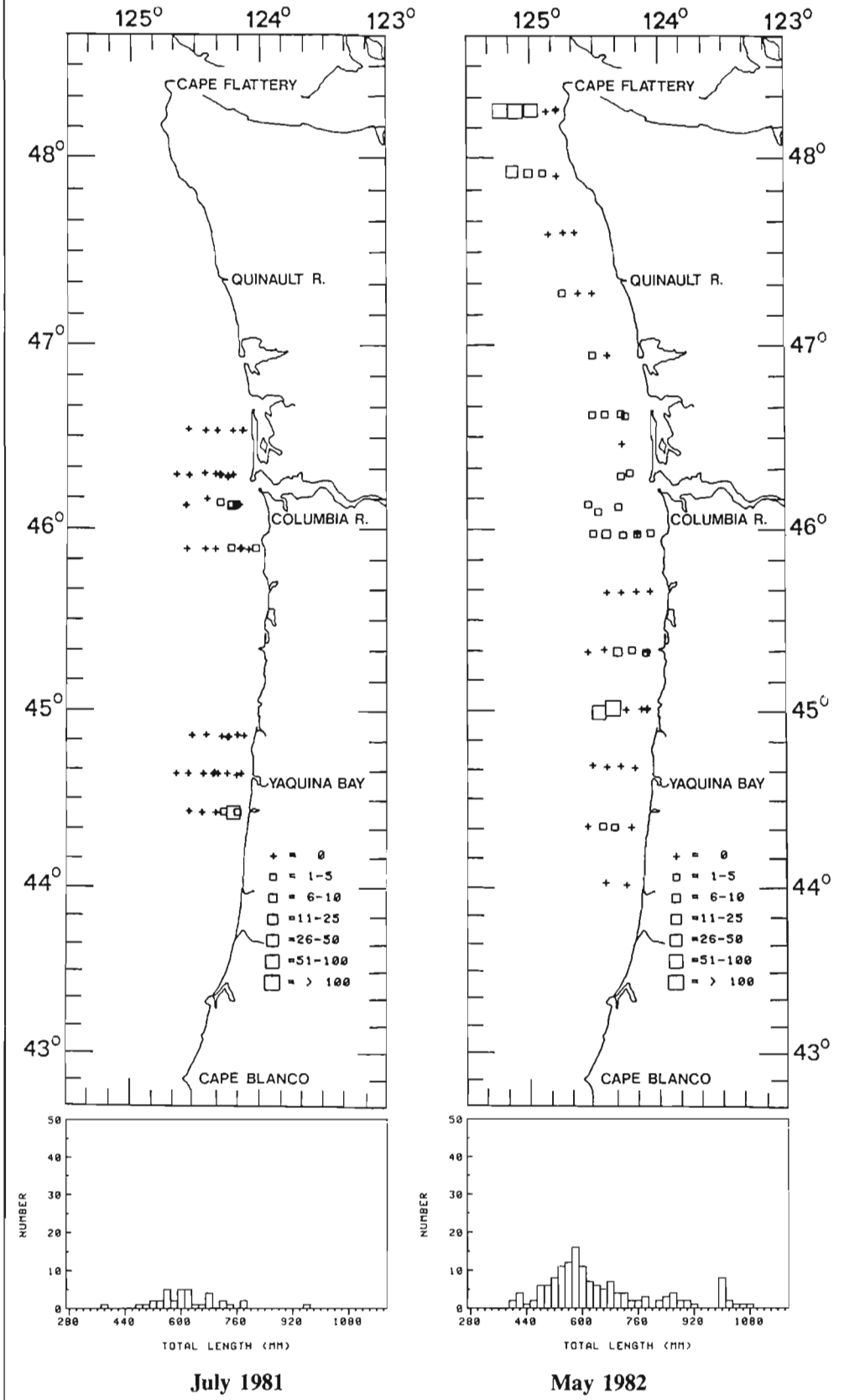


Figure 26

*Squalus acanthias*

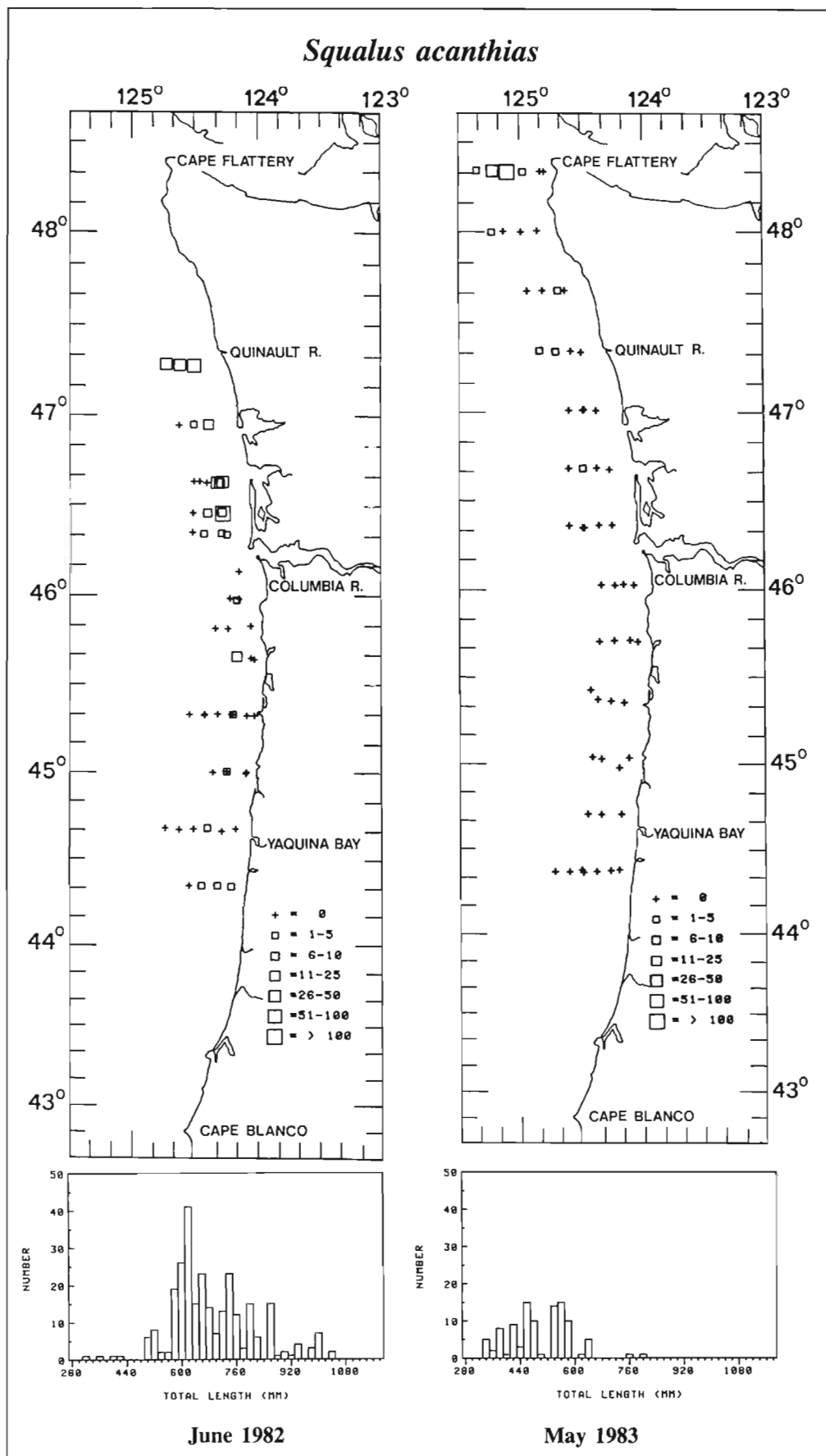


Figure 27

*Squalus acanthias*

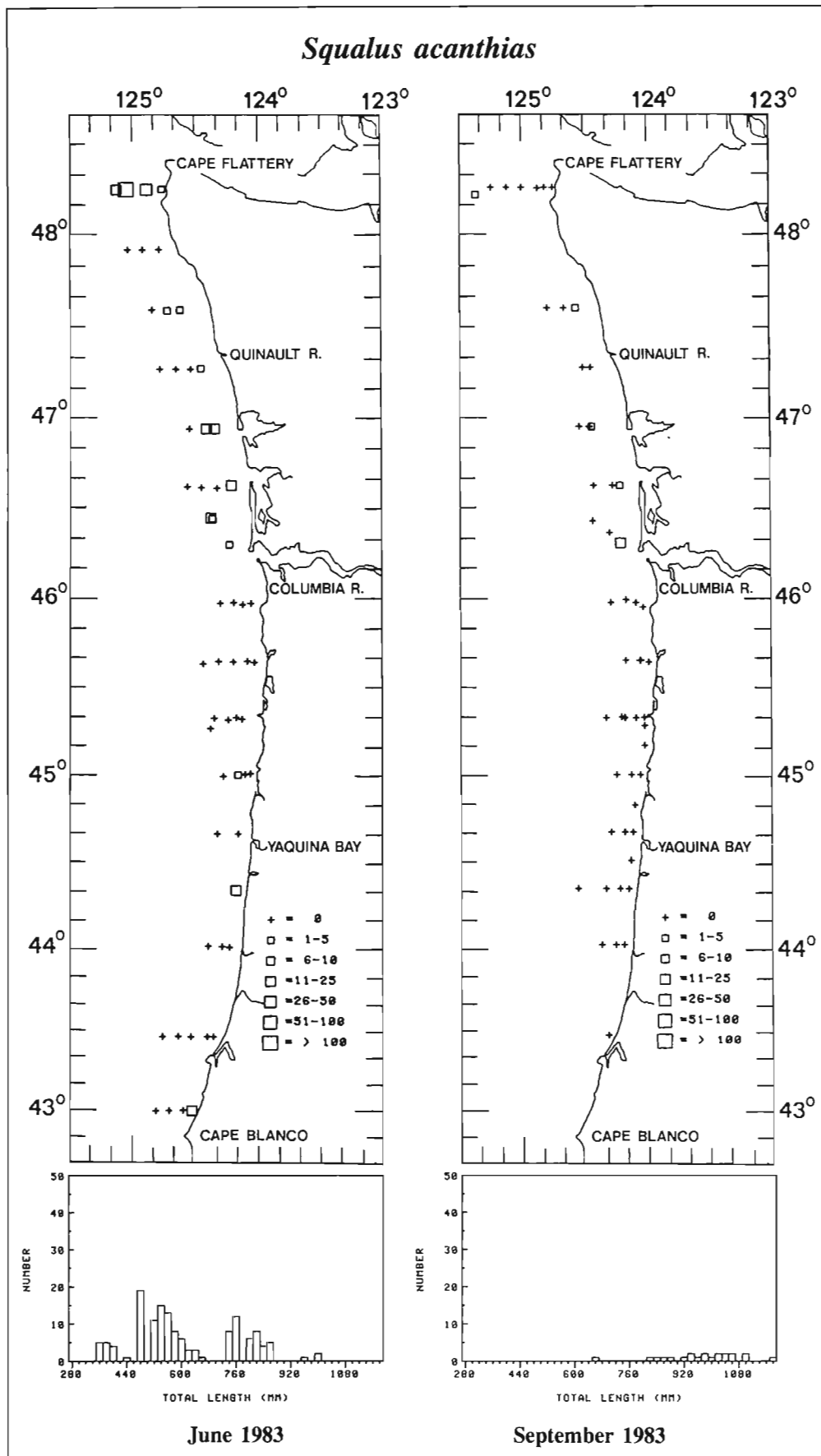


Figure 28

*Squalus acanthias*

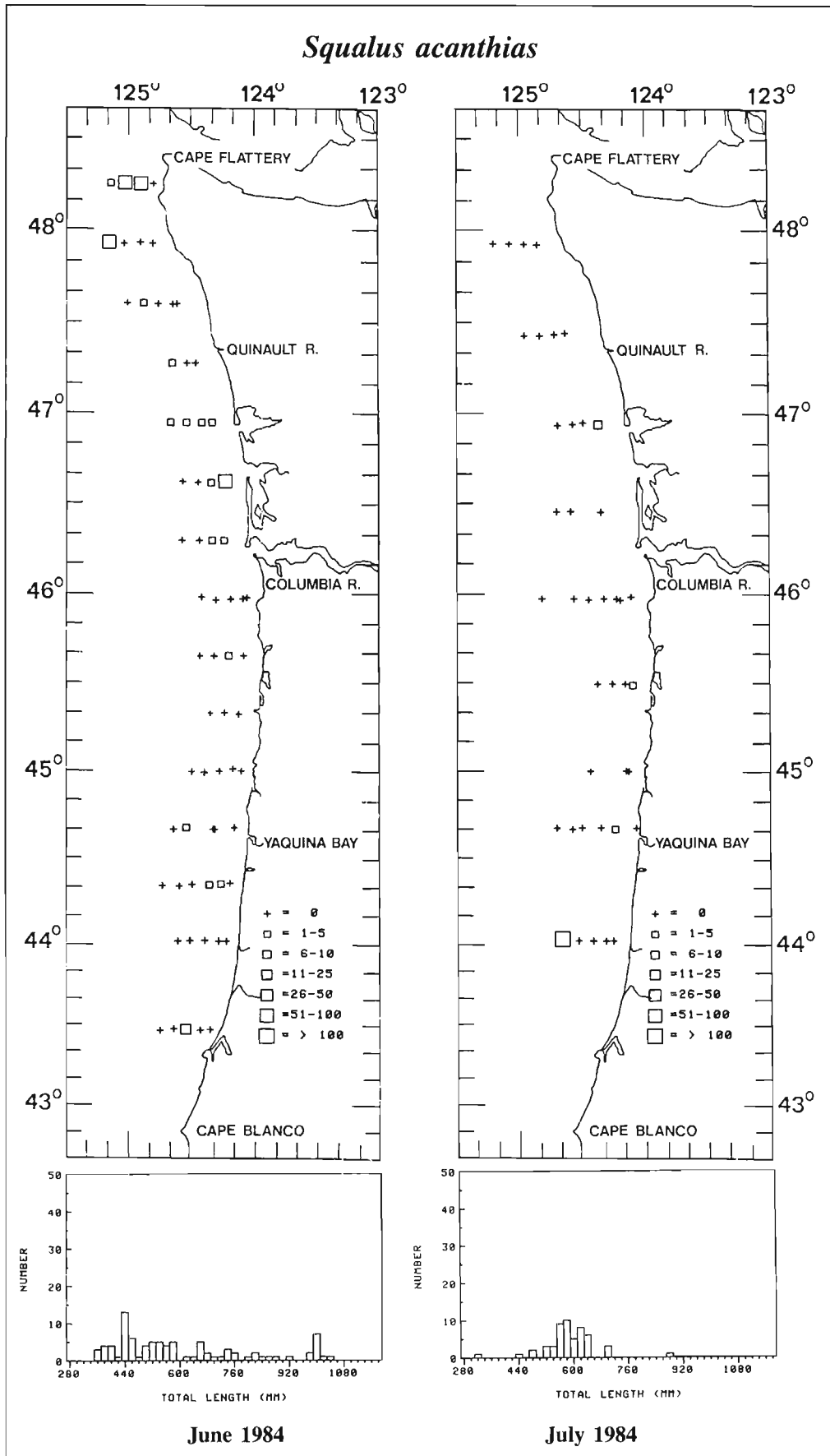


Figure 29

*Clupea harengus pallasii*

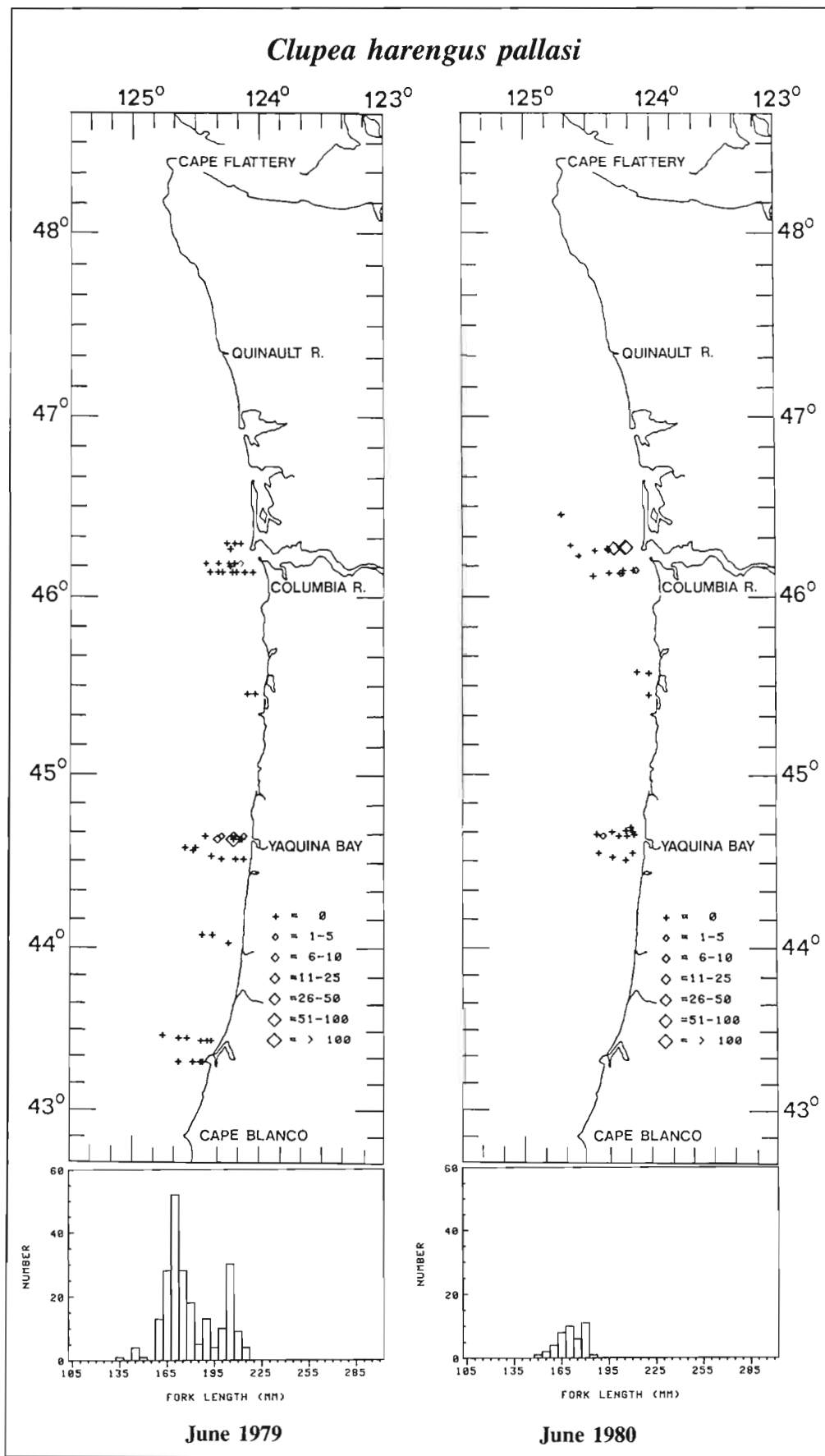


Figure 30

*Clupea harengus pallasii*

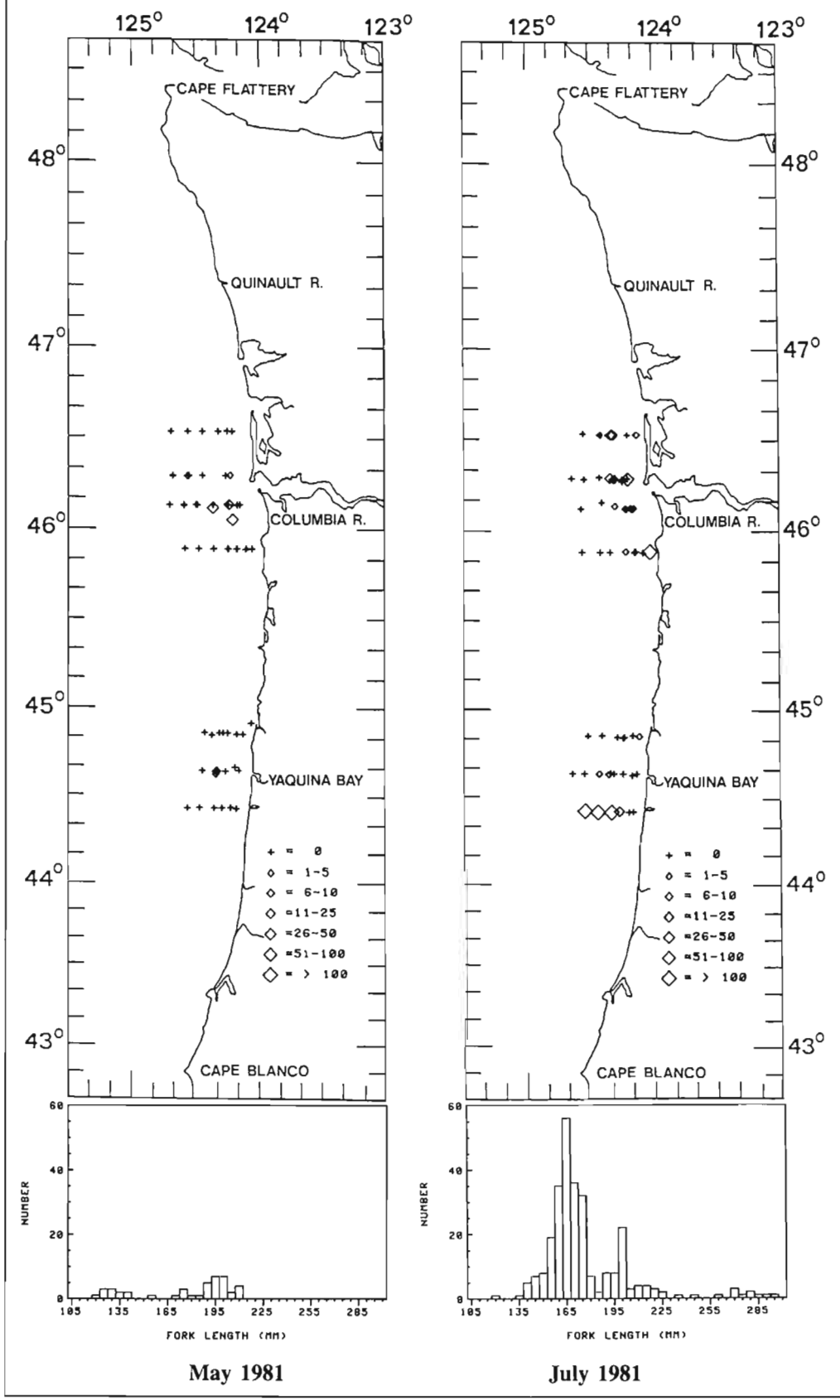


Figure 31

*Clupea harengus pallasii*

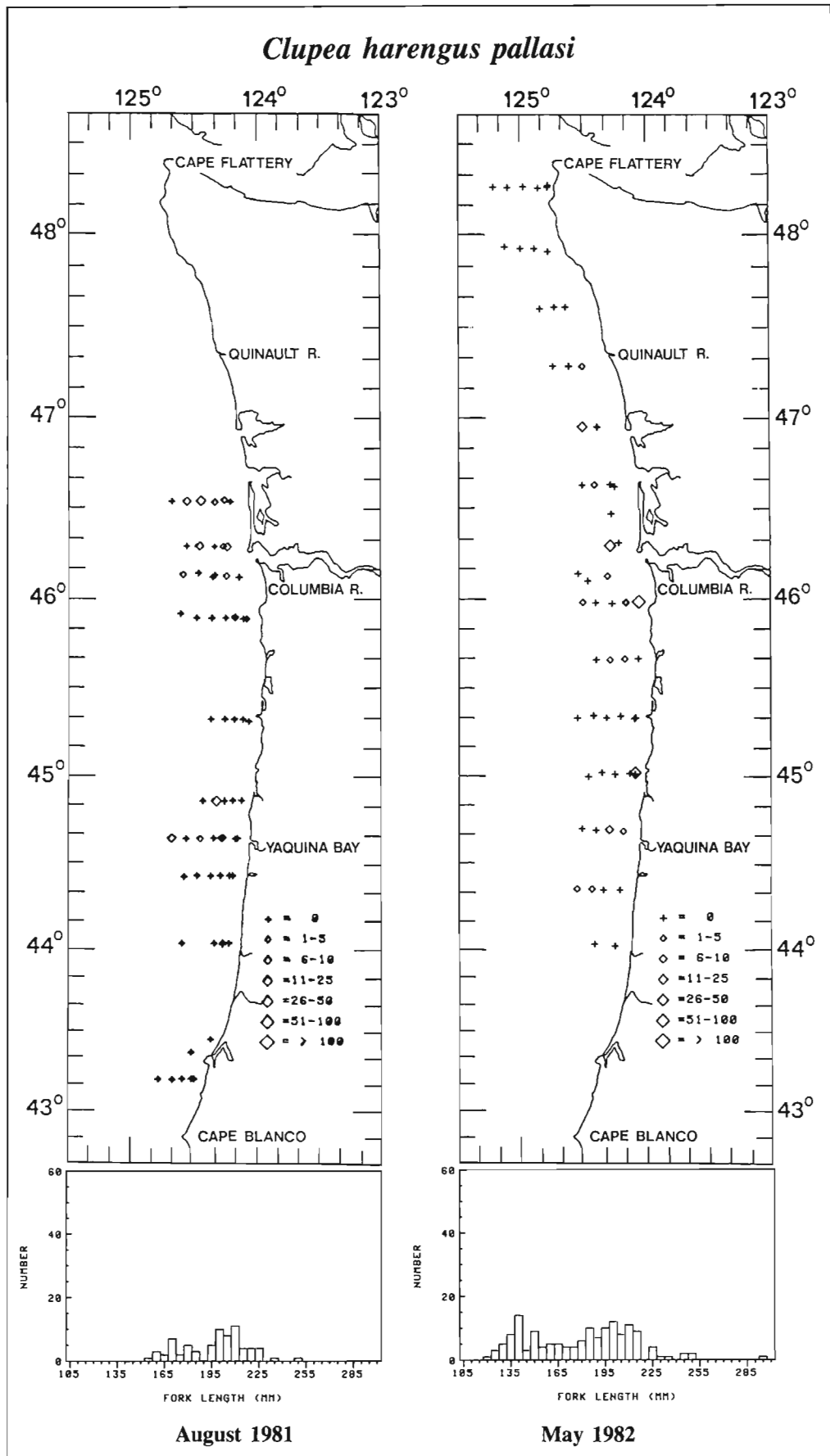


Figure 32

*Clupea harengus pallasii*

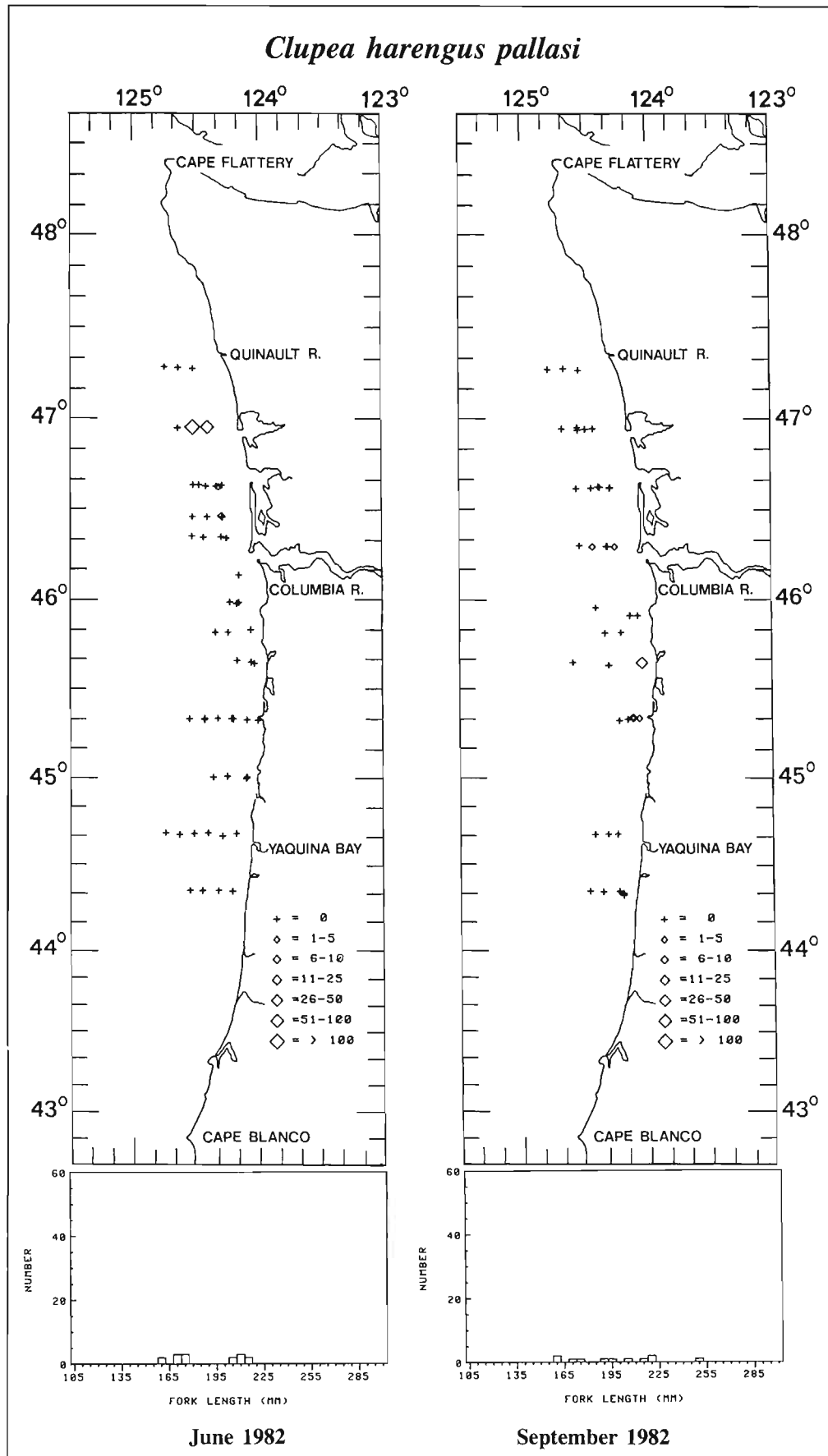


Figure 33



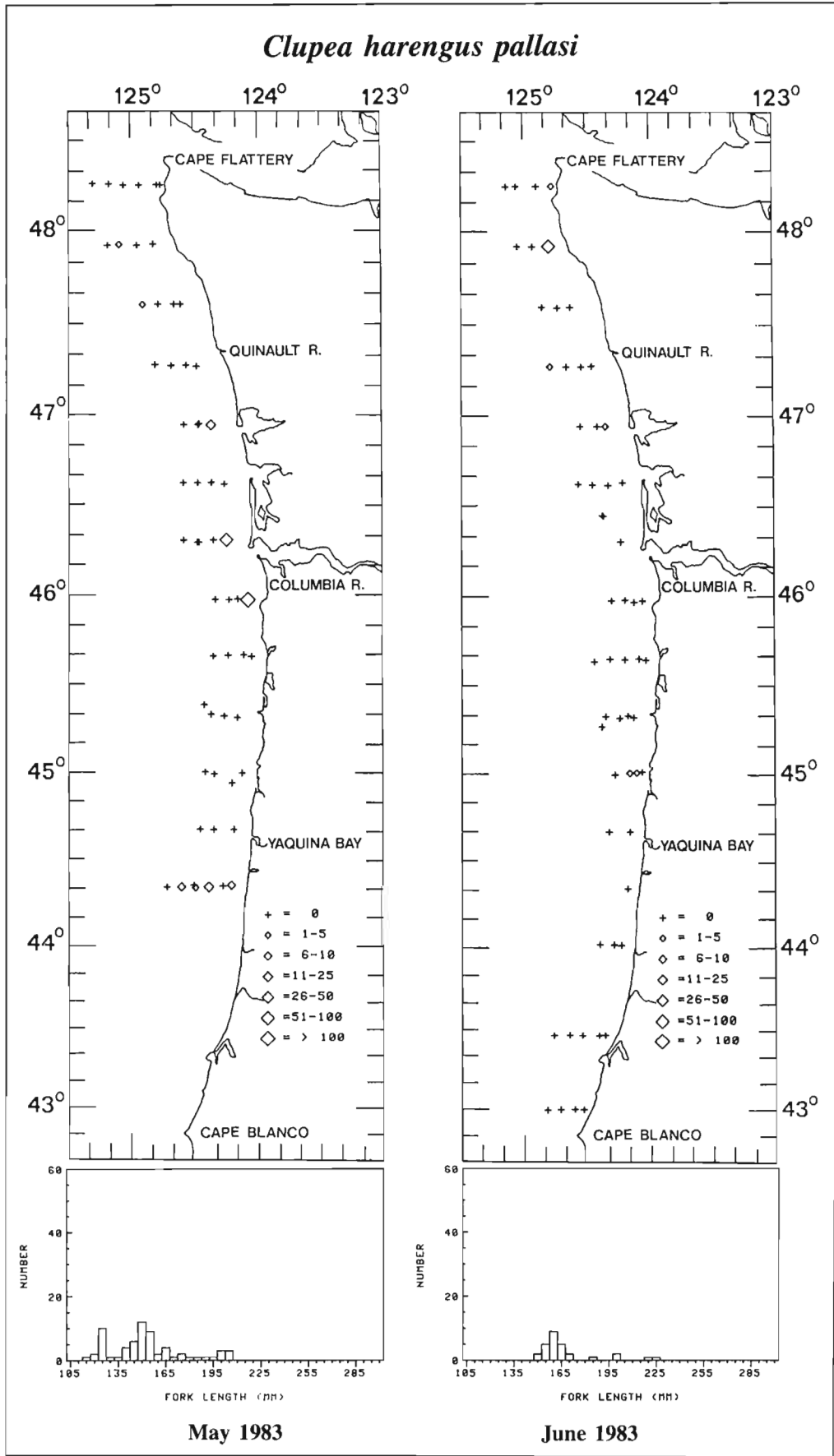


Figure 34

*Clupea harengus pallasii*

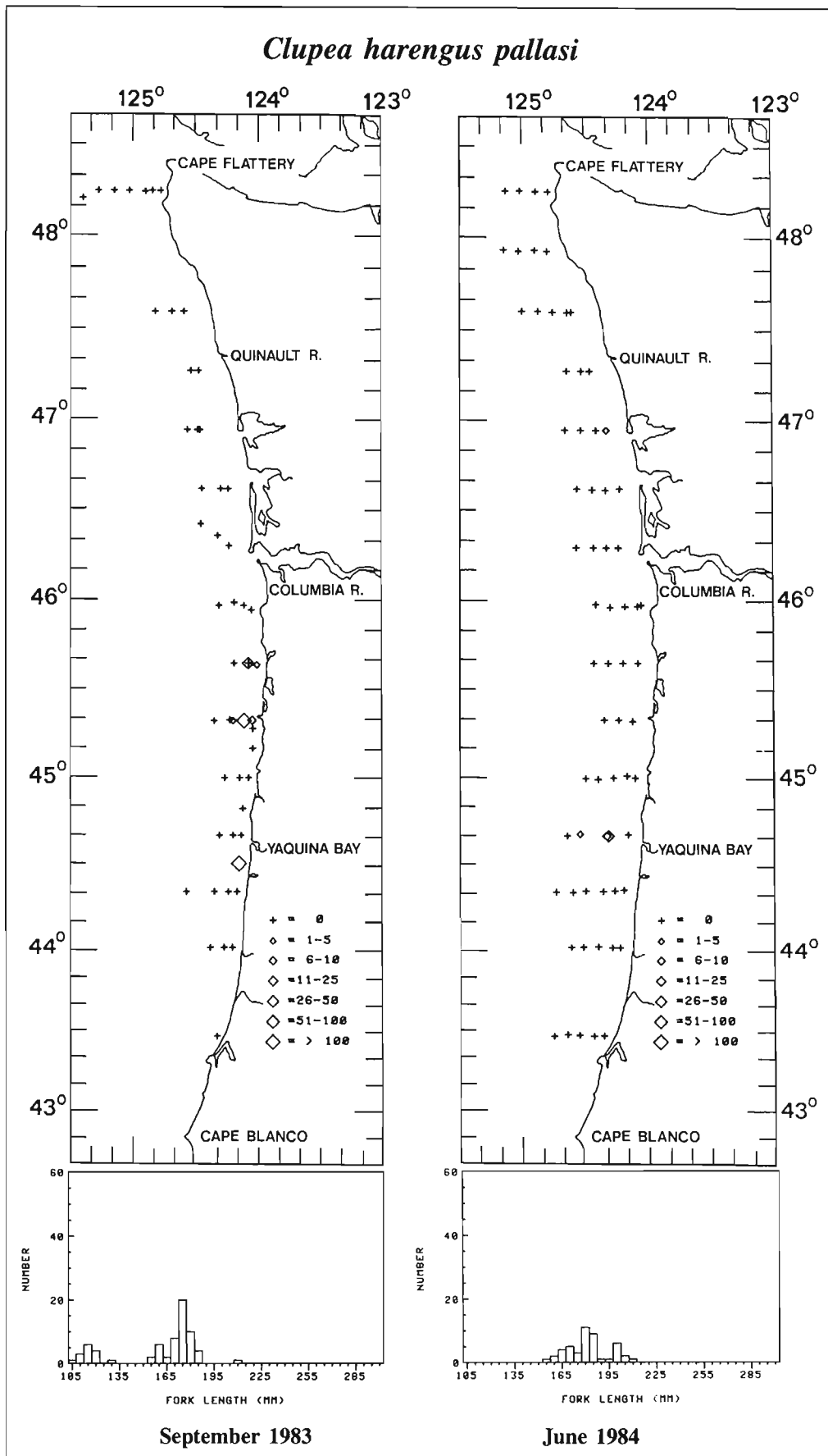


Figure 35

*Clupea harengus pallasii*

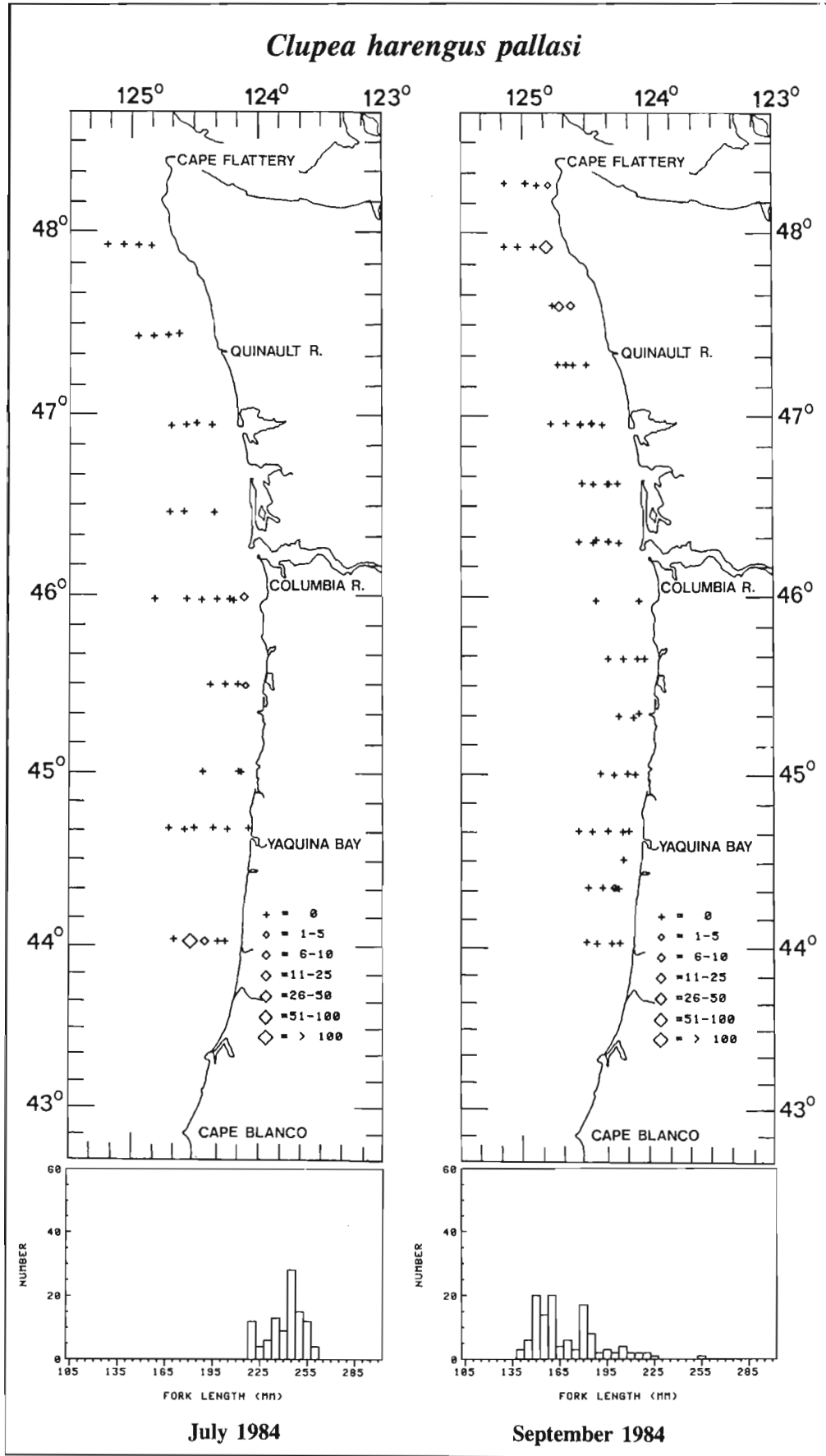


Figure 36

*Engraulis mordax*

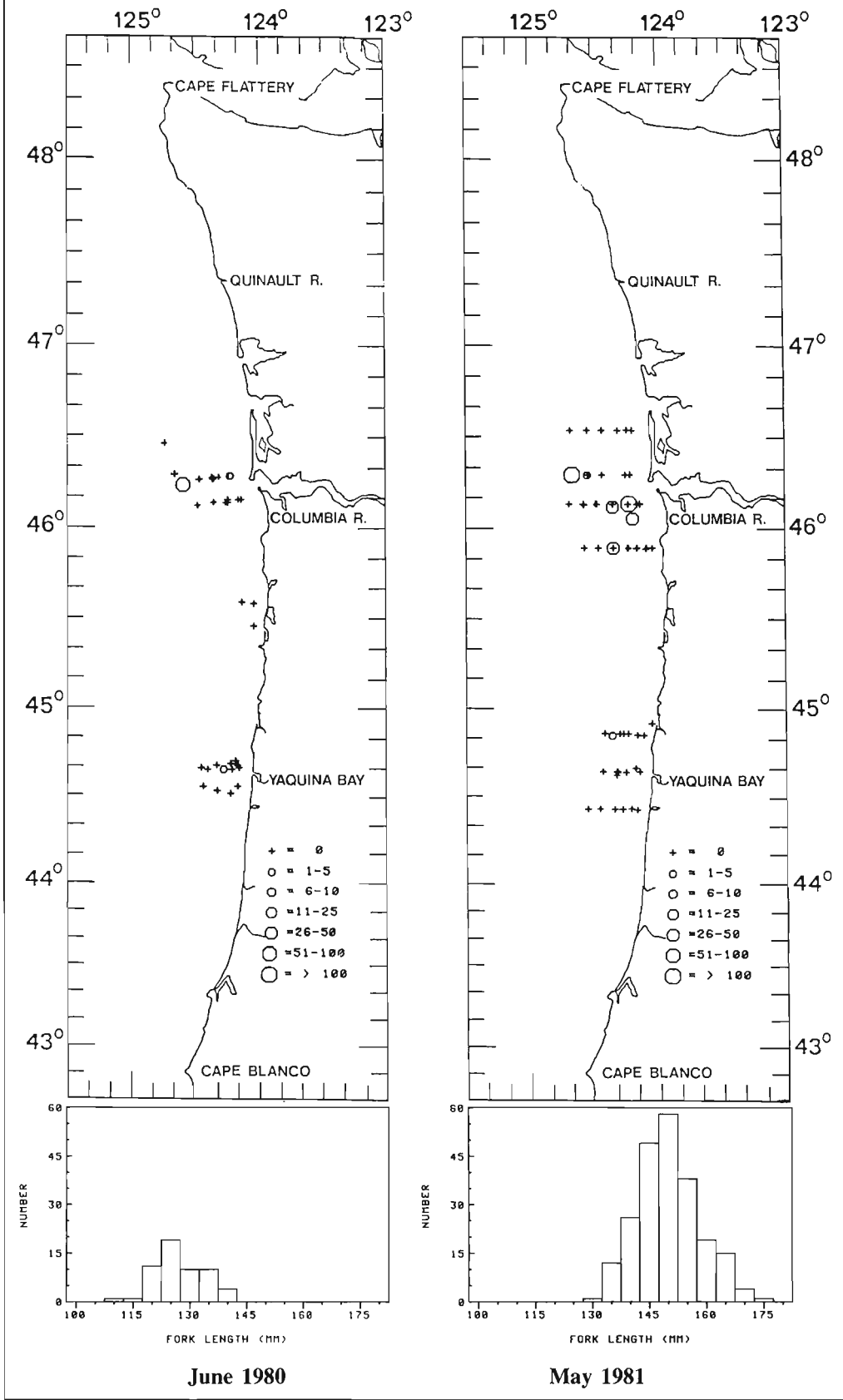


Figure 37

*Engraulis mordax*

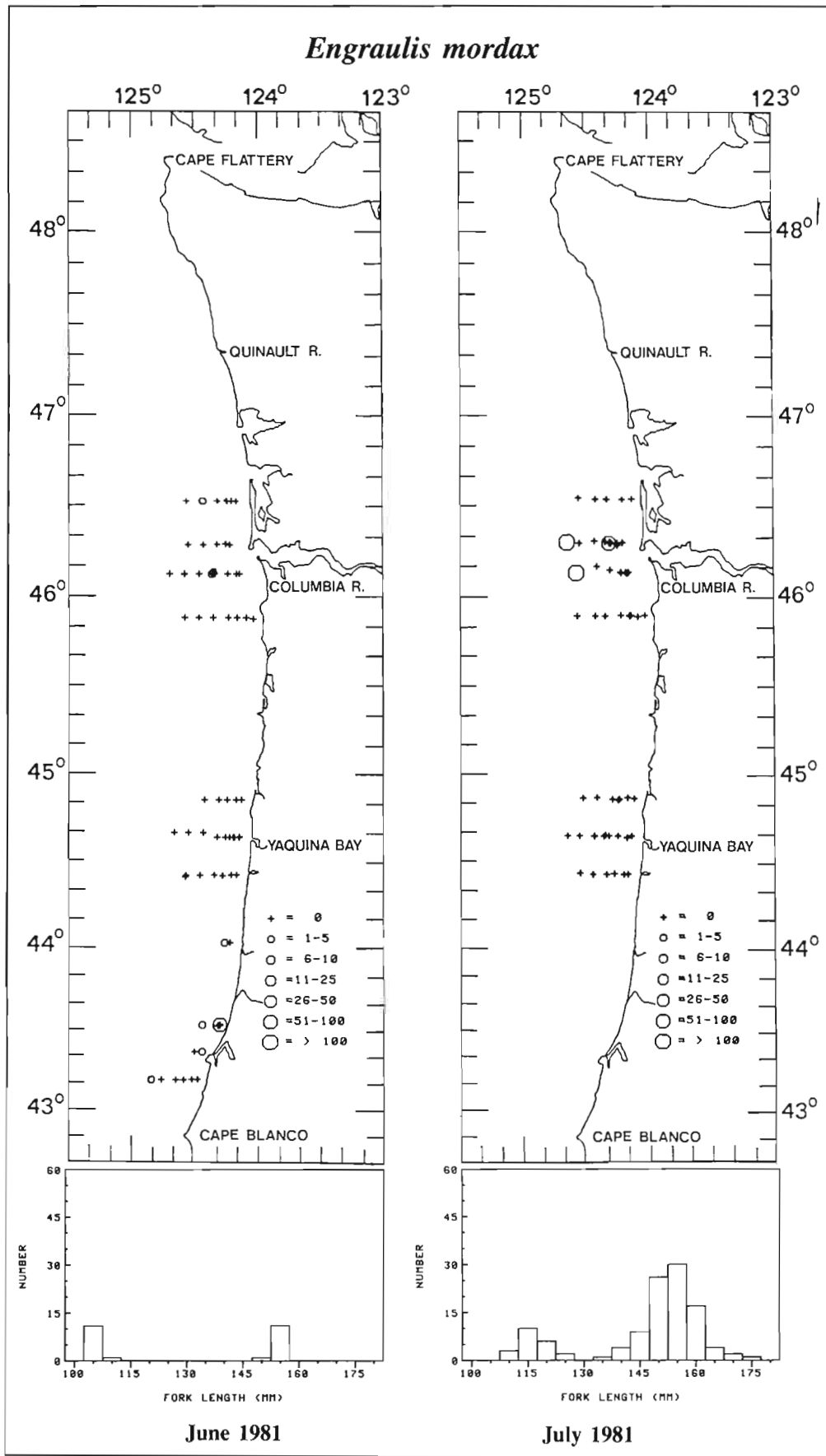


Figure 38

*Engraulis mordax*

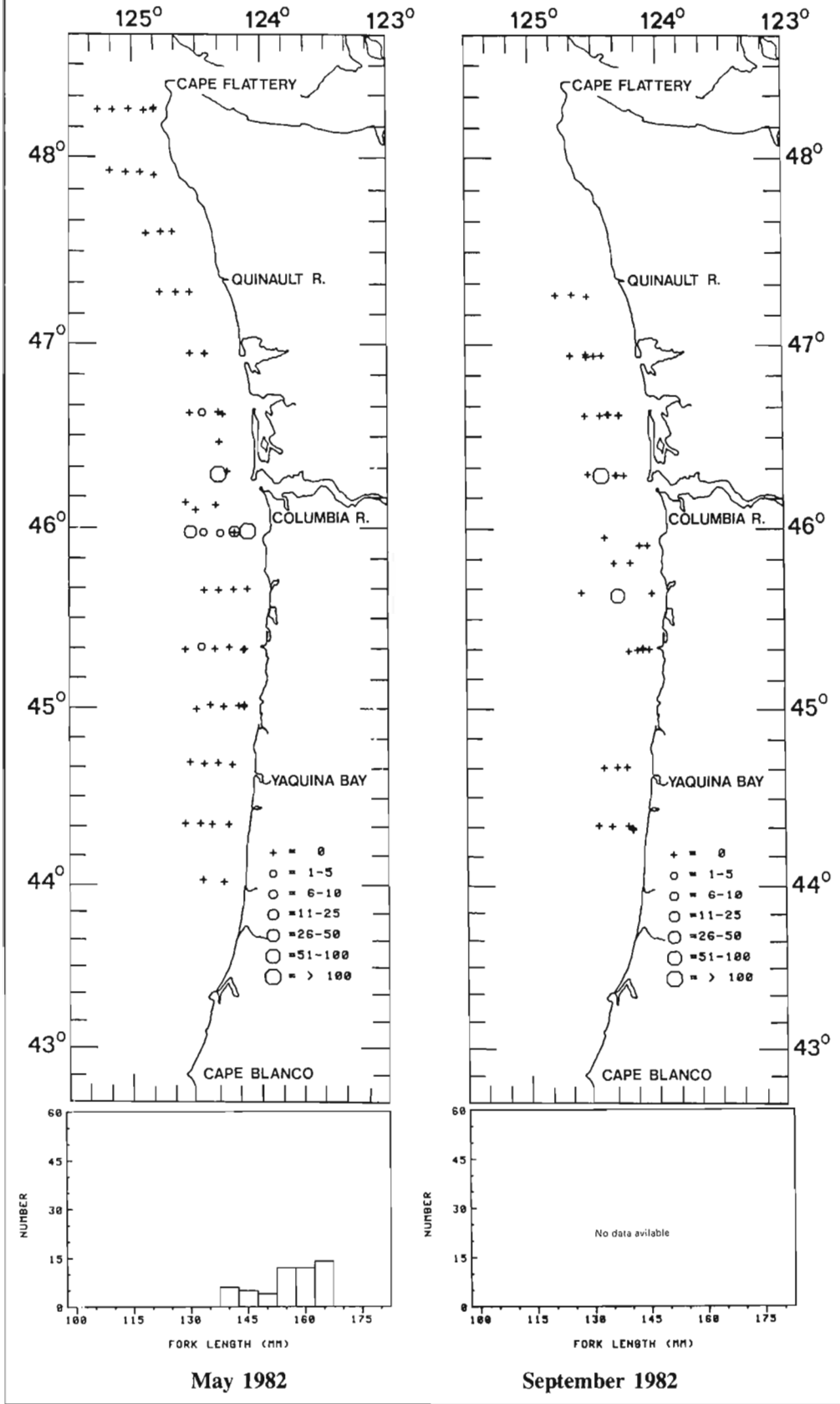


Figure 39

*Engraulis mordax*

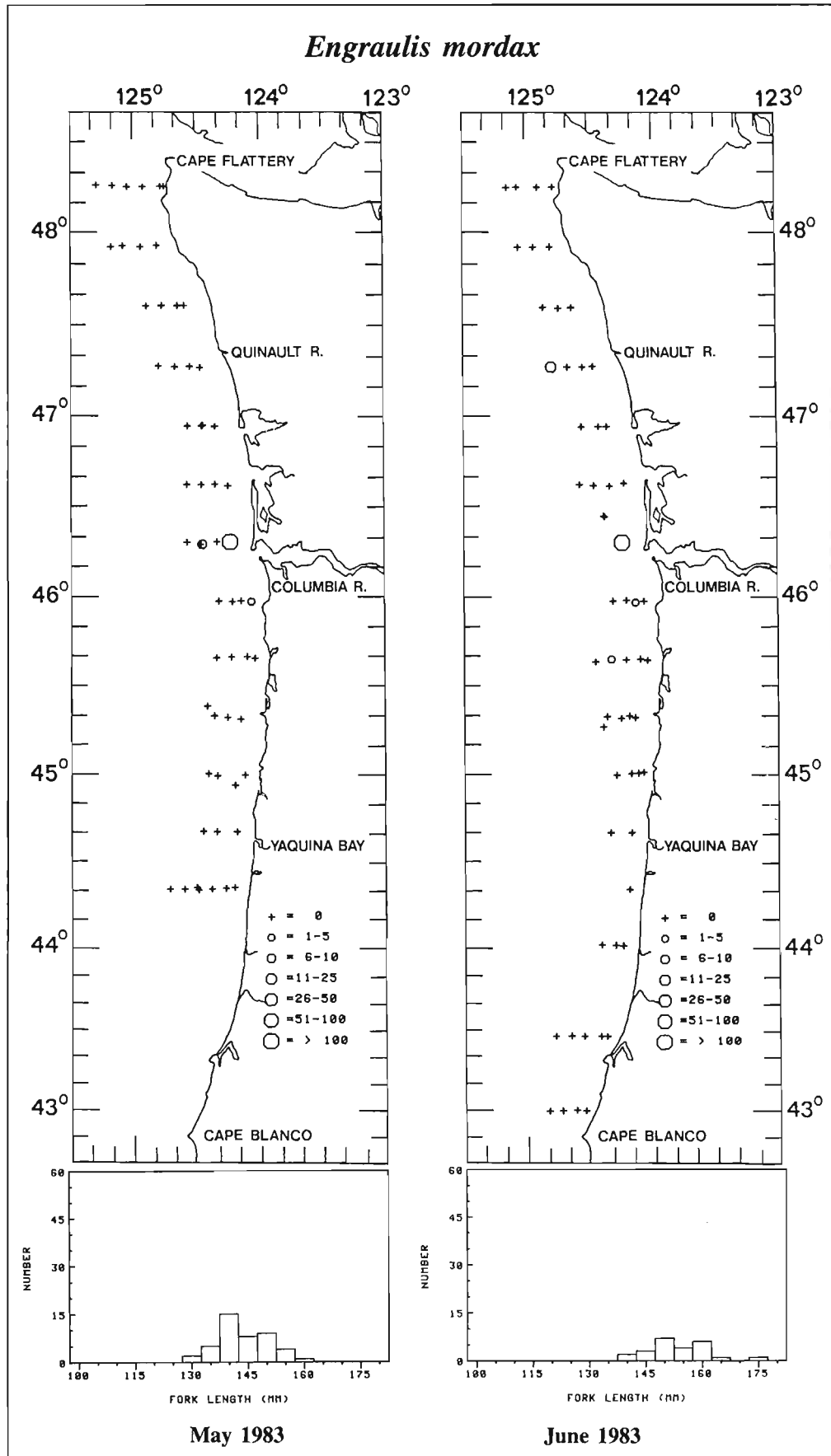


Figure 40

*Engraulis mordax*

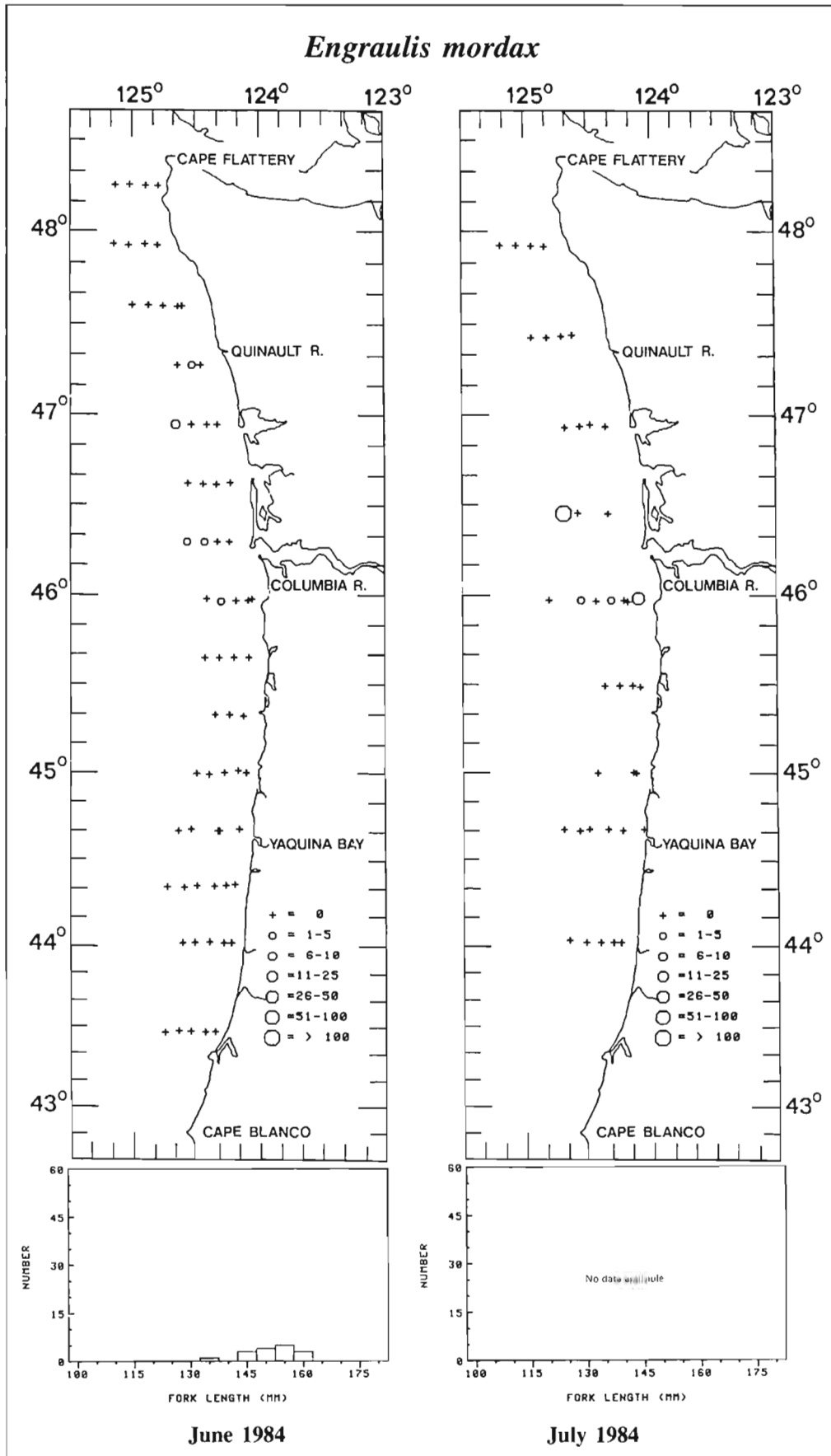


Figure 41





*Merluccius productus*

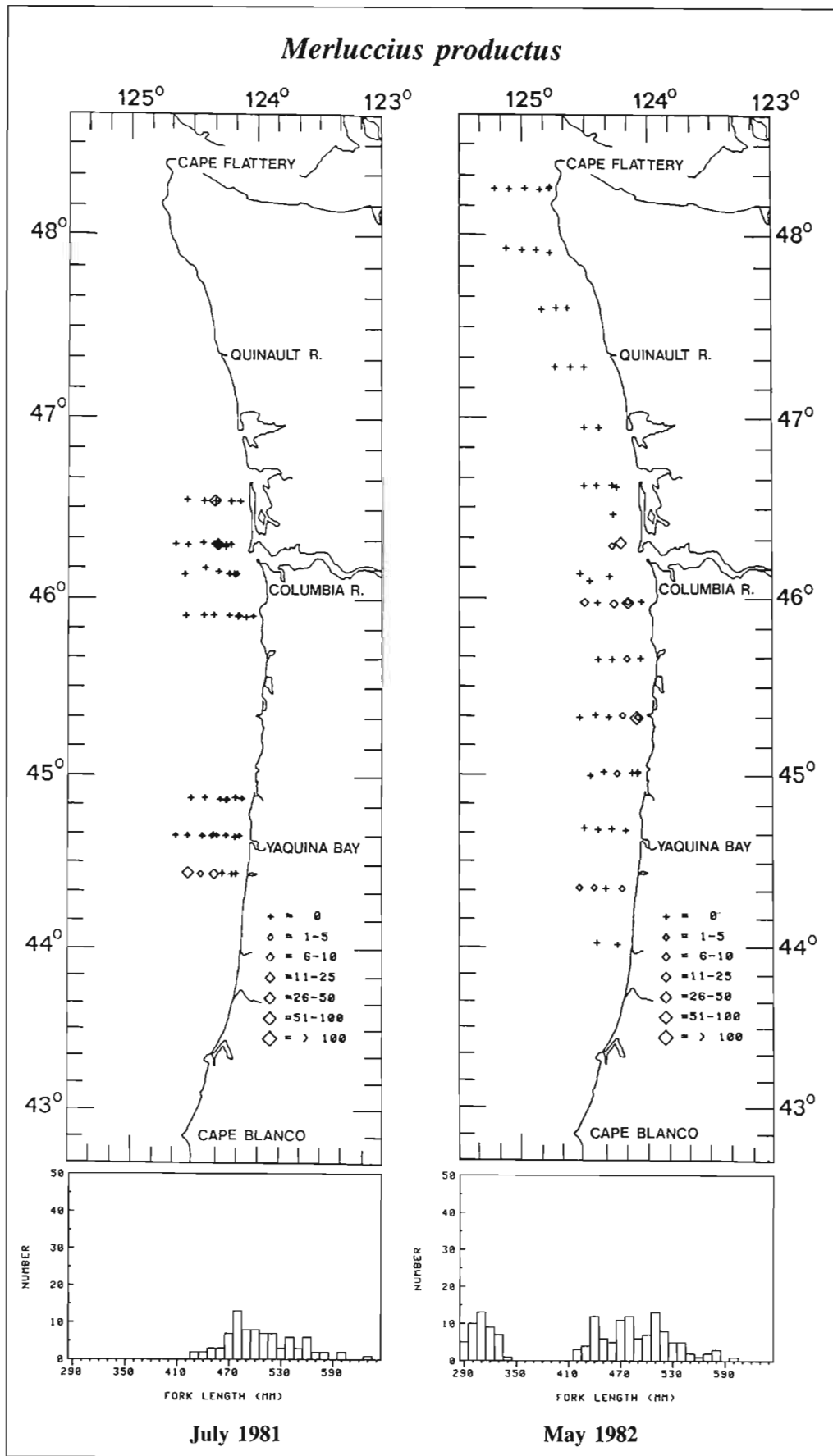


Figure 43

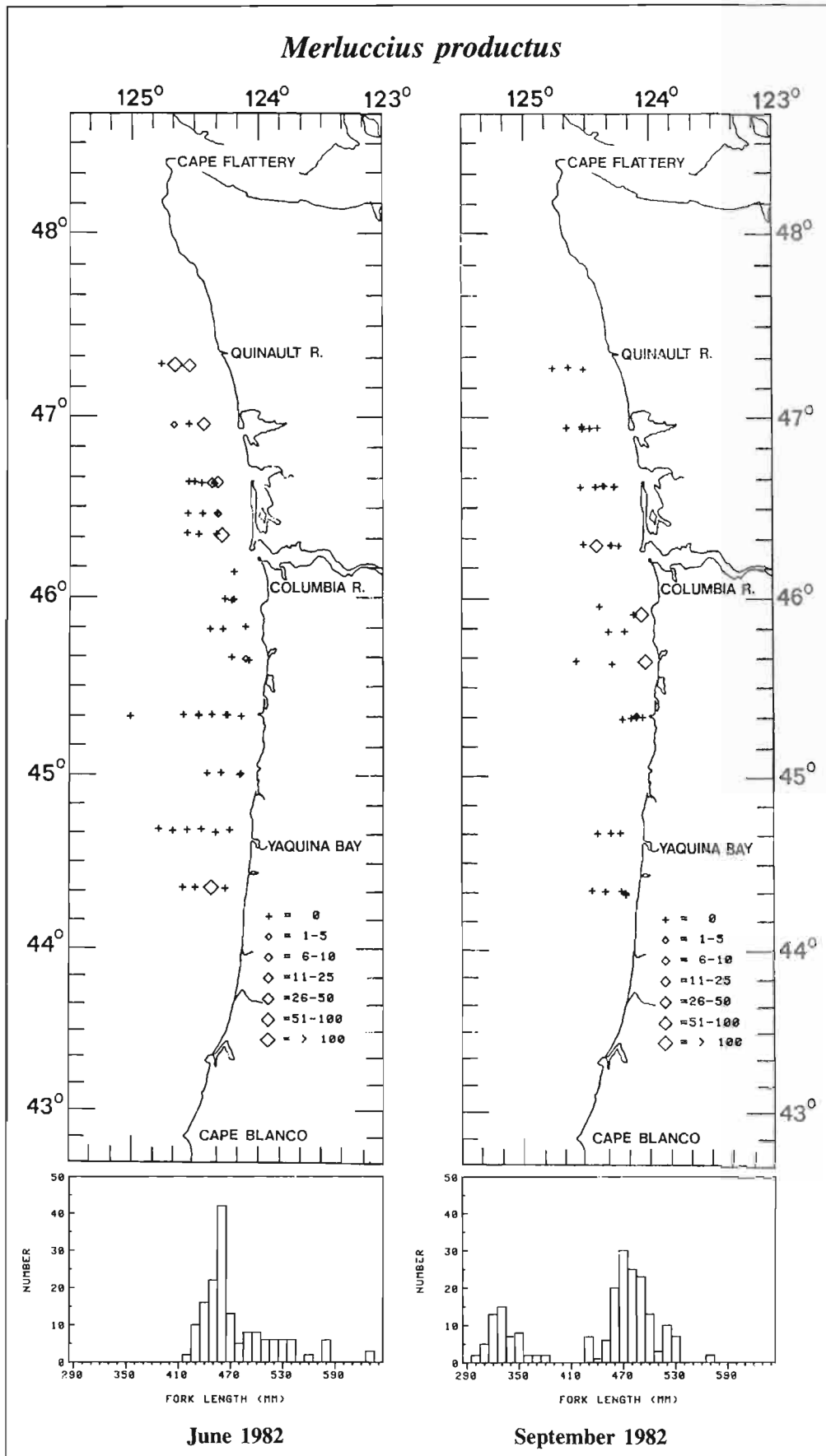


Figure 44

*Merluccius productus*

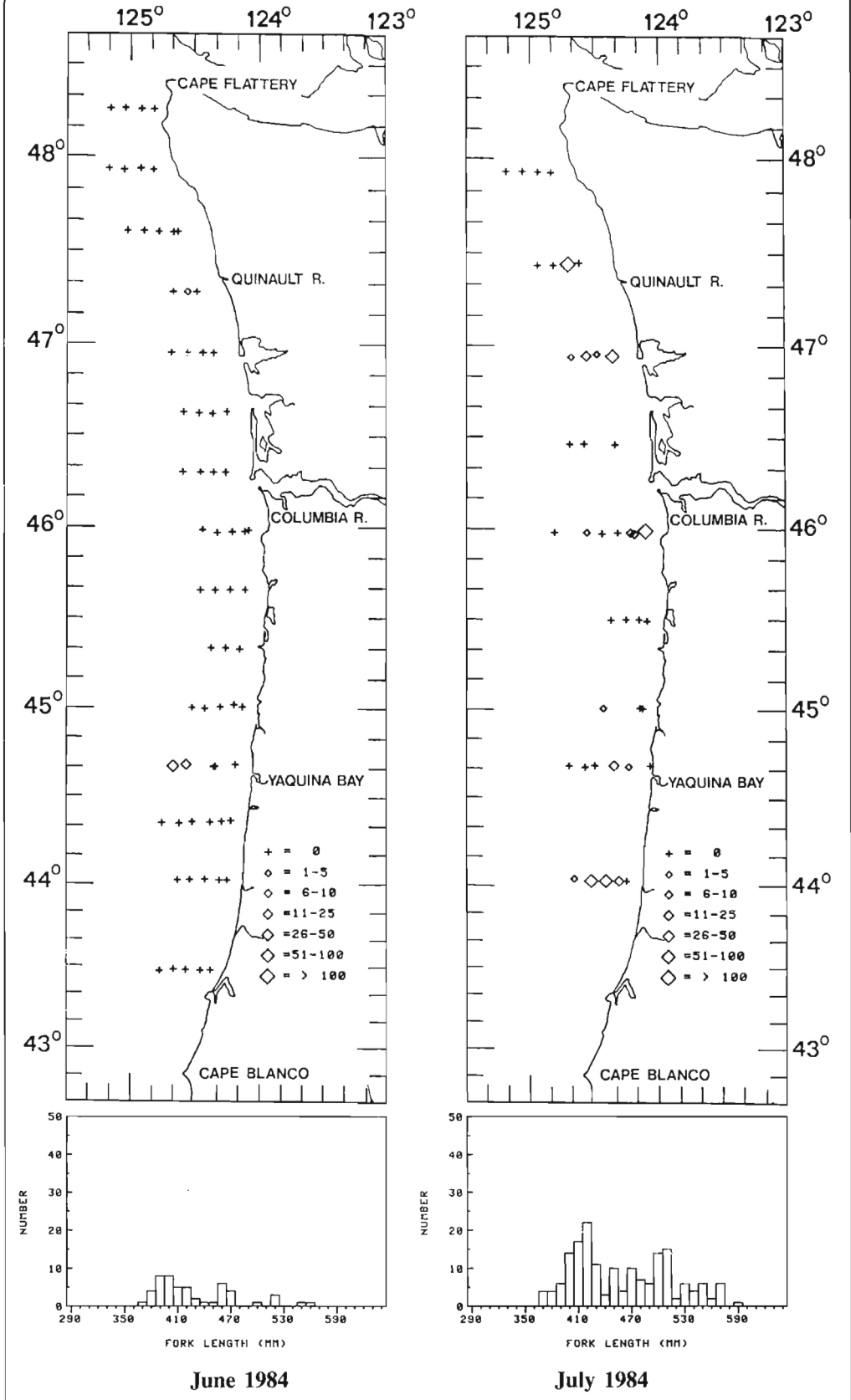


Figure 45

*Merluccius productus*

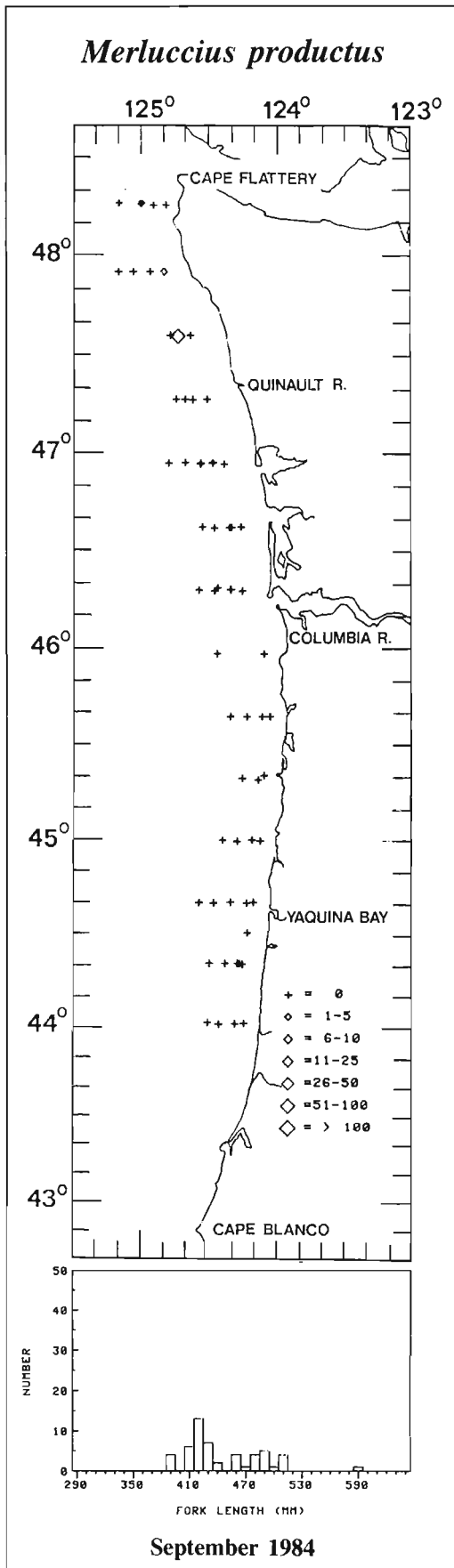


Figure 46

*Cololabis saira*

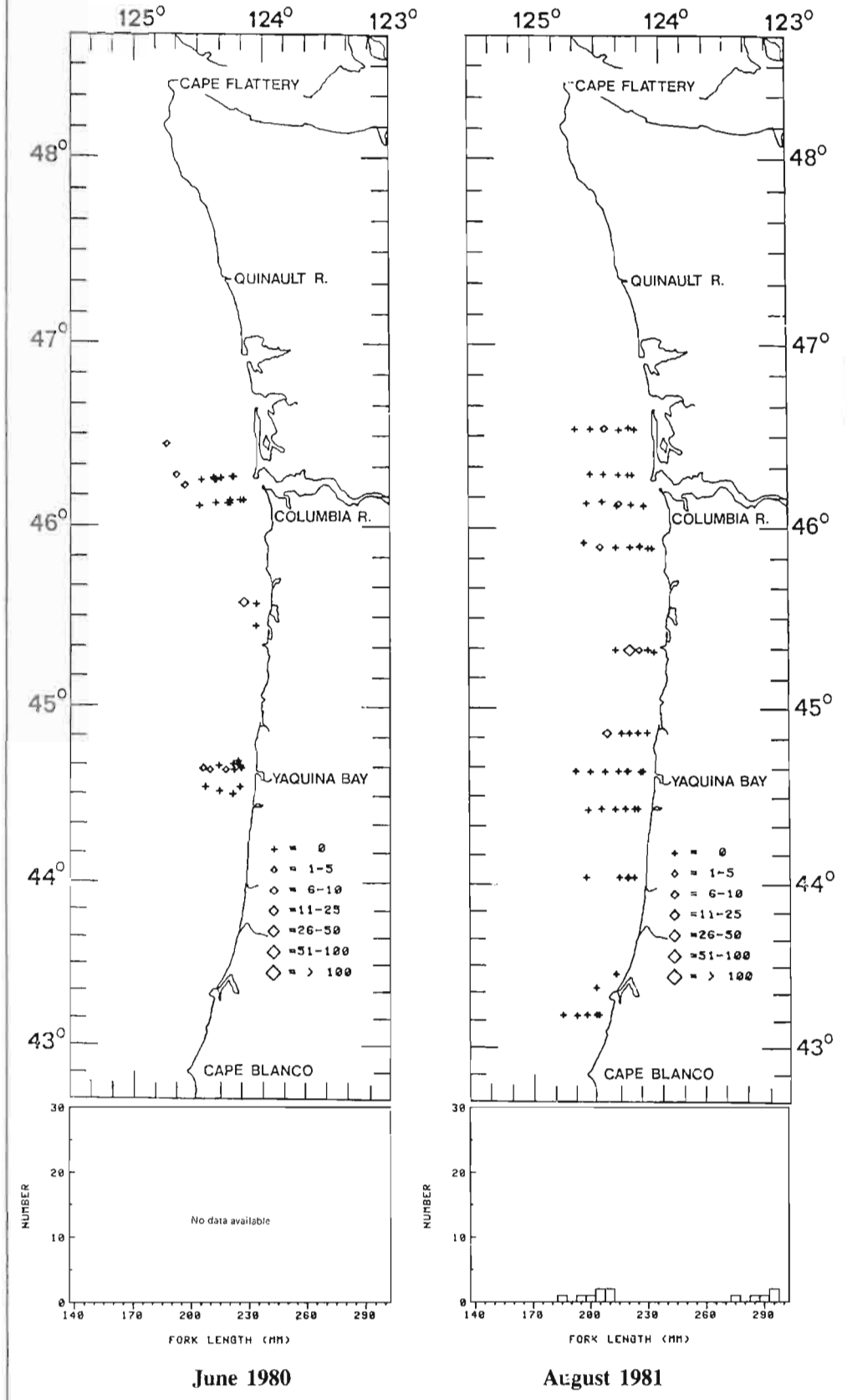


Figure 47

*Cololabis saira*

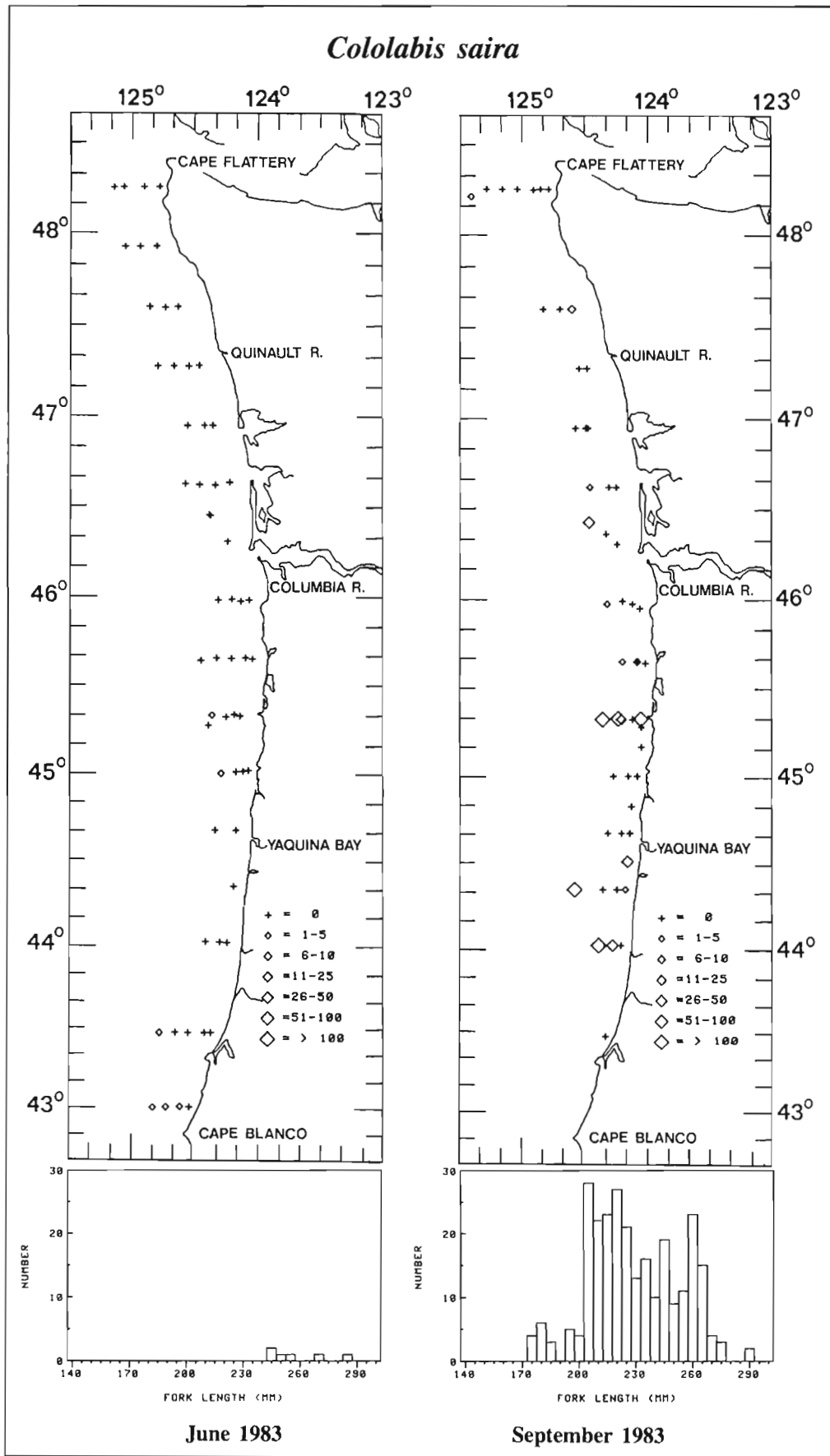


Figure 48

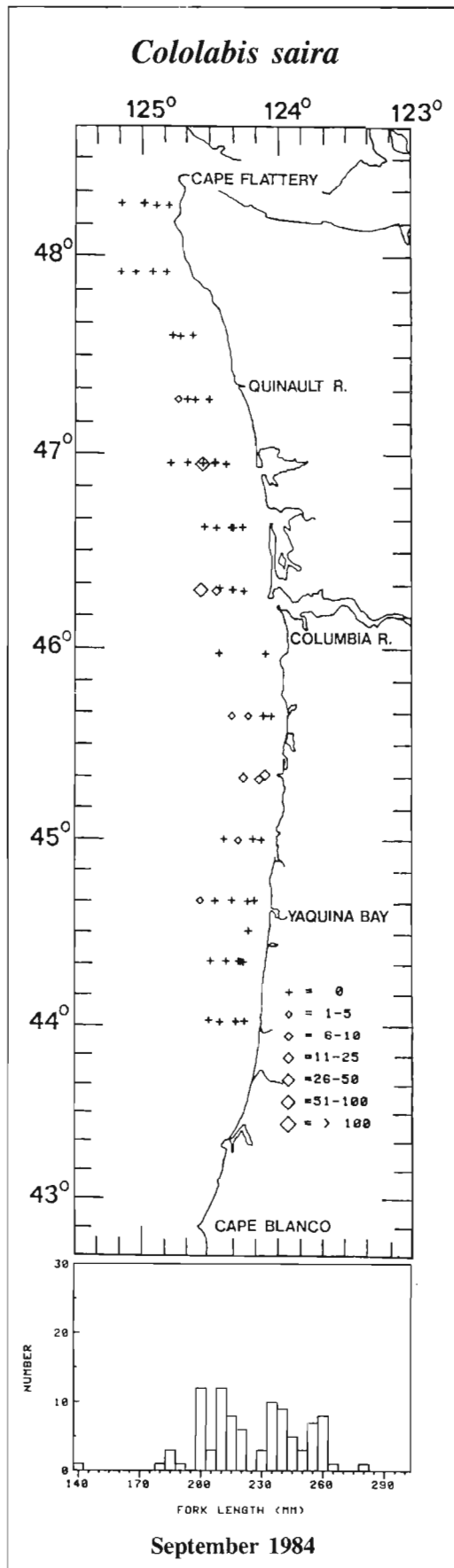


Figure 49



*Anoplopoma fimbria*

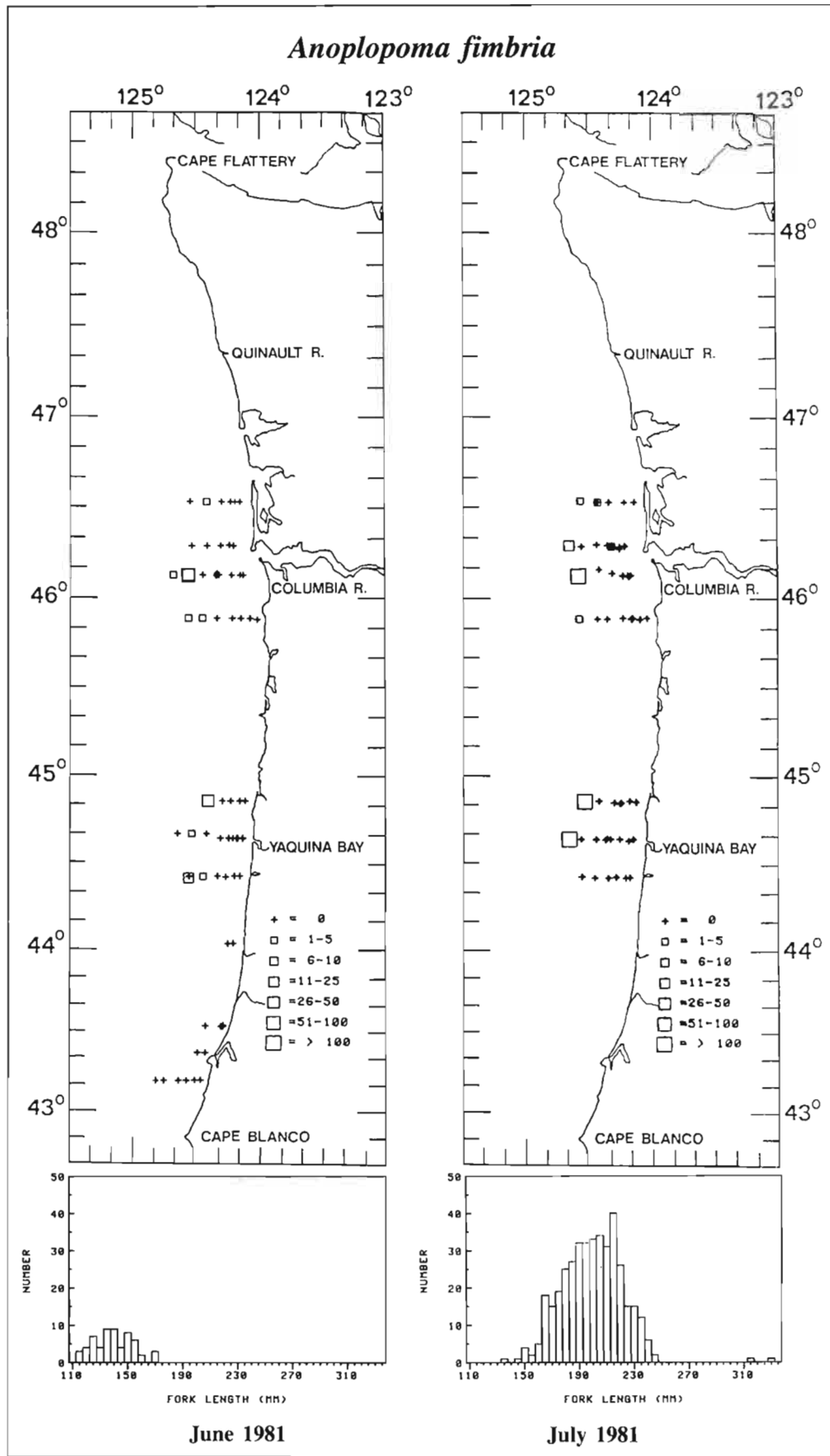


Figure 50

*Anoplopoma fimbria*

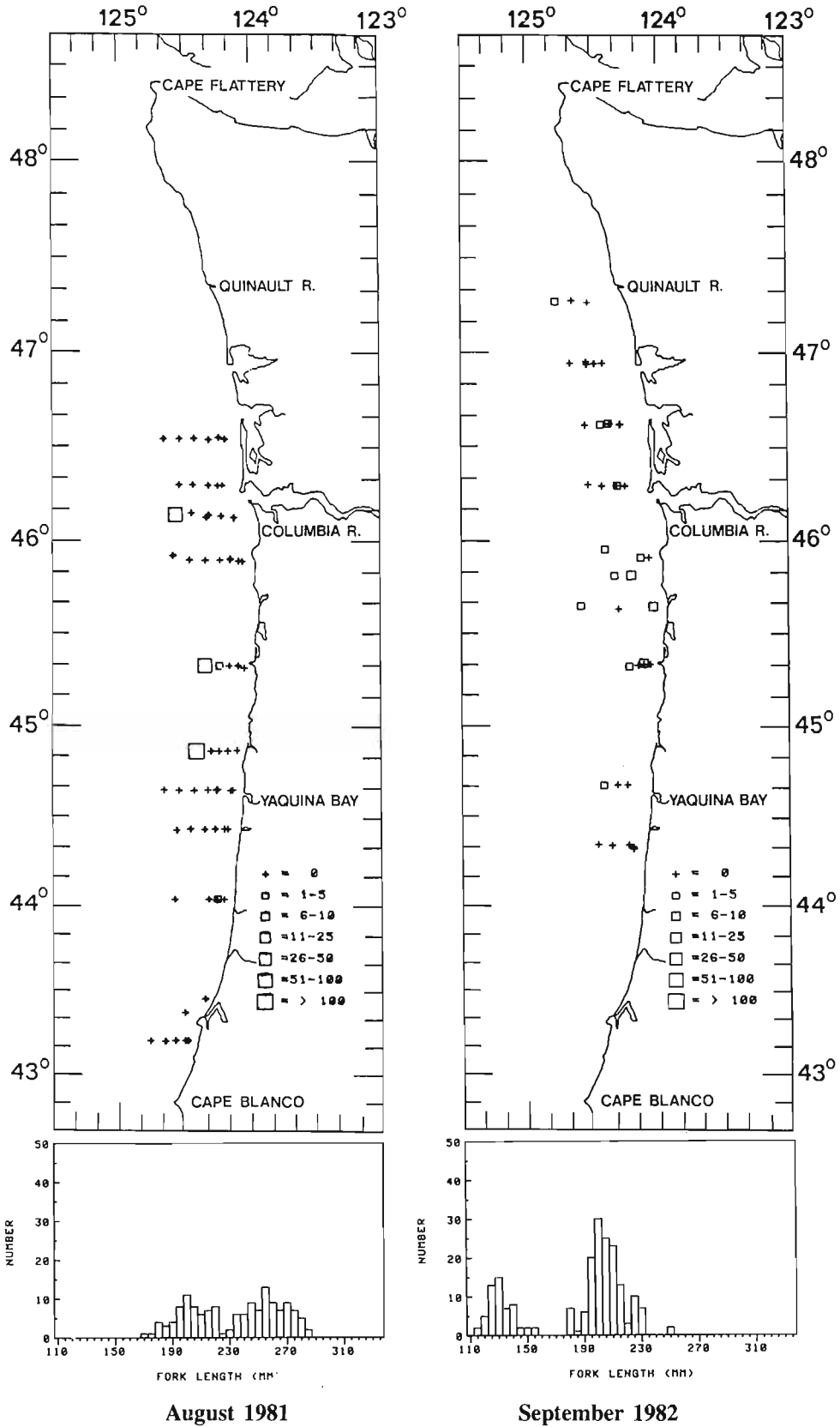


Figure 51

*Anoplopoma fimbria*

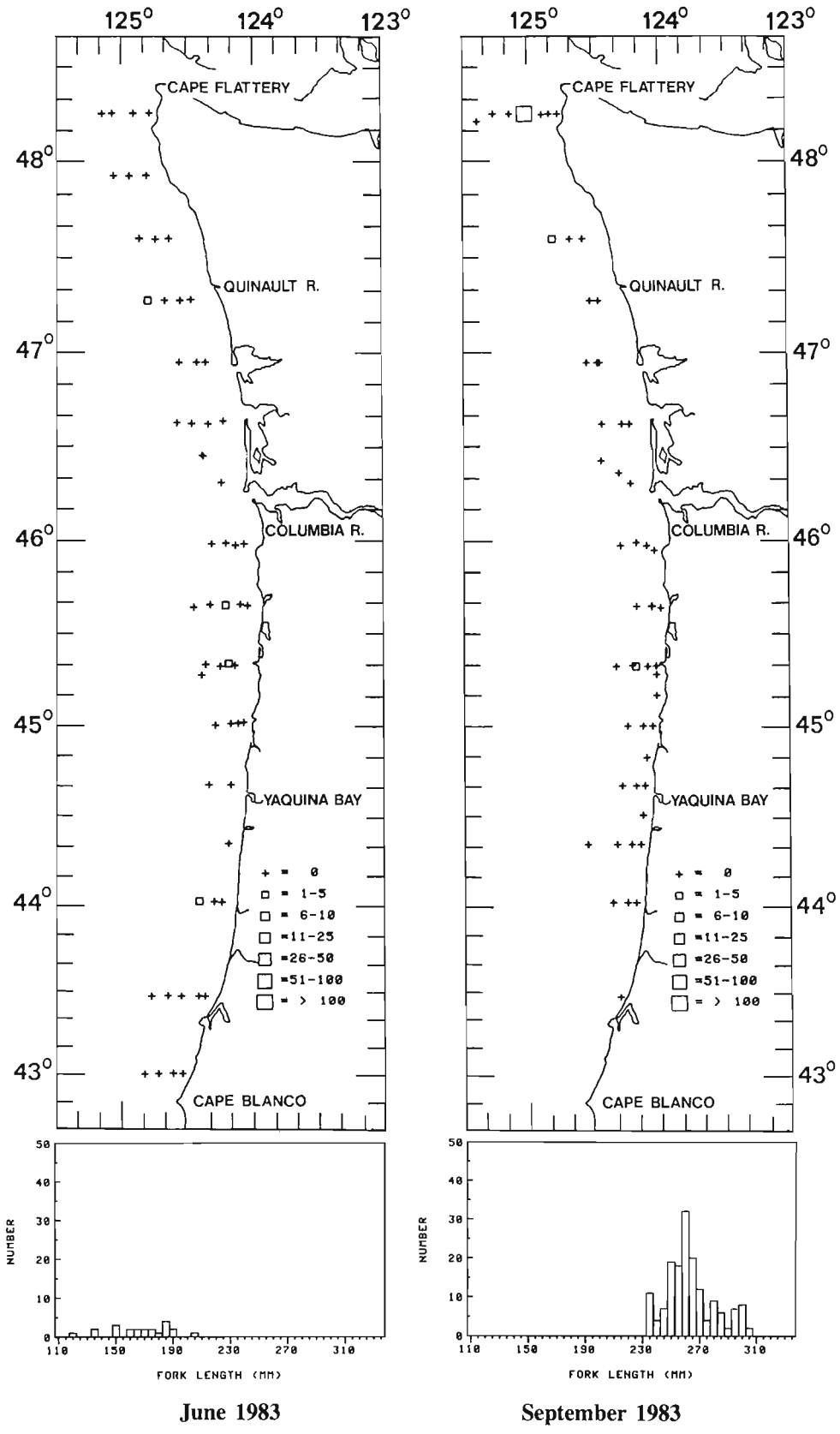


Figure 52

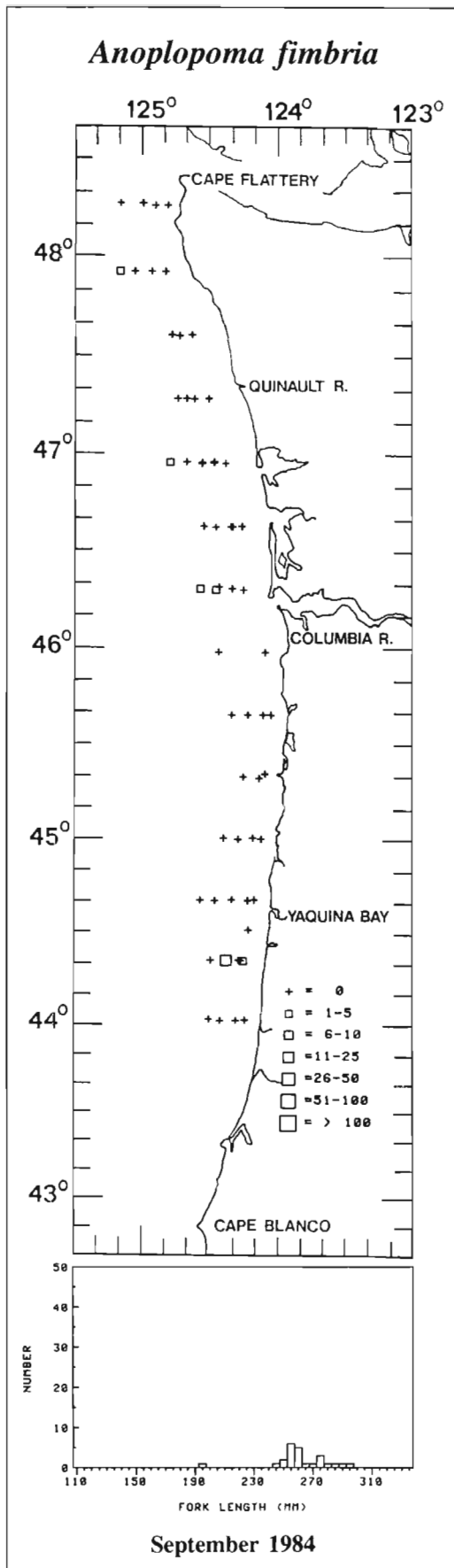


Figure 53

*Trachurus symmetricus*

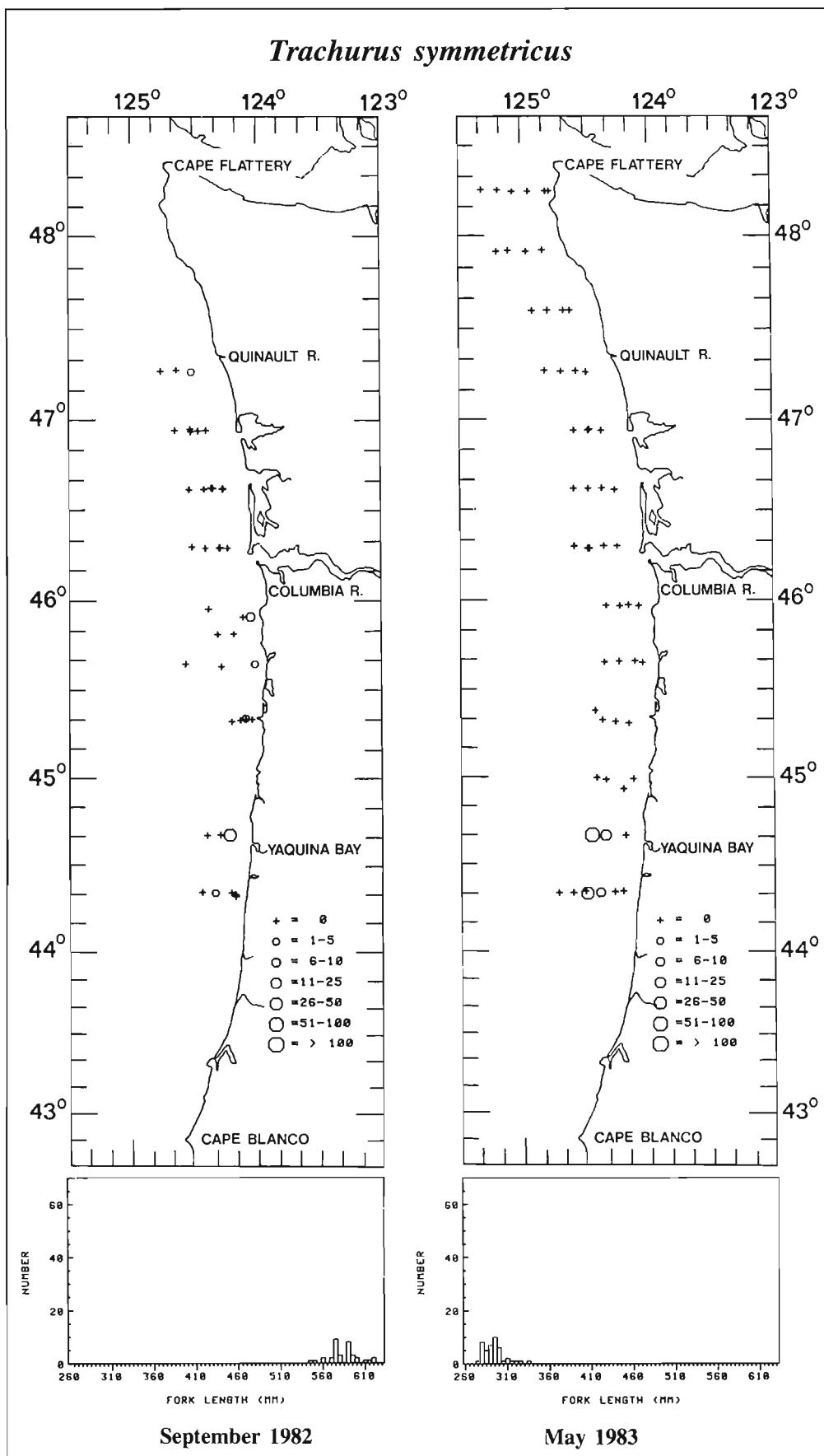
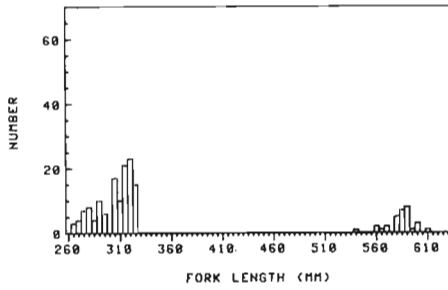
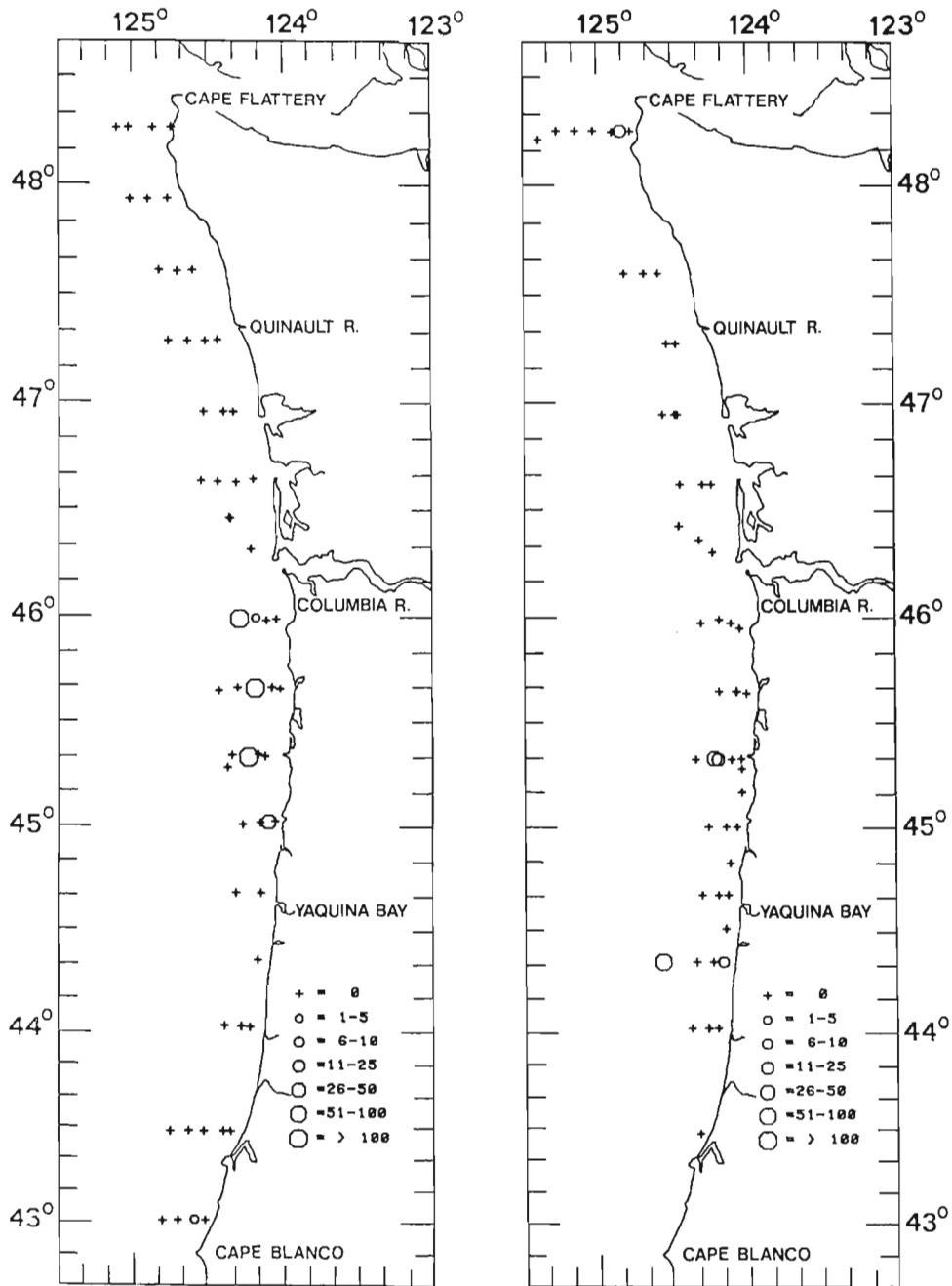
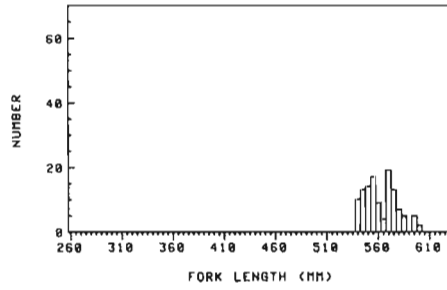


Figure 54

*Trachurus symmetricus*



June 1983



September 1983

Figure 55

*Trachurus symmetricus*

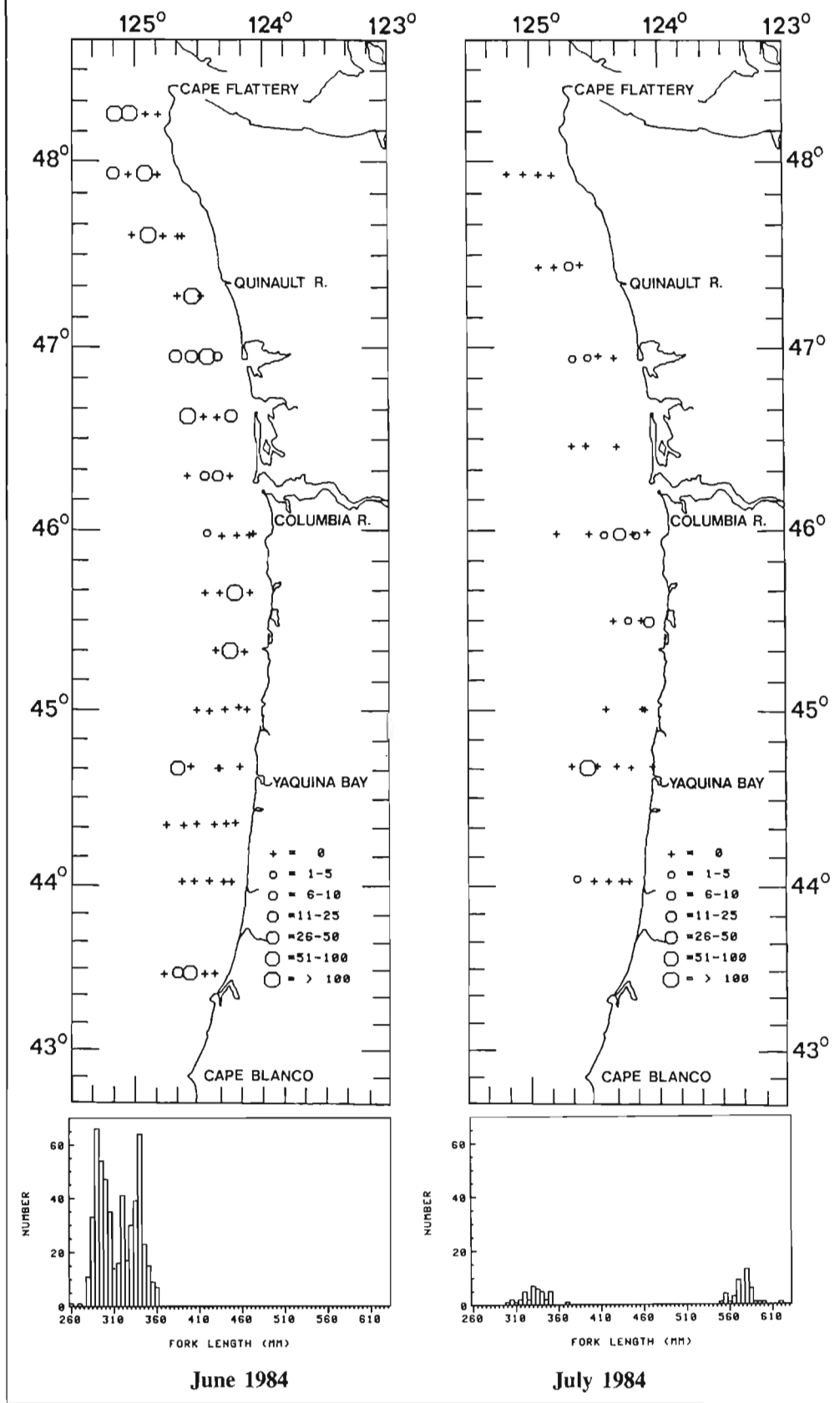


Figure 56

*Scomber japonicus*

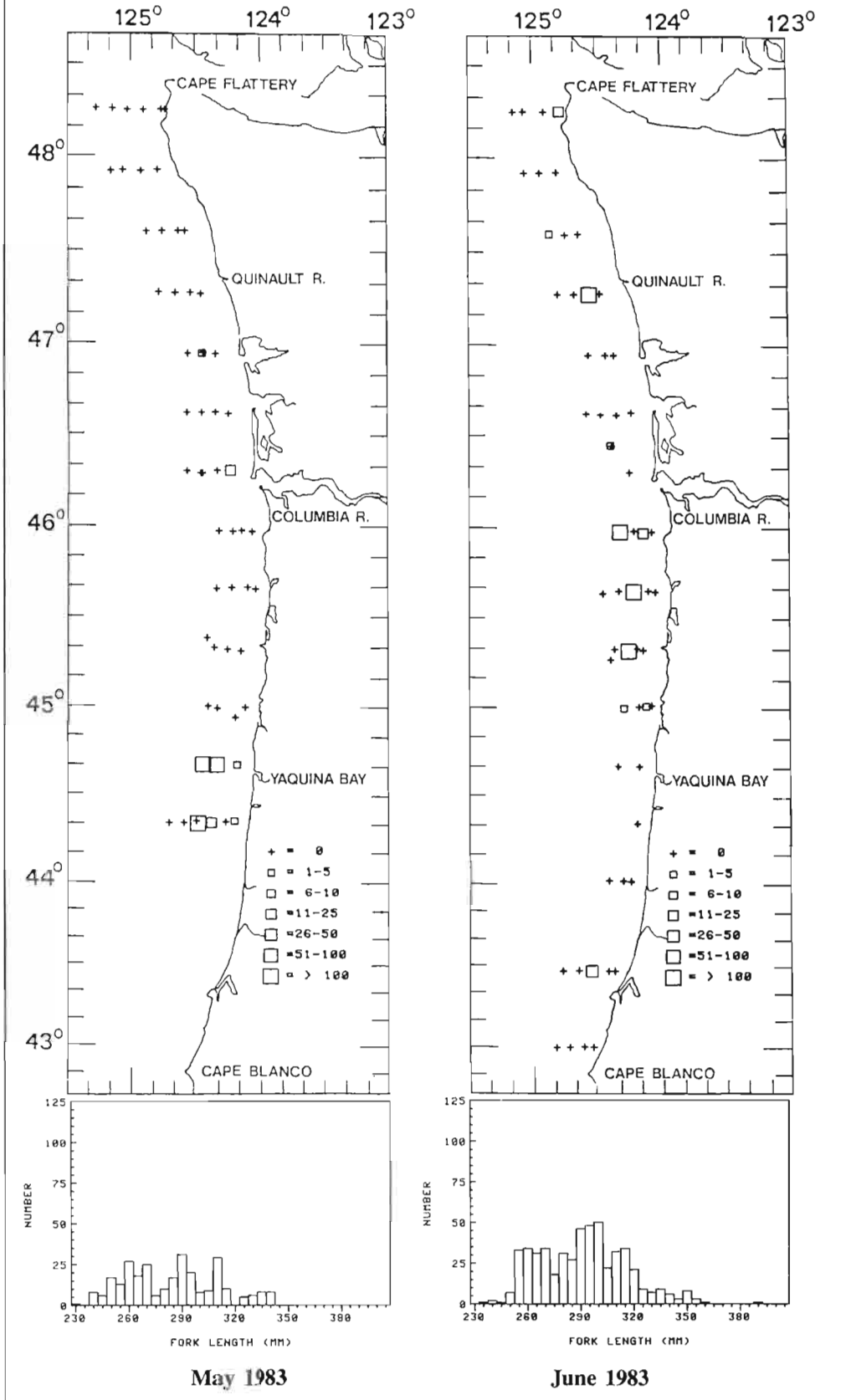


Figure 57



*Scomber japonicus*

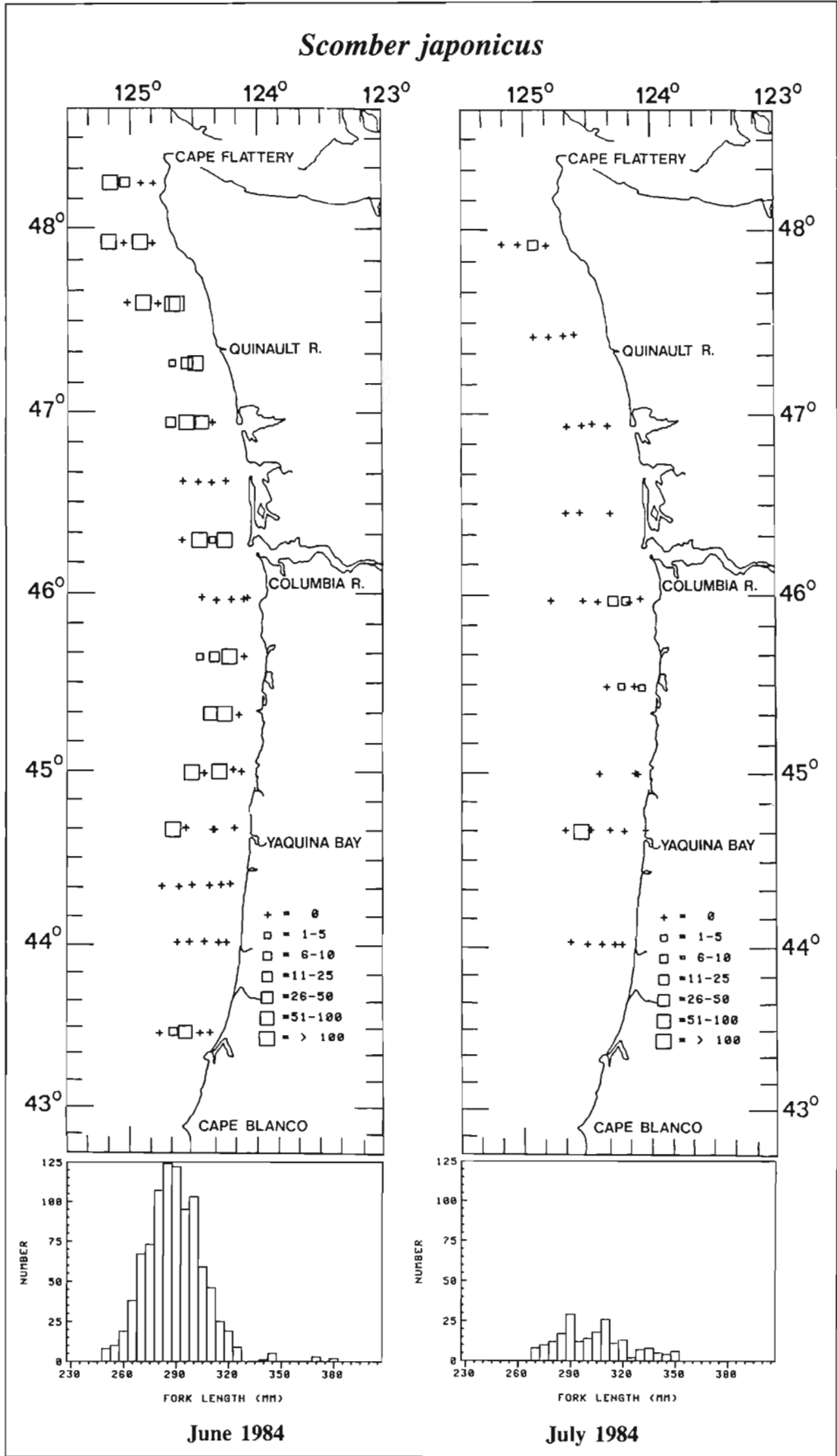
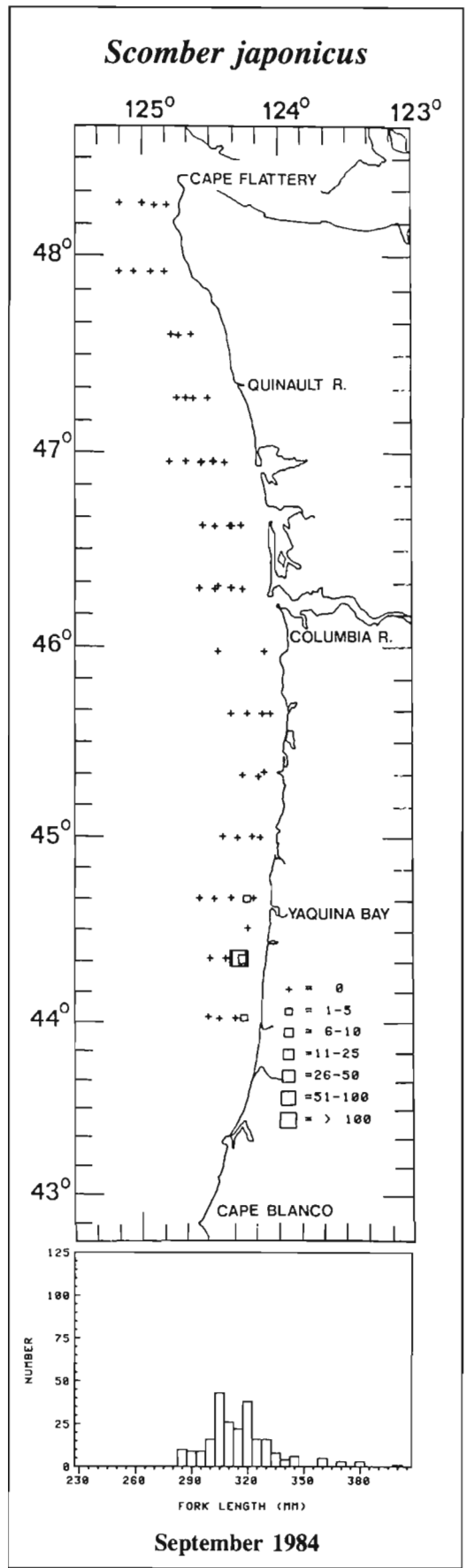
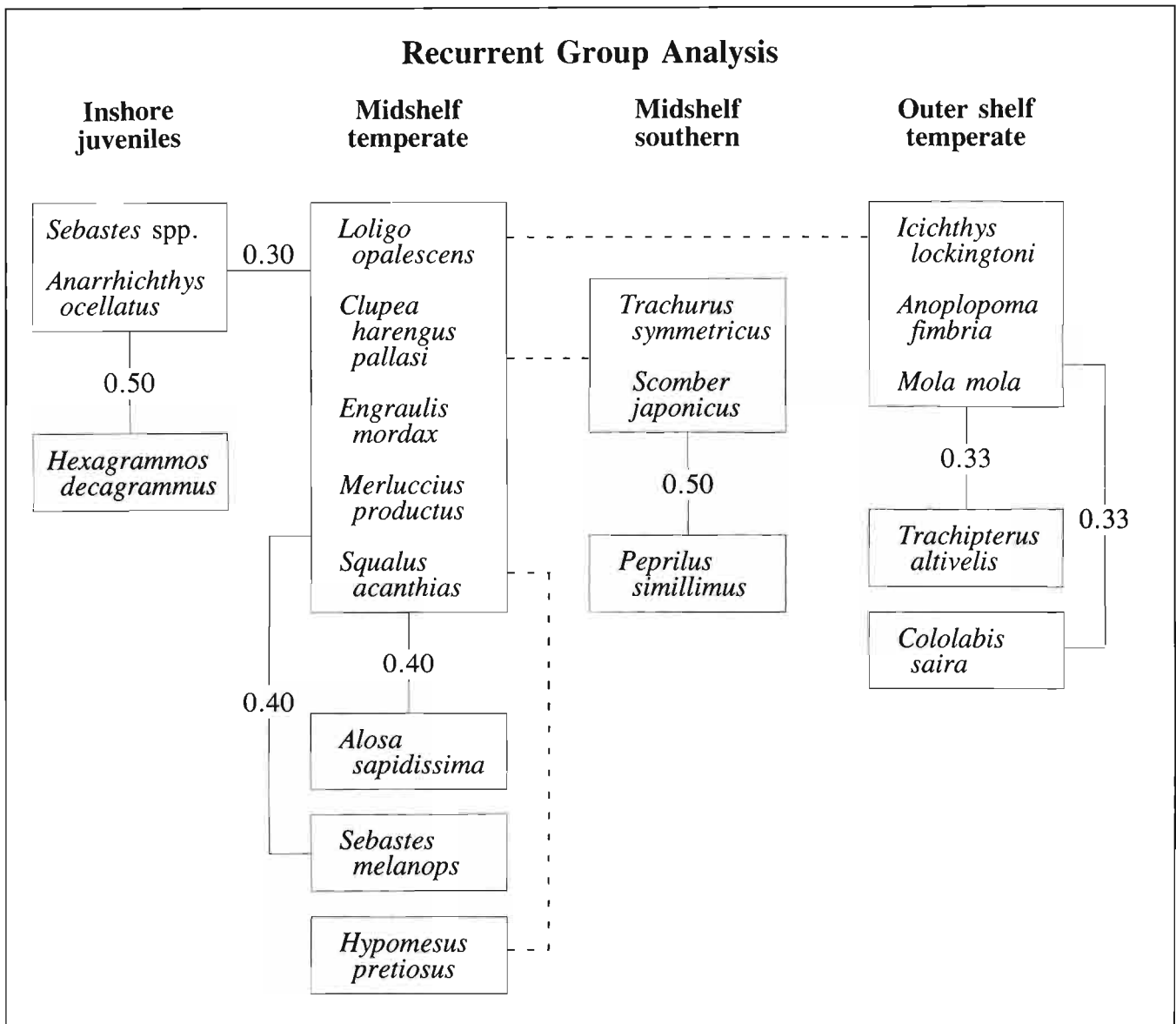


Figure 58



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

Appendix Table 3—Continued.

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

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)	Salinity (‰)	Chlorophyll <i>a</i> (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					



Appendix Table 4—Continued.

Set	Date	Lat. (N)	Long. (W)	Off-shore (km)	Depth (m)	Time at start	Temp. (°C)	Salinity (‰)	Chlorophyll <i>a</i> (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)	Salinity (‰)	Chlorophyll <i>a</i> (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°33'	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	45°39'	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.

Appendix Table 5—Continued.

Set	Date	Lat. (N)	Long. (W)	Off-shore (km)	Depth (m)	Time at start	Temp. (°C)	Salinity (‰)	Chlorophyll <i>a</i> (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)	Salinity (‰)	Chlorophyll <i>a</i> (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°00'	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	

Appendix Table 6—Continued.

Set	Date	Lat. (N)	Long. (W)	Off- shore (km)	Depth (m)	Time at start	Temp. (°C)	Salin- ity (‰)	Chloro- phyll <i>a</i> (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 84-109; 1520

81-090; 1590 84-124; 1580

82-139; 1420 84-168; 1530

82-143; 1830 84-169; 1625

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

*Prionace glauca* (Linnaeus), blue shark

80-020; 1370,1570 82-165; 1370,1520

81-141; 1190 83-123; 1980

81-195; 1170 83-163; 1310

81-196; 1170,1660 83-164; 1320

81-200; 1750 83-165; 940

81-209; 1250 83-166; 1490,1450

81-215; 1170 83-167; 1540,1930

81-217; 1310 83-172; 1350

81-223; 1780 84-100; 1115

81-232; 1750 84-101; 1040,1880

81-249; 920,1520 84-110; 2 - NLA

81-267; 1520 84-160; 1830

81-273; 950 84-167; 1440

82-055; 1740 84-171; 1525

82-154; 1520 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 83-152; 312,318,408

79-016; 400 83-153; 235,392,435

79-023; 419,462,470,480 84-030; 350,351,355,360,

79-043; 484 362,388,402,415,440

80-016; 2 - NLA 84-097; 425

80-018; 3 - NLA 84-114; 357,9 (303-446)

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

Appendix Table 7—continued.

*Clupea harengus pallasii* 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; 54,54,55,55,56,57,59  
 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), striptail 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

**Anarrhichadidae**

*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, prowlfish (total length)  
82-155; 200

**Ammodytidae**

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

**Scombridae**

*Sarda chilensis* (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

Appendix Table 7—continued.

**Icosteidae**

*Icosteus enigmaticus* 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